Solar Energy and the Problem of Path Dependency in Costa Rica's Energy System

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List of Abbreviations

ACESOLAR	Costa Rican Solar Energy Association
ACOPE	Costa Rican Association of Private energy Producers
ARE	Alternative Renewable Energy
ARESEP	Public Service Regulation Authority
BOT	Build Operate Transfer
BUN-CA	Energy Network Foundation
CABEI	Central American Bank for Economic Integration
CAFTA	Central American Free Trade Agreement
CDM	Clean Development Mechanism
CICR	Industrial Chamber of Costa Rica
CM	Causal Mechanism
CNFL	National Company of Energy and Lighting
DEG	Distributed Electricity Generation
DSE	Energy Sector Directorate
EEG	German Renewable Energy Act
EIAs	Environmental Impact Assessment
ESPH	Public Service Company of Heredia
EUISS	European Union Institute for Security Studies
FINE	Research Project Financing Solutions for Innovation and Sustainable Development in the Energy Sector
FECON	Costa Rican Ecologist Foundation
FIT	Feed in Tariff
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GHG	Green House Gases
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit

GW	Giga Watt
GWP	Global Water Partnership
HP	Hydroelectric Plant
IAEA	International Atomic Energy Agency
ICE	Costa Rican Electricity Institute
ICOLD	International Commission on Large Dams
IDB	Inter-American Development Bank
IEA	International Energy Agency
IFI	International Financial Institution
ILO	International Labor Organization
INTECO	Technical Norms Institute of Costa Rica
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
JI	Joint Implementation
LAWEA	Latin American Wind Energy Association
LNG	Liquid Natural Gas
MER	Regional Electricity Market
MIDEPLAN	Ministry of Planning
MINAE	Ministry of Environment and energy
ML	Libertarian Movement Party
MREC	Ministry of Foreign Relations
MW	Mega Watt
NES	National Electric System
NGO	Non-Governmental Organization
NIS	National Interconnected System
OLADE	Latin American Energy Organization

OCIC	Joint Implementation Office of Costa Rica
PAC	Citizen Action Party
PES	Payment for Ecosystem Services
PLN	National Liberation Party
PUSC	Social Christian Unity Party
PV	Photovoltaic Technology
RECOPE	Costa Rican Oil Refinery
REN21	Renewable Energy Policy Network for the 21st Century
REP	Rural Electrification Program
ROR	Run-of-River
SETENA	National Environmental Technical Secretariat
SHS	Solar Home System
SIEPAC	Central American Energy Interconnection System
SINAC	National Conservation Areas System
SNE	National Electricity Service
UCCAEP	Costa Rican Union of Private Enterprise Chambers and Associations
UNDESA	United Nations Department of Economic and Social Affairs
UNFCC	United Nations Framework Convention on Climate Change
UNDP	United Nations Development Program
WBGU	German Advisory Council on Climate Change
WB	World Bank
WCD	World Commission on Dams

Part I Introduction, State of the Art, Theoretical and Methodological Approaches

1. Introduction

1.1 Research Puzzle, Aims and Questions

In March 2011, a few days after a major earthquake hit Japan compromising several reactors at the Fukushima nuclear electricity plant, U.S. former vice president, environmental activist, and Nobel Peace Prize winner, Al Gore visited Costa Rica calling the country "a hero among nations" for its efforts to achieve carbon neutrality by 2021, stating that more nations need to rely on wind and solar energy, including Costa Rica. Indeed, Costa Rica's energy model with nearly 90% of its electricity generated from renewable sources, mostly hydro-produced, includes only subsidiary alternative renewable sources such as solar and biomass-driven energy.

In fact, a contradiction emerged four years earlier, when the country announced its carbon neutrality goals in December 2007. This commitment coincided with natural constraints and legitimation problems affecting hydroelectricity production, as it had been vulnerable to periodical changing weather patterns over the last decade. Consequently, electricity production from oil-fueled plants increased, thus driving electrical energy prices upwardly. In 2013, the political campaign, at the time, prompted reactions from politicians showing their support to further advance and prioritize the construction of larger hydroelectric projects. Additionally, it was the first time that they began considering natural gas as a prospect; nonetheless, no political attention whatsoever was given to alternative renewable energy sources, for example, solar energy.

Energy governance scholars and politicians, worldwide, have turned their attention to the study of energy transitions directed towards low carbon and renewable energy goals. Empirical evidence shows that in the development of energy systems, radical change is not the norm. Technologies that become conventional begin to dominate despite increasing the perception of problems and limitations, whereas non-conventional renewable sources have repeatedly been considered unsuccessful and having no future within energy systems. Why does this happen and how can it be explained?

My dissertation addresses those inquiries by asking why Costa Rica chose to have limited utilization of alternative renewable sources, above all solar energy, to achieve the carbon neutrality goal in a context of declining hydroelectricity contribution, while (expensive and polluting) fossil fuels such as petrol and natural gas gained relevance in future scenarios. Throughout my research I discovered that, in spite of a changing context, Costa Rica's energy system exhibits symptoms of rigidity or decay as result of policy decisions reinforced over time. Hence, beyond technical and economic aspects, I contend that the causes can be attributed to a

problem of path dependency, a concept used to explain the dual nature of institutions, their dynamism as well as their permanency.

The research´s questioning arises from an empirical impasse in the transformation of Costa Rica's energy system, as well as a literature gap to approaching low carbon energy goals from an integrated perspective to the provision of sound policy advice in small developing countries. Literature concerning energy transition towards low carbon and renewable energy systems has been exploring determinants from three different angles: global energy governance; national energy governance; and the role of agents of change. These energy goals are, generally, analyzed from developed or emerging countries' perspective and financial institutions focusing on single factors, mainly the economic drivers of energy decisions. Meanwhile, less consideration is given to the standpoints of "small states", their particular conditions and unfolding patterns over time in the renewable energy field; especially in Latin America.

Furthermore, within these debates, a more limited group of works has been dealing with historical analyses and contradicting interests, power relations and values in energy decisions. Whereas, the work of scholars, like Vargas (2002) and Jiménez (2009), researching energy transition in Costa Rica refers to political and institutional inertia tending to benefit conventional energy sources, none of the authors has directly approached institutional stabilization and change in order to develop historical (theoretical) explanations. Henceforth, the objective of my research is twofold: the first pertains to empirical policy problems and the second refers to theory.

On the one hand, the rationale is linked to policy problems and political interests in order to best comprehend the case and conditions under which the carbon neutral goal can be accomplished by means of sustainable strategies. The Costa Rican electricity sector is an intriguing case of policy outcome, in itself, because of its apparent fixation of technological patterns in Costa Rica in contrast with energy institutions that, occasionally, in the past have been more purposive and efficient. An example of such behavior is when the country pioneered the introduction of new technologies, such as geothermal and wind energy, to the national energy system.

On the other hand, the theoretical purpose of this investigation is to provide a better understanding of the causal mechanisms that explain technology development, stabilization and change in political and institutional frameworks. The research, hereby, focuses on existing theoretical approaches of path dependency and institutional entrepreneurs, combined with other elements of governance, at national and global level, based on the works of Hall & Taylor (1996) and Mahoney (2000), furthered by neoinstitutional scholars, such as Pierson (2004), Garud and Karnøe (2003), Meyer & Schubert (2007). Subsequently, I gather drivers of path dependency in efficiency, political power and legitimation mechanisms.

Anchored on those three mechanisms of path dependency, I found six efficiency drivers that produce a path dependence on hydroelectricity. These drivers are: a) learning effects, b) cooperation effects, c) economies of scale, operating at an individual level; d) climate change effects, e) reliable electricity effects, and f) national welfare effects at a macro (systemic) level. Moreover, I found that their effects are enhanced by two more drivers derived from political power and legitimation mechanisms, respectively: g) empowerment of private investors, and h) national welfare communication.

Conversely, there are three drivers of path breaking by which patterns marked by path dependency might be reversed. They are resultant from efficiency, legitimation and political power mechanisms, respectively: i) the uncertainty of decisions arising from external climatic shocks that reduce hydroelectricity production, ii) local welfare communications from electricity developments and ii) community empowerment derived from socio-environmental clashes. These processes counteract drivers, to some extent, that had reinforced hydroelectricity over time. The aforementioned mechanisms and drivers are part of the empirical findings, widely expounded, in part II of this study.

The methodology, used for this research, is based on a within-case analysis of a mechanism-centered investigation that seeks to respond to the question initially formulated. In this regard, the research strategy is outlined without generalizing the broader population of cases. I refer, chiefly, to the electricity subsector in Costa Rica, which has been the focus of national political attention to foster energy transformations. Solar energy is considered, herein, as a reference of a renewable option, technically applicable and feasible (by its climate) in Costa Rica, but the least used among all alternatives.

The procedure followed is an inductive-deductive approach that is guided by methods of institutional analysis and process tracing. Accordingly, 47 interviews were conducted with different groups of actors, in the energy field, which were complemented with written policy documents and participatory observations for the process-tracing analysis. Other secondary sources include scholarly works on Costa Rica's environmental history, social movements in the electricity sector and market reforms that were useful to expand on the institutional analysis and the observations for the period prior to 1990.

1.2 The Argument and Hypotheses

In spite of the country's ever-changing contexts, Costa Rica's long-standing institutions, in the electricity sector, became stable in a situation of inertia. This stability was reinforced through decision-making processes that resulted in the preeminence of hydroelectricity installations,

while limiting the subsequent ability to further implement policies that incorporate solar energy, wind parks, and other alternative renewable sources to achieve carbon neutrality and 100% renewable energy use. This statement will be the subject of analysis in the present investigation.

In doing so, I resort to the procedure proposed by Van Evera (1997) to test possible explanations. It begins by inferring predictions and developing hypotheses for the monitored phenomenon and then probing if they are confirmed or unconfirmed by evidence. The research questions and hypotheses, formulated in this thesis, are highly specific to the case, which is also backed by academic empirical research on energy.

So as to keep track of what is expected, solar energy shall be used as an example among restrained alternative renewable carriers. Until 2011, electricity generating installations from solar energy remained outside the National Energy System accounts. Overall, solar energy was relegated from main developments; with the exception of rural electrification projects, using micro and small solar home systems (SHS), and private initiatives of small businesses in a niche market. It was not until the first solar energy park reaching 1 MW (i.e. 0.04% of the total NES) launched operations, in 2012, that solar energy was substantiated on the sector's statistics.

An intuitive explanation of this phenomenon is linked to the natural conditions and the abundance of water resources to produce electricity. Although, the country uses about 25% installed capacity of the total identified potential of hydroelectricity, its availability has limitations. Meanwhile, from the theoretical potential of solar energy in the country, Costa Rica only employs less than 1% of its estimated potential.

Another argument is associated to the costs or higher relative prices and strong dependence on imported components of alternative technologies. Nevertheless, this statement juxtaposes with historical evidence stating that prices are not necessarily the only factor contributing to change. At times, when oil prices have reached very low levels, such as in the 1990s, Costa Rica stayed true to its model largely based on renewable sources. Conversely, on those occasions when oil prices were high, the country also continued relying on fossil-fueled thermal plants to back hydroelectricity. In the case of solar energy, although cost and efficiency aspects have drastically improved since 2008, particularly manufacturing rates of the photovoltaic technology, the cost of the electricity it generates continues to be considered high.

The above situation also points to other elements of inertia created by actors' decisions, such as vested interests, fixed assets, as well as sunken costs created by capital intensive installations and large investments that are difficult to reverse. Furthermore, the Costa Rican electricity sector is not a market regime, but rather a mixed model under state control. The country has a long history of institutional development based on the "autonomous institutions" figure, such as

the Costa Rican Electricity Institute (ICE), who also became a political actor over the years. Under these circumstances, which are not considered market conditions, prices are not the sole factor influencing energy decisions, especially in "the world of political institutions" (Pierson, 1996: 141).

Two questions emerge from the historical analyses: (1) why was there no significant support, in the past, for the active incorporation of solar energy within the Costa Rican energy system, while technologies like geothermal energy and wind parks did gain relevant attention?; and (2) why has there recently been an increasing, but limited, interest in solar energy and how is it translated into policies transforming the national energy system to supplement other sources towards reaching 100 percent renewable electricity generation and carbon neutrality by 2021; while, at the same time, expensive and polluting fossil fuels such as petrol and natural gas gained relevance in future scenarios? In this respect, the following indicators shall be taken into account:

a) Different actor accounts
b) Different periods of time
c) Different technologies
d) Additional indicators: technology-related costs, global and national discourses or policy statements, and natural conditions or climatic events.

In order to find answers to the research questions, theory shall also be factored in. According to path dependency theory, self-reinforcing mechanisms are the main figure to distinguish path-dependent phenomena from those that are not. Therefore, competing explanations of institutional status or change in the national energy sector according to different mechanisms that can underpin processes on institutional reproduction shall be clearly outlined. Accordingly, three (causal) hypotheses shall be formulated:

- Hypothesis one: Comparing technologies, choices are based on the cheapest and most efficient option available according to actors' cost-benefit assessments that are either driven by individual profit motivations (individual level) or systemic goals (macro level).
- Hypothesis two: Technological developments are supported by elite groups that benefit from existing arrangements in spite of claims from (subordinated) groups of actors that prefer the expansion of alternative energy installations.
- Hypothesis three: Actors believe that certain technologies are appropriate and morally just for the provision of electricity.

Although, I consider those hypotheses as competing explanations, it is possible that their long term effect is rather complementary. Each hypothesis is related to theoretical concepts of

efficiency, political power, and legitimation, respectively. Hypotheses and theory are used to elaborate a theory-guided analysis of causal mechanisms and the specification of how they operate. Section 1.5 clarifies the theoretical concepts that provide the data analysis.

1.3 Reasons to Study Path Dependency in Costa Rica's Energy System

Primarily, the purpose of this research is to explain the decision making processes regarding alternative renewable energy sources, for instance solar energy, and conventional ones, such as hydroelectricity and fossil fuel sources. Thus, those explanations are relevant to draw inferences that are useful for policy-making in the country. Moreover, without generalizing, this study contributes in closing the research gaps that derive from works that analyze energy transitions towards low carbon and renewable energy systems in comparison to similar queries affecting other countries in Latin America or other regions.

Concerning the first contribution to scholarship research, understanding the specific case is also intriguing, over and beyond the timing relevance for policy-making. In spite of being an unlikely candidate, Costa Rica has become a leader in renewable energy use for electricity production (Wilde-Ramsing & Potter, 2008). However, the country's commitment to carbon neutrality by the year 2021 and the new paradigm of civil society participation in the regulation of the electricity sector, place the country at a turning point (Carazo, 2001; Cartagena, 2010; ARESEP 2014).

In relation to the second contribution, although energy governance literature has extensively studied energy-related challenges of access, climate change, economic and social development (Dubash and Florini, 2011; Flüeler et al, 2012), there is relatively little written about 1) why do countries engage in low carbon and renewable energy goals; 2) why do some energy options dominate while others are relegated; and 3) how do aspects of political power and legitimation influence energy decisions. The present research contributes to close some gaps within these areas.

First, the study of renewable energy governance is just emerging (Hein et al 2011). In approaching the different types of renewable energy sources, literature within the field has evolved from the general consideration of renewable energies without distinctions, to differentiating hydro from non-hydropower sources (Meisen and Krumpel, 2009). More recently, attention towards a broader fragmentation between non-hydro renewable energy sources increases challenges regarding energy governance (Flüeler et al, 2012; Doner, 2007).

Second, I found a regional research gap, since in many cases the focus is on regional powers and emerging economies (e.g. Brazil, India, China) confronting global energy challenges

(WBGU, 2011; IEA, 2012). Therefore, a bias is present when answering the above mentioned questions from the standpoints of "small states", such as those in Central America. For instance, energy governance literature, on a national and global level, regards climate change as the main factor of energy transformation in the last two decades (Newell 2011; Hein et al 2011). Nevertheless, based on my analyses for the case of Costa Rica, I found that the motivation concerning energy decisions might be different since, in this case, it mostly concerns climate change consequences over reliable electricity effects, rather than legitimation of actions against global climate change itself.

Third, I observed a disciplinary gap as academic empirical research, regarding energy, falls short of explaining the preeminence of conventional energy above other alternatives, despite an increasing perception of problems and limitations from the former. One reasoning that is commonly discussed by this literature is technology costs and the lack of incentives or insight towards other technologies, as opposed to established subsidies for conventional sources (Beck and Martinot, 2004; Doner, 2007; OLADE, 2007; IEA, 2011; REN21, 2011). In the case of most Latin American countries that have an abundance of resources, such as oil, gas, or hydro, it is generally easier, cheaper and technically more feasible to keep exploiting conventional energy resources rather than to invest in renewable energies or create appropriate renewable energy policies (Meisen and Krumpel 2009; IEA, 2011).

This empirical observation is vital and important; however, political economy scholars (i.e. the role of change agents) recognize that the emergence of a new techno-organizational path cannot be explained by referring to single factors or single models (Pachauri and Spreng, 2012; Schienstock 2007). Conversely, understanding potential 'sustainable energy' transformations require placing attention towards many tricky issues in social theory related with agency and structure, as well as the interplay of power, contingency, and practice (Stirling, 2014). Still, there are very few studies that allow understanding the contradicting interests, value, and power relations concerning energy decisions, and are especially unavailable in Latin America.

My choice analyses of Costa Rica's energy system render evident that hydroelectricity is reinforced through actors' decisions through time. The motivations, however, were not only aimed at lower-cost technology, but mostly systemic efficiency accounts, supported by political power and legitimation processes. To some extent, the same factors that contribute to the preeminence of hydroelectricity facilities also restrain alternative renewable energy use.

On this same issue, the last gap highlighted is methodological. A less prevalent amount of bibliography deals with historical analyses of conditions and patterns unfolding over time and restraining renewable energies (Meyer & Schubert 2007; Jørgensen 2012). Most studies have limitations explaining policy gaps because they typically look for synchronic determinants of

policies, or snapshots of current conditions, for example, in current social interest or in existing political alliances (Pierson, 1996). Meanwhile, a historical approach emphasizes the importance of initial decisions and choices of venues and, introduces notions such as that of path dependency.

In the case of Costa Rica, evidence of path dependency was found in the presence of self-reinforcing mechanisms of dams and fossil-fueled plants as back up systems. They continued to prevail, among the various options, in spite of legitimation problems of hydroelectricity derived from the communication of local welfare, the political power interaction that triggers community empowerment and the uncertainty in decisions from external climatic shocks. All these mechanisms might reverse or contend the ongoing reproduction of the hydroelectric path, possibly creating a new path of alternative renewable sources, although it is not likely to occur by the year 2021.

1.4 Delimitation of the Study

The basis of my research statements can be summarized as follows. Firstly, this is a qualitative study of the technological and institutional patterns developed along different energy sources in the electricity production history of Costa Rica and in its transition towards carbon neutrality in 2021. Therefore, the analyses focus on the unique qualities of the case, different to case studies that reflect upon a larger population.

Secondly, the present dissertation, by implementing an integrated approach, reconstructs the country's electricity trajectory from the perspective of relevant actors on a national scale. In order to convene the most diverse viewpoints, the actor constellations included: (a) a representation from the Energy Planning Sector who formulate policies and guidelines, (b) state investors, (3) private investors with national and/or foreign capital, (4) civil society organizations, including environmental organizations, producers/users associations, chambers and international cooperation, as well as (5) politicians. Additional experts and media standpoints are comprised. The analyzed policies include electricity production at utility or company level. Conversely, the perception of electricity consumers or consumers producing their own energy for self-consumption (i.e. on-site generation) is left aside.

Thirdly, the technological and institutional patterns to be explained were developed through a long-term history of Costa Rica's energy system. The analysis period begins with the origins of electrification within the country, dating back to the nineteenth century and culminating in the first decades of the twenty-first century, when carbon neutrality commitments were launched. The institutional transformation that occurred during the 1990s, which coincided with the

liberalization reforms of the national electricity sector, stands out within this time framework. Hence, the historical analyses were clustered into periods of observations, divided into three segments: (1) technological and institutional conditions before 1990; (2) transformations during 1990-2014, and (3) energy policies and forecasts to achieve 100 percent renewable electricity generation and carbon neutrality goals by 2021.

Fourthly, this study gathers the alternatives between energy sources for electricity generation covering the whole spectrum of renewables in Costa Rica (i.e. hydroelectricity, wind parks, geothermal energy, biomass electricity stations, and solar energy). Fossil fuel sources, such as bunker or natural gas, or other alternative energy sources, such as nuclear energy, were included as references in a few passages. The reason behind this is that, from the perspective of all possible targeting sectors, the electricity subsector is the one that presents the closest technical possibilities to actually becoming carbon neutral, given the fact that nearly 90% of the electricity generated is currently with renewable sources.

Finally, in this research, the mechanism-centered approach considered places special attention on institutional mechanisms in order to analyze the relationship between actors and institutions. Institutional mechanisms are dealing with how certain intersubjectively present institutions channel actors unintentionally in a certain direction (Parsons, 2007). Accordingly, the analytical level of explanation is at the meso level, considering both situational (i.e. macro-micro) and transformational (i.e. micro-macro) mechanisms (Beach and Pedersen, 2012; Parsons, 2007). Without neglecting their potential influence, psychological and cognitive aspects are not included in the present study.

1.5 Conceptual Clarification

Path Dependency: Definitions and Elements

Path dependency is broadly defined, within neoinstitutionalism, as a phenomenon of limited change where reproduction of initial institutional or policy decisions, even suboptimal ones, prevail over transformation (Liebowitz & Margolis, 1995; Pierson, 1996). Therefore, the concept helps to explain how the evolution of rules and policies, along with social adaptations, create and increase structured polity that restricts the options available to all political actors (Pierson, 1996). In this sense, path dependency is the actors' constraint that emphasizes the influence of structure on outcomes.

At the same time, the concept of path creation stresses the role of agency in the stabilization of an institutional or technological path. Path creation was incorporated in the theory of path processes by Garud & Karnøe (2001; 2003) and further developed by Meyer & Schubert (2007)

in order to expand the scope of emergent events allowing for elements of strategic change. Concepts related to path creation include vested interests, fixed assets, and sunken costs. Therefore, according to path dependency and path creation, the quasi-irreversibility of institutional or technological developments is not only based on investments but also on interests.

Among the constitutive elements of path dependency or path creation, the ones that stand out are: agency, structure, critical juncture, and self-reinforcing mechanisms. Despite differences on emphasis, most scholars suggest a better understanding of their conceptualization and relationship by looking at different phases of path development, distinguishing "genesis", "emergence and diffusion", "reproduction", and "stability" (e.g. Mahoney 2000; Meyer & Schubert 2007; Sydow et al 2009; Sydow & Schreyögg 2013). Each phase has different causal regimes that evolve in a progressive logic of becoming locked into a path and eventually of un-locking processes. They are briefly sketched below highlighting their elements and definitions.

Phases of path development

Genesis- the Role of Agency

Agency, as either individual or collective action, is highlighted in the first phase of path dependency and it can be characterized as an open decision-making situation when several alternatives are possible. According to Giddens (1984), an agent is one who exerts power or produces an effect. Thus, power is not the intention, but rather the ability of getting things done. Nevertheless, this initial phase is neither of completely unrestricted choice (i.e. rational choice theory), nor of determinacy (i.e. historical institutionalism). Rather, it is one of decisions embedded and connected with other developments and imprints from the past. In this phase, agents' decisions are contingent (i.e. their outcomes are unforeseeable consequences of purposeful action), though not random.

Emergence and Diffusion – the Relevance of Critical Junctures

A critical juncture marks the division between the genesis and the emergence phase and path diffusion, also called path creation or formation phase. A critical juncture is a moment of substantial institutional change or a 'branching point' from which historical development moves onto a new institutional formation and developmental pathways (Thelen, 1999; Hall & Taylor, 1996). Hence, increasing selectivity begins in this phase and contingent or mindful choices are made, triggering self-reinforcing dynamics. As long as decisions are made, the number of alternatives is reduced, and choices, while still possible, are essentially constrained.

Reproduction - the Dynamics of Self-Reinforcing Mechanisms

During this third phase, there is further restriction to the scope of action. Decisions are led by mechanisms of self-reinforcing dynamics that may end up in a stage of stagnation or a lock-in. Self-reinforcing mechanisms are regarded a main feature of path dependency, defined as processes, patterns, or routines that develop dynamics on their own, rendering the whole process increasingly irreversible (Sydow et al 2009: 691; Sydow & Schreyögg 2013; Mahoney 2000). Self-reinforcing mechanisms exhibit increasing benefits with its continued adoption, different to reactive sequences of events or similar patterns describing merely institutionalization, institutional persistence, imprinting, or structural inertia.

Stability – the Influence of Structure and the Process of Structuration

Institutional reproduction processes, which result from self-reinforcing dynamics, eventually were stabilized or institutionalized in a third phase that characterizes path dependency and lock-in situations. At this stage, a specific trajectory of development is situated in a state of rigidity, inertia, or decay that is difficult to reverse, hence it is path dependent. From this stage onwards, self-reinforcing mechanisms build a regular pattern or routines which are to be expected. In other words, this stage of path dependency emphasizes the influence of structure on outcomes.

The structural conception highlights people's actions as rational reactions to exogenously given structures in their environment (i.e. the material surrounding) that dictate behavior or create a pattern of structural constraints and incentives (Parsons, 2007). This structure obliges the states (or other relevant actor) to think of an increased revision of existing arrangements. Nonetheless, agency is also present for locking-in a path. Here, authors base their analysis on Giddens' conceptual framework of structuration (Giddens 1979; 1984).

Path Breaking – Reversing Self-Reinforcing Mechanisms

Eventually, the lock-in situation may change through dynamics of path breaking, giving birth to a new phase of path termination or un-locked stage. Path breaking or un-locking is characterized by stopping or interrupting self-reinforcing processes, changing the focus towards institutional change. Therefore, there is again an open situation to a variety of options that increases selectivity by actors; possibly creating a new path. Forms of governance at national and global level, as well as notions of institutional entrepreneurs and future expectations take on particular relevance in a path breaking phase.

Self-reinforcing mechanisms

When responding as to how self-reinforcement occurs and in what form, I consider Hall & Taylor (1996) and Mahoney (2000), whose broad formulation of mechanisms are differentiated

among the calculus approach, the cultural approach, and the asymmetries of power.[1] Accordingly, the present study groups self-reinforcing mechanisms in three forms: efficiency mechanisms, legitimation mechanisms and political power mechanisms.

Efficiency Mechanisms

Efficiency mechanisms are derived from the calculus approach affecting individual or institutional actions by altering expectations of an actor regarding the actions of others. From this perspective, individuals are 'utility maximizers' and strategic interaction clearly plays a key role. In this category of mechanisms, one could also integrate Mahoney's (2000) functional mechanisms of systemic reproduction. Therefore, according to efficiency explanations, an institution is reproduced through the rational cost-benefit assessments of actors or it is justified as functional for an overall system. Institutional change may occur when it is no longer in the self-interest of actors to reproduce a given institution or because an exogenous shock transforms systemic (or the system's) needs.

Political Power Mechanisms

According to political power mechanisms, an institution is reproduced because it is supported by an elite group of actors that benefit from the existing arrangement, even when most individuals or groups prefer changing it. The self-reinforcing processes might operate when the institution initially empowers a certain group at the expenses of other groups. The favored group then uses its additional power to expand the institution even further, which, in turn, increases the power of the advantaged group, and so forth. Inherently, conflicting processes of institutions may eventually give way to institutional change, in which case there is a weakening of the elites and a strengthening of subordinated groups.

Legitimation Mechanisms

The legitimation mechanism stresses individuals' routines or familiar patterns of behavior. Self-reinforcing mechanisms from legitimation operate when an institution is reproduced because actors believe it is morally just or appropriate, although this institution may be less consistent with the values of actors than previously available alternatives. Institutional forces of legitimation include rational myths; a knowledge which is legitimated through the educational system and by the professions, public opinion, and the respective laws (Powell, 2007). Institutional transformation is, thus, positioned with changes within the values and moral codes concerning what is considered appropriate, rationalized myths, declines in institutional efficacy or stability, or the introduction of new ideas on behalf of political leaders.

[1] Mahoney (2000; 2006) has attempted to categorize four possible forms of mechanisms of reproduction: Utilitarian, Functional, Power, and Legitimation.

Governance at national and global level

Governance is broadly defined as the joint contribution of public goods by state and non-state actors (EUISS, 2010). Forms of governance are central to this research, since governance impacts institutions' and actors' decisions (Pierson 1996; Börzel & Risse 2010). On a national level, institutionalization processes not only concern the state. Within the constellation of actors, this research focuses on institutional entrepreneurs. DiMaggio (1998) introduces the role of institutional entrepreneurs who are actors that have interests in institutional change, but rarely possess the resources, power, and legitimization necessary to implement their program.

For this reason, the institutionalization of their "entrepreneurial project" usually requires the assent of various groups and the use of strategies to enlist support and defuse resistance. Therefore, institutional entrepreneur actions and strategies may also take the form of mechanisms applied to path dependency and path breaking approaches (e.g. efficiency, political power and legitimation). In addition, expectations may also enter into the strategies also linked to efficiency mechanisms (i.e. rational expectations model), or political power and legitimation (i.e. fictional expectations) (Beckert 2014).

On a worldwide scale, the global governance discourse stresses the growing importance of multi-actor constellations in inter- and transnational politics in different processes of norm building, mainly through international cooperation (Hein & Kohlmorgen 2007). With a focus on global governance, international practices include multilateral agreements and other governance functions in steering, such as information-sharing, capacity building and implementation, and rule-setting (Andonova, Betsill & Bulkeley, 2009). Therefore, the concept of global governance helps to understand how norms originate, travel, or circulate, as well as the role of the different actors involved. This approach fits in with legitimation mechanisms studying the influences of global norms further discussed in the next Chapter of this section.

1.6 Carbon Neutrality in Costa Rica's Energy System

Costa Rica's natural conditions, together with a long history of institutional development dating back to the early 1900s, provided the material and ideological foundations for the consolidation of the national hydroelectricity-based energy system. Alternative, renewable energy sources were not introduced until the mid-1990s, but their penetration remained limited due to technical considerations by the energy planning sector. By the year 2009, the world's three nations committed to carbon neutrality were the Maldives by 2020, Costa Rica by 2021 and Norway by 2030 (Merchant, 2009).

The small electricity market in the Maldives (with a population of 310,000) completely relies on oil sources, while Costa Rica and Norway have a head start, because they already generate almost all of their electricity from renewable sources, mainly hydroelectricity. In 2010, electricity supply in Costa Rica was divided among hydroelectricity (76.4%), fossil-fueled fired plants (6.7%), geothermal energy (12.4%), wind parks (3.8%), and biomass (0.7%) (DSE, 2011a). Due to its marginal share, solar energy technologies, including solar thermal and photovoltaic plants, are not present within the data.

This particular case is noticeable because Costa Rica is not a wealthy, industrialized country with the necessary amount of resources to invest in capital intensive renewables. Moreover, it has a small energy market, but it does not rely completely on hydroelectricity. Besides, the electricity sector is commanded by a state-owned firm, which in developing countries are considered inefficient and risk adverse; and despite the fact that the country has proven oil reserves, it has refused this kind of investment (Wilde-Ramsing and Potter, 2008).

In spite of being an unlikely candidate, the nation has become a leader in renewable energy use for electricity production. The 2007 proclamation of the carbon neutrality goal to be achieved by the year 2021, was launched together with the "Peace with Nature Initiative", seeking to "strengthen political actions and commitments to reverse the alarming trends of human impacts over ecosystems at global, national, and local level" (MREC, 2008: 12).

The 21st century, however, began with an increasingly growing gap in the national renewable energy system of electricity production. Installed capacity of fossil plants grew rapidly, while the use of alternative renewable sources remained limited. In the case of Costa Rica's energy system, the main challenges pertained to the most extended conventional renewable energy source for electricity production, which is hydroelectricity.

In fact, the country's announcement of the carbon neutrality goal coincided with natural constraints affecting hydroelectricity, mainly changing weather patterns. Sector institutions, with a long-standing engagement in energy planning, responded accordingly by implementing fossil- fueled electricity stations to back-up hydroelectricity. As a result, electricity production from oil plants increased during the following years, thus hiking electricity prices and moving away from carbon neutrality goals.

Despite the advantages provided by fossil-fueled thermal plants, as peak hour plants and as a back-up to hydroelectricity, they are associated with several negative impacts. Besides increasing the cost of electricity and the cost of exceeding capacity (i.e. by not using full capacity), fossil fuels also complicate electricity price regulation, as they are based on international fluctuations of oil and gas prices. The use of fossil fuels also has a negative effect

on the trade balance. Not to mention pollution and CO_2 emissions to the atmosphere, especially from bunker fueled plants used in the country.

Evidence of a progressive exhaustion of Costa Rica's energy model is not only in terms of renewable energy responses, but also in addressing the new paradigm of civil society participation in decision and production processes. Although approximately 25% of the national hydroelectric potential of 6500 MW is being exploited, nearly 16% of the remaining potential is actually located in natural protected areas where the law excludes other commercial activities besides tourism. Another 25% of the potential would directly or indirectly affect indigenous territories, protected by the national Indigenous Law where these interventions in the environment meet heavy resistance (Carls & Hafar, 2010; ICE, 2014: PEG; Weigl, 2014).

In addition, new hydroelectricity installations, from large dams to smaller run-of-the river (RORs) hydroelectric plants, have been suffering problems of legitimacy. In many cases, fierce opposition on behalf of environmental organizations and indigenous groups was also accompanied by cases of dispute with local communities and other grass-root organizations. The aspects that produced the greatest resistance to these projects were community displacement; as in the case of large dams, environmental consequences on water streaming and ecology, and the negative outcomes on other benefits that a river provide to the local economy, or so called socio-environmental impacts (Cartagena, 2010).

Within the political and economic context, Costa Rica is included among the oldest consolidated uninterrupted democracies since the 1950s, a rarity in Latin America (O'Donnell et al, 2004). The political model is defined in terms of "participative democracy" or "socially inclusive capitalist development" often termed "social democratic" or "mixed model"; a characterization that relates to with a widespread perception of the country itself (Martin, 2004; Hoffman, 2007). [2] One of the characteristics of this model is the provision of greater democratic control on environmental resource allocation and economic development, for example, through public and non-profit organizations (Martin, 2004).

Nevertheless, this model also found limitations visibly manifested on local demands of citizen's participation, information, and consultation mechanisms to control hydroelectric projects (Carazo, 2001; Cartagena, 2010). In many cases, such claims propose to limit private electricity generation, stating that electricity is a public service and a state duty, hence, the public companies, and the rural cooperatives (Cartagena, 2010). The Regulatory Authority for Public Services (*Autoridad Reguladora de Servicios Públicos*, ARESEP) has recognized the need to introduce changes in the regulation of the electricity sector, since "the main challenge facing

[2] Participative democracy is broadly defined as the inclusion of diverse perspectives in the policy-making process (Prugh, Costanza & Daily, 2000 cited in Martin, 2004).

electricity services is the integration of community participation within decisions on a local and national level" (ARESEP, 2014).

Thus, Costa Rica's transition towards carbon neutrality illustrates the tensions between past and future electricity configurations, shaped by both technological and institutional developments. The research question initially formulated is emerging from this scenario. In my research, I found that Costa Rica's energy system exhibits features of rigidity or decay, as result of policy decisions reinforced, over time, in spite of a changing context.

1.7. The Thesis' structure

This thesis explores energy decisions in Costa Rica's transition towards carbon neutrality in 2021. The focus lies on the mechanisms leading to technological choices producing inertia or institutional change. Before investigating these processes, the thesis begins with part I that consists of four chapters including this introduction (Chapter 1). Chapter 2 provides a review of the literature relevant to the topic of energy transition towards low carbon and renewable energy systems.

Chapter 3 presents the theoretical framework that begins by an overview of neoinstitutionalism and the mechanism-centered approach. Subsequently, it goes into more detail by defining path dependency, its elements, and progressive logic. This chapter includes a section that defines specific claims from efficiency, political power, and legitimation mechanisms. Finally, it ends with theoretical perspectives of institutional change from concepts of governance discourses, at national and global level, and elements of path breaking theories. Chapter 4 consists of the methodological approach and explains the procedures, methods, and data collection techniques used in the qualitative analyses of the case.

After these preliminary considerations, the thesis proceeds with part II dealing with the empirical findings separated into four chapters. Chapter 5 elaborates on how technological and institutional patterns evolved in the country together with economic, social and environmental context conditions. Chapters 6, 7 and 8 analyze the decisions' mechanisms and drivers in the energy field. Each chapter scrutinizes the mechanisms separately and compares energy decisions by actors, periods of time, and by technology. Chapter 6 focuses on efficiency mechanisms. Chapter 7 looks at the political power mechanisms, and Chapter 8 shows the process of legitimation mechanisms.

Thereafter, the analyses move on to part III, which comprises two chapters. Chapter 9 offers an integrated discussion on the findings regarding the three mechanisms, which evidenced the presence of eight path dependency drivers producing institutional inertia and three main elements of path breaking driving institutional change in the national energy system. Chapter

10, the last chapter, conveys the conclusions of the study. It begins with a discussion on the relevance of the within-case study to the literature on energy transition. This is followed by theoretical and policy implications. Ultimately, it concludes with avenues for future research related to similar puzzling conditions in Central America or other regions.

2. State of the Art: Energy Transition towards Low Carbon Energy Systems

2.1 Introduction

This chapter provides an overview of the literature that analyzes energy transition towards low carbon and renewable energy. It begins with an outline of the main drivers of energy transition from the perspective of global energy governance, which are: global climate change, global energy industry development, and global environmental governance. Thereafter, it shortly discusses the main goals of energy systems with a focus on national energy governance. Successively, it presents key studies which have dealt with examining the role of change agents and historical integrated perspectives of transformations in the energy field.

Considering the main arguments from different standpoints, this chapter also aims to identify scholarly answers to the following questions: (1) why do countries engage in low carbon and renewable energy goals; (2) why do some energy options dominate while others are relegated; and (3) how do aspects of legitimation influence energy decisions. The chapter focuses on common sources of renewable energy, such as hydroelectricity, geothermal stations, wind turbines, solar energy, and some forms of biomass. These are derived from natural processes (e.g. sunlight and wind) that are replenished, at a faster rate, than they are consumed.[3]

2.2 Global Energy Governance

Energy governance, similar to climate governance, is identified and conceptualized as a multi-actor, multi-level and multi-challenged governance (Dubash & Florini, 2011; Hein, García & Holstenkamp, 2011). Global governance scholars frame energy related challenges in the arenas of energy access and security; climate change and other environmental impacts; economic and social development (Dubash & Florini, 2011; Flüeler, Goldblatt, Minsch & Spreng, 2012). Overall, these challenges lie behind countries on their road to energy transitions.

2.2.1 Global Climate Change

According to Dubash & Florini (2011) among the energy-related challenges mentioned above, climate change and its correlated risks are outlined as the main factors having a stronger influence over the shifting global energy landscape within the last two decades. Hein, *et al* (2011) conclude that the emerging renewable energy governance on a global level is linked to both, environmental governance and climate governance, since the latter, and particularly the

[3] There is an ongoing debate on the legal inclusion of nuclear energy among renewable sources, especially since a distinction is made between conventional nuclear fission and the nuclear fission involving fast neutron reactors (World Nuclear Association, 2014).

mitigation of greenhouse gas (GHG) emissions, is closely connected to energy concerns. Foremost, as pointed out by Bradford (2006), renewable energy sources (e.g. solar energy, wind turbines, hydroelectricity) are considered solutions for the increasingly acknowledged climate change.

Precisely, the decarbonization of energy systems describes the historical trend initiated since the Rio Earth Summit, in 1992, which moves away from carbon-rich energy sources, such as traditional biomass (e. g. wood and coal), towards less carbon-intensive energy carriers (e.g. oil and gas), and, increasingly, zero-carbon energy carriers such as renewable energies (WBGU, 2011; 2004). In this commitment, special attention was given to the target of limiting the average increase of global surface temperature to 2^{o} C above the pre-industrial levels in order to prevent 'dangerous' climate change (WBGU, 2011; Geden & Beck, 2014). For the institutions created in the run-up of the Rio conference, including scientific advisory bodies, such as the German Advisory Council on Global Change (*Wissenschaftlicher Beirat Der Bundesregierung Globale Umweltveränderungen*, WBGU), this objective was used as a guard rail to calculate and stipulate that the concentration of greenhouse gases in the atmosphere must be permanently stabilized below 450 ppm CO2eq (WBGU, 2007).[4]

The 2^{o} C target provided a broadly applicable formula for climate change commitments of the United Nations Framework Convention on Climate Change (UNFCCC) and was formally adopted at the 2010 UN Climate Change conference in Cancun. In spite of possible revisions to this objective, Geden & Beck (2014) describe it as an 'anchoring device' that allows actors to communicate and interact.[5] This climate stabilization level is possible if energy systems are converted from the present use of fossil fuels (e.g. delivering approx. 85% of the worldwide energy consumption) to climate-neutral energy sources, also referred to as 'decarbonization of energy systems' (WBGU, 2011).

The German *Energiewende* is the first effort of an industrialized country seeking to decarbonize its energy system by the year 2050 (Goldthoau, 2014).[6] In a short time, after the Renewable Energy Law (*Erneuerbare-Energien-Gesetz, EEG*) was established in 2000, the country reached 24600 MW of installed capacity through wind, biogas, and solar energy generation (Mautz,

[4] A stabilization target of 550 ppm CO2eq, discussed notably by Stern (2006), is likely to result in a global warming of around 3°C, and is thus incompatible, in the Council's view, with the commitment to avoid 'dangerous climate change' (WBGU, 2007).

[5] The possible revision of the 2^{o} C target is based on early critics on the adoption of a single metric and the pressure of current rising emissions that confront this limit. However, the authors consider that a possible revision entails a dilemma: to policy-makers it is unthinkable to continue pursuing political goals that are patently unachievable, but if the limit is just modify signalizing that a threshold between non-dangerous and dangerous is not absolute and scientifically defined, the reputation of climate science would be at risk, as well as policymakers possibilities to take action.

[6] The goal in Germany is to reach at least 80 % of electricity generated from renewable sources by the year 2050.

2007).[7] This is an important success given the infrastructure of the German electricity sector designed to provide a state level (or *Laender*) coverage by means of coal-fired or nuclear plants (Goldthoau, 2014; Mautz, 2007).

The country also started leading the process outside Germany towards implementing an energy system transformation, by means of technology promotion through their international cooperation agencies (WBGU, 2004; Mautz, 2007). The Johannesburg Renewable Energy Coalition (JREC) was created in 2002, by the initiative and stimulus of Germany, who also organized the first International Conference for Renewable Energies, in Bonn, in June 2004 (WBGU, 2004). With the Germany's support, the Renewable Energy and Energy Efficiency Program (REEEP), founded during the Johannesburg UN Conference on Sustainable Development in 2002, has been investing in developing countries and in emerging economies, managing a portfolio of clean technologies in 79 countries.[8]

Hein, *et al* (2011) indicate other attempts of coordination in the renewable energy field, on a global level, taking place thanks to Germany's initiative. They include the creation of the Renewable Energy Policy Network for the 21st Century (REN21) and the International Renewable Energy Agency (IRENA), officially established, in Bonn, in 2004 and 2009, respectively. According to the authors, the success of these processes have been unbalanced until now: while the production and installation of solar panels and wind generators are growing rapidly in China and India, in many poor and developing countries, the process has been very slow, or is non-existing. Moreover, the need for further energy transformation has been followed by changing regulations, the entry of new players, rivalry, lack of coordination or uncertainty about which paths to follow, and who should make the decisions.

Certainly, literature on energy transitions has been providing special attention to the spring of emerging economies as a driver of renewable energies. Renewable energies gained important relevance within the international agenda during the 2002 World Summit on Sustainable Development (WSSD) held in Johannesburg, which highlighted the challenge of growing worldwide energy demands, particularly from emerging economies with consequent rising emissions (WBGU, 2004). Subsequently, towards the end of the decade, renewable energies regained momentum as industrialization processes increased in developing countries (WBGU, 2011).

[7] From 4200 MW wind in 1999 to 21000 MW in 2006; from 50 MW biogas in 1999 to 1100 MW in 2006; from 69,5 MW of solar energy in 1999 to 2500 in 2006 (Mautz, 2007). The installed capacity from these three sources reach approximately 61700 MW in 2012 distributed among 31300 MW wind; 4000 MW biogas; and 26400 MW solar energy (BMWi, 2014).

[8] Where We Work. (2015). The Renewable Energy and Energy Efficiency Partnership (REEEP). Retrieved 21.04.2015, from: http://www.reeep.org/where-we-work

As pointed out by the WBGU (2011), if the 2°C target is to be complied while succeeding in guaranteeing access to modern energy supply by 2030, there is a need to speed-up 'sustainable energy infrastructure' and rapidly commence its large-scale implementation. They add that "If they (developing and newly industrializing countries) do not succeed, there is a risk of path dependencies on high-carbon energy systems that would be very difficult and costly to overcome, which would demand decades to do so" (WBGU, 2011, p. 172).

2.2.2 Global Energy Industry Development

On a global level, those international organizations created to promote renewable energies such as the International Energy Agency (IEA) and the WBGU, deemed renewable energies abundant and with the potential to secure the entire, or a large proportion, of the global energy supply in the long term (WBGU, 2011; IEA, 2012). Nevertheless, in practice, fossil fuels still dominate energy systems, as illustrated in table 1. According to estimates from the IEA, the electricity sector accounted for 38% of the global primary energy demand, relying by up to 75% on fossil fuel input. The agency also estimated that, in a new policy scenario for 2035, this share is merely reduced to 63 % (IEA, 2012).

Table 1. Electricity production per energy source in world regions

Shares (%)	Biomass	Wind energy	Hydroelectricity	Solar energy	Geothermal	Marine	Fossil fuels	Other sources	Total (relative)
Latin America	3.2	0.4	54	0.003	0.7	0.0	40	2	100 (7)
North America*	1.5	3	15	0.05	0.3	0.01	62	18	100 (22)
Europe	4.3	5.1	15	1.3	0.3	0.01	49	25	100 (17)
Eurasia	0.3	0.1	16	0.0	0.03	0.0	66	17	100 (7)
Africa	0.3	0.4	16	0.01	0.2	0.0	80	2	100 (3)
Middle East	0.01	0.03	2.3	0.02	0.0	0.0	97	0.05	100 (4)
Asia-Oceania	0.9	1.4	13	0.11	0.3	0.0	78	5.5	100 (40)

Source: Eurostat (2012). Renewable Energy Statistics

As pointed out by Bradford (2006, p. 76), the reason why these countries are leading the industry is based on pure economics: "Europe's average electricity prices are among the highest in the world because it has high taxes and few native sources of fossil fuels". This high cost structure has motivated European countries to become leaders in "new renewable" energy technologies, such as wind turbines. Furthermore, Japan and Germany gained advantage within the solar market, in the mid-2000s, through government support using various types of subsidies in order to stimulate domestic solar energy industries.

Germany led small distributed capacity investments, common for residential photovoltaic projects, generating less than 1 MW (Deloitte, 2013). Meanwhile, the diffusion of the technology has been considered more difficult in developing countries as they lack subsidies, financing systems, and channels to promote sales/service (Bradford, 2006). The lack of financial resources is highlighted here as a main barrier in advancing in the area of renewable energy.

Along the same line, Dubash & Florini (2011) and several authors from the global energy governance branch of literature (e.g. La Viña, Dulce & Saño, 2011; Newell, 2011), have discussed how domestic energy policies are shaped by global energy institutions, largely international financial institutions, who rule or govern the sector, directly or indirectly. Moreover, within bilateral and multilateral financial institutions, the impact of private sector investments and climate change mandates prevail. Therefore, it is also important to emphasize the need for strong and effective governance systems to steer energy finances towards the fulfillment of policy goals.

More recently, the renewable energy industry was struck by low gas and coal prices that motivated an increase in their use (IEA, 2012). Fossil fuel reserves, indeed, are still believed to be abundant, particularly coal and natural gas. Tissot (2012) and Stevens (2012) regard the rapid expansion of natural gas for electricity generation in Latin America, during the last decade, to the implementation of low cost technologies, market deregulation, and the privatization process of electricity and hydrocarbon sectors.

In this regard and for the prospects of renewable energy, fossil fuels represent a competitor for new infrastructures and financing. For instance, natural gas can provide a transition towards a zero carbon economy though it requires important capital resources that could inhibit investing in renewable sources; an issue which can be difficult to revert at later stages (Stevens, 2012). Herein lies the underlying risk of using natural gas as playing a transition step or "bridge function" towards a low carbon future (Deloitte, 2013).

2.2.3 Global Environmental Governance

The third relevant global discourse, concerning renewable energy, is the challenge of environmental sustainability and social acceptance. As mentioned above, climate change gained attention within the energy policy discussion, due to its relationship with global environmental impacts caused by warming effects. In addition, transformations in the global energy landscape are also propelled by concerns regarding local environmental impacts from global climate change and other human activities (Dubash & Florini, 2011). In particular, the effects and

intensity of environmental impacts vary between the local and global levels, such as in the case of climate change (Engels 2003).

These aspects have been discussed, on a global level, in reports from international organizations and scholars like Martin (2004) and Brown & Quiblier (1994) studying the implications of such global environmental consensus. According to them, global environmental governance gains momentum during the Agenda 21, an initiative derived from the Rio Earth Summit in 1992. Besides developing the concept of 'sustainable development', this agenda incorporated policies to seek a standard of equity rooted in cultural values, prioritizing the right of people to utilize natural resources democratically in order to meet their basic needs (Hein, 1997).[9]

The sustainability of the different renewable energy sources gained attention in the global energy governance literature, particularly concerning their ecological impacts and social acceptance. Within this literature, the case of hydroelectricity governance has been widely discussed. Hydroelectricity is the most widespread renewable energy technology, largely used in Latin America.

Although, authors like Blacksher, et al. (2011: p. 40) argue that hydroelectric projects tend to be accepted by the general public "which views hydropower as a good use of the abundant renewable resources of Latin America's great and powerful river systems", other reports mention that the low social acceptance of hydroelectric installations have caused major conflicts over many large scale dams in different regions (WDC, 2000; WBGU, 2007). In spite of a lack of consensus concerning its general acceptance, there are well known cases of conflicts from dam construction, which include the 40 GW Three Gorges Dam in China, the 11.2 GW Belo Monte HP in Brazil's Amazon region and the 1500 MW Boruca HP in Costa Rica (Martin, 2004; Carls & Haffar, 2010).

Social concerns regarding hydroelectric plants became a global phenomenon when the social movements against large dams reached the heart of the World Bank during the 1990s (Goldman, 2004).[10] The World Commission on Dams (WCD) was created, in 1997, as a joint initiative of the World Bank and the International Union for the Conservation of Nature (IUCN) in response to growing opposition towards large dam projects. The WCD's final report, launched in 2000,

[9] Other authors remark that sustainable development policies prioritize equity over the criteria of economic effectiveness and efficiency; or the ecological limits over the others (Martin, 2004).

[10] In the 1990s, people from India's Narmada River valley echoed their opposition and rejection to Sardar Sarovar dam that resulted in the first ever Independent Review Panel appointed by the World Bank. This report and the social movement pressure caused that the Bank's Executive Directors voted to pull out the project. The cancellation of another large dam in Nepal, Arun 3, marked a turn in the World Bank's way of doing business. Goldman (2004: 56) makes a difference between the "pre-green World Bank of the 1980s" and after 1990s, when projects started following "a new scientific protocol with environmental and social standards".

was broadly accepted, stating the strategic priorities regarding dam development, yet their policy recommendation and principles were less welcomed by financial institutions and interest groups.

According to the International Commission on Large Dams (ICOLD), an older international organization representing the interests of the industry, these concerns refer particularly to the principle of prior indigenous consultarion, which "would mean that basically no dam could be built".[11] Despite public awareness regarding the significant ecological impacts of dams, especially since the 2000 WCD report, there have been few studies carried out in order to understand and monitor the effects on tropical river dynamics, particularly in isthmuses like Central America, where dam construction is expected to increase (Esselman & Opperman, 2010; Chaves et al., 2014).

Latin America countries are more likely to pursue the continuation of hydroelectricity projects while achieving economic growth and fulfilling low carbon global commitments. However, this dependency on hydroelectricity is also highlighted as an aspect of vulnerability (Tissot, 2012; Blacksher et al., 2011). In cases like Brazil and Colombia, the increasing use of natural gas is being triggered as a reaction to hydroelectricity dependency, which has been susceptible to changing weather patterns (Tissot, 2012). When linking global climate change and environmental governance, climate change and its related risks are increasingly being seen as more than an environmental externality and becoming a question of national and international security (Dubash & Florini, 2011).

In summary, global energy governance literature provides a rich platform to understand transformations and challenges, at a global level, and the linkages between global institutions, global industry and global norms. However, four main limitations have been identified within this literature. First, the three global discourses analyzed here mostly deal with emerging economies with larger impacts on a global scale. Second, those debates tend to focus on conventional energy sources (i.e. fossil fuels and hydroelectricity). Third, aspects of legitimation are integrated, to a limited extent, within discussions of environmental governance and social acceptance of technologies. Finally, these global discourses miss aspects of deliberation concerning antagonistic and competing interests between different energy options, which mostly take place at a national level.

[11] The Era of WCD belongs to the past. (2011-2012). The International Commission on Large Dams (ICOLD). Retrieved January 2014, from http://www.tcsr-icold.com/Detail/49

2.3 National Energy Governance

Regarding the role of energy governance at a national level, empirical academic research on energy has been focusing on factors restraining the use of alternative renewable energies. This section closes in to the main determinants for renewable energy use discussed by this literature. They begin with low carbon energy systems, followed by economic growth and social development, followed by the aspect of reliability of electricity services, and lastly technology cost and other incentives. Most of them are connected to global energy challenges (i.e. energy access, climate change, and economic and social development).

2.3.1 Carbon Neutrality and 100% Renewable Energy Goals

The recent trend towards decarbonization of the economy and low carbon energy systems has reached every corner of the world. In this sense, what triggers countries' ambition towards low carbon, carbon neutral or 100% renewable energy goals? Particularly focusing on developing countries where other challenges can be seen as a priority.

Concerning carbon neutrality aims, Gössling (2009) proposes an answer in terms of climate change imperatives, to pressure the tourism industry to become sustainable in regard to its contribution to climate change, often as a response strategy for tourism destination countries, such as Costa Rica. Tourism is a crucial source of economic income, in several countries, including Costa Rica. Therefore, low carbon energy goals are indirectly linked to challenges of economic and social development.

In 2007, the 2nd International Conference on Climate Change and Tourism urged the entire tourism sector to take action and face climate change as one of the greatest challenges to sustainable development (UNWTO, 2007). This declaration called for a range of actors to take action, including governments, international organizations and consumers. Governments within destination countries should focus on investments in energy efficiency programs and use of renewable energy resources, whereas consumers should make travel choices leading to smaller 'carbon footprints'.

Strategies such as "carbon neutrality", "low carbon" and "100% renewable energy" were all thought out to portray a destination that does not contribute to climate change, though each initiative has different goals. Carbon neutrality refers to the compensation of carbon emissions through projects that save emissions, usually in other non-tourism sectors, such as energy efficiency, renewable energy or forestry projects.[12] Low carbon means reduction of emissions,

[12] Forestry projects include aforestation, reforestation, avoided deforestation, forest conservation and forest management.

which is one possible strategy within carbon neutrality using carbon free energy sources. Meanwhile, strategies for 100% renewable energy suggest that no emissions are released, including all transport emissions, and are calculated on a lifecycle basis.[13]

In most countries, offsetting strategies are heavily focused on forestry projects. In fact, "carbon neutral" is correct if an amount of CO_2 similar to that released by a given tourism related activity is stored in biomass, for instance in a forestry project. However, there are problems concerning the permanency of these sinks and the land available for them. In contrast, projects focusing on energy efficiency or renewable energy would then be compensational (i.e. low carbon strategy). [14]

As of 2009, the nations committed to carbon neutrality were the Maldives by the year 2020, Costa Rica by 2021, Norway by 2030, as well as New Zealand, Scotland and Sri Lanka without a specified year (Gössling 2009). Countries like Costa Rica, New Zealand and Norway are already reporting a significant level of annual carbon removal through forest management. Energy efficiency and renewable energy improvements are also important elements for their reduction strategies. For instance, the authors mention Costa Rica's intention to focus on biofuels.

The economics of carbon offsetting schemes, in countries like Sri Lanka, Costa Rica and Scotland, seek to involve industry and tourists on a voluntary basis. However, the complexities and difficulties of carbon neutrality persist and there are no clear priorities for actions (e.g. starting with emission intense sectors). Gössling (2009) considers that, in their current form, carbon neutrality approaches are seen rather as discourses to justify business as usual tourism development with views towards self-regulation, and might, in practice, even prevent the implementation of serious climate policy measures.

2.3.2 Economic Growth and Social Development

Focusing on aspects of sustainable development, at a national level, a group of scholars have been dealing with the relevance of economic, social and environmental aspirations (GENI, 2009; Fletcher, 2010; Pachauri & Spreng, 2012). Pachauri & Spreng (2012) remarked that international organizations from the United Nations system and other non-governmental entities, regarded on occasions as implementing agencies, exerted influence towards more social and environmental ambitions in the energy sector. Since 2000, the emphasis on achieving the

[13] This not possible as long as aviation is involved.
[14] The World's 3 'Carbon Neutral Nations' Gear Up to Cut Emissions. (2009, November 24). Retrieved February, 2013, from: http://www.treehugger.com

Millennium Development Goals has reoriented energy targets towards the social and poverty alleviation benefits of electrification.

In terms of reducing poverty, limited access to electricity, in fact, increases people's struggles in daily life (IPADE, 2004).[15] This situation has forced mainstream dependence on biomass energy for cooking (e.g. fire wood and charcoal) and kerosene for lighting, especially in rural areas. Therefore, it is not by chance that, especially in the case of developing countries, attention has been centered on financial constraints and the role of multilateral aid agencies to tie renewable energy to development (IPADE, 2004, KfW & WB, 2005; Newell, 2009).

Developing countries have historically been able to finance hydroelectric dam construction through infrastructure loans from international lending institutions, such as the World Bank (Bradford, 2006). According to the World Bank (2003; 2008), construction of large-scale infrastructure projects was a popular use of financial funds until the 1970s. Though, this has been replaced by investing in smaller health and education programs, in the 1980s and 1990s, there is now a renewed support for large infrastructure projects as a mean of reducing poverty.

In this regard, hydroelectricity projects have been considered and promoted as a means towards a clean, safe, and reliable energy supply required for steady economic growth and for reducing fossil fuel dependency (GENI, 2009). As pointed out by Fletcher (2010), hydroelectric dams have long been one of the collaborations of conventional development policy. They appear to possess compelling economics because they provide large quantities of reasonably cheap electricity compared to many other energy forms (i.e. between 2 and 10 cents per kWh) depending on dam location, size and type (Bradford, 2006).

In terms of environmental aspirations, World Bank projects support the achievement of universal access to electricity and modern household fuels, based on low-cost options with an emphasis on renewable sources. [16] Small off-grid photovoltaic systems, or solar home systems, are the main technology used in rural energy projects and programs. Therefore, rural electrification programs with renewable energy sources are directly related to CO_2 emission reductions.

Moreover, environmental objectives and renewable energy use are also linked to economic growth in developing countries. The example of the aforementioned tourism and leisure

[15] Besides, the lack of electricity affects the capacity to develop productive activities, water access, education, culture, information, health, hygiene. It is also relevant factor to impel rural migration to cities and thus create territorial imbalances.

[16] Sustainable Energy for All: Sector Results Profile. (2014, April 9). Retrieved 22.04.2015, from: http://www.worldbank.org/en/results/2013/04/10/sustainable-energy-for-all-results-profile

industry illustrates this. The tourism industry is considered an important concern for the global challenges of climate change and poverty reduction (UNWTO, 2007).

2.3.3 Reliable Electricity Services

Literature on national energy governance provides significant attention to secure clean, safe and reliable electricity. Cordaro (2008) and Bradford (2006) state that reliability is actually a key figure used by 'operators' of national energy systems. It is defined as the capacity of electricity plants to continuously supply power to customers, at any time, an issue considered critical "in the delicately balanced modern electricity grid" (Bradford, 2006, p. 9). Under this framework, different energy sources and their coordination within the energy system serve to fulfill the changing energy demand, help to keep operation costs low, and offer long term stable and attractive pricing.

Different electricity sources are classified as base, peak, and intermediate electricity plants according to their load factor, which measures their utilization rate or capacity factor (Cordaro, 2008).[17] As an efficiency measure, the capacity factor not only depends on the type of fuel and plant design, but also varies, over time, depending on the technology's efficiency. In the case of solar and wind energy, in particular, efficiency is constantly improving (World Nuclear Association, 2014).

On a general basis and as means to classify energy sources, the base load sources include coal and nuclear facilities, as well as hydroelectricity and geothermal energies among the renewable options. These plants run throughout the whole year, except in the case of repairs or scheduled maintenance. Peak load plants are most often fueled by natural gas and oil, and are typically smaller than base load plants. While intermediate load plants include intermittent sources, such as smaller hydropower plants, solar energy and wind parks that cannot be relied upon to meet constant supply needs, nor can they be immediately called upon to meet peak demands.

According to these technical characteristics, dams offer several advantages (Blacksher et al., 2011; Bradford, 2006; Cordaro, 2008). First, dams often serve as base load plants to fulfill the needs of larger scale users. Second, they are suitable to satisfy the need of peak load plants with reservoirs that are ready to generate electricity at any time. Third, these technologies are attractive to keep operational costs low and produce energy continuously. Fourth, the engineering technology and economics of dams are well understood by public and private investors, financing organizations, and engineering companies.

[17] Electrical load factor is a measure of the utilization rate, or efficiency of electrical energy usage. It is calculated by dividing the actual output that is provided by a specific electric plant into the maximum possible electricity output during the year (Cordaro, 2008).

As a complement to base load plants, fossil fuels are used for electricity generation with peak load characteristics. These plants are highly responsive to changes in electricity demand and can be started-up relatively quickly, with the capacity of varying the quantity of electricity output by the minute (Bradford, 2006). Peak load plants are very expensive to operate in relation to the amount of power they produce and the cost of fuel to run them (most often natural gas and oil). Nevertheless, due to their size, they are easier and less expensive to build (Cordaro, 2008).

In contrast, many renewable energies, such as wind parks, solar energy and micro-hydroelectric plants are not available on a continuous or consistent basis (WBGU, 2011). Therefore, they cannot be relied upon to meet constant supply needs, nor can they be immediately called upon to meet peak demands, but they are appropriate as intermediate load plants. They can satisfy the gap reducing the need for fossil fuel or the overuse of peak plants during heavy demand periods (i.e. peak load shaving) (Bradford, 2006; Cordaro, 2008). Compared to peak plants, such as oil-fuel plants, intermediate load plants are larger; therefore, their construction costs are higher, though they also run more efficiently (Cordaro, 2008).

Unlike fossil fuels, renewable energies are unlimited in terms of the total quantity available. However, there are potential technical limits to increment their implementation without the added inclusion of energy storage solutions (Bradford, 2006; WBGU, 2007). As pointed out by the WBGU (2011), in theory, these technologies have upper limits in terms of the amount of energy per unit time that they can supply (known as 'potential'). For example, in practice, the technical usability of solar energy is limited by the amount of incoming solar radiation per unit area and time.

The technical limitations or imbalances of these sources can be compensated by the use of smart electricity networking and the creation of energy storage systems (WBGU, 2011).[18] Electricity companies, that build centralized solar plants, can manage their electricity load through the grid in the same way that individual consumers or decentralized generators do, feeding-in the electricity produced during daytime and using grid electricity at night (Bradford, 2006). Smart grids, as well as any other changes, will add costs to the bill, but they do provide other realms of possibilities for renewable energy use (Deloitte, 2013).

2.3.4 Technology Cost and Incentives

Economic drivers of decisions concerning energy are largely explored in the energy governance literature. Scholars like Beck & Martinot (2004) and Doner (2007) comment, that in most cases,

[18] "Smart networks" or "smart grids" can help manage the intermittency that has long been renewable energies' Achilles heal, accordingly to IRENA, this is a fundamental infrastructure to make renewable scale up (Deloitte, 2011). However there are also critics to this… (found paper about this).

energy policies and strategies exclude renewable energies and other alternatives as they are considered to be too costly and technologically unfeasible. The authors reflect on the arguments restraining their use, which also refer, in one way or another, to their perceived risks, either technical (mentioned above), financial or legal, and warning that the country does not have the capabilities to implement them.

The economic barriers, on a national level, are linked to global industry development and technological advances improving efficiency and reducing economic constraints. The WBGU reports of 2004 and 2007 identified, that in terms of economic competitiveness, wind energy, biomass and hydroelectricity were already competitive, as well as the small applications of solar energy. Meanwhile, the WBGU estimations suggest the international competitiveness of large scale implementation of solar energy from around the year 2030. In addition, the council assumes that the supply cost will decline continuously and considerably in conjunction with the growing market volume (WBGU, 2004, p. 3).

Global energy industry analysts noticed that among solar technologies, the photovoltaic is the most extensively used worldwide, but also the most expensive (Tissot, 2012). Nevertheless, its cost and efficiency aspects have been drastically improved since 2008. For instance, the cost of producing photovoltaic systems has dropped from $11 per watt in 1995 to as low as $5 in 2005, falling to less than $2 in 2011 (Bradford, 2006).[19]

On the other hand, according to GENI (2009), one reasoning commonly discussed is the lack of incentives and insight towards other technologies, as opposed to established subsidies for conventional sources. For example, the IEA (2012) stated that, in 2011, global subsidies for fossil fuels totaled US$523 billion dollars, a 30 % increase from the previous year, and six times more than the United States' US$88 billion in subsidies towards renewable energy. Similarly, the development of hydroelectricity technologies receives increasing support from governments (REN21, 2011).

