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Demand side management in Costa Rica:

Exploring regulatory measures for its implementation

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Thesis for the fulfilment of the
Master of Science in Environmental Sciences, Policy & Management
Lund, Sweden, June 2011

MESPOM Programme:

Lund University – University of Manchester - University of the Aegean – Central European University

Erasmus Mundus Masters Course in
Environmental Sciences, Policy and Management

MESPOM

This thesis is submitted in fulfilment of the Master of Science degree awarded as a result of successful completion of the Erasmus Mundus Masters course in Environmental Sciences, Policy and Management (MESPOM) jointly operated by the University of the Aegean (Greece), Central European University (Hungary), Lund University (Sweden) and the University of Manchester (United Kingdom).

Supported by the European Commission's Erasmus Mundus Programme

Education and Culture

Erasmus Mundus

IIIEE Theses 2011:10

Published in 2011 by IIIEE, Lund University, P.O. Box 196, S-221 00 LUND, Sweden,
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ISSN 1401-9191

Acknowledgements

First of all, I want to express a big thanks to my diligent and sharp supervisor Lars Strupeit for being a critical readear, and for his insightful and detailed feedback. I am also thankful to Philip Peck for its valuable guidance in the key stages of my research process.

My sincere thanks to my all my informants in Costa Rica for its time, the knowledge shared, and for making this thesis process an interesting learning experience.

I express my complete gratitude to my family, especially to my parents for being always a shelter of peace and a constant of love and support in my life. Many sincere thanks to my little brother for his patient and for helping me to improve my English throughout this Masters, and to my older brother for stand by me in the important moments. Thanks to my Abuelitas for evoking me tenderness each time that I think about them, and my Tía Yulis for being like a second mom through all these years of study.

Last but not least, I thank my beautiful MESPOM friends for making of this programme such a memorable and unique experience!

A todos .... pura vida!

Abstract

A reliable electricity sector is imperative for the development and competitiveness of Costa Rica. During the last decade, electricity demand has been growing faster than the expansion of the power network, and the demand side efforts have been almost inexistent. Therefore, since 2007 the electricity sector of Costa Rica is in a vulnerable position. In fact, for 2014 energy shortages have been anticipated if no actions are taken. Within this context, DSM emerges as an alternative worth to explore to achieve a more efficient electricity consumption.

In light of that, this thesis identifies the potential advantages that DSM can bring to Costa Rica, and the barriers that are hampering its implementation in order to provide an outline of the policy actions that can be taken by policymakers to kick-start a DSM culture in Costa Rica. The analysis aims to start a discussion about why DSM can be an option for the country and how it could be implemented.

Overall, DSM can significantly contribute to improving the security and sustainability of Costa Rica electric sector in the long run. There are several alternatives and combinations for delineating a DSM scheme, and its final characteristics will be the result of a political negotiation process. DSM is a complex topic because to be effective it requires aligning the country, utilities, and consumers interests. Therefore, the most immediate action is to start raising awareness about the values of DSM to generate enough public support, and get funding to support the actions needed to develop a DSM culture in Costa Rica.

Keywords: Demand side management – energy savings – Costa Rica

Executive Summary

This research was performed under the premise that a secure and reliable electricity system is of paramount importance for the development and competitiveness of Costa Rica. Additionally, it recognises that Costa Rica is facing significant challenges to extend its power and generation capacity. As a consequence, it considers rational to explore DSM framework as an alternative that can help Costa Rica to be more efficient in its electricity consumption. This thesis aims to raise a discussion about why DSM can be an option for Costa Rica and how DSM could be implemented.

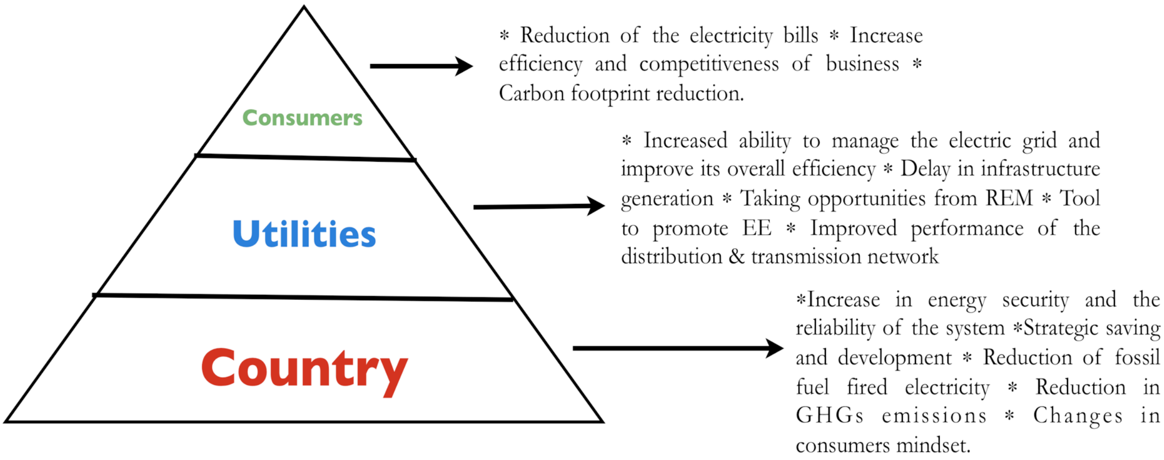
Costa Rica has developed a production model that has been auto-sufficient in electricity production, but externally dependent on petroleum and other fossil fuels (Martínez, 2010). For 2009, crude oil products represented 64% of the total commercial energy. After oil, electricity represented 22%, biomass 12%, and other energy products 2%. Costa Rica does not have proven oil or natural gas reservoirs. Moreover, it has to import 70% of the petroleum needed as final products, because it does not have the capacity to refine all the crude oil demanded (De la Torre 2010a).

Costa Rica fossil fuels dependency increases during the dry season, for the months from January to May 2010, the average percentage of electricity fired with fossil fuel was 12.4%. However, there are days with extreme cases when the percentage can go up to 30% (De la Cruz, 2011). Moreover, in the last decade, demand has been growing faster than the effective development of infrastructure to supply it. This jeopardizes the reliability of the electricity supply system because the planning and management of the electricity sector is focused on the supply side. Therefore, recently, the electricity sector has been placed in a vulnerable position, especially in the dry season. Furthermore, the vulnerability in the supply sector can be broadly explained by a combination of climate effects, social and environmental challenges to develop new renewable projects, and legal constraints upon the development of new projects. According to De la Torre (2010a) this evidences the necessity to act upon the demand-side to achieve a more rational and efficient consumption.

DSM is an umbrella concept and countries have different terminology for DSM measures. It encompasses a broad set of actions (on the side of consumers and utilities) all with an emphasis on reducing the demand of electricity and/or generation capacity. They can be classified in two broad program categories: load management (LM), and energy efficiency (EE) ("IEA" 2010; Yu, 2010; Kim & Shcherbakova, 2011; Yilmaz et al., 2008; Gellings, 1995). Costa Rica has legislation and programs to support the conservation and rational use of electricity, but it does not have policies in place to pursue DSM. Since 1994, CR has been implementing energy conservation measures. However, these efforts are seen as fragmented actions, short term, with a lack of direction, and context-criteria dependent, which have seemed to provide unconcrete impacts (CEPAL, 2009).

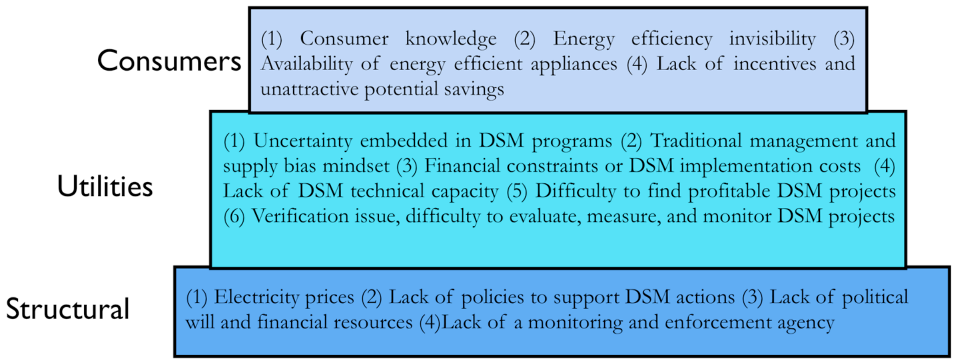
According to MINAE (De la Torre, 2010a), DSM actions have an energy saving potential of 10% to 20% from the demand projected for 2015, where the percentage will vary depending on the penetration of EE equipment, its usage, and the savings by the load management. However, DSM potential is not clear because the lack of quantitative data. Nevertheless, in this research efforts were made to identify the potential benefits embedded in DSM at the different levels: the country, the utilities, and the consumers. The advantages identified are summarised in the next figure. However, there are five key advantages that DSM can bring to Costa Rica: (1) reduce fossil fuel consumption to generate electricity, alleviating with it the macro-economic financial constraints generated by the importation of high oil prices, (2) reduce the energy problem that the country has in the dry season, (3) contribute to the achieving of the national goal to become carbon neutral by 2021, (4) free up some excess

power so that it can be exported to the Regional Electricity Market at fairly attractive prices, (5) catalyse and organize the little private EE initiatives that are trying to thrive in Costa Rica.

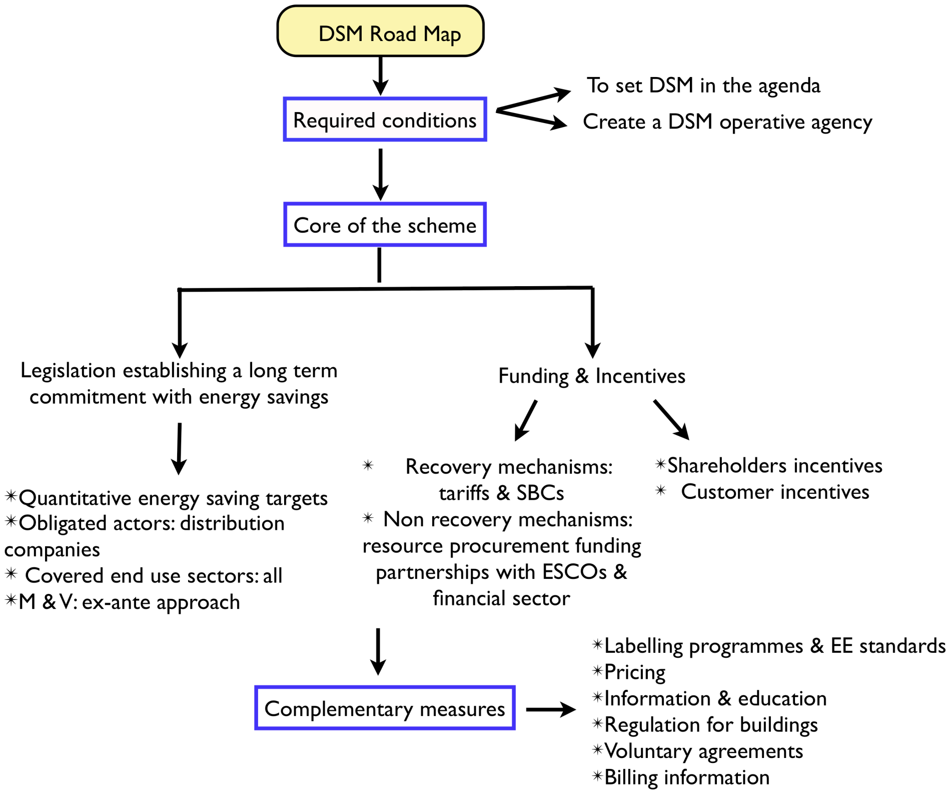


Main barriers hampering DSM implementation in Costa Rica were also identified. Three general thoughts can be underlined:

• There is a lack of policies in support of DSM. Effective legislation that compels utilities to implement long term planning and assume a commitment to systematically include demand side measures in their resource portfolio is lacking.
• There is an important knowledge gap about DSM framework as a methodology that aims to introduce demand side measures in the electricity planning.
•The lack of resources has been the main bottleneck for implementing rational use and energy conservation actions. Therefore, it would be also a major obstacle for DSM implementation.



Based on that analysis, a proposal is made on how policies can be designed to kick-start the development of a DSM culture in CR. In short, the author concludes that, at first, it is necessary to set DSM in the agenda. Secondly, it is important to give the specific responsibility to an entity that can constantly push DSM forward. Moreover, it is important to create an overarching legislative structure that establishes a national energy saving commitment, and to enact complementary measures to increase DSM effectiveness. The next scheme shows the main elements that have to be covered for implementing DSM in Costa Rica.



In short, although DSM is a complicated subject because it implies to align the interest of the country, the utilities, and consumers, it can significantly contribute to improving the security and sustainability of Costa Rica electric sector in the long run. An energy crisis looms in the near future if the appropriate actions are not taken, in both the supply and the demand side. There are several alternatives and combinations towards delineating a DSM scheme, the result will be a consequence of the political negotiation. Nevertheless, what it is important is to start discussing the possibilities to implement a DSM national program. The moment to act is now.

It is a good moment to discuss electricity related topics; it is mainly based on two reasons. First, often large-scale change in an institutional design will take place only after some kind of crisis. The political and economic costs of changing institutions is frequently too high, thus, changes are postpone until some kind of urgency is necessary (Koppejan & Groenewegen, 2005). In light of this, Costa Rica's electricity sector is in the threshold of a crisis, which is more or less triggering the perception that the need to act is urgent. Secondly, Costa Rica is discussing the restructuring of the electricity model, which is seen as a long, political complex process. Currently, DSM is not part of the discussion. However, this attention and legislative window should be used, it would be a strategic move to include DSM in this national forum because it is likely that it can influence the structure of the power sector. Additionally, it will be much harder to change the rules once they have been enacted in a regulatory level.

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Abbreviations

CEPAL: Economic Comission for Latin America

CNFL: National Ligthing & Power Company

DSM: Demand side management

EE: Energy efficiency

IEA: International Energy Agency

ICE: National Electricity Institute

MINAE: Ministry of Environment

RES: Renewable energy sources

SEM: Sectorial Energy Management

PRONACE: National Program for Energy Conservation

NCEC: National Conservation Energy Comission

WEC: World Enegy Council

1 Introduction

1.1 Challenges of Costa Rica electricity sector

As economic development advances around the world, the demand for energy increases as well. Access to energy is essential for the socio-economic development in all countries, economic growth, and quality of life. Indeed, there is a direct correlation between a high human development index (HDI) and per capita energy use, especially in the earlier stages of development (UNPD, 2004).

In the international arena, fossil fuels, and oil in particular continue to be the main energy source. Regardless, it has been forecast that economic oil reserves will depleted in less than 50 years (BP, 2010). Meanwhile, international oil prices are volatile and are continually being affected by a wide range of factors that include: availability of substitute energy carriers, oil speculation, variations in global energy demand and available supply infrastructure, socio-political conflicts (e.g. in the Middle East), accidents (e.g. Deep Horizon in the Gulf of Mexico), the flow of trade, and market effects of natural catastrophes such as the earthquake in Japan. Countries highly dependent on oil, such as Costa Rica, are particularly sensitive to volatility of the global oil market (De la Torre, 2010a).[1]

Costa Rica is a Central American country with a population estimated at 4.6 million (NISC, 2010). Tourism and agriculture are the major economic activities within the country's economy. The principal industries in Costa Rica are food processing, textiles and clothing, construction materials, fertilizer, and plastic products (Chen-Apuy et al., 2001).

In Costa Rica, consumption of commercial energy has been steadily increasing. In fact, it tripled from 1980 to 2009. This growth has been driven by high electrification coverage and the increase in electricity consumption by the residential and industrial sector. In terms of total consumption, the transport sector is the principal energy consumer. It consumes a share of 51.2% of the total final energy consumption. It is followed by the industrial sector, which represents 25.9% of total energy consumption, and the residential sector which consumes 10.5% (De la Torre, 2009a).

Costa Rica has developed a production model that has been auto-sufficient in electricity production, but externally dependent on petroleum and other fossil fuels (Martínez, 2010). For 2009, crude oil products represented 64% of the total commercial energy. After oil, electricity represented 22%, biomass 12%, and other energy products 2%. Costa Rica does not have proven oil or natural gas reservoirs. Moreover, it has to import 70% of the petroleum needed as final products, because it does not have the capacity to refine all the crude oil demanded (De la Torre 2010a). An increase in the demand of fossil fuels used for the generation of electricity besides adding an extra load to the economy and overworked refinery infrastructure, also exposes the country to the instability of external markets prices (Ramírez & Mora, 2010; Martínez, 2010).

As the energy consumption of Costa Rica increases, the dependency on fossil fuels rises as well. During the last 20 years, consumption of oil products has been growing at 4.7% annually. Assuming that the Costa Rican economy will continue to grow at the current rate, fossil fuel demand is expected to double in the next 15 years (De la Torre, 2010a; 2010b).

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[1] De la Torre has been the Minister of Environment for Costa Rica since 2010

Moreover, in the medium term the energy sector has to face two big challenges: climate change, and the exhaustion of hydrocarbons. These two phenomena will vary fossil fuels offer conditions. The first one will directly affect the volume of available renewable sources. It has been forecasted by the National Meterological Institute (2009) that the Central and Northern Pacific regions of Costa Rica will face a reduction in the precipitation levels. The second one will make the access to fossil fuels harder and more expensive. Both affect the energy security of the country, which is not just vulnerable to international market oil prices, but to natural events as well (De la Torre, 2010a).