From this perspective, as stated in several reports from international organizations in the energy field, governmental policies and incentives often provide the primary economic motivation for construction of renewable generation facilities (OLADE, 2009; 2011; EIA, 2011; REN21, 2011). According to the EIA (2012), the rapid increase in renewable energy generation on a global level, mostly solar energy, is mainly driven by sustained subsidies on a national level. They highlight the role of financial mechanisms known as feed-in tariffs (FITs), used in the EU

[19] En Latinoamérica está el futuro de la energía solar fotovoltaica. (2011, December 01). Retrieved 22.04.2013, from http://www.suelosolar.es/newsolares/newsol.asp?id=6407&idp=1

to enable individuals to install small scale solar energy systems in their homes and businesses, and sell excess power back into the grid (i.e. net metering). [20]

When considering the case of Germany, Flüeler et al. (2012) and Mautz (2007) reflect, that up to date, FITs are the most effective economic measure for foster renewables. According to them, this instrument may be set in consideration of price, a chief factor affecting the availability of fuels and connected to local environmental degradation. Nevertheless, the authors also observe that political regulation, as a driving force, was not dependent on a single instrument.

The Renewable Energy Law (*Erneuerbare-Energien-Gesetz*, EEG), established in 2000, and its subsequent reforms (e.g. EEG 2004, EEG 2009, EEG 2012, PV-Novelle, EEG 2014), was and still is a key instrument in the promotion of renewable energy in Germany.[21] However, besides the EEG and technology-specific FITs for electricity producers, the main elements of the German "policy mix" are financial support for research and development, as well as for private investments (e.g. including house owners), and the implementation of appropriate instruments in the field of planning law (Mautz, 2007). More recently, some Latin American countries, namely Argentina, Dominican Republic, Ecuador, Honduras, and Nicaragua, are using FITs to promote renewables (Jacobs et al., 2013).

Even so, some problems have emerged, in recent years, with regards to the FITs due to mistakes in overpricing and over-subsidizing, particularly solar energy installations and social conflicts against large outdoor solar energy plants (Weigl, 2014; Mautz, 2007). Nonetheless, Goldthoau (2014) and Mautz (2007) consider that the major obstacle to implement the country's ambitious decarburization goals in Germany is the inertia of the established energy infrastructure. On that subject, another common, but less established, explanation pertains to how renewable energy development clashes with the interests of powerful players, particularly large energy companies, and therefore receives few supporting incentives (GENI, 2009). For instance, energy policy goals, such as carbon neutrality and renewable energy targets, have been followed by contradicting interests, values, and power relations regarding energy decisions. These aspects are considered in the next section.

In summary, the branch of literature concerning national energy governance, generally, analyzes problems through the lens of a few actors (e.g. electricity 'operators' or regulators) and with a focus on single factors, chiefly economic drivers of energy decisions. Although operators and

[20] It is much about the right to connect and sell energy, as it is about the specific payment for each technology (Deloitte, 2011).

[21] Erneuerbare-Energien-Gesetz 2014. (2014) Retrieved 22.04.2014, from http://www.bmwi.de/DE/Themen/Energie/Erneuerbare-Energien/eeg-2014.html

regulators are relevant in governing national energy systems, the perspectives of electricity companies and civil society organizations are overlooked. In this sense, a less developed explanation concerns the clashes between renewable energy development and the interests of powerful players, particularly large energy companies. Aspects of legitimacy are barely mentioned.

2.4 The Role of Change Actors in Energy Transformations

This section provides an overview of studies dealing with the role of change agents and historical integrated perspectives of transformations in the energy field. Incidentally, authors in this branch drive attention to contradicting interests, values and power relations about energy decisions. This section is divided in two parts. The first part identifies the main institutional and political transformations shaping the energy sector in the last decades. The second part draws attention to a less widespread group of literature dealing with historical and integrated perspectives of conditions and energy patterns unfolding over time.

2.4.1 Institutional and Political Transformations and Actors Involved

Scholars, from the global energy governance branch, regard global climate change as a main factor shaping the global energy landscape. National energy governance literature makes reference to economic and social development goals, besides reliable energy access which drives the decisions of main actors. In this literature, national governments, electric companies and regulatory bodies have been making choices regarding energy options influenced by changing global and national contexts.

With attention to changing institutional and political contexts in developing countries, Pachauri & Spreng (2012) and Goldtahou (2014) state at least two transformation waves, in the energy field, in the last decades. The first resulted from liberalization reforms and the second is connected to climate change and the shift towards decentralized energy.

Liberalization reforms began in Latin America and spread throughout the world during the 1980s and 1990s. During these processes, private actors started to gain relevance from the state. Despite efficiency improvements, most assessments refer to the negative consequences of these reforms in terms of social and environmental sustainability on the long term. These discussions have been gaining importance in the energy field.

From a global energy governance standpoint, Florini & Dubash (2011), Flüeler et al. (2012) consider that the pro-market ideology, that has transformed the energy sector in many countries, faces new competitors from a resurgent model of state capitalism. On that subject, the

regulatory and controlling bodies have become highly relevant and must provide a required long-range perspective for public significance. Subsequent to these reforms, governments and electric companies have remained central but require stronger interrelation with a wide variety of non-governmental actors and levels of interaction (Norman, Bakker, & Cook (2012).[22]

The second transformation wave is driven by a context of mitigating climate change and alleviating energy poverty on a local scale, discussed in previous sections. Furthermore, Goldtahou (2014) draws attention to an outcome derived from both trends that resulted in a shift towards decentralized energy systems, named "distributed electricity generation" or on-site generation. Distributed electricity generation is not new. However, contrary to central generation, it has been considered to be a part of a new paradigm that illustrates the tensions between past and future electricity configurations. [23]

In fact, capital intensity, characteristic of centralized energy infrastructures, also introduces complex interests and possible contradictions since more decentralized energy systems will leave grid extension excluded. As mentioned by Bradford (2006), in relation to on-site generation, as clients become generators of their own energy it is logical that the (electricity) distribution company shall reduce its business yields. In the case of Germany, Mautz (2007, p. 114) refers to the economic dominance of suppliers (or distributors), their organizational structures and their long-term investment strategies, as "evidence that the major companies in the electricity sector will pursue their well-tried path in the future".

The energy transition in Germany is a good example to illustrate the relevance of political power and legitimation aspects, besides technical and economic considerations. Departing from highly centralized infrastructures, by the year 2011, half of the county's 53000 MW of installed renewable energy was locally owned (Deloitte, 2013). On the one hand, energy transformation in the country required both decentralized production and interconnected transmission infrastructure to deal with peak load problems across states (Goldthoau, 2014). On the other hand, this shift was socially embedded and historically linked to social and environmental movements of the 1970s, reinforced by operator and manufacturer networks during the 1990s (Mautz 2007).

In terms of governance and the roles of key actors, according to this emerging paradigm, more collaboration between government policy and industry investment is required (Deloitte, 2011). Goldtahou (2014, p. 138) asserts that even off-grid solutions are far from being independent

[22] The management level is relevant in terms of the type of actors involved and the scale in which they participate (i.e. local, national and global) (Norman et al, 2012).
[23] Distributed (decentralized) electricity generation, is loosely defined as small scale electricity generation or storage systems located near or at the building site (on-site generation) (IPCC, 2001).

from other scales, "as they are part of a larger energy infrastructure ecosystem". The multiplicity of roles, resulting from this decentralization process, also raised questions regarding political power, including legitimation questioning in terms of who makes decisions regarding infrastructure (Goldtahou, 2014).

Authors from different viewpoints agree that effective solutions rely on social deliberation and political negotiation (Bakken et al. 2012; Blacksher et al., 2011; Geden & Beck, 2014). According to them, policies are based on individual preferences or political and management priorities (Bakken et al., 2012; Blacksher et al., 2011). Moreover, "decisions regarding acceptable risks are inherently political in nature" (Geden & Beck 2014, p. 748).

2.4.2 Historical Integrated Perspectives

Although the consensus regarding the effectiveness of more integrated approaches on policies, academic empirical research remains fragmented. Pachauri & Spreng (2012) and Schienstock (2007) remark that academic empirical research, regarding energy, is often disciplinary research that is vital and important, but rarely suited to furnish sound policy advice. Concerning the question of how a new energy trajectory emerges, literature is limited in providing answers given that: "The emergence of a new techno-organizational path cannot be explained by referring to single factors or single models" (Schienstock, 2007, p. 254).

In the case of Costa Rica, the work of two scholars is highlighted here as an example supporting these arguments, in the renewable energy sector. Wilde-Ramsing & Potter (2008) found that despite facing several barriers, such as the economic and institutional constraints mentioned above, which would hamper a country from developing renewable energies, Costa Rica's electricity comes mainly from these sources.[24] The authors introduce then, an institutional organizational approach to explain the interrelations between the Costa Rican electricity institute and the private sector named as a socially "embedded autonomy".

However, less-known literature deals with historical analyses of conditions and patterns unfolding over time. For example, in explaining cases from developed countries, there are studies that relate the problems restraining renewable energies with social conditions of innovation and historical analyses (e.g. Meyer & Schubert, 2007; Jørgensen, 2012). None of these reviews, using this approach, were identified in Latin American countries.

[24] Costa Rica is not a wealthy, industrialized country to invest in capital intensive renewables. It has a small energy market, but it does not completely rely on hydroelectricity and it is commanded by a state-owned firm, which in developing countries, is considered inefficient and risk adverse. Despite this, the country has proof of oil reserves but it has refuse this kind of investments (Wilde-Ramsing & Potter, 2008).

Scholars researching energy transition in Costa Rica refer to political and institutional inertia tending to benefit conventional energy sources (Vargas, 2002; Jimenez, 2009). However, none of them has directly approached this phenomenon in order to develop theoretical explanations. For instance, Vargas (2002) aknowledges that institutional development and experience are the main factors affecting the performance of the electricity sector and the space for clean energy sources. The author considers path-dependency and patterns of interaction between different actors as part of the energy problems in developing countries, even though the study did not contribute much attention to these aspects.

With regards to the above, additional insights are required to understand the demands of urgent changes in the energy sector, including stable and lasting solutions. Nevertheless, less attention has been paid to the voice of civil society organizations and to aspects of political power and legitimation concerning energy transitions over time. The following Chapter investigates the most important dimensions of path dependency along with their social dynamics.

2.5 Concluding Remarks

Academic debates on energy transition towards low carbon energy systems has been looking at determinants from global, national, and/or agent centered angles. Each of them provides answers, to a certain extent, to the following questions: (1) why do countries engage in low carbon and renewable energy goals?; (2) why do some energy options dominate while others are relegated?; and (3) how do aspects of legitimation influence energy decisions? Nonetheless, I identify three main gaps within those debates, as illustrated in table 2.

Table 2. Answers and gaps from literature

Literature Review	Global Energy Governance	National Energy Governance	The Role of Change Agents
Why Do Countries Engage in Low Carbon and Renewable Energy Goals	- Global climate change	- Climate change effects - Technology cost and incentives	- Liberalization reforms - Global climate change - Decentralized energy systems
Why Some Energy Options Dominate While Others Are Relegated	- Global industry developments	- State incentives	- Current social interests and political alliances
How Aspects of Legitimation Influence Energy Decisions	- In global environmental governance discourses	- Through sector regulation and policy implementation	- Centralized vs decentralized energy systems
Actors Involved	- International financial organizations - Governments and civil society organizations	- Governments - Regulators - Private sector	- State - Electricity companies - Civil society organizations

Source: Own compilation

First, in the study of renewable energy governance the fragmentation among sources has grown. Hence, in approaching the different types of renewable energy sources, studies in the field have to evolved from the general consideration of renewable energies without distinctions, or a differentiation between hydro from non-hydropower sources and more recently, towards a broader separation and examination between non-hydro renewable energy sources.

Second, I found a regional research gap, since in many cases the focus is on regional powers and emerging economies (e.g. Brazil, India, China) confronting global energy challenges. Therefore, a bias is present when answering the above mentioned questions.

Third, although state actors and regulators are relevant in governing national energy systems, the perspectives of electricity companies and civil society organizations are overlooked. Though, they are increasingly relevant in the discussion on energy goals. In this sense, a less developed explanation pertains to how renewable energy development clashes with the interests of powerful players, particularly large energy companies, and thus, receives few supporting incentives.

The fourth and last gap is methodological in character. A less widespread group of literature has been dealing with historical analyses of conditions and patterns unfolding over time and restraining renewable energies. Most studies have limitations explaining policy gaps because they typically look for synchronic determinants of policies, for example, in current social interest or in existing political alliances (Pierson, 1996). Meanwhile, a historical approach emphasizes the importance of initial decisions and choices of venues as well as it introduces notions such as that of path dependency.

Concerning responses to the aforementioned questions, energy governance literature, on a national and global level, regard climate change as the main factor of energy transformation in the last two decades (question 1). The climate change discourse is also outlined as a factor that spurred the construction of hydroelectric dams worldwide. However, the standpoints of "small states" are missing, such as those in Central America, which are considered amongst the most vulnerable to the impacts of climate change (CEPAL, 2007; PEN, 2011).

Within the global energy governance branch, debates on energy transition tend to focus on conventional energy sources (i.e. fossil fuels and to some extent hydroelectricity), which limit further discussions on the role of alternative renewable sources (question 2). In addition, aspects of legitimation are integrated into discussions of environmental governance and transnational networks of actors. Nevertheless, it is overlooking a deliberation concerning antagonistic and competing interests between different options (question 3).

Meanwhile, national energy governance literature tends to focus on barriers hindering renewable energy use for economic growth and social development, reliable electricity and technology cost and incentives (question 1). In finding answers to the second question, this literature directs its attention to load factors, costs, and low carbon characteristics of the different technologies. Government support through incentives is also highlighted as a key determinant of renewable energy use (question 2). Aspects of legitimacy are barely mentioned relating the figure of the regulators (question 3).

Literature regarding change agents refers to the effect of institutional and political transformations in the energy field (i.e. liberalization reforms, climate change, distributed electricity generation) as drivers of energy transitions (question 1). Contradicting interests, values and power relations concerning energy decisions are analyzed in works that exemplify conflicts between centralized and decentralized energy systems (linked to questions 2 and 3).

3 Theoretical Framework: Neoinstitutionalism and the Mechanism-Centered Approach

3.1 Introduction

This chapter introduces the concepts and the theoretical framework, which are the basis for the historical analysis of policy decisions towards achieving the goal of carbon neutrality in Costa Rica's energy system. At first, the chapter defines path dependency and its elements, also explaining why it is defined as a problem of policy outcome. Successively, it sharpens the concept of self-reinforcing mechanisms and differentiates three explanatory propositions of "efficiency", "legitimation", and "political power" mechanisms. Thereafter, it elaborates on conceptual elements of the path breaking phase possibly reversing path dependency mechanisms. Lastly, it presents a summary of the theoretical approaches and their main contribution to the present research.

The purpose of this chapter is to understand the causal mechanisms of technology development, stabilization, and change in political and institutional contexts. The main findings of this chapter are twofold. The first relates to concepts and theory. The second refers to the approach of policy problems from a theoretical perspective.

Regarding concepts and theory, the present research proposes a mechanism-centered analysis with a pragmatic use of theories. Therefore, the analysis relies on a combination of existent theoretical approaches of path dependency and path breaking, combined with other elements of governance, at national and global levels, as well as notions of future expectations. Concerning policy problems, the case under analysis is framed as a problem of policy outcome in which the country got entrapped. Analysts of mechanisms and processes regard the coherence and significance of episodes as something to be proven rather than assumed (Tilly, 2001, p. 25-26). Hence, the focus on self-reinforcing mechanisms is used to explain the gaps in political control.

3.2 Defining Path Dependency

3.2.1 Neoinstitutional Approaches of Path Dependency

The present research departs from neoinstitutional approaches of path dependency and path creation advanced by Mahoney (2000), Pierson (2004), Garud & Karnøe (2003), Meyer & Schubert (2007), among other scholars, to cope with the dual nature of institutions, their dynamism, as well as their permanence. Both concepts help to explain stabilization, though path dependency emphasizes the influences of structure on outcomes, while path creation underlines agents' relevance. As opposed to institutionalism currents that traditionally focused on the study

of formal institutions, neoinstitutionalism, restated the relative autonomy of political institutions (Hall & Taylor, 1996; March & Olsen, 1984; Mayntz & Scharpf, 1995; Scharpf, 1997).[25]

Path dependency is broadly defined within neoinstitutionalism as a phenomenon of limited change where reproduction of initial institutional or policy decisions, even suboptimal ones, prevail over transformation (Liebowitz & Margolis, 1995; Pierson, 1996). Therefore, the concept helps to explain how the evolution of rules and policies, along with social adaptations, create and increase structured polity that restricts the options available to all political actors (Pierson, 1996). In this sense, in path dependency, it is the actors' constraint that emphasizes the influence of structure on outcomes.

Conversely, the concept of path creation stresses the role of agency in the stabilization of an institutional or technological path. The concept of path creation was incorporated in the theory of path processes by Garud & Karnøe (2001; 2003) and further developed by Meyer & Schubert (2007) in order to expand the scope of emergent events allowing for elements of strategic change. Concepts related to path creation include vested interests, fixed assets, and sunken costs. Therefore, according to path dependency and path creation, the quasi-irreversibility of institutional or technological developments is not only based on investments but also on interests.

As indicated by Berthod & Sydow (2013), with the introduction of 'institutional entrepreneurs', the neoinstitutionalist focus shifted towards issues of change and evolution. Actions of institutional entrepreneurs have implicit processes of confrontation (e.g. from those who resist change and defend the status quo). Then again, aspects of resistance and the struggle over reproduction evoke path dependency in particular cases, wherein organizations fail to depart from replication and sedimentation of structure over time.

Within neoinstitutionalism there are different schools of thought, including historical institutionalism, rational choice institutionalism, and sociological institutionalism (Pierson, 1996; Hall & Taylor, 1996). Although they have developed quite independently, they all seek to study the role of institutions in determining social and political outcomes, though using a different analytical approach. Among them, historical institutionalism provides a theoretical rich ground to understand the processes or mechanisms, where unintended consequences and inefficiencies generated by existing institutions, contrast images of institutions as more purposive and efficient (Pierson, 1996; Hall & Taylor, 1996).

[25] Functionalism and rational choice theories were distinctive expressions of the 'behavioral revolution' against institutionalism, driving attention towards the individual. As a reaction, neoinstitutionalism stresses that institutions are neither a mirror of society (behaviorism) nor merely the site for individual strategies (rational choice) (March and Olsen, 1984).

This historical approach emphasizes the importance of initial decisions and choices of venues, and introduces notions such as those of path dependency. Therefore, path dependency is one feature of historical institutionalism that has stressed the ways in which such initial institutional or policy decisions, even suboptimal ones, can become self-reinforcing over time (Pierson, 1996). Historical institutionalists also underline the asymmetries of power over institutions, the role of ideas and their institutionalization over time (Hall & Taylor, 1996).

The concept of institutionalization (Colomy, 1998) and path dependency (Liebowitz & Margolis, 1995; Pierson, 1996) refer to this phenomenon of institutional persistence in which reproduction prevails over transformation to a certain extent. However, institutionalization and path dependency are not the same. Institutionalization makes reference to how specific organizational structure or pattern of activities are consolidated and taken for granted over time (whether as a matter of formal law, custom, or knowledge) (Colomy, 1998: 285; Sydow et al., 2009). Similarly, structural inertia or imprinting issues do not equate to path dependency, when these concepts refer to simple identification of traces along a trajectory, accumulation, mimicry, isomorphism, or simply the identification of inertia (Sydow et al., 2009).

Scholars, in path dependency theory, are mostly inclined to perceive the process of becoming path dependent as one particular form of institutionalization (Berthod & Sydow, 2013). Still, path dependency is not only structural inertia or persistence (i.e. external imperatives or mechanisms that enforce the diffusion and maintenance of institutions), especially if it is not clear how self-reinforcement (i.e. internal processes) occur and in what form. In the absence of internal processes of reinforcement, path dependency and institutionalization cannot be exchangeable.

3.2.2 Elements of Path Dependency

Among the constitutive elements of path dependency or path creation, the ones that stand out are: agency, structure, critical juncture, and self-reinforcing mechanisms. Despite differences on emphasis, most scholars suggest a better understanding of their conceptualization and relationship by looking at different phases of path development, distinguishing "genesis", "emergence and diffusion", "reproduction", and "stability" (e.g. Mahoney, 2000; Meyer & Schubert, 2007; Sydow et al., 2009; Sydow & Schreyögg, 2013). Each phase has different causal regimes that evolve in a progressive logic of becoming locked into a path and eventually of un-locking processes. They are summarized in table 3.

Genesis: the Role of Agency

Agency, either as an individual or collective action, is highlighted in the first phase of path dependency that can be characterized as an open decision making situation when several alternatives are possible. According to Giddens (1984), an agent is one who exerts power or produces an effect. Thus, power is not an intention, but rather the capability of getting things done. Nevertheless, this initial phase is neither of completely unrestricted choice (i.e. rational choice theory), nor of determinacy (i.e. historical institutionalism). Rather, it is one of decisions embedded and connected with other developments and imprints from the past. In this phase, agents' decisions are contingent (i.e. their outcomes are unforeseeable consequences of purposeful action), though not random.

Emergence and Diffusion: the Relevance of Critical Junctures

A critical juncture marks the division between the genesis and the phase of emergence and path diffusion, also called path creation or formation phase. A critical juncture is a moment of substantial institutional change or a 'branching point' from which historical development moves onto a new institutional formation and developmental pathways (Thelen, 1999; Hall & Taylor, 1996). Hence, increasing selectivity begins in this phase and contingent or mindful choices are made, triggering self-reinforcing dynamics. As long as decisions are made, the number of alternatives is reduced, and choices, while still possible, are essentially constrained.

This element highlights the importance of timing, sequencing, and interaction of ongoing political processes (Thelen, 1999; Pierson, 2000). In consequence, institutions continue to evolve in response to changing environmental conditions and at the hands of political agents but in ways that are constraint by past trajectories. The main problem lies in explaining what precipitates such critical junctures. Although historical institutionalists generally stress the impact of economic crisis and military conflict, many do not have a well-developed response to this question (Hall & Taylor, 1996: 942).

Reproduction: the Dynamics of Self-Reinforcing Mechanisms

During this third phase, there is further restriction to the scope of action. Decisions are led by mechanisms of self-reinforcing dynamics that may end up in a stage of stagnation or a lock-in. Self-reinforcing mechanisms are considered a main feature of path dependency. They are conceptualized as processes, patterns, or routines that develop dynamics on their own, rendering the whole process increasingly irreversible (Sydow et al., 2009; Sydow & Schreyögg, 2013; Mahoney, 2000). Self-reinforcing mechanisms exhibit increasing benefits with their continued adoption, different to reactive sequences of events or similar patterns describing merely institutionalization, institutional persistence, imprinting, or structural inertia (Mahoney, 2000).

In answering how self-reinforcement occurs and in what form, three main branches within path dependency literature are differentiated: historical institutionalism, political science and organizational analysis (Sydow & Schreyögg, 2013). Scholars, from organizational studies, draw in particular on Arthur's mechanisms (Arthur, 1994) of self-reinforcing processes that result of economic logics producing increasing returns (Sydow & Schreyögg, 2013; Sydow *et al*., 2009; North, 1990). Best known drivers from this branch include learning effects and cooperation on the social level, or economies of scale on the technological level (Sydow et al., 2009).

Historical institutionalism cuts across the usual sharp dichotomy between rational choice and non-rational choice work (Hall & Taylor, 1996; Pierson, 1996). Instead, the approach is drawing on researches from both traditions that emphasize the significance of historical processes. Thus, it includes rational choice analyses, as well as sociological approaches that consider crucial issues of institutional evolution and path dependency (Pierson 1996). Hall & Taylor (1996) differentiate among the calculus approach, the cultural approach, and the asymmetries of power.

With applications on political science case studies, Mahoney (2000) and Mahoney & Schensul (2006) have attempted to categorize four possible forms of reproduction mechanisms: Utilitarian, Functional, Power, and Legitimation.[26] According to them, most economists assume that utilitarian mechanisms of cost-benefit analysis underpin processes of institutional reproduction, once increasing return processes have been initiated. Nonetheless, understanding other specific mechanisms that produce self-reinforcement is crucial because alternative mechanisms suggest different ways in which patterns, marked by path dependency, might be reversed.

As pointed out by Thelen (1999), self-reinforcing mechanisms still need further specification and theoretical development. It is therefore important to explore key issues regarding who exactly is investing in particular institutions and what dynamically sustains these institutions over time. This allows for an approach that includes both actors and structures (Meyer & Schubert, 2007; Thelen, 1999).

Stability: the Influence of Structure and the Process of Structuration

Institutional reproduction processes, which result from self-reinforcing dynamics, eventually became stabilized or institutionalized in a third phase that characterizes path dependency and

[26] The author uses path dependency to discuss deviant cases of two kinds. One group refers to cases when early contingent events set developments on a historical trajectory of change that diverts from theoretical expectations. Another group includes cases in which outcomes are shared by other cases but lack the causal variables normally associated with their occurrence. The cases include the industrial revolution in England and status-based labor legislation in the US.

lock-in situations. At this stage, a specific trajectory of development is situated in a state of rigidity, inertia, or decay that is difficult to reverse, hence it is path dependent. From this stage onwards, self-reinforcing mechanisms build a regular pattern or routines which are to be expected. In other words, this stage of path dependency emphasizes the influence of structure on outcomes.

The structural conception highlights people's actions as rational reactions to exogenously given structures in their environment (i.e. the material surrounding) that dictate behavior or create a pattern of structural constraints and incentives (Parsons, 2007). This structure compels the states (or other relevant actors) to think of an increased revision of existing arrangements. Nonetheless, agency is also present for locking-in a path. Here, authors base their analysis on Giddens' conceptual framework of structuration (Giddens, 1979; 1984).

Sydow & Schreyögg (2013: 8) point out that, from this stage onwards, self-reinforcing dynamics build a regular pattern of degenerating or escalating side effects which are to be expected.[27] Protected by these routines, path dependency is well prepared to reject change and defend the status quo "making it so hard to break the circle". Furthermore, decisions are bound to replicate the path, and agents continue to reproduce this particular outcome, which even newcomers are 'forced' or induced to adopt. [28]

There is still some lack of clarity in the definition of the lock-in stage (e.g. how long it is and how it explains stability). Similarly, it is also unclear for the precision of the un-lock processes (e.g. what is the cause of stopping or interrupting?). Considering these ambiguities, path dependency thinkers suggest to focus on the mechanisms (i.e. the self-reinforcing processes) and spell them out.

Path Breaking: Reversing Self-Reinforcing Mechanisms

Eventually, the lock-in situation may change through the dynamics of path breaking, giving birth to a new phase of path termination or un-locked stage. Path breaking or un-locking is characterized by stopping or interrupting self-reinforcing processes, changing the focus towards institutional change. Therefore, there is again an open situation to a variety of options that increases selectivity by actors; possibly creating a new path. Forms of governance, at national and global level, as well as notions of institutional entrepreneurs and future expectations take on particular relevance in a path breaking phase.

[27] At this stage "the (escalating) dynamics come to an end, but the circular reproduction of the now-routinized interaction, guided by increasingly 'firm' structures, carries on" (Sydow & Schreyögg 2013, p.8).

[28] In an extreme form of lock-in, alternative courses of action are no longer feasible. This dominant pattern that gains a deterministic character has been found in technological solutions, but is not likely to occur in social processes (Sydow et al., 2009).

Table 3. Main elements of path dependency and causal regimes

Phases of path dependency	Main elements	Theoretical predictions or causal regimes
Genesis / pre-formation	Agency / Contingency	Open situation for decisions (several alternatives are possible), but they are historically embedded (i.e. with inputs from the past) and contingent (i.e. unforeseeable consequences of purposeful action)
Emergence / path creation	Critical juncture (Agency)	Critical juncture triggers increasing selectivity, contingent or mindful choices are made triggering self-reinforcing dynamics. As long as decisions are made, the number of alternatives is reduced and choices, while still possible, are essentially constrained
Reproduction	Self-reinforcing dynamics (Agency)	Further restriction of the scope of action. Decisions produce tapering processes and a loss of flexibility lead by self-reinforcing dynamics: learning effects, economies of scale, power relations, increasing legitimacy, etc.
Stability / path dependency	Self-reinforcing routines (Agency)	Self-reinforcing dynamics built a regular pattern of degenerating or escalating side effects, which are to be expected. The (escalating) dynamics come to an end, but the circular reproduction of the now-routinized interaction, guided by increasingly 'firm' structures, carries on
Path breaking or un-locking	Agency / Contingency (Future expectations)	Stopping or interrupting self-reinforcing processes, changing the focus to institutional change. Therefore, there is again an open situation to a variety of options that increase selectivity by actors

Source: Own compilation

3.2.3 Path Dependency as a Problem of Policy Outcome

Studies of how processes get entrapped or become path dependent have recently gained particular attention (Garud, Kumaraswamy & Karnøe, 2010; Meyer & Schubert, 2007; Sydow et al., 2009; Sydow & Schreyög, 2013). Particularly, since the operation of self-reinforcing mechanisms help to explain the gaps of political control. Sydow & Schreyögg (2013) refer to a theory of self-reinforcing dynamics and remark their possibly 'devastating' impact on organizations and society in general, explaining puzzling results such as rigidity, inertia, and decay (e.g. explaining ongoing debt crisis).

Furthermore, as long as routines or self-reinforcing mechanisms involve actors, they are subject to unexpected reactions. [29] On the one hand, routines have a fixed side as overarching pattern, on the other hand, they involve some variation when performed (Sydow et al., 2009). These aspects are at the core of path dependency dynamics, but also of institutional change.

[29] Routines are defined shortly as familiar patterns of behavior (Hall & Taylor, 1996).

Although self-reinforcing mechanisms are dynamic processes or sequences that provide agents and organizations with a "positive" feedback at the beginning of a path, the problem with these routines emerges later. According to Berthod & Sydow (2013, p. 208), in the short-term "paths enable as much as they constrain", but the effect becomes problematic on the long run. Mahoney (2000) also states that the flip side, in the long-term, is that, over time, the whole process becomes irreversible and is more difficult to select the previous available options or to transform the pattern, even if other alternatives would have been more "efficient".

Debates regarding the conceptualization of "efficiency" outside market conditions are evidenced in the literature, mostly, since efficient results could co-exist with high inequality or low legitimacy (Liebowitz & Margolis 1995; David, 2001; Boas, 2007). Arthur (1994) and Pierson (2000) suggest leaving the issue of efficiency aside from the theory of path dependency. Boas (2007) also considers the debate over efficiency less important, for political science, since there is no common assumption, in the discipline, on efficient outcomes.

Yet, Sydow et al. (2009) consider that, from a strategically future-oriented viewpoint, referring to puzzling persistence or rigidity means potential (or latent) inefficiency. Within the present research, the term 'inefficient', as well as 'suboptimal', are used loosely in a path dependency context to designate institutions that generated unintended and sometimes undesired consequences. Specifically, they account for institutions that produce a gap between policy expectations and policy outcomes.[30]

According to Pierson (1996), historical institutionalism emphasizes how the evolution of rules and policies, along with social adaptations, create and increase structured polity that restricts the options available to all political actors. These aspects mark a crucial difference with neofunctionalist views of political control as a zero-sum. This occurs because functionalism considers gaps or losses (between expectations and outcomes of policy implementation), theoretically, unproblematic since transaction costs economics describes two mechanisms to restore efficiency: competition and learning.

However, both mechanisms are of limited applicability "when one shifts from Williamson's focus on firms in private markets to the world of political institutions" once single unintended effects may be quite large and processes may be path dependent (Pierson, 1996, p. 141).[31] Transaction cost economics assumes that institutions and behaviors evolve through some form of efficient historical process that moves rapidly to a unique solution: "Analysts typically look only for synchronic determinants of policies –for example, in current social interests or in

[30] In any case, calling a lock-in "inefficient" always implies a base of reference –a comparison with other standard (Sydow et al., 2009, p. 695).
[31] In reference to Williamson, O. E. (1993).

existing political alliances" (Pierson, 1996, p. 131). While the central idea for Pierson (1996) is that the context is not fully controlled by actors (even collectively), the basic information for decision-making within processes of institutional building is localized and depends on specific contexts.

In summary, the problem of political outcome emerges not only from decisions that result in 'inefficient' or 'suboptimal' burdens later on, but mainly from creating a situation that actors find difficult to reverse (i.e. a lock-in that is self-reinforcing), even when the context has changed (Pierson, 1996; Hall & Taylor, 1996). Such difficulties escalate as initial choices encourage the emergence "of elaborate social and economic networks, greatly increasing the cost of adopting once-possible alternatives and therefore, inhibiting the departure from a current policy path" (Pierson, 1996: 145).

3.3 Efficiency, Political Power and Legitimation Mechanisms

This section refers to Hall & Taylor's (1996) and Mahoney's (2000) broad formulation of mechanisms that differentiate the calculus approach, the cultural approach, and the asymmetries of power.[32] Accordingly, the present study clusters self-reinforcing mechanisms in three forms: efficiency mechanisms, political power mechanisms, and legitimation mechanisms. Since there are different ways to conceptualize path dependency mechanisms, three considerations are highlighted.

First, the focus is on self-reinforcing dynamics, rather than 'reactive sequences', or similar patterns that merely describe institutionalization, institutional persistence, imprinting, or structural inertia. As mentioned previously, these social processes can be analyzed through the lens of path dependency, though they are not necessarily a path dependent process (Sydow et al., 2009; Berthod & Sydow, 2013). As pointed out by Mahoney (2000) self-reinforcing processes exhibit increasing benefits with their continued adoption, while reactive sequences are chains of temporary ordered and causally connected events.

Second, for the analysis of policy problems in the Costa Rican energy sector, I consider that having three competing categories of efficiency, political power, and legitimation is the most assertive way to examine self-reinforcing mechanisms and their possible reversal. Path dependent theorists, such as Hall & Taylor (1996), Mahoney (2000), Meyer & Schubert (2007),

[32] Mahoney (2000) has attempted to categorize four possible forms of mechanisms of reproduction: Utilitarian, Functional, Power, and Legitimation.

among others, categorize mechanisms similarly, identifying related societal forces. Moreover, they are based on general explanations used in social sciences.[33]

Third, in the present study, they are grouped in this way seeking to systematize and monitor theoretical competing predictions in the empirical stage of the research. For instance, functional and utilitarian logics, proposed by Mahoney (2000), are gathered into one category of efficiency which integrates the calculus approach from individual (i.e. in the form of personal profit motivations) and systemic logics (i.e. in the form of efficient functional assessments). This distinction is further clarified during the data analysis.

3.3.1 Efficiency Mechanisms

Efficiency mechanisms are derived from the calculus approach affecting individual or institutional actions by altering expectations of an actor regarding the actions of others. From this perspective, the individuals are 'utility maximizers' and strategic interaction clearly plays a key role. In this category of mechanisms, one could also integrate Mahoney's (2000) functional mechanisms of systemic reproduction. Therefore, according to efficiency explanations, an institution is reproduced through the rational cost-benefit assessments of actors or because it is justified as functional for an overall system. Institutional change may occur when it is no longer in the self-interest of actors to reproduce a given institution or because an exogenous shock transforms the system's needs.

Drivers of efficiency are explained by economies of scale, learning effects, adaptive expectations, coordination effects, network externalities, and complementary effects (drawing in particular on Sydow & Schreyögg 2013). As a common denominator, the criteria to expand and reproduce the same procedure is decreasing cost per unit, increasing profitability and efficiency gains. Therefore, these mechanisms are included in the rational cost or utilitarian logics.

Among them, economies of scale are one of the best known self-reinforcing dynamics. It takes aim at evermore returns by expanding the volume and reproducing the output, which is also related to fixed and sunk costs resulting from large investments. Other examples could be learning effects, by which efficiency is gained when executing subsequent iterations (e.g. with skillful gains increasing returns). Meanwhile, coordination effects produce efficiency gains from rule-guided behavior when more actors adopt and apply a specific institution (i.e. a law, a norm, a routine, etc.).

[33] Mahoney's categories are "loosely" following Collins' (1994) work, "Four Sociological Traditions".

3.3.2 Political Power Mechanisms

According to political power mechanisms, an institution is reproduced because it is supported by an elite group of actors that benefit from the existing arrangement, even when most individuals or groups prefer changing it. The self-reinforcing processes might work when the institution initially empowers a certain group, at the expenses of other groups. The favored group then uses its additional power to expand the institution even further, which, in turn, increases the power of the advantaged group, and so forth. Inherently, conflicting processes of institutions may eventually give way to institutional change, in which case, there is a weakening of the elites and a strengthening of subordinated groups.

This approach fits in with the actions of "successful institutional entrepreneurs", as agents of change, introduced by DiMAggio (1998) and incorporating political power struggles (this is discussed in the following section). Similarly, the "mindful contributions of powerful actors" (Meyer & Schubert 2007:24) are emphasized in approaches of path creation or institutional change. In the classical version of path dependency, historical institutionalists direct their attention to the asymmetries of power (Hall & Taylor 1996).

According to this view point, the power relations present in existing institutions give to some actors or to some interests more power than to others in regards to the creation of new institutions. They tend to emphasize on the way in which some groups lose out while others gain. In social interaction contexts, even subordinated groups can influence their superiors using resources. For example, Sassen (2007) uses the concept of 'embeddedness of the global', in which collectivities or groups internal to states, but strongly integrated into international networks like transnational corporations or social organizations, might also have a transformative power.

3.3.3 Legitimation Mechanisms

The legitimation mechanism weighs in on individuals' routines or familiar patterns of behavior. Self-reinforcing mechanisms from legitimation operate when an institution is reproduced because actors believe it is morally just or appropriate, although this institution may be less consistent with the values of actors than previously available alternatives. Institutional forces of legitimation include rational myths; a knowledge which is legitimated through the educational system and by the professions, public opinion, and the relevant laws (DiMaggio & Powell, 1991). Institutional transformation is, thus, located with changes within the values and moral codes concerning what is considered appropriate, rationalized myths, declines in institutional efficacy or stability, or the introduction of new ideas on behalf of political leaders (Mahoney, 2000).

The legitimation framework of path dependency is linked to the cultural approach of sociological institutionalism. This mechanism stresses individuals' routines or familiar patterns of behavior. It goes beyond the considerations of efficiency and follows an appreciation of the role played by collective processes of interpretation and concerns for social legitimacy. Any individual can transform institutions that are "taken-for-granted", but these institutions resist because they actually structure the choices of reform and bind individual's worldview (Hall & Taylor 1996).

At organizational levels, legitimation is also a driver of path dependency. In order to gain legitimacy, organizations are tempted or constrained to follow the rationale of institutions, structuring their field and thereby, optimizing their access to the resources they require (Sydow & Schreyögg 2013; DiMaggio & Powell, 1991). This formal organizational structure not only reflects technical demands and resource dependencies, but also the fact that they are shaped by institutional forces of legitimations mentioned above.

Nevertheless, there are debates that arise over the sources of institutional pressures, most notably concerning where rational myths come from, the way in which practices travel and circulate, and which are the primary sources of legitimacy (DiMaggio & Powell, 1991). This perspective fits in with global governance approaches studying the influences of global norms, further discussed in the following section.

3.4 Elements of Path Breaking and "Imagined Futures"

Path dependency is recognized to have a wide explanatory power (Mahoney, 2000). Similarly, self-reinforcing mechanisms (SRM) are a powerful explicatory tool of path dependency. Nevertheless, and in order to avoid determinism, this research complements the study of SRM by the incorporation of agency aspects in the form of governance concepts, at a national and global level. In addition, attention is given to their future expectations in influencing decisions.

3.4.1 Governance at a National and Global Level

Governance is broadly defined as the joint contribution of public goods by state and non-state actors (EUISS, 2010). Forms of governance are central to this research, since governance impacts institutions and actors' decisions (Pierson, 1996; Börzel & Risse, 2010). On a national level, institutionalization processes not only concern the state. Within the constellation of actors, this research focuses on institutional entrepreneurs. Institutional entrepreneur actions and strategies may also take the form of mechanisms applied to path dependency and path breaking approaches (e.g. efficiency, political power and legitimation).

On a worldwide level, the global governance discourse stresses the growing importance of multi-actor constellations in inter- and transnational politics, in different processes of norm building, mainly through international cooperation (Hein, Bartsch, & Kohlmorgen, 2007). With a focus on global governance, international practices include multilateral agreements and other governance functions, such as information-sharing, in steering capacity building and implementation, as well as rule-setting (Andonova, Betsill & Bulkeley, 2009).

Institutional Entrepreneurs

DiMaggio (1998) introduces the role of institutional entrepreneurs to the analysis of institutional formation. Theories studying institutional change (and path dependency) are considered to suffer macro biases that impair the recognition of human agency and interest in institutional change (Colomy, 1998; Fu-Lai Yu, 2001). Thus, how is it possible to develop new paths and institutions when institutions themselves (as constraints) define both, incentives and outcomes? (Colomy, 1998).

The concept of institutional entrepreneurs contributes to reducing those macro biases of structure over agency. Moreover, it also provides a category to differentiate between emergent events behind actors (e.g. external shocks) from actors' intended and deliberate actions (e.g. pursuing incentives). Consequently, their moves or actions can be strategic, pursuing their own interests and projects; or action-orientated towards communication and mutual comprehension (Breit & Troja, 2003). Their responses can be creative (radical) or adaptive from namely extraordinary and ordinary entrepreneurs (Fu-Lai Yu, 2001); and their projects can be considered to be totalizing, reconstructive, or elaborative, depending on the level of institutional alterations (Colomy, 1998).

Therefore, institutional entrepreneurs are actors who have interests in institutional change, but rarely possess the resources, power, and legitimization necessary to implement their program. The institutional entrepreneur, along with its "innovative project", is also embedded and strongly influenced by social relationships of power, coalitions, and conflicts involving institutional change (Colomy, 1998; Breit & Troja, 2003). For this reason, the institutionalization of their "entrepreneurial project" usually requires the assent of various groups and the use of strategies to enlist support and defuse resistance.

Under exceptional circumstances, resource-poor entrepreneurs can, however, serve as effective change agents vis-à-vis mass defiance. For example, their project might succeed when rapid economic and social transformations undermine political stability and render uncertain relationships between political leaders and their constituencies (DiMaggio, 1998). According to

this theory, successful entrepreneurs are overrepresented by elites and secondary elites, powerful state actors, and professional groups (DiMaggio, 1998; Colomy, 1998).

Concerning the strategies to enlist support and defuse resistance, Colommy (1998) describes two examples. One is based on institutional entrepreneurs that are estimating probable success and the other on institutional entrepreneurs adapting to contingencies. In the first case, strategic actions result from entrepreneurs' rational assessment of their tactics via estimation of costs, opponents' responses, and probable success. In the second example, it is possible that entrepreneurs display strategic actions from a repertoire of collective actions (with a preference for familiar strategies) in order to mobilize support.

Those strategies also link the micro-level actions of agents with outcomes at the macro-level when they impact institutions (Colomy, 1998). Similarly, from a technological path perspective, Meyer & Schubert (2007) analyze empirical cases where the constitution of a technological path is the result of different levels of actor involvement and diverse strategies. In addition, the authors also consider related strategies of calculating chances of success; situations of companies with sufficient funds that partake in various competing strategic alliances; and also cases of conflicting or competing perspectives.

Therefore, institutional entrepreneur actions and strategies are relevant at the path breaking stage, potentially reversing self-reinforcing mechanisms (e.g. utilitarian or calculus explanations, legitimation, etc.). Since self-reinforcing dynamics are at the core of path dependency, Sydow et al. (2009) point out that the first step in any path breaking intervention is not only to reflect on the fact of being path dependent, but also on the drivers that make this happen. This also depends on the character of the self-reinforcing dynamic itself.

For instance, reversing mechanisms of political power involving inherent contradictions is more plausible than transferring learning effects from one specific field to another. Moreover, Sydow et al. (2009) refer to the additional efforts needed for the restoration of choices, similar to a possible costly subsidy helping the new alternative to catch up to the existing one. Coordination effects might be different since the driver depends a great deal on the willingness to conform to rules and also to reduce uncertainty about others actions.

Conversely, Mahoney (2000) highlights the reversing logics of self-reinforcing processes as elements of change. According to his explanatory modes (e.g. utilitarian, functional, power and legitimation), elements of change may also derive from declining actors' self-interest, inherent power contradictions, or waning legitimacy on institutions. In the case of systemic logics (i.e. functional explanations), change arises as an exogenous shock transforms the systems' needs.

Furthermore, mindful deviation is not a solitary act (of institutional entrepreneurs) but a long lasting process of continued path creation and activity establishment (Meyer & Schubert, 2007). It involves the mobilization of different resources like "minds" and "time" and the accumulation of inputs from multiple actors. As in the case of technological development, the "entrepreneurial agency is distributed across multiple actors" (Garud & Karnøe, 2003, p. 277). However, it is not guaranteed that the path is in any way consistent with the intentions of the actors responsible for its development.

Global Governance

Governance approaches, at a global level, provides social elements to the study of institutional building. These approaches also introduce more systemic dynamics into the analysis of path dependency, while still keeping an eye on the actors' role. Several authors agree that, besides material resources such as financing, social resources like norms, ideas and changes in practice should be also incorporated into the analysis of path dependency (Pierson, 1996). Pierson (1996, p. 146) talks about the *acquis communautaire* as the corpus of existing legislation and practice, that influence behavior.

This structure obliges the states (or other relevant actors) to think of an ever increasing revision of existing arrangements. The author distinguishes two forms of governance impact, one as an institutional framework, and the second influencing current decision-making. Therefore, it is possible to say that "governance consists of both structure and process" (Börzel & Risse 2010, p. 114).[34]

Within global governance literature, governance is largely defined in contradiction to hierarchic power politics, traditionally associated with anarchy, emphasizing instead cooperation, solving common problems and, generally, dealing with transnational threats (Corry, 2010). Alternatively, Corry (2010, p. 170) argues that a global polity exists whenever a set of actors are oriented towards the governance of one or more common governance-objects, "regardless of who or what is doing the steering and whether it is done inside, outside or across states […] not necessary for 'steering' to be consensual or technocratic". Hence, this concept proposes a more 'generic steering', consensually or antagonistically.

However governance is also a contested concept regarding the state's centrality. According to Bell & Hindmoor (2009), states or governments do not give-up their rule-setting role while entering partnerships and alliances with other actors. This also is related with theory critical

[34] This affirmation relates to the concept of practice or international practices, defined as "socially meaningful patterns of action, which in being performed more or less competently, simultaneously embody, act out and possible reify background knowledge and discourse in and on the material world" (Adler & Pouliot, 2011, p. 4).

analysis regarding the role of the state in a context of globalization (e.g. Cox, 1981, Sassen, 2007).

Moreover, transformations also occur transnationally and within the states. According to Sassen (2007), the aims are to identify the origins of transformative character and potential historical phenomena, rather than assuming that states are subject to limited changes (problem-solving theory) biased by the framework of states functioning on the whole. In her book "A sociology of Globalization", Sassen explains how states become embedded in the emerging transnational governance system. She uses the concept 'embeddedness of the global', meaning that states have been a key agent facilitating global processes, and at the same time, states have emerged altered from them.

Besides states, transformative impetus could also be initiated by societal actors. For example, Zürn (2004) analyses the effectiveness of state policies, affected by a context of accelerated globalization, shifting the ultimate addressees of regulations issued by international institutions (e.g. the United Nations) from states to societal actors. The author identifies a mechanism that produces legitimacy problems defined as reflexive denationalization.[35]

This mechanism is linked to "political denationalization" (i.e. an increase in the number and political scope of international institutions) as a response from governments and other political organizations to the challenges of globalization (i.e. societal denationalization). The process becomes reflexive when society and political actors begin to comprehend those changes and to reflect on the features of a legitimate and effective political order beyond national borders. Thus, it also becomes politicized, "the politicization of world politics", which increases the need of a normative and descriptive perspective to legitimize such international institutions (Zürn, 2004, p. 277).

3.4.2 Future Expectations and imagined futures

History does not only matter, within a context of financial crisis, global environmental risk and dwindling fossil fuel supplies, but the future as well (Beckert, 2014). Cooper (2010, p. 175) notes that all of these events are connected by notions of a world of "unexpected turbulence" that has to be predicted or planned. With regards to notions of path dependency and path

[35] The first stage of this mechanism is a more or less unintended side-effect or indirect outcome marked by supranationalization and transnationalization as responses to perceived functional demands on international institutions. In the second stage, the process becomes reflexive (i.e. "reflexive denationalization"). Transnational protests, such as those in Seattle 1999, and the rise of resistance against international institutions, within national political systems, can be explained as part of the process of reflexive denationalization.

breaking, theories of expectations highlight the significance of actors' perceptions of the social world.

Theorists of path dependency would generally argue that change would occur through unforeseen exogenous forces, some, may incorporate an "insidious change" or "mindful deviation" of new members or actors involved, others may be a by-product of other organizational decisions. Taking a step further, change may also occur by the deliberate support of the same actors involved (Mahoney, 2000; Meyer & Schubert, 2007; Sydow et al., 2009). In all cases, dealing with actors' decisions, in contexts of uncertainty, might involve a level of prediction. [36]

Expectations have been commonly used in the rational expectations model, in economics, that views rationally calculating actors as making decisions on the basis of the expected future revenue stream (Hoover, 1997; Beckert, 2014). [37] This aspect is in stark contrast to sociology, which perceives current events as a final outcome emerging from the past, similar to path dependency approaches. To bridge this gap, the author proposes a model of fictional expectations that highlights the significance of actors' perceptions of the social world.

Consistent with the notion of fictional expectations, present day action is not only the ultimate outcome of past events, but also an outcome of perceptions of the future. Since the future is unforeseeable, expectations cannot be determined through the efficient use of available information, as in rational expectations theory. Expectations are, instead, contingent on the actors' interpretation of the state of the world; they may differ between actors and may change in unpredictable ways over the course of time.[38]

Not unlike other mechanisms, expectations also enter into the analysis of reversing self-reinforcing dynamics. On the one hand, the rational expectations model is linked to efficiency explanations applying the probabilistic calculation/calculus approach. On the other hand, political power and legitimation accounts can also be contained in fictional expectations.

As stated by Beckert (2014) and Cooper (2010), actors have an interest in influencing expectations (e.g. through official discourses, marketing, beliefs, confidence, and trust),

[36] Action takes place on the basis of projections that are described as "projects". A project is a plan or a potential way of acting that actors believe will deliver specific yields. Projecting is then anticipating before performing an action and is used by actors to take themselves into an imagined future in which the action will have been completed (Beckert, 2014).

[37] Rational expectations theories were developed in response to perceived flaws in theories based on adaptive expectations, which gives importance to past events in predicting future outcomes. To explain decision-making, the main assumption is that all actors are efficient in processing information, but also that information relevant for the future is available in the present, and that statistical extrapolation of future events is indeed possible from the past (Beckert, 2014).

[38] The calculus probability is applicable to predictable risks but not to uncertainties when the events possess a uniqueness that denies such prediction (Beckert, 2014).

especially if decisions have distributive consequences. Therefore, powerful actors can influence expectations and shape the imagery of consumers, voters, etc. By not being bound to a rational calculation, fictions do not have to be true, but *convincing*.

According to these authors, "imagined futures" influence the interpretations of a given situation in a context of uncertainty. Likewise, fictional expectations are mental representations of the future state of the world by which actors motivate their actions and organize their activities. This openness to the future is simultaneously perceived as a threat to stability (i.e. a cause of economic crisis and a loss of control producing damage and anguish) and a space of promises and hopes (i.e. creative change in the economy). Risk and the notion of an open future conceptually are tied together and come into broad use in a society that is future-oriented.

Cooper (2010) remarks that instruments within this logic of anticipation, such as new forecasting techniques and novel financial instruments, are widely used. They are aimed at responding to unpredictable weather fluctuations. The most popular derivatives have been temperature-related and have been designed for energy producers who may be adversely affected by unanticipated weather swings. [39]

Fictional expectations and potential world philosophy also produce a different response to uncertainty by centering the role of imageries within decision-making. Discussing the future in present day decisions is then a step further that complements the analyses of path dependency. These issues also open an interesting venue for research and a field for further theory development by bringing future expectations into the analyses of present day decisions.

3.5 Concluding Remarks

Within this research, the key propositions explaining institutional inertia and decay are based on the formalization of the concept of self-reinforcing processes derived from path dependency theory. The latter is considered the ideal way to approach the case study under investigation. First, self-reinforcing mechanisms are deemed the direct causes of inertia and loss of flexibility. Second, they are the theory's main feature and the most developed element from a theoretical perspective.

[39] Those techniques include traditional projections or carbon cap-and-trade systems, and newer ones such as catastrophe bonds, securities, and other environmental derivatives. In the context of the first oil crisis, strategists associated with French petroleum companies, Shell and ELF, began experimenting with new forecasting techniques such as scenario planning. Cooper (2010) notes that designers of those techniques sought to develop a mathematically rigorous method that nevertheless built on the non-quantitative and emotional dimension of our relation with future. The author establishes a relationship between 'delusion' and imperialism.

Besides self-reinforcing processes, agency is another element of path dependency. Agency is broadly active, in the early phases, as well as in later stages of path breaking; however, agents are present throughout the whole process. Other elements, such as contingency, are more ambiguous though still relevant.

Path dependency is, by definition, a posteriori phenomenon since the outcome cannot be known unless the process has been formed. Nevertheless, further research on institutional development has sought to move away from the concept of path dependency, focusing on the ways in which institutions change rather than remain stable over time. The aforementioned elements of path dependency are also key factors explaining path breaking.

The hereby research resumes discussions on agency-structure in path dependency and path breaking theories and incorporates two additional elements: governance approaches, at a national and global level, and future expectations. Theoretical features from these elements allow reducing macro biases of the path dependency theory. They also help to explain who is investing or interested in particular institutions and what dynamics sustain them.

Furthermore, the value added, by their incorporation, in the theoretical framework is high since specific components and actors concerned with energy have a clear notion of future challenges (i.e. institutional entrepreneurs). Similarly, a high propensity to change is derived from greater interaction within global dynamics (and forms of global governance). The expectations issue is also at the core of path dependency as a problem of policy outcome, as long as outcomes divert from political expectations. The theoretical framework provides such conceptualization of the theories that will support the explanations of the Costa Rican case towards carbon neutrality by the year 2021.

4 Methodological Approach: Qualitative Within-Case Analysis

4.1 Introduction

This chapter is divided into five sections including the introduction. Section 4.2 presents the formulation of hypotheses. Section 4.3 explains the usefulness of institutional analysis and process tracing methods. Section, 4.4 focuses on data collection methods, the fieldwork experience and the instruments used for the analysis of information and explanation assessments. The last Section 4.5 summarizes the methodological approach and states some concluding remarks.

The objective is to explain the methodological approach used in this research, which is based on a within-case analysis using a 'mechanism-centered approach' with the purpose of explaining an intriguing outcome: why Costa Rica chose to have limited utilization of alternative renewable sources, above all solar energy, to achieve the goal of carbon neutrality in a context of declining hydroelectricity contribution, while (expensive and polluting) fossil fuels such as petrol and natural gas, gain relevance in future scenarios. In this sense, the methodological approach followed in the present study is framed with no intention of generalizing to the broader population of cases. [40]

Costa Rica's sustainability challenges, regarding electricity production, are not unique. Alternative renewable energy transition problems are challenging countries all over the world. Nevertheless, this particular case is noticeable because Costa Rica is not a wealthy, industrialized country with the necessary amount of resources to invest in capital intensive renewables; it has a small energy market, but it does not rely completely on hydroelectricity; it is commanded by a state-owned firm, which in developing countries are considered inefficient and risk adverse; and despite the fact that the country has proven oil reserves, it has refused this kind of investment (Wilde-Ramsing & Potter, 2008).

These characteristics imply that Costa Rica's electricity system could also be framed as a crucial case for theory testing.[41] Whichever the policy outcome, the goal under analysis is provided by history and is closely tied to the country's particular characteristics. Hence, this is not defined by social constructions of classes of events, nor by data set observations.

[40] According to Gerring (2006) this form of *idiographic* research implies that a study focuses on the unique qualities of the case, while case studies reflect upon a larger population (*nomothetic*).

[41] The Costa Rican energy system can be framed as a least-likely case of path dependency, because in spite of lacking the theoretical conditions required to develop self-reinforcing sequences, the endurance of the electricity trajectory is more likely than expected.

This does not mean that theory is set aside. Similar to historical explanation, within-case analysis uses observations on context, processes, or mechanisms (i.e. process tracing), and draws on theories to explain each important step that contributes to causing a particular outcome (Bennett & Checkel, 2012). According to Van Evera (1997), a historical explanatory dissertation uses theory (academically, folk theory, or common sense deduction) to explain the causes, patterns, or consequences of historical cases (theory-applying).

4.2 Formulating Hypotheses

In the specific case of Costa Rica's energy system, the declaration of the country's carbon neutrality goal coincided with natural constraints affecting hydroelectricity, which has been vulnerable to changing weather patterns. The long-standing sector institutions responded accordingly using fossil-fueled plants as back-up. As a result, electricity production from oil plants increased in the following years, thus hiking electricity prices and moving away from carbon neutrality goals.

The historical data of electricity production, since the 1970s, evidenced an episode of substantial institutional change, followed by inertia of previous patterns. This occurred in the 1990s, when alternative renewable energy sources (i.e. geothermal stations, wind energy and biomass stations) were incorporated into the grid to a limited extent. From the options available, solar energy was excluded from alternative renewable sources in this period.

Although renewable energy use has been considered to withstand the test of time in Costa Rica, the 21st century began with a gap in the renewable energy system, which turns out to be growing and unbreakable. Installed capacity from fossil plants grew, while the use of alternative renewable sources remained limited. The evidence of a progressive exhaustion of Costa Rica's energy model is not only in terms of renewable energy responses, but also in addressing the new paradigm of civil society participation in decision and production processes.

Two questions emerge from Costa Rica's energy system developments: (1) why was there no significant support in the past for the active incorporation of solar energy within the Costa Rican energy system, while technologies like geothermal energy and wind parks gain attention; and (2) why has there recently (2010-2014) been an increasing interest in solar energy and how is it translated into policies transforming the national energy system to supplement other sources to reach 100 percent renewable electricity generation and carbon neutrality by 2021.

The first intuitive explanation of this phenomenon refers to the cost or higher relative prices of alternative technologies. Nevertheless, this explanation is in contrast with historical evidence stating that prices are not necessarily the only factor contributing to change. Even in periods

when oil prices have reached the lowest levels during the 1990s, Costa Rica stayed true to its model in which nearly ninety percent of the electricity generated was from renewable sources.

Moreover, the Costa Rican electricity sector is not a market regime, but rather a mixed model under state control. The country has a long history of institutional development based on the figure of "autonomous institutions", such as the Costa Rican Electricity Institute (ICE), who also became a political actor. Furthermore, reaction to shocks (e.g. climatic events) might produce circumstantial (contingent) adaptations or fundamental transformations.

Therefore, competing explanations of the sector's inertia emerged from different paradigms. Following the argument of path dependency seems to be a reasonable way to perform the phenomenon of technological and institutional inertia. Within this argument, input's price incentives or interest groups, established earlier in the past, might have produced changes in a trajectory that later on becomes difficult to reverse (according to early conceptualizations of path dependency).

This statement is subject to analysis in the present research. In doing so, the procedure proposed by Van Evera (1997) to test possible explanations is employed. This starts by inferring predictions or hypotheses from the explanation and then asking if these are confirmed or disconfirmed by evidence over time. Accordingly, three (causal) hypotheses, derived from the case using solar energy as an example among restrained alternative renewable carriers, are formulated:

- Hypothesis one: Compared to solar energy, hydroelectricity is the cheapest and most efficient option available according to actors' cost-benefit assessments that are either driven by individual profit motivations (individual level) or systemic goals (macro level).
- Hypothesis two: Hydroelectricity developments are supported by elite groups that benefit from existing arrangements in spite of claims from (subordinated) groups of actors that prefer the expansion of solar energy installations.
- Hypothesis three: Actors believe that hydroelectric developments, rather than solar energy installations, are appropriate and morally just for the provision of electricity.

Accordingly, in the next step of this dissertation, the formulation of hypotheses is contrasted with empirical facts in different periods of time. In this regard, the following indicators are considered:

a) Different actors' accounts
b) Different periods of time
c) Different technologies

d) Other indicators: technology relative cost, global and national discourses or policy statements, and natural conditions or climatic events.

Although, those hypotheses are pondered as competing explanations, it is possible that their long term effect is rather complementary. Each hypothesis is related to theoretical concepts of efficiency, political power, and legitimation, respectively. Hypotheses and theory are used to elaborate a theory-guided analysis of causal mechanisms and the specification of how they operate. The procedure follows an inductive-deductive approach and is guided by methods of institutional analysis and process tracing. These methods are explained in the following section.

4.3 Combining Methods: Institutional Analysis and Process Tracing

From an ontological and epistemological perspective, the methods used in this research (i.e. institutional analysis and process tracing) are linked to the scientific realistic view (positivism), arguing that social facts exist independently of the observer and can be the subject of defensible causal inferences (Bhaskar, 1975). Accordingly, the situation of the national energy system is analyzed not only as result of infrastructural investments in electricity, production and consumption patterns, but also from discourses, ideologies, and even future expectations or "imagined worlds". Hence, past conditions, current choices, and future scenarios of carbon neutrality are affected by both material conditions and ideas that are transmitted in discourses, archives, and other documentary material.

Thus, the purpose of this research is also to draw inferences that are useful for policy-making. The process tracing and institutional analysis methods are used for testing the proposed hypotheses. On the one hand, the process tracing method is suitable for looking at the explanations of political administrative decisions in the energy sector over time. On the other hand, institutional analysis is used for most of the descriptive sections, guiding the comparative analyses for the role of alternative renewable sources, actors and period of time.

4.3.1 Institutional Analysis Method

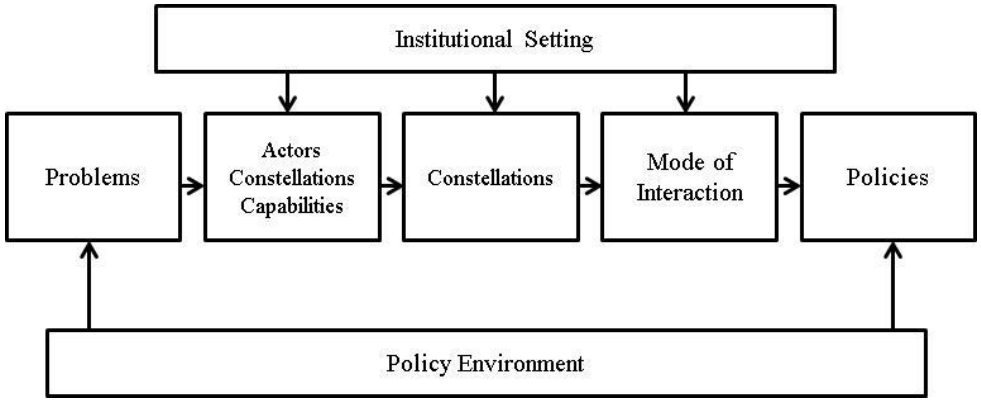
As discussed in the theoretical chapter, institutional analysis has developed different perspectives to study the relationship between actors and institutions. In this field, scholars increasingly conceptualize actors and institutions as being mutually constitutive of one another. As Pierson (1996; 2000) suggests, actors are relevant in the continuation of institutions through processes in which they are immersed, but are beyond their control.

In the case of Costa Rica, the utility of seeing institutions and actors as a dynamic process is in accordance with the persistence of well-established institutions in the national electricity sector.

They include relevant actors that support different types of energy developments over time, such as the ICE and the Energy Planning Sector. Thereby, the integration of structural forces (e.g. power relations), besides rational choice models developed at individual level are needed as well.

Hence, the institutional analysis developed by neo-institutional approaches or actor-centered institutionalism (e.g. Mayntz & Scharpf, 1995; Scharpf, 1997) is important in the present study. This approach is guided by two paradigms of action-theoretic (or rational-choice) and institutionalist (or structuralist) theories (Scharpf, 1997). In this way, and in order to avoid determinism and allowing for new forms of social practice to emerge, aspects of agency and interest within institutional change are incorporated in the analysis based on Scharpf's conceptual framework, illustrated in Figure 1.

Figure 1. Actor-centered institutionalism approach



Source: Scharpf (1997)

Actor-centered institutionalism is combined with path dependency theories to analyze technological patterns within institutions. Firstly, it highlights the role of agents in the processes of technological change. Secondly, it draws a relationship between the institutional setting (i.e. a combination of social and natural environments), actor interactions, and policy outcomes.

The method of institutional analysis consists of identifying the problems, as well as antagonist and consensual interests from different players and the relevance of institutional entrepreneurs (i.e. actors' constellations capabilities). It also provides a tool for a detailed description of the changing conditions, over time, concerning the institutional setting or the policy environment.

Description is a crucial element for the current within-case analysis. Following Van Evera (1997), historical cases often provide a good deal of description but their focus is on explaining what is described. The description part establishes data points, while explanation expounds the structure of data that has already been described (e.g. what elevated the oil prices). Therefore, description must often precede explanation or evaluation, since phenomena that have not been

described cannot be clarified or assessed. Consequently, description, in the hereby research, is guided by the method of institutional analysis.

At the same time, the relationship between institutions and actors points out to another relevant variable concerning their means of interaction, which is their analytical level, being that individual, meso or macro (systemic) levels. Beach & Pedersen (2012) make a distinction between purely macro-level and purely micro-level (i.e. action formation mechanism), as well as micro-macro mechanisms (i.e. transformational) and macro-micro (i.e. situational) mechanisms. The common distinction between micro foundations and macro effects springs from such a conception of explanation (Tilly, 2001; George & Bennett, 2005). The concept of institutional entrepreneurs is an example of those interrelations, linking the micro-level actions of agents with outcomes at the macro-level when they impact institutions (Colomy 1998).