The increase of the oil imports heavily presses Costa Rica's economy because as dependence rises the country has to allocate a bigger percentage of its exports revenues to pay the oil bill. For instance, in 2000 the country spent US$ 455 million (2.85% of the GDP). However, in 2008 during the oil crises the country had to pay US$ 2 150 million (7.3% of the GDP), and some US$1 604 million in 2010 (4.5% of the GDP) (De la Torre, 2010a). It is estimated that for 2011 the oil bill will overpass US$ 2 billion.

Regarding the electricity sector, Costa Rica has been portrayed as having a green electricity model with high electrification coverage (99.12% of the households CEPAL, 2010a). Overall, the electricity sector is of key strategic importance for Costa Rica's development. The maintenance of a constant and reliable electricity supply that can meet the demands of its consumers, in both the short and long term; it is directly related to a healthy rate of development and the competitiveness of the country on a dynamic international stage.

In Costa Rica, the provision of electricity is a public service, and the electricity sector has a vertically integrated structure. The production of electricity is mainly based on three local and renewable sources: hydropower, geothermal, and wind. ICE has aimed to have fossil fuels play just a complementary role. Nevertheless, the share of fossil fuel fired electricity has been increasing in the last decade. For example, in 2005 just 1.5% of the electricity was generated with fossil fuels, meanwhile, in 2008 that figure climbed to its highest peak, at 9% (ICE, 2009).

The country has an energy problem during the dry season. Currently, there is enough generation-installed capacity to produce electricity throughout the year.[2] The main issue is that there are not enough available renewable energy sources during the dry season to cover the demand. The water reservoirs, from February to May, decrease considerably and are insufficient to supply the demand. As the share of other renewable energy sources (RES) is small, the electricity demand for these three critical months, is mainly being supplied with fossil fuel power. This provides the primary explanation of the increase in the percentage of fossil fuel used to generate electricity (De la Torre, 2010a, De la Cruz, 2011; Ramírez, M., 2011).

Vulnerability of the electricity sector in CR

Costa Rica usage of fossil fuel increases during the dry season, for the months from January to May 2010, the percentage of electricity fired with fossil fuel was 12.4%. However, there are days with extreme cases when the percentage can go up to 30% (De la Cruz, 2011). Moreover, in the last decade, demand has been growing faster than the effective development of infrastructure to supply it. This jeopardizes the reliability of the electricity supply system because the planning and management of the electricity sector is focused on the supply side.

[2] It is due to Garabito, a fossil fuel fired power plant that entered into operation in 2010, that the current electricity demand is covered. Garabito's main function is to supply electricity during the dry season – however, its commencement of operation was delayed for financial reasons and as a consequence the country suffered from shortages between April 18th and May 4th 2007. To mitigate this, ICE put in place a Contingency Plan, which was basically to lease fossil fuel power plants (ICE, 2009).

Therefore, recently, the electricity sector has been placed in a vulnerable position, especially in the dry season.

The vulnerability in the supply sector can be broadly explained by a combination of climate effects, fossil fuel dependence, a backlog in supply infrastructure, social and environmental challenges to develop new renewable projects, and legal constraints upon the development of new projects. According to De la Torre (2010a) this evidences the necessity to act upon the demand-side to achieve a more rational and efficient consumption.

Backlog in supply infrastructure

A discordance between the national plan's objectives and the budget capacity of the corresponding institutions, social opposition to projects, and legal restrictions over private producers to generate and sell electricity have been some of the barriers for the development of the infrastructure (De la Torre, 2010.a; ICE, 2009; Ramírez & Mora, 2010).

During the last 20 years, electricity demand has been growing at a rate of 5.4 % annually. It means that, according to the business as usual scenario, the country has to duplicate its current installed capacity over a period of 12 years (add approximately 2 400 MW) to meet the electricity demand in 2021 (ICE, 2009; MINAE, 2008). The development of this infrastructure represents an investment of US$ 9 billion.

The Plan for Electricity Generation Expansion (PEGE) has two key projects: Reventazón (300 MW) and El Díquis (650MW). They were supposed to enter into operation in 2014 and 2016 accordingly (ICE, 2009). However, the implementation of that plan has suffered a two years delay. Consequently, from 2014 and until the operation of the El Diquís project (expected at the end of the year 2018), the country is exposed to electricity shortages. This will be especially serious if demand grows at a higher pace than the forecast for periods of normal economic growth (Costa Rica Executive Power, 2011).

Even though according to the National Electricity Institute (ICE), a two years delay will not generate problems for the electricity supply, it will mean an increase in the fossil fuel fired electricity share (Aguero, 2011). Therefore, the Government[3] has just presented to the Congress (May 10, 2011) a *Contingency Plan Bill.* Its main objective is to eliminate some legal barriers that would to facilitate the development of private power projects based on RES so as to avoid supply shortages in 2014. It aims to encourage the addition of 400 MW during the next 6 years. The legislators are conscious about the seriousness of the situation, and have said that they will give priority to passing this Bill.

Social and environmental challenges to develop new renewable projects

ICE is responsible for planning and supplying electricity to the whole country. It plans to satisfy the constantly increasing electricity demand with an emphasis on RES projects and supply side management measures. However, the development of hydropower and geothermal projects encompasses many environmental and social challenges, and its development may take significant time (Martínez, 2010; De la Torre, 2010a; MINAE, 2008; ICE, 2009).

For instance, El Díquis hydroelectric project is facing serious opposition from Terraba indigenous communities, which see part of their territory affected. Therefore, on March 21st, 2011, the Terraba Indigenous Development Association, the entity who has the property

[3] When the term Government is used, it is to refer to the central government: 1. Ministry of Environment or any of its agencies. 2. The Executive Power (Minister of Environment and President).

rights over the reserve, sued ICE and is asking a set of conditions to start being negotiated (Villa, 2011; Vizcaníno, 2011a, 2011b, 2011c). In short, this situation means not just money but also time. Moreover, there is an important geothermal potential in national parks, which currently cannot be deployed. To pass a law reform to modify that situation would be very difficult as well.

Additionally, maintaining the reliability of an electric system based on hydropower is challenging. According to studies prepared by ICE (2009), the optimal and more accessible locations for developing hydropower projects have already been used. Nowadays, each additional kW installed in hydroelectric power projects costs double that of new capacity installed five years ago (Martínez, 2010).

Legal constraints to develop RES

The legal framework for energy is restrictive and outdated. Law 7200 states that the installed generation capacity of the private companies may not exceed 15% of the total generation capacity of the country. The recent Bill presented by the Government to the Congress, called Contingency Plan Bill, aims to amend some of the main flaws. It seems to be an urgent measure, meanwhile, that the National Electricity Bill, which aims to restructure the electricity sector, is passed.

1.2 DSM as a complementary approach

Demand side management (DSM)[4]

Since 1980, global electricity consumption has doubled. On average, it grows more than 3% per year. Therefore, nowadays, more governments are facing the challenge of assuring a reliable electricity supply for their countries. Traditionally, expanding supply capacity has been the main approach to meet electricity consumption. However, increasing generation capacity has become more and more costly. For instance: construction times are longer, construction costs and interest rates are higher, and the volatility of supply costs of fuel is greater. Moreover, environmental standards are higher and public opposition to large infrastructure projects has also increased. Those situations have increased the risk of depending merely on supply-side options, and they have being altering the traditional planning approach of utilities. Nowadays, governments and regulators around the world see the necessity to act upon the demand side as well, and DSM provides a framework that allows utilities to systematically include demand side measures in their resource portfolio in a cost effective fashion. For instance, in California the cost of efficiency programs over their lifetime have averaged 2-3 cents per kWh of saved electricity, less than half the cost of the avoided generation (Yilmaza et. al., 2008; Kim & Shcherbakova 2011; Yu, 2010).

The concept of DSM was first developed in the United States (U.S.) as a reaction to oil crises in the 1970s. Since then, DSM has faced several change phases, and its evolution is an ongoing process because it is required to continuously adapt to different global settings where power markets are being restructured (Charles River Associates; 2005, Wikler, 2000; "IEA-DSM", n.d.). There is no comprehensive data of how many countries have implemented DSM programs since 1975. Nevertheless, the International Energy Agency (IEA) has a DSM programme which has 18 member countries: Australia, Greece, Norway, Austria, India, Spain, Belgium, Italy, Sweden, Canada, Republic of Korea, Switzerland, Finland, Netherlands, United Kingdom, France, New Zealand, and United States. Moreover, there is evidence that other

[4] Each time that demand side management, demand side measures, or demand side options are mentioned in this thesis; they explicitly refer to energy efficiency and load management. A DSM program in CR would probably have a strong EE component

regions are implementing or trying to implement DSM activities: Africa, South Asia, and Latin America (Koppejan & Groenewegen, 2005; Wikler, 2000; Cepal, 2010a; Dube et al. 2005). This shows that although DSM has faced several critiques and has gone through various changes, it still has relevance and prevalence among policymakers.

DSM is an umbrella concept and countries have different terminology for DSM measures. It encompasses a broad set of actions (on the side of consumers and utilities) all with an emphasis on reducing the demand of electricity and/or generation capacity. They can be classified in two broad program categories: load management (LM), and energy efficiency (EE) ("IEA" 2010; Yu, 2010; Kim & Shcherbakova, 2011; Yilmaz et al., 2008; Gellings, 1995).

Costa Rica has legislation and programs to support the conservation and rational use of electricity, but it does not have policies in place to pursue DSM. Nevertheless, taking as a premise that a secure and reliable electricity system is of paramount importance for the development and competitiveness of CR; and simultaneously, being conscious about the increasing challenges and costs to extend the power network generation capacity it seems rational to explore how to pursuit of the most cost effective delivery of energy services to the Costa Rican public. In this light, DSM offers a systematic framework for improving Costa Rica energy security and the reliability of the electricity system.

Since 1994, CR has been implementing energy conservation measures. However, these efforts are seen as fragmented actions, short term, with a lack of direction, and context-criteria dependent (CEPAL, 2009). For instance, when oil prices go up abnormally, it is a common practice that the Government issues a directive, setting a temporary plan to reduce oil consumption. In of April 2011, a 12 measure plan to reduce oil imports was put in place. None of these measures are new, and at least five of them related to the electricity sector (Villegas & Loaiza, 2011). Another example is the intermittent campaigns to substitute incandescent lights (with low energy lighting), and the failure of the National Programme for Energy Conservation (NPEC).

Certainly, the electricity sector requires urgent actions in the supply side. There is a general consensus that it is important to diversify the generation matrix, and to increase the installed RES generation capacity in order to solve the seasonal energy problem. Additionally, it seems important to take actions to reduce the use of fossil fuel dependent electricity, as far as is economically feasible, to supply the daily demand peak hours. However, it is also necessary to act upon the demand side. It has been forecast that the potential for development of new RE hydro and geothermal projects will be limited after 2030 (ICE, 2009). Moreover, even though the development of non-conventional RES has improved, it is still not sufficient enough to satisfy the electricity demand needs of the country in a cost-efficient fashion (ICE, 2009). DSM can be an opportunity to overcome the short term planning and can generate another source of energy.

According to MINAE (De la Torre, 2010a), DSM actions have an energy saving potential of 10% to 20% from the demand projected for 2015, where the percentage will vary depending on the penetration of EE equipment, its usage, and the savings by the load management. De la Cruz and Castillo (2011)[5] expressed that the implementation of DSM is likely advantageous for the ICE and Costa Rica. However, DSM potential is not clear because no one has generated the statistics and studies to quantify it in a Costa Rican context.

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[5] De la Cruz is the current Director of the electricity planning department of ICE, and Castillo is the subdirector of Sectoral Energy Management (SEM).

Moreover, just because logical thinking or a healthy management practice supply and demand should be considered in the planning process, the question can be posed: Why must managers have to assume that the demand will keep growing annually as an unstoppable or uncontrollable function?

The different sectors in Costa Rica's electricity system are not totally alienated to such thinking. At a policy level, the importance to act over the demand is explicitly recognized. However, the said policies remain trapped within the traditional discourse because they are not implemented. Mainly, it can be explained by a lack of political will and effective allocation of financial resources, where both can share a component of misinformation. One step beyond that, the country is also missing effective legislation that compels utilities[6] to implement long term planning and assume a stable commitment of systematically including demand side measures in their resource portfolio.

Consequently, considering the pressure and time constraints that the country faces to keep the pace with supply electricity demand, the high interest of the country to maintain its green electricity model, and the social and economic costs that this implies, appear to make a strong case for DSM. In turn, serious pursuit of DSM would require that the electricity sector in CR would pursue an integrated resource management planning strategy. This requiring the integration of DSM into the system planning process, besides just using the traditional electricity expansion planning, which relies on supply side efforts. Changing the current planning model can bring positive effects. DSM actions have the potential to organize and incentivize energy conservation and energy efficient activities, decouple development from energy consumption, and reduce the risks of electricity shortages. It can also help to reduce fossil fuel consumption, as well as the emission of other green house gases (GHGs).

In short, DSM can significantly contribute to improving the security and sustainability of Costa Rica's electricity sector in the long run. The moment to act is now. An energy crisis looms, in the near future, if appropriate actions are not taken, in both the supply and demand side. One of those key actions is to start overcoming the knowledge gap about DSM among policymakers and other key actors in the electricity sector, this is what this thesis is about.

1.3 Objective and research question

This thesis is to develop an understanding of the potential advantages that DSM can bring to Costa Rica, and the barriers that are hampering its implementation in order to provide an outline of the policy actions that should be taken by policymakers to kick-start a DSM culture.[7] This analysis has the objective to start a discussion about why DSM can be a viable option for the country and how could it be implemented. As energy topics have momentum in Costa Rica, and one of main issues for innovation is a knowledge problem, the outcome of this research could provide useful inputs to the forthcoming activity of the National Conservation Energy Commission (NCEC), as well as the discussion of the National Electricity Bill.

Towards achieving the aforementioned objective, this research aims to focus in the next research question: *How can policies be designed to kick-start the development of a DSM culture in CR?*

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[6] When the word utilities is used in the Costa Rica context; it is referring to the public companies involved with the generation or/and distribution of electricity in Costa Rica (ICE, CNFL, JASEC, ESPH), as well as the rural electrification cooperatives (COOPESANTOS, COOPEGUANACASTE, COPE ALFARO RUIZ)

[7] This paper understands DSM culture as a social process where the stakeholders of the electricity sector develop a particular set of behaviors, values, customs, mindsets, and structures aligned with demand side management principles.

Moreover, in order to address this research question this paper aims to delineate the potential benefits embedded in DSM for the country, the utilities and the consumers, and to identify the main barriers that are hampering DSM implementation in Costa Rica.

This research was performed with the view to raise an interest about DSM in Costa Rica, namely in the key stakeholders: policymakers, utilities, and non-governmental organizations (NGOs). The intervention of policymakers is essential because history has shown that market drivers alone are not enough to overcome the barriers that hamper DSM implementation (Yu, 2010). The involvement of the NGO sector is key, as they mobilize international funds and provide human resources to perform research, contribute to the policy making process, conducting awareness campaigns or implementing projects. Lastly, the participation of utilities is essential because in most of the cases they carry the largest responsibility for DSM implementation.

1.4 Scope of thesis

The scope of this thesis is limited to the analysis of the electricity sector in Costa Rica, which justifies why the DSM framework is used. Even though the author recognizes that the transport sector is the largest consumer of oil, it has more impact in the energy security of the country, and that it faces great challenges as well, the decision to focus in the electricity sector is founded on the following reasons:

- Despite the fact that the electricity sector is not the main oil consumer, it still is a cornerstone for the development and competitiveness of the country.
- Although, historically the electricity sector has been a quite reliable system; the situation is changing. Since 2007, the electricity sector is in a rather vulnerable position. The country has been feeling the consequences of having a supply bias management model without enough development and investment. For instance, in 2007 Costa Rica had shortages, since then electricity prices have raise significantly, and currently there is a prognosis of shortages in the near future.
- At this time, there is a general recognition among legislators, planners, and regulators as to the urgency of the situation.
- The solutions that are being discussed are mainly focus on the supply side.
- It is a good moment to propose new alternatives.

Based on the above, the author considered that to analyze the management of the electricity sector offered a great research opportunity. Moreover, DSM is an innovative topic with actual term. Lastly, there are several approaches to implement DSM, but they can basically be sorted within two main categories: public policy based and the market-based approach. Thus, the emphasis was set on them, and two case studies were chosen to illustrate each one of these approaches.

1.5 Methodology and research approach

- This research is primarily a qualitative study. The data collected comes from two main sources: Primary data: collected through interviews. At first, the relevant stakeholders were identified, they are: utilities, regulators, the national governing energy agency, industries, customers, private generators, energy business companies, academics, non-governmental organizations (NGOs), environmentalists groups, and local communities. Then, a field study was conducted from February 7th to February 25th 2011 with the objective to conduct 10 semi-open interviews with key stakeholder groups (i.e. government, regulators, utilities, NGOs, and consumers).
- Secondary data: gathered through a literature review and the field study.

This data is used in a complementary manner throughout the paper with the purpose of backing up the argumentation. Nevertheless, some chapters highlight one kind of source more than others. Furthermore, in order to achieve the proposed objective, the essential components for analyzing a possible implementation of DSM were identified, and the research was divided into five tasks.

Task 1: To delineate the context of the electricity sector in Costa Rica
Approach: This part of research involves the study of the main features of CR electricity sector. The objective was to set the factual context and give the reader an understanding of what the position of the electricity sector in Costa Rica is at present. First based on the main stakeholders identified a literature review was conducted, then, the chapter explains: the structure of the electricity system, overview of the current situation of the electricity sector, supply side management, and electricity projections. This was elaborated based on (1) a careful and critical literature review of official governmental documents or reports, peer review articles, opinion papers, policies, institutional plans, and newspapers, (2) taking into consideration key primary data collected through interviews to key actors in the electricity sector the chapter.

Task 2: To understand the rational, main concepts, and operation issues of DSM in general *Approach:* This task addresses another essential component of the research; the theoretical framework. Here the purpose is to develop an understanding of DSM theory, namely the introduction of its background, rationale, main concepts, approaches, and some operational issues (through case studies). This was carried out by an extensive literature review of reports, peer review articles, opinion papers, policies, and databases.

Task 3: to explore DSM potential in Costa Rica
Approach: this task involves efforts to frame DSM in Costa Rica by identifying the potential benefits of developing a DSM strategy, as well as the possible barriers that are hampering DSM implementation. Therefore, in order to provide first hand insights and juxtapose them to the underlying theory and/or expected phenomena delineated in the literature, 10 semi-open interviews with representatives of the different interest groups in the electricity sector in Costa Rica were conducted. The interviewers cover the following groups: energy governing entity (SEM), regulator (ARESEP), planning entity (ICE), main distribution companies (CNFL and ICE), and NGOs.

Task 4: to analyze the policy alternatives and to propose an action road map
Approach: The development of this task builds up on the main findings of the previous chapters. It explores the different policy alternatives while bearing in mind the perspectives of the key stakeholders. The analysis integrates the main barriers identified, and the experiences of other countries.

Task 5: conclusion and identification of options for future interventions
Approach: this tasks answers the research question. It also recaps the main findings, and points out future research opportunities.

1.6 Limitations and assumptions in the study

This research has two main limitations:

- This paper aims to base its analysis on the views of the main stakeholders. Thus, a field study was conducted from February 7th to February 25th to collect primary information. However, as that period of time was short, it was not possible to contact all the actors in the main interest groups identified (government, regulators, utilities, NGOs, and consumers). Rather, the author had the opportunity to interview only selected representatives of these groups. Consequently, although the author made significant efforts to give uniform representation to the different stakeholders, there remains the potential for over-representation of the views of a particular groups i.e. ICE; especially, in the identification of benefits and barriers. The utilities group encompasses several actors, but due to time constraints the author only interviewed representatives from the main utilities (ICE and CNFL). Moreover, the author did not have time to run surveys among customers.

- The research lacks quantitative data to back up DSM potential. The reason is that neither the government nor the utilities have conducted a detailed study on the potential benefits of DSM. Moreover, during the interviews, representatives from ICE and SEM admitted that they have not generated the statistics to perform these calculations. The author tries to lessen this issue: explicitly recognizing the situation as a main limitation for implementing DSM, and using the information collected through the interviews in an authoritative way.

ICE and CNFL were the only interviewed utilities, as they are key actors in the sector. They are the main utilities in Costa Rica together they are responsible for roughly 70% of the electricity generation and 80% of the total distribution. Moreover, it was anticipated that they have greater financial and administrative capacity than the rest of utilities. In light of this, even though the rest of the utilities may have different business cases, it is assumed that they could face similar obstacles ICE and CNFL when trying to implement a DSM program.

1.6 Outline of the study

This thesis has 6 chapters with the following disposition: **Chapter 1**: commences with a general background to the Costa Rican electricity sector. It sets out: the objective, research question, scope, and limitation of the study, followed by the methodology adopted for the study. **Chapter 2:** gives an overview of electricity sector in Costa Rica. It identifies key parts of the electricity sector framework and electricity management in Costa Rica. **Chapter 3**: aims to provide a basic understanding about the underpinning of DSM. Therefore, it explains the DSM concept (3.1), the elements/tools covered in the concept (3.2.), and DSM rationale and benefits (3.3.). Also, it describes the evolution of DSM framework, and exposes the experience of two countries implementing DSM (3.4.). **Chapter 4:** intends to frame DSM to the Costa Rica electricity sector, and set the basis for the next chapter. It identifies the potential advantages of developing a DSM strategy in Costa Rica, and the main barriers that are inhibiting its implementation. **Chapter 5:** is a propositional chapter, it identifies the main policy routes the Government can take to implement DSM in Costa Rica, and recommends a number of potential paths forward. **Chapter 6:** concludes the work. The content seeks to provide answers to the research question, summarize the main findings, and identify future research opportunities.

2 Characterization of Costa Rica electricity sector

This chapter gives an overview of the electricity sector in Costa Rica. The objective is to set the factual context and give the reader an understanding of key parts of the electricity management model in Costa Rica. The chapter encompasses four sections: organization of the electricity sector in Costa Rica (2.1.), status and trends in electricity supply and demand (2.2.), electricity demand projections (2.3.), supply side management (2.4), and demand side policies (2.5.).

2.1 Organization of the electricity sector in Costa Rica

In Costa Rica, the provision of electricity is a public service, and the electricity sector has a vertically integrated structure. The governing entity is the Ministry of Environment (MINAE), which, through the Sectoral Management of Energy (SME), is responsible for planning the energy sector development. SME creates policies and harmonize efforts among the different actors of the sector: Costa Rican Institute of Electricity (ICE), public distribution companies, private generators, and electrification cooperatives (Ramírez & Mora, 2010).

According to the Act 449, enforced since 1949, the ICE is responsible for generating, transmitting and distributing electricity for the country as a whole. ICE is an autonomous public institution, and it is the main managerial and operation entity of Costa Rica's electricity sector. Besides being the leader in electricity generation, ICE also owns 100% of the transmission network, and distributes circa 40% of the total electricity consumed in the country (ICE, 2009; MINAE, 2008).

There are several important actors involved in the production of electricity: 3 distribution companies, 6 electrification cooperatives, and 31 private generators. Of the installed generation capacity until December 2009, ICE owns 69.36% with own plants, it subcontracts 14.77% with private generators, and the distribution companies generate 6.7% while the remaining 15.87% is generated by the electrification cooperatives (De la Torre, 2010b). After electricity is generated/produced, ICE is the only buyer, and is the entity in charge of transmitting the electricity for distribution and commercialization. The distribution of electricity is shared among several enterprises (MINAE, 2008; Chen-Apuy et al., 2001). Figure 2-1 shows the coverage area for the different distribution companies; Figure 2-2 presents the complete picture of the country's electricity model.

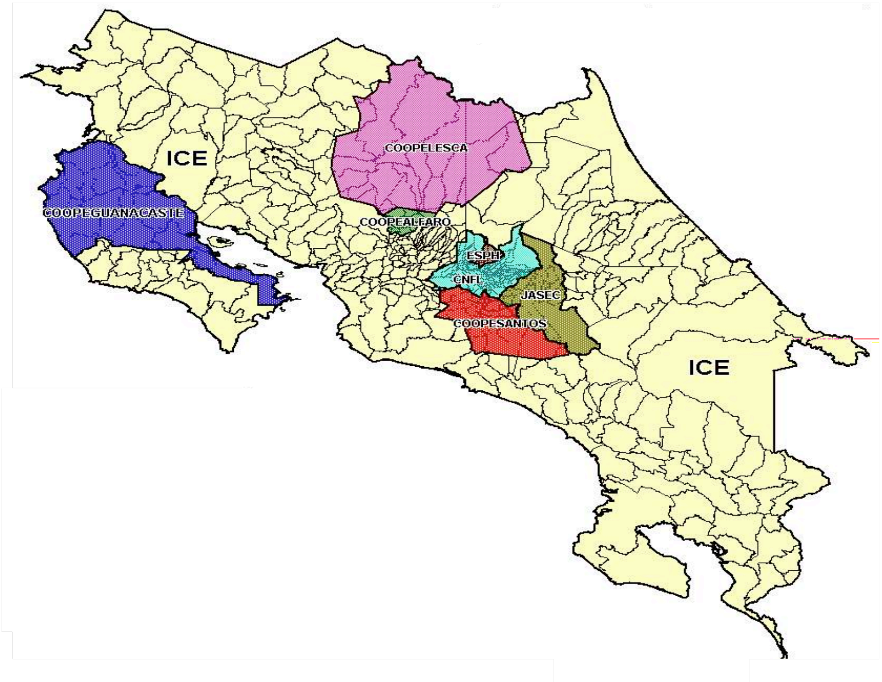

Figure 2-1: Coverage area per distribution company in December 2009.

Source: De la Torre 2010.

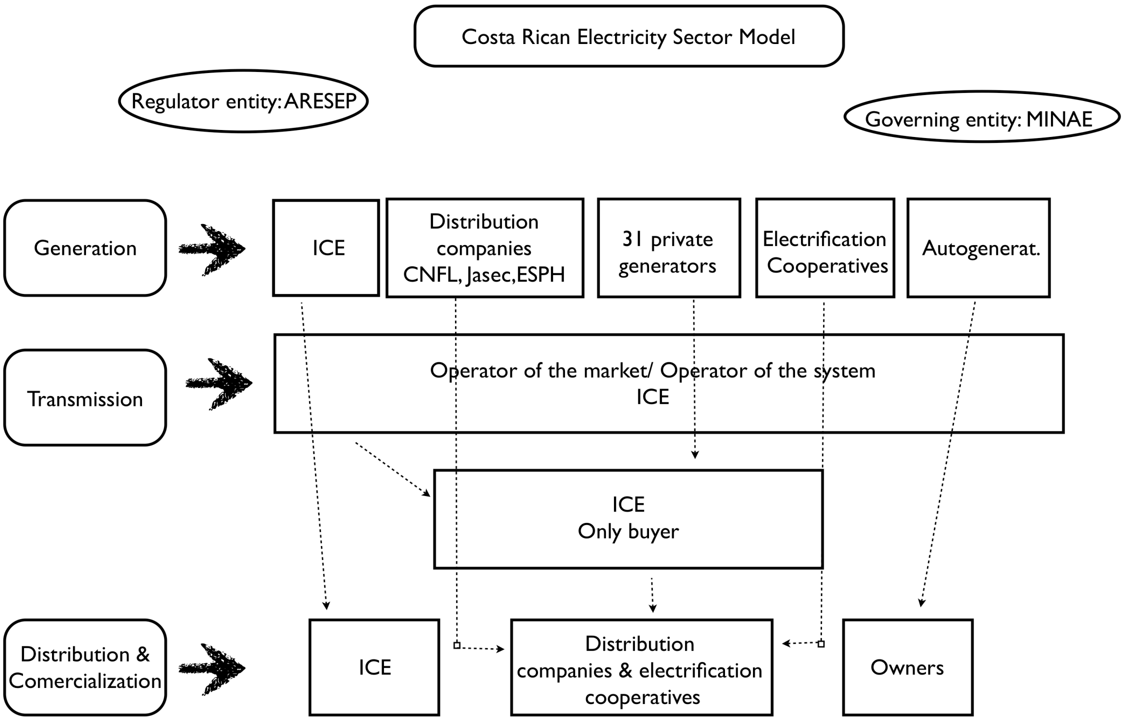

Figure 2-2: Costa Rican Electricity Model.

Source: Elaborated by the author with data from MINAE 2008.

The National Company of Power and Light (CNFL) is an ICE subsidiary,[8] and it is the most important electricity distribution company supplying 40% of the national electricity demand in Costa Rica (MINAE, 2009a). Its area of coverage represents 1.8% of the national territory, and it is located in Costa Rica's metropolitan region[9] (Gran Area Metropolitana, GAM). CNFL serves 480 000 clients, which represents 37% of the total amount of customers. It holds a large share of the residential market, and it provides electricity to a 46% share of the commercial sector (Chen- Apuy et al., 2001, CNFL, 2010; De la Torre, 2010.b).

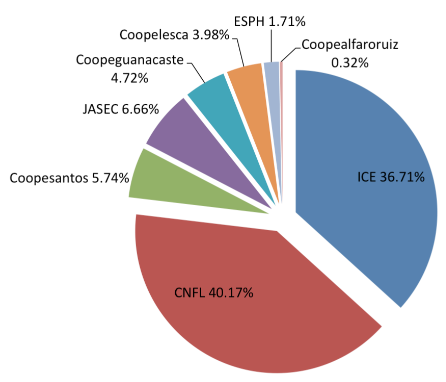

Figure 2-3: Total electricity delivered per distribution company in terms of kWh in 2008.

Source: MINAE 2009.

Most distribution companies generate a fraction of the total electricity output supplied to customers; however, they are limited to developing projects based exclusively on RES. Most of the electricity that they distribute is bought directly from ICE (ICE, 2009). Private companies engaged in electricity generation operate under the observance of Law 7200, which states that the installed generation capacity of the private companies may not exceed 15% of the total generation capacity of Costa Rica (MINAE, 2008).

The Public Authority for the Regulation of Public Services (ARESEP) is the entity responsible for establishing the technical standards for the operation of all public services, for assuring the application of the regulatory framework, and for setting the tariffs.

2.2 Status and trends in the electricity supply and demand

Historically, Costa Rica's production model has been auto-sufficient in electricity production, but externally dependent from petroleum and other fossil fuels (Martínez, 2010). Crude oil products are the main secondary energy source by supplying 64% of the total commercial energy, followed by electricity that represents a 22% (De la Torre, 2010.b).

For 2010, electrification coverage reached 99.12% of the households (CEPAL, 2010a; De la Torre, 2010b). The production of electricity in the country is mainly based on three local and renewable sources, for 2009 a 78.22% of the electricity generated came from hydropower,

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[8] Since 1968, the ICE acquired the 98.6% of the shares (CEPAL, 2010a)

[9] It is an area integrated by San Jose, the capital, and other three main cities. The whole area represents 2% of Costa Rica's total territory, but approximately half of the total population lives there.

12.84% from geothermal sources, and 3.53% from wind. Morevoer, 4.89% was supplied with fossil fuel fired electricity. Hydropower has prevailed in Costa Rica's electricity generation system since 1960, as it is showed in Figure 2-4. That same figure also illustrates how Costa Rica's fossil fuel consumption for the means of generating electricity has historically been quite low.

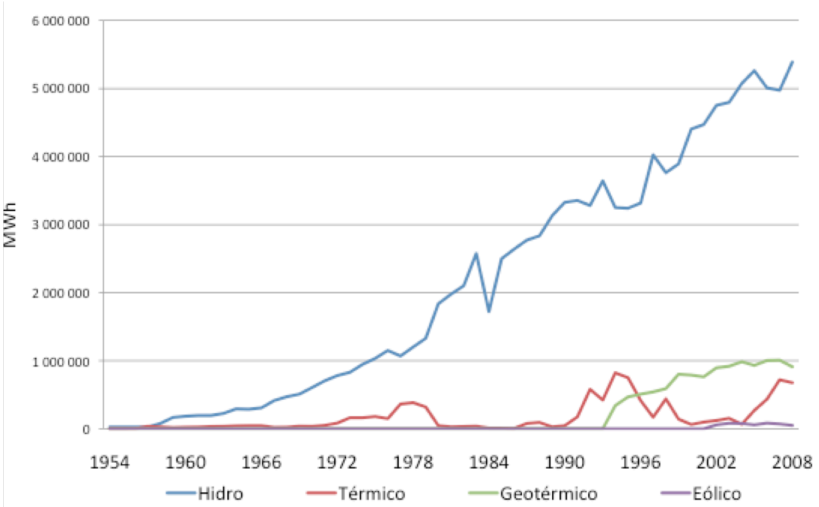

Figure 2-4: Evolution of Costa Rica's electricity production since 1954-2008.

Source: ICE, 2009.

According to ICE (2009), the country is deploying just 23% of its technical potential hydropower capacity, 63.7% of its geothermic capacity, and 35.2% of its wind capacity. Figure 2-5 shows that 11.8% of the total technical hydropower capacity affects protected areas, and 25% indigenous reserves[10].

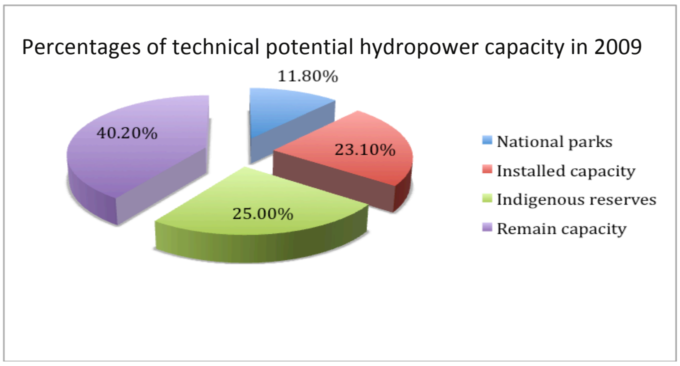

Figure 2-5: Percentages of technical hydropower capacity

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[10] The protection regime of the indigenous reservations is different from other protected areas. According to the Indigenous Act, Law 6172, the Indigenous and Tribal People Convention, Convention 169, and constitutional jurisprudence, the indigenous reservations are inalienable, imprescriptible, untransferable, and the inhabitants of the land have the exclusivity right to manage, deploy, and guard their natural resources. The property right of the indigenous reservations are accredited to the Development Association (the government of the indigenous communities). Therefore, for the development of any activity within the boundaries of the indigenous reservation is absolutely necessary to have the authorization of the Development Association. Additionally, if they decide to use their natural resources to obtain an economic benefit (e.g. payment for environmental services), by law, the Development Association has to guarantee that those incomes will be distributed equitably among all the members of the community.

Source: De la Torre, 2010a.

Moreover, in Costa Rica 60% of the hydropower plants are run-of-the-river facilities[11]. Therefore, during the dry season the total generation capacity is reduced circa 25% (Ramírez, M., 2011; De la Cruz, 2011; Musmanni, 2011). Fossil fuel fired electricity shares a small portion in the supply generation matrix, and has an essential complementing role in the country's electricity system, mainly. Currently, fossil fuel fired electricity is being used to satisfy the demand in the dry season, when hydropower is scarce, and in the daily peak hours (ICE, 2010).