Furthermore, the elements contained in (causal) mechanisms depend on what type of theoretical explanation they are dealing with. Parsons (2007) and Beach & Pedersen (2012) differentiate four types of theoretical explanations within the social science: structural, institutional, ideational and psychological. Similarly, Tilly (2001) proposes a rough classification of three sorts of mechanism: environmental, cognitive, and relational.

Structural and environmental explanations coincide in referring to externally generated influences (i.e. exogenous constraints and opportunities) on conditions affecting political action or social life (Tilly, 2001; Parsons, 2007). The structural conception highlights people's actions as rational reactions to exogenously given structures in their environment (i.e. the material surrounding) that dictate behavior or create a pattern of structural constraints and incentives. Tilly (2001) links environmental explanations with words such as disappear, enrich, expand, and disintegrate, applied not to actors but rather to their settings, suggesting the sorts of cause-effect relations in question. For instance, climate change effects or national energy demands are examples of those structural or systemic aspects relevant in the energy field.

Ideational, psychological, as well as cognitive and relational mechanisms operate through alterations of individual and collective perception, and are characteristically described through words such as recognize, understand, reinterpret, and classify (Tilly, 2001). Relational mechanisms alter connections among people, groups, and interpersonal networks. Words such as ally, attack, subordinate, and appease give a sense of relational mechanisms to identifying mechanisms that operate at the level of the individual or small group but aggregate into larger scale effects. Power relations, actors' expectations, or the collective creation of myths are examples of this more relational mechanism.

Parsons (2007) relates path dependency with institutional mechanisms. Institutional mechanisms are distinct from structural ones in that institutions are manipulable constraints (i.e. arranged rules and conventions) and path dependent (i.e. earlier choices shape later ones in unintended ways). Typical institutional mechanisms deal with how certain current intersubjectively institutions channel actors unintentionally in a certain direction. Path dependency and temporal effects are emphasized within this sort of mechanisms (Beach & Pedersen, 2012, p. 81; Parsons, 2007).[42]

Conversely, Beach & Pedersen (2012) consider that the relevant analytical level depends upon the empirical manifestation of the theorized mechanism. This research is centered on technological and institutional developments in the electricity sector, and hence, the analytical level is closer to relational and institutional processes. Structural and environmental types are also relevant for the analyses.

4.3.2 Process Tracing Method

In a broader sense, process tracing refers to the examination of intermediate steps in a process to make inferences about hypotheses on how that process took place and whether and how it generated the outcome of interest (Bennett & Checkel, 2012). These intermediate processes took the form of a causal mechanism (CM), introduced in the theoretical chapter. Since the objective of this research is to explain a particular outcome (i.e. Costa Rica's restrained utilization of alternative renewable sources, above all solar energy, to achieve the goal of carbon neutrality), the pragmatic use of mechanisms allows to account for the important aspects of the case.

In a mechanism-centered approach, a general analytical framework is defined in terms of outcome, conditions and CM. The outcome is that which needs to be explained (explanandum or dependent variable) and that which contains the explanation (explanans or independent variables), a cause, antecedent events, or other conditions that triggers specific processes or CM. Thus, the CM is the link between the conditions (X) and the outcomes (Y) of interest, or "the dynamic, interactive influence of causes upon outcomes and in particular how causal forces are transmitted" (Beach & Pedersen, 2012: 40).[43]

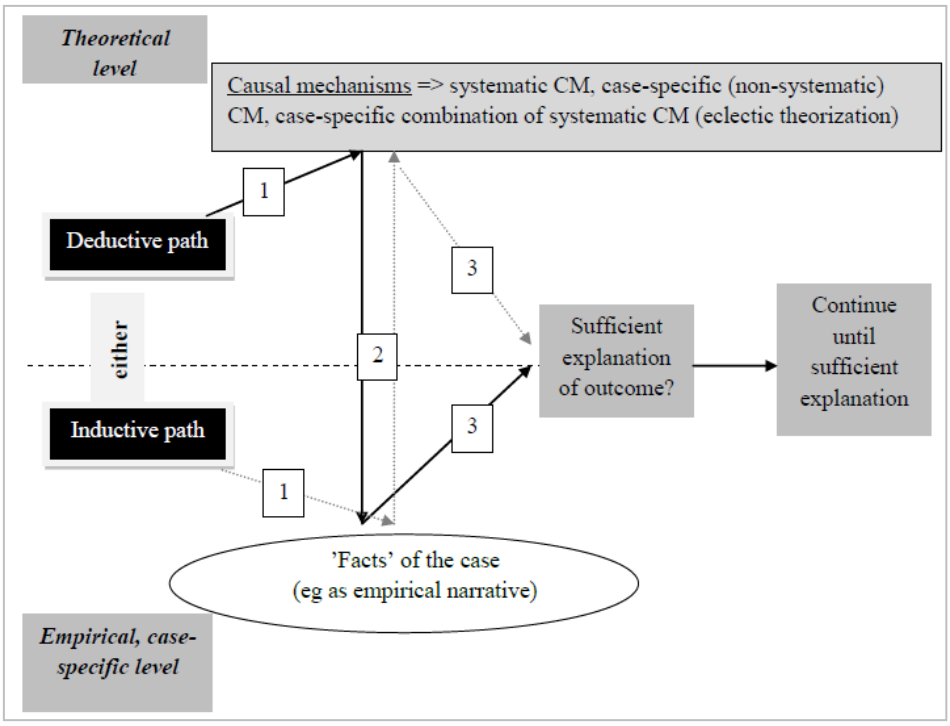
According to Brady & Collier (2004), in a system-oriented approach, independent and dependent variables affect one another.[44] However, this inherent aspect of systems does not

[42] Beach and Pedersen (2012) also refer to incremental causal mechanism when the causal impacts become significant after they have been in action over a long period of time.
[43] In contrast to a regular empirical association between X and Y, causality is, therefore, understood in more complex terms as the causal mechanism linking X to Y.
[44] Henry E. Brady & David Collier (Eds.) (2004). Rethinking Social Inquiry: Diverse Tools, Shared Standards. Lanham, Md.: Rowman and Littlefield, 362 pages, ISBN 0-7425-1126-X, USD 27,95. pp. 237-242

restrict the identification of causal mechanisms that induce status or change. The analysis of causal process observations is allowed by 'bracketing' the salient phenomena. Bracketing means to keep the structure constant and to take a look at the activities of a group of actors that interact with others. The advantage of within-case analysis is that the structure remains more or less the same, facilitating the control of context variables that affect comparative analysis.

This approach is considered of great significance for this research. First, it proposes a mechanism-centered analysis with a pragmatic use of theories. Second, it is suitable for a historical analysis in a single case. In this sense, the present research is not theory-centered seeking law-like empirical generalizations. Rather, a case-centric research, as described by George & Bennett (2005), makes use of causal mechanism theories to provide historical explanations accompanied with explicit causal hypothesis, highly specific to the case.

Figure 2. The model of explaining outcome process tracing



Source: Beach & Pedersen (2012)

Beach & Pedersen (2012) refer to this use of process tracing as "explaining outcome process tracing", differentiating it from other variants of the method (i.e. theory testing and theory building process tracing). This variation of process tracing has characteristics that makes it an ideal analytical framework to respond to the research's question from a 'mechanismic perspective'. As illustrated in Figure 2, the selection of mechanisms results from an iterative analysis between deductive and inductive paths, derived from both a theoretical level and an empirical case-specific level.

Taking an inductive path, as a point of departure, process tracing begins with an empirical puzzle in which the unit of analysis is the Costa Rican energy system and the outcome is the restrained utilization of alternative renewable sources, challenging the attainment of carbon neutrality. Then, moving back to the theoretical level, the main variables start to take form, in this case the systematic CM derived from the path dependency theories. In a next step, these theoretical elements are combined with case specific CM. The result is an eclectic theorization of CM.

In explaining outcome process tracing, the CM includes systematic and non-systematic parts that produced the outcome in question. The systematic parts are theory-guided and the non-systematic ones are highly case-specific (Beach & Pedersen, 2012; George & Bennett, 2005). This possibility implies a dialogue between theory and evidence, which according to Rueschmayer (2003), constitutes the proportional advantage of comparative historical analysis. The heuristic application of theorized mechanisms is used to elaborate the best possible explanations of a particular outcome (Beach & Pedersen, 2012).

Moreover, the study of single historical cases can do much more than merely generate initial hypotheses. According to Rueschmayer (2003, p. 307-312), while any explanation requires theoretical premises, case centric studies can not only develop new theoretical ideas, but also put them to the test and use the results in the explanation of outcomes. [45] Nevertheless, political interests can also create a very strong urge to recognize and comprehend the conditions, under which, one's objectives can be fulfilled; what are the major obstacles, which goals must be considered utopian, what compromises will likely impose themselves, what will be the consequences of the reutilization of passionate commitment, and so on.

These are relevant considerations for this research because its purpose is not just story-telling about decisions made in the country's energy sector, but also a theory-guided analysis of causal mechanisms and the specification of how they operate. Non-systematic elements of the mechanism are, for example, those related with the role of the national electricity company (i.e. the ICE) and the relationship with private actors on a national level. Some other (systematic) parts are completed by borrowing from existing mechanisms that have a causal-explanatory focus; the mechanisms of path dependency, for example.

Although mechanisms, by definition, have uniform immediate effects, practitioners of mechanistic explanations recognize that their aggregate, cumulative and longer-term effects vary considerably depending on initial conditions and on synergies with other mechanisms

[45] Hypotheses, which are developed (or refined) in one case, can be tested and used as explanations in the same case and can tend to be more counterintuitive. However, good historical explanations and especially analytical oriented historical studies do precisely this.

(Pierson, 1996; 2004; Tilly, 2001). Therefore, dimensions of analytical level, contextual specificity and temporal conditions are important to define the effect of the causal mechanisms. In the case of path dependency, the self-reinforcing mechanisms have particular characteristics in these dimensions.

Mechanisms of path dependency are considered, by Beach & Pedersen (2012), as one form of institutional mechanisms (i.e. both at micro-macro and macro-micro levels) prioritizing temporal effects. One of the main figures constituting this phenomenon are the self-reinforcing mechanisms. They are also defined as incremental causal mechanism; the causal impacts become significant after they have been in action over a long period of time (i.e. reinforcing an outcome). The degree of contextual specificity of mechanisms is defined as the scope sets forth the conditions that are necessary for a given mechanism to function (Beach & Pedersen, 2012: 82).[46]

Furthermore, the method of "explaining outcome process tracing", provides the framework to craft a minimally sufficient explanation that accounts for a particularly intriguing outcome. [47] The objective of using the explaining outcome process tracing is to assess from competing explanations or assumptions for prediction, therefore, to exclude some (or all except one) possible explanation. The assessment of explanations is the last part of the process tracing method.

Even though the present research is not framing any specific test of theories or explanations, it keeps track of what is expected by inferring predictions. Hence, keeping track of their presence or not, as well as their changes over time. In this case, the focus of attention is on the mechanisms explaining the lack of flexibility of the Costa Rican energy system.

The problem of *equifinality* (i.e. many alternative causal paths for the same outcome) is not excluded; however, in that particular case, the failure will be spelled out.[48] According to the conceptualization followed in this research, if one mechanism is completed by the other in order to explain the case, then the consistency of path dependency explanations is reduced because its central figures are self-reinforcing sequences of the same mechanism. Then again, such result would be compatible with the eclectic use of theories from historical institutionalists who

[46] The context is the relevant aspect of a setting where the initial conditions contribute to produce an outcome through the operation of the mechanisms.
[47] A minimally sufficient explanation is defined as an explanation that accounts for an outcome with no redundant parts being present (i.e. no parts of the complex is sufficient); this ensures that every factor that is part of the complex cause is an indispensable part in bringing about the effect. Historians remain skeptical about full-scale causal accounts: History is not rule-governed, and it does not know sufficient causes" (Thomson 1978, cited in Rueschmayer, 2003), in reference to openness of the process in question to the "historical actors".
[48] George & Bennett (2012) defines equifinality as "many alternative causal paths for the same outcome" (p. 10).

combine the ‘calculus approach’ and the ‘cultural approach’ to explain how institutions affect behavior and why institutions persist over time (Hall & Taylor, 1996).

Moreover, the study is also aware of the difficulties in assigning causality in single case designs because of the limitations of the evidence and the underlying assumptions. However, those limitations are also shared by quantitative works (Rueschmeyer, 2003). When these or other problems in crafting explanations emerge, they are clearly stated.

Generalization is not the aim of explaining outcome process tracing; therefore it is possible that some systematic parts of the mechanisms could “travel”, but not the case-specific conglomerate. Researchers, in the field, could also judge the findings of the particular case interested in relation to similar puzzles affecting other countries in Latin America or other regions. However, this research leaves “the identification of universal or quite general problems” (Rueschmeyer, 2003, p. 330) for further research.

4.4 Data Collection and Analysis

4.4.1 Historical Review

Empirical cause-effect relations, initially observed by literature in the Costa Rican case, were subsequently combined into the study with theoretical predictions from institutional theories in order to draw alternative explanations. I found that it was possible that some electricity technologies had a differentiated support, due to long-standing institutional issues, which can be clustered in efficiency, political power and legitimation explanations. These modes of explanation were broadly used by institutional theorists to explain status or change.

Technological and institutional patterns explaining decisions towards carbon neutrality in 2021 were studied in the historical case of Costa Rica’s energy system. The period of analysis covered developments before 1990, during the 1990s and from 2000 to 2014. Thereby, preliminary conditions are incorporated in actors’ perspectives towards 2021, during which the goal of carbon neutrality should be achieved.

The procedure followed is an inductive-deductive approach and is guided by methods of institutional analysis and process tracing. Accordingly, 47 interviews were conducted with different groups of actors in the energy field that were complemented with written policy documents and participatory observation for the process tracing analysis. Other secondary sources included scholarly literature on Costa Rica’s environmental history, social movements in the electricity sector and market reforms that were useful especially to elaborate on the institutional analysis and the observations in the period before 1990.

With those premises in mind, the strategy and the instruments for data collection, during fieldwork, were prepared. The idea was to gather empirical information from all possible energy sources and diverse actors in order to use this as evidence to support or discard possible explanations. The strategy is explained in the next sections.

4.4.2 The Fieldwork Experience

Objectives, Activities, Duration and Location

The fieldwork was carried out from August 2013 to October 2013, in Costa Rica, with some additional information gathered in August 2014. The focus of the data collection was the reconstruction of the electricity trajectory from the perspective of relevant actors and institutions to answer the research questions. The collection of data from primary and secondary sources, as well as expert opinions, follows the activities of the Fieldwork plan, scheduled in a rather flexible manner.

Once in Costa Rica, activities started from the work package that focused on research covering the future perspectives of the national energy system based on interviews with experts. In this way, the research took advantage of experts' knowledge, not only in terms of their area of expertise but also in terms of networking for potential future interviews. Subsequent to these first contacts, the subsequent weeks were intensively dedicated to interviewing other relevant actors, visiting projects, and participating in correlated events (e.g. forums and conferences). Activities, from the work package, also focused on the data collection from other primary and secondary sources, such as laws and bill proposals at the National Assembly and various university studies.

Data Collection Methods and Instruments

Data collection, during fieldwork, followed the general analytical explanatory framework previously defined in terms of outcome, conditions and CM. This included gathering information on the different renewable energy sources supported in the country, the set of historical conditions, and the different mechanisms (e.g. efficiency, political power, and legitimation). The information compilation instruments included interviews, participatory observation and document analysis. The questionnaire and the list of interviewees by type of actors, institutions, and the period of comparison are included in Annexes 12.3 and 12.5.

Interviews

Forty-seven interviews were conducted, in total, through semi-structured or in-depth interviews that followed a general script to cover the topics of interests: actors' decisions in different

periods of time according to different logics/mechanisms. This data collection method is also open ended, which allowed for other relevant topics to come up (Bernard, 2013). Moreover, using this method made it easier to adapt to the different types of actors considered.

The actors interviewed include: (1) a representation from the Energy Planning Sector who formulate policies and guidelines, (2) state investors, mainly the ICE who developed projects in the past and present from different energy sources, (3) private investors who built projects in the past and present from different energy sources, (4) civil society organizations, including environmental organizations, producers/users associations, chambers and international cooperation, and (5) politicians. Other interviews included experts and the media.

The questionnaire was made up of twenty-five open questions, separated into five sections, to guide the interviewees' conversation. The first set of questions focused on aspects regarding the changing context or setting conditions, in the past, which might have influenced decisions between technologies. The second section gathered information on the type of technology they chose and the reason why this and not another was selected. Similarly, the third and fourth sections of the questionnaire presented choices on energy sources and the logics behind them. Lastly, the final round of questions dealt with the future perspectives towards carbon neutrality in 2021.

These interviews shed light on the type of electricity projects and energy sources, supported by the different actors, in different periods of time. For example, in the interview held with the Costa Rican Association of Private Energy Producers (ACOPE), a non-profit organization created in 1990, they have been active, since then, in supporting a mix of technologies, also geared towards carbon neutrality. The arguments used in their decisions can be linked to efficiency, legitimation and political power claims.

Participatory Observation

Participatory observation is another data collection method that provides knowledge and allows the researcher to collect data, narratives or numbers "where the action is" (Bernard, 2013, p. 3010). During the fieldwork, in Costa Rica, three significant events, concerning Costa Rica's energy system, took place and allowed to conduct observations form a participant's standpoint (see Annex 12.4). The summits' topics pointed towards the relevance of energy issues in the national agenda, with the additional advantage that each of them dealt with different topics, actors and energy sources.

The main objective was to collect viewpoints about the constellations of actors, their interests, and their claims or decisions' logic. The first conference was "The National Forum on Clean

Energy '*Jorge Manuel Dengo'* organized by presidential candidate Johnny Araya from the National Liberation Party (Partido Liberación Nacional, PLN). Throughout the meeting, there were statements and discussions concerning alternative energy developments. For instance, politicians stated their support to the Diquís hydroelectric dam, natural gas prospections, and solar energy as a future alternative.

The second seminar held was "The 1st Seminar on Development and Exploitation of Solar Photovoltaic Energy in Costa Rica" organized by the Costa Rican Association of Private Energy Producers (ACOPE), and the third meeting was "The 2nd Annual Forum on Prospects for LNG and Natural Gas in Central America" organized by the Institute of the Americas (IAS). These two events evidenced competing interests in the energy arena, supported by different actors, with varying economic and political resources.

The material gathered from these events included flyers, audio recordings, and presentations. This observation method added insights to the research that otherwise would have been difficult to attain, for example, politicians' and higher officials' interests from the energy planning sector (e.g. the Ministry of Environment). These empirical evidences provided information on political power interests and legitimation aspects.

Policy Documents and Archives

Primary and secondary information, from documentary sources (laws, sector statistics, national and energy plans, sector regulations, norms and surveys), concerning the electricity sector were used as additional sources of evidence to complement empirical information. For instance, they included liberalization laws from the 1990s and bill proposals from 2010 that state the motivations and general interests of those supporting them. Other secondary sources included authors' analyses on social movements linked to electricity and market reforms, in general.

This information was gathered from the National Assembly (legislative commissions and archives), digital archives from the Energy Direction of the Ministry of Environment and Energy and the Ministry of Planning, as well as documents from regulatory offices and university libraries. Additional bibliographical information was collected through conversations with relevant actors. Data gathered from these sources included sector statistics and national energy plans that provided information on efficiency claims, while laws and bill proposals complement information on political power interests and legitimation aspects.

4.4.3 Data Analysis

After three months of fieldwork, the data analysis phase began. The first step was the organization of the empirical material gathered in Costa Rica, which included interviews, policy documents, reports and articles, together with secondary literature reviewed in different phases of the research process. These materials were consolidated according to type of actor, type of technology or energy source, and the relevant theoretical explanation (e.g. logics of efficiency, power and legitimation). The systematization of information was compiled in a simple data spread sheet.

Following the methods of institutional analysis and process tracing, the empirical information was organized by period of time in order to build the case's story line as a sequence of events. The main goal was to identify critical junctures and their association with causal mechanisms that triggered the choices between energy technologies during different time periods. The qualitative analysis of interviews and documents was supported by the use of Atlas.ti (i.e. qualitative data analysis software used to extract meaning from text, image, audio, and video). This software was basically used with the objective of clustering the argument lines by period of time, actors, technologies and mechanisms, whenever possible.

Assessing Explanations

In theoretical terms, predictions, from competing explanations of the outcome, are assessed by contrasting them with evidences of the case through the process tracing method. Therefore, the explanation assessment is based on two criteria: one is its adequacy to explain the case (according to research questions), and the other is whether or not the elements of the theory work as predicted. The procedure is based on the triangulation of results from the various information sources (interviews, documentary information and observation material), as well as contrasting the theoretical predictions between each other. In this way, the empirical results were scrutinized and evaluated until sufficient explanations of outcome are crafted.

Moreover, the accuracy of the assessment is improved by increasing the number of observation periods. This is done by comparing decisions in different periods of time and contrasting them among different alternative renewable sources. In this regard, the analysis is separated into three time periods when technological developments occurred:

a) Before 1990: for the origin and consolidation of hydroelectricity in the National Interconnected System.
b) Between 1990- 2014: besides hydroelectricity, new electricity generation sources were incorporated in the National Interconnected System. They include geothermal fields,

wind energy parks, and biomass electricity stations. The first solar energy installations, at larger scales, were connected to the National Interconnected System in 2010.

c) Towards 2021: different routes leading towards carbon neutrality.

4.5 Concluding Remarks

The methodological approach, developed in this study, to explain the choices made in Costa Rica regarding alternative renewable sources towards carbon neutrality is based on a within case analysis design. Therefore, the present study combines the theoretical approach with a narrative perspective to take an in-depth look into the case. The research intends to shed light, on recent energy developments, based on past decisions explaining the inertia, rearrangement, and emergence of energy choices. Furthermore, to some extent, this technological approach is also considering the relevance of past developments in future expectations.

To reply to the research's questions, this thesis proposes that, in the case of Costa Rica, there is room for competing explanations of path dependency. These alternative explanations are framed as 3 competing hypotheses derived from the empirical level and informed by theory based on approaches that mainly differ in terms of their mechanisms (i.e. efficiency, political power and legitimation). The hypotheses are then contrasted with observations over time (data points).

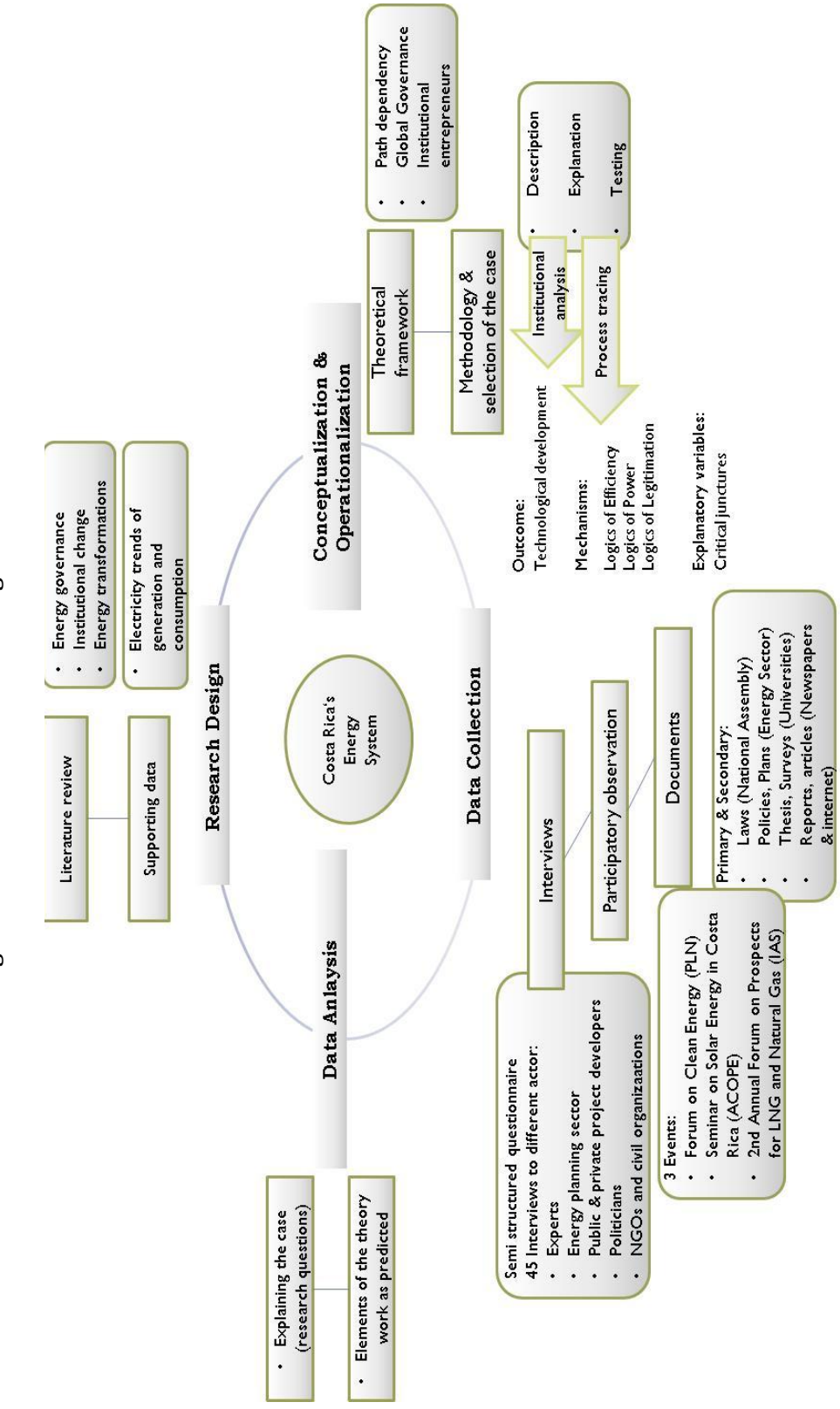
The selected methods of qualitative research were institutional analyses and process tracing considered suitable to a mechanism-centered approach applied to within-case analysis. Translating the specific properties of the methods into practice, the institutional analysis is used for most of the descriptive sections, guiding the comparative analyses between energy sources, actor constellations, and at different moments in time. The method of explaining outcome process tracing is an iterative research strategy that is applied to trace the complex conglomerate of systematic and case-specific causal mechanisms that produced the outcome in question.

Explaining outcome process tracing is a heuristic application of theorized mechanisms, which is used to elaborate the best possible explanation of a particular outcome. Thereby, results of process tracing are also relevant to draw inferences that are useful for policy-making. Energy transformation capacities in Costa Rica have political implications to achieve carbon neutrality, by 2021, by means of sustainable strategies. This research focuses on institutions, actors and mechanisms, with aims to contribute for an integrated understanding of the electricity sector.

The summary of stages in the methodological framework, applied in this study, is composed of the research design and the conceptualization of the analytical explanatory framework, which started to take form at earlier stages. This methodological framework is illustrated in Figure 3, based on the cycle of social and political research, revealing the interrelations and sequences

between courses of action (Schmitter, 2008). Accordingly, the next empirical section begins with the historical analyses of decisions in the national electricity system.

Figure 3. Overview of the methodological framework



Source: Schmitter, 2008

Part II Historical Analyses of Decisions in the National Electricity System

5 From Green Republic to Carbon Neutral Nation: Technological and Institutional Trajectories of Costa Rica's Energy System

5.1 Introduction

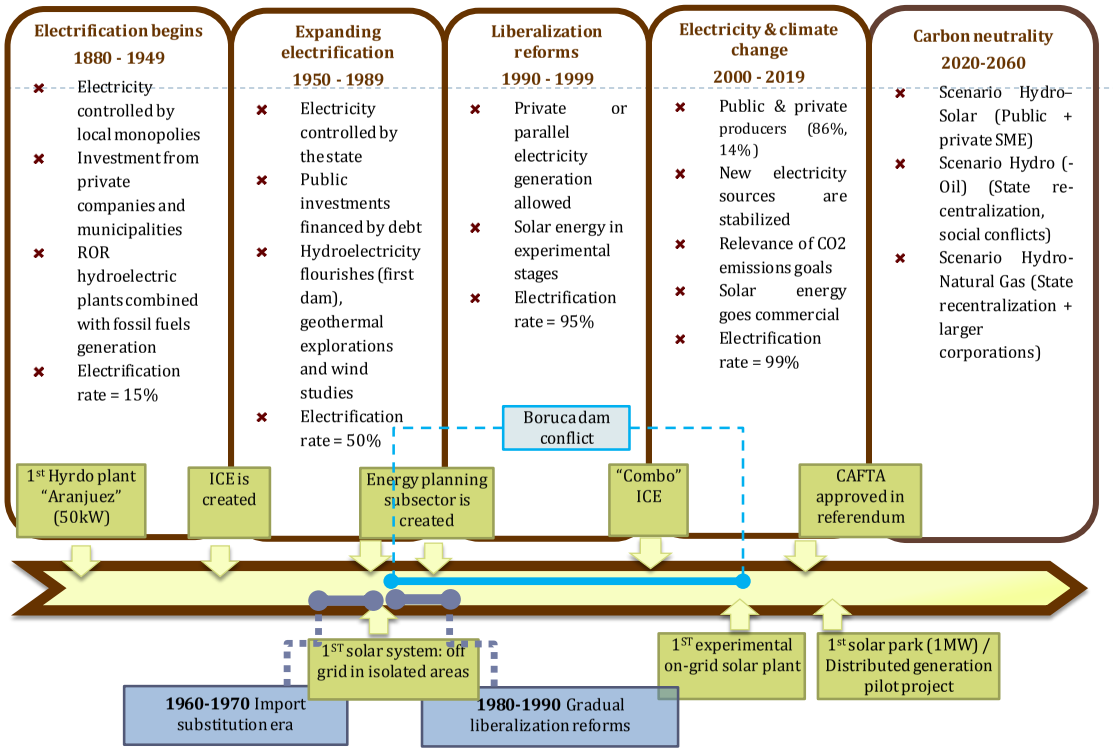
This chapter describes technological and institutional developments, throughout the electricity history of Costa Rica, that are the basis for further analysis of decisions towards carbon neutrality in 2021. The chapter takes on a double purpose. First, it aims to characterize Costa Rica's general technological path within the institutional, social, economic and political context. Second, it seeks to identify the conflicting processes and the actors involved, emerging from the intersection of technological and institutional trajectories.

The path under analysis emerges from technological and institutional entanglements in Costa Rica's energy system. At the technological level, the path alludes to the continued reproduction, though possibly at slower rates, of hydroelectricity investments (i.e. a stabilization stage). This technological trajectory is not only based on investments but also on institutional, political or personal interests. These processes render the change to incorporate alternative renewable technologies difficult.

At the institutional level, the path is notably due to the impact of the ICE and the peculiar electricity regulatory sector in the country. They provided the material and ideological foundations for the consolidation of the national energy model. Institutions, in the electricity sector, evolved along with Costa Rica's geographic conditions and environmental history, urged by the creation of natural protected areas in the nation.

The first part of the chapter describes the technological trajectories in the national energy system. It distinguishes the foundation and consolidation of the hydroelectric path, as well as the emergence of alternative renewable sources. The second part of the chapter comprises the evolution of institutional developments and context conditions. This part focuses on the legacies of the "green republic" and the birth of the "carbon neutral nation", considering technological, economic, environmental and social aspects framing the socio-technical challenges of the electricity sector.

Figure 4. Institutional and technological trajectories in Costa Rica's electricity sector



ICE: Costa Rican Institute of Electricity; Combo: bundle of bills; CAFTA: Central American Free Trade Agreement with the U.S.

Source: Own elaboration

5.2 Technological Trajectories in Electricity Production (1880-2010)

5.2.1 Overview: Available Energy Resources

Costa Rica, like most Latin American countries, has an abundance of identifiable energy resources such as hydro, geothermal, wind, solar, biomass, as well as reserves from oil and gas. Hence, from an efficiency perspective, the electricity system uses all of them to make the most of their potential. From the total identified potential of each energy resource, the country utilizes about 25% installed capacity of hydroelectricity, 22% of geothermal energy, 16% of wind parks, 31% of biomass and 1% of solar energy, as illustrated in table 4. The use of other renewable sources is minimal, while national fossil fuel reserves are not currently exploited.

Table 4. Energy potential from different local sources

Shares (%)	Biomass	Wind energy	Hydroelectricity	Solar energy	Geothermal
Identified potential (MW)	122	894	7034	126	875
Installed capacity (MW)	38	144	1768	2	196
% Installed capacity	31%	16%	25%	1%	22%

Source: ICE (2014)

On the whole, the Central American region is favored with abundant water resources, most of them untapped, with the exception of Costa Rica that harnesses 20.7% of its water supply (GWP, 2011). Amid the country's economic activities linked to water use, electricity uses 94% of total water extractions. Irrigation activities for agriculture represent 3%, while another 3% is distributed among drinking water, tourism, other industries and commercial consumption, as illustrated in table 5.

Table 5. Water use in Central America

	Water supply (mm3/year)	Water demand (mm3/year)	Resource utilization (%)	Main users (%)
Panama	193500	12500	7.0	Hydro (72); Transportation (20); Irrigation (3.5)
Costa Rica	113100	23500	20.7	Hydro (98); Irrigation (3); Drinking water and others (3)
Nicaragua	189700	1956	1.0	Hydro (25); Irrigation; Drinking water
Honduras	92850	8450	9.1	Irrigation (61); Drinking water (23); Hydro (16)
El Salvador	18252	1844	10.1	Irrigation; Drinking water; Hydro
Guatemala	97120	9596	10.0	Irrigation (41); Drinking water (9); Hydro (4); Others (4)
Belice	18550	568	3.0	Agriculture (44); Industry (36); Domestic (20)

Source: GWP (2011)

The country has 34 major hydrographic water basins, half of them with hydroelectric installations (DSE, 2008a). The considerable volume of annual rainfall (3.300 mm) and the distribution of water flow in several watersheds located in different regions (PEN, 2005)[49] produce favorable conditions for the utilization of the resource. Water flow is different between watersheds; those located in the Pacific have lower volumes, especially notable during the dry season (from December to April), than those in the Caribbean, where the dry season is not clearly defined.

Underground energy is another important source, used in the country, for electricity generation. Costa Rica is among the top ten geothermal producers in the world (IEA, 2010). There are 28 areas identified with geothermal potential, whose main sites are located in the Guanacaste province (Northern region) and the Central Valley, specifically in the volcanic areas of the Guanacaste and the Central Volcanic Mountain Ranges (Yock Fung, 2008). The country's volcanoes are part of the 'Pacific Ring of Fire', which encircles the Pacific Ocean, sitting on the edge of the Pacific Tectonic Plate. Along this plate are located most of the active or dormant volcanoes on Earth (about 75%). In Costa Rica alone, there are over 120 volcanic sites of which six are considered active volcanoes, 61-are dormant and the balance is believed to be extinct.[50]

Situated in the same Volcanic Mountain Ranges, the areas with major wind potential in the country are Guanacaste, Arenal Lake and the Central Valley. The Northern region is among the

[49] In regions with higher precipitation, such as the Caribbean and Northern regions, the annual volume surpasses 7000 mm. As a reference for comparison, in Germany, annual precipitation reaches 700 mm.

[50] The Pacific Ring of Fire. (1996-2015). Retrieved June 23, 2015, from http://education.nationalgeographic.com/encyclopedia/ring-fire/

best area for electricity production and where wind velocities are most suitable to develop on-grid projects (DSE, 2008a). Costa Rica is a leader in Latin America's wind energy use, even though most of its wind potential still remains untapped (LAWEA, 2010). Pioneering wind projects in the Central American Region were developed in Costa Rica, by private investors, during the early 1990s based on information from previous technical studies launched by the ICE in the 1970s. The theoretical wind potential was initially estimated in 14000 MW, but more recent valuations reduced the economic potential to half. In the ICE's last report, the identified wind energy potential was established in 894 MW.

Back to earth, biomass resources such as firewood, agricultural residues, biogas and ethanol have much potential in the country; though, little research has been conducted in this area (DSE, 2008a). Besides the traditional firewood, extensively used for lighting and cooking, biomass from bagasse is considered an established technology able to produce electricity at a low cost. Biomass resources, for electricity production, were integrated in the national grid connection with the incorporation of co-generation from existing sugar cane producers. Other biomass resources, like biogas and biofuels, are regarded as emergent. The first biogas plant in the country running with waste-to-energy technology began operations in 2004 (i.e. Río Azul, 3.7 MW).

Biomass is already an important source of power generation in Brazil, Colombia, and Central America. Its growth is influenced by the sugar mills' ability to expand production and by fluctuations in sugar prices. The use of sugar cane residues, for electricity generation, could further be encouraged in light of a ban against burning field trash and related regulations.

Meanwhile, the theoretical potential of solar energy, in the country, is enormous (i.e. estimated in 10,000 MW); however, the current economic potential is identified at only 126 MW (DSE, 2008a; ICE, 2014). Costa Rica's average irradiation levels are between 1650 and 2200 W/m²/year. The lowest irradiation levels, in the nation, are comparable to the higher irradiation sites in Germany (i.e. 1300 W/m²/year). The areas with higher irradiation are located in the Northern Pacific and the Central Valley.

Although the cost of the solar technology (e.g. photovoltaic and thermal) is considered high, recent studies indicated that, in terms of average cost, the technology is already competitive with conventional infrastructures. The average cost of solar energy ranges between 7.8 and 9.1 US dollars cents per kWh for small- and medium-scale applications. Meanwhile, the planned cost of hydroelectric production ranges from 7.6 to 16.2 US cents per kWh, a similar price range to new geothermal projects. In turn, the costs of fossil fired thermal plants escalate to more than 50 US cents per kWh. These higher costs are the outcome of high oil and diesel prices, a low utilization ratio and the decreased efficiency of generators (Weigl, 2014).

Costa Rica has proven existence of oil reserves; however, the country is dependent on fossil fuel imports, especially for transportation.[51] Prospection, exploration and exploitation activities of fossil fuels and natural gas resources were initiated in 1874 in Talamanca, in the province of Limón (Southern Region), and developed in different stages (DSE, 2008a). During the 1950s and 1960s, several exploratory oil fields were opened in this region, one of them yielding 1000 barrels per day, but its production was stopped due to technical problems. Oil exploration and exploitation continued, in the following years, through the Costa Rican Petroleum Refinery (*Refinadora Costarricense de Petroleo*, RECOPE) in agreement with several international organizations.

Since 1993, private companies were also allowed to develop those activities. In 1999, a concession, to explore 4 blocks (2 offshore and 2 onshore), was granted to Harken oil drilling holding. However, this concession was halted during President Abel Pacheco's Administration (2002-2006, PUSC) due to pending environmental impact assessment studies. Currently oil drilling is banned in the country until 2021.

Conclusively, although nuclear energy is considered a low carbon energy source, it is commonly excluded from renewable energy definitions (World Nuclear Association, 2014). Costa Rica has no nuclear reactors and no research reactors. With the Fukushima crisis still fresh, pulling away from nuclear energy is considered a must, not only in Japan but also in a number of European countries, excluding France (Deloitte, 2013). In Latin America, nuclear energy expansion is not being excluded; however, plans have been put on hold in some countries.[52] Table 7 and Map 1 included at the end of this chapter provide an overview of the type of projects carried out in different periods of time and their geographical location.

5.2.2 Foundation and Consolidation of the Hydroelectric Path

The origin and expansion of electrification, in Costa Rica, is largely based on the foundation and consolidation of the hydroelectricity path. In this country, electrification began shortly after the first lighting systems were installed in 'modern cities' of the world in the ninetieth century (Rohrmoser, 1986).[53] During this period, private entrepreneurs mounted the first hydroelectric plants (HPs), in Costa Rica, in order to provide electricity to the city of San Jose's center. These

[51] Oil refining, transport and distribution can be carried out in the country.
[52] "Bolivia Wants Nuclear Energy, But Brazil and Other Latin American Countries are Abandoning It", International Business Times. 01.03.2014.
[53] San José became the first city in Latin America with street lights, three years after New York.

HPs were mainly small run-of-the-river (ROR) hydroelectric stations, such as the 50kW Aranjuez HP built in 1884 by the first Costa Rican electric company. [54]

The construction of HPs continued, as a result of municipal and private undertakings, from national and foreign electric companies motivated by industrial and commercial demands. From 1928 to 1948, the services continued under the monopoly of the Electric Bond and Share Corporation. Since 1949, the state took control and the Costa Rican Institute for Electricity (ICE), a vertically integrated decentralized public company, became the entity in charge of supplying electricity services.

Since then, the National Electric System (NES) and the National Interconnected Systems (NIS) were developed together with hydroelectricity installations.[55] Between 1950 and 1987, most of the seven largest HPs of the country (i.e. over 100 MW) were built by the ICE, including the Arenal dam (i.e. 157MW installed capacity) that began operations in 1979 (ICE, 2014). The company took advantage of the local resource availability and economies of scale developing electricity infrastructure based on hydroelectricity (Wilde-Ramsing & Potter, 2008).

Hydroelectric projects were combined with fossil fuel-based thermal plants, which were considered an important complement due to the dynamics of peak load demands (Wilde-Ramsing & Potter 2008). In this period, fossil-fueled stations generating electricity by means of steam, such as the Colima thermal plant (i.e. 19 MW), built in 1956, were also operating as back-ups to HPs, during the dry season, when their production is considerably reduced. In Costa Rica, oil derivatives and gas were usually the energy sources of fossil-fueled thermal plants, but since the mid-2000s it changed to bunker, which is a cheaper fossil fuel but also a more pollutant one (ICE, 2013; DSE, 2009, p.106).

In the 1970s, the national energy system was made up of 70% hydroelectricity and 30% oil products (Mayorga, 2013: 9-8). Research on other forms of renewable energy in the country, including geothermal energy, wind resources, solar energy, biomass and small hydro was initiated by the ICE in this period, triggered by the oil crisis and a "further increase in the ecological awareness of the public opinion" (Díaz, 2006). All reports and research conducted, during this period, gave birth to the ICE's Program of Non-Conventional Energy Sources. Nevertheless, concrete projects, using these technologies, were delayed for two decades.

[54] Historia del ICE. (2013, January 14). Retrieved February 22, 2014, from http://www.grupoice.com/wps/portal/gice/acercaDe/acerca_ice_asi_somos/acerca_ice_asi_somos_historia.

[55] The National Interconnected Systems (NIS), different to the National Electric Systems (NES), excludes off-grid installations. Both include the ICE own plants, private generation and public-private partnerships.

Meanwhile, similar to other Latin American countries, the government had access to loans that allowed investing in mega hydroelectric projects (Tissot, 2012). The main source for financing electricity projects was the Inter-American Development Bank (IDB), a similar role portrayed by the World Bank (WB) in the telecommunication sector (Bull, 2005). For instance, the construction of the Arenal dam and its reservoir was financed by an IDB loan (i.e. US$525 million) (OIRSA, n.d.). The ICE's own resources were limited because of the political vision regarding the need to subsidize rates for several society groups (Vargas, 2002).

Lake Arenal is the second largest artificial water reservoir in Central America (after El Cajón dam in Honduras, 300MW) and is one of the main HPs of the NES. The most important role of the Arenal dam, within the NES, is the inter-annual regulation capacity of the reservoir; in addition to an important irrigation system located downstream (i.e. the Arenal-Tempisque multi-use irrigation project). The dam is part of the hydroelectric Arenal-Corobicí-Sandillal complex, which consists of three power plants built in cascade (DSE, 2011a).

The Arenal-Tempisque multi-use irrigation project was developed between 1975 and 1978, which operates under administration of the National Irrigation and Drainage Service (*Servicio Nacional de Aguas Subterráneas, Riego y Avenamiento*, SENARA) (DSE, 2011a). This is the country's largest irrigation project, not only in terms of serviced territory, but also in number of beneficiaries (IICA, 1991). This irrigation project highlights the relevance of the Arenal watershed, not only for electricity, but also for irrigation purposes.

Besides the Arenal dam, other medium- and small-sized RORs were also equipped with regulation reservoirs (i.e. smaller dams) in order to reduce their sensibility to rainfall variability. These smaller dams have the capacity to store water during the rainy season and to generate electricity during the dry season (DSE, 2008b). Some of these plants even surpass the Arenal's installed capacity to produce electricity (e.g. Angostura HP), but none of them have a similar water reservoir with inter-annual storage capacity.

By the end of the 1980s, just after the Arenal dam went into operation, hydroelectricity provided 99% of the national supply and, consequently, the use of fossil-fueled thermal plants was kept to a minimum (DSE, 2008b). Even in periods when oil prices decreased, during the 1980s, and most neighboring countries shifted to fossil fuels, Costa Rica remained true to its hydroelectricity-based model (Bull, 2004). In this period, no additional fossil-fueled plants were incorporated in the NES, although four new ones came into being during the next decades reaching larger generation capacities, as illustrated in Table 7 at the end of this chapter.

5.2.3 Emergence of Alternative Renewable Energy Sources

During the 1990s, the ICE continued the construction of HPs with ongoing liberalization reforms of the sector. After the Arenal complex's last dam, another hydroelectric complex, known as Toro, began operations also in the Northern region (e.g. Toro I HP, 23 MW and Toro II 65 MW). The last HP, Toro III (50 MW) started functioning, in 2013, after 5 years of problems with constructions and delays due to litigation and expropriation processes.[56]

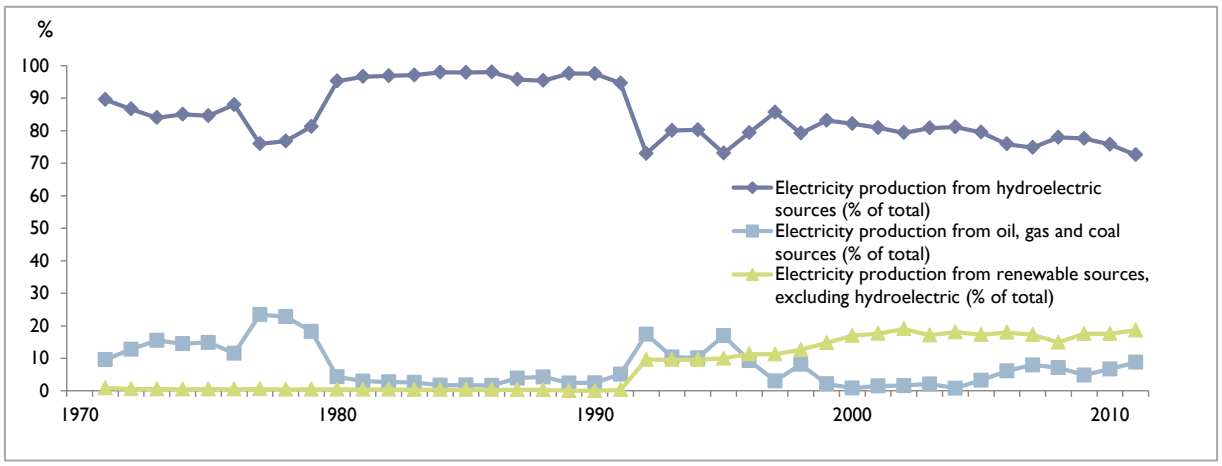
In the 2000s' decade, the largest hydroelectric plant was Angostura HP (180 MW, including a dam). According to expansion plans, the next largest would have been the Boruca dam (1500 MW), in the Southern region, foreseen to be inaugurated in 2010.[57] However, this giant project was involved in a long conflict resolution process, mainly because it would flood parts of indigenous territories (Carls & Haffar, 2010).

Meanwhile, legislation amendments, introduced by Laws 7200 (1990) and 7508 (1995), allowed limited participation of private generation plants (i.e. Independent Power Producer, IPP) in delivering electricity to the grid. Their incorporation had given a new impulse to private hydroelectric projects, though according to regulations their size was restricted to below 20 MW. The projects then scaled up to 50MW, with the use Build-Own-Operate-Transfer, known as BOT, specified in Law 7508. From 1990 to 2000, nearly 27 RORs of small to medium capacities, were built (Cartagena, 2010).

Parallel to the proliferation of RORs, the 1990s also witnessed the emergence of alternative renewable energy carriers. Diversification of the NES, with alternative renewable sources, became evident, in the mid-1990s, when the first geothermal units, wind parks and biomass stations went on line. As pointed out earlier, most modern technologies, using renewable energy sources, were invented (and patented in industrialized countries) before the 1970s. However, from a technological standpoint, they were not radical innovations (Mautz, 2007).

[56] "Litigio por expropiaciones frena y encarece hidroeléctrica Toro III" La Nación, 14.02.2010.
[57] "La Angostura prende máquinas" La Nacion, 21,07.2000.

Graph 1. Costa Rica: Electricity production from different sources (% of total)



Source: World Bank, World Development Indicators.

As illustrated in Graph 1, compared to previous decades, alternative renewable sources came into the scene after 1990, displacing part of the oil electricity production. The development of geothermal fields was already planned, since the mid-1970s, but given the complexity and cost of geothermal developments, the first geothermal station was not connected to the grid until 1994 (Battocletti, 1999; Interview 4C, 2013). From 1995 to1998, installed geothermal capacity grew from 60 MW to 110 MW, all developed by the ICE, even though different external partners supported the ICE since the beginning. External partners included international organizations, such as the United Nations doing first assessments, whereas multilateral banks and international cooperation (e.g. Japan, Mexico, the IDB) financed technical studies prepared by consultancy firms, research organizations, and specialized manufacturers (Moya & Yock, 2007).[58]

Private investments were directly included in the construction and operation of the Miravalles III geothermal plant (26MW) that came on line in 2000 using the BOT figure (ICE, 2014). Two more geothermal units, operated by the ICE, were added in the following years (i.e. Miravalles V, 11 MW and Las Pailas I, 35MW). In 2010, total geothermal installed capacity reached 165 MW (i.e. 6% of the total installed capacity) and generated over 12% of the national electricity (DSE, 2011a). By the year 2012, this capacity grew to 217.5 MW, producing over 14% of the national electricity (ICE, 2014).

In Costa Rica, geothermal electricity production for commercial purposes uses high enthalpy geothermal resources (i.e. a common criterion that provides a rough estimate of the resource

[58] Recognized technology manufacturers and consultancy firms included Rogers Engineering Co., GeothermEx and Foraky-Foramines during the 1970s; ELC-Electroconsult during the 1980s; and more recently, in cooperation with the International Atomic Energy Agency (IAEA), the Department of Scientific and Industrial Research (DSIR) and the Los Alamos Technical Laboratory (Moya & Yock, 2007).

value).[59] Those resources of high enthalpy are located in nearby volcanic areas, most of them inside or adjacent natural parks or protected areas where economic activities are restricted by law. At the moment, the low enthalpy is exploited for ecotourism purposes (Arias, Barahona & Valverde, 2014).

Currently, *Las Pailas* is the only geothermal area under development. A large portion of *Las Pailas* geothermal resource is located within the Rincón de la Vieja National Park boundaries and the Guanacaste Dry Forest property, which is the reason why the study area is restricted to 11km^2 (Yock Fung, 2008). Still, other pre-feasibility and feasibility studies underway are considering areas located inside or near natural parks (Moya & Yock, 2007).

In the case of wind energy, early resource assessment difficulties were later translated into advantages for private investors. During the 1980s, the ICE faced problems in gathering precise data, as criteria, to select the area for future wind parks. Thus, the Institute decidedly hired the Swiss company, Electrowatt Ingenieros Consultores S.A., as a consultant backed with a credit from the International Bank for Reconstruction and Development (IBRD). The consultation report noted that "it was probable that the electricity generated from wind sources would never reach relevance in comparison to hydroelectric energy", even though it should be considered an alternative in areas where its production could be guaranteed (Díaz, 2006, p. 11).

Similar experiences and evaluations of the wind resource continued parallel to technical studies of geothermal fields. The government finally opted to continue pursuing geothermal projects. In 1994, a US$4 million credit from the Inter-American Development Bank (IDB), signed in 1977, led to the development of the Miravalles geothermal field (Boca de Pozo, 5MW and Miravalles I, 55 MW) (Díaz, 2006; Battocletti, 1999). According to technical reports comparing geothermal and wind energy potential, the geothermal energy potential for electricity generation was greater than that of wind:

> "reaching an approximate potential of 1000 MW in reserves and 2250 MW in resources (…) of geothermal production in areas type A, compared with a (wind energy) annual potential of 600 MW (…) in zone 1 including Tilarán" (Díaz, 2006, p.24).

Consequently, and differing from the geothermal case, in the development of wind technology, private capital provided the resources necessary to initiate operations. Nonetheless, in previous decades, wind potential assessments, in the country, had been carried out by the ICE. In 1996,

[59] The enthalpy of the geothermal fluids act as the carrier transporting heat from the deep hot rocks to the surface, it is more or less proportional to temperature and is used to express the heat (thermal energy) content of the fluids (What is geothermal energy?. (2004, February). Retrieved June 10, 2014, from: http://www.geothermal-energy.org/what_is_geothermal_energy.html, last visited 10.06.2014)

the private company, Pesa S.R.L, developed the first wind park in Costa Rica (i.e. Plantas Eólicas, 20 MW) (LAWEA, 2011). The project was followed by another two private wind facilities that also went on line in the 1990s (i.e. Aeroenergía S.A., 6 MW and Tierras Morenas, 20 MW) (ICE, 2011a).

In the 2000s, another private wind plant was added to the grid (i.e. Guanacaste, 50 MW) together with the first wind park from the ICE (i.e. Tejona, 20 MW). After 2010, two more were inaugurated in the Central Valley, one from a cooperative (i.e. COOPESANTOS) and another from the Power and Light National Company (*Compañía Nacional de Fuerza y Luz*, CNFL), a subsidiary of the ICE that operates in the region (DSE, 2011a; ICE, 2014).

By 2010, wind energy was generating 4% of the national electricity, while the installed capacity reached 121 MW (i.e. 4% of the total NES). This infrastructure increased to 148 MW in 2012 (i.e. 5% of the total NES). At present, out of the options available, wind technology offers benefits to private investments since it is considered a mature technology and the cost continues declining (LAWEA, 2010). Additionally, it offers a key advantage as a complement to hydroelectricity generation since the generation of each one is independent from the other (Tissot, 2012).

Meanwhile, biomass was integrated in the NES, with the co-generation incorporation from existing sugarcane producers, after liberalization reforms in the 1990s. During that time, the sugar mills *El Viejo* (18 MW) and *Taboga* (19 MW) started to sell their energy surplus generated by bagasse from their own equipment, a fibrous matter resulting from sugarcane processing (ICE, 2014). Similar to wind energy, biomass from bagasse also complements hydroelectricity because "the seasonality of the sugar cane crop supplements the seasonal variations of hydroelectric plants very well" (ICE, 2014, p. 39). In 2004, the first biogas plant, in Costa Rica, running with waste-to-energy technology (i.e. Río Azul, 3.7 MW) began operations as a private initiative undertaken by the Group Zaret.

In the case of biofuels, the ICE deems their potential important, since they can be used as a fuel source for existing thermal plants running with fossil fuels by making minimal adjustments (ICE, 2014). Nevertheless, this option is limited due to the lack of infrastructure for national production, on a large scale, and the inexistent distribution or storage chains. Moreover, production costs of biofuels are still higher than market prices from fossil fuels (ICE, 2014). By 2010, the installed capacity of biomass units reached 44 MW (i.e. 2% of the total NES) and generated over 0.7% of the national electricity (DSE, 2011a).

The solar cell and photovoltaic technology (PV) was invented, in the 1950s, in industrialized countries and was only used for spacecraft and certain small-scale niche applications (e.g. toy

cars, watches) until the 1970s (Mautz, 2007). In Costa Rica, the first experimental applications of solar energy systems date back to the 1970s, in projects conducted by Universities, and focusing on solar thermal applications such as solar cookers and solar dryers for varying purposes (Nandwani, 2009).[60] Simultaneously, the ICE conducted research on the PV and started to use this technology in niche applications for telecommunication and grid operation in the 1980s (ICE, 2007).

Among available options, solar energy was excluded from the step in size of alternative renewable sources in the mid-1990s, as illustrated in Graph 1. While commercial applications of solar energy at end-user level were disseminated in industrialized countries since 1980s, in Costa Rica, the ICE installed, in 1991, the first photovoltaic (PV) solar home systems (SHS) targeting indigenous settlements without access to electricity (ICE, 2007; Mautz, 2007). Later on, more SHS were distributed on islands, protected areas, and other communities with low population density and difficult access to public services (ICE, 2007; MINAE, 2005).

Following developmental approaches and technical considerations, these projects were integrated in the Rural Electrification Program with Renewable Sources (*Programa de Electrificación Nacional con Energía Renovable en Áreas no cubiertas por la Red*, from now on referred to as REP) launched by the ICE in 1998 (MINAE, 2005). The REP included the participation of Coopeguanacaste R.L., a rural electricity company located in the Northern Pacific Region where solar systems were also distributed.[61] These projects were financed partly by the ICE or by Coopeguanacaste´s own funding, besides credits and donations obtained from developmental financial organizations (e.g. IDB; UNDP; GEF).

Accordingly, these alternative renewable technologies provided beneficiaries with electricity access in rural and remote areas, where energy is often crucial to human development, at subsidized rates (MINAE, 2005). The SHS capacities remained at micro and small scales ranging from 70 to 100 Watts in order to fulfill some elementary energy demands such as lighting and running basic electrical appliances (Interview 1Q, 2013; ICE, 2007).[62] In addition, the proposal for donors, prepared in 2005, stated that the REP followed two country goals: one to achieve 100% electricity coverage and the other to use renewable energy (i.e. small hydro or PV) avoiding CO^2 emissions (MINAE, 2005).

[60] Applications of solar thermal include distillation, sterilization, pumps for clean water supply, water heating, milling of grains or drinking canals, besides measuring equipment and electric generation systems (Nandwani 2009).
[61] The Northern Pacific Region is important for the national economy in terms of agriculture, cattle and tourism, but it is also one with the highest poverty levels. The region posses the best radiation conditions of the country (Weigl, 2014).
[62] The PV applications include lighting and running basic electrical appliances (TV, radio, mobile phone charger, refrigerators, and computers).

From 1998 to 2009, the program installed 1500 photovoltaic systems in different regions of Costa Rica (ICE, 2009). However, given the solar systems' small size, their energy provision was not evidenced within the sector's electricity statistics. By the year 2010, they jointly only reached 323 kW of installed capacity, remaining with low visibility and attracting reduced political attention.

Besides rural electrification projects, with the use of micro and small SHS, in the early 2000s, commercial solar energy applications, at end user level, were also sold in a domestic niche market by the private initiative of small businesses. Commercial solar systems focused on two types of technologies, solar water heating and PV panels, mostly purchased by wealthier residents and few customers from the national industry (e.g. eco-tourism). The domestic market is made up of local distributors or installers, with the balance of system components (Interview 5N, 2013.[63]

Supporting this process are studies promoted by research institutes at the ICE, universities and associations; as well as donors, banks, and other financial organizations providing funds at company and user level in the first steps of the business. For example, the solar energy market became more dynamic, in 2010, with the stimulus of the Net Metering Pilot Program, also known as Distributed Electricity Generation Plan (i.e. *Plan Piloto de Generación Distribuida para Autoconsumo*, from now on referred to as DEG), and the first 1 MW solar park launched by the ICE in 2011. With these projects, solar energy installations grew in more than 100% in a few years and the installed SHS goals reached almost half of the target proposed in the expansion plan for the next 10 years.

Table 6. Photovoltaic systems installed by the ICE

Solar projects (medium size installations)	**Year of installation**	**Total installed capacity (MW)**
Miravalles Solar Park	2011	1
Net Metering Pilot Program	2010-2013	0.17
Rural Electrification Program (ICE and Coopeguanacaste)	1998-2012	0.32
On-grid Solar Plants for Self Consumption ICE	2005-2012	0.04
TOTAL		**1.53**

Source: Own elaboration based on Arias (2013).

[63] The solar-component manufacturers are firms from industrialized countries like Siemens Solar, Sharp, Kyocera, General Electric, and solar divisions of oil-companies such as BP Solar and Shell Solar (Interviews 5N, 2013).

Until 2011, electricity generating installations, from solar energy, remained outside the NES accounts. It was just after the first solar energy park that this type of energy was evidenced on the sector statistics. Solar energy is an example of a technology largely unused compared with the theoretical estimated potential. Table 6 summarizes the advance of photovoltaic systems installed by the ICE.

According to the National Household Census (2011), 1772 households are using solar panels in Costa Rica, most of them are located in Puntarenas (in the Central Pacific province), and the majority are part of the rural electrification program (i.e. 1650 according to the ICE's data). From the year 2000 and 2011, households without electricity fell from 3.2 % (30.244 households or 126.753 people) to 1.1 % (13.533 households or 47.209 people). Yet, at the end of the 2000s, the use of firewood sources for residential energy consumption reached 50%, while in this decade the use of electricity decreased (DSE, 2009).

The limited penetration of small-scale systems in the Costa Rican market has been connected to high front costs and low electricity tariffs that discourage private investments (LAWEA, 2010; FINE interviews 2010). This also applies to wind energy, at small scales, since the necessary equipment has relatively elevated costs when factoring in transportation, import and national taxes. Meanwhile, the construction of fossil-fueled thermal plants increased during this period.

Besides the Moin II (i.e. 131 MW) in 1992, four more fossil-fueled facilities were added in the next decade, expanding by twofold the existing capacities. Furthermore, delays in the construction of Pirris HP, motivated hiring more fossil-fueled plants from private companies, two of them were later bought by the ICE in 2008 (i.e. Guápiles and Orotina plants).[64] By the year 2010, fossil-fueled installations, without considering the plants temporarily hired, reached 616 MW and 23% of total installed capacity. When included, they reached 862 MW (i.e. 31% of the total installed capacity). In terms of electricity generation, fossil-fueled plants provided 6.7% of the national electricity consumed during 2010 (DSE, 2011a).

Despite the advantages provided by fossil-fueled thermal plants, as peak hour plants and as a back-up to hydroelectricity, they are associated with several negative impacts. Above and beyond increasing the cost of electricity and the cost of exceeding capacity (i.e.by not using full capacity), fossil-fueled thermal plants also complicate electricity price regulation, given international fluctuations in oil and gas prices. It also negatively affects the trade balance. Not to

[64] "ICE garantiza servicio de plantas térmicas rentadas" La Nacion, 11.12.2007. "Atraso en obras obliga al ICE a comprar plantas a Grupo Pujol" LA Nación 29.01.2010.

mention pollution and CO_2 emissions to the atmosphere, especially from bunker fueled plants used in the country.

In summary, by the end of the 2000s, hydroelectricity upholds its preeminence. Total electricity generation for the NES was made up of 70% hydroelectricity, 15% from other alternative renewable sources and another 15% was from oil products. The country was situated in the forefront of renewable electricity production from a diversity of sources, of which more than 12% corresponded to electricity generated from geothermal stations, 4% from wind parks and 1% biomass stations. However, the year 2010 showed a stark increase in the share of fossil-fueled installations, coupled with a fall in hydroelectricity shares.

In terms of installed capacity, comparing figures from 2000 and 2010 hydroelectric total installed capacity in use fell from 72% to 57%, while the share of oil-fueled stations spiked from 17% to 31% (including temporally hired plants). According to the Energy Planning Sector, fossil-fueled thermal plants began to rise in the last decade, reaching unprecedented levels since 2006, while alternative renewable sources' penetration remained limited (DSE, 2011b). Although, this could be considered a transitory situation, a trend can be traced over the last decades.

In terms of electricity production, except for geothermal stations, the generation from alternative renewable sources was stranded below 5-7%. Meanwhile, hydroelectric shares have been falling gradually over the decades, in spite of the incorporation of larger hydroelectricity projects. Compared to the 1980s, the hydroelectricity share from total electricity production fell from 99% to 80% in the 1990s and remaining over 70% in the late 2000s, comparable to the 1970s level. The Latin American region reflects a similar trend and estimates suggest that hydroelectricity will continue to be the most important source of electricity generation, though with declining contributions to the electricity mix (Tissot, 2012).

The present description of the technological electricity trajectory in Costa Rica raises several concerns from an institutional perspective. Firstly, what are the institutional factors that explain the predominance of hydroelectricity in the first place, even in periods when oil prices went down? Secondly, what are the origins of its declining contribution? Thirdly, why does the penetration of alternative renewable sources remain limited? And finally, if there is a growing relevance of alternative renewable sources in the last years, particularly solar energy, why is this taking place?

The next section is not aimed at answering all these questions; however, it shall outline the institutional conditions, along with the social, economic and political context, which evolve jointly with technological trajectories. In this sense, the following segment draws attention to

the center of conflicting processes that emerge when technological paths and institutional trajectories are intertwined.

5.3 Institutional Trajectories in Electricity Production (1880-2010)

5.3.1 The "Green Republic" of Costa Rica

The construction of the Costa Rican "green republic" is based on the relationship between the country's economic growth model and environmental conservation policies. These entanglements also shaped developments in the electricity sector, from material and ideological bases. The legacies of this Republic help to understand the consolidation of the national hydroelectricity-based energy model, with limited dissemination of alternative renewable sources, as well as the institutions that flourished by the hand of state actors, in particular the ICE, and the consensual or antagonistic relations between state and society.

According to Sterling (1999), the historical background of Costa Rica's image as a "green republic" can be traced back to the sixteenth century, when early decrees and proclamations for forest preservation and soil conservation were declared. However, the author states that the scientific interest regarding Costa Rica's tropical ecology actually began in the nineteenth century with the international demand for coffee and the construction of the Panama Canal. It was not until then that works on the nation's Natural History became known.

Furthermore, the events of the nineteenth century were a milestone for the national institutional trajectory in many areas of the country's development, including electricity services. Historical analyses points to the Welfare State as a critical juncture explaining "the Costa Rica's uniqueness factor" in terms of social and economic indicators that distinguished the country from other nations in Latin America (Sterling, 1999, p. 1).[65] The foundation of the Welfare State, in Costa Rica, is usually linked to political events that occurred during the 1940s, yet its first origins can be traced back to the establishment of the Liberal period, in Central America, during the nineteenth century (Bull, 2005).