According to ICE (Ramírez, M., 2011), to substitute the portion of fossil fuel fired electricity with RES can be very expensive. Fossil fuel fired plants have high operation costs, but very low installation costs. In contrast, RES have very high installation costs that are recovered during the years with the continuously operation of the plants. Therefore, if they are installed to function around three months and some hours per day, the system will have a large surplus of unutilized installed capacity of RES. This can substantially alter the total electricity generation costs. Additionally, it is hard, fossil fuel fired utilities are relatively easy to installed, and they are a based load power that can quickly provide peak load power.

An electricity generation model based on RES has brought to the country several benefits. For instance, it can be presumed that the primarily the dominance of hydropower has kept prices relatively low (Figure 2-6). However, that trend can change due to the increase in the generation of more expensive electricity such as that produced from fossil fuels. In 2005, just 1.5% of the electricity was generated with crude oil bi-products, meanwhile, in 2008; it reached the highest peak at 9%. This situation is highly associated with weather patterns. The country has an energy issues in the peak-use hours, especially in the dry season.

Moreover, this situation has been exacerbated by the backlog in the development of infrastructure to generate electricity (ICE, 2010). Low prices for electricity can also be threatened by the increase in overall investment costs, which can affect the installation and operation of new plants. For instance, nowadays, each additional kW installed in a hydroelectric plant costs double than that five years ago (Martínez, 2010). According to studies prepared by ICE (2009), this can be explained because the optimal and more accessible locations for developing hydropower projects have already been used. Additionally, even though there is no legal obstacle for developing projects in indigenous reserves, it is anticipated that the negotiations with the indigenous communities to get the authorisation for affecting their land can significantly increase the cost of the projects. Also, the costs associated with materials necessary for energy generation have been steadily increasing (De la Cruz.2011).

[11] It is a type of hydroelectric generation with relatively small or without any water storage capacity. The run-of-the-river facilities without a reservoir are expose to seasonal river flows, and they just generate electricity when the water in the river is sufficient. Therefore, during the dry season its generation capacity can be very low (Kosa et al. 2011).

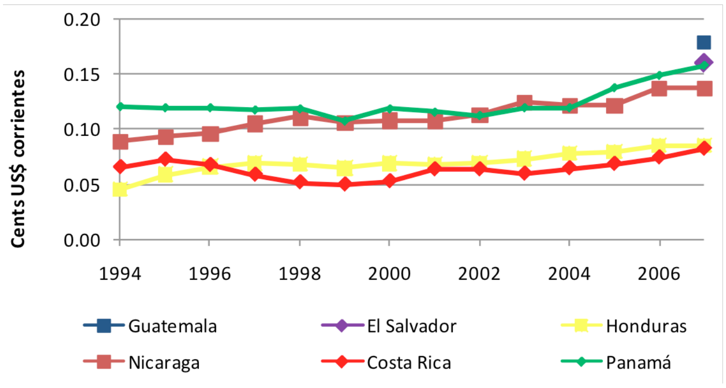

Figure 2-6: Average retail prices of electricity for the residential sector in Central America from 1994 to 2007.

Source: ICE 2009.

The growing demand rate for electricity from the residential sector has been quite constant during the last decade (Figure 2-7). For May 2010, demand for electricity in the residential sector increased 1.3% in comparison of the accumulated figure for May 2009. In contrast, the commercial and industrial sectors have shown a strong growth correlated to the development of the economy (ICE, 2009; Martínez, 2010). For May 2010, the electricity consumption of the commercial sector had grown up 8.8% in contrast to the same period in 2009. The industrial sector also showed an increase of 6.47% (ICE, 2010).

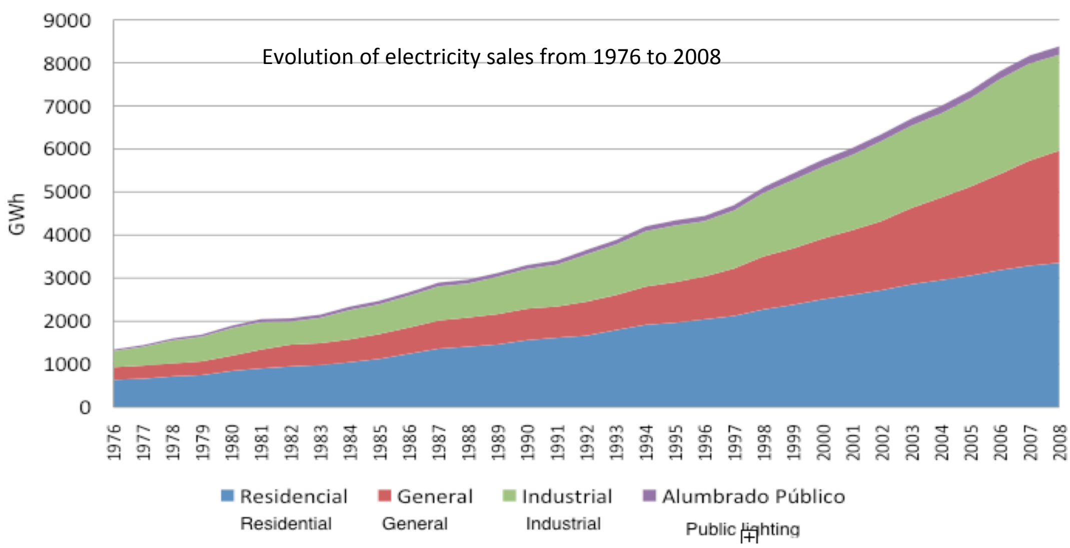

Figure 2-7: Electricity sales from 1976 to 2008.

Source: MINAE, 2009.

The ongoing growth of electricity demand is sensitive to several factors: historical high levels of electrification coverage, growth of economy as represented by Gross Domestic Product (GDP), development of the service and commercial sector. Additionally, by an increase in the Power Purchase Parity which gives people broader possibilities of consumption, large number of appliances with high- energy requirements in the residential sector. The usage of old industrial machinery in the industry sector and the equipment usage practices also affects electricity demand (Chen-Apuy et al., 2001; De la Torre, 2010a; ICE, 2009).

Until May 2010, 87% of the total customers in the electricity sector were from the residential sector, 12% came from the commercial sector, and 1% from the industrial sector. Furthermore, the country displays an electricity consumption pattern dominated primarily by the household sector (ICE, 2010). Figure 2-8 illustrates the similarities between the residential sector load curve and the demand load curve of the CNFL. The composition of the CNFL load curve is quite similar to national load curve, which is showed in Figure 2-9. The weekly pattern shows that more electricity is consumed from Monday to Friday than on the weekends. During the day the demand starts rising in the morning and peaks close to noon, the other important peak period is from 5 P.M. to 8 P.M.

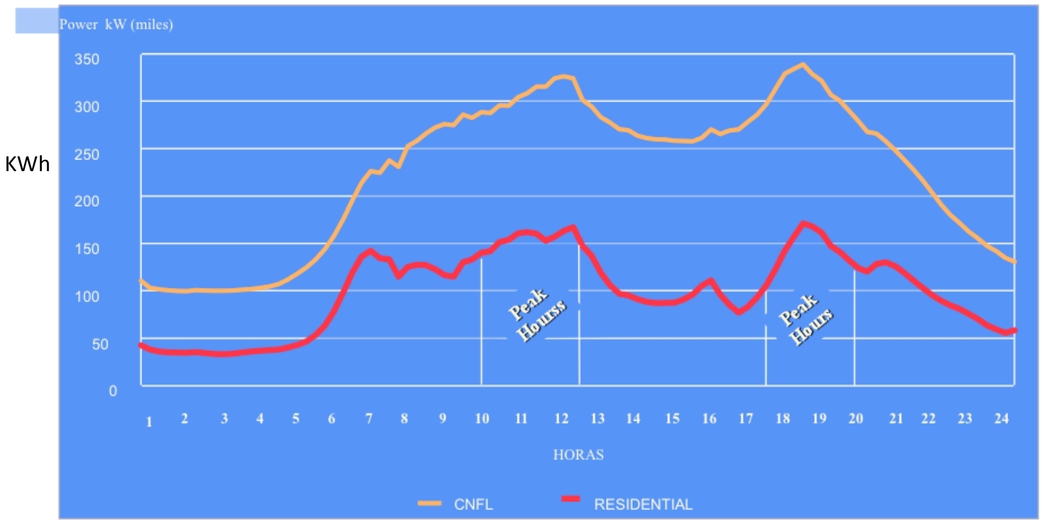

Figure 2-8: Composition of CNFL's load curve and its residential end-use sector. Year 2009.

Source: CNFL, 2011.

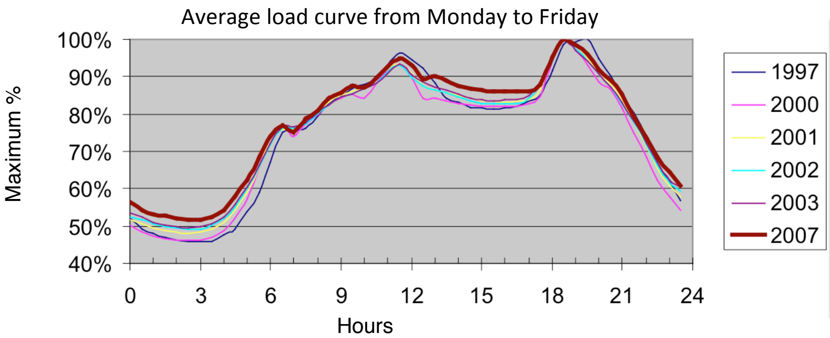

Figure 2-9: Average load curve from Monday to Friday.

Source: ICE 2009.

The residential sector is clearly the largest electricity consumer (Figure 2-10). Nevertheless, it has been decreasing in influence, for instance, in 1980, this sector consumed almost half of the total distributed electricity, but currently it consumes approximately 40% (ICE, 2009).

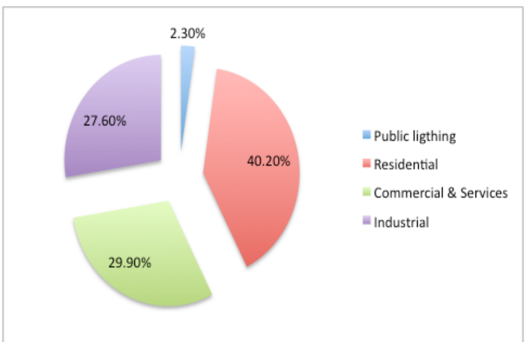

Figure 2-10: Share of the electricity consumption per end-user sector. Year 2007.

Source: MINAE 2009.

A survey to characterize the electricity demand composition, conducted by MINAE in 2007, shows that cooling is the most important electricity consumption usage in all the sectors except public lighting. Table 1 summarizes the shares of electricity usages per sector in 2007 (MINAE 2009).

Table 2-1: Share of electricity uses per sector in 2007.

Sector	Cooking	Cooling	Heating	Steam generation	Lighting	Power generation	Other uses
Residential (2005)	26. 2%	36.9%	15.1%	-	12.2%	9.6%	-
Industrial (2001)	-	17.2%	6.4%	1.3%	12.4%	60.5%	2.2%
Commercial & Services (2002)	1.4%	41.5%	7.6%	-	16.0%	5.5%	28.0%
Public sector (2004)	0.3%	19.4%	8.1%	0.2%	12.2%	35.8%	24.0%

Source: MINAE, 2009.

In the residential sector there are important consumption differences according to the socioeconomic level and other characteristics such as urban versus rural considerations. For example, 66% of the electricity is consumed in urban areas, while the remaining 33.6% is consumed in rural areas. Cooling is the activity that consumes the most electricity in all the socioeconomic groups except in the low-income group; then, cooking and heating are the other activities that demand the highest amount of electricity. Cooling includes refrigerators, ventilators, air conditioner, and freezers. Cooling is also the most prevalent consumer use of electricity both in rural and urban areas. It is probable that power generation and entertainment are underestimated because of the difficulty to collect that data (MINAE 2009).

The cooking category encompasses the electric kitchen and other electric cooking appliances. The percentage for cooking usage decreased from 26.2% in 2006 to 23.2% in 2008. According to MINAE (2009) a possible explication can be that nowadays liquefied petroleum gas (LPG) kitchens, microwaves, rice cookers are more widely used, as well as a higher penetration rate of other devices. Moreover, the survey that was used in 2008 included more usage categories than the survey used in 2006. Nevertheless, it is clear that the main source of energy for cooking is electricity; 57% of the houses use electricity for cooking versus 35%, which use LPG kitchens or wood. The use of electric heating showers is higher in urban regions, where 60% of the households have one, than in the countryside. Furthermore, the middle high-income group is the main user.

Regarding lighting, one-third of the houses use compact fluorescent lights (CFLs). Urban areas and the middle-high income group show the highest consumption. In 2006, the survey reported that 16,2% of the households used CFLs, and for 2008 that percentage increased to 32,3%. Finally, 65% of the interviewed houses implemented some saving energy measure mainly to minimise the electricity use of lights (55.7%)(MINAE 2009).

The service sector experienced an annual growth rate in electricity consumption from 2.5% in 1995 to 7.7% in 2007. The usages with the highest electricity consumption are: power generation (39%), cooling (24.2%), and lighting (23.3%). Fluorescent and CFLs are the most widely used lights. The use of air conditioners is widely spread in the sector regardless of the activity of the company. The majority of the enterprises do not use electricity for cooking (MINAE, 2009).

Most of the institutions have taken measures to reduce their electricity consumption. The education service and other service sectors stand out for the implementation of saving measures: replacement of lights and equipment were the most popular measures implemented. The financial institutions have the highest implementation percentage of institutions that have not implemented any saving or substitution measures (22%). An average of 50% of the companies in each group have plans to implement saving programs with an emphasis on specific measures: change of equipment, lighting improvements, and raising awareness among the personnel. The main reasons that hamper the implementation of measures are lack of incentives and governmental support, as well as lack of regulation to enforce them (MINAE, 2009).

The commercial sector is characterised in three groups, and the retail trade is the one that consumes more electricity. The most important electricity usages in the commercial sector are lighting, cooling and power generation. Heat generation equipment (e.g. ovens, driers, deep fryers, irons, welding torches) is quite significant in hotels, restaurants and retail trading. Fluorescent and CFLs are the main source of lighting, both in the administrative area and sales. Regarding cooling 59% of the companies use air conditioners, 55% use cold storage rooms, and use 40.8% ventilators. In power generation the main source of electricity consumption is the electric motor (i.e.74%). Most of the companies have taken measures to save electricity. Basically, these measures consisted on improve lighting and to turn off the equipment. Private companies recognise that the main reasons that impede the implementation of electricity-saving actions are lack of incentives and support from the government, as well as a lack of legislation that compel them (MINAE, 2009).

The industrial sector is divided into 10 different kinds of industries with the chemical and food industry being the largest consumers of electricity. From all the companies a percenage of 12.8% auto-generate electricity, and thus produce an average 25% of what they consume. The usages that consume the most electricity are power generation (42%) and cooling (37%). Fluorescent lights and CFLs are the most popular kind of lighting used. Most of the industries have implemented electricity-saving programs (88%), but the main measure was converting existing equipment to turn itself off (MINAE, 2009).

2.3 Electricity demand projections

Electricity demand projections are at core of the planning and expansion procedure for the electricity system. ICE has always developed these analyses. The projections allow to the managers to prepare investment and actions plans to maintain the reliability and efficiency of the electricity supply service, as well to calculate tariffs, and to define budgets among others.

Given its importance since 2003, the ICE has been implementing a projection model encompassing three scenarios. The baseline scenario, which is the most likely to occur in the next years, considers the normal growth rates in the prices. In compliance with this scenario, the electricity demand will increase on average 5.10% annually for the period of 2010-2033. The high scenario is characterized by higher economic growth rates than the reference period (1983-2001). Under this scenario, it was projected that the demand will grow in average 7.16%

annually for 2010-20033. Lastly, the low scenario projected a mix of adverse economic conditions with lower economic growth rates than the reference period (1983-2001). Figure 2-11 presents the three scenarios

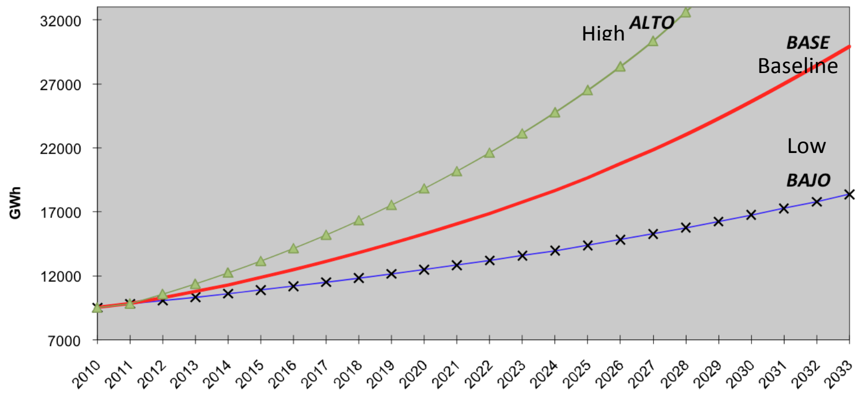

Figure 2-11: Projections of electricity generation according to different scenarios.

Source: ICE, 2010.

During a world economic crisis, it is hard to predict the future electricity demand because the behaviour related to electricity demand is abnormal. In the elaboration of Plan for the Expansion and Generation of Electricity (PEGE) for 2010-2021, the ICE recognized this situation, and decided to take a cautious position basing this plan in a scenario of quick economic recovery. Figure 2-12 shows how the economic crisis affected Costa Rica's electricity demand and also provides a projection of the electricity demand for 2018 (ICE, 2009).

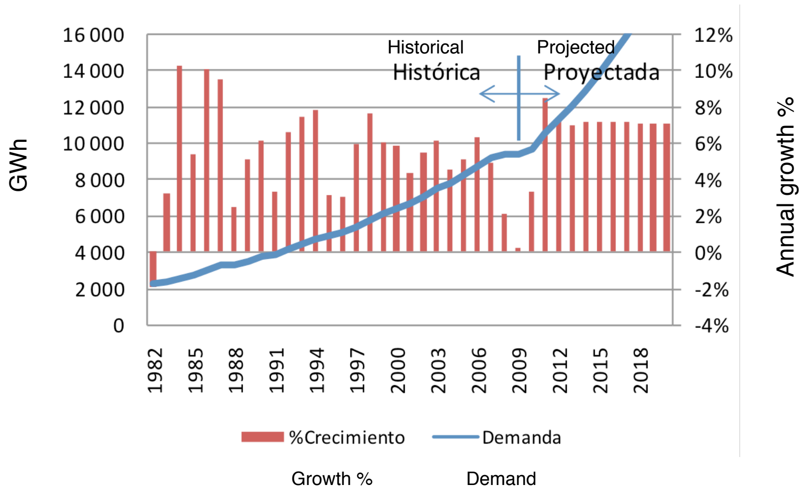

Figure 2-12: Historic evolution of electricity consumption and projected electricity demand.

Source: ICE, 2010.

2.4 Supply side management

In Costa Rica, the energy planning activities started in 1979 with the elaboration of the first diagnosis of the sector, and the first national energy balance report. Also, the National Program for Energy Planning and Development was created which was the foundation for the first National Energy Plan in 1986 (MINAE, 2001). The current National Energy Plan covers the period from 2008 to 2021, and among the lines of action related to electricity that can be underlined are to reduce the use of imported energy sources and use renewable energy sources, to implement educational programs related to rational use of energy, to steadily reduce the demand by implementing programs for energy saving and energy efficiency, and to develop infrastructure to promote local production of electricity (MINAE, 2008).

The Plan for Electricity Generation Expansion (PEGE) is a reference framework that aims to establish a common point of departure for all the participants in the electric sector for middle and long-term projection. Based on the guidelines established in the national energy policies this plan sets up the action line for the main planning components: prioritisation of investments, definition of development strategies, fixation of tariffs, and market analysis, among others (ICE, 2009).

Currently, the PEGE horizon covers the period from 2009 to 2021. It is mainly focus in the study, preparation, and funding of renewable energy projects. Roughly, the next points explain how the Government is planning to manage the electricity sector (ICE, 2009; De la Torre, 2010a):

(a) To avoid the dependency of external energy sources for electricity generation, and to promote the use of renewable sources, the ICE will prioritise the construction of 7 hydropower projects, which will add 1 440 MW to the system in the next decade. Additionally, it includes several small-scale renewable projects to consider possible developments that are still not identified. The final goal is to have fossil fuel fired electricity just as a backup.

(b) It is envisioned that halfway through the established horizon, the development of projects based on non-conventional renewable sources will be more feasible: mainly solar electricity and biomass. These will be incorporated to the PEGE in accordance to their availability.

(c) Natural gas is being contemplated as possible fossil fuel for the transition period when petroleum runs out or is no longer a feasible option.

(d) To establish the legal framework for encouraging the private sector and distribution companies to increase their participation in the development of new projects based on RES under competitive schemes. It is projected that these groups can add to the system at least 600 MW in the next decade.

(e) To obtain the authorisation to allow the ICE to deploy the geothermic energy located in two national parks, keeping strict conservationists principles and a rigorous communication and control with environmental agencies.

(f) To encourage distributed electricity generation. In other words, to incentivize final consumers to develop private small-scale renewable generation projects.

(g) To take opportunities offered by the Regional Electricity Market (REM).[12]

(h) To incentivize the development of "clusters" for the fabrication and development of

[12] Since 1985 the Central American countries decided to integrate their electric systems. Then, the region has ratified several treaties to reaffirm this objective, and to create the legal and institutional framework to develop the market. In 2009, the region was connected with México; currently, there are plans to expand the system to the south to interconnect with Colombia (ICE 2009).

energy efficient technologies at the national and regional level.

From that list, some improvements have been made in several points: (a) There is progress in the development of two hydroelectric projects: Reventazón (300 MW) and El Díquis (630MW), they were supposed to enter into operation in 2014 and 2016 (ICE 2009). However, the Plan is delayed for two years. Now the Reventazón will enter into operation in 2016, and El Díquis at the end of 2018 (Aguero 2011). Besides this, El Díquis is facing serious opposition from Terraba indigenous communities. El Díquis needs to flood 900 hectares, which are in an indigenous reserve. On March 21st,, 2011, the Terraba Indigenous Development Association, the entity who has the property rights over the reserve, sued ICE. They claim that ICE is occupying their land illegally because they still have not authorized ICE to use their land. To start the negotiations there are asking ICE to leave their land. Additionally, they are asking 10% of the project revenues (Villa 2011, Vizcaníno 2011a, 2011b, 2011c).

Regarding point (b), ICE is already developing some small projects of solar, wind, and biomass; (f) last year ICE started a pilot program to guarantee the access to the electric system for small-micro auto-generation programs based on RES, and to measure electricity in both; and (h) there exists at least one “clean tech” cluster; however, its not very active at the moment (Guevara, 2011; Castro 2011; ICE, 2009; Villegas, 2011a, 2011b).

Regarding REM, point (g), the interconnection infrastructure of the Regional Electricity Market (REM) is still under development but significantly progressing. According to the work schedule in force, the transmission infrastructure will be finished at the end of 2011 in the six countries (WOC, 2011). Nevertheless, it will take several years for the REM to mature. Currently, the market is quite incipient to guarantee the electricity supply in the same conditions than an electricity plant located within the country. Therefore, the current PEGE does not consider the import of electricity from REM as another energy source for the country, but it does consider as an essential action of the expansion plan to prepare the country to seek an active participation in the REM. ICE clearly recognises that as REM extends the options of the electric national market, it would probably be necessary to review the strategies of investment and operation in the generation sector in order to take advantage of REM opportunities (ICE, 2009).

Then there are other areas in which the Government is working but there is not much progress. For instance, the discussion of the Electricity Bill,[13] which addresses point (d), has approximately 13 years in Congress. According to Solera[14] (2011) currently the process to pass the bill is quite complicated; the discussion is stuck because of an ideological entrenchment between the different parties. Therefore, the negotiation is not getting to a pragmatic negotiation level where it can progress.

Also, the Bill 16.137, “Law to regulate the production of geothermal energy in national parks”, was presented in 2007, but the project was filed away. However, the Government just announced (April 2011) that will promote a law to authorize the generation of geothermic

[13] It aims to restructure the current electricity system to partially open the market, increase generation with RES, as well as to increase the participation from the private sector among others actors. It is priority project for the Government because it is consider a cornerstone policy measure to be able to cope with the electricity demand in the next decade.

[14] Fracinni Solera is the current counsel of the SME. She has being working as the legal advisor in SEM for circa 20 years.

electricity in national parks, as a plan to reduce fossil fuel consumption (Villegas & Loaiza, 2011; Hidalgo, 2011).

2.5 Demand side policies

Costa Rica does not have policies in place to pursue DSM, but does have legislation and programs to support the conservation and rational use of electricity. This section summarizes the key aspects of the energy framework related to demand management.

The Energy Policy, and Law 7447, Law for the Rational Use of Energy, in force since 1994, provides the legal framework for energy conservation. Regarding demand in the electricity sector, the Energy Policy proposes three specific actions: to update the National Energy Plan; and the Program for Energy Conservation (PRONACE); as well to develop energy efficiency standards for electric appliances (De la Torre, 2010a).

The objective of Law 7447 is to consolidate the participation of the Government in the implementation of a program for the rational use of electricity. Even though in theory, it is the strongest regulatory tool in force in Costa Rica, its mandates are greatly unobserved. According to Solera (2011) and Castillo (2011), both employees of SEM, this law was passed without creating an administrative unit to enforce it. They strongly argue that it is not within SEM's capacity to enforce this law because they are a planning entity, not an operative one. Therefore, the perception is that though Law 7447 has good spirit and offers useful tools, it does not have the capacity to work because now, 17 years after its approval, MINAE has failed to produce the human and administrative capacity to enforce it.

Law 7447 proposes five main mechanisms to achieve its general objective; two of them are working. Firstly, there is the permanent exoneration of material and equipment, either national or imported, which promotes an efficient use of energy, from paying any kind of tax. The list encompasses 20 categories of products or materials. For instance: solar water heaters, home appliances that can be directly used with photovoltaic panels and well as with wind and hydro power, materials to built equipment to exploit renewable energies, thermal materials, among others (Law 8829). Additionally, the MINAE and CNFL, have implemented professional programs to train teachers, at a national level, how to raise awareness in schools and high schools about the importance of electricity conservation, the rational use of electricity is now part of the curriculum in public schools (Chanto, 2011; CEPAL, 2010).

There are also some improvement in the implementation of the mandate to develop regulations for the fabrication and importation of efficient equipment. A National Committee, lead by ICE, has developed 15 technical standards that regulate the energy efficiency of domestic and commercial refrigerators and freezers, fluorescent and compact lights, and motors (Castillo, 2011). Nevertheless, these standards are voluntary, non-binding, and the country is far from implementing a labelling system as is mandated by Law 7447. The SEM is quite conscious of the importance of having proper energy efficiency standards and a labelling system. However, Solera (2011) and Castillo (2011) recognize that for this system to work it requires a strong administrative capacity to control the market actors' performance. As currently there is no possibility of getting the financial resources to do that the SEM made the decision to begin developing, at least, a set of voluntarily technical standards. This action does not demand economic resources, and if, in the long term, the economic and political conditions change, it will be easier to implement a labelling system (Solera, 2011; Castillo, 2011).

Little progress has been made in the enforcement of one of the key disposition of Law 7447, it compels big consumers to present a yearly energy declaration, and to execute electricity saving programs (the companies that implement the program properly can receive incentives, while the ones that do not observe this mandate can be fined). However, of the more than 900 big consumers identified, a very small number voluntarily observe this tenant. Again, the SEM lacks the human capacity to monitor these companies and to implement the thorny legal procedures necessary to put sanctions against them (Castillo, 2011; Solera, 2011). Another disputable point is that the Law can be interpreted in such a way that it would identify the distribution companies and electrification cooperatives as major consumers. In principle it offers a tool to compel these entities to implement electricity saving programs, but neither SEM nor ARESEP enforces this, arguing that it is not within their field (Solera 2011; Ramírez, E., 2011).

Finally, this law designates MINAE as the responsible party in the elaboration, coordination, and supervision of the National Program for Energy Conservation (PRONACE). The National Commission for Energy Conservation (NCEC) was created in order to coordinate and implement the institutional activities in this area by Decree 23335-MIRENEM established in 1994. Among the Commission's main functions are to elaborate the PRONACE, and to coordinate and monitor its implementation. In 1994 the first version of PRONACE was published; then a second version for the period 2001-2006 was published. Thus far the Program has not been actualized, in fact the NCEC stopped meeting in 2006.

As it is stated in PRONACE 2001-2006 its general objective is "to slow down the growth rate of the electricity demand without compromising the economic development, quality of life, and environment of Costa Ricans". In order to achieve this, it has established seven subprograms-each of which encompass a set of projects that specify the expectation of results and the necessity of following of a timeline. The subprograms related to the topic of analysis are: information and education; the improvement of the energy efficiency of equipment; institutional savings programs; macro consumers; and regulatory frameworks and tariffs. Even though some of the projects were partially implemented, very few of the subprograms achieved their stated objectives. The information and education was the only subprogram where many of the objectives were implemented successfully (MINAE, 2009).

The pricing of electricity and tariffs has been an important issue in Costa Rica because to a large extent the electricity pricing model is based, not on the production costs or consumption patterns, but the characteristics of the users. The differences in the tariffs, in both generation and distribution, have been given due to social, political or opportunistic reasons but do not obey technical rationale. Therefore, tariffs are very distorted, and do not reflect the real cost of electricity.

In the late 90's, ICE and ARESEP began the process of rebalancing the tariffs; currently the subsidies have been substantially reduced but the process is ongoing and quite slow because of its political nature. The residential sector received a large amount of subsidies, mainly from the commercial sector. Essentially, household electricity prices continue to be subsidized, although the subsidies are lower than before, they have not yet reach a level that reflects the full costs of production, transmission, and distribution. Additionally, as the residential sector is very sensitive to the fluctuation of the price of electricity, the subsidies cannot be completely eliminated (Ramírez, E., 2011; De la Cruz, 2011). Regarding tariffs, all the distribution companies, except Copesantos, have a time-of-use-tariff for the industrial sector, but only CNFL has a time-of-use-tariff for the residential sector (Ramírez E, 2011), Additionally, subsides are quite difficult to identify and delineate because the different sectors are mixed (MINAE, 2001).

An investigation was conducted to analyze why PRONACE was not successful in achieving its objective (Chanto, 2011), among the main causes it can be mentioned: (1) There were no clarifications as to how specific tasks were to be planned. The detailed planning of the projects was the responsibility of each individual institution. (2) The NCEC did not have their own budget so the implementation of projects depended on the financial resources of the individual institutions. Mainly, ICE and CNFL provided funds for the implementation of projects. The distribution companies and electrification cooperatives did not have sufficient resources to pay for the implementation of energy saving programs, as mandated by Law 7447. (3) The CNEC employees were required to bear the burden of additional coordination responsibilities without receiving any additional compensation; most of them did not commit seriously to the program. (4) PRONACE did not have quantitative saving goals. Therefore, it did not perform any accomplishment evaluations. (5) CNEC did not have enough political influence to force the different actors to achieve the stated objectives.

The Government has also used directives as a policy tool to achieve energy savings in the public sector. It has issued several directives toward the rational use of energy in the public sector. For instance, Directive 017, which requires institutions in the public sector to have an energy saving program, or Directives 22 and 46 that authorize an opening hour change in public administration (CEPAL 2009.a). However, according to Solera, they are not very effective because evaluation is an issue, which difficults its enforcement. Another, aspect that diminishes the effectiveness of this policy tool is that it cannot compel the private sector to take measures (Solera, 2011).

Finally, there are the actions and programs lead by non-governmental organizations (NGOs) and private consultants. For instance, the Central American Commission of Environment and Development (CACED) has a partnership with Bun-ca, a national NGO specializing in energy efficient solutions, to develop the Central America Energy Efficiency Policy. Its main objective is to design a framework of public policies to promote the development of an energy efficiency market at the end user level in the electricity sector. This policy is understood as a dynamic process that focuses in removing political, financial, cultural, and technical barriers; helping to open the energy efficiency markets at a regional and national level. Based on the barriers found, this policy lays out seven objectives. Bun-ca has been working to increase the energy efficiency of the hotel sector at a national level in Costa Rica. They also analyzed the main barriers for energy efficiency markets in Costa Rica and proposed a package of incentives, and supporting labeling process.

GiZ, a German development corporation, with offices in Costa Rica, leads an energy efficiency program in Central America. In Costa Rica, the program has three lines of action:

- Supporting governments to develop a regulatory framework that promotes EE. In Costa Rica, they mainly work with SEM, and are supporting them to reactivate PRONACE. They are also evaluating appropriate incentives, as well as analyzing why the ones given in Law 7447 did not work.
- Building institutional capacity to implement projects. Here they work with the Industrial Association, which has a department of EE and renewable energies, to develop a training program to promote public and private investment in EE. Also, they are working with ICE to define a program to incentivize the replacement of household refrigerators and a program that promotes the utilization of biomass, namely biogas. They are also working with the Industries Union to develop an initiative to encourage the construction of sustainable industrial parks.
- Education and awareness, they assist the Industrial Union in the preparation of congresses and seminars about EE.

Private consultants have the role of stirring firms' interest in EE, they study the corporations' business and processes and show them how to make improvements. For example, Geotecnologías a firm that is trying to introduce smart grid technology (Castro, 2011).

3 Framing DSM theory

This chapter aims to create a basic understanding about the contents underpinning DSM. Therefore, it explains the DSM concept (3.1), the elements/tools covered in the concept (3.2.), and DSM rationale and benefits (3.3.). Also, it describes the evolution of DSM framework, and exposes the experience of two countries implementing DSM (3.4.).

3.1 DSM definition

DSM as a concept refers to a "set of tools and practices utilized to affect the amount and/or timing of customers' energy demand in order to use electricity most efficiently" (Yu, 2010). DSM deals with the planning, implementation and evaluation of programs to influence the amount and timing of energy usage, and it is one of the ways of balancing supply and demand (Yilmaz et al., 2008).

In this regard, it is considered that electricity saved is more valuable than the electricity generated (Saini, 2004)[15], that phrase encloses rather plainly the DSM rationale. DSM programs look at convenient ways to stop users from creating a demand for generating the next megawatt-hour of energy, thus deferring the next generating plant (Gehring, 2002). According to the IEA (2010) DSM logic can be described with the following statements:

- "A better use of resources equals lower cost for service,
- A balanced use of resources means a more secure and reliable energy supply,
- An expansion for products/services using less energy (using more wisely) is an injection for future business."

It is important to make here the distinction between energy conservation programs and DSM. Although they share some similarities, they are different because DSM programs have to benefit both: the electric company and the client. Also, DSM is a long-term planning activity; it stipulates that demand side options should be considered as an additional source of power and energy in the traditional portfolio of investment options to cope with growing demand (Consortium PREEICA, 2000).