Prior to 1929, the agricultural export model, established in the Central American region, was based on single crop farming, such as coffee or bananas, which in Costa Rica accounted for

[65] These indicators were not only in terms of poverty, income per capita and literacy rates, but also consider social services, such as socialized healthcare and electricity coverage; also with one of the lowest electricity tariffs and reduced efficiency losses in electricity transmission (Sterling, 1999: Bull, 2005).

nearly 90% of export earnings (Schneider, 2013).[66] With the introduction of the Liberal statute, the public sector and the state could now collect increased revenues. State institutions were created and the national infrastructure was improved, though rural areas continued to be isolated (Bull, 2005). The origins of public electrification dates back to this period when the first public lighting system was set up in 1884.

In the late 1920s, in Costa Rica, the market for electricity services was dominated by the Electric Bond and Share Corporation from the United States (U.S.) and a few more private companies (Vargas, 2002). Emerging resistance against U.S. companies, influenced by ideas from abroad which opposed excessive international influence, complicated the situation for the foreign corporation, as well as for banana companies located on the Caribbean coast (Bull, 2005). Moreover, financial problems and the lack of perspectives to expand electricity services gave way to disconformities on behalf of the general public (Vargas, 2002).

As a result, the movement seeking to increase state control over the country's hydroelectric forces grained strength. In 1928, Law 77 established the National Electricity Service (*Servicio Nacional de Electricidad*, SNE) as an autonomous institution with the authority to exploit energy sources, granting concessions, and supervising their utilization.[67] Nevertheless, electricity problems continued in the downturn of the Great Depression, coinciding with a period of economic disruption, and political and social unrest (Schneider, 2013).

Bull (2005) notes that by the 1940s, the Costa Rican agro-export elite was weaker than in neighboring countries which reduced the need for a military apparatus to control the land and labor. This simultaneously allowed for greater state power centralization and the emergence of a liberal oligarchy with a project to promote welfare and development. Nevertheless, prolonged social reforms, under Calderón Guardia's presidency (1940-1944), including the creation of other autonomous institutions (i.e. the Costa Rican Social Security Institution), resulted in struggles with the oligarchy that escalated into civil war in the aftermaths of the 1948 elections.

The war ended a month later with the victory of a revolutionary "*Junta*" headed by Figueres Ferrer (1948-1949, later president in 1953-1958 and in 1970-1974), who declared the funding of the 'Second Republic'.[68] During this period the Costa Rican Electricity Institute (ICE) was

[66] Unlike many Latin American countries, coffee trade was controlled by local Costa Ricans, while in the banana business large capital intensive labor and transportation infrastructure opened the door to foreign multinational corporations, such as the United Fruit Company (Sterling, 1999).

[67] Historia del ICE. (2013). Retrieved January 14, 2013, from http://www.grupoice.com/wps/portal/gice/acercaDe/acerca_ice_asi_somos/acerca_ice_asi_somos_historia

[68] In reference to a breakdown with the old generation of politics and politicians that belonged to a "First Republic". The "*Junta*" represented a new elite who sent the old oligarchic leaders to exile and banned the Communist Party. The military was abolished under this reform platform.

established, in 1949, by Law 449. The ICE assumed the monopoly of electricity generation and supply and was given the responsibility to ensure the availability of electricity for the national economy and the welfare of Costa Ricans.

In order to enhance autonomy from politicians, the ICE was also conceived as an autonomous institution, with full independence from the executive power, and to be guided exclusively by its own Board of Directors. The Board was conformed of private sector representatives, engineering schools, and other civil society organizations (Vargas, 2002; Bull, 2005). The electricity provision structure relied on the ICE, as a decentralized and vertically integrated public company, that merged the private local monopolies into a national state company with vertical integration in the chain of production (Vargas, 2002).[69]

From its onset, rural cooperatives and municipalities had been incorporated and perceived as complementary distribution companies in order to integrate those remote areas from the Central Valley (Vargas, 2002). The Latin American region experienced similar transformations after World War II (WWII), with the subsequent rapid expansion of the electricity sector with vertically integrated State-owned utilities (Tissot, 2012). Although the events of the 1940s, in Costa Rica, can be seen as a continuation and not a rupture of state intervention, they gave way to state expansion in order to achieve the economic modernizing project (Bull, 2005). Moreover, they were of significant political relevance for the country as the two traditional political parties, National Liberation Party (*Partido Liberación Nacional*, PLN) and the Social Christian Unity Party (*Partido Unidad Social Cristiana*, PUSC), emerged from these events.[70]

In this modernization project, the creation of the ICE, in 1949, became a cornerstone fulfilling this task with favorable conditions. First, state responsibility for welfare was combined with the protection from politicization of implementing institutions (Bull, 2005). Second, the appropriation and use of natural resources, namely water for hydroelectricity production, was secured by the ICE's law (Law 449).

Simultaneously, scientific ecological research and environmental conservation were created in this period. In the 1940s, the foundation of the University of Costa Rica and the development of other organizations promoting environmental conservation such as the Inter American Institute for Agricultural Science, later CATIE *(Centro Agronómico Tropical de Investigación y Enseñanza),* gave a national base of support for the green republic's view. In most countries,

[69] In vertically integrated electricity markets/sectors, a single firm owns assets and is responsible for all aspects of production, sale and delivery of electricity (to include generation, transmission, distribution and retail) (Dixit et al., 2014).

[70] The PLN was founded by Figueres Ferrer and his followers in 1951, while the PUSC had a more recent origin (1983), though it was founded by the followers of Calderón Guardia, considered "The Father of the Social Reforms".

conservation policies were a mid- and late-twentieth century phenomena (Sterling, 1999). In this nation, this development came amidst the height of the Welfare state during the period known as the "Developmental State".

During the second half of the century, a 'developmental state era' was introduced in the country. This period, between the 1950s and the 1980s, was characterized by state involvement within the national economy and welfare, as well as the establishment of a series of new autonomous institutions (Vargas, 2002; Bull, 2005). Since the beginning, Law 449 (1949) laid down the creation of the ICE with the objective of electrifying the country and creating the necessary competencies to develop the national energy generation sources, particularly by means of hydroelectricity.

Electrification was planned in stages, by the ICE, according to the operation of electricity generation plants. First, priority was on providing services in urban areas or the most populated settlements in different regions. This was followed by expanding electrification in rural areas surrounding those urban areas, and eventually expanding to resolve the problem of small isolated groups not having access to electricity through installations that worked independently from the interconnected system.[71]

Furthermore, as pointed out by Schneider (2013), developmental projects were favored with renewed commercial opportunities for exports during the post WWII period. Prospects returned to traditional products, but were limited in their potential to raise profits, causing exporters to begin searching for alternatives. During the 1950s, new products such as beef, sugar, and cotton increased their share of exports, expanding the agricultural frontier to other regions in the Pacific lowlands and with greater potential for the application of capital and technology.

However, as in other developing regions, Central American countries experienced the boundaries of this model, which included high dependency on exports and structural problems of international trade (i.e. unequal exchange, unemployment and external dependency) (Coronil, 2002). Following Prebish's ideas and proposals from the United Nations Economic Commission for Latin America and the Caribbean (ECLAC), countries in the region combined their export-oriented model with an import substitution model, also known as "inward development", as a way to address these problems. The relative weak Central American industrialists were hampered, compared to larger foreign producers and given small domestic markets, when the Central American Common Market (CACM) integrated regional markets while establishing external tariff protections in 1963 (Schneider, 2013).

[71] Sistema eléctrico, fuentes energéticas e historia de la electrificación en Costa Rica. (2001). Retrieved August, 2013, from http://www.cientec.or.cr/ciencias/energia/articulo3.html#solares

During this period (1960s), the region moved towards a new growth model based on diversification of agricultural exports and the promotion of intra-regional trade of manufactured products, but still highly dependent on imported inputs. The external limits to this model were partly built into the hybrid strategy of exporting agricultural exports to secure foreign exchange for the imports necessary to sustain import substitution industrialization. Internally, the limitations depended on the distribution of surplus between domestic and foreign capital, as well as the relationship with popular sectors, which determined subsequent patterns and degrees of social conflicts and state institutions (Torres-Rivas, 2013).

Such internal conditions, in the case of Costa Rica, were highly favorable for state institutions, as exemplified through the case of the ICE. Fulfilling the state's developmental goals, electrification increased, together with a social orientation of electricity pricing and network developments (Vargas, 2002). The ICE not only benefited from a formal autonomy and good informal relations with governing elites (Bull, 2005), but also gained legitimation in the relationship built with popular sectors.

Throughout the import substitution era in 1960s and 1970s, economic expansion and the industrial demand for electricity and quality was extremely important (Vargas, 2002). As in other parts of Latin American, the expansion of electricity was based on large projects exceeding demand requirements (Tissot, 2012). Hydroelectric dams' economics and technical characteristics were essential to achieve those electricity goals and were further developed by means of the government's access to loans via external debt (Tissot, 2012; Bradford, 2006).

In the electricity production arena, Bull (2005) denotes that the ICE soon became one of the electricity companies with the highest productivity and the uppermost levels of technological development in Latin America. During 1963, the telecommunication infrastructure´s operation was also delegated to the ICE. The electricity coverage increased rapidly thanks to rural electrification programs, which went from a coverage of 15% of the population in the 1940s to nearly 50% in 1970, and subsequently reaching over 70% of the population in 1980 (ICE, 2013b).

At the same time, this period gave birth to the first protected areas and forest conservation policies in the country that are milestone in Costa Rica's conservation history. The Institute of Tourism (*Instituto Costarricense de Turismo*, ICT) was created in the 1950s and the first wildlife legislation was passed during this period as well (The Wildlife Conservation Law of 1956). The Forestry Law in 1969 established a system to designate protected areas.[72] The Law

[72] Other consideration was given to wildlife issues in the 1970s, when the Costa Rican legislature endorsed international treaties regarding threatened or endangered species, for instance Law 5605 (1975) for the Convention on International Trade in Endangered Species of Wild Fauna and Flora.

was revised, in 1983, eliminating the understanding of wildlife as a simple natural resource and implementing stronger hunting regulations (Sterling, 1999).[73]

Sterling (1999, p. 10) indicates that the "utilitarian multiple-use perspective of conservation" was present since the origin of natural parks and protected areas with the Forestry Law **(**and its revisions). Within this law, logging and recreation are considered high management objectives of forest reserves. Other forest purposes were eventually incorporated, highlighting the importance of national parks and other protected areas in sustaining life, such as oxygen production and public health, preservation of biodiversity and life zones, as well as the production of scientific data.

This legislation was followed by the creation of the first National Parks (i.e. Cahuita National Monument in the Caribbean coast; Poás Volcano in the Central Valley, and Santa Rosa National Park in the North Pacific region). As noted by a biologist and conservationist "all possible arguments were used in the lobbying to support the creation of natural parks and a national base of support for conservation, including tourism…" (Interview 3A, 2013). Fundraising, on an international level, was promoted in order to support the project and obtain the resources to acquire land for national parks and consolidate the system in the years to follow. Although international organizations were reluctant to provide capital for this purpose, they offered funding to support research projects (i.e. UNESCO, The World Wildlife Fund, UICN).

Nonetheless, the situation of state policies became complicated with the international crisis of the 1970s that produced inflationary processes, devaluation and scarcity of state resources. Social disparities enlarged as real wages declined and the cost of basic goods increased. Demand for agricultural exports fluctuated widely and several shocks exacerbated the situation, including an increase in the prices of key inputs such as petroleum, while governments influenced economic activity in a more direct manner (Schneider, 2013).

The economic and institutional developments of this period (1970s) are important to understand, not only the consolidation of the ICE as a state institution, but also the emergence of tensions with elites and party politics. According to Bull (2005), on the one hand, political elites were struggling to influence the operation of institutions to a larger extent. On the other, the ICE gained a reputation with opposition parties and members of the old elite who assumed positions in this institution.

In the midst of the 1970s' crisis, governments also had to contend with revenue pressures of the national industry that emerged under an era of state protection. According to Bull (2005), Costa

[73] In 2012, a new law prohibiting sport hunting in the country is the first passed by Popular Initiative procedures. Popular Initiative is the constitution provision for the people to push for new laws, and environmental regulations, as well as provide local input on the implementation of new laws.

Rican businesses emerged as suppliers to autonomous institutions with reduced competition from abroad and increasingly depended on political connections. As an example of industrialists' power, the author notes that the Chamber of Commerce lost influence compared to the Industry Chamber, whereas in 1975 an umbrella organization, the Costa Rican Union of Private Enterprise Chambers and Associations (UCCAEP), was created.

At the same time, party politics started struggling to regain control of autonomous institutions and strengthen their link with the Central Government. This trend was also influenced by international planning concepts that were implemented in order to ensure the optimal use of scarce resources.[74] Nevertheless, the ICE continued to have a special place within the Presidential discourses "as a symbol of the heroism of the Costa Rican development project" (Bull, 2005, p. 93). The following newspaper text, citing President Figueres Ferrer's remarks about the construction of a tunnel from one of the dams in the 1970s, illustrates this:

> "It is a victory, repeated Figueres, of man over rocks, water, and the harshness of weather. These are heroes, he said (referring) to the workers". (La Nación 28 March 1974, quoted in Amador, 2000, p. 4).

In addition, during this period, geothermal energy became part of the renewable sources pool according to the Law 5961 of 1976, laying down the foundations for research, exploration, and exploitation of geothermal resources as activities exclusive to the ICE. Moreover, the ICE also gained a reputation for its redistributive role and its potential to provide subsidize electricity in poor and rural areas, financed by the profits resulting from telecommunication (Bull, 2005). Therefore, the ICE gained a broad social base of legitimation on behalf of the Costa Ricans.

The extended autonomy of the ICE produced the unintentional consequence of converting the institution into a political actor, resembling "a state within the state", as depicted in its nickname 'the autonomous republic of the ICE' (Bull, 2005, p. 91). This aspect became important in the shaping of future political events and institutional developments of the electricity sector. Furthermore, in 1981, the country had accrued one of the largest per capita debts in the world, mainly due to deficits incurred by state institutions of which the ICE had one of the largest.

The financial situation of electricity utilities, all over the region, deteriorated rapidly when inflation eroded their incomes and governments were reluctant to increase tariffs (Tissot, 2012). Continued pressures from the International Monetary Fund (IMF) resulted in the declaration of a unilateral debt moratorium by President Carazo Odio (1978-1982, Unity Coalition Party, PCU), only one year before Mexico sparked the global debt crisis. However, pressure from

[74] The chief of the executive's limitations were highlighted by external consultants as one of the main problems of the country's public administration (Bull, 2005).

international financial institutions (IFIs) regarding the evolving debt crisis continued and tensions over state institutions became greater, increasing the ICE's budget control. The World Bank (WB) and the Inter-American Development Bank's (IDB) vision went along the same lines in separating telecommunications and electricity, stating that the telecommunication sector had increasing possibilities of obtaining private financing (Bull, 2005).

In addition, neoliberal ideas from the late 1970s and 1980s started to permeate the region (Leiva, 2008). According to neoliberal pursuers, the purpose of modernization through industrialization as proposed by structuralism and state-led industrialization, from the 1940s and 1960s, had deficiencies that markets and price signals could resolve on their own. In 1982, Chile became the first country to deregulate and privatize electricity, followed by a trend of liberalization reforms in most countries of the region.

Although affected by similar pressures over privatization, events unfolded differently in the case of the ICE. Essentially, financing issues worsened when President Arias Sánchez's first administration (PLN, 1986-1990) decided to halt external loans for the ICE and forced the purchase of state bonds, subsequently leading the energy sector into a critical situation. However, the relation with elite groups and IFIs esteemed the differences between Costa Rica and other countries regarding state-owned institutions and continued favoring the ICE's autonomy (Bull, 2005).

With the creation of the Energy Planning Sector, in 1983, the electricity infrastructure's development continued during the 1980s, as stated by the mandatory central plans, headed by the Energy Sector Administration (*Dirección Sectorial de Energía*, DSE). Besides the DSE, the Energy Planning Sector was comprised of the Ministry of Natural Resources, the Ministry of Planning, the ICE, the RECOPE, the SNE, and the National Council of Research in Science and Technology (*Consejo Nacional para Investigaciones Científicas y Tecnológicas*, CONICYT). Under their mandate, physical transmission facilities and distribution infrastructure were planned and developed using cost structure and budget constraints as guiding criteria.[75]

A structural perspective on the crisis also evidenced a development contradiction regarding the growth model, the allocation of resources and the distribution of surplus generated by economic activities. For instance, in the late 1970s, over 90% of all land was associated with the cattle industry, while its production accounted for only 12% of total agricultural exports (Sterling, 1999). At the same time, major multinational corporations were controlling export products (i.e. banana and timber), while not enough crops were produced to fulfill the country's needs (Schneider, 2013; Sterling, 1999).

[75] Sistema eléctrico, fuentes energéticas e historia de la electrificación en Costa Rica. (2001). Retrieved August, 2013, from http://www.cientec.or.cr/ciencias/energia/articulo3.html#solares

Furthermore, from 1950 to the 1980s, Costa Rica sustained enormous environmental damage related with its agricultural development (Hein, 1993; Sterling, 1999). One crucial indicator was the high deforestation levels.[76] Similar to Brazil, extensive livestock production was the main cause of deforestation in Costa Rica (Coronil, 2002). The banana and timber industries were also responsible for massive deforestation, also including pollution, loss of wildlife habitat, degraded worker conditions, and other social problems. Sterling (1999, p. 39) cites former Costa Rican President's statement, in 1987, "we deplore the sad leadership we possess towards destroying our forest".

Of special interest to this research, deforestation was also associated with the decrease in watershed water quantity and the consequent reduction in hydroelectric generating capability.[77] As of 1949, Sterling (1999) documented a decree, issued by the reigning Junta, in order to establish a Forest Council which was given the task to register forest resources and protect forested watersheds. Although this was not established in practice, a similar division was ascribed to the Ministry of Agriculture and Livestock, which remained until the mid-1990s.

In the 1980s, two opposing trends were challenging Costa Rica's image of a "green republic". On the one hand, in this decade, Costa Rica had more protected areas and more personnel working on conservation issues than any other Central American nation. On the other hand, the country's deforestation rate per year was among the highest in the world during the same period.

Among the social implications of the growth model's development contradiction were unemployment of workers whose services were no longer required, forced migration when the land was exhausted, and a vicious circle that encouraged rainforest destruction and poverty (Hein, 1993; Schneider, 2013). Protected areas were not exempt of these patterns related to subsistence activities of squatters (i.e. underprivileged settlers colonizing farmlands) who occupied private and state lands in order to seek for ways to shelter and feed their families (Sterling, 1999). The social movement's origin was also associated to the enclave economy extended in the Caribbean and the Southern region (Sanchez, Zuñiga & Cambronero, 2010).

The Southern region, in particular, has been the arena of recurrent conflicting processes. Considered one of the poorest regions in the country, the area is also permeated by indigenous movements and problems concerning land tenure, forest invasion, and conservation issues. Mobilizations against the transnational Aluminum Company of America (ALCOA) and the

[76] During the 1980s, deforestation levels in Central America were the highest of the tropical regions and similar to those in West Africa (Hein, 1993).
[77] As early as 1888, a decree to protect watershed areas in mountains and the Fire Law in 1909 already understood the connection between forest coverage and water supply (Sterling, 1999).

foreign-owned logging firm, Ston Forestal, took place in this region during the 1970s and 1990s respectively. Both are considered milestones in the social movements' national history.[78]

In the case of ALCOA, protests were originated by locals opposed to the company's extractive activity. The construction of the largest hydroelectric plant in Costa Rica's history, the Boruca dam (1500 MW), is associated to this event. The project was originally planned, by the ICE, in combination with one of the aluminum exploitation plants to be located in the county of Perez Zeledón, Southern Region. As the project took shape in the Assembly, the resistance movement grew incorporating university students and worker unions. Heavy protests, against these projects, eventually convinced ALCOA to pullout of the country (Carls & Haffar, 2010).

Additionally, the 80s was also a period of civil wars in Central America, with the exception of Honduras and Costa Rica. Conflicts devastated the countries' economies and disrupted the integration of regional markets and production (Schneider, 2013). In the aftermaths of these wars, transformations in the growth strategy of the region and a new pattern of international insertion took shape, largely based on a continued expansion of exports.

More dynamic export opportunities were also supported by international actors, especially the United States and multilateral institutions. International loans and aid came with conditions favoring a neoliberal agenda and a new model for the re-insertion into transnational chains, such as Structural Adjustment Programs (Schneider, 2013).[79] These strategies were based on trade liberalization, privatization and deregulation, as well as the promotion of non-traditional products through the creation and/or support of free trade zones (Leiva, 2008; Schneider, 2013). Also, as in many other developing countries with limited mineral resources, Costa Rica began to promote the development of its tourism industry (Hein, 1997).[80]

In summary, the center of conflictual processes derived from Costa Rica's "green republic" (1800-1989) is rooted in structural characteristics of the growth model that confront land/resource intensive production patterns, employment and environmental conservation. Nonetheless, the incursion of the neoliberal agenda, together with new global dynamics, transformed the country in many ways. Within the electricity sector, relationships between neoliberalism and environmental conservation devise the energy sector's policies. Moreover,

[78] Ston Forestal began planting beechwood (Gmelina arborea), in the early 1990s, aside from acquired land in Golfito (South Pacific), the company also leased several hectares from local farmers to plant trees for later logging ("Ticos exigen $26 millones a Stone Container". El Financiero, 10.10.2014).

[79] Costa Rican governments signed agreements with IFIs, as of 1985, through structural adjustment loans from the World Bank as part of the first Structural Adjustment Program (SAP I). Followed by SAP II in 1988 and SAP III in 1991 (PAE III).

[80] Expanding exports were not only made up of traditional products such as coffee, bananas, cotton, sugar, and meat, but also nontraditional agriculture such as palm oil, seasonal fruits and vegetables (Schneider, 2013).

the incorporation of new actors and interests also impacted future developments, as described in the following section.

5.3.2 Steps towards a Carbon Neutral Nation

Costa Rica's first steps of as a "carbon neutral nation" were distinguished by the entanglement of liberalizations reforms, conservation policies and the emerging environmental global governance discourse. The legacies of the 'green republic', in the electricity sector, were displayed in the carbon mitigation strategy of the country, largely based on forest conservation and the expansion of hydroelectricity. However, this approach also unleashed latent conditions of social conflicts.

The Costa Rican society began to move more intensively towards markets as of the mid-1990s (Rovira, 2007). The most significant reforms, in the electricity sector, were implemented during the administrations of ex-presidents Calderón Fournier (1990-1994, PUSC) and Figueres Olsen (1994-1998, PLN) thanks to the approval of Laws 7200 (1990), 7508 (1995), and 7593 (1996). These and subsequent reforms, in the sector, were gradually including new actors in the provision of electricity and also improving public entities competencies.

In 1990, Law 7200 (Costa Rican Law Authorizing Autonomous or Parallel Electricity Generation) incorporated private investments in electricity plants of up to 20 MW capacity. According to the Law, the selection and incorporation of private projects is approved by the ICE, through public procurement procedures, mediated by an electric power purchase contract. In 1995, Law 7508 modifies Law 7200 adding a Second Chapter (Electric Power Purchasing in a Competitive System) which authorizes the ICE to buy electricity blocks of a maximum 50 MW from generation plants owned by private enterprises. In this case, the selection is made by competition and a BOT contract scheme (DSE, 2008a).

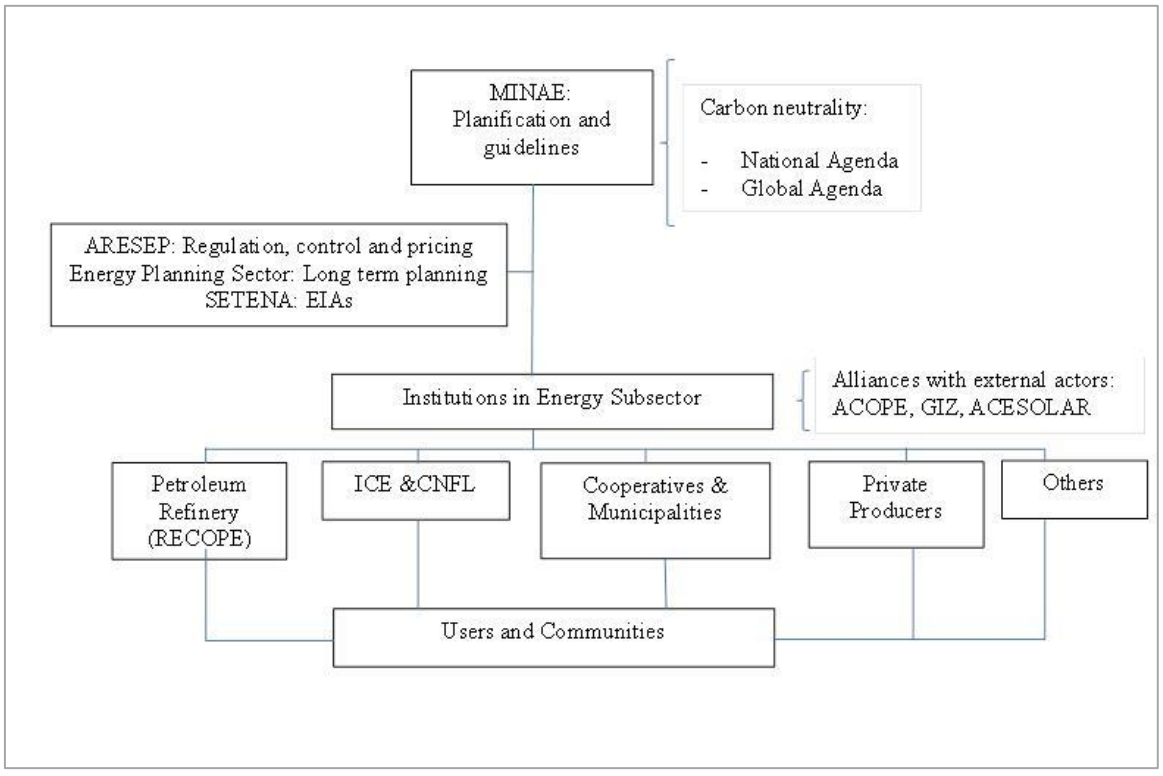
Both, electricity generation and BOT projects should not exceed 15% of the total installed capacity of electricity generation from the NES (DSE, 2008a). Another requisite is a minimum 35% of national ownership of the total project investment. Furthermore, Law 7789 (1998) establishes the regional public service company of the province of Heredia (*Empresa de Servicios Públicos de Heredia*, ESPH), while Law 8345 (2003) regulates the participation of rural electricity cooperatives and public municipal companies in different stages of electricity. In the meantime, Law 8660 (2008) allows associations and strategic alliances between public and private entities.

In terms of renewable energy use, this regulatory framework (Law 7200, 1990) authorized the ICE to buy electricity from private companies whose primary energy sources are

hydroelectricity, geothermal energy, wind energy or another non-conventional renewable source (from now on referred to as alternative renewable energy sources, ARE).[81] New legislation also incorporated consumption tax exemptions to promote the rational use of energy and renewable energies at end-user or retail level (Law 7447, 1994 *Ley Reguladora del Uso Racional de la Energía*).

In addition, these Laws introduced an authorization, in the form of a public service concession, for electric generation or distribution; a price system, which created competition among electricity generators; and they also established institutions for their coordination changing the composition of the Energy Planning Sector. The Regulatory Authority for Public Services (*Autoridad Reguladora de Servicios Públicos*, ARESEP), created with Law 7593 (1996 reformed in 2008), substituted the former SNE as the regulator responsible for pricing, quality control, and technical norms in providing the service.

Figure 5. Structure and regulation of the electricity sector



Source: Own compilation

The public service concession, sanctioned in the ARESEP Law, is granted by the state through the Ministry of Environment (Law 7593, 1996, Chapter 5, incise A). In the case of hydroelectricity, investors also need a water concession for the use of public state property,

[81] A non-conventional renewable source is defined, by law, as all sources that use any basic element, except fossil fuels, mineral carbon or water for energy production.

given the special condition of water as a public good.[82] However, when the SNE was substituted by the ARESEP it left a legal void in terms of water concessions. Figure 5 illustrates the structure and configuration of actors in the electricity sector.

Additionally, companies became subject to perform accordingly to other requisites established in the Environmental Impact Assessment (EIAs) studies approved by the National Technical Secretariat Office for the Environment (*Secretaría Técnica Nacional del Ambiente*, SETENA). The SETENA office is an autonomous institution, ascribed to the Ministry of Environment, created by the Environment Law, in 1995, whose purpose is to regulate environmental impacts of economic and production activities, including their relevant infrastructure (Arts. 17-24, Law 7554, 1995). Electricity producers also need the EIAs' approval as a requisite to obtain the public service concession.

The notion of having a national technical entity that uses scientific information to assess environmental impacts of economic activities was compatible with international commitments acquired at the 1992 Rio Declaration on Environment and Development, signed and ratified by Costa Rica. Therefore, SETENA became a new actor incorporated in the group of sector regulators. Since then, electricity regulation is executed by ARESEP, who sets the tariffs and ensures the quality of the services in consultation with the ICE. In turn, the ICE grants eligibility conditions of the projects according to the National Energy Plan, along with the Ministry of Environment's approval of the EIAs (Law 7593, 1996).

Private investors had organized themselves, early on, in the Costa Rican Association of Private Energy Producers (ACOPE), a non-profit organization created in 1990 to promote the interests of the private members they represented (Interview 4G, 2013). The association took an active part in issuing Law 7200 (1990) and subsequent reforms, including the formulation of auctions and contracts that allowed the integration of private electricity producers. Affiliate associates, from ACOPE, include private electricity suppliers of renewable energy, consulting and legal organizations, construction contractors, providers and financial entities in the energy sector.

The 1990s were also active in regards to environmental protection as the Assembly passed a considerable amount of correlated legislation. According to Lindo (2006), bearing in mind that the promotion of hydroelectricity developments also has particular environmental risks, the focus of the Laws was placed on regulating impacts on watersheds and the environment in general. Most relevant were the Wildlife Conservation Law in 1992 (*Ley de Conservación de la*

[82] This is protected by the Water Law (1943), the Constitution (1949) and the Law of the National Electricity Service (1941).

Vida Silvestre, Law 7317, 1992) and the Law of the Environment in 1995 (*Ley Orgánica del Ambiente*, Law 7554, 1995).[83]

During this period, the consolidation of protected areas continued as well. In 1994, the Costa Rican National System of Conservation Areas (*Sistema Nacional de Areas de Conservación*, SINAC) was created. Between 1991 and 1999, national protected areas increased in extension from 21% to 25% (INBio, 2004). Other data, from 1995, estimates 28% of land designated as legally protected land, of which 11% corresponds to national parks, 4% to indigenous territories, and 13% to other categories of protection (Sterling, 1999). These figures also include privately-owned protected areas.

The category of indigenous reserves is included within the protected areas system of SINAC, as several protected areas are within the indigenous territories, though each of them has their own regulatory framework. The government formed the National Commission on Indigenous Affairs (*Comisión Nacional de Asuntos Indígenas*, CONAI), in 1973, in order to oversee the administration of the nation's 22 indigenous reserves (and 36,350 people) (Sterling, 1999). The Indigenous Law of 1977 (Law 6172) laid down the use of the land , rights, and restrictions to these territories, while the Forestry Law (Law 7575, 1996), the Natural Parks Law (Law 6084, 1977), and the Environmental Law (7554, 1995) established regulations on natural protected areas.

Nevertheless, there is a closer relationship between natural protected areas and indigenous populations. In Central America, it is estimated that 40% of indigenous areas overlap conservation areas.[84] Similar to the case of natural protected areas, indigenous territories have confronted problems with logging and mining inside or nearby their reserves, especially in the Terraba Reserve (Southern region of Costa Rica). Different indigenous organizations have been voicing demands to strengthen their autonomy, enforce regulations over indigenous land, as well as for state support to develop production activities and improve their livelihoods.

Meanwhile, following the emerging global environmental governance, in 1992, a delegation of Costa Rican Indigenous organizations attended the United Nations Conference on Environment and Development (or "Earth Summit") in Rio de Janeiro, Brazil, to voice their concerns and demands. They rallied the support of different native groups from the United States, Mexico and Guatemala, who organized protests, in Costa Rica, a few months after the summit. Other demonstrations ensued, including the largest one in 1996, although with very little attention from the press (Sterling, 1999).

[83] Other laws included the Forestry Law and its reforms (1996) as well as the Biodiversity Law (1998).
[84] "Actualizarán mapa de áreas indígenas y zonas protegidas de Centroamérica", CRHoy, 06.12.2014.

On a national level, the environmental movement was consolidated, as a sector, during this period (Sterling, 1999). Yet, environmental organizations that emerged in the 1980s and 1990s focused more on specific demands, at local levels, than on global transformations (Sanchez et al., 2010). Some of these organizations sprang from the communities immersed in conflict processes, particularly in relation with water management, rivers, and hydroelectricity.

For instance, the Costa Rican Ecologist Federation (FECON), created in 1989, became an umbrella organization constituted by a network of Costa Rican environmental organizations (reaching 30 member organizations in 2013). The organization became a key actor in the process for political maturity of environmentalism in Costa Rica (Sterling, 1999). In the next few years, FECON grew in experience, regarding collective actions and agenda coordination, gaining relevance ahead of other political actors as well as the state itself. [85]

The construction of initiatives and the incidence of environmental organizations supported by FECON, such as the Citizens Environmental Management Commission in 1993 (i.e. *Comisión Ciudadana de Gestión Ambiental*) and the Environmental Advocacy Network in 1995 (*Red de Defensoría Ambiental*), contribute to the development of technical and political capacities of the environmentalist sector. These experiences also strengthen their position, before the legislative agenda, in several environmental laws passed during this period.

In fact, environmental organizations also expressed concerns regarding the Water Law (Law 276), a key normative that regulates water uses, particularly regarding the need to control water disposal and regulate groundwater, which accounts for 70% of the total drinking water supply. The Water Law remained, without substantive reforms until 2014, despite bill proposals since the 1990s that demanded an integral reform of this legislation on behalf of environmental organizations and academia.[86]

Basically, the introduction of liberalization reforms already exacerbated social tensions, especially in rural regions (Sanchez et al., 2010). A relevant case occurred, in the Southern region, when in 1996, several communities in Perez Zeledón created a River's Defense Committee (*Comité de Defensa de los Ríos*) against "*Los Gemelos*" private project and the protection of the Chirripó Pacífico River watershed (Municipalidad de Pérez Zeledón, 2013). The Committee submitted a writ of amparo and a constitutional appeal to the Constitutional Court, whose resolution, in 2000, paralyzed private hydroelectric developments. The problem

[85] Breve descripción de la FECON. (2007, February 5). Retrieved October, 2013, from http://www.feconcr.org/index.php?option=com_content&task=view&id=12&Itemid=30
[86] "Nueva Ley de Aguas: urgencia nacional", La Nación 08.08.2013.

was partially solved by the Constitutional Court's amendment (i.e. Voto 2000-10466) (Alvarez, 2013).[87]

In the 1990s, environmental mobilizations also emerged, in other regions of the country, opposing hydroelectric projects (e.g. the Pacuare HP in the Central Caribbean, the Pirrís HP and the Savegre HP in the Pacific), open pit mining in Miramar de Montes de Oro (i.e. Central Pacific region), and oil drilling in the Southern Caribbean region (Sanchez et al., 2010; FECON, 2014). In 2002, another mobilization took place, opposing open pit mining, in Crucitas de San Carlos (Northern Region) (Isla, 2002; Alvarez, 2013). Those latent conflicts resulted in legal processes, some still underway (i.e. between grass-roots organizations and the local subsidiaries of Canadian mining companies), while oil drilling is banned in the country until 2021.[88]

Conversely, those examples also illustrate the duality of the government environmental discourse and its utilitarian use of natural resources. While it promotes conservation policies and forest protection, it also encourages foreign investments in oil (and mining) explorations. For example, in 1994, the Assembly sanctioned the Hydrocarbons Law (7399), which promoted and regulated oil and any other hydrocarbon exploration and development, declaring it a public interest (Cajiao, 2002). This also reveals that in terms of energy, the political elite's position has been ambiguous.

The environmental movement gained strength with the integration of environmental organizations that became aware of those new concerns and challenges (Sanchez et al., 2010). In the 2000s, local problems and the defense of water resources became a central axis for collective actions concerning the construction of hydroelectric plants; the conflict between tourism and drinking water (i.e. community of Sardinal in the Northern Pacific region), as well as water contamination (i.e. aquifer Barba, Central region) (PEN, 2006). Since 2000, Costa Rica's environmentalism was characterized by conflictual process derived from the environmental movement struggles against the development model.

The country's exports shifted towards higher value goods, as the country attracted more sophisticated firms that could take advantage of the Costa Rican workforce's higher rates of literacy and education, after decades of investment in education and welfare (Hein, 1997; Schneider, 2013). This country's profile was consolidated, in 1997, with the installation of electronic goods manufacturing, such as INTEL and Hewlett Packard, as well as medical

[87] The new reform establishes that the Ministry of Environment is the sole authority to grant the water concession. However, according to the constitutional writ, the Ministry's authority was against established normative, such as environmental impact assessment, citizens' consultation and Municipal competences over its territory.

[88] "Ticos exigen $26 millones a Stone Container", El Financiero, 10.10.2014. "Luis Guillermo Solís extiende moratoria a explotación petrolera hasta el 2021", La Nación, 25.07.2014.

equipment and automotive parts. Valves, electronic tubes and tourism became an important source of foreign exchange (Schneider, 2013).[89]

Compared to more capital intensive products, which boomed in the 1950s and 1960s, contemporary nontraditional products require greater technology, standardized production techniques, and financing alternatives. At the same time, greater exports diversification together with the economic modernization process produced other environmental problems. Besides continued high use of pesticides, they also include remarkably high use of water per capita in irrigation and tourism (Hein, 2008).

Those structural changes resulted in a number of impacts on labor force, urban-rural composition, migration, and consumption patterns that are difficult to assess (Schneider, 2013; Hein, 1997). For instance, the tourism boom, with the globalization of leisure and travel, became an important source of foreign exchange, but with controversial consequences on development (Hein, 2008; Schneider, 2013). Schneider (2013, p. 33) refers to tourism drawbacks, including minimal technology and skill transfer, limited job productivity and wage potential, speculation in land and homogenization of culture. As a result, international tourism consumption squeezes resources for producers and local communities.

As most population migrated to the cities, another consequence of these changes is reflected in the rise of energy consumption (Hein, 2008; 1997). The use of electricity in the residential, commercial, and public sectors rose from 10% in 1970, to over 50% in 2005 (DSE, 2008b). Within total energy consumption, electricity reached 17% in 1990 and 20% in 2005, while the use of oil derivatives, as an energy source, remained stable, around 60%, during the same period (DSE, 2008b).

Costa Rica entered into this growth strategy dynamics, with relative success, while keeping the signature of the 'developmental state era', particularly in the electricity sector. As remarked by Bull (2005, p. 82) "By the beginning of the millennium it (Costa Rica) could be considered a last refuge of state ownership in Latin America". Electricity and telecommunications remained under control of a state-owned company, the ICE, and the private sector had only been allowed to participate in some parts of the business.

However, new challenges were affecting the organization internally and the electricity sector, as a whole. First, the ICE was under pressure of increasing financial controls, much as a result of the state reform under the Structural Adjustment Programs (SAPs) and deepening privatization trend (Solís, 2002). Second, there were challenges to handle the technical revolution in the

[89] In the year 2000, valves and electronic tubes were the single largest generator of foreign exchange, while as percentage of the GDP's net tourism receipts peaked at over 9% (Schneider, 2013).

telecommunication and electricity sectors leading to an increase in plant size and subsequently requiring larger investments (Bull, 2005).

Effectively, by the year 2000, the ICE had plans for two of the largest hydroelectric generation projects, the Angostura HP and the Boruca HP. Similarly, the institution dealt with several privatization attempts, a project led by the governing political elite. The two processes (i.e. liberalization reforms and the expansion of electricity projects) converged in the events of the "ICE Combo".

Several privatization attempts began, ever since the presidency of Arias Sánchez (PLN, 1986-1990), and did not dismiss the importance of ICE top managers' personal motives in support of the institution's privatization (Solís, 2002; Bull, 2005). These attempts met fierce resistance from the workers unions and the general public. One of the major privatization clashes was, in 2000, when a law reform known as the "*ICE Combo*" was presented during President Rodríguez Echeverría's government (PUSC, 1998-2002).

It was very likely that the proposal may have become a law in the second debate, but it was dismissed, after strong opposition, due to differences between political parties and the Constitutional Court's declaration of vicious procedures (Solís, 2002; Carazo, 2001).[90] Mobilizations, against the ICE Combo, are considered the first multi-sector alliance between the ICE's labor union and the environmentalist sector (Cartagena, 2010). With this group effort, worker unions got the support of a traditional coalition of environmentalists, community groups, rural and indigenous people, whose major concerns were the proposal's environmental implications. Specifically, they rejected the promotion of large hydroelectricity plants and the exploitation of geothermal energy in natural protected areas (Carazo, 2001; Cartagena, 2010).

On a national level, between 1998 and 2002, the ICE was immersed in negotiations with indigenous communities concerning the Boruca dam. In the analysis of the Boruca HP case, Carls &Haffar (2010) consider this as one of the longest processes of conflict resolution in the country and also a costly one, starting since the 1970s when the ICE began studying the project and investing over US20 million dollars into the project. The project was planned in the Térraba River (Southern region) and was associated with severe negative effects, mainly by flooding a vast area (i.e. 25000 hectares) which included parts of three indigenous reserves, as well as roads and infrastructure in another four reserves.

In the aftermath of the ICE Combo, the Boruca HP plan slowed down in the following years, given the strong opposition that rose from different groups and international organizations,

[90] A pact between the two main traditional political parties, PLN and PUSC, to support the proposal was behind this outcome (Carazo, 2001).

mainly from the affectation of indigenous territories. Furthermore, in 2000, the "ICE Combo" process coincided with the release of The World Commission on Dams (WCD) report that spurred global dynamics. International movements organized themselves in networks to support affected communities against dams. Through this report, social movements against dams were echoed, on a global level, highlighting the elevated cost of dams for displaced people, downstream communities, taxpayers and the environment, stating that "in too many cases an unacceptable and often unnecessary price has been paid to secure those benefits" (WCD, 2000, p. 310).

While actors, in the electricity field, focused on those local challenges, the Costa Rican government became actively involved, during the initial implementation phases of the Agenda 21, the Kyoto Protocol, and the United Nations Framework Convention on Climate Change (UNFCCC) (Landreau, 2006; Martin, 2004). These initiatives were established at the 1992 "Earth Summit", along with the Intergovernmental Panel on Climate Change (IPCC), promoting environmental protection and the goal to offset greenhouse gas (GHG) emissions at a global level (Martin, 2004).

In the next few years, the country endorsed international agreements for environmental protection, including the Convention for the Protection of the Ozone Layer (1991) and the Convention on Biological Biodiversity (1994). Through the use of joint implementation (JI) strategies and clean development mechanisms (CDM), derived from the Kyoto Protocol (signed and ratified by Costa Rica between 1998 and 2002), the nation started an early cooperation with industrialized countries in order to offset GHG emissions (Landreau, 2006). Costa Rica became the first developing country to participate in arrangements based on international associations in which private businesses, government agencies, and nongovernmental organizations (NGOs) undertake joint mitigation or sequestration activities in a host country, in order to promote their mutual interests (Martin, 2004).

The country then turned to the implementation of sustainable development, in domestic policies connected to those international mechanisms, as a new vision for addressing environmental degradation and economic underdevelopment. The expression "development in harmony with nature" in vogue during this period reflected these ideas (Martin, 2004, p. 161). The phrase was recorded for posterity, since the creation of the policy think-tank P*rograma Estado de la Nación,* in 1994, an independent initiative that became institutionalized with the support of national universities and the United Nations. [91]

[91] The program publishes an annual evaluation regarding the situation of the country's sustainable human development, including an environmental chapter under the label "harmony with nature".

Mitigation strategies in the country generally fall into two categories. The first concerns land use, which means increasing a given area's potential to fix carbon (planting trees) or preserving natural carbon stocks (forest, soil threatened by destruction). The second is based on energy projects, which alternate fuel sources or use of renewable energy that decrease the use of carbon-based fuels (Martin, 2004).

Costa Rica took advantage of these climate change instruments, with particular success, within the first category based on land use. Less attention was given to promote transformations in the energy field, which in the case of electricity, was already using low carbon fuel sources thanks to hydroelectricity. In part, this explained the relatively few projects with GHG potential for reduction, in the energy sector, registered by the Costa Rican Joint Implementation Office (OCIC) in 1998 (Landreau, 2006).

On the same track, the country was a pioneer in the development of the Payments for Ecosystem Service (PES) program, which implied selling emission reductions through the instrument of Certifiable Tradable Offset (CTO) (UNDESA, 2012). In accordance to the Forestry Law (Law 7575), the national PES promoted forest conservation and regeneration, based on the implementation of market mechanisms, translated into economic incentives for landholders to be compensated for providing ecosystem services (i.e. environmental protection). Funds for landholders' compensations have been generated by fuel taxation, grants and loans from national and international institutions, agreements with the private sector and additional charges to water users. [92]

With the application of this instrument, the Costa Rican policy gained national and international recognition in regards to the country's conservation strategy. Costa Rica's PES initiative has been ascribed as playing an important role in reducing the nation's deforestation levels. As pointed out in a report from the United Nations Department on Economic and Social Affairs:

> "(…) prior to 1992 (Costa Rica) had one of the highest rates of deforestation globally, however the establishment of an innovative national PES program later that decade has been a major contributor to a dramatic reduction in forest loss. This has involved a direct shift in economic focus from agriculture to ecotourism – something which larger countries have struggles to replicate. Moreover the successful implementation of this program has been dependent on various other structural conditions including amongst others political stability, high investment in education and agricultural reform. The absence of these conditions, in many other developing forest rich nations, would appear

[92] Pago de Servicios Ambientales. (2014). Retrieved November, 2014, from http://www.fonafifo.go.cr/psa/index.html.

to be a major reason for absence of effective woodland related to the PES program." (UNDESA, 2012, p. 113).[93]

Nonetheless, changes in the growth model also helped to ease deforestation trends and its severe effects on local, regional and global ecosystems, through reducing GHG emissions, shifting from dominant primary exports to a greater share of assembly manufacture and nontraditional products (Hein, 2008; Schneider, 2013). At any rate, the success attracted international funds to support 'green policies', as well as interest from environmental organizations on a global scale (Martin, 2004; UNDESA, 2012). The national environmental strategy continued focusing on the conservation of watersheds and natural areas, but currently, not only for conservation goals, but also for carbon mitigation.

Beyond the domestic boundaries, after a long-discussed integration effort, the Central America Energy Interconnection System (SIEPAC), an energy infrastructure project to build a distribution line from Panama to Mexico, has picked up speed (Martin, 2010). Since 1998, the initiative is led by a consortium of public and private companies from Central America, Mexico, Colombia and Spain, supported by funds from the IDB and the CABEI, and is currently at the final construction stages. The project's goals are firstly, to support the consolidation of a Regional Electric Market (MER) and to facilitate the participation of private investments in electric generation capacity, and secondly, to establish the infrastructure that allows exchanges among participants. The rationale behind SIEPAC is to reduce dependency on imported sources through scale economies in "a region endowed with plentiful water resource" (Martin, 2010).

The project's design has been criticized, by environmental organizations and some experts, based on the assumption of the SIEPAC and the MER that private initiatives will improve services through efficiency and price competition, but its main beneficiaries will be transnational corporations that will benefit from logistic and price subsidies.[94] The SIEPAC has encountered major obstacles in Costa Rica, where the last lines were still under dispute. Moreover, in Costa Rica, the participation of actors in the MER is restricted to the ICE, according to regulation, but pressures to deregulate the Costa Rican electric sector are strong and transcend national interest.[95]

The issue of telecommunication and electricity liberalization emerged, again, in the context of a package deal included in the Central American Free Trade Agreement (CAFTA) with the

[93] More recently (2005), the initiative on Reducing Emissions from Deforestation and Forest Degradation (REDD) in developing countries has been promoted by the Rainforest Coalition, lead by the governments of Papua New Guinea and Costa Rica, and supported by numerous other forested nations (UNDESA, 2012).
[94] 2009. "La geopolítica de la apertura del mercado de electricidad". Kioscos Ambientales UCR
[95] "País completará en julio red para intercambio regional de luz" La Nacion, 18.05.14

United States. This time, the project of electricity liberalization was embedded in a broader scheme of the free trade agreement and it separated main line telephony and electricity, from mobile telephony and internet services (Hoffman 2007). Moreover, the agreement left the issue of private - state participation, in the electricity sector, as a matter of domestic ruling (Lindo, 2006).

However, different sections of the text were considered a threat in terms of environmental and social implications, particularly because, according to the Costa Rican Constitution, international agreements surpass domestic laws, and hence, the CAFTA divided the society and raised concerns from different angles (Lindo, 2006). Those apprehensions generated social mobilizations since the beginning of the agreement's negotiation and after its ratification during 2006 and 2007, including protests led by heterogeneous groups of actors demanding the government to remove the CAFTA from the Congress (Lindo, 2006; Sanchez et al., 2010).

The range of actors, who participated in protests against the CAFTA, included public universities, environmental and labor unions, students, as well as organizations of national producers, opposition political parties, women and other forms of social organizations.[96] They identified diverse concerns regarding threats to public institutions (i.e. health, education, telecommunications, and insurances), the vulnerability of labor and environmental laws, and the sovereignty in areas such as food safety and indigenous awareness. The marked polarization, caused by the CAFTA, led the government to pursue a referendum, Costa Rica's first in its history, preventing that mobilizations may reject the agreement (Sanchez et al., 2010).[97]

Not without struggles and a huge influential media campaign, the CAFTA was finally approved in October 2007. Analysts of the process considered that the CAFTA's demonstrations, similar to the ICE Combo, were "in defense of the public, and against private acquisition".[98] Sanchez *et al*. (2010) states that CAFTA got into the social fabric of the Costa Rican society and prompted old conflictual processes over land tenure, expansion of agricultural frontiers, and threats to the protection of nature.

The same year of the CAFTA referendum, Costa Rica launched the initiative of carbon neutrality by the year 2021. The initiative was presented during the Bali United Nations Climate Change Conference in December 2007. Together with the "Peace with Nature Initiative", it was announced by the presidency, aiming at "strengthening political actions and commitments to

[96] "Pacífica marcha contra TLC" La Nación, 24.10.2006. "Marcha contra el TLC evidenció aislamiento del gobierno", Siempre Verde, 28.02.2007. "Majestuosa manifestación contra el TLC" ANEP, 27.02.2007.
[97] Total participation in the referendum reached 60% of people of voting age, from which 51.62% voted in favor and 48.38% against.
[98] "Referéndum sobre el TLC potenció la participación ciudadana" Noticias UCR, 10.10.2012.

reverse the alarming trends of human impacts over ecosystems at global, national and local levels" (MREC, 2008, p.12).

The 'peace with nature' initiative was promoted, on the global forum, together with "The Costa Rican Consensus", a proposal to include ethical criteria in public expenditure in accordance with the Millennium Development Goals (MREC, 2008). The proposal's goal was to introduce changes within the frameworks of development aid, credit and debt relief of donor countries and international financial organizations. On October 2007, both initiatives derived in a pioneer exchange of Debt for Nature Swap of US 26 million dollars with the United States (MREC, 2008).

On a national level, carbon neutrality was defined primarily as a commitment to offset, reduce and avoid carbon emissions domestically, generated as part of the country's intention of aspiring to become the first carbon neutral economy of the world.[99] Therefore, it is composed by both national and international agendas, the first with a focus on mitigation and adaptation, the second aiming to have incidence and attract foreign resources (IMN, 2009). In the route towards carbon neutrality, the Costa Rican Ministry of Environment declared the need to diversify the energy mix, "since a large part is still generated by hydroelectricity and fossil fuels" (MINAET, 2009, p. 62).[100] However, few changes were implemented, within a carbon neutrality plan, by means of a national sustainable energy strategy. This is applicable to the transport sector, by far the largest emitter of GHG, and the electricity generation field.[101]

Chief actions were directed to the economic internalization of CO_2 emission costs within the fossil fuels prices and tax incentives on hybrid or electric vehicles (IMN, 2009; MINAET, 2009), as well as to electricity. This was reflected in the energy goals defined in the National Development Plan 2006-2010, as well as in the National Strategy for Climate Change. They stated objectives: "To improve technologically and restore reliability levels, quality and security in energy supply, thus reducing the use of fossil fuels in electricity production to become by the year 2021 the first nation that produces 100% of its electricity consumption from renewable energy sources" (MIDEPLAN, 2007, p.81).

According to this carbon neutrality approach, hydroelectricity became the easiest path to achieve the goal. The ICE 2010-2021expansion plan proposed a series of seven major new dams

[99] Programa País. (2012, May, 22). Retrieved April, 2014, from http://cambioclimaticocr.com/index.php/2012-05-22-19-47-24/programas/programa-pais

[100] However, among alternative sources, only a short reference to biofuels, especially for the transport industry, is included.

[101] The main initiatives in the transport sector, namely the electric train and the introduction of biofuels in the transport sector, remained at a proposal level (IMN, 2009).

with a total generating potential of 1440 MW (Carls & Haffar, 2010). At least three of them have already been initiated (e.g. the Reventazón, the Savegre and the Diquís HPs).

The country's conservation patterns have encountered, up to a certain point, those of production and market orientation by discourses of carbon neutrality. Costa Rica will be able to sustain economic growth and consumption patterns while remaining low carbon, as long as the forest coverage can off-set an important amount of CO_2 emissions and large hydroelectric projects can provide electricity, minimizing oil imports. Nevertheless, these advantages in approaching climate change cannot disregard other social, cultural, and environmental relationships that became increasingly unstable.

In spite of suitable economic growth rates, this model has been unable to reduce poverty and has increased inequality indicators. Since 1994, the incidence of poverty and extreme poverty remained around 20% and 6% respectively, while inequality has been growing.[102] The high levels of human development and declining poverty that followed active and sustained policies for social inclusion since the 1940s, started to deteriorate (PEN, 2012).

Simultaneously, a widespread disenchantment with politics and politicians had repercussions at a political level. According to the system's support index, measured by the Latin American Public Opinion Project (LAPOP), the lowest levels were reached in 2002 and again in 2012. All in all, these processes resonated broader social and political demands for more citizen participation in the decision-making apparatus. This aspect marks a new phase for the electricity sector, a claim that transcends the public or private character of the activity.

As an expression of those social demands, a new political actor emerged giving birth to the Citizens' Action Party (*Partido de Acción Ciudadana*; PAC), a center-left fragment of the PLN, founded in December 2000. In 2014, the PAC candidate, Luis Guillermo Solís Rivera, was elected President of Costa Rica, breaking off 66 years of bipartisanship. Part of the purposes and principles expected from this administration were the decrease in poverty and social inequality levels, together with a platform based on encouraging citizen participation and involvement in public affairs.

In summary, although in the transition from a 'green republic' to a 'carbon neutral nation', the country's growth model shifted from natural-resource intensive to non-traditional exports, structural conditions, such as poverty and inequality remained unchanged. Moreover, the political disenchantment also manifested itself in the electricity scene with a number of protests and demands for political participation. At this juncture, hydroelectricity was associated to

[102] Those poverty indicators are similar for urban and rural areas suggesting an absence of regional exclusion; nevertheless, inequality is still highest in rural zones (PEN, 2012).

insecure livelihoods, unequal access to water resources and lack of participation in decision-making, which caused conflicts with local communities. Those developments are further analyzed in the next chapters.

5.4 Concluding Remarks

Technological and institutional developments towards carbon neutrality, by the year 2021, are interlinked. The origins of the technological path, based on the continuation and expansion of hydroelectricity projects, coincide with the foundation of the country as a "green republic", a category that distinguished the national growth model until today. From the study of past events, three observation periods were distinguished.

A first period, before 1990, was initiated by a critical juncture in the national electricity sector with the creation of the ICE (1949), which occurred during the welfare state era. During this time, electrification was expanded in the country and the hydroelectricity model base was consolidated, mainly through the development of state dams and RORs, by the hand of state actors, in particular the ICE. Fossil-fueled plants were incorporated to the national network right from the beginning, as peak demand and back-up plants. At the end of this period, solar energy was at an experimental stage, geothermal stations were under exploration, and preliminary studies of wind parks were conducted.

A second time period is bracketing transformations during the 1990s, preceded by the Law to promote private electricity generation and subsequent reforms (1995). This timespan experienced the diversification of energy sources, as well as the incorporation of new actors due to liberalization reforms in the sector, particularly the participation of private energy producers. These reforms also produced tensions between actor constellations with repercussions in future developments.

A third time period identifies more recent developments, following climate change commitments and the country's carbon neutrality initiative (2007) to be achieved in 2021. Although technology research in the energy sector began in previous decades, the first electricity projects went on line until the mid-1990s. In the year 2010, the proportions of total electricity generation were distributed among hydroelectricity (70%), alternative renewable sources (15%) and fossil fuel sources (15%).

Most production, from alternative renewable sources, came from the ICE geothermal stations (12%) that had an expansionary phase during the 1990-2000 period. Private wind parks, with a lower contribution (4%), were continuously pressed forward, during this phase, similar to biomass stations (1%). While the share of fossil-fueled electricity generating installations grew

steadily during the last decade, alternative renewable sources remained stagnant. In terms of state–society relations, each period triggered new arrangements between actors in the electricity sector, but also latent conflictual processes placed in terms of relations between state, private actors and community-based organizations.

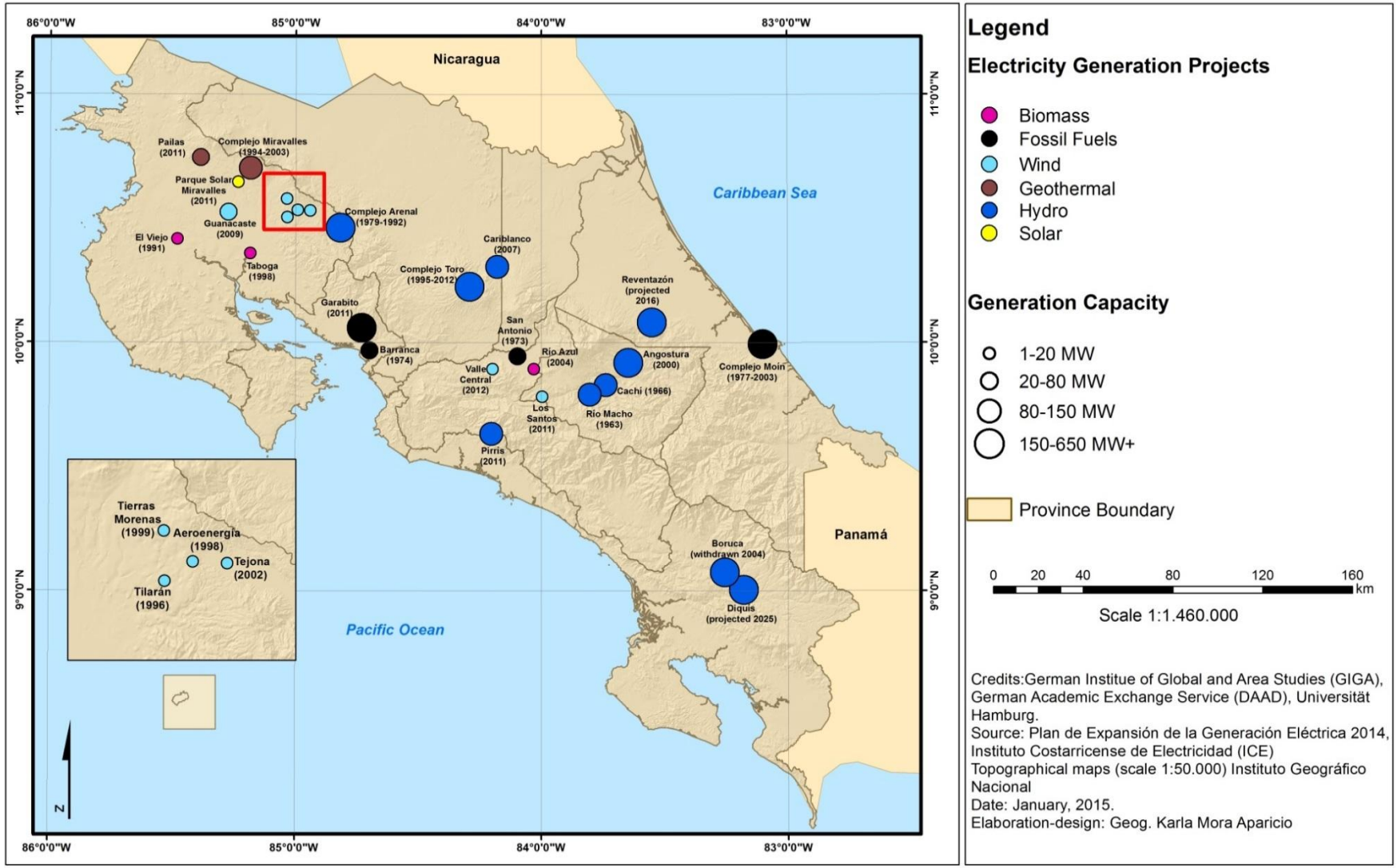
The next four chapters go into detail on the self-reinforcing mechanisms causing status, as well as those drivers of change, in the national energy system. Their purpose is to explain decision-making in the energy sector of Costa Rica. In the following chapters, the drivers of decisions are separated according to efficiency mechanisms, political power mechanisms and legitimation mechanisms.

Table 7. Characteristics of existent plants over 1 MW and total installed capacity by Energy source and year of operation.

Year	Hydro*		Fossil Fuels		Geothermal		Wind		Biomass		Solar**		Total
	Plants (year on line)	Installed capacity (MW)	Plants (year on line)	Installed capacity (MW)	Plants (year on line)	Installed capacity (MW)	Plants (year on line)	Installed capacity (MW)	Plants (year on line)	Installed capacity (MW)	Plants (year on line)	Installed capacity (MW)	MW
	Carrillos (1951) La Garita (1958) Rio Macho (1963) Cachí (1966) Arenal (1979)	2 40 134 103 157	Colima (1956) San Antonio (1973) Gas Barranca (1974) Moin I (1977)	12 37 36 20									
1980		**444 (74)**		**154 (26)**		**0 (0)**		**0 (0)**		**0 (0)**		**0 (0)**	**598**
	Corobicí (1982) Ventanas Garita (1987)	174 100											
1990		**743 (84)**		**146 (16)**		**0 (0)**		**0 (0)**		**0 (0)**		**0 (0)**	**890**
	Sandillal (1992) Toro I (1995) Toro II (1996) Daniel Gutiérrez (1996) San Lorenzo (1997) Doña Julia (1998) Angostura (2000)	32 27 66 19 15 16 180	Moin II (1991)	131	Boca de Pozo I (1994) Miravalles I (1994) Miravalles II (1998) Miravalles III (2000)	5 55 55 26	Tilarán (1996) Aeroenergía (1998) Tierras Morenas (1999)	20 6 20	El Viejo (1991) Taboga (1998)	18 19			
2000		**1220 (72)**		**294 (17)**		**145 (9)**		**43 (3)**		**37 (2)**		**0 (0)**	**1701**
	Peñas Blancas (2002) Cote (2003) Los Negros (2006) La Joya (2006) General (2006) Cariblanco (2007) Canalete (2008) El Encanto (2008) Pocosol (2010)	37 7 17 50 39 84 18 8 26	Moin III (2003) Guapiles (2008) Orotina (2008)	78 14 10	Miravalles V (2003)	18	Tejona (2002) Guanacaste (2009)	20 50	Río Azul (2004)	3.7			
2010		**1554 (57)**		**862 (31)**		**165 (6)**		**121 (4)**		**44 (2)**		**0 (0)**	**2746**
	Pirrís (2011) Toro III (2012) Cubujiquí (2012)	140 50 22	Garabito (2011)	200	Pailas (2011)	36	Los Santos (2011) Valle Central (2012)	13 15			Miravalles (2011)	1	
2012		1700 (62)		616 (23)		218 (8)		148 (5)		44 (2)		1 (0.04)	2723

Source: Plan de Expansión de la Generación Eléctrica 2014-2035 (ICE, 2014).

Figure 6. Map of Costa Rica and electricity generation projects (a



Note: Smaller hydroelectric run-of-the-river stations as well as solar home systems at micro and small scale are not evidenced in the map.