Often, DSM is framed under integrated resource planning theory (IRP). The literature offers numerous definitions for IRP as is applied to the energy sector. Overall, IRP can be explained as a process that takes place during the planning period that aims to find an optimal combination of demand and supply side measures to meet the energy service needs at the lowest reasonable cost. In the IRP models, an optimal situation is attained when the load demand curve equals that of the supply availability. Therefore, the utilities perform combinations of supply and demand side options for achieving a flat profile versus time for the optimum supply in the load demand curve (Yilmaz et al., 2008).

The central concept behind the IRP approach can be summed up in three core ideas: (1) IRP puts demand side options at the same level than supply side resources, and assesses them equally; (2) it looks to meet the projected demand for electricity at the lowest possible cost; (3)

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[15] In compliance with Saini (2004) one unit saved at the consumer end is worth 1.10 units saved at the generator end (considering the long transmission and distribution line losses).

it incorporates societal costs, such as environmental impacts, and not just the organizational costs (Yilmaz et al., 2008, D'sa, 2004; Didden & D'haeseleer, 2003).

In this analysis, IRP is seen as a framework for DSM (Didden & D'haeseleer, 2003), and as a theoretical structure to introduce DSM rationality. IRP is understood as an approach that considers demand side options into the traditional planning process of utilities, or, in other words, as a good management principle, which recognizes that balancing supply and demand can contribute to meet the energy needs in a cost effective manner.

Nonetheless, it is important to recognize that beyond theory IRP is indeed a tool that helps utilities to consistently assess a broad range of demand and supply measures, and to explicitly define the amount, as well as the appropriate mix, of possible the supply and demand actions (Didden & D'haeseleer, 2003; D'sa, 2004; Hirst 1994). In this sense, the effectiveness of IRP has been criticized mainly because of methodological issues. For instance, the are several factors that can lead to false judgements or conclusions from IRP considerations: (1) limitations in the relative accuracy of the available modelling tools to perform the supply and demand assesment analyses, (2) difficulties when linking different models with each other, (3) uncertainties in the input data required by the models (Eto1990). Regardless, IRP is still being used and maintains prevalence among policy makers. Anyhow, this discussion is out of the scope of this research because considering Costa Rica's context, it is first needed to implement DSM in order to be able to perform IRP.

3.2 Elements and tools encompassed in DSM

DSM is an umbrella concept and many countries have different terminologies for DSM measures. DSM encompasses a broad set of actions (on the side of consumers and utilities) all with an emphasis on reducing the demand for electricity and/or generation capacity; however, they can be classified in two broad program categories ("IEA", 2010, Yu, 2010, Kim & Shcherbakova, 2011, Gellings, 1995):

- Energy efficiency programs: they affect the load level and aim to reduce a customer's total amount of energy used on a permanent basis through the installation of energy-efficient technologies and behavioural changes. The policy tools used to promote it include, among others, rebates, investment incentives, energy audits, stringent monitoring and verification of energy savings.
- Load management programs: they affect the load shape and mainly target to curtailing or shifting demand away from peak demand periods which have high costs. Generally, they are implemented through the following policy tools: time of use pricing, interruptible load programs, real time pricing, advanced metering, and demand bidding.

Demand response measures are a subset of load management programs but are themselves more market-based. This means that they use financial signals as incentives for changing the consumers' electricity use patterns. Their ultimate goal is to redistribute demand and flatten the daily and seasonal peaks to improve supply reliability (Kim & Shcherbakova, 2011; "IEA", 2010 n.d.).[16]

[16] It has been identified that since the beginning of 21st century, popularity of demand response (DR) has been growing in the U.S (Kim & Shcherbakova, 2011, Gehring, 2002). The US is a well-established example on how DSM programs are proven to be cost-effective, and in countries with fast growing economies, especially in Asia, seems to be very attractive and natural; they need to optimize the resources to propel the expansion (Kim & Shcherbakova, 2011, Yu, 2010, Nilsson, 2007).

It has been identified by the "IEA" (2010?), that Energy Efficiency (EE) has the highest economic and greatest potential to reduce costs and environmental impacts, and thus its popularity is growing steadily. However, EE expansion still has to deal with an important shortcoming; that is that it is invisible and is delivered in small packages. DSM offers an excellent framework to overcome those problems; through its deployment EE small resources are aggregated into larger programmes to make the results visible and attractive for industries, governments, and customers ("IEA", 2010).

IEA has classified DSM initiatives into three groups (Didden & D'haeseleer, 2003):

- Frameworks: they define how to fund DSM activities; e.g. public policy based approach or market based ortiented approach or artificial and natural framework.
- Programs: initiatives that try to change the consumers' electricity consumption directly e.g. rebates, labels.
- Additional mechanisms: comprised of all other activities that stimulate the implementation of programs; e.g. raising a fund through a public benefit charge.

The public policy based DSM framework is created when the government imposes an energy saving obligation over actors who do not have a natural incentive to implement energy saving initiatives. Therefore, it becomes necessary to give utilities incentives to promote DSM investments. IRP is the best-known example to illustrate this approach. There are several variations about the application of this framework, which can be reflected in the price. For example, customers pay the same price per kWh as they did before the introduction of the IRP process; it implies that the utility will have to pay all the costs of the demand side measures, as well as the lost profits due to the decrease in sales of kWhs. Another application is the so called 'public benefit charge' or 'wires charge'. Here, utilities are authorized to raise the tariffs to pay for the DSM initiatives. Lastly, applications where utilities can raise tariffs to recover any lost profits, and even make profit on the money invested in DSM; this is known as the demand side profitability.

The core idea a market-based ortiented DSM approach is to give the responsibility for energy efficiency to an entity that will have no financial losses if electricity consumption is reduced. In other words, the actor who gets the primary responsibility to achieve energy savings has a financial motivation to implement them; for example, the Energy Service Companies (ESCOs). In this approach there is no rate mechanism or other public financial support through which utilities can recover costs. Therefore, DSM initiatives find their funding from a combination of the utility, customer, and/or third party investment, for example (Weisbrod 1999):

- Utility customers: they directly pay the cost of DSM when is clear for them that their investment will be recovered through reduced consumption and/or enhanced equipment performance and useful life.
- Utility company: the utility gives the funding if such investment produces a revenue benefit that offsets the costs.
- Third parties: manufacturers or service providers pay the costs of DSM when there is the possibility to expand sales of their products or services to offset expenditures.

The measures that DSM generally uses to affect both load level and/or level shape can be summarized as follows (IEA-DSM, n.d):

- Reduce the peaks in demand
- Shift the loads between times of day or even seasons

- Fill the demand valleys to better utilize existing power resources
- Reduce overall demand (strategic saving) in the context of delivering the required energy services by use of less energy (and not a reduction in services)
- Provide strategic growth especially to shift between one type of supply to another with more favourable characteristics, for example, in terms of the environment

3.3 DSM rationale and benefits

The electricity as an energy carrier has some unique features, which make the use of DSM particulary attractive for the electricity sector. Some of those attributes are:

- Electric energy is difficult to store with commercially available technologies; storage is very expensive.
- Hence, electricity needs to be produced when it is consumed.
- Building up supply side infrastructure takes time: the planning and building process for a new power station can take years.
- It is difficult to transport electricity over long distances. Thus, electricity markets are typically national or regional markets.

Demand side actions should have priority in all energy policy and planning processes designed to create or increase the reliability and sustainability of the electricity systems. The implementation of DSM measures brings benefits to every link in the chain: from generation, through transmission and distribution to the consumer.

Balancing supply and demand has positive impacts on both the reliability and the security of the given systems because the resource portfolio is more diverse and the power network is less dependent on large generation and distribution systems. Additionally, it can lessen grid congestion, transmission, and distribution infrastructure. Moreover, it can increase a country's competitiveness by reducing overall electricity costs, diminishing energy shortages, and by pushing local enterprises to be more efficient (Yilmaz et al., 2008; WEC, 2008, IEA, 2010; Nilsson, 2007)

DSM programs can also be beneficial for the environment and climate: an energy system with a low demand requires less primary energy. It can reduce local pollution and CO_2 emissions, and enhance the allocation of obligations for reducing greenhouse gas emissions between sectors and countries ("IEA", 2010; WEC 2008, Yilmaz et al., 2008; US Department of Energy, 2007).

Other merits of DSM are: lower electricity rates for customers, and creation of long-term jobs due to new technologies. It can contribute to clear market conditions for ESCOs and to boost EE products. Additionally, it can contribute to improving the use of market communication mechanisms, for instance standards and labels (Yilmaz et al., 2008; IEA, 2010; Nilsson, 2007; Saini, 2004).

Moreover, there is a fairly extensive body of literature analyzing outcomes of load shaping activities or DR programs. One key advantage of DR programs is that they engage the consumer in a process that has historically been a producer's responsibility; that is, to ensure a reliable and uninterrupted electricity service. By actively shifting usage to lower-cost time periods, DR programs help consumers realize their electricity usage profile and its effect in the region or country load demand curve profile. As a consequence, commonly expected and observed benefits are (US Department of Energy, 2007; Kim & Shcherbakova, 2011; Nilsson 2007):

- Improving operating conditions for utilities from increased peak-time rates, and reducing marginal costs of lower peak power quantities.
- Reducing the amount of generation and transmission assets required for providing electric services, and contributing to postpone infrastructure investment.
- Cost savings for end users.
- Increasing the spread of energy-efficient appliances.
- Reducing the potential for forced outages or full-scale blackouts.
- Improving operation and use of flowing renewable sources.
- Enhancing operators' ability to manage the electric grid.

Such control in the ability to handle systems may deliver additional benefits: reduced price volatility by improving short term price elasticity, improved system security by decreasing dependency on vulnerable supply resources, improved restoration capacity in or after emergencies, and creating an elastic response as complement to competition.

3.4 Evolution and experience of DSM in selected countries

3.4.1 Evolution and prevalence of DSM

From the mid-1970s to the 2000s important changes have taken place in global electricity markets. For example, average costs and construction times have increased for new projects, and other factors such as higher interest rates (applicable specially for developing countries), and greater volatility of supply costs of fuel drive the cost even further up. Those situations have increased the risk of depending merely on supply-side options, and they have altered the traditional planning approaches of utilities, which now include demand-side management measures in their resources portfolio (Yilmaza et. al 2008).

DSM development was born in the United States and was largely a response to the oil crisis of the 1970s. It started to be widely discussed in the 1980s as the alternative to supply-side "overspending" in energy systems. The traditional DSM approach was delivered through vertically integrated electric utilities; the basic idea was to compare more supply and less demand on equal terms and choose the least costly option for the energy system's performance. Utilities aimed to achieve a flatter demand load curve, and ultimately to delay capital- intensive investments in power generation (Wikler, 2000; IEA-DSM, n.d.).

Since then, DSM has faced several waves of change, and it has proven to be a quite dynamic and fluid concept. Throughout more than three decades, DSM's nature has been modified by different sources, and this evolution is an ongoing process. DSM is still evolving and adapting to different global setting where power market rules are being changed and restructured (Charles River Associates, 2005, Wikler, 2000, IEA-DSM, n.d.).

In the U.S., the power market's privatization came with a succeeding elimination of regulatory requirements for utilities to conduct DSM. Then, the rationale and motivation for DSM became a little obscured. Many utilities redefined their business strategies and, as a consequence, could no longer afford to allocate as much money to DSM as before (Wikler, 2000; Weisbrod, 1999). For instance, from 1993 to 1997, the investment in energy-efficiency programs declined from USD 1.6 billion to USD 900 million. However, nowadays, privatization efforts are not seen as a roadblock for DSM (IEA 2010, Didden & D'haeseleer, 2003). DSM still maintains a fairly high profile among policymakers and industries. In fact, for many countries that already have or are in the process of privatizing their electric power sectors, DSM is explicitly a part of the equation. It is believed that DSM will continue to receive public funding while more countries continue to place energy security, environmental awareness, and impact mitigation at the top of their agendas (e.g. in the U.S. the government authorities have recognized the need to continue active measures, and in 2000 spending on DSM rose steadily to USD 1.10 billion) (Yu, 2010; Wikler, 2000).

In Europe, most DSM processes began in the late 1980s or early 1990s. Their common characteristic was the lack of financial incentives for the utility to implement DSM measures. Currently, these processes are mostly focused in energy efficiency and energy conservation options (Didden & D'haeseleer, 2003).

The International Energy Agency (IEA) (2010) agrees that DSM seems to be as important now as it was in the past and will continue to have relevance in the future. DSM embodies a set of technologies and market incentives that evolve in response to changing situations in the energy marketplace (Wikler, 2000). The IEA has gone through a set of wave changes and critiques, but the use of this framework in different regions around the world, such as Europe, Africa, Latin America, and South Asia, shows that DSM theory and practice thus showcasing that DSM approach holds firm (Koppejan & Groenewegen, 2005; Wikler, 2000; Cepal, 2010a, Dube et al. 2005). The smart grid technologies, which are quite in vougue at the time, may benefit DSM usage by acting as a facilitating factor for a wider DSM implementation.

Lastly, the intrinsic value of DSM to individual electricity users has not changed since the mid-1980s. DSM is still popular to the extent it lowers customers' bills, mainly if the actions do not detract them from comfort or performance. Additionally, rising costs to build new generation capacity and sustainability concerns will continue to add to DSM's popularity with utility management, regulators, and other stakeholders (Gehring, 2002, Wikler, 2000).

3.4.2 DSM experience in California and India

For implementing DSM, policymakers need to consider different policy options, from public purpose programs to private sector oriented initiatives. The following case studies from India and the California show two different approaches for DSM. Although, it is recognised by the author that background (e.g. economy, weather, development issues) of this cases studies are very different to Costa Rica, they do illustrate a general policy route to implement DSM from two different approaches. The California case study is more public policy based, and India case is market based oriented.

3.4.2.1 California

Two-thirds of U.S. states are developing DSM efforts. Among these states, California was the first to develop DSM, and California figurates among the ones that have achieved the most success (Wikler, 2000; Yu, 2010)

Since the oil crisis of the 1970s, California has supported DSM programs. All these years working with DSM have lead California to achieve the following merits: (1) since 1975 until 2010, DSM programs have reduced energy costs for residents and firms in California by US$56 billion; (2) DSM programs have developed an energy service industry that employs 30 000 people; (3) California's cumulative electric load has been reduced around 15% of the total electric load BAU, it is equivalent to postponing the construction of 24 large power plants, avoiding 40 billion kilowatt-hours of electricity consumption annually, and minimizing greenhouse gas emissions by about 17%; (4) the cost of efficiency programs over their lifetime has averaged 2–3 cents per kWh of saved electricity, less than half the cost of the avoided generation; (5) During the last decade California's economy has received a net benefit of about US$ 4.1 billion from efficiency programs. (6) DSM activities played a key role in calming

Californians avoided blackouts by reducing demand in summer 2001 by more than 5500 MW a reduction in peak demand of more than 10% (Yu, 2010).

The required funds for DSM in California come mainly from electricity surcharges, which are about 600 million dollars annually. Basically, the funds are used for product and project rebates, technology development, and systems design (Yu, 2010). The history of California's DSM can be divided into four distinct periods (Vine, Rhee, Lee, 2006):

The pre-protocol era (1970s–1994)
The California Public Utilities Commission (CPUC) authorized the use of ratepayer funds to promote energy efficiency activities. In the early to mid-1980s, the load management programs were also emphasized. CPUC also authorized the major investor-owned utilities (IOUs) under its jurisdiction to administer EE programs. This had the aim to support a comprehensive planning, funding, and implementation regulatory scheme, as well as to contribute overcome the divisions among utilities, and other stakeholders. A wide variety of programs was authorized by the CPUC and administered and implemented by the utilities in virtually all customer market segments. From the late 1980s until 2002, the CPUC enable the utilities to recover from ratepayers the costs of shareholder incentive mechanisms. The terms under which the utilities were allowed to recover these payments varied for the different utilities and year to year, especially in the 1990–1994 timeframe.

In 1983, the Standard Practice Manual was published jointly by the CPUC and the California Energy Commission (CEC) to provide standardized methodologies to assess the cost-effectiveness of utility-administered DSM programs. Before it, there were not any official guidelines for these kind of programs. The manual was composed of several tests; these include: the ratepayer impact measure test, the utility cost test, the participant test, the total resource cost test, and the societal test.

In June 1990, the CPUC decided to increase energy efficiency program funding, adopt shareholder incentives, and establish a more rigorous measure and evaluation (M&E) infrastructure. In 1993, the CPUC adopted a comprehensive and rigorous set of measurement requirements, requiring that utilities to evaluate energy efficiency programs be based on ex-post actual performance instead of engineering or ex-ante estimates. In addition, it created the California DSM Measurement Advisory Committee (CADMAC) to ensure the continuing development of these protocols.

The protocol era (1994–1997)
For the 1994–1997 years, the CPUC enacted statewide consistency for the shareholder incentive mechanisms, set stricter conditions for the measurement and verification of costs and benefits. In this period, shareholder incentives were tied to lifecycle net benefits, instead of first year energy savings.

In 1995, the uncertainty about energy restructuring was one of the core driving factors for lower EE spending. Beginning in 1995, EE programs eligible for shareholder incentives had to be cost-effective on a forecast basis.

The restructuring era (1998–2000)
CPUC's approach to EE funding and evaluation was dramatically affected by EEPPP. Starting in 1998, Energy Efficiency Public Purpose Program (EEPPP) codified the mechanism for collecting and disbursing EEPPP funds. At first, funding for traditional rebates was reduced and supplemented by Standard Performance Contract (SPC) programs targeting the commercial and industrial sector. Second, funding for upstream market transformation

interventions was significantly increased. Furthermore, utility performance awards were substantially de-linked from cost-effectiveness considerations for some programs, so that the earnings opportunities for the utilities were more limited. Lastly, expenses on M&E studies were increase, this aimed to quantify market effects and indirect benefits assigned to the expanded upstream market transformation programs, while total expenditures on evaluation were reduced.