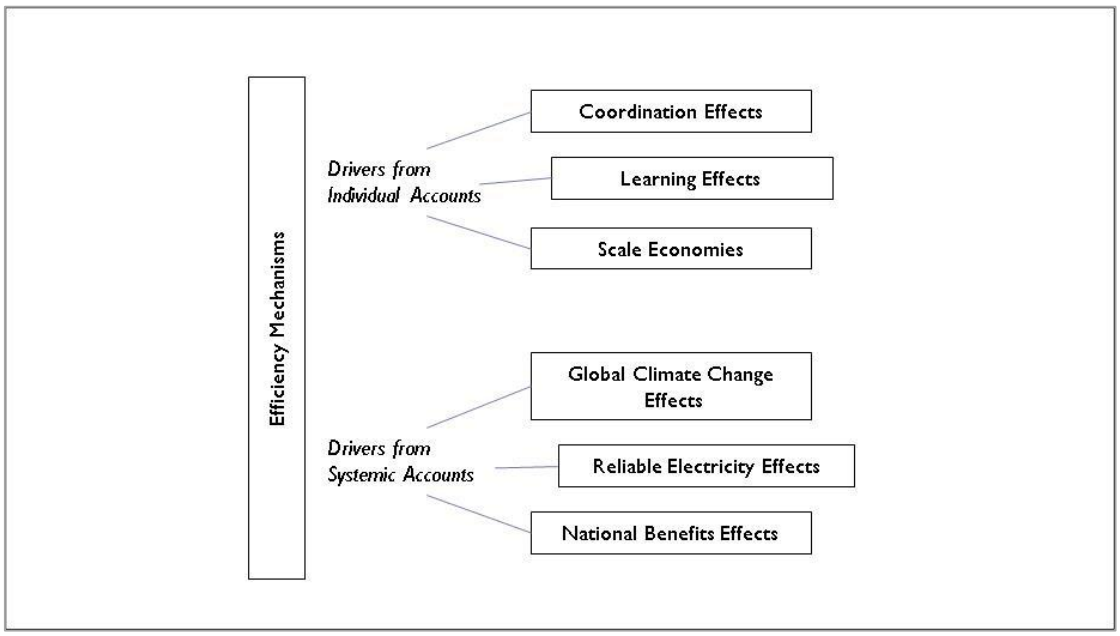
6 Efficiency Mechanisms in the National Electricity System

6.1 Introduction

The present chapter traces the choices between energy projects and technologies following the logics of efficiency. Decision-making, through efficiency mechanisms, is separated into two levels: individual and systemic. In the case of individual accounts, actors' decisions are based on rational cost-benefit assessments (i.e. calculus approach). They, either follow profit motivations (private actors) or effectiveness to achieve goals at the minimum cost (public actors). Accordingly, three drivers of efficiency were identified at this level: a) coordination effects, b) learning effects and c) scale economies.

Regarding systemic accounts of efficiency, actors' choices also comprise cost-benefit logics, but the optimization concerns the energy system as a whole, not only individual projects. Moreover, the mechanisms, at the systemic level, are beyond individual viewpoints in the sense that they refer to survival or adaptation of the overall energy system. Three drivers of efficiency were identified at the systemic level: d) global climate change effects, e) reliable electricity effects and f) national welfare effects.

Figure 7. Efficiency mechanisms and drivers



Source: Own compilation

The following sections explain how efficiency drivers operate over time. After the introduction, Section 6.2 briefly presents the actors involved in the framework's efficiency. Section 6.3 elaborates on drivers from individual accounts, followed by Section 6.4 with explanations from

the systemic accounts. The chapter ends with Section 6.5, which includes some preliminary conclusions.

6.2 Actors Involved and their Interests in the Decision-Making Processes

Since its origins and during the 'developmental state era', the Costa Rican Electricity Institute (ICE) developed characteristics of a natural monopoly in terms of electricity production. Hydroelectric dams provided the infrastructure to achieve the state's goals of electricity supply for the domestic industry and to expand grid connections (Vargas, 2002). During this period, the ICE's employees gained technological expertise and efficiency in building hydroelectric installations.

After liberalization reforms, the incorporation of private investors gave way to the development of several run-of- the river (RORs) hydroelectric plants. Private electricity generating installations were limited, in scale, according to the Law. In this period, the first wind energy, and geothermal stations came on line, though, to a limited extent. In both cases, advances in technology were supported in the earlier stages by the ICE and by the international partners who provided technology transfer.

The subsequent legislation created the regulatory body (i.e. the Regulatory Authority for Public Services, ARESEP), whose responsibility was that of establishing the electricity tariff, at all stages (i.e. generation, transmission, distribution, and commercialization), with a more technical (efficient) approach.

The new legislation also enforced mandatory Environmental Impacts Assessment studies (EIAs) to every productive activity, including electricity projects, a task that was assigned to the National Technical Secretariat Office of the Environment (SETENA) ascribed to the Ministry of Environment.

At the same time, the ICE continued developing large dams sustained by national economic growth goals, but also to further expand electricity sales. The ratification of the Central American Electric Market protocol provided incentives to fulfill a regional demand for large quantities of electricity at a low cost. Hydroelectric dam characteristics were also suited for this purpose.

Simultaneously, Costa Rica was the first country to join industrialized nations to offset greenhouse gas (GHG) emissions (Landreau, 2006). The country was also a pioneer in the development of the Payments for Ecosystem Services (PES) selling emission reductions through the Certifiable Tradable Offset (CTO) instrument according to the Kyoto Protocol. The creation

of a global carbon market became attractive for private and state actors, at a national and international level, to follow the very same institution in its carbon emission reduction efforts. Moreover, global climate change and national energy security challenges concerning oil dependency facilitated the communication channels between governments, corporations from industrialized countries, electricity investors at a national level and non-governmental organizations (Interview 4H, 2013).

In this period, the ICE and the rural electricity cooperatives (e.g. Coopeguanacaste) launched the Rural Electrification Program (from now on referred to as REP) that used solar home systems (SHS) to provide electricity for the remaining population without electricity, to reduce dependence on firewood and other oil fuel sources, as well as to target CO_2 emissions reductions. The REP is supported by partners from the international cooperation (e.g. implemented by the United Nations Development Program and financed by the Global Environmental Fund).

The first Costa Rican Association of Solar Energy was created in the 1990s as part of the initiative of public university researcher, Shyam S. Nandwani, to become part of the Costa Rican Section of the International Solar Energy Society (ISES) (Böer, 2005). After ten years of being active and nearly 120 members, the Association was dissolved in 2006 (Interview 3N, 2013). In 2010, solar technology advocacy groups organized themselves again in a new association: "the Costa Rican Solar Energy Association" (ACESOLAR), a non-profit private organization promoting the use and development of solar energy in Costa Rica.

The Association is made up by members of national universities, the industry chamber (i.e. CICR), small business in the solar energy market, and the German International Cooperation Agency. (i.e. GIZ), who works alongside national regulatory bodies (e.g. ARESEP; SETENA; INTECO). Among other activities, ACESOLAR supports research on technology cost, efficiency, and reliability issues.

In the same year, the ICE launched the Net Metering Pilot Project *(Plan Piloto de Generación Distribuida para Autoconsumo)* or distributed electricity generation *(DEG)*, another project, besides the Rural Electricity Program, using alternative renewable sources at smaller scales. However, the DEG was not providing solar home systems, at subsidized rates, to users in isolated areas; instead, it was promoting their self- consumption use to clients already connected to the grid. By 2012, the first solar energy park, in Costa Rica, reaching 1MW of installed capacity started operations (i.e. the Miravalles Solar Park). It was developed by the ICE and financed through the Japanese government's donations, conceived as a demonstrative project providing electricity to the grid (Interview 3J, 2013).

In 2014, two main actors are considered key players in the efficiency framework: decision-makers at an individual projects level (i.e. state and private investors) and regulatory actors at the systemic level (i.e. the Energy Planning Sector; ARESEP; SETENA). Among secondary actors and institutional entrepreneurs are mainly private associations, the influence of international organizations, and the global industry. Their actions affect decisions in terms of cost-benefit assessments.

6.3 Individual Accounts and Efficiency Mechanisms

6.3.1 Drivers of Coordination Effects

According to the rationale of *coordination effects*, they are producing efficiency gains from rule-guided behavior that can be anticipated, making them attractive for others to adopt and follow the very same institution (e.g. targets, limits, standards). Since the 1950s, different actors adopted and applied laws and norms to develop the country's national energy resources with a national welfare goal. To the private sector and the future institutional orientation of the energy system, liberalization reforms increased private competencies and prompted side-effects on energy decisions through new laws and regulations.

Subsequent to liberalization reforms, *coordination effects* altered individual accounts for electricity production through three rule-guided norms that can be clustered into market regulation, environmental impact assessments, and carbon mitigation incentives. These norms came into effect more or less simultaneously and began shifting energy decisions after the 1990s. Evidence of these effects provides possible justifications for the reinforcement of hydroelectric projects, as well as for advances in wind parks, and initial steps in solar energy at larger scales.

New laws regarding liberalization of the electricity sector in the country authorized the ICE to buy electricity from private companies "whose primary energy sources are hydropower, geothermal, wind or another non-conventional renewable source" (Law 7200).[103] However, during this decade private hydroelectric installations continued growing faster than other alternative renewable energy projects. Nearly 27 hydroelectric plants of small and medium capacities were built under co-generation Laws 7200 (1990) and 7508 (1995) (Cartagena, 2010) versus three private wind parks, built between 1990 and 2000.

In terms of market orientation, the new approach of electrical regulation was assumed by the Regulatory Authority for Public Services (ARESEP). According to the methodology initially

[103] In this Law, a non-conventional renewable source includes sources that use any basic element, except fossil fuels, mineral carbon or water for energy production (Law 7200, Art.4).

established by the ARESEP, the cost of private generation should be lower to that of the ICE (i.e. principle of avoided cost). However, this approach is limited in providing incentives for improving efficiency and reducing costs (Dixit et al., 2014).

In addition to market regulations that stimulated hydroelectric projects, another group of norms started to deal with the environmental impacts of these projects. Formal regulations, on Environmental Impacts Assessment studies, were initiated in 1995 with the creation of the National Technical Secretariat Office of the Environment (SETENA). Moreover, state and private developers started to adjust their behavior to this norm through informal channels of diffusion as well.

Environmental regulations were also in line with the growing importance of Corporate Social Responsibility (CSR) that emerged as a form of corporate self-regulation to deal with environmental impacts and legitimacy problems. According to previous studies, since the 1990s, Costa Rica experienced a second phase of CSR strategies, by the hand of multinationals that included CSR within their corporate policies (Empresarial, RIDRS, 2005).[104] This was also confirmed during interviews at the ICE.

The ICE's planning department managers refer to internal processes of reengineering taking place, in the 1990s, that gave birth to the systematic incorporation of the socio-environmental variable (Interview 4L, 2013). As a result, the ICE created the Environmental Planning department and special attention was given to new methodologies of environmental impact assessment at projects' initial stages. Since then, these issues gained relevance in the Institute's agenda.

While private and state investors directed their attention to projects' local effects, another group of instruments started to gain relevance in attention to impacts, at a global scale, from reducing carbon dioxide (CO_2) emissions. In the 1990s, the Costa Rican government and the Ministry of Environment became active partaking in joint implementation strategies (JI) and clean development mechanisms (CDM). Furthermore, the country also developed similar instruments, at the national level, in the 1990s, through the Payments for Ecosystem Services (PES) and in the late 2000s, in the promotion of carbon neutrality by 2021.

Carbon mitigation incentives created a rule-guided behavior that encouraged decisions on renewable energy sources, applicable to private and state investors. Two considerations, from a calculus approach, help to explain their adoption from national actors' perspective. First, the innovative mechanism of a global carbon market coincided with the oil price shock, in the early

[104] The first phase was during the 1930s when foreign companies invested in infrastructure in isolated areas. (Empresarial, RIDRS, 2005).

1990s, and the oil price speculation again in the late 1990s, which increased oil prices and attracted interest on alternative renewable sources worldwide. Second, global climate change and national security concerns facilitated communication channels between governments, corporations from industrialized countries, electricity investors at the national level, and non-governmental organizations (Interview 4H, 2013).

The first consideration points out to individual accounts and profit motivations in decisions towards alternative renewable sources. The second refers to more systemic accounts discussed in the next sections. At any rate, all three private wind projects that went online in this period became part of the JI strategies issued by the UNFCCC.[105]

Similarly, during the 2000s decade, all private wind and biomass projects, as well as the ICE wind park were registered at OCIC (Landreau, 2006). Project reports from these initiatives remarked the displacement of fossil fuel electricity units and the subsequent reduction of CO_2 emissions. However, the number of projects implemented jointly in Costa Rica was relatively small (i.e. around 10), and most of them were on forest conservation, rather than renewable energy projects.

Likewise, the national environmental strategy of the PES had focused on the conservation of watersheds and natural areas for carbon mitigation goals (i.e. offset carbon emissions at a global level). Over the years, the number of projects at the OCIC did not increase much (i.e. around 17 in 2015). Nevertheless, carbon mitigation incentives applied to all wind projects built in the country, in the 1990s, and most of the new ones, as well as to biomass energy projects (OCIC, 2015).

Nonetheless, the question remains why private and state developers choose wind or biomass energy projects, instead of opting for solar energy or other alternatives. Asked about this inquiry, non –governmental organization and international cooperation partners in Costa Rica and Central America indicated that their focus was on the promotion of a range of 'commercial' energy sources.[106] According to them, their role was as facilitators doing local capacity building and taking advantage of "non-oil, domestic, indigenous, and commercial energy sources" (Interview 4H, 2013).

[105] Wind parks were the Plantas Eólicas S.A Wind Facility; the Tierras Morenas Wind Park Project and the Aeroenergía S.A. Wind Facility, financed partly by investors and international cooperation, such as the US International Development Agency.

[106] The term 'commercial' energy sources is based on the nature of their transaction in the market, it excludes energy sources like firewood, biomass and animal dung. (Clasificacion of Energy Sources. (n.a.). Retrieved April, 01, 2014, from http://www.ces.iisc.ernet.in/energy/paper/alternative/classification.html)

Further, responses from private and state investors reported that wind energy was, at that time, already an established technology and its selection was also motivated by the *opportunity* presented from international players in the wind industry (Interview 5D; Interview 1A; Interview 1P; Interview 1G, 2013). As pointed out by a project manager, at the time, "wind resources were not only abundant, but the technology also had the support of international partners" (Interview 5D, 2013).

Solar energy systems (i.e. thermal and off-grid photovoltaic applications) were sold on the national market, by few small private businesses, since the late 1990s. However, the systems were at micro, and much smaller scales as compared to projects included in the JI and CDM schemes with installed capacities of over 3.4 MW.[107] In the interviews carried out, solar energy entrepreneurs repeatedly referred their interest in benefiting carbon mitigation instruments, but the lack of information and cost were considered the main barriers (Interview 5N, 2013).

According to the ICE's solar energy project managers, given the size of solar installations it is not worth applying for CDM mechanisms (Interview 1Q, 2013). Therefore, solar energy remained outside the scope of the carbon mitigation rule-guided system. In addition, as late as 2010, employees in charge of those solar energy projects, within the ICE, refer to the need for technology research before further steps in larger applications. However, the situation started to change in the same year, given the interest from international partners of the solar energy industry (Interview 1Q; Interview 5H, 2013).

The first solar energy park, at a larger scale (i.e. the Miravalles Solar Park, 1MW) began operations in 2012, chiefly due to the interest of foreign partners. This park was designed as a demonstrative project donated by the Japanese government. For the government of Japan, the project was not only an opportunity to introduce solar electricity, as a clean energy option for Costa Rica, but also to promote Japanese technology and employment (Interview 3J, 2013).

Further steps on solar technology at larger scales have been cautiously taken. From the electricity producers' standpoint (i.e. state and private investors and electricity distributors), this precautionary position is not completely misguided due a regulatory framework that is still at its initial steps. In interviews with private investors and academia respondents, they refer to some "gray areas" of solar technology that still need to be clarified. They include the need for basic research at larger scales and other ambiguities in terms of socio-environmental impacts (Interview 3L; Interview 1A; Interview 1P; Interview 2C; Interview 2H, 2013).

[107] ICE. (2007, June). Energía solar. Retrieved from http://www.grupoice.com/esp/cencon/gral/energ/info/nuevas_fuentes.htm

A stable and predictable regulatory framework is crucial for the effective operation of any business (i.e. coordination effects). This is acknowledged by several players in the electricity market who initiated actions in this direction. They include the government, the regulatory authority, state and private investors and technology advocacy groups.

In the past few years, the promotion of alternative renewable sources, clearly evidenced in the case of solar energy, is taking advantage of the same rule-guided norms created in the 1990s. During interviews with ARESEP officials in 2013, they pointed out that, currently, the regulatory authority is working on a new tariff methodology for solar energy electricity plants. Similarly, they are working with SETENA to develop specific criteria for environmental impact assessments that includes specific aspects of solar energy installations. Until now, the Office has been using the methodology for hydroelectric projects (Interview 2F; Interview 3F, 2013; Interview 2I; Interview 4B, 2013).

In this process, advocacy groups, such as ACESOLAR, became relevant actors in making solar energy visible and reaching massive commercialization. According to *market regulation norms*, the organization started working together with the Costa Rican Technical Standards Institute (INTECO) for the harmonization of solar components in the national market. In the same manner, it worked with ARESEP in the new tariff methodology and with SETENA to develop specific criteria for the environmental impact assessment of solar projects (Interview 2I; Interview 4B, 2013).

In addition, ACESOLAR has supported technical studies regarding solar energy application in Costa Rica, as well as providing answers to main barriers ascribed to the technology. They include issues such as high cost, low efficiency, high variability, low load factor and lack of storage system. These are the industry's areas of major concerns. However, from ACESOLAR and other solar energy advocators' perspective, some of these concerns are considered "the myths of solar energy" limiting further progress on the domestic market (Interview 2I; Interview 4B, 2013). The term was used by ACESOLAR members, who refer to studies that indeed suggest that the technology is competitive and efficient in the country (Interview 2I, 2013). [108]

In the same direction, the government brought support to the ICE's new Net Metering Pilot Plan or distributed electricity generation (DEG). ICE project developers remark that the implementation of the DEG plan has not only been positive from the perspective of users' acceptance (one of their indicators), but also because solar energy is leading among the implemented technologies (Interview 2A, 2013).[109] Although, this plan is not yet defined nor

[108] Results of this study are further discussed in Chapter 9.

[109] From total installations, 95% have been for solar systems (107), the rest are combining solar and wind power applications (2), solar and hydro (1), wind (1), biomass (1) and hydro (1). By consumption sector,

regulated within the national legislation, it has been linked to new policy instruments that make reference to solar energy targets by 2020 (e.g. MINAE Directive 14-2011; VI National Energy Plan 2012-2030) (Interview 4G, 2013).[110]

After launching the carbon neutrality initiative in 2008, the Ministry of Environment followed a similar approach for the JI, CDM and PES incentives, largely based on carbon sequestration through reforestation and forest conservation practices. In 2012, the Ministry included a new strategy with the formalization of the "Carbon Neutrality Country Program for Costa Rica" (i.e. *Program País Carbono Neutralidad*) (Acuerdo -36-2012 – MINAET). The program targets energy users, mainly local companies, which could compensate their carbon emissions by means of alternative renewable energies (e.g. co-generation, wind energy, solar energy). As part of the program, the Ministry created a carbon neutral certification system awarded to those who comply with the established standards.[111]

In the period under review, individual accounts of energy decisions were triggered by coordination effects of ruled-guided behavior from market regulations (e.g. standards, tariffs), environmental impact assessments and carbon mitigation incentives. All of these instruments reinforced hydroelectric projects, especially the RORs. In this sense, environmental impact assessments similar to carbon mitigation and the PES program were also a useful instrument for investors to gain recognition in the national or global market.

In the case of carbon mitigation instruments (e.g. CDM), it is possible that initially similar reactions to the new incentive did not anticipate further commitments with alternative renewable energy, in the country, explaining the reduced number of projects. This also concurs with Landreau's (2006) observation, which referred to the fact that the reduced number of projects registered before the OCIC is largely explained by a national energy system predominantly based on low carbon energy sources such as hydroelectricity. However, in the case of wind energy, the carbon mitigation instrument has played a role as an incentive to opt for this technology and develop wind parks together with foreign partners.

Following this argument, private and state developers choose wind energy or biomass projects, instead of solar energy, because the latter lacks the aforementioned coordination effects (i.e. market regulation, environmental impact assessments and carbon mitigation incentives). The same also applies to other efficiency drivers, at individual level (i.e. learning effects and scale

most of the systems are for residential consumption (83%), followed by general (14%) and industrial (3%).

[110] The VI National Energy Plan 2012-2030 included the specific goal "to equip 10% of households with distributed generation from solar energy by 2020" (DSE, 2011).

[111] This is the INTE 12-01-06 ("*Sistema de gestión para demostrar la carbono neutralidad*"), the single norm recognized by the government to demonstrate carbon neutrality.

economies). Interests on larger scale solar applications were just recently triggered by global industry developments.

More recently, the ACESOLAR, ARESEP, SETENA's efforts, among other regulatory agencies, to incorporate specific criteria for alternative renewable sources, in particular, solar energy, illustrate the relevance of rule-guided behavior. Their actions began to have initial escalating effects, including solar energy targets, energy policies and plans in 2011. The same drivers operate at the ICE's DEG and in the carbon neutral certification system.

6.3.2 Drivers of Learning Effects

As a result of learning effects, efficiency is gained when executing subsequent iterations (e.g. with skillful gains increasing returns). Therefore, time is a necessary condition to develop these effects. Throughout the history of hydroelectricity in the country (i.e. first plant built in the 1880s) and under state control of the Costa Rican Electricity Institute (ICE) for more than half a century, skillful applications and expertise on the technology were successfully brought about.

ICE technicians developed skills at building hydroelectric plants. Over time, expertise on these constructions not only grew in terms of knowledge and talent, but also in terms of the size and scale of the installations. From 1950 to 1989, the ICE built five of the seven major hydroelectric dams of the country, besides several hydroelectric projects at lower levels.

Learning effects were not the only drivers of energy decisions for state investors. In fact, liberalization reforms gave way to several smaller run-of-the river (ROR) hydroelectric plants built by private investors. The influence of learning effects, from private investors' standpoint, was also relevant.

Interviews conducted with private investors who started businesses in the electricity sector during the 1990s confirm this. The private companies were created by former engineers at the ICE, or had previous experience as construction contractors in the development of hydroelectric projects, at earlier stages (Interview 5D; Interview 5M, 2013). As pointed out by one interviewee: "the opening of the sector, through Laws 7200 and 7508, provided a business opportunity for those who had gained knowledge and skills through their experience with the ICE" (Interview 5M, 2013).

In comparison, further evidence suggests that similar effects resulted in the emergence of geothermal stations and wind parks by state and private investors, respectively. Though, these developments appeared recently, and their expansion was limited from the onset, which somehow reduced efficiency gains at this early stage. The first geothermal station, developed by

the ICE (i.e. the Boca de Pozo I, 5MW), was inaugurated in 1994. While the first wind park, (i.e. the Tilarán, 20MW) was built by private investors in 1995.

In previous decades, research on the technologies was conducted by the ICE with the support of international partners, who played an important role for technology transfer (e.g. research institutes, consultants). This is illustrated in the case of geothermal installations. After the first station had come online, in spite of the high cost of installations, the ICE developed five more geothermal plants between 1990 and 2009. As pointed out by project developers:

> "Geothermal energy continues to gain relevance over the years. While local expertise has been created, technology was acquired by the ICE (not rented), and proprietary innovations were incorporated (Interview 4C, 2013)."

Besides, Costa Rican engineers were also trained abroad and became head of project departments at the ICE (Interview 4C, 2013). Furthermore, the Institute was the only developer authorized by Law. Hence, the ICE's engineers developed knowledge and skillful operations of geothermal stations. According to IEA data, Costa Rica is among the top ten geothermal producers in the world (IEA, 2010).[112] In 2011, a new ICE geothermal station came on line (i.e. Pailas, 36 MW). Statements from project developers indicated that thanks to the expertise gained by the state company through the years:

> "[…] We have installed, together with the one we inaugurated today, six geothermal plants which have been working efficiently. We have acquired machinery, equipment and high technology tools. We have innovated new technologies some unique in the world […]. Thanks to the talent, innovation and dedication of our people […]." (Mayorga, 2013, p. 9).

A private company operates the geothermal plant "Pailas" through a BOT arrangement. According to private investor's statements, together with the ICE they were providing investments to speed up the advancement of electricity projects (Stauffer & Long, 2013). However, geothermal energy potential is also limited by sites with higher potential, which are located in the volcanic areas and under some category of natural conservation (ICE, 2014).

Conversely, in the case of wind parks, private installations, and state developments later on, were triggered by the interest of international players from the global energy industry. Nevertheless, private wind investors also benefited from the ICE's previous knowledge of the

[112] Most of Latin American geothermal potential is concentrated in Central America, Mexico, and Chile (Tissot, 2012).

availability of the wind resource, acquired through technical studies conducted at earlier stages. Though, foreign partners prompted decisions to materialize the projects.

As pointed out by interviewees, even though the ICE was experimenting with wind technology for decades, the decision also followed the logic of interaction with "a 'global demand' of wind energy that changes specific preferences" (Interview 5D; Interview 1A, Interview 1P, 2013). After the first wind park (i.e. Pesa, 20 MW, 1995), private investors built three more wind plants, including another BOT project, by incorporating foreign shares. Similarly, in 2002, the ICE's first wind park (i.e. Tejona, 20 MW) was a joint venture with international players (Interview 5D, 2013).

The evidence presented above reveals that learning effects are possible explanations for the reinforcement of hydroelectric installations, state and private, as well as for the development of geothermal stations. These effects, not only strengthened their continuation over time, but also encouraged the introduction of innovations with domestic expertise. The observed difference between geothermal stations and wind parks suggests that these effects were not yet applicable to wind installations or solar energy.

Even though the ICE was experimenting with wind technology for decades and created a basis for potential *learning effects*; the first state-owned wind park was connected to the grid much later than private installations. The same applies to solar energy applications, which remained relatively small scale and at the level of pilot projects. The lack of partners, at the industry level, helps to explain this result (i.e. learning effects).

6.3.3 Drivers of Scale Economies

Drivers of *scale economies* refer to efficiencies wrought by volume (i.e. provide large quantities at low cost). Those drivers were intrinsically integrated with the ICE's reasoning when making choices about energy options, since earlier stages. Based on a calculus approach and aided by benefits of scale economies from electricity production dams, the ICE developed characteristics of a natural monopoly. From this perspective, dams provided large quantities of electricity, at a reasonably cheap prices, compared with many other forms of energy.

The characteristics of dams matched very well with the social orientation of electricity pricing and grid development that predominated during the 1950s until the 1980s. Their relevance continued in the following decades, not only for grid development but to sustain economic growth and further expand electricity sales. The government's goals and the actions taken by the ICE, during the 1990s, confirm this.

For example, in the year 2000, after finishing one of the largest dams of the decade (i.e. the Angostura HP, 180 MW), the ICE revived efforts to develop the next largest dam known as "The Great Boruca" (i.e. 1500 MW). Planning officials, at the ICE, during this period stated that according to their plans, the Boruca HP would follow, foreseen to be in operations in 2010.[113] According to Sacchi (2002) and Carls & Haffar (2010), at that time, project managers presented the Boruca HP as a key project for the country's growing electricity demand and to supply energy to neighboring countries.

There were contradictory statements in this regard. The authors found out that, in other statements, the ICE's officials affirmed that the dam production would be used only towards satisfying the national electricity demand. However, the Boruca dam would significantly increase the national energy generation capacity by nearly 50% (Sacchi, 2002; Carls & Haffar, 2010), the surplus could be sold in the Central American region. Similar inconsistencies were detected during interviews with the Energy Planning Sector, in 2013, concerning the Diquís HP (i.e. 650 MW).

Nevertheless, when the government ratified the Central American Electric Market, in 1998 (i.e. Law 7848), the dams' advantages became apparent. Firstly, hydroelectricity is a clean energy source; secondly, the benefits of scale economies, from hydroelectric dams, increase the country's competitiveness in the region. As indicated by the policy think tank "Programa Estado de la Nación":

> "(Tariffs) differences are explained by issues such as Costa Rica's lower tariffs because its electricity generation mostly comes from renewable sources, mainly hydroelectricity, different to other countries that use (fossil-fueled) thermal energy…" (PEN, 2008, p. 54).

According to the market protocol, among electricity players in the country, only the ICE is allowed to participate in the regional electric market. In the case of private investments, their incorporation as electricity producers began after liberalization reforms, in the 1990s, but still limited to the domestic market. The continued opening of the sector promoted by the Central America-Dominican Republic Free Trade Agreement (CAFTA-DR) increases their interest in the national and regional market.

On the other side of the coin of hydroelectric projects was the use of solar energy at smaller and micro-scales within the Rural Electrification Program.[114] According to project documents, pre-

[113] "La Angostura prende máquinas" La Nacion, 21.07.2000.
[114] RORs, geothermal stations and wind projects are in the middle with small and medium size installations.

feasibility studies of the Program considered two possible technologies for electrification in rural areas: SHS and micro hydroelectric stations (GEF, 2005). The choice of using decentralized renewable energy systems (i.e. SHS or micro-hydro) versus centralized (i.e. central plant delivering electricity through the grid) had cost-benefit logics (e.g. additional cost per kW). This was confirmed in interviews stating that "The cost of the grid expansion in areas with difficult geographical conditions or disperse settlements was higher than the energy provision with solar home systems" (Interview 1Q, 2013).

In the documents, it was also found that within the projects' portfolio, comparing micro hydroelectricity stations and solar energy installations, the latter were more costly (MINAE, 2005; UNDP-GEF, 2011). Moreover, the REP aimed at incorporating micro hydroelectric stations, hence including "the expertise of private developers and other rural distributors" (MINAE, 2005, p. 96-99). However, preliminary feasibility studies, in selected areas, showed that hydropower potential was lower than expected (UNDP-GEF, 2011).

Therefore, in spite of the higher cost of the SHS, the state company chose this technology with the implications it has for the overall program. As pointed out in project documents: "if the proportion of hydroelectric projects is significantly lower, the implications, in terms of costs and quality of the services provided to the consumers, have to be re-evaluated in the program" (MINAE, 2005, p. 100). In addition, given the poverty reduction objectives, the SHS were provided to the beneficiaries, at subsidized rates, increasing the cost to project investors.

In part, these difficulties explain the slow progress in the distribution of these systems to the remaining population without electricity. By the year 2002, 1000 solar energy systems were installed in rural communities (MINAE, 2005). According to the ICE's data, 1325 solar systems were installed in 2006 and by the year 2010 the number of systems reached 1650 (UNDP-GEF, 2011; Interview 1Q, 2010). By the year 2011, the number of households without electricity remained at 13.533 (i.e. 1.1% of total households) (INEC, 2011).

With the Net Metering Pilot Project or distributed electricity generation *(DEG)*, one of the purposes is to promote renewable energy sources at small scales. In a next step, the project seeks to incorporate other state companies and rural electricity providers. However, these companies have been reticent to get involved in DEG.

In interviews to managers at Coopeguanacaste, a rural electricity cooperative that operates in Guanacaste province, argued that existent infrastructure is mainly distribution grid supplied by hydroelectric plants. Therefore, their primary concerns in taking further steps in DEG projects are mainly due potential adverse effects on their core business: energy distribution.

Furthermore, since 2010 they are opposed to bill proposals in the legislative that come up to changes in supply electricity to the segments of 'great consumers' (FINE, 2010).

Conversely, the first solar energy park is still small (i.e. Miravalles Solar Park, 1MW). The park was not designed to compete or complement other electricity plants, neither in terms of size nor in production. Technicians and operators reaffirmed the following, when assessing the solar parks against geothermal stations of similar size:

> "Comparing geothermal energy and solar *energy productivity per hectare*, solar energy generation capacity is far behind, for example in 30 hectares, the solar energy installation produces 1MW, while one geothermal station in the same area produces 10 MW" (Interview 3J; Interview 2D, 2013).

Nevertheless, state and private investors have expectations to continue developing solar energy installations at larger scales in the future. The benefits of the pilot solar parks in terms of electricity production, low maintenance cost, and avoided carbon emissions, are remarked by project developers (Interview 3J; Interview 5H, 2013). For instance, technicians affirmed that in spite of the relative lower production (e.g. kW per ha.) "the net energy generation of the plant surpassed expectations in terms of kWh during most part of the year" (Interview 5H, 2013).

Even though, the issues of scale and other "gray areas" of the solar technology still need to be clarified. As stated in interviews with project developers and academia, one problem to resolve in the future development of the solar technology is that basic research is conducted at smaller scales, though profits are produced at larger scales (Interview 2H; Interview 2C, 2013). Besides, there are some ambiguities in terms of socio-environmental impacts of the technology (Interview 3L; Interview 1A; Interview 1P, 2013).

Based on this evidence it seems to be clear that in the case of large dams, drivers of scale economies are an incentive for the ICE to expand further these projects. In this way, the ICE could fulfill not only national but also a regional demand with massive quantities of electricity at low cost. This is different in the case of private investors because although RORs can also reach larger scales, the possibilities to profit from *scale economies* were limited by Law. Moreover, private producers compete in the national small market (when a bid is open), but they are not allowed to participate in the Central American Electric Market that is exclusive for the ICE. This restriction of the regional market is expected to change in the near future, and both, the ICE and private investors are foreseeing competition in the regional market (Interview 1G, 2013).

Even so, the anticipation of the country's regional competitive advantage, based on "clean" hydroelectric sources, might not be applicable in the near future. As pointed out by experts during the interviews conducted, other countries in the region have accelerated developments, not only in hydroelectric projects, but mainly in wind and solar energy installations (e.g. in Nicaragua and Honduras) (Interview 2P, 2013). In the case of solar energy, other efficiency logics different from scales economies motivated initial energy decisions in the selection of the technology to achieve electrification, at minimum cost and in isolated areas. Those motivations can be linked to economies of scope (i.e. efficiencies wrought by variety, not volume).[115] Nevertheless, over time, scale economies also became relevant in the proliferation of solar technology on a global level.[116]

The lack of commitment to net metering or distributed electricity generation (DEG) is a central limitation to further advances in the use of the technology. From the statements above, a possible explanation for this might be that DEG is a limitation to the core business of electricity distributors that takes advantage of *scale economies* from the existent distribution infrastructure. The fact that there is much controversy, on sizeable consumers, stresses the relevance of larger scales: the profitable segments are those who consume large amounts of cheap electricity. This also points out to other elements of inertia, created by actors, such as vested interests, fixed assets and sunk costs (further expounded in the next chapter).

6.4 Systemic Accounts and Efficiency Mechanisms

6.4.1 Drivers of Global Climate Change Effects

Efficiency drivers of *global climate change effects* are connected to systemic accounts by logics of resource optimization and economic competitiveness of the energy system. On the one hand, climate change mitigation strategies help to reduce the use of fossil fuels, avoiding negative environmental externalities and dependency on oil imports for electricity generation. On the other hand, having a low carbon energy system also operates as a response strategy to position the country as a clean energy producer, at a regional and global level.

Accordingly, efficiency drivers of *global climate change effects* imply that the more a technology can contribute to the decarburization trend of the energy mix the more it is used with

[115] Plan for Economies of Scope. (November 1983). Retrieved January, 2015, from https://hbr.org/1983/11/plan-for-economies-of-scope

[116] This is also evidenced by several references to the Swanson law, on a global manufacturing level, stating that the cost of photovoltaic cells fell by 20% with each doubling of global manufacturing capacity. The term was coined by a publication, since 2012, after a solar manufacturer observed this phenomenon.

this aims. The more a technology is used with mitigation aims, the more it gains efficiency reducing carbon emissions, and therefore, it is reproduced in subsequent decisions.

In 1998, experts at the OCIC considered that renewable energy sources for electricity production, such as hydroelectric and geothermal stations, consumed more initial capital than fossil-fueled plants (Manso, 1998). However, they also added that, in the long run, the renewable options are more profitable, especially if the environmental costs of negative externalities of fossil fuels are incorporated within the cost. The environmental externalities included air pollution and climate change, which according to experts, overall, produce "environmental, economic and social impacts that would be catastrophic to human kind" (Manso, 1998, p. 10).

Therefore, having a national energy system predominantly based on low carbon energy sources, mainly from hydroelectricity, provides a competitive advantage to the country. As indicated, in 2008, by the policy think tank "Programa Estado de la Nación", hydroelectricity provides a competitive advantage to national developers as a clean energy source, in contrast to a regional energy mix based on fossil fuels (PEN, 2008). This economic advantage is due to scaling economies at micro level (i.e. see drivers of scale economies).

The same low carbon logic applies to alternative renewable sources. In the case of geothermal energy, the low carbon characteristic is highlighted in different documents and statements from the ICE and the Energy Planning Sector. For instance, the Geothermal Resource Department at the ICE mentioned that over the years geothermal energy started fulfilling other (systemic) needs as low carbon energy source (Interview 4C; Interview 2D, 2013). Geothermal energy advantages included "reducing oil dependency and diversify the energy system with clean and autonomous alternative renewable sources" (Mayorga, 2013).

Similar statements were found in the case of wind energy potential, not only to complement hydroelectricity, but also to displace part of the fossil-fueled electricity production. Because of this, wind energy creates "economic and environmental benefits for the country" (ICE, 2013c). Therefore, efficiency drivers of *global climate change effects* are also applicable in the case of wind energy decisions.

On smaller scales, decentralized renewable energy systems such as solar energy also provided additional services to the overall energy system, besides the provision of energy in isolated communities without electricity. Since most of these communities depend on fossil fuels and firewood to satisfy their energy needs, one of the goals of the Rural Electrification Program is CO_2 emissions reduction, estimated by 5700 tons in ten years (MINAE, 2005).

More recently, global climate change effects started to gain attention from different actors. According to the Energy Planning Sector and the ICE, limited hydroelectricity production, during the last dry seasons, increased the use of fossil-fueled plants as a back-up plan. This was the direct cause of increasing electricity tariffs considering the ARESEP's established calculations methodology (Interview 4N, 2013; Interview 2F, 2013).

In this context, the Diquís HP became the center of a renewable energy scenario required to accomplish the country's goal of carbon neutrality in 2021 (MINAE, 2010; Interview 4N, 2013). The Ministry of Environment draws attention to the dams' advantages, since dams have the capacity to store energy and to produce cheap and large amounts of electricity (MINAE, 2010). In 2013, at the Natural Gas Perspectives in Central America" forum, the Energy Planning Sector officials presented the Diquís HP as the alternative versus a natural gas scenario towards carbon neutrality (Interview 4N, 2013; Interview 5E, 2013).

Therefore, this one-sided statement considers dams not only the most effective mitigation strategy but also the best climate change adaptation strategy. In terms of mitigation, efficiency drivers of global climate change effects incentivize the use of the most cost-effective alternative for the CO_2 emissions reduction, which are dams. The choice also provides a competitive advantage by positioning the country as a clean energy producer. In terms of adaptation, dams' storage capacity is deemed appropriate to adjust to climate variations.

Statements concerning decisions of alternative renewable sources like geothermal fields, wind and solar energy also refer to the low carbon characteristics of these alternatives. However in terms of scale of installations, besides hydroelectric plants, only wind energy and geothermal stations emerged as a potential alternative to displace oil fuel electricity at the national level.

6.4.2 Drivers of National Welfare Effects

According to the literature, economic growth, and social development are primary conditions of energy systems at national level. These goals make reference to national welfare effects of electricity production. In line with this, the main objectives of the ICE, since it was created in 1949 were to serve the industrial demand for electricity, increase electrification, social orientation of electricity pricing and grid development (Law 449).

Although the focus changed over time, the same social orientation remains in the national energy sector. At earlier stages, the sector had an emphasis on 'developmentalist' policies to exploit own energy sources available and provide electricity to most of the population. Later, the orientation changed towards 'sustainable development' and the dynamic interaction between

environmental sustainability, social equity and economic efficiency. Here, economic competitiveness gained a fundamental status.

Based on technical characteristics from scale economies, at the individual level, hydroelectricity became important for the country's orientation, since the very beginning, especially hydroelectric dams. In terms of electricity coverage in 1999, the electrification rate reached 95% of the population (ICE, 2013b). Therefore, in the following years, the economic competitiveness goals sustained the prioritization of hydroelectric dams. Cost-benefit logics, from the perspective of national welfare effects, were present in the emergence of geothermal explorations in the 1970s, overlapping with the 1970s oil crisis.

After liberalization reforms, arguments of economic competitiveness started to gain relevance in the national agenda. In 2003, the Energy Planning Sector published the National Energy Plan 2002-2016, framing the national energy policy within a model of 'Sustainable Development' (DSE, 2003).[117] According to this plan, the main challenges of the sector were social wellbeing, energy productivity, economic competitiveness and environmental degradation. Therefore, the energy supply's strategic objectives were to develop, optimize, and make the best of the different energy resources, minimizing their vulnerability and environmental impact (DSE, 2003, p. 5).

This optimization logic of energy resources has implications to both conventional and alternative energy sources. For alternative renewable sources (i.e. geothermal, wind, solar energy, biomass, biogas) and micro-hydroelectric stations (i.e. up to 10MW) this meant that their incorporation was cautiously undertaken. The process included an examination of their characteristics in order "to optimize their financial cost, maximize benefits to electricity users and minimize inherent risks intrinsic to these technologies" (Guideline 22-2003 MINAE, in DSE, 2008a, p. 43).

Whereby, for national conventional energy sources (i.e. hydroelectric dams and fossil fuels), their energy potential inventory has to be updated, and their environmental impacts managed (DSE, 2008a, p. 43). The concrete objectives are aimed at substituting fossil fuels and developing electricity generation capacity with alternative renewable sources. The specific target was to reach 15% in 2010 "as long as they are economically, environmentally and socially cost effective for the country" (DSE, 2003, p. 9).

In terms of the potential of conventional energy sources, the National Water Policy stated that "water is the main source of energy within the national electricity portfolio …" and this is "a

[117] "Sustainable Development" is defined as "a process that is framed in a tridimensional relationship between environmental sustainability, social equity and economic efficiency" (DSE: Plan, 2003, p. 1).

situation that will remain in the future, since water is the largest source of renewable energy" (MINAE, 2008, p. 14). According to this statement, there is a considerable and untapped potential in terms of water availability for electricity generation. Similar arguments were linking competitiveness to hydroelectric projects, on the one hand, and alternative renewable sources with cautious optimization according to their inherent risks, on the other.

Sustainable development and logics of economic competitiveness became a central principle of national energy policies in the following years. [118] The National Strategy for Climate Change 2009 and the National Energy Policy 2010 established the goal of minimizing risks of climate change and maximizing 'socioeconomic competitiveness' of different sectors (MINAE, 2009). The relation to "price competitiveness" is also relevant and it results from "the implementation of projects under criteria of sustainable development, including social and environmental aspects" (MINAE, 2010, p. 17).

In this period, the political context also favored those priorities. According to the government, those changes might also help to cope with price increases caused by oil price fluctuations "through the diversification of energy sources and a broad participation of public and private sectors" (MINAE, 2010, p. 35). Hence, the last governments had sent several bill proposals to reform the sector and increase private participation. Even the National Energy Policy 2010 mentioned those electricity bill proposals as key tools, in the national energy strategy, "to keep and improve the population's standard of living and the competitiveness of the productive sector" (MINAE, 2010, p. 35).

In fact, national welfare effects and economic competitiveness, in particular, were highlighted by different actors during the interviews in 2013. Respondents from the industry sector and politicians repeatedly alluded to economic competitiveness as the first challenge of the national energy system. This was usually linked to the communication of developmental objectives and poverty reduction (Interview 2M; Interview 4N; Interview 3H, 2013).

Although electricity prices remained relatively competitive, in 2010, they have had an increasing trend over the last 5 years (MINAE, 2010; DSE, 2011b). According to data from the Energy Planning Sector, from 2005 to 2010, the average annual price of electricity increased in all sectors, led by the residential prices that went up from 0.069 US dollars/kWh to 0.135 US dollars/kWh. Similarly, the industrial sector experienced increases from 0.066 US dollars/kWh to 0.130 US dollars/kWh (DSE, 2011b, p. 11). The cause was identified in the use of fossil fuels for electricity generation that climbed from 1.5% to 9% of the total electricity generation

[118] Other principles besides competitiveness are conservation and sustainable development, universality, solidarity, efficiency, innovation, viability (environmental, social and economic), as well as public and private participation (MINAE, 2010).

between 2005 and 2008, and remained over 7% in 2010 (DSE, 2011b).[119] However, this did not trigger further engagement with alternative renewable sources.

Conversely, the ICE's Managing Departments and the Energy Planning Sector use this context of hiking electricity prices to further advance and prioritize the construction of larger hydroelectric projects. For instance, the Reventazón HP and the Diquís HP are expected to be "adding at least 1400 MW of capacity during the next decade" (MINAE, 2010, p. 26-30). Furthermore, the National Energy Policy 2010 encourages the energy sector to seize opportunities of the Central American Electric Market Treaty, positioning the country, as a regional leader, by using the renewable energy potential (MINAE, 2010, p. 27).[120]

This claim is contradicting with statements extracted from interviews with Energy Planning Sector officials, who affirmed that supply and demand are always very tight due to high costs of being over invested (Interview 5E, 2013). Consequently, national energy needs are barely satisfied and compel the energy sector to take all possible energy sources into consideration, including natural gas prospects (Interview 5E; Interview 4E, 2013).

Nevertheless, by the year 2010, the target of 15% of electricity generation from alternative renewable sources established in the National Energy Plan 2002-2016 was reached. The proportions of total electricity generation were distributed among hydroelectricity (70%), alternative renewable sources (15%), and mostly geothermal and fossil fuel sources (15%). Yet, limited advances were conceded to manage the aspect of negative externalities from conventional projects, especially concerning integrated watershed management.

6.4.3 Drivers of Reliable Electricity Effects

Drivers from reliable electricity effects refer to efficiencies from continuously supplying electricity to customers. This characteristic is considered critical to promote industrial development (Bradford, 2006, p. 9), it also helps to keep operation costs low and offers stable, attractive pricing through long term agreements (Cordaro, 2008). Therefore, reliability is also related to the calculus approach at individual level following the logics of scale economies. Similar to these logics, systemic accounts based on drivers of reliable electricity effects provide arguments for the inertia of large hydroelectric projects.

The Costa Rican electricity system was organized, since the beginning, according to theoretical predictions. Hydroelectricity is used for based-load electricity, while oil fuel plants are used as a

[119] Other factors increasing electricity prices are higher costs of energy infrastructures, including construction works and social components.
[120] Law 7848: Tratado Marco del Mercado Eléctrico de América Central and its protocols under discussion in the National Assembly.

back-up and to handle demand spikes. Similarly, experts and engineers at the ICE considered that, in general terms, the Costa Rican electricity system is a bi-technological system based on large dams and fossil-fueled plants (Interview 4E; Interview 4N, Interview 3H, 2013). Historically, these two technologies have been used to secure the Costa Rican energy system's reliability.

Hydroelectric dams built in Costa Rica since the 1950s, were equipped with regulation reservoirs in order to reduce their sensibility to rainfall variability. Parallel, they were also backup by new fossil-fueled plants connected to the national network during this period. Meanwhile, larger reservoirs like the one in the lake Arenal built in 1979 with an inter-annual storage capacity, reduced dependency on periodical climatologically rainfall variability (DSE, 2008a).

Later on, the incorporation of geothermal stations added a new energy source to provide base load energy demand as a complement to hydroelectricity and to diversify the energy mix. According to project developers and planning documents, geothermal energy has a base load characteristic close to hydropower (e.g. DSE, 2003; Mayorga, 2013). In view of the *availability* of resources, larger hydroelectric plants and geothermal stations became the sources used to provide *base load* energy to the electrical system (Interview 4E; Interview 3H, 2013).

During the 1980 – 1990 period, hydroelectric resource availability for electricity production, aided by climatic conditions, might also explain the late response of the ICE in the development of wind installations and even geothermal energy. Furthermore, the use of fossil fuels for Electricity production was controlled and reduced to a minimum during this period. Therefore, although the development of the wind technology was foreseen in the energy generation plans of the ICE earlier (Interview 5B, 2013), they have a lower priority within the energy portfolio of projects.

Nevertheless, this arrangement of the system is also highly vulnerable to changing weather conditions. Though, in 1992, electricity production from oil sources started to increase, reaching levels of over 10% of the total electricity generation in the mid-1990s, by the year 2000, the lower levels were reestablished again. According to the Energy Planning Sector, the 1990s spike in the use of fossil fuels was the outcome of a combination of factors. First, a period of a four-year drought experienced in the region, since 1992, led the Arenal dam reservoir to reach its minimum level ever in 1994 (DSE, 2008a). Second, the drought affected the whole Central American region; thus, reducing the possibilities to import electricity, and hence, having to resort to the use of oil fuel thermal plants. A third cause of these changes pertains to "periodical adverse climatologic conditions related to rainfall variability produced by a meteorological phenomenon known as "El Niño" and other climatic variations" (DSE, 2008b, p. 11). The "El

Niño" and "La Niña" phenomena are predicted to occur every ten years. In fact, a similar situation began again in the year 2010.

In 2013, drivers of reliable electricity effects continued reinforcing the construction of hydroelectric dams. In interviews during 2013, head of departments at the ICE repeatedly pointed out to the high load factor from hydroelectric plants as a key figure explaining its relevance in the national energy system (Interview 4E; Interview 3H, 2013). According to them, hydroelectricity has been the main provider of base load electricity to the electrical system with a load factor close to 100%.

In fact, resource reliability was continuously referred as a key criterion for the selection of energy sources for electricity, as well as for their restriction. According to the interviewees at the Energy Planning Sector and ICE project developers, the central issue for the selection of different energy sources is the need of a backup (i.e. safeguards or energy storage system) to tackle occasional shortfalls in net electricity generation. From their perspective, when comparing the different technologies, dams or hydroelectric reservoirs are providers of the best-known electricity storage systems.

The availability of hydroelectricity itself is acknowledged by the Energy Planning Sector to be highly dependent on rainfall variability (DSE, 2008b). However, it uses oil fuel generation plants as a backup, providing a 'self- regulation' mechanism to the system. From an electricity reliability perspective, fossil-fueled thermal plants have the advantage that they do not depend on rainfall variability, but they do on oil price fluctuations (Interview 3H, 2013).

Then, the use of oil-fueled plants began to increase, when a drought period, such as the one that affected the region in the 1990s, undermines hydroelectricity availability. In 2010, this situation was recurrent and raised national concerns on the oil fuel dependence in electricity generation. However, warnings stalled as the reservoir levels were reestablished again in 2015.

Besides hydroelectricity, the advantages of geothermal energy and wind energy, in terms of availability and reliability, as well as to complement hydroelectricity were highlighted during interviews in 2013. For instance, references to wind abundance were also found in printed documents of the Institute, in which wind's potential distribution is compared to the availability of hydropower (e.g. DSE, 2008b; 2011b; ICE, 2013c). These statements also highlighted the fact that wind energy could partially supply the energy needed during peak demand periods in the dry season.

6.5 Concluding Remarks

In the period under review, efficiency drivers, at the individual level and those at a systemic level, are relevant in clarifying decisions in the national energy system. I found that most individual accounts (i.e. coordination, learning effects and scale economies) were key motivations, at earlier stages. Meanwhile, systemic accounts (i.e. global climate change effects, national welfare effects, and reliable electricity effects) are mostly relevant in the reinforcement of an established technology, in a path dependency stage.

Coordination effects of ruled-guided behavior from market regulations (e.g. standards, tariffs), environmental impacts assessments and carbon mitigation instruments, drove decisions that reinforced hydroelectric dams at earlier stages, as well as RORs and wind parks afterwards. In this sense, environmental impact assessments similar to carbon mitigation and the PES were also a useful instrument for investors to gain recognition in the national or global market. More recently, drivers of coordination effects were initiated triggering interest in solar energy.

Learning effects clearly explain the reinforcement of hydroelectric installations and the advances of geothermal stations. Even those encourage the introduction of innovations with domestic expertise. The observed difference between geothermal stations and wind parks suggests that these effects were not applicable to state wind installations.

In the case of large dams, drivers of scale economies incentivize the ICE to further expand hydroelectrically and fulfill a regional demand for large quantities of electricity, at low cost. In the case of private investors, drivers of scale economies would boost the construction of larger RORs, but until now this is limited by national and regional regulations. Instead of scale economies drivers, the efficiency gains of private investors were based on investors' effectiveness to accomplish the task through drivers of learning effects.

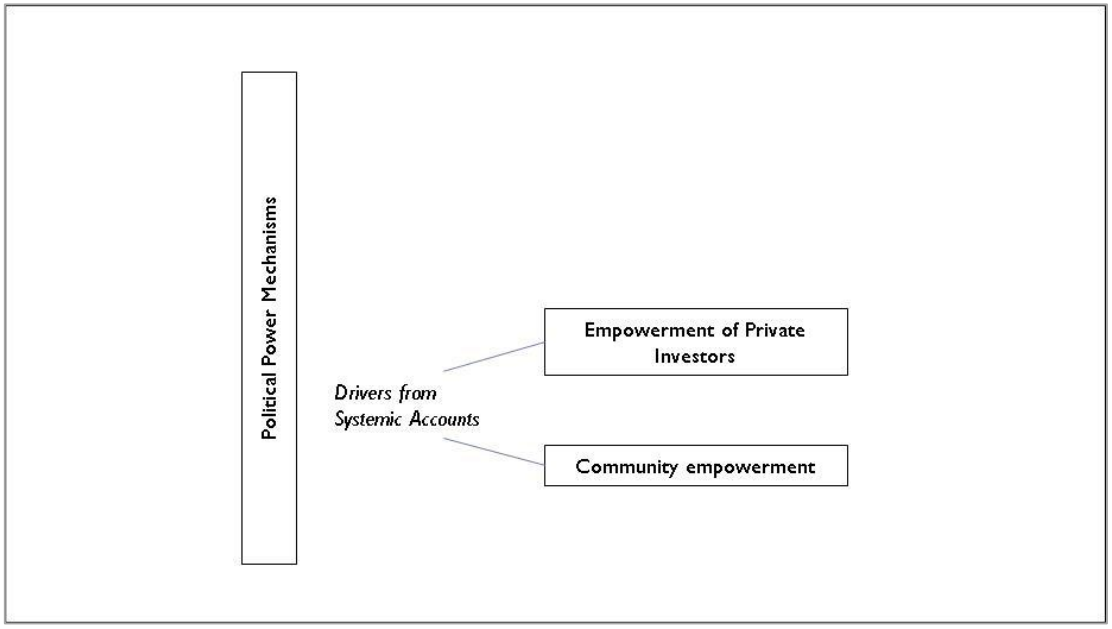
All systemic efficiency accounts (i.e. climate change effects, national welfare effects and reliable electricity effects) play a critical role in the ICE's and the Energy Planning Sector's decisions reinforcing the use of hydroelectricity. Among them, drivers of reliable electricity effects step up. Further advances in geothermal energy, wind park installations and biomass were guided by drivers of availability and reliability electricity effects, but also limited by the same. Although wind or biomass electricity potential could supply the energy needed during peak demand periods, in the dry season by strengthening the reliability of the system, they are also dependent on the installation of firm or based load energy, such as geothermal.

7 Political Power Mechanisms in the National Electricity System

7.1 Introduction

This Chapter traces the choices between energy projects and technologies according to political power mechanisms. Actors' decisions, within this framework, are influenced by the empowerment of individuals or groups benefiting from existing arrangement. Accordingly, two drivers of political power were found in the historical analyses: i) empowerment of private investors and ii) community empowerment. Similar to the case of legitimation mechanisms, decision-making is based on political power relations related to the systemic accounts that are beyond individual viewpoints (see Figure xx).

Figure 8. Political power mechanisms and drivers



Source: Own compilation

The Chapter is organized into the following four sections including the introduction. Section 7.2 presents main actors involved in political power relations and their interests over time. The next Section 7.3, explains actors logics of decisions based on mechanisms of empowerment of private investors and community empowerment. The last Section 7.4, summarizes the main characteristics of the political power framework and states some concluding remarks.

7.2 Actors Involved and their Interests in Decision Making Processes

During the 'developmental state era' (1950-1989), the ICE emerged as a new political actor. The ICE was not alone in developing electricity. Private groups also had a role as project developers, construction contractors of electricity projects or as consultants. Moreover, foreign

organizations, including financial institutions, experts, and consultancy firms, were also relevant partners for the transfer of knowledge in earlier stages. The case of geothermal energy illustrates this cooperation with foreign companies, since the 1970s (Interview 4C; Interview 1F, 2013).[121]

Together with the creation of the Energy Planning Sector in the 1980s, hydroelectric dams, and geothermal infrastructures experienced an expansionary phase lead by the ICE in accordance with national energy plans elaborated by the Energy Planning Sector. Their development continued after liberalization reforms according to these centralized plans, incorporating private investors as direct electricity producers. Private groups were also linked to international and regional corporations within a portfolio of energy investments.

Private investors organized themselves, since the beginning, through the Private Energy Producers Association (*Asociación Costarricense de Productores de Energía*, ACOPE) created in 1990. Historically, ACOPE had been an antagonist actor of the ICE, not only because it represented different interests within the electricity generation system (i.e. private and state, respectively), but also ideologically. Their positions, however, have been more congruent in the last years (e.g. in the development of alternative renewable energy sources, in the incursion of the regional market). Although tensions exist concerning market liberalization, both have tacitly agreed to a mixed model that integrates the ICE as a leading actor, as well as a form of competition in some stages of the electric industry.

Besides influence peddling in electricity projects that implicated politicians from official parties confronted by the ICE worker unions and left-wing parties, other disputes emerged between state and private investors against local communities. These conflictual processes concerning impacts of dams and RORs emerged as a key issue that involved distributive and ecological aspects. The conflicts implicated landowners regarding expropriations, community- based organizations, environmental organizations, private and state investors and the regulatory entities, including the ICE who approved contracts with the private producers. The government, through the Ministry of Environment, has been confluent to private interests and favored more electricity investments.

By the year 2014, powerful actors included the Energy Planning Sector, the ICE and politicians, where the influence of private investors was evidenced. Meanwhile, subordinated/secondary actors who could tip the balance changing the power game in the energy system (i.e. institutional entrepreneurs) were private and state investors, local governments and civil society organizations. The latter with the support of international organization networks, who support environmental organizations and indigenous rights.

[121] As recalled by respondents who referred to experts and consultancy firms from Italy, New Zealand, Iceland, Japan, Mexico, all of them countries with experience on geothermal energy generation.

7.3 Systemic Accounts and Changes in the Power Game

7.3.1 Empowerment of Private Investors

According to political power mechanisms applied to the case, the empowerment of private investors, throughout the history of the electricity sector, changed the power game. Though, to a limited extent, since state actors uphold a central position in decisions. This section explains how drivers of empowerment operated in such a manner that the more a technology profited private investors, the more it was supported in subsequent decisions, even when other actors preferred to change this.

In the period before the 1990s, the relationship between governing political elites and the ICE favored the latter as a provider of efficient and standardized electricity services. The development of dams, as well as geothermal fields, was institutionalized by the Law 449 (1949) and Law 5961 (1976). These laws established the exclusive authority to the ICE to develop those projects. Hence, the Institute fulfilled its mandate with the development of hydroelectric plants and geothermal stations in the country.

In the following decades, geothermal and hydroelectricity developments continued based on centralized plans. Although in the case of the geothermal fields, they were "… completely established through Costa Rican ownership" (DSE, 2008a, p. 96). Though, for decades, private construction firms have been active in public works for the ICE. Nevertheless, liberalization reforms increased the private interest at stake in electricity projects.

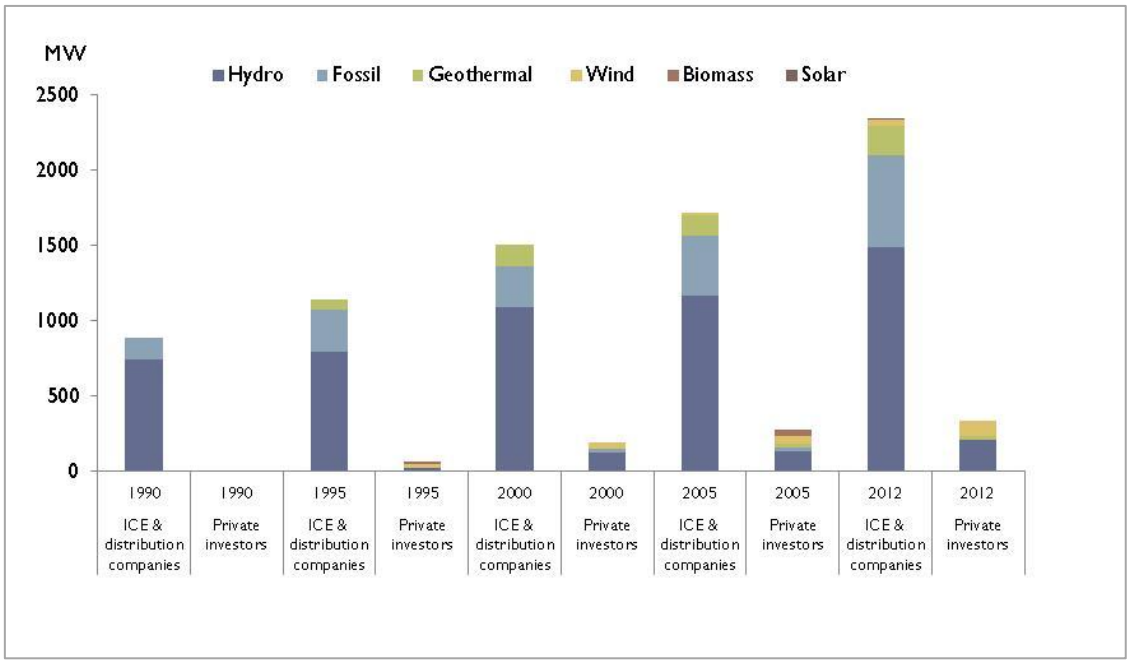
First, they became direct private investors in electric plants, through the Laws 7200 (1990) and 7508 (1995) that sanctioned the ICE's purchase of up to 20MW and up to 50MW from private electricity projects. Second, they reduced from 65% to 35% of private companies' ownership, in which holders must be Costa Ricans. Third, they incorporated the BOT scheme allowing private companies (or consortiums) to own and operate electricity plants for a maximum period of 20 years (Law 7508, 1995 Chapter II).

During interviews conducted with experts, private investors and state actors in the electricity sector, they all agreed that liberalization reforms, during the 1990s, were a turning point in the future institutional orientation of the energy sector. Besides the legal changes that boosted the interest at stake from private investors' standpoint, experts also referred to the mandate to cut public spending in accordance to requirements agreed with international financial organizations (Interview 1F, 2013). Through this mandate, the government of Costa Rica froze almost every large electricity project (Battocletti, 1999).

This situation, together with the legal authorization to involve IPP, partly justified the use of more private capital or funds (Merino, 2003). Private investors focused on the development of the smaller RORs, which gave way to several in just a few years. As a result, liberalization reforms deepened changes in the political power relations through the empowerment of private investors, while reinforcing the hydroelectricity-based energy model.

In the first decade after liberalization reforms, private hydroelectric installations continued growing faster than other alternative renewable energy projects. In terms of ownership composition, between 1990 and 2000, the total installed capacity belonging to the state was reduced from 98% in 1995 to 89% in 2000. Meanwhile 11% of the total installed grid is in the hands of private concessions or BOT (DSE, 2009a).

Graph 2. Public and private electricity projects in the national energy system (NES)



Source: Own compilation

At the same time, the regulation of the electricity sector was experiencing a period of change, along with modernization demands of public services promoted by the IMF (Interview, 2013).[122] However, the regulation of the Costa Rican electricity sector has its own particularities as it is not a competition regime, but rather a vertically integrated regime still under the ICE's control (Interview 2F; 2013).

Initially the regulatory authority, the ARESEP, established the prices of energy purchased by the ICE according to the principle of 'avoided cost' defined as the long-term marginal cost of

[122] ARESEP Antecedentes e Historia. (2014-2015). Retrieved August, 2014, from http://www.aresep.go.cr/index.php/aresep/antecedentes-e-historia

the system (DSE, 2008a). Later, it changed to a tariff methodology of "rate of return" (Interview 3F, 2013). This methodology refers to a process of balancing costs incurred by companies and future estimated revenues (a risk -adjusted profit margin), also referred to as the return on equity (ROE) or "cost plus method" (Dixit et al., 2014). [123]

According to the ARESEP, a weakness of this method is the difficulty in correctly establishing costs that reflect efficiency performance (Interview 2F; Interview 3F, 2013). Essentially, the allocation of public resources and calculations of electricity tariffs had inefficiencies that resulted in overpricing and profits to private investors. Besides, cases of influence peddling and illicit sale of electricity production that involved politicians.

Consistent with studies launched by this group, between 1997 and 2001, the basic tariff with adjustment produced a surplus of 17 thousand million colones to the private sector and, between 1996 and 2000, created a surcharge of 271 million colones to five private projects (Merino, 2003).[124] Those cases, with fixed tariffs, favored at least thirteen of twenty-eight private hydroelectric projects formalized under Law 7200 (Alvarez, 2003). While nearly nineteen private electricity projects belonged to politicians (Romero-Perez, 2004).

Conflicts of interest were ongoing in the case of other technologies as well, for instance, in the bid competition for the BOT geothermal station or in a biomass project (i.e. the Taboga sugar mill) (Romero-Perez, 2004). However, they were not present in the number of hydroelectricity. The 28 private hydroelectricity owners collectively brought in 35 billion colones annually, while the ICE made less than 32 billion (Lindo, 2006).[125]

The liberalization trend continued gradually during the decade shaping the national electricity sector; this, has been contested by social groups. The case of bill proposals aiming to deepen reforms of the energy sector in 2000, labeled as the "ICE Combo", was a cusp of conflicts and marked a downturn for the neoliberal project. This resulted in political power struggles and social protests that escalated over the time, obliging its withdrawal from Congress.

The ICE Combo was presented by the government, supported by political and economic elites, as a necessary reform to reduce the cost of electricity, improve services, stimulate capital investments and restrain internal debt (Solís, 2002; Bull, 2005). In the Congress, the proposal was defended by the government in terms of eliminating the legal controls that limited the ICE's

[123] In contrast, the performance- based regulation provides incentives for improving efficiency and reducing costs (Dixit et al., 2014).
[124] As of December 2001, 17 thousand million colones were equivalent to 52 million United States dollars and 271 million colones were equivalent to 820 thousand United States dollars (own calculations).
[125] As of March 2006, the 35 billion colones were equivalent to approximately 70 million United States dollars, and 32 billion colones were equivalent to approximately 65 million United States dollars.

competitiveness, efficiency, and expansion possibilities (Solís, 2002). Meanwhile, the movement against these bills, led by the ICE's labor unions, grouped several and diverse social groups. [126] These groups considered that those inefficiencies of the ICE existed, though they were the outcome of intentional political decisions to create the conditions for the privatization or corporatization of the ICE (Solís, 2002).

Other organizations, such as the Ombudsman/woman's office, the National Comptroller and even the right-wing Libertarian Party, a clear advocate of privatization, also questioned the bill's proposal. They argued against the lack of institutional controls and leeway of political interference over electricity activities, which already existed (FECON, 2009; Solís, 2002). These issues were denounced by the ICE's labor unions and echoed by deputies from the left-wing party (i.e. *Frente Amplio)* as well as environmental organizations (i.e. FECON). [127]

The media also played a role by questioning private generation plants as compared to the ICE's cheapest dams. This comparison however, did not make distinction on scale or size of the plants, neither referred to the environmental problems. [128] For the movement against the "ICE Combo" and most of the public, the common enemy was identified in the "political class" accused of "corruption, voracity, autism and sterility", while the ICE continued upholding legitimacy (Solís, 2002, p.35-36).

Meanwhile, the lack of response from ARESEP and the ICE authorities, despite the statements of illegality from the National Comptroller and the General Procurement Office, led to a continue waste of the public resources (Merino, 2003). In the mid-2000s, a context of expiring contracts created an opportunity to make the necessary corrections and renegotiate tariffs. At this time, the Attorneys' office opened a legal investigation to all previous officers at ARESEP who authorized tariffs without introducing corrections to nearly 15 private electricity companies. [129]

Since 1998, some contracts faced regulatory problems regarding water concessions covered by the Law 7200, and hence, they were not renewed (DSE, 2009: diagnostic V). The effect of these events produced a temporary slowdown in hydroelectricity installations from 2000 to 2005.

[126] Among the diverse social groups against the ICE combo were communal organizations, branches of the Catholic Church, students and environmentalist groups; progressively other public workers, women organizations, indigenous communities and other groups were incorporated (Carazo, 2001).
[127] "Gobierno y privados quieren afianzar estafa de electricidad privada" FECON, 16.02.2009
[128] Several publications, during 2000, single out the cheapest plants, whereby the ICE's larger hydroelectric stations compared to smaller private hydroelectric plants limited by law: "Diversidad en costos de energía" La Nación, 06.08.2000; "ICE al vaivén de los políticos", La Nación, 30.07.2000; "Energía privada cuesta cara" La Nación, 01.08.2000; "Impugnan tarifas de generadores", La Nación, 31.08.2000.
[129] "Aresep valora modificar tarifas" La Nación 20.03.2006.

According to national statistics, private hydroelectric installations increased from 130 MW in 2000 and then to 135 MW in 2005. In the case of the ICE, after the Angostura HP (i.e. 180 MW) went online in 2000, hydroelectric installations barely experienced any expansion in this period (DSE, 2009: diagnostic V chart 3-10).

However, they continued spreading again by 2006, when new and larger hydroelectric projects went online (i.e. Cariblanco, 84 MW) and a boost was experienced due to new hydroelectric BOT projects (DSE, 2009a; 2011b). In spite of the fact that private electricity capacities remained below the share permitted by law (i.e. the maximum limit of 30% from both private generation and BOT), there were numerous private electricity plants. By 2008, there were 30 private electric plants (i.e. 24 hydroelectric, 4 wind and 2 biomass stations) and 45 more waiting for approval.[130]

In the meantime, in the mid -2000s, the country continued in its initial stages in developing alternative renewable sources such as the wind and the solar energy. Interest from international organizations was directed to these technologies. For example, the World Bank funded some small wind parks in the country, taking advantage of the high potential of this technology, but also considering the environmental problems of relying on hydroelectricity and fossil fuel (Anderson, 2002). In reports from the American Wind Energy Association (LAWEA) Costa Rica was regarded with strong potential for wind parks, solar energy, and geothermal stations.

At the same time, private actors and their organizations, such as ACOPE, began to lobby by pointing out the Central American regional market's opportunities, and the relevance of private investments towards reducing oil dependency. These claims were supported by a turn from the media who alluded the missed opportunities of the existing legal framework that limits private generation, especially when this electricity from private plants is "cheaper than the one produced by ICE's electricity plants".[131]

Not coincidentally, in 2006, the issue of telecommunications and electricity liberalization resurfaced again in the context of a package deal, included in the Central American Free Trade Agreement (CAFTA) with the United States. Although the agreement left the issue of private - state participation in the electricity sector as a matter of domestic decision, different sections of the text were considered to have important environmental and social implications. These issues

[130] "Gobierno y privados quieren afianzar estafa de electricidad privada" FECON, 16.02.2009.
[131] "ICE perdería oportunidad de comprar energía a precio bajo" La Nación, 20.03.2006.

divided the society, on the one side the government (e.g. the Ministry of Environment), and on the other side, environmental organizations (e.g. FECON), workers unions, and universities.[132]

Following Lindo's (2006) and Durán's (2006) analysis, at the heart of the environmental problem was a loophole in the Costa Rican environmental law that allows over-exploitation and commercialization of its watersheds. Particularly because current legislation does not limit the number of hydroelectric plants per watershed, which combined with a restriction on plant's size (i.e. 20 MW and 50 MW), result in too many projects on a watershed. Although they are smaller in size, the individual environmental damage comes together to create even more severe destruction (Lindo, 2006).

Another point of difference was the aspect of foreign investment ruling. Environmental organizations and the academia were concerned by the use of the treaty to wreak havoc on labor and environmental laws, including difficulties of expropriations and business interest protection (Lindo, 2006). The case of the Harken oil drilling initiated during President Abel Pacheco's administration (2002-2006, PUSC) already set a precedent (Durán, 2006). In spite of social mobilizations against the CAFTA, the treaty was finally approved, in 2007, by means of a public referendum.

The same year, the presidency launched the "Peace with Nature" and carbon neutrality strategy by 2021 initiatives (MREC, 2008). However, environmental organizations and other groups became also critical of the government's proposal, particularly when the Executive favored private interests in the project of open pit mining (i.e. in Crucitas de San Carlos, Northern Region) and the construction of a new aqueduct in the community of Sardinal in the Guanacaste province (Feoli, 2009). These projects were temporary halted, by an appeal to the Supreme Court, and subsequently the works were suspended by decision of the local government.[133]

To sum up, decisions from the environmental office SETENA were questioned from communities, environmental organizations, and opposition political parties. Denounces were also related to cases of corruption and political interference involving ICE officials, which undermined public confidence in their effectiveness towards environmental protection and EIAs (Lindo, 2006).

[132] Besides they included students, organizations of national producers, businessmen, women's and other kinds of social organizations, as well as the major opposition political parties.
[133] Environmental organizations leading the opposition to these projects sued the President and the Ministry of the Presidency of prevarication (i.e. pervert the curse of justice).

There have been cases of political interference during former president Arias' administration (2006-2010, PLN). Members of the Executive Power pressured to favor particular interest and were subsequently denounced by the left-wing party in 2010.[134]

In 2010, a deputy from the left-wing party (i.e. Frente Amplio) presented a bill proposal to the Congress to depoliticize SETENA (*Ley para Rescatar, Despolitizar y Fortalecer la Secretaría Técnica Nacional Ambiental*, SETENA, File N° 17.860, 2010). Besides strengthening the political independence of the entity, the proposal sought to provide human and financial resources to the regulatory body, to enhance assessment and monitoring capacities. The bill also seeks to reverse restructuration processes, promoted by different administrations to speed up proceedings, on behalf of competitiveness but at the expenses of exhaustive environmental impact assessments.

Essentially, on the side of the private sector' interests and from state project developers' standpoint, there were great expectations regarding more expeditious proceedings of electricity projects. In 2013, this claim came up during interviews conducted with the ICE and private investors (Interview 4G; Interview 2A, 2013). The statement refers not only to environmental impact assessments proceedings, but also concerns tariffs, the granting water concessions and the sector's general regulation.

Meanwhile, the subsequent PLN governments (i.e. Arias Sánchez, 2006-2010; and Chinchilla Miranda, 2010-2014), in alliance with center-right wing parties (i.e. PUSC and the Libertarian party) and congruent to private enterprise interests, focused their attention on new electricity bill proposals (e.g. the bill proposals File No.16949 in 2008; 17666 in 2009; 17812, 2010; 18093, 2011). The bills' purposes were mainly the opening of the sector, to speed up procedures and to upsurge the share of independent private producers. None of these proposals passed in the Congress due to the lack of agreement among different branches; however, they are illustrative of the interests at stake.

Supporters of the proposals based their arguments on future electricity needs, framing the law as relevant to handle growing electricity demands with renewable energy sources in the short and mid- term (File 17812, 2010; File18093, 2011). They emphasis the need of private investments since during the next ten years the country has to double its generation capacity with a required

[134] Noting a recentl controversy surrounding SETENA's approval of environmental impact report of the pineapple grower Tico Verde S.A., though that approval had been overturned twice before. Strong pressures led to the resignation of officials rejecting the project. See Asamblea Legislastiva, File No. 17.860, 2010.

investment of 9 US billion dollars (File 17812, 2010). This is an amount of investments that exceeds ICE's capacities. [135] As pointed out by a right-wing politician:

> "Private investments are technically and economically justified because there is a need of abundant, steady, and sustained electricity provided by a reliable range of options" (Interview IJ, 2013).

Some ideas, included in the proposals, referred to the use of alternative renewable sources' untapped potential in other sectors of the economy, such as the utilization of electricity technology for transportation (File No. 17666, 2010).[136] However, none of them provided tangible measures to further develop alternative renewable energies in the country, except for laying down the requirement of applying the net metering pilot plan (i.e. distributed electricity generation, DEG) to all electricity distribution companies. Concerning incentives to renewable energy sources (in general), they refer to fiscal exemptions, project selection based on price competition (i.e. *subasta*) differentiated by the type of technology and scale, and the segmentation of a regulated demand for renewable energy sources in long-term contracts (File No. 17666, 2010; File 17812, 2010).

In the interim, a left-wing minority party promoted a more concrete initiative to incentivize the development and the use of alternative renewable energy, without the need of a new law. The proposal was approved by the Legislative, in 2010, removing both, import taxes and the 13% sales tax on equipment and components for renewable energy generation and energy efficiency for self-consumption, including solar panels, solar hot water sets as well as wind and hydroelectricity generators (File No. 17086, 2009).[137] This was clearly evidenced in the case of DEG, where an adequate institutional framework is missing:

> "Institutional barriers (to DEG) include an interconnection normative framework or tariff for self-consumption, as well as resolving the issue of water concessions. That is why other companies do not participate, only the ICE, (i.e. 40-400 kW)" (Interview 2A, 2013)

[135] The previous bill proposal presented by former president Arias calculated this amount in US$700 million.

[136] The national renewable energy potential available was calculated to be over 90% of the total demand. A suggested possible composition of the future electricity matrix might include 80% hydro, 10% geothermal, 5% wind parks, 2.5% biomass and 2.5% solar energy (File No. 17666, 2010, Section 6.10).

[137] These changes were aimed to revert the revoking of article 38 from the Law Regulating the Rational Use of Energy (Law 7447, Ley Reguladora del Uso Racional de la Energía, 1994). The incentive, was annulled, in 2001, by the Tax Simplification Law (Law 8114, Ley de Simplificación y Eficiencia Tributaria).

The bill proposals from the presidency, by contrast, made concrete references to water concessions as a clear indication of their interests. It proposes that the Ministry of Environment would be the authority entitled to grant water concessions for up to 60MW generation capacity per project or up to 100MW if projects are in association of two or more developers. This last point, similar to what was proposed by the Modernization Law of the ICE Combo in 2000, allows private generators to own up to 25% of the national installed capacity, pushing the limits to private projects capacity laid down by Laws 7200 and 7508 (i.e. 20MW and 50MW per project and up to 15% of total installed capacity, respectively).

Additionally, they declared: "the convenience of electricity generation, transmission, and distribution, included within the National Electricity Plan, as public interest". The proposals even authorized the removal of the forest cover, without any restoration or compensation (File 18093, Article 7, 2011). All these proposals, including the ones from the last administration (2010-2014, PLN) that recommended a more regulated opening of the sector, raised major controversy. Chambers and associations of the private business sectors (e.g. UCCAEP and ACOPE) considered that these laws were closer to their interests, while the ICE's labor unions opposed the projects from the beginning.[138]

The rural electricity cooperatives also lined up against these Laws. From their perspective, the aspect raising a major concern were the negative effects on cooperatives' finances by possibly losing their more profitable clients.[139] First, these proposals focused on extending the limits of private projects' capacities and creating a regulated competitive wholesale market. Hence, allowing private companies to sell electricity to national distributors and to the Central American Market (File 18093, Article 3, 2011; Files 17666 and 17812, 2010).

Second, they proposed the legal figure of the "great consumer" (i.e. those who demand 1MW-10 MW electricity per year). According to the bill proposals, a great consumer could bilaterally sign contracts with public or private companies, national or regionally based, at non-regulated prices (File 17812, Article 53, 2010). Alternatively, the cooperative sector launched another proposal retaining more elements of the current model (File No.17811, 2010).

Nevertheless, two years after a Special Commission in the Legislative initiated the analysis of the proposals and through several different texts, the government desisted to pursue them due to

[138] 19.04.2010. "FIT-ICE contra proyecto ley de electricidad de los Arias", ANEPtv; 29.09.2010. "Empresarios meten presión a proyecto de electricidad de los Arias" Semanrio Universidad.
[139] 08.08.12. "Sectores ven como una provocación del Gobierno convocatoria de ley de electricidad" Semanario Universidad

the lack of agreement among different branches within the Legislative.[140] Another bill proposal (i.e. the Electricity Contingency Law) produced similar apathy and was rejected by the center and the left-wing opposition branches in the Legislative (File No.18093, 2011).

As exposed later by the media and deputies from the center-left wing Citizens' Action Party (*Partido Acción Ciudadana*, PAC), vested interests in electricity generation were implicated in those bill proposals. In 2012, the PAC denounced that private electricity producers and shareholders were important contributors financing the political campaign of the last two ex-Presidents. Information on the result of such investigations revealed that the same business groups also supported the campaign in favor of the Central American Free Trade Agreement (CAFTA). [141]

This agenda is supported by the international financial organizations. Such as the IDB, that besides financing future dams (e.g. for the Diquís HP and the Reventazón HP) are also interested in geothermal developments, and private wind energy projects. In recent public declarations, IDB officials stated that their interest in Costa Rica is driven by the size of the electricity market (i.e. considered the largest in the Central American region) and the composition of energy sources that are less dependent on oil fuels. "The goal is to improve Costa Rica's energy system in terms of sources and cost […] to achieve a sustainable electricity generation policy". [142]

However, no other alternative renewable energy technology had incentives to encourage private investments such as hydroelectricity. Private investors and right-wing politicians referred to institutional and political barriers hindering further developments and they blamed the ICE for restraining further advances of alternative renewable sources. For instance, wind park developers referred to the wind energy cap set by the Energy Planning Sector and the ICE: "This cap is responding to political decisions rather than technical considerations" (Interview 1G, 2013).

These group of actors also accused the ICE of obstructing the progress to solar energy and DEG by opposing the electricity bill proposals (Interview 1J; Interview 1G, 2013). While the ICE argued that all this was the outcome of legal and political constraints beyond their control (Interview 2A, 2013). Environmental organizations, also referred to this trend, in the electricity

[140] Opposition rose from the cooperative sector and there was a lack of government interest in the context of the pre-election campaign. "Gobierno desiste de plan para apertura de mercado eléctrico", La Nación, 23.10.2013.
[141] Financial contributions reached 220 million colones. Deputy Juan Carlos Mendoza carried out an investigation based on registers from the PLN, the Electoral Tribunal (Tribunal Supremo de Elecciones, TSE).
[142] "Generación eléctrica privada atrae a prestamistas" LA Republica.net, 13.01.2014.

sector generating a new expansionist wave of public and private hydroelectric projects. But fundamentally, they resulted from political power relations that are perpetuating vested interests; initiated by the previous Laws 7200 and 7508, in the 1990s.[143]

On the one hand, environmentalists' positions reject the implications of the bill proposals promoting hydroelectricity and deregulating the use of rivers and water resources. On the other hand, they argue against laws that increase the provision of incentives towards private investments in general, instead of including specific incentives to alternative renewable energy sources (Interview 4G, 2013).

To summarize, by the end of the period and in terms of ownership composition, out of the total installed capacity in 2010 (2745 MW), 87% were state-owned plants and 14% belonged to private generators according to Law 7200 and Law 7508 (DSE, 2011a, p.77). Private installations peaked in 2012, reaching 19% of the total installed capacity, including both concessions and BOT projects (DSE, 2009a; ICE, 2013). Graph 2 provides an overview of public and private electricity developments.

In terms of conflictual processes, this upright model is filled with contradictions on socio-environmental claims. The ICE Combo and the CAFTA mobilization are example of these clashes. This trend was opposed by left-wing parties, ICE labor unions, environmental organizations and other civil society groups. Although this group of actors is less powerful, their mobilizations raised awareness amongst the population, questioning the legitimation mechanisms of hydroelectricity from the communication of national and local welfare. Eventually, an opposing process of political power emerged through the empowerment of local communities.

7.3.2 Community Empowerment

According to political power mechanisms applied to the case of Costa Rica's energy system, drivers of community empowerment can potentially reinforce or change the power game in the electricity subsector. The more communities accept or stand for an electricity project, the easier is for a project developer to advance installations, if not the opposite occurs. This section explains how drivers of community empowerment operated as a counterbalance of private investors empowerment and to what extent this might favor the adoption of a different technological path.

One of the oldest and longest episodes of confrontation on the construction of dams dates back to the 1970s, when the first attempt to build the Boruca HP (1500 MW) was proposed by the

[143] "Gobierno y privados quieren afianzar estafa de electricidad privada", FECON, 18.02.2009.

ICE. The project was originally planned in combination with an aluminum exploitation plant from the transnational Aluminum Company of America (ALCOA), which was to be located in the county of Perez Zeledón (Southern region). However, weighty protests against these projects originated by local people opposed to the extractive activity by ALCOA and convinced the company to pullout from the country (Carls & Haffar, 2007).[144]

First explorations of geothermal fields also date back to this period. In the case of geothermal projects, the major limitation to their future development was foreseen in the possible environmental restrictions. For instance, parts of the geothermal systems are located in protected areas (e.g. the geothermal system of the Rincón de la Vieja National Park) (Battocletti, 1999). More recently, the ICE's energy generation plans also acknowledged these constraints and is trying to negotiate clearances to explore the resources in natural parks with environmental authorities (DSE, 2008b; 2011b).

The direct participation of private investors in electricity generation, mainly in new hydroelectric RORs, Were accompanied by cases of dispute with local communities. In such occasions, hydroelectricity projects were opposed and rejected by local communities and environmental organizations, but the aspect that produced the greatest resistance to these projects was though not community displacement, as in the case of dams. In the cases of RORs major concerns were the environmental consequences on water streaming and ecology, as well as on other benefits they provide to the local economy, so called socio-environmental impacts.

According to Cartagena (2010), the struggles with electricity projects were sparked by distributive and ecological disputes. Both aspects are confluent since the land property is considered an important element in the socio-ecological distribution of natural resources. The author uses the concept of socio-environmental impacts in reference to this convergence between distributive and ecological disputes.

One illustrative socio-environmental conflict took place, in 1996, when several communities of the Perez Zeledón county (Southern region), created a River's Defense Committee against the "Los Gemelos" private project seeking to protect the Chirripó Pacífico River watershed (Municipalidad de Pérez Zeledón, 2013). The project had problems with landowners, regarding expropriations, and with the Committee on other watershed impacts. In this case, the ICE cancelled the contract with the private producer, in 2002, and resulted in an ensuing dispute.[145]

[144] As the project took shape in the Assembly, the movement grew and incorporated university students and labor unions. The Boruca dam project remained within the ICE's generation plans and was revived in 2000.
[145] "ICE en lío por anular contrato", La Nación, 04.06.2002

In theory, small-scale hydroelectricity plants are considered to produce lower impacts than dams. However, communities perceived equally the threat to their water resources and their livelihoods. Even though the capacity of private electricity projects installed, is restricted by law to 20 MW or 50 MW, as long as several hydroelectric stations proliferated within the same watershed, downstream impacts became relevant, these effects were observed, by Anderson (2002) and Lindo (2006). By the year 2000, they identified more than 30 hydroelectric stations in the country, many of them were exploiting just three watersheds of the San Carlos, Reventazón, and General Rivers.

Based on information from the ICE and other technical studies, the environmental organization FECON and the university program "*Kioscos Socio-Ambientales"* remarked that, in the year 2000, 14 hydroelectric projects were operating at the same time in the San Carlos River basin (Northern region), becoming the main area of hydroelectricity production in the country.[146] These projects generated socio-environmental conflicts, not limited to the Northern region (e.g. communities in the Atlantic region and the Southern region).[147]

The ecological implications were related to changes in the biological dynamics of the rivers, the risk associated with the future availability of the water resource and other risks entailed in the construction works (e.g. flooding or accidents in case of earthquakes) affecting the local communities (Municipalidad de Pérez Zeledón, 2013). While, distributive aspects were also present, since according to FECON, the construction of hydroelectric plants became an end on itself, driven by profit motivations (Alvarez, 2003a).

All hydroelectric projects in operation had approved EIAs according to the requisites stated in the Law (Law of the Environment 7554, 1995 and ARESEP Law 7593, 1996). However, environmentalists argue that the impacts of hydroelectric projects on living communities downstream are not captured by these technical studies. They remark that "Environmental impact assessments are not designed to prevent this cumulative and synergic effect", and hence, found technical difficulties to limit electricity developments in a watershed (Alvarez, 2003b, p.31).

Therefore, FECON has been demanding more control over private concessions. This position expressed by environmentalists also accords with Anderson's (2002) observations. According to her findings Costa Rica's regulation was not accountable on cumulative impacts (i.e. legislation does not limit the number of projects per watershed), but neither on the vulnerability to climate change and drought problems.

[146] "Ambientalistas temen que 28 proyectos hidroeléctricos acaben con cuenca del río San Carlos", Semanario Universidad 28.03.2012
[147] "Gobierno y privados quieren afianzar estafa de electricidad privada", FECON 18.02.2009

Furthermore, concerning the vulnerability to climate change, the author considers that schemes such as the Payment for Ecosystem Services (PES) are indirect incentives to hydroelectricity, though efficient. As for environmental mitigation, multiple private hydroelectric plants have entered programs of the PES for forest protection with a local nongovernmental organization, while others have started reforestation projects within their surrounding watersheds. However, the majority of small-scale hydroelectric plant production occurs during periods with high inflow, hence largely affected by the influence of changing weather patterns (Bakken et al. 2012). As pointed by Lindo (2006), similar forms of subsidies or compensations could be used to promote alternative renewable sources and try to reduce river exploitation.

By the end of the 1990s and the 2000s, national conflicting processes were centered between two main antagonist interests. One group was represented by the government, the interest of economic groups and international financial organizations that supported more private initiatives according to the formula proposed by the IMF. Another group was made up of environmental organizations, together with community groups, supported by the left-wing party, university programs and the ICE's worker unions, who brought attention to the socio-environmental conflicts of private electricity projects.

As indicated by Cartagena (2010), the confluence between distributive and ecological aspects among the second group of actors explains their coinciding demands against private investors. Moreover, more active environmental organizations in the conflicts (e.g. Yiski and APREFLOFAS) were closer to socio-environmentalist positions. This position is different from traditional conservationist organizations focused on ecosystem management, avoiding social or public controversy; some of their leaders are public servants, easily shifting between public administration and NGOs. Yet, this convergence was relevant balancing forces in the national struggles of 2000 over electricity reforms during the ICE Combo mobilizations. [148]

Even though the environment was not the main concern of the ICE Combo mobilizations, led by worker unions, neither was significant in numbers the environmental organizations participating in the protests, environmentalist claims were considered important in the political arena. As a result, the environmental sector was incorporated in a Special Mixed Commission, created in the Congress, to formulate an alternative law proposal (Carazo, 2001).[149] The so-called "social representatives", integrated by communal and Catholic church delegates, environmentalists,

[148] According to Cartagena (2010), at the local level, there were also a convergence between communities' dynamics and the work of civil servants, in decentralized departments in the Region or ICE worker unions and the Water and Sewage Company (i.e. AyA).
[149] The Special Mixed Commission is a legislative figure that integrates deputies and people external to the Congress as advisors without right of vote.

students and workers unions representatives, conceived a Law proposal for the modernization of the ICE (*Ley para de Fortalecimiento del ICE*, File 16200) (Carazo, 2001; Cartagena, 2010).

Nonetheless, the position from socio-environmentalists, were even more against private electricity generation than the ICE's workers unions. Therefore, in 2003 fundamental differences emerged between environmental organizations and worker Unions representatives, which at the end wrote a different law proposal. The focus of disagreement was precisely the socio-environmental regulations of hydroelectricity, proposed by communities and Catholic Church delegates, environmentalists and students representatives, as long as the ICE's worker unions considered them limitations to the ICE's scope of action.

Cartagena (2010) summarizes the socio-environmental organizations' position concerning electricity generation on four points. First, the environmentalists' experience with private producers was negative because it was involved in several conflicts since the 1990s. Second, environmental organizations considered that private projects never promoted the energy self-sufficiency of communities or private consumers, though they did create a business and vested interests. Third, they rejected the bill proposal's implications because, in terms of water uses, the proposal gave priority to electricity over other uses, contrary to integrated watershed management. They also deregulated the use of rivers; while excluding incentives to alternative energies.[150] Fourth, the ICE Combo allowed the intervention of protected natural areas for geothermal electricity generation, creating a precedent for hydroelectricity and large-scale tourism.

In relation to that, the bill proposal allows land expropriations in state protected areas and agricultural lands in favor of private developers, excluding communities, indigenous people and consumers in decision-making processes. A key aspect viewed from a socio-environmental perspective. As pointed out by the author, amongst the main concern of environmental organizations was that, according to them, the proposals put the "immaculate character" of natural protected areas at risk (Cartagena, 2010, p. 55).

In the end, the social representatives' proposal exceeded the ICE's demands and interests as an electricity provider. In their proposal, environmentalists opposed energy generation in natural protected areas and they also demanded more citizens' participation, information and consultation mechanisms to control hydroelectric projects (Carazo, 2001; Cartagena, 2010). In the law drafting, they even proposed to eliminate Laws 7200 and 7508 (i.e. private electricity

[150] Moreover, the law created incentives to fossil-fueled electricity, but not to research and use of alternative renewable sources.

generation) stating that electricity generation is a public service and a duty from the state, the public companies and the rural cooperatives (Cartagena, 2010).

To support these claims would have been inconsistent with the ICE's interests. By May 2000, the ICE had proposed the Boruca HP and in July, the Angostura HP commenced its operational phase, two large hydroelectric projects that demonstrated differences in terms of developmental perspectives (i.e. legitimation claims).[151] Meanwhile, projects with alternative renewable sources were at initial stages, mainly geothermal fields and wind parks that had their expansionary phase during 1994-2000. In their initial period, both wind parks and geothermal stations did not raised conflicting interests or competition for resources with other sector or groups in the society.

After mobilizing different societal groups and achieving the withdrawal of the law, the movements of the 2000s did not articulate a concrete political action at the time. Yet, the events of the ICE Combo, similar to the CAFTA mobilizations in 2007, did become crucial for the future of the national political trajectory. Basically, the events substantiated differences in developmental perspectives of electricity projects concerning the ICE's expansionist view and socio-environmental organizations. Moreover, mobilizations were relevant and questioned the legitimation of the two traditional political forces (i.e. PLN and PUSC), changing the power game in the 2014 elections.

This finding supports previous research into this brain area that states the ICE Combo gave a national dimension to conflictual processes from electricity projects at a community level (e.g. Lindo, 2006). It also created synergies between communal based groups with ecological concerns and environmental organizations with distributive approaches. The organization of national meetings of communities affected by hydroelectric projects is one example of these synergies.

Other authors' findings suggest that the mobilizations against the ICE Combo reinforced a development trajectory of the electricity sector in a different direction from other countries in the region. Particularly in attention to positive aspects, for the most part, the sector avoided privatization taking other forms of gradual structural adjustments (Solís, 2002; Bull, 2005), including the possibilities to maintain lower energy costs, higher efficiency (i.e. low production losses), and high electricity coverage (Lindo, 2006). The present research found that in fact, the same trajectory continued, but this included the negative aspects concerning latent conflicts of

[151] "ICE retoma Boruca" La Nación, 21.05.2000; "La Angostura prende máquinas" La Nación, 21.07.2000.

the energy development model, based on building dams and RORs, lacking a counterbalancing weight or alternatives.

The concentration of several RORs, in the same watershed, has been increasing the awareness of hydroelectric problems among communities and based-root organizations concerning the competing uses of water at a local level (Municipalidad de Buenos Aires, 2013; Municipalidad de Perez Zeledón, 2013). According to the FECON, out of sixty private electricity projects under the ICE's evaluation, since 2012, ten have loose conflicts with communities in the southern counties of Perez Zeledón and Buenos Aires. In 2013, these two municipal councils declared a moratorium to hydroelectric dams, in their counties, until there is a planning proposal or a project to secure water provisions for human consumption.

Among issues that concern communities are that those ten projects, located in seven rivers of the region, where hydroelectric projects are in conflict with drinking water. In the county of Perez Zeledón, there is one water concession (license) granted to the Costa Rican Water and Sanitation Institute (AyA), since 2007, for the provision of drinking water to the communities. This alone cannot cope with community needs.

Moreover, socio-environmentalist claims have been historically present in the Municipality of Perez Zeledón, where the River's Defense Committee has been protecting this area for 15 years. People from affected communities also argue there is a lack of transparency and information about project developments. According to them, the rumors of some investors buying land was the first indication they got from intentions of building hydroelectric plants in the river. Communities also claim that the private acquisition of resources has the consent of public authorities.

In response to recurrent demands of citizen's participation and on incentives to alternative renewable sources, ARESEP recognized the need to introduce changes in the regulation of the electricity sector. According to the regulatory body, the main challenge facing electricity services is the integration of community participation in decisions on a local and national level.[152] In addition, efforts have been directed to overcome difficulties finding methodologies to set tariffs according to the characteristics of different renewable energy technologies (Interview 2F; Interview 3F, 2013).

In 2013, the FECON organized the "Meeting of Communities Threatened by Hydroelectric Projects in the Southern Region", gathering together 70 participants, from 30 communities of the Southern region, as well as people from the Northern, the Caribbean and the Chiriquí region

[152]ARESEP Antecedentes e Historia. (2014-2015). Retrieved August, 2014, from http://www.aresep.go.cr/index.php/aresep/antecedentes-e-historia.

of Panamá. The meeting joined efforts concerning the construction of 10 new RORs and the potential privatization of up to 90% of the rivers in the Southern region. They demanded a cessation of the hydroelectric projects and to respect the moratorium of projects from municipal councils and the indigenous autonomy. [153]

Furthermore, the organizations at the meeting also claimed support for the Water Law and the constitutional reform that lays down water as a public good and human right (*Ley para la Gestión Integrada del Recurso Hídrico*, File 17.742). The Water Law was approved in first debate at the Legislative in 2014 after more than ten years under discussion, although consultations to the Constitutional Court halted the process. The incoming administration of the Citizens' Action Party (PAC) supports the project that should be discussed in a second debate.[154]

While communities were gathering together in the meeting against hydroelectric projects, two other similar events were taking place in San José, but with a different constellation of actors. One was the 1st Seminar on Development and Exploitation of Solar Photovoltaic Energy in Costa Rica and the other was the 2nd Annual Forum on Prospects for LNG and Natural Gas in Central America. The balance of political power between them was quite different.

In the first case, the initiative was organized by ACOPE together with the Costa Rican Solar Energy Association (ACESOLAR), the project Accelerating Renewable Energy Investment in Central America and Panama (ARECA) launched by the Central American Bank for Economic Integration (Cabei) and the German International Cooperation (GIZ) Program Renewable Energy and Energy Efficiency in Central America (4E). This seminar is an example on how ACOPE mobilize support through networking permanently with national actors and international organizations.[155] The seminar approached different aspects supporting or restraining solar energy development in the country and it also had educational purposes to increase the public and private sector's interest on solar energy (part of the new renewable energies) as a crucial topic in the country.

In the second case, the forum was launched by the Institute of the Americas, an inter-American public policy think tank, located at the University of California, San Diego (UCSD), working with public and private sectors in the U.S. and Latin America cooperation to encourage investment and information-sharing in energy and technology markets. Sponsors of these and

[153]Encuentro de comunidades amenazadas por represas en la Zona Sur (2013, September 26). Retrieved December, 2013, from http://www.feconcr.org/index.php?option=com_content&task=view&id=2256

[154] "Sala IV se trae abajo proyecto de ley sobre protección del agua", La Nación 10.08.2014, February 2015.

[155] Seminar sponsors were Juwi, Enel Green Power and the Initiative MIPYMES Verdes from Cabei.

similar activities in the region are CAF Development Bank of Latin America and Wärtsilä North America, Inc (a subsidiary of Wärtsilä Corporation and market leader in diesel and natural gas business, as well as U.S. defense systems supplier). Indeed, the forum was an ideal platform to lobby in favor of LNG and natural gas companies, as well as to share what they considered key energy trends and opportunities for Central America, referred as "the North America unconventional resource revolution" and "the Golden Era of natural gas".[156]

Moreover, a different profile of participants also indicates political power misbalances. In contrast to the Forum on Prospects for LNG and Natural Gas in Central America, in the Costa Rican solar seminar, private participants were more numerous (i.e. 66% against 46%), while government actors had a lower representation in the latter (i.e. 28% against 42%). Moreover, in the natural gas forum, authorities of the Energy Planning Sector were present also as speakers (i.e. the Ministry of Environment, the ICE's presidency).

In addition, the profile among the private actors themselves was also different between events. In the case of the solar energy forum, the majority of the private actors represented small-medium companies or independent consultants who are based in Costa Rica. Although, some managed to have regional operations in Central America, the Caribbean and South America (e.g. Agua Imara), few of them worked as subsidiaries of energy global corporations of the size found in companies from the oil and gas sector (e.g. Juwi, Enel Green Power). In the case of natural gas, larger firms prevailed.

Nevertheless, it was interesting to notice a growing attention for alternative renewable sources, in particular solar energy. The year 2010 was a critical one, since most actors organized themselves, such as ACESOLAR and the 4E Program. Currently, the presidency of ACESOLAR is held by a representative from the university, while the board of directors includes representatives from the industry chamber, the German-Costa Rican chamber, the organizations Greenergy World, Enerplanet, Consortium, and the 4E Program from the GIZ.

7.4 Concluding Remarks

Before the move towards the market, Costa Rica's renewable energy model was already grounded in institutional arrangements that favored autonomous institutions, like the ICE, through forms of state empowerment. In the cases of the hydroelectricity and geothermal stations, agency was executed by the ICE's employees since the initial phases. With the direct

[156] Other companies and multinationals like Shell, Total, General Electric, GDF Suez Energy were also among sponsors.

incorporation of private investors, the actor constellations changed towards more private participation, originally reinforcing the hydroelectricity path through decisions that created a path dependency based on the empowerment of private investors.

Liberalization and market reforms in the sector effectively empowered private actors and, on occasions, favored the creation of vested interests in electricity infrastructure, mostly smaller RORs. Private participation in public projects, as well as interest of foreign companies represented by national private groups, were nothing new in the national electricity development. First, in some cases, there were family connections between politicians and private investments. Second, the interests of the private (electricity) sector (e.g. further inclusion in the national and regional electricity market) have influenced governments, policies, and bill proposals.

Another consequence of these processes is the changing status of the ICE, who upholds political power, but shifts from 'extraordinary' to 'ordinary' institutional entrepreneur. Just like any another commercial firm, the institute's goal is to pursue economic competitiveness, nationally and regionally. These processes were supported by politicians (i.e. center-right wing political parties), private investors and related associations.

While in terms of renewable energy sources, the composition did not changed much in terms of type of sources, but it did in terms of size of installations. Instead of a model based on large dams, geothermal stations and oil fuel plants, the model incorporated several RORs and some wind park installations and biomass electricity stations. Overall, the period under analysis and the expansion of the hydroelectric model was reinforced with small variations by political power sequences.

On the other hand, latent conflictual processes were present during the period. One remarkable antagonistic trend is community empowerment against the prevailing electricity model. Generally, this model confronts the state with subordinate groups (indigenous and non-indigenous) that are mainly local communities affected by some electricity projects. The findings, in the current study, identify drivers of community empowerment, possibly changing the power game, though indirectly and to a limited extent, because state and private investors have more weight in the sector's decisions.

Basically, those clashes evidenced differences in developmental perspectives of electricity projects, also concerning the ICE's expansionist view, and socio-environmental organizations. Moreover, mobilizations were relevant; questioning the legitimation of the two traditional political forces (i.e. PLN and PUSC) and changing the power game in the elections of 2014. The present research found out that, in fact, the same trajectory continued, but it included the

negative aspects concerning latent conflicts of the energy development model based on building dams and RORs, while lacking a counterbalancing weight or alternative.

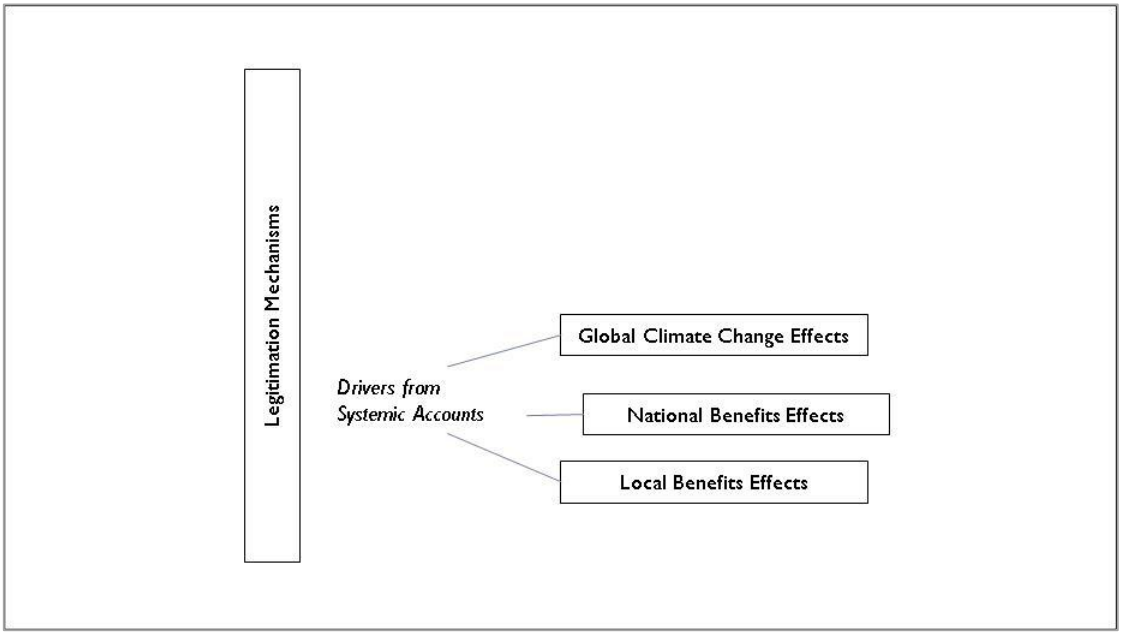
8 Legitimation Mechanisms in the National Electricity System

8.1 Introduction

This Chapter comes across presenting the choices between energy projects and technologies according to legitimation mechanisms. Actors' decisions within this framework are based on subjective orientations and beliefs of what is appropriate or morally correct. Accordingly, three drivers of legitimation were found: 1) the communication of actions against global climate change, 2) national welfare, and 3) local welfare.

In the case of such legitimation, explanations, even individual decisions on projects and technologies, allude to the energy system as a whole (i.e. technologies are appropriate or morally correct to the overall system). Therefore, in this section the individual accounts in decision making are incorporated within systemic explanations, illustrated in Figure 9. The historical analysis focuses on the 1990-2014 period, with references to previous stages or future expectations towards carbon neutrality 2021.

Figure 9. Efficiency mechanisms and drivers



Source: Own compilation

The following sections explain how efficiency drivers operate over time. After the introduction, Section 8.2 briefly presents actors involved in the legitimation framework. Subsequently, Sections 8.3, 8.4, and 8.5 elaborate on drivers of climate change communication, national welfare communication, and local welfare communication respectively. The Chapter ends with Section 8.6, including some preliminary conclusions.

8.2 Actors Involved and their Interests in in Decision Making Processes

The development of dams, as well as geothermal fields, was institutionalized by Law 449 (1949) and Law 5961 (1976), which laid down the creation of the ICE and the competencies to develop the national energy generation sources, particularly hydroelectricity and geothermal energy. In this period, the ICE gained autonomy and a good reputation from politicians and the general public and emerged as a new political actor, with the capacity to set and change norms in energy decisions. While the characteristics of dams, in terms of scale economies, were suitable to achieve national development goals (e.g. economic growth, poverty reduction).

Those large infrastructures continue advancing due the expertise of the ICE's employees in building dams, the support of international financial organizations and other actors in the global arena, such as powerful non-governmental organizations and industry players. Those actors supported the construction of national hydroelectricity installations based on developmental aims, ensuring "that dams are built safely, efficiently, economically, and without detrimental effects on the environment". [157] They not only provided funds for the constructions, but also capacity building.

In the 1990s, low carbon electricity production became another goal of national energy systems worldwide. The government and the Energy Planning Sector; took advantage of a national electricity sector already low carbon, thanks to hydroelectricity, as a platform to impel global climate change commitments and carbon mitigation strategies. In the case of the ICE, carbon emission reduction was a goal included in the performance indicators of electricity projects. The Ministry of Environment has been also framing this goal according to "green growth" economic aims.

However, on a local level, the construction of state-owned dams, as well as several privately owned RORs suffered legitimation problems. People from local communities, concerned about the negative impacts of hydroelectric plants, gained support from national and international organizations, researchers and activists. Their claims were echoed, on a global level, when the World Commission on Dams (WCD)' principles were launched in 2000. The work of the Costa Rican Ecologist Federation (FECON), one of the main national environmental organizations, created in 1989, has been consistent with the WCD principles.

Meanwhile alternative renewable energy sources are not among energy priorities in decisions making processes. In their preferences between technologies, different actors pointed out to the appropriateness of geothermal and hydroelectricity dams. Even though, project developers

157 The Era of WCD belongs to the past. (2011-2012). Retrieved January 2014, from http://www.tcsr-icold.com/Detail/49

remark that the implementation of the Net Metering Pilot Plan (i.e. distributed electricity generation, DEG) has been positive, not only from the perspective of users' acceptance (one of their indicators), but also because an alternative renewable energy source like solar energy is leading (Interview 2A, 2013).

By the year 2014, most relevant actors in the legitimation framework are those who set the norms and have the capacity to rule the energy system, these being basically the Energy Planning Sector, the ICE, and the politicians. While those who consensually or antagonistically follow the rule setting are: the state and private investors, local communities, and the general public. Institutional entrepreneurs, among secondary actors, are civil society organizations and the influence of international organizations with the capacity to tip the balance (in terms of legitimacy) of the ruling elite.

8.3 Systemic Accounts and Legitimation Mechanisms

8.3.1 Global Climate Change Communication

According to legitimation mechanisms of actions against global climate change applied to the case of Costa Rica's energy system, it is appropriate and morally correct to make energy decisions that reduce global climate change impacts. Thus, the legitimacy of actions against global climate change imply that the more a technology can contribute to reduce CO_2, the more it is legitimized and reproduced in subsequent decisions. This is connected to the legitimation axis of the national initiative of carbon neutrality.

Since the 1990s, Costa Rica's government, took advantage of global policy instruments for CO_2 emissions reductions (e.g. JI and CDM) with positive results, particularly regarding the country's forest conservation strategy. Similarly, by the end of the 2000s decade, the government took advantage of the global climate change framework as a platform to impel the country's mitigation policy through the "Carbon Neutral" strategy. Although, these policies, including carbon neutrality, did not trigger, at least initially, significant changes in the energy sector, they provided the country with another point for international recognition.

The carbon reduction strategy, in the electricity sector, was not a priority in the country given an energy mix predominantly based on low carbon energy sources. Consequently, diversification of renewable sources was not really urgent since the electricity system was already low carbon-based, largely thanks to hydroelectricity. However, the government has not submitted any explicit proposal either for other oil-based energy subsectors, such as transportation.

Meanwhile, the effectiveness of hydroelectricity, as a mitigation strategy, has not been at question. This technological advantage is important in the communications from the perspective of institutions working on climate change or energy at a global level (e.g. the UNFCCC, the US Energy Agency, the World Bank or the Chinese Banks), as well as from the Costa Rican government's perspective. However, in the eyes of the ICE, mitigation goals have not been central in decisions between technologies.

Interviewees at the ICE's planning departments referred to the CO_2 emissions reduction target as an additional criteria indicated by the government and the Energy Planning Sector, rather than an internal commitment of the organization (Interview 4L, 2013; Interview 3H, 2013). Carbon emission reduction *per se* was a goal included in the performance indicators of electricity projects. For instance, the wind park (i.e. La Tejona) and the Rural Electrification Program, incorporated CO_2 emission reduction targets from the use of the wind-park and solar systems, respectively (MINAE, 2005; Manso, 1998).

However, their position in the global climate change debate has been quite conservative, questioning the global climate change concept itself and pointing to the use of the term "global warming" instead of "global climate change". According to managers at planning departments, the confirmation of climate change would need the analysis of longer period series of data, which are not available (Interview 4L, 2013; Interview 3H, 2013). Similarly, the Energy Planning Sector acknowledges that the availability of hydroelectricity is highly dependent on rainfall variability (DSE, 2008b). However, the cause of these changes is not regarded to global climate change but to cyclical weather patterns.

> "Periodical adverse climatologic conditions related to rainfall variability caused by meteorological phenomena such as "El Niño" and other climatic variations" (DSE, 2008b, p. 11).

At the same time, the effectiveness of hydroelectricity, as an adaptation strategy, is highly relevant in the eyes of the ICE and the Energy Planning Sector, but this aspect is more closely linked to reliable electricity effects. Comparing the different technologies, officials, from the ICE's planning departments, place dams or hydroelectric reservoirs first "as providers of the best known electricity storage systems to tackle occasional shortfalls in net electricity generation" (Interview 3H; Interview 4E, 2013).

In the 1990-2014 period, climate change gained the attention of the Energy Planning Sector and the ICE. This occurred as the government took further steps positioning the country, internationally, as a carbon neutral nation and as a consequence of 'periodical adverse climatological conditions'. Nevertheless, the findings of the current study go further to suggest

that the drivers of such discourses, in the case of Costa Rica, were based on efficiency claims, rather than legitimation.

8.3.2 Communication of National Welfare

According to legitimation drivers of national welfare communication, the more communities or societies accept or stand for an electricity project, the easier it is for a project developer to advance installations. Hence, it would be appropriate and morally correct to make energy decisions that produce national welfare in terms of poverty reduction, job creation, economic competitiveness, etc. Drivers of national welfare, reinforce technologies that increase these effects because it is the right thing to do based on subjective beliefs.

Since earlier stages, hydroelectric dams became the main electricity generation infrastructure of the national system. During the "Developmental State" era, the ICE took advantage of economies of scale from dams, developing efficiencies at individual level of projects to provide large quantities of electricity at low cost. Its dominant position was reinforced in subsequent decades, partly explained by efficiency mechanisms, but also upholding this position by logics of legitimation.

The development of dams, as well as geothermal fields; were institutionalized by Law 449 (1949). In Law 449 (1949) it was established that the ICE's mandate was that of "controlling hydroelectricity utilization to strengthen the national economy and the welfare of the Costa Ricans" (Article 1). Similarly, the emergence and expansion of the geothermal resource was a matter of public interest for the state, as stated in the Geothermal Law 5961 (1976). This statement was confirmed by project developers at the ICE. According to interviewees, the goal, at that point, was to develop an "ambitious and innovative project with renewable sources of the country", which needed political and financial support from different actors (Mayorga, 2013, p. 9).

On a national level, dams rendered numerous social and economic benefits to accomplish goals of the country's national electrification. As pointed out by Bull (2005), the ICE not only gained a good reputation and credibility regarding its efficiency and technical standards, but also provided political results to the governing elite in terms of content voters that benefit from electricity services. Besides, the Institute also gained legitimation in the eyes of the general public.

Furthermore, the technology was largely supported by international financial organizations since the beginning and professional associations, such as the International Commission on Large Dams (ICOLD), who considered dams "appropriate" in order to fulfill energy needs from

the population and reach important levels of economic growth (WCD, 2000). According to the World Commission on Dams (WCD), multilaterals were considered strong particularly among countries that have not built many dams and do not have local planning and construction expertise and capacity.

> "In Costa Rica, which relies on hydropower for roughly 90% of its power generation, the World Bank and the IDB had directly supported over half of the installed hydropower capacity by the mid-1990s" (WCD, 2000, p. 78).

Likewise, international financial organizations not only provided funds for the construction of dams, but also capacity building. In fact, at a national level, Costa Rican engineers and politicians who held high positions in the electricity sector (i.e. related to the ICE) were trained abroad and became members of consolidated international professional organizations. One of them is ICOLD ensuring "that dams are built safely, efficiently, economically, and without detrimental effects on the environment".[158] Between 1990 and 1996, the executive chairman of the ICE and CNFL was the national representative of ICOLD in Costa Rica.

By the end of the 1990s, the results were quiet positive in terms of national welfare and their communication was effective for the energy-planning sector. According to regional reports and national statistics, the ICE provided an integrated system with national coverage of electricity and communication networks that reach 95% of the population in 1999. Moreover, the electricity price was one of the lowest in Central American, mainly due to hydroelectricity, while costly fossil-fueled electricity generation has been dominant in the other countries (PEN, 2008).[159]

At the same time, the ICE itself enjoyed a special standing in the society. For instance, Amador (2000) analyses the myths surrounding the ICE arguing that the institute became a complex symbol for the Costa Rican population (i.e. external myth), connected with a range of words including 'innovation', 'technological sovereignty', 'welfare of the popular sectors', 'human protection' and 'community solidarity' (Amador, 2000, p. 1). This was combined with an internal Institute's myth of creating a "new man" and characterizing it with a messianic sentiment of a historic mission to serve the Costa Rican people (Amador, 2000).

Moreover, such achievements being the outcome of own resources, developed by a Costa Rican company, brought up aspects of national pride. For instance, during the 1995-1998 period, the geothermal installed capacity reached up to 110 MW, as pointed out by the ICE's planning

[158] The Era of WCD belongs to the past. (2011-2012). Retrieved January 2014, from http://www.tcsr-icold.com/Detail/49
[159] ICE, 2013. Indice de cobertura eléctrica 2013.

managers “it was completely developed through Costa Rican ownership” (Mayorga, 2013, p. 40). However, since the beginning, it was clear that in the case of geothermal projects, the major limitation to their future development was the possible environmental restrictions because part of the geothermal systems were located within protected areas (e.g. the geothermal system of the Rincón de la Vieja National Park) (Battocletti, 1999).

In the case of dams this position is even more evident. In the year 2000, the ICE’s project managers presented the Boruca HP (i.e. 1500 MW) as a project that will deliver several national and local welfare. They include supplying 60% of national energy demand, selling electricity to the Regional Electric Market during the first 5 years, and granting benefits to local communities through the generation of employment and tourism potential. Furthermore, project developers highlight the lack of other energy alternatives for Costa Rica (Sacchi, 2002).

By contrast, in 2000, a report from the WCD also recognized the significant contribution of dams to human development, but also remarked the elevated cost it implies for people to be displaced, communities downstream, taxpayers and the environment, stating that “in too many cases an unacceptable and often unnecessary price had been paid to secure those benefits” (WCD, 2000, p. 310). This conclusion had repercussions on national energy decisions when, in 2005, the WB and the IDB, declined to finance the Boruca HP (Carls & Haffar, 2007).

The incorporation of private investors after liberalization reforms, did not alter the pattern of the electric system based on hydroelectricity, on the contrary, it was reinforced through the proliferation of RORs. The aspect of environmental sustainability was highlighted as one advantage of these smaller hydroelectric plants. According to the World Bank, “run-of-the-river projects differ from conventional hydropower projects in that they require no water storage and are less likely to alter environmental flows” (The World Bank, 2008). Private developers also argue in favor of them, since they do not interrupt the river flow. Interviews with private investors from this period also pointed out its relatively low footprint (Interview 5I; Interview 5M, 2013).

Nonetheless, support towards larger hydroelectric projects, among the ICE and development banks, did not change during this period either. Hydroelectric installations continued growing mainly driven by claims of national and regional growth of electricity consumption (Carls & Hafar, 2010). In 2008, the government declared the Diquís HP, a downsized version of the

Boruca HP, a project of national convenience and public interest, even with pending Environmental Impacts Assessment's proceedings among other legal inconsistencies.[160]

A declaration of national convenience implies that social effects overpass socio-environmental impacts, meaning that a regular Environmental Impact Assessment wouldn't be enough (i.e. cost benefit assessments at individual level). These logics are comparing, and opposing, the benefits at national level with the effects at local level. The government, the Energy Planning Sector and the ICE support the continuation of dams based on drivers of national welfare communication. Meanwhile, the local welfare of hydroelectric projects, large or small, are questioned by communities and environmental organizations based on problems of local sustainability. In fact, the declaration of 'national interest' of the Diquís dam was followed by the opposition from local, national, and international organizations. This indicates problems of legitimation for the local welfare communication, possibly reversing legitimation mechanisms for the reproduction of hydroelectric projects in future decisions.

This aspect evidences a change, in terms of external and internal perceptions or myths, of the institute as well. As pointed out by the ICE's presidency, "nowadays, the environment is more aggressive and centered on the debate of competitiveness" (Interview 4N, 2013). In this sense, the ICE behaves with a commercial purpose to sell services, but the balance sheet is more important in telecommunications that in electricity. Internally, there are also changes in people. The same official remarks the loss of membership from the ICE's employees: "There are micro-cultures within the ICE and there is a global outfit. Employees are very creative in project design in their own spaces" (Interview 4N, 2013).

Those statements confer to high levels of confidence in engineering capacity of the ICE within the institute. Among energy sources, dams and geothermal fields installations are guided by the higher standards as they are considered an endogenous technology.[161] These aspects denote logics of efficiency, but also reinforced by legitimation in terms of national welfare communication.

The Diquís dam is an example of this reinforcement and increasing electricity tariffs provided the setting for the government and political parties in campaign to declare this project as a priority. After years postponing the decision, in political discourses towards elections in 2014, politicians referred to the Diquís hydroelectric project as the solution to national problems such

[160] 14.07.2011. "El Diquís, frente a la jurisprudencia de la Corte IDH"; 01.11.2012. "Ilegalidades del Proyecto Hidroeléctrico Diquís".

[161] The term, endogenous technology, refers to a technology that is being produced, used and reproduced in a structurally confined production system. The knowledge needed is locally available and disseminated in the society; and the production organization is embedded in the local institutional setting (Müller, 2011).

as the cost of living, inequality, or poverty (Araya, during forum in 2013).[162] The dam, also became the center of the renewable energy scenario required to accomplish the country's goal of carbon neutrality in 2021 (MINAE, 2010).

On a global level, there is also evidence of this reaffirmation of dams' advantages in a context of global climate change. Differing from the principles and suggestions of the WCD in 2000, in 2012 the World Bank Vice-President for Sustainable Development and several officers from developed and emerging economies, such as the United States, China and Brazil, declared that there is no such thing as a "without dams alternative", particularly, in light of climate change mitigation. The opposite applies to ROR, considering "that a few large dams were much better than many small dams, both for the environment and for the economy".[163]

What is more, these arguments marked a distance between dams and ROR, while the possibilities of alternative renewable sources were obviated or at least not mentioned within these statements. The perspective of other actors concerning the appropriateness of renewable energy sources, including the alternatives, revealed that their preferences are not so different from the government and international organizations. Furthermore, their drivers are similar, except in the case of environmentalists who made reference to global climate change and local considerations.

During interviews in 2013, politicians and the media respondents commented that their preferences between sources depend on which is better for the environment or which prevents oil dependency (Interview 1I; Interview 4Q, 2013). Following such responses, the interviewed consider that besides hydroelectricity, geothermal is preferable, followed by solar energy, wind energy, and biomass. In opinion of right-wing politicians (i.e. *Movimiento Libertario, ML*), large dams are a priority, but delays in projects caused by social opposition put geothermal stations as the second best option (Interview 1J, 2013). Solar energy is gaining attention from private developers and right-wing politicians as well, in applications at a utility and consumer level, such as the DEG (Interview IJ, 2013; Interview 5D, 2013).

In fact, since 2010, a group of bill proposals were submitted by deputies from the official party (PLN) and the right-wing party (ML) to allow geothermal exploitation in natural protected areas by the ICE (Files No. 17680; 17707), and to incorporate private actors into this activity (File

[162] In a context of increasing electricity tariffs, presidential candidate J. Araya referred to the Diquis dam with the following statement "the main enemy of communities is poverty" (Forum: "PLN future energy…" 01.10.12).

[163] The vice-president also pointed out the example of water evaporation, much larger in small projects than in larger ones, and also to the question that should be asked "what happens if this project is not built?" (The Era of WCD is belonging to the past. (2011-2012). Retrieved January 2014, from http://www.tcsr-icold.com/Detail/49)

No. 18182). Their arguments to change existing laws that lay down the exclusion of commercial activities in natural protected areas and the exclusiveness of the state for the exploitation of geothermal resources alluded to the utilization of geothermal energy as "a source of national development and sustainable financing to the National System of Conservation Areas" (File No. 17707, Art. 1) or "human wellbeing", "to pursue national sustainable development and ecologically sustainable of Costa Rica" (No. 18182, p. 1). The proposals also make reference to low carbon emissions of geothermal energy.

Environmentalists interviewed in 2013 favored the geothermal energy alternative first, followed by dams, as an option for electricity generation at larger scales (Interview 2J; Interview 3E, 2013). Yet, in the case of dams, environmentalists' saw them as a response technology to global climate change mitigation and adaptation. According to them, "Only as long as dams are constructed properly and guarantee fair compensation to displaced communities" (Interview 2J, 2013).

In general terms, respondents from environmental organizations opt for smaller developments that take advantage of primary energy sources (i.e. solar energy, wind energy and wave energies) followed by biomass, geothermal and hydroelectricity (Interview 3E, 2013). They argue that there is no such thing as a "good energy" but rather their combination and diversification is the key towards saving energy resources (Interview 2J, 2013).

State and private investors also support wind park developments given the large potential in the country and the favorable business opportunities (Interviews 5D, 2013). Their claims have been based mainly on efficiency mechanisms. First, they pointed out to technology competitiveness; second, to their advantages for the overall energy system to complement hydro and displace fossil fuels.

Concerning solar energy, private and state investors mentioned that off-grid applications at smaller scales produce less socio-environmental impacts and are more flexible; however, they generate disposable batteries that are avoided at on-grid larger scales (Interview 3L, 2013). At the same time, automation increases on larger scales, hence creating less jobs (Interview 2H, 2013), while increasing competition with alternative land use (Interview 3H, 2013).

Nonetheless, opinions on the results of the first solar park (i.e. Miravalles) diverge among actors. Most private investors and right-wing political parties have been critical on the lower capacity of the pilot project and the high cost of installations (Interview 4G; Interview 1J, 2013). Project developers at the ICE acknowledged such limitations but also argue that it is not located in the best site (Interview 3H, 2013), although its location is also strategic: "The Solar

Park Miravalles became part of a renewable energy corridor of the Guanacaste province, the only in the world within a 15 km radius" (Interview 3J, 2013).

Besides the solar park, located at the Miravalles Generation Center this corridor includes the Miravalles geothermal production center, the wind park Guanacaste and the hydroelectric plant Arenal. According to the solar park managers, the project has a demonstrative and educative purpose. First, it allows to study the behavior of the technology on larger scales, and second to attract numerous visitors from diverse population groups (e.g. students, politicians, national, and foreigners) (Interview 3J, 2013).

8.3.3 Communication of Local Welfare

According to drivers of communication, electricity projects are reinforced because they are appropriately and morally correct. On a local level, issues of sustainability play a major role and the potential impacts of electricity production sources have major significance. Thus, the more a technology reduces negative impacts at local level or is accepted by communities, the more it is legitimized and reproduced in subsequent decisions. Otherwise, the cost of projects increases since developers have to spend more time and money to build social acceptance to operate.

At earlier stages of electrification, similar to national welfare, the perception from hosting communities of the ICE's projects, being them hydroelectric dams and geothermal stations, was very positive. This was related to the fact that the projects provided local welfare, especially to rural or isolated communities, including communication infrastructure and jobs. These aspects came up by interviewees at the ICE's project units: "In the past, communities have such favorable opinions regarding the institution that we were received like heroes…" (Interview 4C; Interview 5Q, 2013).

Nevertheless, not everything was favorable back then, as one of the oldest and longest episodes of confrontation on the construction of dams dates back to the 1970s, when the first attempt to build the Boruca HP (1500 MW) was proposed by the ICE in combination with ALCOA. However, heavy protests against these projects originated by local people convinced ALCOA to pullout of the country (Carls & Haffar, 2007). The protests were originated by local people opposed to the extractive activity by the company.

With liberalization reforms the proliferation of RORs gave way to community disputes. Environmental and social concerns became a recurrent topic of grass-root and environmental organizations, not only with respect to dams, but also with the smaller RORs. Moreover, people from the local communities concerned about the negative impacts of hydroelectric plants gained support from national and international organizations, researchers and activists. Their claims

were echoed on a global level when the WCD launched the principles stating the strategic priorities on dams' development. These principles became a main guideline for networks of environmentalists, grass-root organizations, and citizens nationally and abroad, including the work of the Costa Rican Ecologist Federation (FECON). [164]

Even though the objectives and priorities of the WCD were broadly accepted, their policy recommendations and guidelines were less welcome by financial institutions and interest groups, such as the World Bank itself and the International Commission on Large Dams (ICOLD). An aspect of major controversy was the principle of indigenous prior consultation, which "would mean that basically no dam could be built".[165] According to the principle, "all countries should be guided by the concept of free, prior and informed consent, regardless of whether it has already been enacted into law." (WCD, 2000, p. 219).

In fact, the right of consultation was already stipulated in international conventions and legislation ratified by Costa Rica. They include jurisprudence from the Organization of American States (OAS), such as the Inter-American Court of Human Rights and the American Convention on Human Rights ratified by Costa Rica in 1970.[166] Likewise, the International Labor Organization Convention (ILO Convention 169) ratified by Costa Rica in 1994 stipulates the right of consultation (Sacchi, 2002; Carls & Haffar, 2010).

As contradictory as it may seem, in the same year the WCD principles were launched (i.e. 2000) the ICE revived the Boruca dam proposal (i.e. 1500 MW) in spite of its history of controversy. A conflict mediation process was extended in the following years. On a national level, the projected was supported by the government, the Energy Planning Sector and the ICE on the basis of national welfare to supply energy demand and local welfare for the communities through the generation of employment and tourism potential (Sacchi, 2002).

On the local level, however, the Boruca HP in the Térraba River was also associated with severe negative effects. Among them, Carls & Haffar (2010) remark the dam will flood approximately 25000 hectares, including parts of three indigenous reserves, as well as roads infrastructures in another four reserves. The total population affected by the project was 6704, moreover it would be necessary to relocate about 2500 indigenous people, flood areas containing archeological vestiges, expropriate and provide payments for land and relocate communication routes.

[164] The principles include gaining public acceptance; comprehensive options assessment; addressing existing dams; sustaining rivers and livelihoods; recognizing entitlements and sharing benefits; ensuring compliance; and sharing rivers for peace, development and security (WCD, 2000)

[165] The Era of WCD belongs to the past. (2011-2012). Retrieved January 2014, from http://www.tcsr-icold.com/Detail/49

[166] "Ilegalidades del Proyecto Hidroeléctrico Diquís", La Nación, 14.07.2011.; "El Diquís, frente a la jurisprudencia de la Corte IDH", La Nación, 01.11.2012.

These impacts, together with effects on water, flora and fauna, especially in the Terraba-Sierpe wetland (considered a wetland of international importance under the Ramsar Convention) not only mobilized indigenous groups claiming their traditions and livelihoods with the land, but also environmental organizations such as the FECON (Sacchi, 2005; Carls & Haffar, 2010). The aspect that produced the greatest resistance to the Boruca dam was community displacement, mainly groups belonging to the indigenous *brunca - Rey Curré* community, in addition to environmental concerns (Sacchi, 2005).

Altogether, the lack of success or inappropriateness of the conflict management techniques used by the ICE, thereby resulted in a decline of the WB and the IDB to finance the project in 2005. In consequence, the ICE dropped the idea as originally planned and commenced a progressive downscale towards smaller options. In 2006, the Diquís Dam Project (631 MW), was chosen by the ICE as the hydroelectric alternative that considers the importance of the socio-environmental impacts (Carls & Haffar, 2010).

The option of the Diquís HP dam will flood 6800 hectares 6800 hectares, less than a third part of the Boruca HP option. Still, near 10% of the flooding area of the Diquís HP are indigenous territories (610 hectares), but no indigenous population would be displaced (Carls & Haffar, 2010, p. 117). The impacts projected include near 1100 persons (no indigenous) relocated, flood of archeological sites, as well as ecological implications to the Térraba-Sierpe wetland, among other affectations in the river uses, road infrastructure and productive activities, but in a lower magnitude than the Boruca HP.[167]

When the government declared the Diquís HP of "national convenience and public interest", in 2008, this announcement was strongly opposed by environmental organizations, eco-lodges, nearby communities and indigenous communities who claimed their right for consultation. Since then, the Diquís HP conflict and mediation was underlined by an increasing national and international pressure against the dam. Main concerns were grounded on the lack of prior indigenous consultation, given the affectation of 10% of indigenous territories. The indigenous people of Costa Rica demanded the protection of the ILO Convention 169.[168]

These conflictual processes have delayed the government approval of the Diquís HP. Project developers at the ICE and private investors blame the government for the delay in the case of the Diquís, as well as in other projects. According to them, slow progress of electricity projects is due to the lack of clarity in the national energy policy and guidelines, as well as for not attending the socioeconomic demands of the communities (Interview 1Q; Interview 5Q, 2013).