Beginning in 1998, the CPUC shifted to a market transformation goal for energy efficiency programs. The CPUC codified a policy that emphasized removing market barriers to energy efficiency so that private sector entities would be able to provide energy efficiency services, once public funds were no longer available. For instance, EE funds were spent on upstream market transformation activities that focused on product developers and/or suppliers rather than end users/ customers.

Another important hallmark of this period was the adoption of the public purpose test (PPT). The PPT is based upon the Societal Test and PPT includes aspects that were not traditionally included in the total resource cost test (TRC) calculations, such as non-energy costs-benefits, positive-negative externalities, and reductions in the cost of measures or practices caused by the program. Moreover, the PPT is applied at the portfolio level because regulations required the programs as a whole to be cost effective, while the TRC and Societal Tests are applied at the program level. In 1999, the PPT was adopted as the standard test for cost effectiveness. The CPUC also approved statewide rules for avoided electricity generation costs, avoided electricity transmission and distribution costs, among others.

Post-2000 period

A period characterized by great uncertainty regarding the level of spending for energy efficiency programs, and the administration and implementation of these programs. It was also marked by the urgency of trying to resolve the energy crisis of 2000–2001. Between the summer of 2000 and the early winter months of 2001, the California Independent System Operator declared over 70 days of system emergencies, and rolling blackouts were implemented on several occasions. California addressed this unprecedented electricity crisis allocating unparalleled amounts of funding to demand side policy initiatives. Overall, more than US$1.3 billion in funding was authorized for demand reduction initiatives, standing for a 250% increase over the spending in 2000.

Currently, California law requires the state's investor-owned utilities to use modest regular adjustments in electric rates to break the connection between the utilities' profitability and the volumes of electricity sold. CPUC approves the costs and investments of utilities, and then adjusts electricity rates to achieve a certain return on their investment. Meanwhile, power companies can procure an extra rewards for effectively improving EE (Yu, 2010).

3.4.2.2 India

In the recent years, India's energy consumption has been increasing at one of the fastest rates in the world due to population growth and economic development. India ranks fifth in the world of primary energy consumption. Since 1999, India's energy intensity has been decreasing and is expected to continue to decrease. Currently, energy intensity is decreasing at about 1.5% per year when using market exange rates (MER). However, India energy intensity is still high, which provides a large potential for EE improvements. The peak and energy shortage, from the year 2008 to 2009 were around 13% and 9% respectively. It has been estimated that DSM measures have an electricity potential saving of 15%. Therefore, DSM offers to the government an important policy tool to overcome shortages (Kumar, 2009;

Indian Energy Portal, 2009; Painuly, 2009).

Important hallmarks of India EE and DMS process (Painuly, 2009; Kumar, 2009; Wikler, 2000) are: (1) The international development community has played a key role in promoting DSM through grant funds and concessional loans. Since the late 1990s India has receive significant amount of funds for EE from USAID, GiZ, the World Bank, and Asian Development Bank. Currently, one of the most innovative aspects is that some projects are being partially funded through the UNFCCC Clean Development Mechanism. (2) Universities, institutes and non-governmental organizations (NGOs), industry associations have their own cells EE and had an important role in promoting DSM actions. (3) A wide range of EE initiatives are underway in India, many of them quite creative and with great promise, but are fragmented. (4) The ESCO sector is still small and needs more experience. (5) Some of the identified barriers to DSM are: lack of proliferation of DSM projects and concepts, low awareness amongst public and policy makers, financial barriers for financing EE projects, and capacity building of banks and financial institutions.

In 1970s, energy conservation programs started in India. The Energy Conservation Act 2001 was a major initiative on energy conservation. It states the energy consumption norms and standards for the most energy intensive industries. In addition, the 11th Indian Five Year Plan, which establish the key economic development objectives for the country for the period 2007-2012. It also sets a mandatory EE target of 5% by 2012 below business as usual levels. This led to the establishment of the Bureau of Energy Efficiency BEE in 2002. It empowered BEE as the nodal statutory body, its efforts must be directed to incorporate EE and DSM measures in the energy development strategy so that decoupling of economic growth and energy growth is sustained. It also must develop and advise the Central and State Governments on valuable strategies to foster EE, coordinate their implementation, and set out systems and procedures to monitor and verify EE conservation measures. The appointed State Designated Agencies (SDAs) have to cooperate with BEE and implementation actions at the State (ICER, 2010; Painuly, 2009; Kumar, 2009).

In India the DSM road map has sorted the identified opportunities in two board categories: Utility Driven DSM (UDDSM) and Market Transformation Driven DSM (MTDDSM). The nature of UDDSM programmes could range from public awareness programmes to DSM resources acquirement programmes encompassing technology, fiscal incentives, and monitoring and verification protocols. The MTDDSM is led by interventions created through enabling policies at the end use level. For instance: standards and labeling programme, and energy efficient building codes.

BEE has initiated an Energy Efficiency Financing Platform (EEFP) for promoting financing of EE projects, which sets up of partial risk guarantee funds, development of innovative financial contracts, and fiscal and tax incentives for investment in this sector. This financial mechanism jointly with a robust ESCO industry can be a strong driver to stimulate the expansion of EE markets. In order to address the barriers that have resulted in market failures till date, a comprehensive portfolio of measures have been put in place, some of them are (ICER, 2010; Kumar, 2009): (1) enforcement of enabling legislation; namely the Energy Conservation Act, 2001. It empowers the Central Government and SDAs to notify energy intensive industries, other establishments and commercial buildings as designated consumers and mandate energy consumption norms and standards for them; (2) putting in place a multi-sectoral policy for EE: Integrated Energy Policy, and the Energy Efficiency Action Plan; (3) As part of the regulatory and legal strategy BEE has launch several measures to:

- Enactment of the Energy Conservation Building Code (ECBC): currently, it is enforced on a voluntary basis. It establishes energy standards for new commercial buildings.

- Promoting agricultural DSM by programs that aim to replace inefficient pump sets, street lighting, among others. It is carried out especially through the establishment of public-private partnerships.

- Increase demand for EE products and services through raising awareness about their efficacy; requesting government policies and programs to integrate EE; preparing bankable projects to stimulate the process, and incentivizing cost effective improvements in EE in energy-intensive industries.

- Assure availability of adequate supply of EE products, goods and services. It is being acomplished by creating a pool of energy professional, promoting ESCOs, standards and labeling of end use equipments and appliances, preparing structured programmes to leverage Clean Development Mechanism (CDM) to reduce transaction costs to attract private investment.

- Creation and adoption of robust and credible monitoring and verification protocols to capture energy savings from all energy efficiency activities in a transparent manner.

- Promotion of energy efficiency measures through ESCOs. For this activity BEE has initiated several measures, some of them are: (1) increasing demand for energy services through Government programmes in commercial, municipal, agriculture and small and medium Enterprises sectors by creating over 1200 bankable EE retrofit projects; (2) enhancing credibility by enrolling 37 ESCOs selected throughout a competitive process; (3) accreditation of ESCOs through credit rating agencies.

- For stimulating market development BEE has assume several measures: (1) creating a standard encompassing the entire project cycle from audit to performance measurement and verification; (2) design of contract standard performance; (3) design of instruments for project funding; (3) project post evaluation of impact; (4) capacity building of policy makers, awareness amongst general public and facility project owners.

There are some interesting remarks that can be extracted from these two case studies for a future application of DSM in Costa Rica. Both DSM implementation approaches require strategic governmental intervention. Furthermore, California DSM experience shows that providing recovery mechanisms for utilities it is an effective tool for promoting DSM implementation. It also illustrates that recovery mechanisims in order to work effectively need stable long-term funding. Additionally, strict measurement and evaluation protocols need to be delineated and enforced. India case study demonstrates that DSM can occur without recovery mechanisms or government subsidies, but that it is still needed a solid and consistent governmental intervention to create the necessary conditions to allow creative partnerships between utilities, customers, and third parties, as well as the ESCOs market to flourish. Both case studies show the importance to have the financial sector on board.

4 Status of DSM in Costa Rica

It intends to frame down DSM to CR electricity sector. It reviews the experience with DSM of two key utilities in Costa Rica (e.i. ICE and CNFL) within the context of the regulatory framework describe in section *2.5 Demand side policies*. Additionally, it analizes the potential advantages of developing a DSM strategy in Costa Rica, and the main barriers that are inhibiting its implementation. Its aim is to set the foundations for the analysis in the next chapter.

4.1 Experience of Costa Rican distribution companies with demand side actions

ICE and CNFL are the main utilities in Costa Rica; together they are responsible for roughly 70% of the electricity generation and 80% of the total distribution. This section describes their experience with demand side related practices.

4.1.1 National Light and Power Corporation (CNFL)

In 1992, CNFL took its first step toward electricity conservation by carrying out a demand characterization survey; it resulted in the system's load curve (Chen-Apuy et. al 2001). Currently, CNFL has an Energy Efficiency and Innovation Management Unit, which is in charge of the energy education programs (at local and national levels). It also coordinates the free customer service of technical assistance to the firms with high electricity. Besides that, this management office is in charge of the electric transport program, which is considered a strategic area for CNFL's future business (Chanto 2011). Solís explains that the forthcoming integration of electricity vehicles, in both the public and private sectors, is going to significantly alter the nature of the electricity consumption curve of the country. If it is managed properly, it will give people the price signals to charge their vehicles at night, it can greatly contribute to the improvement of the loading factor[17] of the current system because it would help to level out the load curve. Finally, EE and Innovation Management Unit leads the charge in improving the public lighting system by introducing LED lights (Solís, 2011).

Other examples of activities that CNFL undertakes are (CEPAL 2009.a, MINAE 2001):

1. Information measures: (1) giving advice to the companies as to how they can create energy conservation committees, in accordance with Law 7447; (2) offering talks about the efficient use of electricity in work places and communities; (3) distributing electronic bulletins with ideas that encourage the efficient use of electricity; (4) online response of inquiries about energy efficiency; (5) participating, organising and presenting in seminars and fairs, which target key areas or customers for CNFL; (6) managing a website with practical advices for the rational and efficient use of electricity.

[17] It is understood as a measure of the output of a power plant compared to the maximum output it could produce. Therefore, a power plant is with a high load factor is more efficient. A higher load factor usually means more output and a lower cost per unit.

2. Consulting services: (1) Performing energy audits, analysis of the power factor, among others technical assistance services to help enterprises identify electricity savings opportunities, and corrective measures; (2) CNFL has been trying to work closely with big consumers; it had done so by the implementation of a personalised customer service to promote the continuous improvement of their electricity system; (3) developing of software for the efficient use of energy per sector.

3. Pricing measures: (1) offering differentiated time tariffs to reduce consumption in peak hours; (2) promoting the hour differential tariff for the residential sector. Currently, there are less than 5000 clients under this tariff. The CNFL has proposed to make this tariff binding for all its residential costumers. According to Solís, they have evidence that the people who used the tariffs started to manage their electricity consumption, and started saving 10% or 11% over their consumption histories, just displacing consumption, changing their habits. Nevertheless, ARESEP is reluctant to implement this change in tariffs. Meanwhile, they are trying to organise, jointly with providers of electric appliances, to give direct assistance to the residential clients visiting their homes to incentivize them to join the hour differential tariff (Solís, 2011).

4. Financing schemes for EE equipment: (1) from 1996 – 2000, CNFL implemented a campaign to replace incandescent lights. It had the objective of selling 1400 000 CFLs, and succeeded to sell 134 517 of them, generating an estimated accumulated saving effect of 774 MWh from 1996 to 2006 (Chen-Apuy et al 2001). Then the CNFL jointly with ICE, and implemented a program for the replacement of incandescent lights at the national level from 2008 to 2009. In the next few months they are probably going to implement the last big campaign in this area (Solís, 2011); (2) CNFl tries to come to agreements with providers of energy efficient equipment to facilitate their clients' purchasing of these products by charging monthly an amount of the cost in the electricity bill (Solís, 2011).

Additionally, in the public sector, the CNFL advises different institutions in the development of electricity saving programs by carrying on audits to identify saving opportunities. Also, it collaborates with the public sector in order to move toward efficient illumination systems by replacing the incandescent lights and charging progressively through electricity bills (CEPAL 2009.a).

Concerning official measures of these programs' results, they have specific examples on how the efficiency of an industry can improve. They also have some preliminary figures of the savings that the modernization of public lighting can bring, but they do not have comprehensive evaluations that assess the effects or savings these programs can yield.

4.1.2 Electricity National Institute (ICE)

ICE's work plan lays out four cornerstone programs for energy conservation (Chanto, 2011): (1) an EE program, which encompasses energy audits, and EE certifications in the industrial and commercial sectors; (2) the implementation of an institutionalized program of electricity savings oriented to promote energy savings in public institutions; (3) an EE laboratory, the only accredited entity in Central America that measures the efficiency of the equipments to certify the observance of the technical standards. The Laboratory measurement capacity has developed the country's ability to implement voluntary saving programs. It is essential to the effort to operation of the ENERGICE stamp because it does the required measurement to issue it (CEPAL, 2009a); (4) national programs for energy savings, which aims to promote energy efficient technologies and a cultural change among the clients from all the sectors. Regarding the educational and awareness actions, for example, ICE holds the ICELEC information service, and in the Customer Service Units of each of its 50 branches along the country, ICE provides customers with information about the efficient use of electricity. It also has a website with practical advises for electricity savings (CEPAL, 2009a).

According to the actual PEGE (ICE, 2009) the effects of the different energy conservation programs implemented by ICE are implicitly considered in the projections of demand growth. However, additional details are not provided due to the lack of evaluation of the effectiveness of these programs (De la Cruz, 2011).

ICE does not have a proper DSM program, however, it is aware of the advantages of developing a DSM program, in 1999, ICE appealed to an agreement between Costa Rica and Canada, which aimed to improve electric sector management, to seek for training in the DSM topic (Consortium PREEICA, 2000).

Therefore, in 2000 ICE started a process to develop a DSM program, with the counseling of Manitoba Hydro. This firm agreed to share with ICE its experience trough the conceptualization, design, formulation, organization, execution and evaluation of a DSM program, and lead them through its institutionalization. A detail work plan covering a period of 24 months was decided and approved by both companies. They expected that at the end of this period the ICE would have incorporated DSM as an additional and permanent tool in its portfolio of options to supply electricity demand. Also, that ICE would have a proper institutional infrastructure to implement DSM, and would had improved its marketing capacity to be able to implement DSM programs in a cost-effective manner (Consortium PREEICA 2000).

The notion of DSM learned by ICE had an emphasis in the commercial perspective. ICE understood DSM as a permanent commercial activity, which aims to modify consumers' consumption patterns in both aspects the moment and the level of demand (efficient use of electricity, reduction of demand or displacement of the consumption), and brings economic and technical benefits for the clients and company. DSM has to be considered an additional source of power and energy, an integral part of the planning process; it means that real and permanent commitment.

However, the training finished and ICE did not continue with the process. According to De la Cruz (2011), Salazar (2011), and Ramírez, M. (2011), it was a managerial decision, they were changes in the directors board, and several people had doubts about the benefits DSM programs could realistically handle. Mainly, this was because within the context of the moment (technical barriers, lack of economic incentives for EE equipment, lack of standards to regulate the quality of the products, distorted tariffs, and the quality of the EE in the market was very low and cost of the EE was very high), the ICE was having a hard time finding programs that could fit within the notion of DSM learned.

4.2 Possible benefits of implementing a DSM strategy in CR

According to MINAE (De la Torre, 2010), DSM actions have an energy saving potential of 10% to 20% from the demand projected for 2015, where the percentage will vary depending on the penetration of EE equipment, its usage, and the savings by the load management. However, Castillo (2010), from SEM, explained that those are rough calculations. They are an estimation extrapolated from surveys and the technology that has been used, also reaffirmed by specific case studies through energy audits. Truly, SEM does not have access to the statistics they need to calculate more accurately the DSM potential. Consequently, they are not sure if that percentage is lower or higher. Moreover, De la Cruz (2010)[18], expressed that DSM that while a DSM program is more than likely a good idea, thus ICE should promote one. The argument for DSM is not yet clear because they have not performed the necessary studies to identify and quantify the real benefits that a DSM program can bring to the institution.

The above illustrates that a paramount limitation in the path towards a real DSM implementation is the lack of information. Additionally, it shows how imperative it is that a detailed study needs to be conducted in order to quantify the real potential and benefits of DSM.

In any case, it can be argued that if DSM programs are incorporated in the planning stage, and implemented systematically, with a long range perspective, and are properly evaluated, they can bring benefits to Costa Rica's electricity sector. Both load shape programs and load level programs can be advantageous for the country, the utilities, and the consumers. DSM benefits can be classified in three groups: benefits for the country, benefits for utilities, and for consumers. Figure 4-13 summarizes the benefits indentified for Costa Rica context.