[167] "El Diquís sustituye el gran proyecto Boruca" La Nación, 21.12.2008.
[168] "Ilegalidades del Proyecto Hidroeléctrico Diquís", La Nación, 14.07.2011.; "El Diquís, frente a la jurisprudencia de la Corte IDH", La Nación, 01.11.2012.

In interviews during 2013, officials at environmental planning, economic engineering and other planning departments at the ICE stated that they are guided by the highest standards (Interview 4L, 2013), thus could not understand the opposition from hosting communities, not only towards the projects, but also towards the institute and its employees (Interview 5Q; Interview 4C, 2013). Interviewees repeatedly made reference to this change in attitudes compared to the past and claim that compensations are never enough to affected populations: "The communities want the ICE to solve all their problems even though this is the government's job" (Interviews 1F, 2013).

In the period 2010-2014, legitimation problems continued affecting hydroelectric projects, either large dams or smaller RORs. The concentration of several RORs in the same watershed has been increasing the awareness among communities and based-root organizations concerned about their environmental impacts and competing uses of water at local level (Municipalidad de Buenos Aires, 2013; Municipalidad de Perez Zeledón, 2013). Consequently, in 2013 the two municipal councils declared a moratorium to hydroelectric dams in their counties until there is a planning proposal or a project to secure water provisions for human consumption.

Environmental organizations, such as FECON and Co-ecoceiba, have been using WCD reports and other research from international networks (e.g. International Rivers) to support their arguments and taking position on the side of affected communities. According to them "the projects are imposed, therefore communities are reluctant" (Interview 2J, 2013). Environmental organizations have a clear position regarding hydroelectric projects and have been advocating for other alternative renewable sources, such as solar, biomass, wind and hydrogen. Nevertheless, they do not have further commitments with one technology in specific.

On the other hand, conflictual processes from electricity projects at community level created synergies between communal based groups with ecological concerns and environmental organizations with distributive approaches that have been increasing over time. One example is the organization of national forums since 2001, becoming a regular meeting point to exchange experiences between communities from the North and South of the country (Interview 2J, 2013).

In summary, drivers from local welfare communication started to play a role in decisions of electricity investors since early stages. Is at the project site where the hosting communities are directly affected by social and ecological impacts, affecting their livelihoods positively or negatively. This is exemplified by the reversal and slowdown on decisions of several RORs and new dams that raised awareness from environmentalist and grass-root organizations from a local sustainability perspective.

Since the 1990s, hydroelectricity legitimation suffered intensively what path dependency theory outlines as (degenerating) side effects from decisions. In fact, local welfare communication started reversing self-reinforcing mechanisms of hydroelectricity legitimation based on national welfare communication and of hydroelectricity efficiency based on scale economies. Meanwhile, from the perspective of the government, the Energy Planning Sector and the multilateral financing organizations, hydroelectricity remained a legitimate source to satisfy growing electricity demands and reduce poverty. These contradictory perspectives are also explained in the section on political power mechanisms.

8.4 Concluding Remarks

Drivers from legitimation mechanisms discussed above (i.e. global climate change, national and local welfare communication) had a great transformative potential for the national energy system. However, in the first decades of the 21st century their effect was rather ambiguous. The communication of national and local welfare influenced decision-making process that reinforced the hydroelectricity path since early stages. However, degenerating side effects were dawdling or even reversing them, in particular from local benefit communication.

Alternatively, I discovered that legitimation mechanisms of actions against global climate change did not have a role as a driver of decisions from the perspective of legitimation mechanisms. The communication of actions against global climate change was present in several strategic documents from the Energy Planning Sector (e.g. National Strategy on Climate Change and Carbon Neutral initiative). However, the legitimation of this criterion played little role in energy decisions of the ICE and private investors. Conversely, the effectiveness of hydroelectricity as adaptation strategy is highly relevant in the eyes of the ICE and the Energy Planning Sector, but this aspect is closely linked to reliable electricity effects.

This finding further supports the idea of Fletcher's (2010) which showed that the resurgence on dam construction worldwide is underway, substantially spurred by the climate change discourse. This occurred as the government took further steps positioning the country internationally as a carbon neutral nation, but mostly as consequence of 'periodical adverse climatological conditions'. Nevertheless, the findings of the current study goes further suggesting that the drivers of such discourses in the case of Costa Rica were based on efficiency claims, rather than legitimation of these measures against global climate change.

Since early stages, national welfare communication played a major role in energy decisions and for the legitimation of hydroelectricity projects. These drivers also have positive repercussions on the ICE's special standing in the society. From the perspective of the government, the

Energy Planning Sector and the multilateral financing organizations, hydroelectricity remained a legitimate source to satisfy growing electricity demands and reduce poverty. Other alternative renewable sources, except geothermal energy, lack such drivers on larger scales.

Although in the early 2000s, international organizations showed a precautionary viewpoint towards financing dams, a new wave of support towards dam construction resurged by the end of the 2000s decade. Domestically, the impulses were driven by increasing electricity prices, an issue that started to dominate the public debate supported by the media. On the global realm, global discourses reinforced dams' continuation by providing material and ideological resources from national welfare communication.

With the publication of the WDC principles, in 2000, contentions increased for the construction of dams. Dams were ascribed with large environmental impacts, besides important social and cultural repercussions. Conversely, in the case of RORs, the aspect of environmental sustainability was highlighted as one advantage of these smaller hydroelectric plants.

Nevertheless, over time dams continue upholding an important level of legitimation among actors in the energy system, but not RORs. Even environmentalists consider dams as an option to global climate change, if they are built properly and guarantee fair compensation to displaced communities. Meanwhile several RORs face problems of legitimation, not only from the perspective of environmentalist and hosting communities, but also losing support in communications from the Energy Planning Sector and some international hydroelectric advocacy groups.

Drivers from local welfare communication play a critical role in decisions of electricity investors, especially the ICE, regarded among the population as having great deal of legitimacy. Is at the project site where the hosting communities are directly affected by social and ecological impacts, affecting their livelihoods positively or negatively. In the period under review, there were indications of legitimation problems from local welfare communication.

Concerning geothermal energy, different actors consider this source appropriate as an alternative to hydroelectricity. Firstly, geothermal energy is low carbon; secondly, it also avoids the problems surrounding hydroelectricity generation (e.g. local opposition and/or ecological impacts), and thirdly, it provides the same advantages of 'firm' electricity. Environmentalists' position tend to favor this source, on a larger scale, before dams, but their claim is not in terms of national socioeconomic benefits provided by dams or geothermal plants, but rather is in terms of global climate change legitimation.

Part III Integrated Discussion and Concluding Remarks

9 Path Dependency and Path Breaking in the Costa Rican Energy System towards Carbon Neutrality 2021

9.1 Introduction

The present chapter provides an integrated discussion of the findings from the dissertation. The main result of the analyses confirms that Costa Rica's energy system developed a path dependency in the electricity sector that reinforces hydroelectricity development through decisions that are beyond individual cost-benefit assessments made by long-standing sector institutions. The drivers of these decisions evolved in all three mechanisms of efficiency, political power and legitimation. The same factors that reproduce the preeminence of hydroelectricity installations, restrain the subsequent ability of the national energy system to further implement policies that incorporate solar energy and other alternative renewable sources.

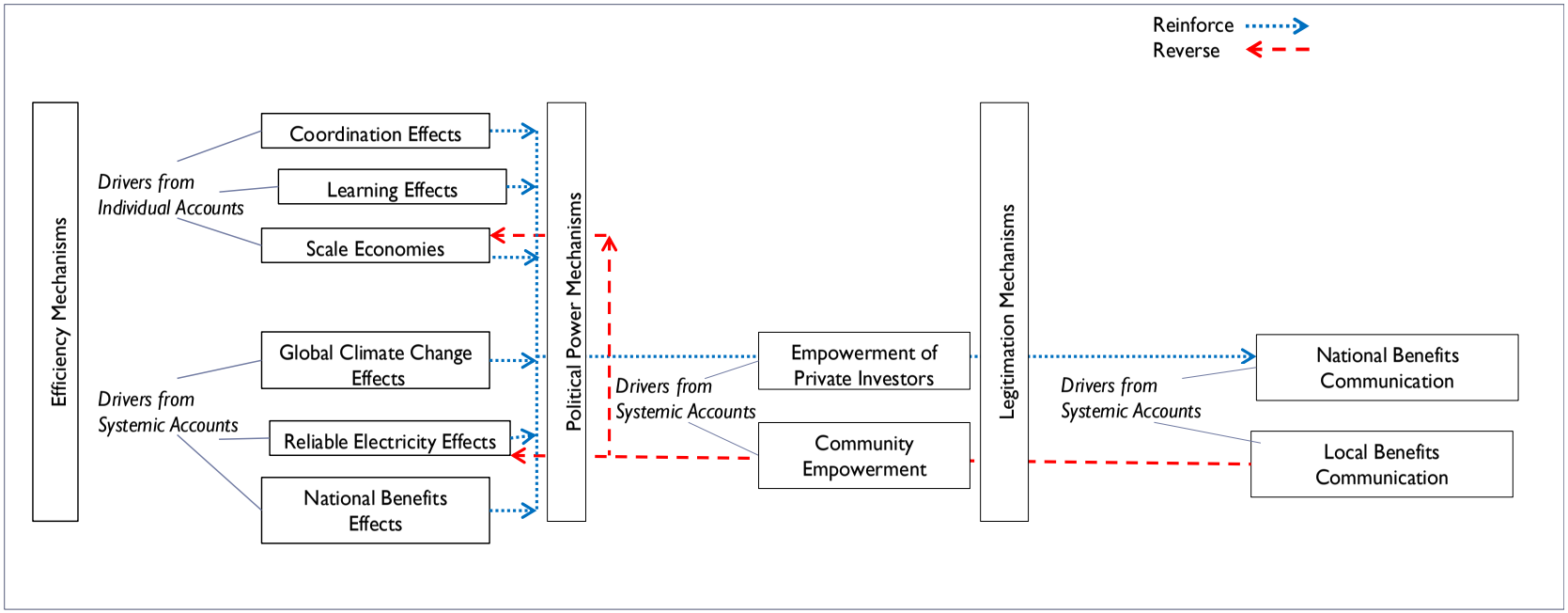
The technology selection in the country is largely influenced by centralized decisions made in the past and reinforced over time by politicians, the ICE, as well as the energy planning sector. I distinguished 10 drivers of decisions and one external shock to explain technological and institutional developments in Costa Rica's energy system (see Figure 10). On one hand, eight drivers produce a path dependence which reinforces hydroelectricity at systemic and individual levels.

At systemic efficiency level operated a) drivers of global climate change effects, b) drivers of reliable electricity effects and c) drivers of national welfare effects; at individual efficiency level d) coordination effects, e) learning effects and f) scale economies. Those drivers were also enhanced by g) drivers of empowerment of private actors; and h) the communication of national welfare, from political power and legitimation accounts, respectively.

Then again, there are three drivers of path breaking by which patterns marked by path dependency might be reversed, they are: i) the communication of local welfare from legitimation mechanisms; ii) community empowerment from political power struggles; and iii) uncertainty over efficiency effects from exogenous climatic shocks on hydroelectricity projects that will complicate things for hydroelectricity, eventually reversing efficiency mechanisms of scale economies and reliable electricity effects from these installations.

Accordingly, this chapter addresses those mechanisms in separated sections, one for the elements of path dependency and the other for the elements of path breaking. Furthermore, after this introduction an additional section is added for an integrated discussion on the level of analysis, actor interactions and scenarios of carbon neutrality. The last section sums up some final considerations and concluding remarks.

Figure 10. Mechanisms and drivers reinforcing or reversing the hydroelectric path



Source: Own compilation

9.2 Level of Analysis, Actors Interactions and Scenarios of Carbon Neutrality

Starting with the level of analyses, particularly in the case of efficiency mechanisms, there is distinction between individual accounts and systemic accounts as drivers of decisions. It was found that individual decisions, motivated by scale economies, learning and coordination effects, are at the same time connected to systemic drivers of economic growth, reliable electricity effects and global climate change effects that refer to the overall system (i.e. systemic accounts).

In the cases of legitimation and political power mechanisms, their effects concern the overall energy system. For instance, the systemic accounts from legitimation are linked to drivers from the communication of national welfare, local welfare and global warming effects that refer to larger scale processes. Similarly political power mechanisms consist of drivers of empowerment of private actors and community empowerment in reference to the electricity model or the energy system as a whole.

Therefore, systemic accounts from efficiency, legitimation and political power are classical mechanisms producing path dependency because they are beyond actors' individual decisions. Although they are also connected to individual accounts on projects and decisions, it was found that systemic accounts played a major role explaining the lack of dynamism of the electricity sector in Costa Rica. Thus path dependency discussions have a focus on drivers at the systemic level.

In addition, some differences were found in the mechanisms emphasis among actors and over time. For instance, powerful state actors put more attention on efficiency mechanisms at the systemic level (e.g. reliable electricity effects). Meanwhile, among secondary actors and institutional entrepreneurs, such as private investors, civil society organizations and the influence of international organizations (and the global industry) drivers of efficiency at individual level play a major role (e.g. coordination effects).

In this regard, I found that in the case of Costa Rica's energy system drivers of efficiency mechanisms at individual level are key to incentivize interest on technologies at initial stages. These drivers were relevant, for example in the emergence of wind energy in the 1990s. Meanwhile, other systemic drivers more clearly operate in later stages of path dependency.

In terms of actor constellations and their interactions, by the end of the period three constellations of actors can be distinguished in the analyses of mechanisms. The first are decision makers or actors making choices on projects and energy policies, they include: state and private investors, the Energy Planning Sector and politicians. A secondary group of actors

that are directly influencing decisions are civil society organizations, public and private associations (and related clusters), the media and international organizations. The third constellation is indirectly influencing energy decisions, they are local communities and the general public who elect and pay for governments.

Historically, state empowerment during the 'developmental state era' favored the ICE's autonomy, which enjoyed good reputation from politicians and the general public. Therefore the institute emerged from this period as a new political actor. After liberalization reforms, the actor constellations changed and new renewable energy sources were incorporated to the national energy mix.

By the year 1997, the actors involved in different stages of the electricity service included four cooperatives, two municipal companies, as well as over 20 private investors that owned additional installations (Battocletti, 1999). After liberalization reforms, the interest of private investors in the electricity sector increased as long as their installations grew in number and size (e.g. until permitted limits). The relative political importance between state and private actors is changing over time, but in general terms the institutional arrangements established in the electricity sector tend to emphasize their cooperative interrelation.

Table 8. Actors' interests and logics of decision

Period	Relevant Actors Involved	Interest in Technologies	Logic of Decisions (Systemic)
Before 1990	Powerful state actors: ICE, politicians Other decision makers: Private construction contractors, experts and consultants (national and international); Rural electricity providers Secondary actors: Worker unions	Hydroelectric dams Social and economic development	Efficiency: reliable electricity effects, national benefit effects Political power: state empowerment Legitimation: national and local benefit communication
1990-2014	Powerful state actors: ICE, the Ministry of Environment, politicians and regulatory bodies Other decision makers: Private and other state electricity producers; international shareholders; Private Energy Producers Association (ACOPE); Costa Rican Association of Solar Energy (ACES) Secondary actors: Worker unions, environmental organizations and other civil society organizations	Hydroelectric dams and RORs; geothermal fields; Solar Home Systems (SHS); first wind parks; biomass stations; small private solar installations Socio-environmental concerns	Efficiency: global climate change effects; reliable electricity effects, national benefit effects Political power: empowerment of private investors Legitimation: national and local benefit communication
2014-towards 2021	Powerful state actors: ICE, the Ministry of Environment, politicians and regulatory bodies Other decision makers: Private and other state electricity producers; ACOPE; international shareholders; the Costa Rican Solar Energy Association (ACESOLAR) Secondary actors: Environmental and civil society organizations; international organizations; local municipal councils	Hydroelectric dams and RORs (e.g. Diquís dam, Reventazón HP); geothermal fields; Distributed Electricity Generation; first Solar Park Miravalles; natural gas prospects Socio-environmental concerns	Efficiency: global climate change effects; reliable electricity effects, national benefit effects Political power: empowerment of private investors; community empowerment Legitimation: national and local benefit communication

Source: Own compilation

In addition, differences in power relations between actors also influence decisions that result in the preeminence of choices from the most powerful actors. Key players in each framework are mostly the ICE, the Energy Planning Sector and politicians. However, their interactions with other actors also frame the selection of projects, though, their interrelation varies to some extent in each framework.

In the efficiency framework most powerful actors are decision-makers who are the state and private investors making choices about energy projects and technologies, as well as the policy-makers stating priorities among them. Institutional entrepreneurs among secondary actors are mainly private investors. In the political power framework, the powerful actors are the Energy Planning Sector, the ICE and politicians, where the influence of private investors is evidenced. Among subordinated/secondary actors, those who can tip the balance changing the power game in the energy system are civil society organizations and local governments with the support of international networks (i.e. environmental organizations and indigenous rights).

In the legitimation framework most relevant actors are those who set the norms and have the capacity to rule the energy system. They are basically the Energy Planning Sector, the ICE and the politicians. While those who consensually or antagonistically follow the rule setting are, besides state and private investors, the local communities and the general public. Institutional entrepreneurs among secondary actors are environmental organizations, community based organizations and the influence of international organizations with capacity to tip the balance (in terms of legitimacy) of the ruling elite.

In terms of renewable energy sources in the country, geothermal stations, wind parks and biomass stations, started to operate as a complement to hydroelectric plants. Private electricity generation focused on hydroelectricity and wind energy on smaller scales, while the ICE concentrated on the development of larger hydroelectric projects and geothermal fields. Already in the early 2000s, hydroelectric projects were using 50% of the country's 34 major watersheds (Lindo, 2006). Table 8 illustrates actors' interest and logics of decision in different periods of time.

Concerning scenarios towards carbon neutrality in the year 2021, the interests of powerful state actors on technologies are reflected in the Electricity Expansion Plan (2014-2034). This plan includes the projects that are currently being executed and the recommended ones (ICE, 2014, p. 107). In short, an overview on those perspectives show the same trend followed in the past years.

Among the recommended projects, three different projections or "routes of expansion" are the most relevant. The Route 0 or base scenario progressively incorporates abundant small and

medium size renewable energy projects (generic) with high variability (e.g. wind energy and run-of-the river stations). Then, Route 1, which is the recommended one by the ICE and the Energy Planning Sector, is based on the development of the Diquís hydroelectric dam. The Route 2 introduces liquefied natural gas (LNG) in future projections.

In these analyses, the projected electricity demand in 2035 is not varying much between the low, the medium-level and the high demand scenario (i.e. projected 3.3%, 3.4% and 3.6% annual growth in 2035 respectively). Likewise, the estimated present cost (i.e. including the environmental criteria) of the different routes is very similar (ICE, 2014, p. 92). For instance, the medium-level demand scenario used in the Route 1 has an estimated present value of 4081 million dollars; this is reduced to 4078 million dollars in the Route 0 and to 4043 million dollars in the Route 2 (MINAE, 2010; ICE, 2014).

In the future, a potential reduction from hydroelectricity in national energy projections would make it difficult to achieve carbon neutrality by the year 2021. In this scenario, the role of alternative renewable sources, is and becomes relevant. Nevertheless, it also directs attention towards non-conventional fossil fuels like natural gas. Consequently, the aspects that might inform decisions for future scenarios in the national energy transition are in the end more political rather than just technical.

9.3 Elements of Path Dependency

This section integrates the analyses of factors producing path dependency or lock-in of hydroelectricity in Costa Rica's electricity sector towards carbon neutrality. According to scenarios projected by the ICE towards 2034 (i.e. route 0 abundant small-medium size, route 1 Diquís dam and Route 2 natural gas) the estimated cost and projected demand is not varying much among them. Therefore, what are the criteria for decisions in the electricity sector that cause a path dependency on hydroelectricity? In this section it is argued that systemic efficiency mechanisms played a major role from the point of view of decision makers. In addition, two more drivers of decisions from political power and legitimation mechanisms trigger status in the system.

Above all drivers, reliable electricity effects from efficiency mechanisms prevail in decisions of the ICE and the Energy Planning Sector explaining path dependency in the Costa Rican case. Choices based on the reliability of the different energy sources were also supported by impulses of economic growth and global climate change effects. The results indicate that these efficiency mechanisms motivate the selection of technologies that favor hydroelectricity and geothermal energy characteristics.

Furthermore, the current study found that policies and projects launched by these actors with the support from political elites were also motivated by the empowerment of private actors and the communication of national welfare. Altogether, those mechanisms help to explain not only the reinforcement of hydroelectricity, but also the advance in geothermal developments as a second best option. Partly, they also explain a slowdown of investments in alternative renewable energy.

9.3.1 Path Dependency from Efficiency Mechanisms

The present study found that systemic accounts from efficiency based on drivers of economic growth, reliable electricity effects and global climate change effects are closely interlinked. These logics of decisions are predominant in the perspective of the ICE, the Energy Planning Sector and the politicians who have the political power to implement institutional change. Therefore, they provide explanations on path dependency of hydroelectric dams and RORs.

The recommended route of expansion (2014-2034) foresees the incorporation of two large hydroelectric plants (i.e. Reventazón HP, 292 MW and Diquís HP, 650 MW) that will commence operation in 2016 and 2025. Since the announcement of carbon neutrality, the Energy Planning Sector and the ICE discuss climate change with a focus on systemic efficiency accounts. For instance, the National Strategy for Climate Change (2009) considered that mitigation and adaptation options should not only be based on an improvement on energy efficiency but also on "water efficiency" (i.e. *eficiencia hídrica*), as water is the main source of clean energy.

In the mitigation strategy, it is estimated that the country uses 63% of the water resources to produce electricity, fulfilling over 95% of the national electricity consumption. Hence, from the standpoint of the Ministry of Environment hydroelectricity has an indirect but fundamental role within the mitigation strategy of the country and the energy system.

> "Clean energy production is one of the major benefits that we make to the mitigation of GHG emissions on a global level, since it is amply demonstrated that electricity production from fossil fuels is the activity that accounts for the larger concentration of CO_2 emissions worldwide" (MINAE, 2009, p. 51).

Private investors also reinforce drivers of global climate change effects through decisions, at individual levels, driven by coordination effects from carbon mitigation instruments. For instance, through the PES, state and private investors as well as global environmental organizations involved in carbon mitigation projects (e.g. The Nature Conservancy) finance

conservation efforts on watersheds (Lindo, 2006; Fletcher, 2010). Following profit motivations such incentives reinforce the reproduction of hydroelectric plants.

In terms of adaptation, the implications of climate change over water resources are seen in terms of system's efficiency driven by reliable electricity effects. The National Strategy for Climate change also argues for a more efficient administration of the country's water supply, among watersheds and the protection of water sources (MINAE, 2009). Dams have advantages in terms of reliable electricity production and carbon mitigation strategies because they possess a water reservoir.

On the contrary, it is precisely the aspect of reliability that relegates alternative renewable sources to a subsidiary position. With the exception of geothermal, the potential of alternative renewable sources is disregarded under similar arguments of reliability. In interviews during 2014, officials at planning departments drew attention to the advantages of geothermal energy in terms of reliability: "(Geothermal energy) renders wonderful results, provides energy all the year and it's of the best quality" (Interview 2P, 2014).

The Route 0 or base scenario progressively incorporates generic renewable energy projects with high variability (e.g. wind energy and run-of-the river stations). The case of run-of-the river stations (RORs) is different because in spite of its variability and reduced production in summer RORs are seen as a relevant back-up source. From the perspective of the ICE the high variability of production and the lack of storage capacity are main drawbacks from these renewable projects: "Possibly this route will suffer a deficit of storage and regulation capacity that has to be corrected through additional investments that are not addressed in the present analysis" (ICE, 2014, p. 92).

During interviews this limitation was also highlighted, including the estimations of an upper bound or "technical preventive measure" of installed capacity for the cases of wind and solar energy installations. Wind energy was considered a very good complement to hydroelectricity, however unlike geothermal, it's highly variable and needs back-up (i.e. hydroelectricity dam or fossil-fueled plants) during periods of low production. As pointed out by interviewee at the ICE:

> "If 300 MW of wind energy are installed, where is the back-up? Then we need to build a 100MW hydroelectric plant or (oil) thermal station. (…); the expansion must consider that there is a technical preventive measure to no more than 350 MW" (Interview 2P, 2014).

Solar energy remains largely underrepresented within expansion plans with less than 2 MW of installed capacity. In the expansion plan the ICE acknowledges decreases in technology costs and lower socio-environmental complexities as compared to other technologies (ICE, 2014, p.

40). Nevertheless, besides problems on reliability effects of solar energy, perceptions of higher costs and low generation potential of this technology still persist among the Energy Planning Sector and the ICE's planning departments (Interview 4N, Interview 4E; Interview 5E, 2013).

> "The variability is more accentuated in the case of solar energy than wind energy, though increasing their use will also require more run-of-the river stations in different areas of the country and more hydroelectric dams. (…) In the case of solar energy there is a limitation given a technical preventive measure to no more than 5 MW installed capacity" (Interview 2P, 2014).

In fact, continuity of supply is the ICE's major concern. Planning departments at the ICE have the strategy to opt for a national energy renewable mix and with diverse energy sources. These diverse sources, including fossil fuels, are arranged according to the variation of dams as back-up. When the situation is critical, fossil-fueled plants are rented or traded in the Central American Electricity Market: "Plants with a dam are operated with forecast or prediction. It could be the case that it is raining but still we are burning fossil fuels to recover the reservoirs." (Interview 2P, 2014)

The route of expansion 2 elaborates on projections regarding possible scenarios of natural gas, which contribution is foreseen in 2025 (ICE, 2014). In the eyes of the ICE's planning departments, given the mandated for the provision el electricity, it is not viable to disregard the alternative of conventional and nonconventional fossil fuel sources: "We do not see viable to disregard oil fueled plants, for example Garabito, 200MW (...), and concerning natural gas, at the moment the options are to import natural gas from the United States" (Interview 2P, 2014).

Natural gas is considered by the Ministry of Environment and the Energy Planning Sector as an "alternative to other more expensive fossil fuels, given the growing energy demand and the climbing electricity prices in the country" (Interview 5E, 2013). In this sense, politicians on a national level have been following the arguments of the natural gas industry as a transition towards carbon neutrality.[169] However, this perspective is problematic from different points of view.

From an efficiency point of view, interviews with experts and officials at planning departments make reference to the consumption of natural gas in Latin America as very low in comparison to Asia. For this reason, the national refinery (i.e. RECOPE) has to be involved in the deal for Costa Rica to start-up the industry for electricity generation (Interview 2P, 2014). Moreover, as

[169] In his book, Hefner (2009) makes the case that natural gas is the essential bridge fuel to renewable energy sources. These issues were discussed at the 2nd Annual Forum on Prospects for LNG and Natural Gas in Central America, San José 02.10.2013

long as the natural gas is imported like in the case of conventional fossil fuels, there is a risk that energy cannot be imported in the moment needed.

From an environmental point of view, the production of natural gas and the fracking technique to extract the resource prompted environmental and health concerns in the United Sates and other countries.[170] Besides, the natural gas scenario also contradicts the environmental policy of carbon neutrality. International energy agencies refer to the natural gas risk of moving away from low carbon targets.

> "The negative effect takes place by artificially depressing electricity cost producing lower returns and also by competing for new infrastructure, given natural gas capital intensity" (Deloitte, 2013).

The effect of a lower price of natural gas creates the possibility of reducing electricity costs, with the risk of displacing alternative renewable energies (Deloitte, 2013; IEA, 2012). The rising use of natural gas, in cases like Brazil and Colombia, is also triggered in reaction to dependency on hydroelectricity, which has been vulnerable to changing weather patterns (Tissot, 2012).

Systemic accounts of efficiency make reference to energy as a critical factor for economic growth. In documents and discourses this aspect is constantly mentioned usually linked to economic competitiveness. From this particular perspective, dams have a great potential and are adequate to achieve the goals of national socio-economic development and carbon neutrality.

However, more than an aspect of efficiency, the communication of national welfare, including economic growth and poverty reduction, seems more closely connected to legitimation mechanisms and the communication of national welfare. First, electricity demand growth is expected to remain rather low. Second, the production of dams like the Diquís HP would significantly increase installed capacity, and thus it is expected to be sold in the regional market. These aspects are further developed in the legitimation section.

In summary, the results of the historical analysis show that the drivers of global climate change and reliable electricity effects reinforce dams' preeminence over time. Moreover, the systemic accounts were also triggered by individual accounts based on drivers of coordination effects through incentives that promoted carbon mitigation. These effects continue reinforcing hydroelectricity in the route towards carbon neutrality.

In most cases, references to global climate change effects alluded to efficiency mechanisms and to the advantages of hydroelectricity in terms of adaptation and survival of the overall energy

[170] "What is fracking and why is it controversial?", BBC News 27.06.2013.

system. Drivers of economic growth also reinforce hydroelectricity because it increases competitiveness, energy efficiency and lower electricity bills from a low carbon energy source, but the logics of these mechanisms appear more as a powerful legitimation argument.

Alternative renewable sources including RORs, wind parks and solar energy are highly variable and lack storage capacity. Among them, RORs still enjoy the confidence of the ICE and the Energy Planning Sector that used them to back-up dams, displacing fossil fuels. Lastly, the evidence provided suggests that although the natural gas scenario has support among politicians, its advantages are questioned inside planning departments at the ICE and other experts. In terms of efficiency, in the country this technology lacks drivers of scale economies that are important to develop capital intensive industries. Moreover, the use of natural gas in electricity production challenges carbon neutrality from a systemic perspective, besides other environmental concerns that difficult its feasibility in the country.

9.3.2 Path Dependency from Political Power Mechanisms

The current study found that in terms of political power relations the empowerment of private actors reinforced the same energy pattern driving hydroelectricity to a stage of path dependency. Private investors, some of whom lead investments in alternative renewable sources in the 1990s, favored the predominance of hydroelectricity projects in their initial choices, aided by power relations. Nonetheless, at present private investors are seen by state and private actors as potential relevant actors to propel solar energy developments and biomass electricity stations in the future.

Besides profit motivations from incentives (i.e. market regulations and carbon mitigation) at individual levels, political issues of structural relations of power also played a role driving private and state investors' decisions. Since liberalization reforms the empowerment of private investors was facilitated by existing environmental and market regulations. These processes also created vested interests in the electricity sector where the state apparatus was used by some politicians with private businesses in electricity production. Left-wing parties, environmental organizations and universities identified these "blows" against the ICE and public financing following the 1990s reforms of the sector, as referred in chapter 7 (p.11).

During the last two governments (2006-2010 and 2010-2014), the electricity agenda was based on the promotion of private investments in renewable energy. This agenda foresees the expansion of hydroelectricity projects, while environmental aspects and latent problems with local communities remained out of the political discussion. That became clear in the texts of the bill proposals promoted during these administrations (see chapter 7, p.31-33).

As an example, the only conflicts foreseen in the laws were between electricity companies and grid operators or between projects, which will be solved by the Ministry of Environment based on the National Energy Plan (File 17666, 2010; File 17812, Article 98, 2010). In particular, none of these laws made reference to water concessions that confront communities and private interests.

Vested interests present in electricity have been influencing decisions. More recently business groups in the sector financed political campaigns and lobbied to open up the sector or increase their share in the market. Still, they are not considered powerful enough to tip the balance in political decisions, as pointed out by interviewee: "(…) the situation will not change, unless more powerful regional actors make pressure tipping the balance towards more private participation in the national market" (Interview 1G, 2013).

Concerning conflictual power relations, the problem arises when the interest of private or state investors reach the level of political energy decisions against public interests. This occurred in the case of several private hydroelectricity investments, but also in cases of the ICE investments. For instance, powerful groups with interest on the Diquís dam, including the ICE, the Energy Planning Sector, politicians and global environmental organizations eager to take advantage of the benefits from the PES, exerted influence through the state to announce the declaration of public interest and national convenience for the project, in spite of pending legal aspects.[171] In fact, feasibility studies and road infrastructures were advanced and the environmental organizations already started the promotion of "water funds", an innovative form of the PES to finance conservation efforts on watersheds feeding the future Diquís reservoir (Fletcher, 2010).

Most sensitive aspect on the dam is the lack of consultation with indigenous groups, given affectation on their territories. Nevertheless, compared to the Boruca HP, the social and environmental effects of the Diquís HP are downsized, as well as the social mobilization (e.g. environmental organizations and community-based organizations) against it (Fletcher, 2010). Claims of the ICE, the Energy Planning Sector and politicians who defend the Diquís HP would have stronger resonance on final decisions if adequate deliberation would take place.

In addition, the trend towards market and the corporatization of the ICE changed institutional emphasis on efficiency goals (i.e. economic competitiveness) above other national welfare. In this context, being "profitable" became part of the Institute's values.[172] Likewise, the ICE got

[171] "El Diquís, frente a la jurisprudencia de la Corte IDH", La Nación, 01.11.2012.
[172] Misión - Visión - Valores - Grupo ICE. (2015, March, 15). Retrieved June, 2015, from https://www.grupoice.com/wps/portal/acercaDe

adapted to the rules of the game in competition with private investors, domestically and abroad through the Central American Electricity Market.

Although further advances of the neoliberal agenda in the electricity sector found resistance in the country in the early 2000s, the trend towards market and international competitiveness of the sector continued unchallenged until 2014. With the incoming center-left government taking power, it is probable that there will be some reluctance by the new government to go deeply into liberalization and market reforms, while favoring a move towards citizens' participation. However, a change to turn in the national developmental growth strategy based on large dams is less likely to happen.

To sum up, liberalization reforms empowered private investors in the national energy system with an initial effect that reinforced the hydroelectric path through power relations. At the same time, the trend towards market and the corporatization of the ICE produced a gap of policy outcome (i.e. path dependency) in terms of sustainable energy transformation. As a result, efficiency goals of economic competitiveness were above local people's wellbeing. These processes reinforced hydroelectric projects, but also antagonism between actors.

9.3.3 Path Dependency Elements from Legitimation Mechanisms

Legitimation mechanisms are analyzed according to drivers of global climate change communication, national welfare communication and local welfare communication. The evidence analyzed in chapter 8 shows that the communication of national welfare really plays a role in the path dependency of hydroelectric dams, while the communication of local welfare do so for path breaking. Contrary to expectations, legitimation actions against global climate change were not so relevant in decisions between energy sources.

Social acceptance of electricity projects varies among different actors as well as over time. At the end of the 1990-2014 period, actors with the capacity to change norms, such as the ICE, the Energy Planning Sector and politicians tend to support hydroelectricity projects in general, and dams in particular. Dams have high legitimation within this group mainly due to the communication of national welfare, including the ICE's national mandate for the provision of electricity.

Although global climate change was constantly present in communications from the Ministry and politicians, it was not the case in the selection of projects. In interviews during 2013, planning departments at the ICE challenged the concept of climate change due to lack of sufficient data. Likewise, in the Electricity Expansion Plan (2014-2034) the ICE acknowledges

that the national renewable hydro-based energy model is vulnerable to climate change, but the effects are somehow downsized and able to be modeled.

> "Nevertheless, everything seems to indicate that in the time horizon of the (electricity) expansion plan, the changes on climate variations will be modest, therefore, it is acceptable to model hydro meteorological events as cyclostationary process" (ICE, 2014, p. 64).

Furthermore, the concept of climate change is not intrinsically integrated in the institutional vision of the ICE, whereas concepts of economic development and social welfare are rooted in the Institute's history and present in the organizational values. This is evidenced in the mission and vision of the ICE, as well as in the values agreed by the Managing Board in 2014.

> "Group ICE Mission: We are the Corporation property of the Costa Ricans that offers electricity solutions and telecommunications, contributing to economic, social and environmental development of the country. Group ICE Vision: Being a leading Corporation, innovating in the business of electricity and telecommunications in convergence, focused on the client, profitable, efficient, promoter of development and national welfare, with international presence."

During the political campaign in 2013, claims from the Energy Planning Sector, the ICE, and politicians in support of the Diquís dam alluded to the advantages of the dam in such terms. In a context of increasing electricity tariffs, presidential candidate J. Araya, referred to the Diquís dam with the following statement "the main enemy of communities is poverty".[173] From their perspective, hydroelectric projects have a great potential and are adequate to achieve the goals of national economic development, poverty reduction, and carbon neutrality by the year 2021.

Even the National Strategy for Climate Change (2009) reinforces the support of the larger hydroelectric plants scenario, since besides clean, "their production results are cheaper to the country, reliable and more environmentally sustainable than other sources" (MINAE, 2009, p. 52). In the same strategy, the Energy Planning Sector suggested actions to approach conditions creating delay on investments and insufficient diversification of energy sources. Failure in approaching these problems would have negative consequences to the energy system which are framed in terms of national welfare.

[173] These issues were discussed at the National Forum on Clean Energy "Jorge Manuel Dengo", San José, 02.09.2013. However, the way tariffs are set by the ICE, the poorest households have subsidized tariffs. Increases have been afforded by the residential and the industry sector (note: include figures and references).

> "If these conditions are not considered, the country could affront severe consequences such as reductions in security of energy supply, increases of electricity/or fossil fuel imports, which not only increase CO_2 emissions but also rising oil bills with the corresponding increasing trend on electricity tariffs for consumers and, as a main result, a notably reduction in the quality of life of the Costa Ricans" (MINAE, 2009, p. 62).

In the case of alternative renewable sources and legitimation mechanisms, the communication of actions against global climate change has not prompted any deviation from the hydroelectric pathway, neither have the communication of national or local welfare triggered them. The Energy Policy (2010) remarks that in official projections towards reaching carbon neutrality, hydroelectricity will remain dominant until its limited potential are reached by the year 2033. At this point, the era of "technological revolution with new energy sources" will begin (MINAE, 2010).

Decisions of the ICE to initiate developments of wind parks and geothermal projects in the 1990s period were supported by the institute's belief that it was the right thing to do to complement hydroelectricity. However, this claim was not related to appropriateness or moral reasons, rather system's efficiency (i.e. drivers of reliable electricity effects). Similar motivations towards alternative renewable energy were found in 2013-2014 during interviews of planning departments at the ICE.

According to interviewees from planning departments at the ICE, geothermal energy was ranked first, followed by hydroelectricity. Biogas grid-connected was third, which also provides stable electricity (i.e. with a load factor close to 1). Wind and solar energy were ranked fourth because they are dependent on the site where the resources are available (Interview 2P, 2014). While the potential from all of them, including oil sources, have to be combined, fulfilling the ICE's mandate: "The institute has a national mandate for the provision of electric energy (…). We also depend on the sources to look after the dams" (Interview 2P, 2014)

The preferences among sources from other groups of actors were not different from those of the ICE, even from environmental organizations. Although in the case of environmentalists the communication of global climate change plays a role in choices. From the perspective of actors setting the rules in the energy system all alternative renewable sources are low carbon as well. Therefore, legitimation of actions against global climate change did not explain the choices among alternatives. Thus, preferences on hydroelectricity and geothermal energy are linked to their higher reliable electricity effects in terms of efficiency.

Contrarily, the communication of local welfare from hydroelectricity suffers from legitimation problems. Politicians acknowledge this, in their interviews by stating that large dams are a

priority, but delays in projects caused by social resistance place geothermal stations as a second best option (Interview 1J, 2013). State and private investors increased the interest on geothermal energy, inside or outside natural protected areas, partly resulting in these limits to hydroelectricity.

Besides the Diquís dam, several RORs and even geothermal installations, in natural protected areas, raised criticism from environmental organizations together with organized communities, indigenous groups and global networks. In relation to that, the contradictions between the ICE's institutional mandate for the provision of electricity and issued laws that restrict electricity developments in indigenous territories and natural protected areas is a tension towards path breaking.

Therefore claims of the Energy Planning Sector, the ICE, and politicians who defend the Diquís HP allude to broader national welfare and the system's efficiency. The communication of national welfare, including economic competitiveness and poverty reduction, appears as a powerful legitimation argument reinforcing dams. Meanwhile, the results of the historical analyses show that in the 1990-2014 period, global climate change legitimation did not reinforce nor questioned hydroelectricity preeminence over time.

Furthermore, the advantages ascribed to hydroelectricity in terms of the communication of national welfare contribute to the subsidiary role of alternative renewable sources. In this regard, choices of the ICE coincide with those of politicians and even with some environmentalists' position. However, the antagonism between actors' position is evidenced at the local level, where aspects of path breaking are linked to political power relations approached in the following sections.

9.4 Elements of Path Breaking

The result of this study indicates that the elements of path breaking are associated to endogenous factors of legitimation and political power mechanisms. Contingently, efficiency mechanisms could also change the energy trajectory as result of an exogenous shock reversing self-reinforcing mechanism from efficiency. Throughout all these drivers of path breaking patterns marked by path dependency on hydroelectricity might be reversed.

Elements of path breaking from efficiency are originated from exogenous effects of climatic variability increasing hydroelectricity vulnerability (i.e. reversing drivers of reliable electricity effects and scale economies). Meanwhile, endogenous elements of path breaking are originated from reversing drivers of local benefit communication also triggered by enacted laws that restrain activities in natural protected areas or indigenous territories. In the case of political

power mechanisms, attempts of path dissolution were found in drivers of community empowerment that also bounded electricity projects. [174] Another important finding was that in the case of solar energy and other alternative renewable sources, they started to gain relevance thanks to escalating side effects based on drivers of coordination effects at individual level.

9.4.1 Path Breaking from Efficiency Mechanisms

In recent years Costa Rica has experienced shortcomings of hydroelectricity generation, in which not even the lake Arenal reservoir with its inter-annual storage capacity was able to provide electricity during the peak summer months. The effects of changing climatic variations are well known by the ICE and the Energy Planning sector. As declared during interviews with officials at planning departments: "The only way to storage energy for the dry season is through dams, but as there were losses in water resources during summer, the fossil fuel thermal back-up must be used" (Interview 2P, 2014)

The reduced productivity of hydroelectricity during the dry season was considered responsible for the implementation of the costly oil fueled plants. This trend raised the alarm from different actors with various interests and motivations. Technical studies into this area support this cause-effect relation for the Latin American region.

The studies found on this issue conclude that most obvious threats to hydroelectricity production in Latin America are related to droughts, precipitation variability, and higher temperatures (Tissot, 2012; Blacksher et al., 2011). In reference to Central America, besides the indication of increasing droughts and heavy precipitation events, a significant increase in hurricanes and temporal variability of river system discharge are expected (Blacksher et al., 2011).

Those findings coincide with the studies carried out in Costa Rica suggesting rainfall increases in the Atlantic, but with the opposite result in the Pacific (MINAE, 2009, p. 52). Another study by Birkel (2006) analyzes hydroelectric droughts in Costa Rica in order to determine if this trend has become more frequent and severe by using data from 17 watersheds with observations from over 30 years (i.e. 1973-2003). Even though a pattern was not found for the whole country, the results suggest a significant trend in terms of severity and frequency of drought for some watersheds in the Northern Region and Central Pacific.

[174] A distinction is made between legitimation and political power mechanism because reversing legitimation mechanisms should be triggered by those who set the rules (e.g. the Energy Planning Sector). When the norm is questioned by subordinated groups, the processes are linked to political power relations.

A more recent study from Sainz de Murrieta and Chiabai (2013) use a sample of 40 hydroelectric plants in Costa Rica and relate them with biophysical data in order to estimate the quantity of water available (i.e. runoff) for energy production with projections to the year 2100. Their estimated climate change scenarios suggest that hydroelectric production will be reduced between 41% and 43%. According to the study, it would be necessary to increase the installed capacity about 50% or to double the installed capacity of all plants to reduce economic losses in 12%. This is indeed the share that the Reventazón HP and Diquís HP add in terms in installed capacity (near 800 MW).

In the case of the ICE this was considered a temporal measure until new hydroelectric projects enter their operational phase (ICE, 2014; Weigl, 2014). However, the extended period and implications of these losses in hydroelectricity production also highlighted by the media, increased awareness in planning departments at the ICE. In a coverage during 2013, the Director of the Energy Planning Department at the ICE refers to the commissioning of a study financed by the IDB to understand how changing weather patterns affect electricity production. According to him: "The effects of climate change on temperature and river flows of Costa Rican watersheds can lead the ICE to accelerate decisions regarding geothermal energy".[175]

Certainly, the position of the ICE is not different from the Ministry in terms of strategies on the uses of water resources; however the ICE was more cautious in its assessments in terms of climate change adaptation. During interviews in 2013 there was detected an open debate at the ICE concerning future climate change scenarios and decisions to be taken. Respondents from planning departments felt that the discussion of "whether building large dams or not is the best strategy against extreme climatic events, is still not clear" (Interviews 2P & 5Q, 2013).

Meanwhile, the renewable electricity potential of geothermal energy is considered the best source to complement the decay of the hydroelectric preeminence. The potential of geothermal installations is attractive and considered in all the routes of expansion. According to the Electricity Expansion Plan (2014-2034), geothermal potential includes 165 MW currently identified (i.e. Pailas 2, Borinquen 1 and Borinquen 2) and other new 330 MW geothermal projects in natural protected areas (ICE, 2014, p. 91).

Apart from geothermal, specific projections at the country level concerning the incorporation of alternative renewable sources, particularly the "non generic" ones like solar energy and biomass stations, have yet to be developed. In Electricity Expansion Plan (2014-2034) the Route 0 or base scenario progressively incorporates generic renewable energy projects with high variability (e.g. wind energy and run-of-the river stations) without including specific projections.

[175] "Energía geotérmica en Costa Rica", Energías renovadas, 16.01.2013.

However, future scenarios were mentioned during interviews with officials from planning departments at the ICE.

To begin with, wind energy is already considered a generic renewable energy source like RORs and soon will become part of the conventional energy sources. Nevertheless, the use of the technology is constraint by its variability. There are projects to expand the ICE's wind park (i.e. "Tejona", 20 MW), but considering the technical preventive measure (i.e. 350 MW burden) (Interview 2P, 2014).

Planning departments at the ICE give considerably less attention in terms of exploring the potential of "non generic" renewable sources like solar energy, biomass and biogas. The explanation follows a straightforward train of thought, first these plants do not produce much electricity, second their production is highly variable and third, in the case of biomass, the ICE does not produce the raw material. Therefore, the strategy followed by the ICE is to support the expansion of these sources through joint programs with private investors who have more interest in these sources.

> "The expansion of solar energy projects is estimated in 6MW, although there are projects from private companies of 20MW and 10MW. (…) There is no intention to build biomass electric plants because we do not produce the raw materials and the ICE should be producing it in order to secure a continuity of supply" (Interview 2P, 2014).

These statements show that interest in wind parks, solar energy and biomass stations exists among planning departments at the ICE, but this is built on their effects for the function of the overall energy system. On the other hand, the institute also considers that private investors have more interest in solar energy and biomass electric plants. In fact, the ICE participates in joint projects and programs with private investors, which are not at the core of the institutes business but are seen as a form of 'social corporate responsibility' or "the social face of the ICE" (Interview 2P, 2014).

For instance, in the case of biomass there is a public-private project in the framework of the Energy and Environmental Partnership for Central America (EEP), the ICE provides feasibility studies and the private producers make the investment. The German Cooperation (GIZ) also brings support with the cost of machineries. Similarly, through the Distributed Electricity Generation (DEG) pilot program in the ICE brings support to private customers with the small applications of solar energy and wind energy.

In the case of DEG, electricity produced by the customers from solar energy or other renewable systems cannot be sold to the grid, although the ARESEP was working on protocols to incorporate sales of solar energy through the Law 7200 (Interview 2F; Interview 3F, 2013).

Through the Law 7200, electricity from biomass/biogas, similar to RORs and wind parks could be sold to the grid. However, under this law the projects must be very cost competitive (due auctions or invitation to tender): "First, projects have to be competitive in site. Second, when the distribution lines are connected" (Interview 2P, 2014).

Main concern of private investors is a leveled regulatory framework to make transactions in the electricity market fair among sources: "We are not asking for any prerogatives, just an established legal framework" (Interview 4G, 2013). As derived from interviews to private investors conducted in 2013, in this way the country can expand solar energy and other alternative renewable energy infrastructures without expending large amounts of the national budget in subsidies (Interview 4G, Interview 3P, 2013).

Taking the case of solar energy, a report from Deloitte (2013) indicated that while the drop in cost of solar energy takes place in industrialized countries with manufacturing capacities, developing countries can benefit from efficiency improvements and lower cost. At the level of private investors and users, solar energy penetration is taking advantage of these improvements. During interviews, private investors and civil society organizations claim that solar energy is currently technologically feasible and economically profitable in the country.

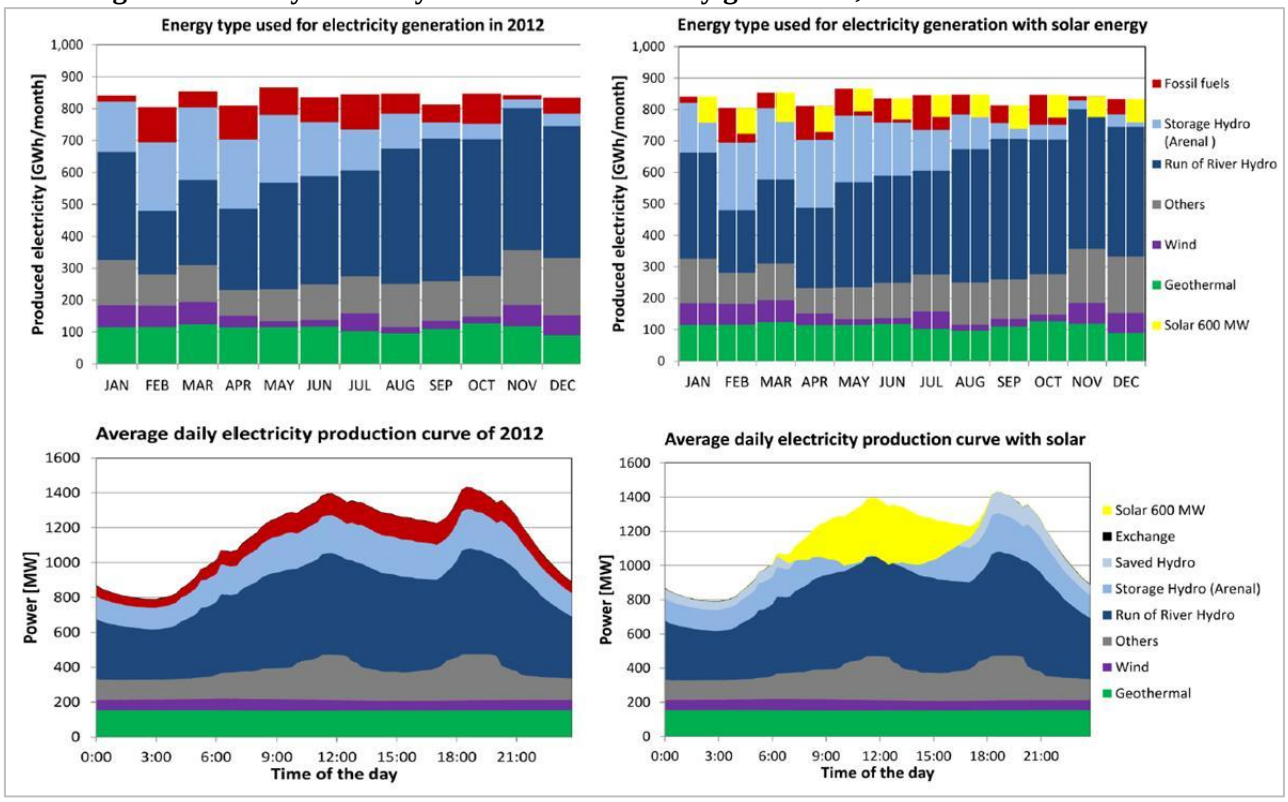
Furthermore, the country has suitable irradiation conditions, twice as high as those in Germany, and an average cost of the solar technology (between 7.8 and 9.1 US dollars cents per kWh for small and medium scale applications) is cost competitive compared with conventional infrastructures (Weigl, 2014). In addition, solar energy produce benefits for the overall energy system using the technology to substitute all electricity produced from fossil fuels for peak demand periods in a carbon neutral scenario. One interviewee inferred that solar energy is "a significant alternative to substitute the use of bunker in Costa Rica, the cheapest option among fossil fuels but also the one that contaminates most", to supply the current and upcoming electricity demand (Interview, 3P, 2014).

The use of solar energy alone to reach carbon neutrality in 2021 would be unrealistic.[176] However, the contribution of wind energy, biomass, and other hybrid systems could also make the goal achievable. In addition, since solar energy cannot be turned on and off as it is possible with the use of fossil fuels, the country has hydroelectricity produced at the Arenal dam to fulfill the electricity needed during peak demand periods. The study from Weigl (2014) modelled this substitution of fossil fuels by solar energy and the balancing task of hydroelectricity on a yearly and daily basis. His results are illustrated in Figure 11.

[176] Though, 150 MW installed capacity per year will create more than 1 GW of solar installations by the year 2021. This will represent 10 % of the estimated electricity demand in 2021, instead of using fossil fuels, for more details see Weigl (2014).

The solar energy example shows that it would be technically possible to move away from the large dams and the fossil fuels era sooner than projected. Even without the Diquís HP, the water reservoir of the Arenal complex (i.e. Arenal, Corobicí and Sandillal) would be an effective counterpart for solar electricity. In cases of higher requirements, other hydroelectric plants (e.g. Cachí, Pirris and Angostura) could easily cover daily demand fluctuations, including the possibility of the Reventazón HP since 2016 covering extra demands.

Figure 11. Yearly and daily scenarios of electricity generation, 2012 and 2021



Source: Weigl (2014)

Although the level of uncertainty is elevated, statements from the ICE's planning departments suggest that hydroelectricity vulnerability might be an element of path breaking in the future. Climate change (or global warming) is an exogenous factor that will complicate hydroelectricity generation, eventually reversing efficiency mechanisms of scale economies and reliable electricity effects from these installations. To some extent, these antagonistic trends bring into question the effectiveness of the ICE's recommended plan based on the expansion of larger hydroelectric projects.

Alternative renewable sources, like solar energy, have been growing faster, driven by profits motivations of private investors encouraged by rules and norms that trigger coordination effects. In addition, the escalating reactions take place when investors benefit from solar energy and biomass opportunities domestically, supported by global industry developments that reduce technology costs and improve efficiency. These effects are substantiated on the advantages of

scale economies at a global industry level. Together, coordination effects at a domestic level and scale economies at a global industry level, account for investors' decisions.

9.4.2 Path Breaking Elements from Political Power Mechanisms

Community enabling drivers operate by changing the power game in decisions between technologies. Communities, affected by hydroelectric projects, are gaining political power through the law or the international support from different actors. This situation hinders further installations of state- or private-owned technology. Drivers of community empowerment are linked to legitimation mechanisms that reverse the self-reinforcement of dams.

Political power relations confront two main actor constellations. On the one hand, state and private investors, the Energy Planning Sector and politicians (i.e. decision makers). On the other hand, local communities allied with civil society organizations and international networks that oppose such developments (i.e. secondary actors, directly and indirectly, influencing decisions).

Aside from hydroelectric projects withdrawn or delayed in the past (e.g. the well-known Boruca HP, Los Gemelos HP, Pacuare HP), another group of projects had been left stranded with pending legal issues, including the Diquís HP and another 10 private projects, out of 60 under analysis, that raised concerns in different communities (Interview 2J, 2013). Two of them prompted a moratorium declaration to new hydroelectric projects from local councils (i.e. Perez Zeledón and Buenos Aires Municipal Councils).

In the case of the Diquís HP, opposing groups, besides local community associations, included indigenous and environmental organizations, eco-lodges, civil society from nearby communities and university students who raised concerns over social and environmental risks on the region's rivers.[177] Meanwhile, powerful groups, with interest on the Diquís dam, are mainly the ICE and the Energy Planning Sector, as well as politicians and some global environmental organizations.

In spite of political power differences, indigenous organizations have voiced concerns over the Diquís HP, at international organizations and national legal instances, which forced the ICE to slow down the project's continuation. The visit of the United Nations Special Rapporteur on the Situation of Human Rights and Fundamental Freedoms of Indigenous Peoples, in 2011, drew attention on the weaknesses of deliberation processes in the Diquís HP development.[178] Nonetheless, community empowerment, against hydroelectricity, was not only channeled through international support and enacted regulations.

[177] "Comunidades de la zona sur conformarán bloque de oposición a proyectos hidroeléctricos", crhoy.com, 22.10.2013.
[178] "Relator de la ONU llama la atención por situación de pueblos indígenas", Semanarion Universidad, 08.06.2011.

The convergence between socio-environmental organizations and communities' claims noted by Cartagena (2010) were reinforced, in the early 2010s, as they reached other local participation instances. For instance, through networking with other national and international organizations or reaching decision-making agents at municipalities. Through regular meetings, such as the Meeting of Communities Threatened by Hydroelectric Projects in the Southern Region, held in 2013, communities exchanged information and joined efforts to oppose the construction of several hydroelectric plants in the region.

In the case of communities, affected by the Díquis HP, they argue that the energy generated from the HP would not remain in the national territory but rather be sold to the regional market through SIEPAC.[179] In the case of the smaller RORs, the projects raised local concerns on the threats to water supply for the communal drinking water aqueducts (i.e. ASADAS), agriculture, cattle, wildlife conservation and rural community tourism, while creating uncertain benefits. Furthermore, as noted by the FECON, an environmentalist organization:

> "These projects will add 71 MW, but because they are run-of-the-river and have small reservoirs, their production is expected to decrease during the dry season. Consequently they do not solve the underlying problem, which is to reduce oil electricity generation produced during summer". (Alvarez, 2013, p. 2).

A common denominator, among those discontent with the HP, is a top down imposition of projects without prior consultation to local communities (i.e. indigenous and non-indigenous) and the lack of integrated watershed management. At the heart of the conflict, there is a structural distributive aspect "in defense of the public, and against private acquisition" and a legitimation dispute concerning the communication of national and local welfare. Those conflictual processes are a potential source of path breaking.

On the one hand, community empowerment operates as a counterbalance to the empowerment of private and state investors, and the vested interest they created. Over time, this opposition constituted a serious obstacle for the ICE and private developers given difficulties to find adequate sites for new hydroelectric installations. Therefore, from the investors' perspective, these problems increase the (environmental and social) cost of electricity generating installations.

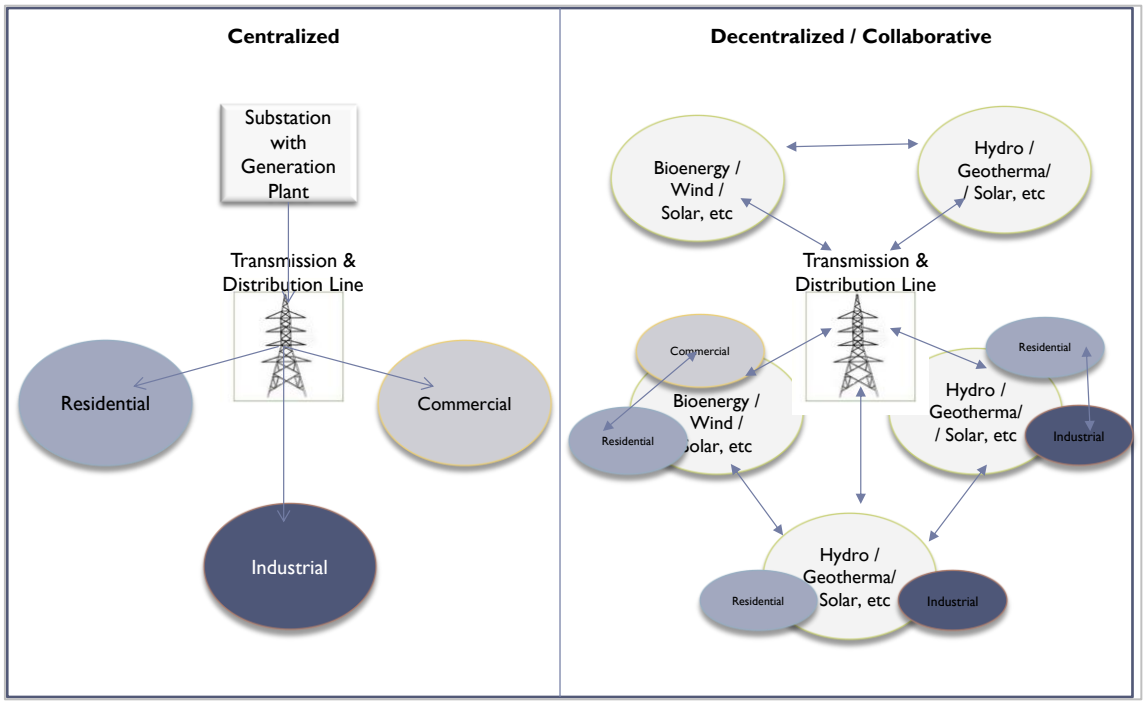
On the other hand, liberalization reforms, in the electricity sector, produced another unintended side effect over community empowerment that results from an emphasis on decentralization of services. First, liberalization reforms increased the number of actors and the level of regulation.

[179] "Encuentro de comunidades amenazadas por represas en la Zona Sur", FECON, 26.09.2013.

Secondly, efficiency gains and low prices enabled the proliferation of distributed or decentralized applications from alternative renewable sources.

Although the organization of the electricity sector, in Costa Rica, remained highly centralized and regulated, altogether institutional and market transformations triggered diversification of actors and electricity generation sources. Among experts, more decentralized or distributed energy systems started to be considered the headland of a new emerging paradigm for renewable energies such as solar PV. Figure 12 illustrates the differences between centralized and decentralized energy systems.

Figure 12. Schematic view of centralized vs. distributed electricity generation



Source: Own compilation based on interviews

The main differences between centralized and decentralized electricity generation are in terms of infrastructure (i.e. production, storage, transformation and distribution), but also in terms of actors and governance structures. National and sub-national energy infrastructure used to be built around a central converter (aka power plant) and grid networks would distribute the generated electricity to end-consumers. Meanwhile, decentralized systems enhanced the reliance towards distributed generation that involved local and small-scale providers including actors with multiple and simultaneous roles as producers and energy consumers (Goldtahou, 2014).

However, this paradigm is contested by established centralized distribution companies. In Costa Rica, the introduction of the Distributed Electricity Generation (DEG) pilot project best illustrates the tensions between past and future electricity configurations (i.e. technologies and institutions). The plan established the expansion of DEG to other regions, but this mandate has

not echoed responses from other distribution companies. On the contrary, interviewees at the ICE expressed reservations concerning distributed generation, seenas a disruptor of their core business.

Meanwhile, in favor of distributed generation were private producers and their associations (i.e. UCCAEP, ACOPE), solar energy advocates (e.g. ACESOLAR) and international cooperation (i.e. GIZ), who consider that the changing paradigm "is a tendency that distribution companies cannot stop" (Suntrace interview, 2014). In interviews held with experts from the electricity sector, they also consider decentralized generation, or DEG, is likely to be the framework for Costa Rica's energy systems in the future.

As outlined by a Costa Rican expert: "decentralized units or nodes will be able to produce their own electricity by using local sources through on-site technologies". Combined with energy efficiency practices and storage capacity to manage peak load demands, these decentralized units could be integrated with other nodes (and scales) to exchange electricity among them (Interview 1F, 2013). Moreover, even the transport sector will change this paradigm:

> "Mobility will be more efficient since some productive activities and other services would be integrated within the nodes, hence distances are reduced and the use of electricity in transport is possible, while the quality of life is improved." (Interview 1F, 2013).

In summary, managerial aspects of the changing electricity paradigm, together with social discontent, and increasing demands of political participation from different actors, create further challenges to the preeminence of the existing model. Community empowerment, together with communication problems of local welfare and efficiency difficulties, can potentially disrupt the outsets of a powerful actor constellation, who could reconsider or renegotiate commitments towards hydroelectricity in future policies.

9.4.3 Path Breaking from Legitimation Mechanisms

Social acceptance evolves with social norms (formal and customary) recognized by society, who also can turn them down. In the national energy system, clashes between norms, such as the national mandate for the provision of electricity in the country and the autonomy of indigenous territories, or the status of natural protected areas, have been important factors generating mobilizations against the Boruca and the Diquís dams. These contradictions are another element for the dissolution of the hydroelectric path dependency.

The institutional mandate's belief to provide reliable electricity to the nation is still strong within the ICE. The legitimation of this norm, beyond simple profit motivations, explains the

position of the ICE to rebut the prohibition of electricity projects in some territories. The main limitations are laid down by the National Parks Law 6084 (1977), the General Environmental Law 7554 (1995) and the National Indigenous Law 6172 (1977) that restrict activities in natural protected areas and indigenous territories.

In the Electricity Expansion Plan (2014-2034), the ICE has identified that approximately 25 % of the national hydroelectric potential of 6500 MW is being exploited, while 780 MW or 16 % from the remaining potential is actually located in natural protected areas (ICE, 2014). According to the National Parks Law and the General Environmental Law, other commercial activities besides tourism are excluded from these protected areas. Another 25 % of the potential would directly or indirectly affect indigenous territories, protected by the National Indigenous Law where these interventions in the environment meet heavy resistance (ICE, 2014).

Therefore, the actual potential that the ICE identified for further electricity production is reduced at 2300 MW (ICE, 2014). The route of expansion recommended by the ICE and the Energy Planning Sector in a carbon neutrality scenario based on the Reventazón HP (292 MW) and the Diquís HP (650 MW), would already use almost half of these available potentials (Interviews 2D; Interviews 4C, 2013). Hence, Costa Rica's hydroelectricity availability is actually becoming constrained.

Compared to the Boruca HP, the social and environmental effects of the larger Diquís HP are downsized; this might reduce social mobilization against it, though, a number of illegalities still remain present. The declaration of public interest and national convenience for the Diquís dam project was questioned in the media upon pending Environmental Impacts Assessment proceedings.[180] Additionally, 10% of the project affects indigenous territories where the lack of consultation has violated jurisprudence from the Inter-American Court of Human Rights and the American Convention ratified by Costa Rica in 1970. Furthermore, this also contradicts several articles of the National Indigenous Law 6172 (1977).[181]

At the moment of writing this research, none of these aspects have been resolved and consequently, the Diquís HP is at a standstill until the consultation process, with affected populations, is carried out.[182] The incoming government will have to assume the responsibility regarding the project's future. The assessment of the carbon neutrality scenario is also fundamental for this resolution and so are the choices to be made.

[180] "El Diquís, frente a la jurisprudencia de la Corte IDH", La Nación, 01.11.2012.
[181] "Ilegalidades del Proyecto Hidroeléctrico Diquís", La Nación, 14.07.2011.; "El Diquís, frente a la jurisprudencia de la Corte IDH", La Nación, 01.11.2012.
[182] "Proyecto eléctrico Diquís cumple tres años varado", LA Nación, 29.04.2014. Since the visit of the indigenous speaker James Araya, in 2011, who made suggestions on the issue.

In the case of alternative renewable energy, geothermal energy has more social acceptance among sources. In the interviews carried out, geothermal energy was ranked first among politicians, interviewees and the media (Interview 3E; Interview 3H; Interview 1J; Interview 2J, 2013). Geothermal energy is also number one among Planning Departments at the ICE. The technology is regarded as equivalent to hydroelectricity in terms of reliable electricity effects (i.e. providing firm and stable electricity) with the advantage that it is not disturbed by changing weather patterns.

Nonetheless, geothermal energy capacity is limited since the sites with the highest potential are located in volcanic areas that are under some category of natural conservation (ICE, 2014). According to the Electricity Expansion Plan (2014-2034), 76% of the high enthalpy theoretical potential is being exploited already. Therefore, it is expected that low enthalpy geothermal exploitations and investments outside natural protected areas will be accelerated (Interviews 2D; 4C, 2013).

The country's interest to develop geothermal energy is high; likewise, among private investors. State and private investors have promoted different bill proposals to change the law and allow, either high enthalpy geothermal exploitations by the ICE inside natural parks, or low enthalpy exploitations by private companies outside natural parks. In this regard, interests of state and private investors coincide.[183]

Natural protected areas, on the other hand, also have high legitimation in the Costa Rican society. Natural parks and conservation areas are iconic in the national conservation history and continue being relevant in the economic development paradigm based on tourism revenues and carbon neutrality aims (i.e. legitimation based on the communication of national welfare). This limitation is acknowledged by the ICE, as indicated in the expansion plan: "The feasibility to develop the 330 MW new geothermal projects, before 2028, is diminished if there is no agreement concerning the resource inside national parks" (ICE, 2014, p. 91).

Meanwhile, solar energy, wind parks and biomass stations have currently no constraints of this type. First, they are at initial stages of their potential capacity, particularly solar energy. Second, they are not bounded to be produced in natural protected areas. Third, none of them have faced resistance with local communities.

To sum up, whether restriction to electricity generating installations, of any kind, is allowed or not in natural protected areas or indigenous territories is still a matter of debate that involves not only efficiency, but also legitimation aspects. If clashes between norms continue, it is more

[183] "PAC y Libertarios replantean posición sobre energía geotérmica", Semanario Universidad, 10.06.2015.

likely that projects, like the Diquís dam, and geothermal developments will continue to be stranded. Hence, the solution is a matter of deliberation among different society groups, an aspect that highly relies on power relations.

9.5 Concluding Remarks

The integrated analysis of findings regards path dependency in the Costa Rican electricity sector to systemic mechanisms from the perspective of efficiency, political power and legitimation frameworks. At the actors' level, main interactions are between powerful state players, private investors and grass-root organizations, which directly or indirectly sway decisions. Their influence on energy policies have been at different phases with changing emphasis and a great deal of interweaving.

Historically, state empowerment during the 'developmental state era' favored the ICE's autonomy and good reputation from politicians and the general public. Therefore, from this period, the Institute emerged as a new political actor. After liberalization reforms, the actor constellations changed and new renewable energy sources were incorporated to the national energy mix. In spite of inherent contradictions, the institutional arrangements established in the electricity sector tend to emphasize their cooperative interrelation.

Concerning the mechanisms' results causing path dependency on hydroelectricity, they are mostly driven by reliable electricity effects, the empowerment of private actors and the communication of national welfare. To some extent, the same factors that reproduce the preeminence of hydroelectricity installations, restrain alternative renewable energy use. In particular, solar energy illustrates very well how alternative energy sources were reduced to a subsidiary role in the national energy system.

Interest, on alternative renewable sources, exists within the ICE, but this could be separated into two different logics. On the one hand, the ICE has an interest in alternative renewable sources that is directed to the function of dams to the system. On the other hand, the Institute also considers that private investors have much interest in solar energy and biomass electric plants.

Additionally, the present study found that systemic efficiency accounts based on drivers of global climate change effects, effects, and reliable electricity effects are closely interlinked. From the perspective of the ICE, the Energy Planning Sector and the politicians who have the political power to implement institutional changes, these decision logics are predominant. References to global climate change effects alluded more to efficiency mechanisms rather than to its legitimation. Conversely, drivers of national welfare effects reinforce hydroelectricity

because it increases competitiveness, energy efficiency and lowers electricity bills, but the logics of this mechanism appears more as a powerful legitimation argument.

Alternative renewable sources, including RORs, wind parks and solar energy, are considered highly un-reliable and lacking storage capacity by powerful state actors. Regarding fossil fuel sources, although the natural gas scenario has gained acceptance among politicians and part of the Energy Planning sector, its advantages are questioned inside planning departments at the ICE and by other experts.

About the forces reversing path dependency, the elements of path breaking challenging the preeminence of hydroelectricity are triggered by community empowerment, problems in the communication of local welfares, and the negative effects from exogenous climatic shocks. Although the uncertainty level is high in the case of external shocks, results of technical studies in this field are congruent with the statements from the planning departments at the ICE. Both suggest that changing weather patterns, although contingent and perhaps cyclical, are seriously challenging the hydroelectric path.

Political power relations have shown tensions between hydroelectricity project developers and socio-environmental impacts on local communities. In this sense, social discontent and increasing demands of political participation are combined with the challenges of the changing paradigm towards decentralized energy systems. On the other hand, hydroelectricity remained a legitimate source to satisfy growing electricity demands and reduce poverty from the perspective of the ICE, the Energy Planning Sector, politicians and powerful international organizations.

Nevertheless, community empowerment, together with additional problems from legitimation, at a local level, can potentially transform powerful actors' viewpoint who could reconsider or renegotiate their commitment towards hydroelectricity in future policies. Since the 1990s, hydroelectricity legitimation suffered more intensively what path dependency theory outlines as (degenerating) side effects from decisions. In this sense, the communication of local welfares started reversing. To some extent, these antagonistic trends question the effectiveness of the ICE's recommended plan based on the expansion of larger hydroelectric projects.

Finally, the restriction to electricity generating installations, of any kind, in natural protected areas or indigenous territories is still a matter for debate that involves efficiency, political power and legitimation elements. If clashes between norms (i.e. natural conservation, indigenous rights and electricity provision) continue, it's more likely that projects like the Diquís dam and geothermal developments will continue stranded. Therefore, the solution lies in the deliberation among different society groups, an aspect that also shall highly depend on power relations.

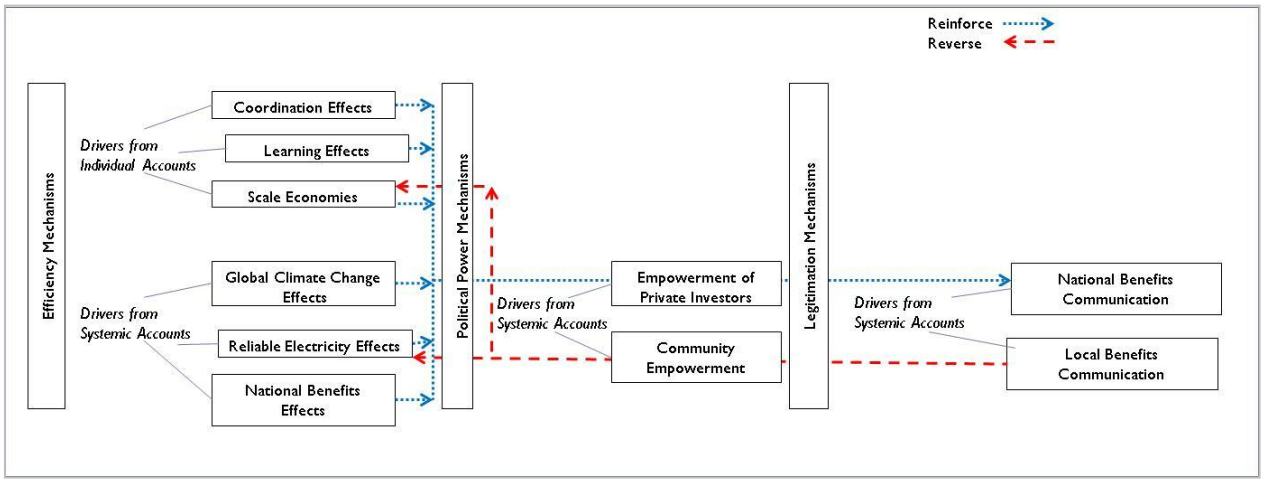
10 Conclusions

10.1 Main Research Results

Why did Costa Rica choose limited utilization of alternative renewable sources, above all solar energy, to achieve the goal of carbon neutrality by the year 2021, while in an existing context of declining hydroelectricity contribution, the use of conventional energy sources gain relevance in future scenarios? To answer these questions I conducted an analysis of three types of mechanisms (i.e. efficiency, political power and legitimation) influencing decision makers' choices among main renewable electricity generation sources (i.e. hydroelectricity, wind parks, geothermal energy, solar energy and biomass stations) and analyzed them, over different periods of time, which led me to the following conclusion:

Costa Rica's energy system developed a path dependency, in the electricity sector, that reinforces hydroelectricity development through decisions, which are beyond individual cost-benefit assessments made by long-standing sector institutions. As a result, the country engaged in long-term investment strategies prioritizing the well-tried hydroelectric path to achieve carbon neutrality and 100% renewable energy by the year 2021. The same factors, which reproduce the preeminence of hydroelectricity, restrain the subsequent ability of the national energy system to further implement policies incorporating solar energy and other alternative renewable sources.

Figure 13. Mechanisms and drivers reinforcing or reversing the hydroelectric path



Source: Own compilation

The choice of technologies, in the country, is largely influenced by centralized decisions made in the past and reinforced, over time, by politicians, the Costa Rican Electricity Institute (ICE) and private regulatory entities. I identified eleven driving forces to explain technological and institutional developments in Costa Rica's energy system, which evolved from the three

mechanisms of efficiency, political power and legitimation on the basis of Sydow and Schreyögg's, (2013), Hall and Taylor's (1996) and Mahoney's (2000) formulation of self-reinforcing mechanisms. On the one hand, eight of them produce path dependency reinforcing the hydroelectricity path, while on the other hand, there are three drivers of path breaking by which patterns marked by path dependency might be reversed. Figure 13 captures these dynamics.

The path under analysis emerges from the intersection of technological and institutional trajectories in Costa Rica's energy system (see Chapter 5). On a technological level, this path dependency explains the continued reproduction, though possibly at slower rates, of hydroelectricity investments (i.e. a stabilization stage). This technological trajectory is not only based on investment decisions, but also on institutional, political or personal interests. There is a clear pattern that path dependency on hydroelectricity renders decisions, on alternative renewable technologies, difficult to incorporate.

On the institutional level, the path is notably due to the impact of the ICE and the peculiar mixed electricity regulatory sector in the country. They provided the material and ideological foundations for the consolidation of the national hydroelectricity-based energy model, with limited dissemination of alternative renewable sources. Institutions, in the electricity sector, evolved along with Costa Rica's geographic and environmental history, urged by the creation of natural protected areas in the country.

In fact, from the study of past events (1950-1989), I distinguished a first observation period, initiated by a critical juncture in the national electricity sector, given by the creation of the ICE (1949), which occurred during the welfare state era. During this interval, electrification was expanded in the country and opportunities for hydroelectricity developments (planning and construction of large dams) flourished under public actors, in particular the ICE. This timespan also set the bases for the Costa Rican "Green Republic", bringing about a compatibility between the economic growth model and progressive environmental conservation policies. At the end of this period, solar energy was at experimental stages, geothermal energy generation was being explored and preliminary studies of wind parks were conducted.

A second time frame, during the 1990s, seeks transformation preceded by the Law to promote private electricity generation and subsequent reforms (1995). This period brought a certain degree of diversification of energy sources, as well as the incorporation of private energy producers thanks to legal liberalization reforms. These, in turn, produced tensions between public and private interests with repercussions on future developments.

A third time period identifies more recent developments, following climate change commitments and the country´s carbon neutrality initiative (2007) to be achieved by 2021. Each interval triggered new arrangements between actors in the electricity sector, but also latent conflicting processes, in terms of public-private relations (i.e. state, private actors and community based organizations). Figure 4 provides a general overview of technological and institutional patterns of Costa Rica's energy system in different time frames.

During the 2000s, Costa Rica's transition towards carbon neutrality and its reliance on hydroelectricity illustrated, more clearly, the tensions between past and future electricity configurations. Technologically, climate change (or global warming) became an exogenous factor that challenged the use for hydroelectricity, while a new paradigm of distributed electricity generation defied the model of centralized energy distribution from established companies. Institutionally, conflicts due to established norms and regulations became apparent, such as the ICE's national mandate for the provision of electricity in the country vis-à-vis reforms promoting private initiatives in electricity generation, the respect of the autonomy of indigenous territories (guaranteed by international treaties ratified by Costa Rica), and the status of natural protected areas.

When comparing actors' decisions over time, it became evident that there are some patterns in the selection of electricity projects. These patterns or routines initiated in the past, remained ever-present in current decisions, and are also reflected in the energy plans beyond 2021. Among the self-reinforcing mechanisms, producing path dependency on hydroelectricity in Costa Rica's energy system, are systemic and individual efficiency accounts enhanced by drivers of political power and legitimation mechanisms.

Systemic efficiency accounts, include global climate change effects, reliable electricity effects and national welfare effects. All three systemic efficiency accounts are interlinked and considered important the country's renewable energy system decision-making. Those drivers are also associated to individual cost-benefit assessments, in the selection of projects by public and private investors, which include coordination effects, learning effects and economies of scale.

Among systemic efficiency mechanisms, promoters of reliable electricity prevail in decisions, i.e. powerful public entities such as the ICE, ever since the early stages of the national electricity sector during the 'developmental state era' (1950-1989). Those drivers provide arguments for the inertia of large hydroelectric projects and fossil-fueled plants as back-ups. Within this logic, efficiencies, resulting from continuously supplying electricity to customers, produce increasing gains to the national energy system, including low operation costs and attractive pricing through long-term agreements. Other technical characteristics, at individual

level, such as load factor and scale economies, make hydroelectricity and its fossil fuel back-up systemically reliable.

Promoters of reliable electricity from different energy sources have been closely related to drivers of national welfare effects, since the beginning of electrification, through the impulses of economic growth. Furthermore, when climate change commitments gained relevance, in the national political agenda during the 1990s and also after the announcement of carbon neutrality, the Energy Planning Sector discussed global climate change with a focus on potential efficiency effects on national mitigation and adaptation strategies.

More recently (2010-2014), when comparing the different technologies powerful state decision-makers from the energy planning sector, including - besides the ICE - the Ministry of Environment, politicians and regulatory bodies consider dams or hydroelectric reservoirs to be the best providers of electricity storage systems to guaranty reliable electricity supply. Furthermore, the electricity expansion plan (2014 – 2034) recommends the incorporation of two large hydroelectric plants, the Reventazón HP (292 MW) and the Diquís HP (650 MW), to begin operation in 2016 and 2025, respectively. The plan also elaborates on the projections regarding possible scenarios of natural gas starting as early as 2025. According to the ICE's planning departments, and given its national mandate to provide electricity, the alternative of exploiting conventional and nonconventional fossil fuel resources should not be disregarded.

Meanwhile, the aspect of reliability precisely limits the progress of alternative renewable sources. Except for geothermal energy, which is considered steadfast by the energy planning sector, the potential of alternative renewable sources with high variability (e.g. wind energy and run-of-the river stations) is underrepresented within this plan. While an alternative scenario considers their progressive incorporation, it also points out to their main drawbacks in terms of high variability and the lack of storage capacity. Therefore, they are limited by technical preventive measures that, in the case of solar energy, restrain the advance of installations to no more than 5 MW of installed capacity.

Also from the perspective of political power and legitimation frameworks, Costa Rica's energy system developed elements of path dependency. Hydroelectricity installations progressed and were considerably reinforced by both frameworks. Two drivers from these mechanisms, causing path dependency, are the empowerment of private actors and the communication of national welfare, derived from political power and legitimation mechanisms, respectively. They evolved from interactions between main decision-makers and secondary actors influencing decisions, such as worker unions (especially before 1990), civil society organizations and other private associations, international actors and local municipal councils, more recently. Table 8 provides

a general overview of the constellation of actors involved, their interests and systemic mechanisms, driving their decisions, in different time periods.

As to political power relations, the empowerment of private actors in Costa Rica's energy system followed the same energy pattern in the selection of technologies, as did the ICE and the Energy Planning Sector, at previous stages. Although private electricity producers lead investments in alternative renewable sources, like wind energy and biomass stations, initially their choices favored the predominance of smaller hydroelectricity projects. Nonetheless, private investors are seen by other actors (i.e. the ICE, regulatory bodies and other private organizations) as institutional entrepreneurs who propel solar energy developments and biomass electricity stations.

Since liberalization reforms, the empowerment of private investors was facilitated by existing environmental and market regulations. This process created vested interests in the electricity sector where the state apparatus was used by political and private business interests during the last two governments (2006-2010 and 2010-2014), to promote an electricity agenda of private investment in renewable energy. This agenda foresaw the expansion of hydroelectricity projects, disregarding environmental aspects and problems with local communities, which became evident in bill proposals promoted during these administrations.

Concerning legitimation, the national welfare aspect also plays a key role in the path dependency of hydroelectric dams, particularly within powerful state actors, like the ICE, and its national mandate to provide electricity. Concepts of economic development, solidarity and social welfare are rooted in the ICE's history and continue present in its organizational values. During the political campaign, in 2013, this was reasserted by the Energy Planning Sector, the ICE, and political parties in support of the Diquís Dam project.

Contrary to expectations, legitimation concerning actions against global climate change was not relevant in the decision-making process among energy promoters, and while global climate change was constantly present in communications from the Ministry and politicians, it had no impact on the choice of projects. Similarly, the electricity expansion plan (2014-2034), while acknowledging the vulnerability to climate change of the national renewable hydro-based energy model, does not reflect this in its recommendations.

In the case of alternative renewable sources, neither legitimation of actions against global climate change has prompted any deviation from the hydroelectric pathway, nor have national or local entities. During the 1990s, the ICE's decisions to initiate developments of wind parks and geothermal projects were supported by the institute's belief that it was the right thing to do to complement hydroelectricity.

Energy promoters' preferences tend to rank hydroelectricity or geothermal energy highest, while for the energy planning sector, the criterion is mainly one of systemic efficiency, thus ranking wind and solar energy last because of load factor considerations (i.e. they are considered highly variable and lacking storage capacity). The preferences of politicians and environmentalist organizations were not so different from those of the energy planning sector. Although in the case of environmentalists, global climate change plays a significant role in their selection.

Politicians place dams as a priority, but delays in projects, caused by social resistance position geothermal stations as the second best option. State and private investors have shown interest in geothermal energy as well, inside or outside natural protected areas. Therefore, elements of political power and legitimation mechanisms are also at stake influencing preferences.

Precisely, the aspects of institutional change, which I describe as elements of path breaking, emerge from intrinsic conflicting political power relations and legitimation problems. Among the self-reinforcing mechanisms producing path breaking are community empowerment and local welfare communication of electricity projects. Contingently, another exogenous element of path breaking is the outcome of climatic variability effects increasing hydroelectricity vulnerability (i.e. reliable electricity effects).

Legitimation mechanisms, interrupting hydroelectricity reproduction, are centered on the contradictions between the ICE's institutional mandate for the provision of electricity and decreed laws that constraint electricity developments in indigenous territories and natural protected areas. For instance, the most sensitive aspect of the Diquís hydroelectric dam is the lack of consultation with indigenous groups, given affectation on their territories. Claims of the ICE, the Energy Planning Sector and politicians, who defend the project, would have a stronger resonance on final decisions if the effect on indigenous territories is excluded.

The institutional mandate's belief to provide reliable electricity to the nation is still strong within the ICE. The legitimation of this norm, beyond simple profit motivations or efficiency claims, explains the ICE's position to rebut the prohibition of electricity projects in some territories. The main limitations are laid down by the National Parks Law 6084 (1977), the General Environmental Law 7554 (1995) and the National Indigenous Law 6172 (1977) that restrict activities in natural protected areas and indigenous territories.

In the Electricity Expansion Plan (2014-2034), the ICE has identified that approximately 25% of the national hydroelectric potential is being exploited, while 16% of the remaining potential is actually located in natural protected areas, and another 25% of the potential would directly or indirectly affect indigenous territories. The remaining potential has faced some problems of social acceptance as well. Social clashes were evidenced, in 2000, when a reform proposal,

named the “ICE Combo”, aimed to change the structure of the sector and loosen projects’ legal restrictions.

Geothermal energy capacity is also limited, since the sites with higher potential, are located in the volcanic areas that are under some category of natural conservation. According to the ICE, 76% of the high enthalpy theoretical potential is being exploited already. Therefore, it is expected that low enthalpy geothermal exploitations and investments, outside natural protected areas, will be fast-tracked. Private investors, supported by different associations, have been promoting a group of bill proposals to change the law and allow either high enthalpy geothermal exploitations by the ICE, inside natural parks, or low enthalpy exploitations, by private companies, outside natural parks.

Natural protected areas, on the other hand, also have high legitimation in the Costa Rican society. Natural parks and conservation areas are iconic in the national conservation history and continue to be relevant in the economic development paradigm based on tourism revenues and carbon neutrality goals (i.e. legitimation based on the communication of national welfare). This is acknowledged by the ICE, who considers that the feasibility to develop new geothermal projects, before 2028, is lessened if there is no agreement concerning future resource exploitation inside national parks.

Nonetheless, legitimacy problems are not limited to dams, neither to indigenous territories and natural protected areas. Several smaller run-to the river stations, outside protected areas, raised criticism from environmental entities, organized communities, indigenous groups and global networks. Most of these hydroelectricity projects were contemplated, under Law 7200 (1990, 1995), which allowed limited participation of private generation plants.

At the same time, within the ICE itself, there are some contradictions between organizational values. Earlier institutional emphasis, on economic and social development, has been shifting towards efficiency goals of economic competitiveness. In this context, being “profitable” became part of the Institute’s values. Likewise, the ICE adapted to the rules of the game in competition with private investors, nationally and internationally, to invest domestically as well as abroad through the Central American Electricity Market.

Path breaking elements, from political power relations, confront two main actor constellations. On the one hand, state and private investors, the Energy Planning Sector and politicians (i.e. decision makers), on the other hand, local communities allied with civil society organizations and international networks that oppose such developments (i.e. secondary actors directly and indirectly influencing decisions).

A general political disenchantment has manifested itself in the electricity scene. Several hydroelectric projects are associated to vulnerable livelihoods, inequitable access to water resources and a lack of participation from local communities. Besides hydroelectric projects withdrawn or delayed in the past (e.g. the well-known Boruca HP, the Los Gemelos HP, the Pacuare HP), another group of projects are stranded with pending legal issues, including the Diquís HP and another 10 private projects, out of 60 under analysis, that raised concerns in different communities. Two of them prompted a moratorium declaration to new hydroelectric projects by local councils (i.e. Perez Zeledón and Buenos Aires municipal councils).

In spite of political power differences, indigenous organizations have voiced concerns over the Diquís HP, at legal instances, forcing the ICE to slow down the project's continuation, especially after the visit of the United Nations Special Rapporteur on the Situation of Human Rights and Fundamental Freedoms of Indigenous Peoples in 2011. According to the U.N. Special Rapporteur, deliberation processes have been weak in the Diquís HP development.

A common denominator of discontent is a top down imposition of projects without consultation with local communities (i.e. indigenous and non-indigenous) and a lack of integrated watershed management. At the heart of the conflict, there is also a structural distributive aspect described, in short, as "in defense of the public, and against private acquisition" (Raventós 2012) and a legitimation dispute concerning the communication of local and national welfare. Community enablement operates as a counterbalance of private and state investors' empowerment, which in the past, joined forces in decision-making. Over time, this opposition constituted a serious obstacle for the ICE and private developers given the difficulties to find adequate sites for new hydroelectric installations. From the investors' perspective, these problems increased the (environmental and social) cost of electricity installations. Therefore, these processes also produced an effect on efficiency mechanisms as well, reversing drivers of scale economies and reliable electricity effects to some extent.

For alternative renewable energy sources, such as solar energy, this open situation is unlocking the hydroelectric path. Besides political power and legitimation problems, efficiency advantages to these sources have also emerged from the adverse effects undergone by hydroelectricity. Considering climatic hydroelectricity vulnerability, the level of uncertainty is high. The ICE's planning departments suggest that these antagonistic trends bring into question the effectiveness of the suggested plan based on the expansion of larger hydroelectric projects.

Instead, the Energy Planning Sector estimates that solar (and marine) energy will have more relevance around 2030. Private investors and other civil society organizations claim that, currently, solar energy is technologically feasible and economically profitable in the country and technical studies supported by the Solar Energy Association in Costa Rica (Acesolar)

demonstrate that, in terms of irradiation conditions and an average cost (i.e. ranging between 7.8 and 9.1 US dollars cents per kWh for small and medium scale applications), solar energy plants are considered to be cost competitive compared with conventional infrastructures.

Furthermore, solar energy also has systemic advantages, providing benefits for the overall energy system. The technology can be used for peak demand periods in a carbon neutral scenario. According to estimations, solar energy could substitute all electricity produced from fossil fuels and reduce hydroelectricity vulnerability, including surges in the electricity demand by the year 2021.

In addition, solar energy, wind parks and biomass stations have more possibilities for expansion. Not only because they are at initial stages of their potential capacity, particularly solar energy, but also because they are not bounded to be produced in natural protected areas or indigenous territories. Neither have they faced problems with local communities. However, preferences among sources rank solar and wind energy third or fourth after on-grid biomass.

10.2 Theoretical and Policy Implications

This research sought to understand the need for an integrated approach to the analysis of energy transitions towards low carbon and renewable energy goals, as proposed by Pachauri and Spreng (2012). Through the combination of theoretical approaches of path dependency and institutional entrepreneurs, together with elements of governance, at a national and global level, I was able to reveal significant aspects of Costa Rica's energy system development, stabilization and change, which have been less explored in the academic literature. The research findings also include theoretical and policy implications.

Five theoretical implications are highlighted from the analysis. First, the concept of path dependency and path breaking show that Costa Rica's energy transition towards carbon neutrality, in 2021, and its reliance on hydroelectricity illustrates tensions between past and future electricity configurations. In this context, this thesis confirms Stirling's (2014) claim that understanding possible 'sustainable energy' transformations require attention towards many thorny issues in social theory related with agency and structure, as well as the interplay of power, contingency, and practice.

Decisions between technologies, in the Costa Rican electricity sector and features of rigidity or decay found, in specific cases, were explained by distinguishing three types of mechanisms (i.e. efficiency, political power and legitimation mechanisms) and comparing how they unfolded over time from the perspective of different actors. The thesis also elaborated on the different

drivers that emerge from each framework, distinguishing antagonistic trends as well as elements of institutional change (see Chapters 6, 7, and 8).

Second, this thesis further developed the concept of self-reinforcing mechanisms, in particular for the operation of different forms of mechanisms derived from efficiency, political power and legitimation accounts. The historical approach of path dependency emphasizes the importance of initial decisions and choices of venues. In the case of Costa Rica, this thesis found that the progressive logic of self-reinforcing mechanisms can explain a policy gap in the national energy system towards carbon neutrality, leading to a stage of path dependency on dams and fossil-fueled plants as back-up.

The development of a path dependency in Costa Rica's energy system and the elements of path breaking, on the basis of the three self-reinforcing mechanisms, confirmed the proposition to explain path dependency from Mahoney (2000; 2006). According to his claim, specific mechanisms, besides utilitarian logics (i.e. efficiency), can explain path dependency with application on political science cases. He introduces functional systemic aspects, political power and legitimation explanations.

Following this framework, the present research operationalizes both concepts of legitimation and political power, in a way, that they were useful to seize drivers linked to values and power relations that otherwise are difficult to grasp. Chapter 2 developed the theoretical approach and defined the main concepts, such as those of self-reinforcing mechanisms, as well as notions of efficiency, political power and legitimation. In the case of Costa Rica, for instance, there are clashes between norms that implicate solutions based on deliberation among different groups of the society, an aspect that depends on power relations as well.

In that regard, a third theoretical implication shows that "change actors" or institutional entrepreneurs can shape institutions through strategic behavior, but they are also constrained by existing institutions, social norms and power relations, as has been argued by neoinstitutionalists. Findings, in this thesis, question the claim by Sydow et al., (2009) that power structure is part of context conditions or contextual factors that enhance or hinder the unfolding self-reinforcing mechanisms, but are not equated to them.

In the case of Costa Rica's political power, accounts also developed patterns in actors' decision that became apparent in the strategies of the energy planning sector and in the strategic behavior of institutional entrepreneurs, such as the ICE, private investors associations or civil society organizations. Although, there are no strong political elites in the country that benefit from existing institutions, powerful actors' decisions respond to particular dynamics of reproduction that accounted for the empowerment of private actors, on the one hand, and community

empowerment on the other. In this way, this thesis introduces power relations into the analysis of a path dependency outcome in Costa Rica.

Fourth, the research, hereby, confirms that global norms are interpreted and adapted to a specific context by actors' interests and values, which are not fixed, but some of them have enduring consequences that are difficult to change. In this sense, some values that are considered universal are interpreted differently by diverse actors. Global climate change, for instance, is considered the main factor driving decisions on energy transformation in the last two decades.

Based on my analyses, for the case of Costa Rica, I found that climate change discourses certainly drive energy choices that favor the prioritization of dams (see Chapter 9). An in- depth analysis of the mechanisms behind actors' decisions evidenced that the motivation of the energy planning sector is mostly concerning climate change consequences over reliable electricity effects, rather than legitimation of actions against global climate change itself; conversely, global climate change is widely accepted among environmental organizations.

Fifth, this thesis provides evidence of the increasing fragmentation in the emerging renewable energy governance field and investigates decision-making processes in the electricity sector of a variety of actors and among different renewable energy sources. In terms of renewable energy sources, they evolve from the only consideration of hydroelectricity dams towards a broader fragmentation that include distributed electricity generation sources, such as solar energy systems (small and medium size, on- and off-grid). In terms of actor constellations, the spectrum of actors involved in electricity decisions changed with liberalization reforms, in the sector, during the 1990s. By the end of the period, three constellations of actors can be distinguished: decision makers (i.e. state and private investors, the Energy Planning Sector and politicians); secondary actors directly influencing decisions (i.e. civil society organizations, public and private associations, the media and international organizations); and secondary actors indirectly influencing energy decisions (i.e. local communities and the general public as well as their international networks).

The policy implications from the present research are directly connected to the relevance of timing for policy-making in Costa Rica towards achieving carbon neutrality in 2021. In this pathway, the country's challenges are framed in the arena of energy decisions that are based on elements of efficiency, political power and legitimacy shaping technological and institutional trajectories. Therefore, sound policy advice is derived from the entanglements that are beyond single models, evidencing the causes of inertia and the opportunities for change.

When asked why there was no significant support for solar energy, in the past, and why there has recently been an increasing interest in the technology to be translated into policies transforming the national energy system, efficiency arguments hold an important part of the answer. In particular, the systemic aspects of the technology reliable electricity effects are of central motivations restraining the technology's use.

In the last years, installed capacities of solar energy have been growing faster, in part, urged by profit motivations of private investors. The current study found that the individual choices of private investors are motivated by rules and norms that trigger coordination effects from market regulations, but also by the new paradigm of distributed electricity generation. Nonetheless, their penetration is still limited.

Although technology prices and cost play a role in individual accounts of investors, they have limited weight in policy decisions. Decisions by powerful actors that are tipping the balance towards alternative renewable sources, through systemic accounts, have more relevance. These actors include the energy planning sector, at a national level, and also the influence of global participants from the energy industry to which political power and legitimacy resources also play a role. Similar conclusions can be drawn from the case of other alternative renewable energy sources, such as wind turbines, whose installations have been growing since the 1990s, but that remain limited in decisions towards carbon neutrality.

All these contributions to theory and policy confirm the benefits of applying within-case analysis by means of a mechanism-centered approach. Hypotheses and theory are used to elaborate a theory-guided analysis of causal mechanisms and the specification of how they operate in the case. Distinctly, I found that most mechanisms from efficiency, political power and legitimation worked as expected when applied to the Costa Rican case.

Although generalization was not the objective, it is possible that some systematic parts of the mechanisms could "travel", but not the case-specific conglomerate. Researchers, in the field, could also judge the findings of the particular case interesting in relation to similar puzzles affecting other countries in Latin America or other regions. However, this research leaves "the identification of universal or quite general problems" (Rueschmeyer, 2003: 330) for further research.

The problem of equifinality (i.e. many alternative causal paths for the same outcome) is known. This was the case in the current research since the outcome from efficiency mechanism is complemented by political power and legitimation accounts in order to explain the case. Therefore, the consistency of path dependency explanations is reduced because its central figure is self-reinforcing sequences of the same mechanism. Then again, such a result was compatible

with the eclectic use of theories from historical institutionalists who combine the 'calculus approach' and the 'cultural approach' to explain how institutions affect behavior and why institutions persist over time (Hall and Taylor, 1996).

Lastly, this study is also mindful of the difficulties in assigning causality in single case designs because of the limitations of the analysis and the underlying assumptions. Those limitations are not resolved, however causality is not a particular weakness of this research and it is also shared by quantitative works (Rueschmeyer, 2003). Furthermore, an ongoing debate among scholars on mechanisms reveal differences between path dependency and causal mechanisms, since studying contingent events is not generalizable to causal factors. Nevertheless, path dependency is a potentially important strand in the overall project of historical-sociological investigation.

10.3 Implications for Future Research

Future research can tie into further questions and findings from this thesis and contribute to academic literature on energy transition towards low carbon energy systems, in small states, on several points. First, future in depth analysis, in other cases, with similar ambitions of energy transformation might be relevant to approach low carbon energy aims, from an integrated perspective, suited to furnishing sound policy advice. The approach used, in this thesis, can help to identify possible causes of status or change from different perspectives that can be grouped into efficiency, political power and legitimation. In addition, policy implementation can be improved, drawing from different experiences, through international or South-South cooperation projects and partnerships.

Second, it might also be interesting to extract comparative analyses (i.e. most similar or most dissimilar research design) once comparative puzzling cases are found. This might allow obtaining inferences to a wider population of cases, as well as for theory development. In particular, it might be of interest to analyze whether self-reinforcing mechanisms operate similar to the case of Costa Rica or as expected by theory.

For example, in relation to the relevant role of systemic efficiency mechanisms, in the Costa Rican case, it would be pertinent to see whether these accounts have less weight in countries with a market regime in electricity production. Similarly, it would be appealing then, to see how aspects of legitimation and political power are incorporated in such regimes. For instance, it is intriguing whether there are differences with respect to aspects of legitimation concerning actions against global climate change from the perspective of other "small states".

Third, in the particular case of Costa Rica, the present study encourages further research and attention to trends and tendencies on environmental and social vulnerability for future sustainable strategies. On the one hand, the antagonistic trend affecting hydroelectricity, the

main renewable energy source of the country, brings into question the effectiveness of the recommended plan of the ICE towards 2021 based on the expansion of larger hydroelectric projects like Reventazón and Diquís, as well as several smaller hydroelectric plants. In the future, a potential reduction from hydroelectricity in national energy projections would make it difficult to achieve carbon neutrality by the year 2021.

In this scenario, the role of alternative renewable sources is and becomes relevant, but also attention to non-conventional fossil fuels like natural gas, as it was evidenced in the competing projections contrasted in the ICE's electricity expansion plan (2014-2034). Concerning alternative renewable sources, it might be interesting to explore the implications for the institutional regulatory framework and future energy plans of distributed electricity generation, speeding the growth of (non-generic) alternative renewable sources. Although the organization of the electricity sector in Costa Rica remained highly centralized and regulated, among experts, more decentralized or distributed energy systems start to be considered the headland of a new emerging paradigm for renewable energies such as solar photovoltaic.

In relation to fossil fuels, recent attention to prospects of fossil fuels, over the last few years, has received low public enthusiasm concerning the carbon neutrality goal in Costa Rica. Furthermore, the promise of a "carbon neutral nation" became unlikely since the energy planning sector and politicians started to promote natural gas prospects during 2013. Besides environmental concerns and legitimation problems associated with electricity generation from natural gas, this scenario also has several drawbacks from an efficiency view point.

Experts and officials at planning departments refer to the lower consumption of natural gas in Latin America in comparison to Asia. For this reason, the national refinery (i.e. RECOPE) has to enter in a deal for natural gas prospects in Costa Rica to start an industry for electricity generation and initiate its penetration at larger scales. Moreover, as long as the natural gas resource is imported, as in the case of conventional fossil fuels, the country remains vulnerable to price fluctuations or supply limits.

The current research left the study of the natural gas projections and its implications to future investigation. Nonetheless, an important remark on future trends is derived from the awareness of natural gas prospects. The analyses of the expansion routes (2014-2034) compare the hydroelectricity based-route with one route that incorporates generic alternative renewable sources, and another one that introduces natural gas projections. In their analyses, neither the projected electricity demand, nor the estimated present cost (i.e. including environmental criteria) between the different routes is varying considerably. Consequently, the aspects that might influence decisions for future scenarios, in the energy transition towards carbon neutrality, are in the end more political rather than just technical.

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Law No. 8660. *Strengthening and Modernization of the Public Entities of the Telecommunications Sector* (Ley de Fortalecimiento y Modernización de las Entidades Públicas del Sector Telecomunicaciones). Year: 2008

Renewable Energy Law (Erneuerbare-Energien-Gesetz, EEG). Year: 2000, 2004, 2009, 2012, 2014

Law proposals

File No.16949. Ley Marco de Concesión de Aguas para la Generación de Energía Hidroeléctrica. Year: 2008

File No. 17666. Ley General de Electricidad. Year: 2009

File No. 17812. Ley General de Electricidad. Year: 2010

File No. 18093. Ley de Contingencia Eléctrica. Year: 2011

Interviews

Aldo Sebianne. Current Institution: Chief Wind Plant Valle Central - National Company of Energy and Lighting (CNFL)

Alexandra Arias. Current Institution: Coordinator Distributed Electricity Generation Program – the Costa Rican Electricity Institute (ICE)

Álvaro Ugalde. Current Institution: Environmentalist. Past: Co-Founder - National Conservation Areas System (SINAC)

Bernhardt Johst. Current Institution: Advisor in Energy Efficiency and CIM expert - Industry Chamber of Costa Rica (CICR)

Boris Westphal. Current Institution: Managing Director - Suntrace, Hamburg

Carlos Meza. Current Institution: Coordinator SESLab - UCR, ITCR; President of the Costa Rican Solar Energy Association (ACESOLAR)

Carolina Hernández. Current Institution: Engineer Biomass Energy - Costa Rican Electricity Institute (ICE)

Cindy Torres. Current Institution: Electrochemical and Chemical Energy Center – University of Costa Rica (UCR)

Dunia Porras. Current Institution: Member of Plenum Commission - National Environmental Technical Secretariat (SETENA)

Eddie Sánchez. Current Institution: Director Geothermal Resources - Costa Rican Electricity Institute (ICE)

Enrique Morales. Current Institution: Civil Engineer, Managing Director Central America and the Caribbean - Juwi

Fabio Chaves. Current Institution: Coordinator – ICE Workers Union

Fernando Molina. Current Institution: Center of Geothermal Resource Service - Costa Rican Electricity Institute (ICE)

Gabriel Rivas-Ducca. Current Institution: Environmentalist - Coecoceiba

Gilberto de la Cruz. Current Institution: Director of the National Center of Electricity Planning - Costa Rican Electricity Institute (ICE)

Gloria Villa de la Portilla. Current Institution: Director - Energy Sector Directorate (DSE)

Greivin Mayorga. Current Institution: Civil Engineer, Faculty of Civil Engineering - Universidad de Costa Rica (UCR)

Guillermo Monge. Current Institution: General Director - Public Service Regulation Authority (ARESEP)

Marco Vinicio. Current Institution: Electricity Services Department - Public Service Regulation Authority (ARESEP)

Mario Alvarado. Current Institution: Executive Director - Costa Rican Association of Private energy Producers (ACOPE)

Irene Cañas. Current Institution: Coordinator - 4R Program

Jan Borchgrevink. Current Institution: President Nordteco - Nordica de Tecnología & Comercio S.A.

Jorge Blanco. Current Institution: General Manager Cointica Ltda.; Member of the Costa Rican Solar Energy Association (ACESOLAR) and the Costa Rica-Germany Commerce and Industry Chamber (AHK Costa Rica)

José A. Aragón. Current Institution: Director Generation Technologies - Costa Rican Electricity Institute (ICE)

José María Blanco. Current Institution: Regional Director – BUN-CA Energy Network Foundation

José María Ureña. Current Institution: Manager - Energías Ureña

José María Villalta. Current Institution: Deputy and presidential candidate - Frente Amplio Party

Katja Frick. Current Institution: Consultant - Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ); President of the Costa Rican Solar Energy Association (ASESOLAR)

Leiner Vargas. Current Institution: Academic Researcher - International Center for Economic Policies of Sustainable Development (CINPE- UNA)

Leonardo Merino. Current Institution: Research Coordinator – State of the Nation Program (PEN)

Luis Rodolfo Ajún. Current Institution: Director Solar Energy Projects - Costa Rican Electricity Institute (ICE)

Marielos Alfaro. Current Institution: Deputy - Liberty Movement Party (ML)

Mauricio Álvarez. Current Institution: President - Costa Rican Ecology Federation (FECON)

Mauro Arias. Current Institution: Solar Energy Park Miravalles - Costa Rican Electricity Institute (ICE)

Mercedes Agüero. Current Institution: Journalist - Grupo Nación S.A.

Miguel Hernández. Current Institution: Economic Engineering Area - Costa Rican Electricity Institute (ICE)

Misael Mora. Current Institution: Director - Rural Electrification Program (REP)

Pablo Hernán Corredor. Current Institution: Consultant and System Operator - Colombia

Ricardo Garro. Current Institution: Business Developer Central America and the Caribbean - Juwi

Roberto Jiménez. Current Institution: Director Environmental Planning - Costa Rican Electricity Institute (ICE)

Rodrigo Ledezma. Current Institution: Project Manager - Grupo Marshall & Associates

Rolando Madriz. Current Institution: Solar Energy Laboratory – National University of Costa Rica (UNA), member of the Costa Rican Solar Energy Association (ACESOLAR)

Ronald Jiménez. Current Institution: President CODISA Software Corp; President Costa Rican Association of Large Energy Consumers (ACOGRACE) and member of the Board of Directors of the Costa Rican Union of Private Enterprise Chambers and Associations (UCCAEP)

Shyam S. Nandwani. Current Institution: Retired professor – National University of Costa Rica (UNA)

Teófilo de la Torre. Current Institution: Executive President - Costa Rican Electricity Institute (ICE)

Thomas Fees. Current Institution: Manager Inti-Tech Solar Energy Systems

Vanessa Castro. Current Institution: Chief Department Project Engineering - National Company of Energy and Lighting (CNFL)

Newspapers

La Nación

21.05.2000. “ICE retoma Boruca” La Nación

21.07.2000. “La Angostura prende máquinas”

30.07.2000. “ICE al vaivén de los políticos”

01.08.2000. “Energía privada cuesta cara”

06.08.2000. “Diversidad en costos de energía”

31.08.2000. “Impugnan tarifas de generadores”

04.06.2002. “ICE en lío por anular contrato”

20.03.2006. “Aresep valora modificar tarifas”

20.03.2006. “ICE perdería oportunidad de comprar energía a precio bajo”

24.10.2006. “Pacífica marcha contra TLC”

11.12.2007. “ICE garantiza servicio de plantas térmicas rentadas”

11.12.2007. “ICE garantiza servicio de plantas térmicas rentadas”

21.12.2008. “El Diquís sustituye el gran proyecto Boruca”

29.01.2010. “Atraso en obras obliga al ICE a comprar plantas a Grupo Pujol”

14.02.2010. “Litigio por expropiaciones frena y encarece hidroeléctrica Toro III”

14.07.2011. “El Diquís, frente a la jurisprudencia de la Corte IDH”

01.11.2012. “Ilegalidades del Proyecto Hidroeléctrico Diquís”

08.08.2013. “Nueva Ley de Aguas: urgencia nacional”

23.10.2013. “Gobierno desiste de plan para apertura de mercado eléctrico”

29.04.2014. “Proyecto eléctrico Diquís cumple tres años varado”

18.05.2014. “País completará en julio red para intercambio regional de luz”

25.07.2014. “Luis Guillermo Solís extiende moratoria a explotación petrolera hasta el 2021”

10.08.2014. “Sala IV se trae abajo proyecto de ley sobre protección del agua”

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27.02.2007. “Majestuosa manifestación contra el TLC” ANEP

28.02.2007. “Marcha contra el TLC evidenció aislamiento del gobierno” Siempre Verde

16.02.2009. “Gobierno y privados quieren afianzar estafa de electricidad privada” FECON

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19.04.2010. “FIT-ICE contra proyecto ley de electricidad de los Arias”, ANEPtv

29.09.2010. “Empresarios meten presión a proyecto de electricidad de los Arias” Semanario Universidad

08.06.2011. “Relator de la ONU llama la atención por situación de pueblos indígenas” Semanarion Universidad

28.03.2012 “Ambientalistas temen que 28 proyectos hidroeléctricos acaben con cuenca del río San Carlos” Semanario Universidad

08.08.12. “Sectores ven como una provocación del Gobierno convocatoria de ley de electricidad” Semanario Universidad

10.10.2012. “Referéndum sobre el TLC potenció la participación ciudadana” Noticias UCR

27.06.2013. “What is fracking and why is it controversial?” BBC News

16.01.2013. “Energía geotérmica en Costa Rica” Energías renovadas

22.10.2013. “Comunidades de la zona sur conformarán bloque de oposición a proyectos hidroeléctricos” Crhoy.com,

01.03.2014. “Bolivia Wants Nuclear Energy, But Brazil and Other Latin American Countries are Abandoning It”, International Business Times.

10.10.2014. “Ticos exigen $26 millones a Stone Container”. El Financiero

10.10.2014. “Ticos exigen $26 millones a Stone Container”, El Financiero.

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10.06.2015. “PAC y Libertarios replantean posición sobre energía geotérmica”, Semanario Universidad

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Breve descripción de la FECON. (2007, February 5). Retrieved October, 2013, from http://www.feconcr.org/index.php?option=com_content&task=view&id=12&Itemid=30

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Encuentro de comunidades amenazadas por represas en la Zona Sur (2013, September 26). Retrieved December, 2013, from http://www.feconcr.org/index.php?option=com_content&task=view&id=2256

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Pago de Servicios Ambientales. (2014). Retrieved November, 2014, from http://www.fonafifo.go.cr/psa/index.html

Plan for Economies of Scope. (November 1983). Retrieved January, 2015, from https://hbr.org/1983/11/plan-for-economies-of-scope

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12 Annex

12.1 Abstract in German and English

Zusammenfassung

Auf der UN-Klimakonferenz auf Bali im Jahr 2007, war Costa Rica das erste Teilnehmerland, das sich zur Erreichung der Klimaneutralität bis zum Jahr 2021 verpflichtete. Die Klärung der Forschungsfrage, warum sich Costa Rica für eine beschränkte Nutzung von alternativen erneuerbaren Energiequellen entschied und statt dessen den Bau größerer Wasserkraftwerke bevorzugt sowie die zukünftige Nutzung von Erdgas in Aussicht stellt, gibt Aufschluss über Entscheidungsprozesse zur Energiewende hin zu kohlenstoffarmen und erneuerbaren Energiesystemen.

Neben dem politischen Interesse den Fall Costa Rica selbst zu verstehen und angesichts der dortigen Dringlichkeit von Entscheidungen in dem Politikbereich, sind Staaten auf der ganzen Welt mit ähnlichen energiepolitischen Zielstellungen konfrontiert. Das Konzept der Pfadabhängigkeit wurde vielfach als Analyserahmen genutzt, um technologische Veränderungsprozesse zu verstehen. Innerhalb der Debatte zur Energiewende, beschäftigt sich nur weniger bekannte Literatur mit historischen Analysen, der im Zeitablauf entstandenen Bedingungen und Muster des Politikfeldes. Die Doktorarbeit analysiert die Mechanismen, die energiepolitische Entscheidungen für die Ziele Klimaneutralität und die Umstellung der Energieversorgung auf einhundert Prozent erneuerbare Energien in Costa Rica gelenkt haben. Insbesondere wird auf Aspekte der Effizienz, der politischen Macht und der Legitimationsmechanismen eingegangen, die aus der Perspektive unterschiedlicher Akteure und innerhalb unterschiedlicher Zeiträume analysiert werden (vor 1990, von 1990 bis 2014 und bis 2021). Im Rahmen einer qualitativen Einzelfallstudie werden Methoden der Institutionenanalyse und Process-Tracing angewandt. Die Instrumente zur Datenerhebung beinhalteten Interviews, teilnehmende Beobachtungen und Dokumentenanalyse.

Die Forschungsergebnisse deuten darauf hin, dass Pfadabhängigkeit bei energiepolitischen Entscheidungen in Costa Rica eine Rolle spielt. Die historische Analyse deckt die Existenz von systematischen selbstverstärkenden Mechanismen innerhalb der Entscheidungsprozesse beteiligter Akteure auf, die eine Priorisierung von Wasserkraftwerken bewirken. Die treibenden Faktoren, die diesen Pfad verstärkten und den Ausbau alternativer erneuerbaren Energien verhinderten, waren auf der Ebene der politischen Entscheidungsträger: a) Effekte des globalen Klimawandels, b) Effizienz der Stromversorgungssicherheit, c) gesamtgesellschaftlicher Nutzen; auf der Ebene der Investoren: d) Koordinierungseffekte, e) Lerneffekte, f) Größenvorteile. Die Mechanismen wurden auf beiden Ebenen verstärkt durch g) das Erstarken

von privatwirtschaftlichen Akteuren und h) das Werben mit dem gesamtgesellschaftlichen Nutzen in der Bevölkerung. Unterdessen wurden gegensätzliche Kräfte gefunden in Bezug auf 1) die Unsicherheit hinsichtlich externer klimatischer Schocks, 2) das Erstarken der Zivilgesellschaft und 3) fehlende Legitimation auf lokaler Ebene. Diese Mechanismen könnten die Reproduktion des Wasserkraftpfads umkehren und möglicherweise einen neuen Pfad alternativer erneuerbarer Energiequellen schaffen.

Abstract

During the Bali United Nations' Climate Change Conference, in December 2007, Costa Rica became the first nation declaring carbon neutrality to be achieved by the year 2021. By exploring why Costa Rica chose a limited utilization of alternative renewable sources, whereas giving priority to new larger hydroelectric projects and natural gas prospects in future scenarios, I intend to shed light, in this research, on the decision-making processes in energy transition towards low carbon and renewable energy systems.

Leaving aside political interests to comprehend the case in itself and the relevance of timing for policy decisions, countries all over the world face similar energy-related goals. The notion of path dependency has been widely used, as a framework, to understand technological trajectories. However, within energy transition debates, less-known literature deals with historical analyses of conditions and patterns unfolding over time. This thesis analyzes the mechanisms driving decisions regarding energy options, in Costa Rica, towards carbon neutral and 100% renewable energy goals, through the combination of path dependency and governance approaches. Specifically, I account for aspects of efficiency, political power and legitimation mechanisms, analyzed from different actors' viewpoints and in different time periods (before 1990, from 1990 to 2014 and towards 2021). As a qualitative within-case analysis, I rely on methods of institutional analysis and process tracing. The information compilation instruments included interviews, participatory observations and document analyses.

My research indicates that, in Costa Rica, path dependency plays a role in energy decisions. The historical analysis detected the presence of systemic self-reinforcing mechanisms in actors' choices that upholds the preeminence of dams over time. In this regard, at systemic levels, the drivers that reinforced this path and, limit the progress of alternative renewable sources in policy decisions, were: a) global climate change effects, b) reliable electricity effects and c) national welfare effects; at investors' individual level, decision drivers were: d) coordination effects, e) learning effects and f) scale economies. Those drivers, at both levels, were also enhanced by g) the empowerment of private actors, and h) the communication of national welfare. Meanwhile, contradicting forces were found in 1) the uncertainty in decisions from external climatic shocks, 2) community empowerment, and 3) communication of local welfare. These mechanisms might reverse the reproduction of the hydroelectric course, possibly creating a new path for alternative renewable sources.

12.2 List of Publications Related to this Dissertation

Potencial y limitaciones de la economía verde. Ambientico No. 222, Artículo 2, Pp. 10-13, 2012

With Hein, Wolfgang and Holstenkamp, Lars. Gobernanza global y evolución de las energías renovables en el sur: Objetivos políticos y estructuras de gobernanza. Letras Verdes 4, 8, 12-14, 2011

Costa Rica: una agenda ambiental más allá de carbono neutro. Iberoamericana 38, p.169-172, 2010

12.3 Interviewees Data

Annex Table 1. Interviews to the planning sector

Type of actor	Interview	Period[184]				Type of project and energy source					
		I Phase	**II Phase**	**III Phase**	**IV Phase**	SOL	WIN	GEO	HYD	BIO	MIX
Planning sector	Interview 3H Date and Place: 06.08.13 San José.		√	√	√						√
	Interview 4E Date and Place: 07.08.13 San José.		√	√	√						√
	Interview 4L Data and place: 08.08.13 San José.			√	√						√
	Interview 5E Date and Place: 02.10. San José.		√	√	√						√
	Interview 2F Date and Place: 04.10.13 San José.			√	√						√
	Interview 3F Date and Place: 03.10.13 San José.			√	√						√
	Interview 3C Date and Place: 17.10.13 San José.			√	√						√
	Interview 3H Date and Place: 14.01.15 San José.				√						√

[184] Phase I starts from 1950-1979, Phase II from 1980-1999, Phase III from 2000-2014 and Phase IV towards Carbon Neutrality in 2021.

Annex Table 2. Interviews to project developers (public)

Type of actor	Interview	Period				Type of project and energy source					
		I Phase	**II Phase**	**III Phase**	**IV Phase**	SOL	WIN	GEO	HYD	BIO	MIX
Project developer (public)	Interview 4C Date and Place: 12.08.13 San José.		√	√	√			√			
	Interview 2D Date and Place: 29.08.13 Guanacaste	√	√	√	√			√			
	Interview 5D Date and Place: 08.10.13 San José.		√	√	√		√				
	Interview 1Q Date and Place: 03.10.13 San José.		√	√	√	√					
	Interview 1P Date and Place: 27.08.2013 San José			√	√		√				
	Interview 5H Date and place: 06.08.13 San José.			√	√	√					
	Interview 3J Date and place: 30.08.13 Guanacaste.			√	√	√					
	Interview 2A Date and Place: 01.10.13 San José.			√	√						√
	Interview 1B Date and Place: 16.10.13 Cartago.			√	√					√	
	Interview 5Q Date and Place: 12.08.13 San José.		√	√	√						

Annex Table 3. Interviews to project developers (private)

Type of actor	Interview	Period				Type of project and energy source					
		I Phase	**II Phase**	**III Phase**	**IV Phase**	SOL	WIN	GEO	HYD	BIO	MIX
Project developer (private)	Interview 5M Date and Place: 27.09. San José.		√	√	√		√		√		
	Interview 1G Date and Place: 22.10.13 San José.		√	√	√	√	√				
	Interview 2H Date and Place: 13.09.13 San José.		√	√	√	√			√		
	Interview 5N Date and place: 23.08.13 Alajuela.		√	√	√	√					
	Interview 3L Date and Place: 01.10.13 San José.			√	√	√	√				
	Interview 5I Date and Place: 01.10.13 San José.		√	√		√			√		
	Interview 3P Date and Place: 28.08.14 Germany.			√	√	√					

Annex Table 4. Interviews to experts

Type of actor	Interview	Period				Type of project and energy source					
		I Phase	II Phase	III Phase	IV Phase	SOL	WIN	GEO	HYD	BIO	MIX
Expert (related industrial clusters: agri-business, electronic)	Interview 1F Date and place: 09.08.13 San José.		√	√	√						√
	Interview 3A Date and Place: 22.08.13 Heredia.	√	√	√	√						
	Interview 3N Date and place: 05.08.13 Heredia.	√	√	√	√	√					
	Interview 4H Date and Place: 26.08.13 San José.		√	√	√						
	Interview 2L Date and place: 05.09.13 San José.			√	√						√
	Interview 3H Date and Place: 05.09.13 San José.		√	√	√						√
	Interview 5B Date and Place: 20.09.13 Skype Italy.		√	√	√	√					
	Interview 1M Data and Place: 20.09.13 Berlin.			√	√	√					
	Interview 2C Date and Place: 07.10.2013 San			√	√	√	√		√	√	

Annex Table 5. Interviews to politicians, organizations/associations, clusters, and media

Type of actor	Interview	Period				Type of project and energy source					
		I Phase	**II Phase**	**III Phase**	**IV Phase**	**SOL**	**WIN**	**GEO**	**HYD**	**BIO**	**MIX**
Politicians	Interview 4N Date and Place: 04.09.13 San José.	√	√	√	√	√					√
	Interview 1J Date and Place: 01.10.13 San José.			√	√	√		√	√		
	Interview 1I Date and Place: 23.10.13			√	√						√
Organizations / Associations (Environmental, Producers/Users Association, Chamber/Union, International Cooperation)	Interview 4G Date and Place: 21.08.13 San José.		√	√	√						√
	Interview 1D Date and Place: 07.10.2013 San José.		√	√	√						√
	Interview 4H Date and Place: 19.09.13 San José.		√	√	√						√
	Interview 3E Date and Place: 26.09.13 San José.		√	√	√	1st	2nd	4th	5th	3rd	√
	Interview 2J Date and Place: 08.10.13 San José.			√	√						√
	Interview 5G Date and Place: 15.10.13 San José.			√	√	√		√			√
	Interview 4A Date and Place: 27.09.13 San José.			√	√	√		√			√
	Interview 2I Date and Place: 27.09.13 San José.			√	√	√					
Related clusters (industrial clusters: electronic)	Interview 2M Date and Place: 16.09.13 San José.		√	√	√						
The media	Interview 4Q Date and Place: 20.09.13 San José.		√	√	√						

12.4 List of Events for Participatory Observation

Annex Table 6. Forums and seminars attended

Event	Panelists	Resume
Forum: National Forum on Clean Energy "Jorge Manuel Dengo". San José, 02.09.2013. Organizer: presidential candidate Johnny Araya, political party (PLN)	Dr.Pablo Hernán Corredor (Consultant, Colombia); Dr. Jorge Blanco (planning sector CR); Ing. Salvador Lopez (ICE); Ing. Civil Mario Alvarado (ACOPE); Dr.Christian Nicolai Orellana (Consultant, Chile); Dr. Carlos Srek (Consultant Argentina); Dr.Juan Carlos Villa (Consultant Mexico); Ing.Rolando Araya Monge (Consultant, CR); Ing.José Bernardo Sandoval (Consultant, CR); Ing. Julio Calvo (Expert, TEC); Dr.Leiner Vargas (Expert UNA/PLN); Ing.Johnny Araya (Candidate PLN)	L: Competitiveness, equity & poverty P: Politicians, ICE, MINAE, ACOPE and experts (mainly engineers) E: PLN SXXI electricity price and reduce oil use F: Low demand produces a surplus, then less oil is needed. Renewable energies like solar and wind power need (technical) regulation Renewable energies: the present is the Diquís Dam & natural gas prospections, the future is solar energy.
Seminar: 1st Seminar on Development and Exploitation of Solar Photovoltaic Energy in Costa Rica. San José, 01.10.2013. Organizer: the Costa Rican Association of Private Energy Producers (ACOPE)	Ing. Mario Alvrarado (ACOPE); Student MSc. Toni Weigl (ACESOLAR); Ing. Ricardo Garro (Juwi); Ing. Hugo Pereira (3TIER); Msc. Alexandra Arias (ICE); Ing. Max Fernandez (4E Program GIZ); MSc. Gina Carvajal & Geilyn Aguilar (ARECA Project, CABEI); Raquel Salazar (BatallaLaw Firm); Ing. Mauricio Solano (Trama TecnoAmbiental); Adrián Bellavita (ENEL); Ing. Luis Ajún (ICE)	L: Ambiguous regulation P: Between public institute (Service Departments at the ICE) and private business (at utility and user level) E: Regulatory instruments, solar cost fall 45% last year, efficiency. Profitability: area (m2), resource (kWh/m2), consumption (kWh/m2), price ($/kWh) and technology ($/Wh) F: Substitute thermal production/day (100%=600MW=85MW per year) and complement Arenal dam- thermal back-up/night
Forum: 2nd Annual Forum on Prospects for LNG and Natural Gas in Central America. San José, 02.10.2013. Organizer: Institute of the Americas (IAS)	Jeremy M. Martin (Energy Program IAS); René Castro (Ministry of Environment, CR); Vicente Prescott (Energy Secretary, Panamá); Ariel Yepez (Senior Economist, WB); Ignasi Nieto-Magaldi (Consultant, IDB); Teófilo de la Torre (President, ICE); Ada Georgina Barrientos de Flores (Director Electricity Market, El Salvador); Gerardo Salgado (Director National Electricity Company, Honduras); Eduardo Cuevas (Manager, IFC-WB); Roberto Dobles (Director C-FELA)	L: Substitute oil, back-up for intermittent renewable energies P: Politicians, the ICE, Central American directors & banking sector (boom in North America). E: Emissions, benefits & price attractive, diversification F: The electricity sector is a catalyst in terms of scale, rather tan the transport sector which cannot do it in short term (CR electricity binary system: large hydro & oil)

12.5 Questionnaire for Interviews

General Introduction: Doctoral research project to investigate energy transformation processes in Costa Rica. Research interest: To study different energy pathways, important actors, and relevant decisions taken within the electricity trajectory of Costa Rica. To analyze changes in different phases: past (origins of the projects/sector), present (current situation or new projects) and have insights about future perspectives.

Section I Changing context (critical junctures)

1. According to your knowledge/experience, could you briefly describe the major or critical changes in the energy sector in the past 20/30 years? (open question)
    1.1. Which alternative technologies emerged or started being used?
    1.2. And which sources did not emerge? Why?

Section II Origins of project / business / sector

2. In the past, did your organization experienced decision situations in which different alternatives of renewable sources were evaluated or compared (also ask if there is any project related documentation)?
3. What was your professional/business position within the organization and what activities do you carry out during that period?

Section III Criteria or reasons for the selection of energy sources (mechanism in the past)

4. In such decision situation(s) in the past, what was the decision criterion about different alternative renewable sources/technologies?

(Power)

5. Were all the involved parts agreed (departments/members from your organization) on the decision? Or there were some struggles?
6. Who support/ally / confront or opposed (national groups/organizations/persons)?
7. Did your project/organization have any international links or mainly a domestic perspective?
8. Were such projects/alternative renewable sources considered relevant by any political party/politician/member of the cabinet? (power claim and legitimation claim)

(Efficiency)

9. Were financial aspects (cost and/or benefits, return, interest rate) decisive criteria?
10. Which national or/and international institutions financed your project/organization? Conditions?

11. From all the alternative renewable sources available in Costa Rica (e.g. geothermal, wind, biomass and solar) which technologies did you consider cheaper or more expensive?
12. What was the level of information from your organization about various options?

(Legitimation)

13. Did you believe some options (e.g. solar energy) have other particular advantages? What advantages? (legitimation claim)
14. Were you involved with other groups –also beyond your work- in actions that support the development of the technology you use? (legitimation claim)
15. What was the philosophy of your organization at that time? (open question)

(Functional)

16. Did you believe that the national energy system affronted a particular urgent risk? Why?
17. Did you base your decision/arguments in expectations of a growing energy demand? Why?
18. Did you base your decision/arguments in expectations of oil prices/peak/shocks or financial crisis? Why? (functional claim/efficiency claim)
19. Did you base your decision/arguments in terms of Climate Change? Why? Or any other environmental pressure? (functional claim/legitimation claim)

Section IV Criteria or reasons to change/maintain energy sources (present mechanism)

20. Would you agree with the affirmation that "nowadays there is a new boom of renewable energy sources"? Why? (open question)
21. Have your organization witnessed new decision situations in which different alternatives of renewable sources are evaluated or compared (also ask if there is any project related documentation)?
22. In such decision situation(s) in the past, what was the decision criterion about different alternative renewable sources/technologies?

(Power) (Efficiency) (Legitimation) (Functional)

Section V Towards carbon neutrality 2021 (future perspectives)

23. Can you mention government policies that support the technologies you use (e.g. law, incentive, program, etc)?
24. What do you think is the goal of the energy policy nowadays? Has this changed over time?
25. According to your knowledge and experience, which sources might lose importance or are considered without future in the national energy system towards CN 2021? Why? (open question).