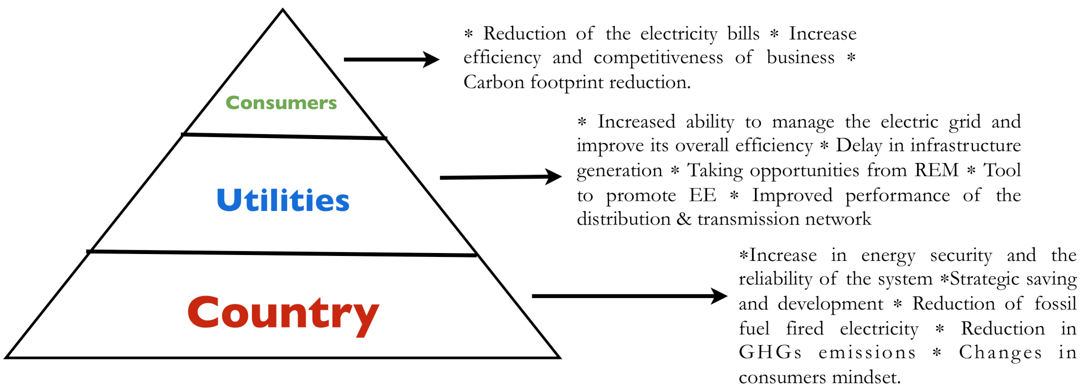

Figure 4- 13: Summary of DSM potential advantages in Costa Rica

Next, DSM's potential benefits for the country will be discussed:

- **Increase in energy security and the reliability of the system**

Demand side measures can become another source of electricity, and thus, they can contribute to diversifying the supply generation portfolio options and increasing in this way the energy security of the system. In the long term, the results of a solid DSM program can be conceptualized as virtual power plants while in the literature they are known as efficiency power plants (EPP). They are meet when energy savings from EE or load shape programs equals the quantity provided by a conventional power plant (Yu 2010).

Additionally, DSM can reduce the dependency on vulnerable supply resources, namely fossil fuel products. Load shape programs can help to reduce peak consumption, which currently is mainly being supplied with fossil fuel fired electricity. EE programs are important in order to reduce the load level, and to reduce the energy problem that the country has in the dry season when fossil fuel power plants are working almost 24 hours per day. By diminishing the demand for fossil fuel products Costa Rica's energy security increases because it is less

[18] Current sub-director of the electricity planning department from ICE.

vulnerable to oil crisis' in the international market. Furthermore, it can contribute to preparing the country for a softer transition when petroleum begins to phase out.

Lastly, DSM can help to have a better control of the grid and it also increases the usage of local resources which reduces the probability of facing an energy crisis or having energy shortages as the one which occurred in 2007. All these have a positive influence in the electricity prices and the competitiveness of the country.

- **Strategic saving and development**

DSM can provide strategic growth by reducing overall demand without a reduction in energy services. It can help to control and slow down demand growth, improve energy intensity, and decouple development from consumption.

- **Reduction of fossil fuel fired electricity**

Fossil fuel fired plants supply the demand in peak hours and in the dry season. Their generation costs are affected by oil prices in the international market (ICE 2010). Costa Rica's electricity sector has the potential to reduce fossil fuel consumption through the implementation of DSM measures alleviating with this the macro-economic financial constraints generated by the importation of high oil prices. For instance, the reduction of consumers' purchasing power, shortages of capital for the required investment in energy supply, and reduction of energy utilities budget and profitability, e.g. tariffs are fixed in advance based on estimations, therefore, if oil prices increase and/or the amount of oil needed, the generation costs steadily increase as well, and that difference in the costs has not been always recognized by the regulator, ARESEP. Since 2007, this has put ICE into serious budget constraints (De la Cruz, 2010).

DSM offers a more stable and long-term opportunity to reduce the necessity to put in place urgent and intermittent contingency plans each time the prices go up irregularly[19]. For example, during the mid months of 2011, the price per barrel of crude oil fluctuated around US$109, and it is foreseen that it is part of an increasing trend.[20] Thus, as usual, the Government has announced in April 2011 a 12-measures plan to reduce oil consumption. They plan to extend biodiesel and ethanol throughout country.[21] The plan also vows to extend vehicular circulation restrictions (i.e. regulating when/where vehicles can be driven), create a mandate for all public institutions to turn off all lights during the night, create incentives for households to install solar panels, telecommuting will be promoted, and an awareness campaign to promote the rational use of electricity (Villegas, 2011a, 2011b; Alvarado, 2011;Villegas & Loaiza 2011).

- **Reduced GHGs emissions**

Costa Rica has a goal to become carbon neutral by 2021 and, even though the transportation sector is the responsible for most of the GHGs emission, the electricity sector also has its share, and all reduction efforts are important. Moreover, it is of key to implement measures now for avoiding the necessity to increase fossil fuel fired electricity generation in the future.

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[19] Costa Rica's main energy source is oil, and it has to import 70% of the petroleum needed as final products, because it does not have the capacity to refine all the crude oil demanded (De la Torre 2010.a). Each time that the prices of fossil fuels grow up dramatically, the economy of the country greatly suffers. Even though the fossil fuel fired electricity in Costa Rica represents a small percentage in the generation matrix, every decrease counts.

[20] Even though it is expected the prices will not get up as much as in 2008 when the barrel reach the price of US$150 (Alvarado 2011, Villegas & Loaiza 2011).

[21] A complete Biofuels Program was created in 2006, but in was not implemented.

- **Change consumers mindset**

It can allow the Government and utility companies to involve consumers and transfers to them a share of responsibility in the effort to achieve a more secure and sustainable electricity sector.

DSM benefits for the utilities can be organized as follows:

- **Increased ability to manage the electric grid and improve its overall efficiency**

Costa Rica has a fairly marked load demand curve, as well as seasonal energy problem. That makes it necessary to have installed a system for surplus generation capacity. This, on its own, already represents a big investment which, most likely will be underutilized most of the time. By flattening the load curve the load factor of the system can increase bringing financial benefits to the utilities.

DSM can help utilities improve operating conditions from increased peak-time rates, and reducing marginal costs of lower peak power quantities. Thus, DSM can reduce production costs by increasing the "generation" options and giving the operators the opportunity to choose from the less expensive option to supply the demand. For instance, CNFL has a clear DSM case; they have calculated that the profits they make by reducing the amount of energy they buy from ICE during the load peak hours, outcompete the revenues made for selling that same amount of electricity (generation costs represents circa 50% of the electricity distributed). This explains why they have time-of-use-tariffs in the residential and industrial sectors, as well as energy audits, among other measures (Solís, 2011). This same argument could be applied to other government distribution companies. Nevertheless, the case for electrification cooperatives has to be analyzed in more detail because they require subsidies in order to purchase electricity. Also they have a very small share of the market which is located in rural areas.

In addition, according to Solís (2011) director of CNFL EE and Innovation Management Unit, in the near future electric transportation options will be a reality in Costa Rica. It will represent a paramount change in the consumption patterns of the country. Firstly, the electricity demand can grow anywhere from 70% to 80% taking as a reference BAU electricity consumption. Secondly, if the proper measures are taken it can achieve a significant flattening of the load demand curve. Within this context, DSM measures represent an opportunity for Costa Rica to be able to cope with the demand and avoid service failures due to overworked electricity transformers. Therefore, the sector needs to keep developing a smart network, and to implementing time-of-use-tariffs to incentivize consumers to re-charge their electric vehicles at night or in the other valleys. Electricity consumption has to be optimized in every level to be able to cope with and increase in the electricity demand, and EE programs can contribute to that.

- **Delay in infrastructure generation**

ICE has recognized that one of the main advantages of DSM could be the delay of investments in supply infrastructure; unfortunately, they still have not performed the necessary studies to confirm it (PREICA, 2000; De la Cruz, 2011; Salazar, 2011; Ramirez, M., 2011).

However, this could be quite important for ICE given the following facts:

- Studies prepared by ICE (2009) have concluded that most of the optimal locations for developing hydropower projects have already been used, and future projects have increased costs in relation to past projects. Also, there are very few areas where hydropower plants with multi-reservoirs[22] can be developed.

- De la Cruz, director of the planning electricity direction in ICE, also recognizes that it is becoming harder to develop supply projects. On the one hand, renewable resources are getting scarcer because of competition between ICE and local communities for resources such as rivers or land. The latter believes that those resources are "theirs" and that they should be used for other activities, e.g. tourism and environmental protection. On the other hand, petroleum is beginning the process by which it will be phased out, and it's only a matter of time before prices increase dramatically. The development of infrastructure outlined in the Plan Electricity Generation Expansion (PEGE) is delayed and it is facing problems, specially the Diquís hydroelectric project, which is the main project of the plan.

- The country needs big investments in generation capacity. As since 2009, the economy of Costa Rica has being depressed, some sectors are doubtful if the Government will have the capacity to assume all those financial obligations on time (Musmanni, 2011).

- **Taking opportunities from REM**

In Central America, electricity demand is growing at an average pace of 6% anually (Bun-CA, 2007). Moreover, the Central American electric market is fossil fuel based which has lead to high prices for electricity (Bun-CA, 2007; ICE, 2009). In theory, DSM programs can lead to freeing up some excess power so that it can be exported to the regional market REM at fairly attractive prices (Salazar, 2011). As the Costa Rica becomes more efficient in its electricity consumption and supply infrastructure is not outpaced by demand growth, the higher amounts of electricity can be exported. According to De la Cruz (2011), this can be quite profitable, and can be a great reason to incentivize DSM, but it first needs to be proved.

- **Tool to promote EE**

Nowadays, penetration of EE technology is fairly slow. In the eyes of the consumer it is still insecure or insignificant to invest in EE (Musmanni, 2011). Therefore, there is a need to find supportive policy instruments to promote EE changes ("IEA", 2010?). It has been recognized by ICE, that one of the main advantages of DSM is to channel or organize private EE initiatives. DSM can contribute to clear market conditions for energy service companies and performance contracting. Utilities with DSM programs can be a driving force to change market conditions (PREICA, 2000; "IEA", 2010).

- **Improved performance of the distribution and transmission network**

DSM can lead to congestion relief in the distribution and transmission network. DSM programs can also extend the capacity of the current network to supply more clients by reducing or displacing energy consumption during load peaks.

Finally, DSM programs can help consumers to reduce their electricity bills, for example CNFL has recorded that households that participate in the time-of-use-tariff save at least 20% on their electricity bill; those savings can be extended up to 50% (Solís, 2011; Ramirez, M., 2011). Also, it gives consumers the opportunity to be active and engage in tariff setting and in reducing GHGs emissions.

[22] Hydroelectric power systems with the capacity to receive, store, and release potential energy throughout all the year (Kosa et al. 2011).

4.3 Perceptions and barriers for implementing DSM in CR according to the main actors of the electricity sector

This section is based on 11 interviews of people from different groups in the electricity sector in Costa Rica. Even though all the actors recognize the importance of managing the electricity demand, they also agree that the implementation efforts are timid and weak. For instance, Musmanni (2011) expressed that DSM actions have always been discussed, and that it is clear that the first end use sector that it is important to attack is the residential sector, however, nothing is moving forward. As stated before, De la Cruz (2011) declared that probably they should have a DSM program, and they are talking a lot about it, but not really doing anything. He also thinks that DSM projects are very difficult to implement and they are surrounded by very romantic views.

Following the literature, but mainly based on those interviews, the author extracted the central barriers that can be hampering DSM implementation in Costa Rica, and organized them in three groups: structural barriers, utilities barriers, and consumer barriers. Figure 4 - 14 summarizes the identified barriers.

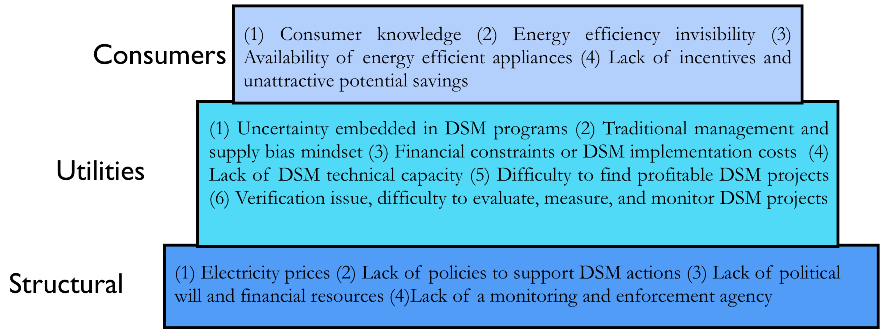

Figure 4- 14: Summary of barriers hampering DSM in Costa Rica

4.3.1 Structural

- **Electricity prices**

Electricity prices represent a classic market failure; often electricity rates do not reflect the true marginal generation costs. This difference leads to a faster demand growth than the capacity to add power to the system (Kim & Shcherbakova, 2011). De la Cruz (2011) strongly agrees that price signals are essential for a DSM program. He shared that during the 2000 -2001 time period, when ICE was trying to create a DSM project, electricity prices were quite low and tariffs were much distorted. They did not reflect well the electricity generation costs, and it made harder to appeal to consumers in EE programs. Nowadays, prices have grown up significantly, mainly due to high oil prices and the tariff restructuration process, thus people are more responsive to energy saving programs.

Ramírez, E. from ARESEP, considers that the process to correct tariffs has to continue. Today there are still subsides without consideration of the distribution, generation, and transmission costs. Tariffs should be based on the supply costs in each voltage level, but the supply costs are not well defined, therefore the overall level of subsidies cannot be determined; it varies for each distribution company and comparisons among them are difficult to make. Nonetheless, the issue of eliminating subsides is complex one, and above all a very political process.

- **Lack of policies to support DSM actions**

Clear price signals alone are not enough to achieve DSM. The literature seems to agree that government regulation has an important role to play in promoting supply and demand side balance. Other conditions require the removal of usual barriers to develop a DSM culture, named policies should contribute to set up: incentives to invest in demand side options, risk sharing, development of financing mechanisms, development of standards and labels for appliances, and means to provide final consumers with appropriate information (Kim & Shcherbakova, 2011; Torriti et al., 2010; WEC, 2008).

ICE's attempt to develop a DSM infrastructure in 2000-2001 illustrates this point. As it was aforementioned, another reason why ICE did not continue its process to institute a DSM program was because the legal framework conditions were not favourable or supportive. At that moment, in 2001, there were no financial incentives for buying EE appliances; Law 8114, Simplification and Efficiency Tax System Act, eliminated the tax exoneration given by Law 7447. This left EE products in clear disadvantage; they were too expensive to compete, and any program to promote the replacement of inefficient equipment required high subsidies. In addition, standard regulations for energy efficiency, label programs, and EE requirements for buildings were inexistent. ICE interviewers commented that ICE tried to propel a DSM program, but they found too many barriers: the quality of the products in the market was very low, the prices of EE equipments were extremely high, consumers did not have any incentives to buy EE equipment, and finally, it was difficult to put into action a project to improve EE of some appliance or equipment without an official EE standard. They concluded it is almost impossible for a utility to structure and maintain a DSM program, if it is not supported by a high governmental level and accompanied by proper regulations. Otherwise it is an effort too big for a standalone firm and it is clear that it will hardly pay for itself (De la Cruz, 2011; Salazar, 2011; Ramirez, M., 2011).

Furthermore, Solera's (2011) opinion is that the legal framework lacks an effective mechanism to compel distribution companies to implement DSM actions. Law 7447 has failed to meet this objective, and if it is not modified, it is not likely that distribution companies will start implementing energy conservation measures. Moreover, some interviewers perceive that nowadays Costa Rica's fiscal crisis and the discussion of the National Electricity Bill make harder to propose new policies.

Moreover, another issue is that MINAE does not have an independent policy action line. Historically, ICE and the National Oil Refinery has provided SEM with technical capacity or financial resources; thus SEM's policy actions have been highly influenced by them. As a result, it is not clear that MINAE can differentiate between the country's interests and the particular interests of those public institutions, which can lead to protectionism, or even overall lack of action. For example, DSM has been informally discussed, in strategic high level settings, as viable option for Costa Rica's electricity sector; however, nothing happens because there is not a strong actor interested in setting the agenda and the action lines (Musmanni, 2011).

Overall, the country lacks an appropriate and strong legal framework to support the development of the long-term conditions required to promote the cultural change needed to institute DSM (Blanco, 2011; Musmanni, 2011).

- **Lack of political will and financial resources**

Prices and regulations are not enough to create an effective DSM culture; it is also necessary for political conviction to engage with the vision and allocate financial resources to operate the framework. Legislation contributes to accomplishing these results, but the institutional management (a function between time and resources dedicated to achieve the results) is as important as the dispositions in a law, if not, laws and policies become ineffective (Castillo, 2011; Musmanni, 2011; Blanco 2011).

In that regard, there is a wide spread perception that the government has a dual discourse because even though all the policy instruments encompass the mandate to act over the demand (something different will be politically incorrect), the national efforts in energy conservation are very weak. There is a visible disconnect between the discourse and the practice because human and financial resources have not really been assigned to implement the legal framework (Musmanni, 2011; Solera, 2011; Castillo, 2011).

According to the interviewers, this situation has its roots in the fact that the energy sector is an area of MINAE, and historically, the minister of MINAE comes from a conservation or green background. Conservation or "green" efforts are much more popular than energy initiatives, and truth be told there is a lot of work to do there. Consequently, the protection and conservation efforts take up the majority of the resources that MINAE has available. For instance, Law 7447, which is the strongest regulatory instrument in the energy sector, was created without a source for financing, and nowadays, 17 years after it was passed, no entity has been provided with resources to enforce it (Musmanni, 2011; Solera, 2011; Castillo, 2011).

The failure of the NCEC (National Commission for Energy Conservation) is another example. A study concluded that the lack of interest and engagement with projects, lack of effective monitoring, as well as the lack of resources, were major reasons why NCEC did not work. SEM reported that ICE and CNFL were the only institutions that hardly dedicated some resources for energy conservation programs (Chanto, 2011). The EE standards are another example. Their discussion started because of an ICE initiative, and these are voluntary because ICE did not have that much time and resources to promote legally binding standards. Even though SEM recognizes the importance of standards, and it is also the entity that is legally responsible for leading the process, they explicitly explain that they do not have resources. Thus they prefer to propose and collaborate to develop voluntary initiatives and programs, while on the contrary, biding regulations required a strong monitoring capacity that the MINAE lacks (Castillo, 2011; De la Cruz, 2011).

Another appointed issue is the few initiatives in energy conservation or EE that the government launches lack stability over time; they are not created with a structure that supports the Administration changes. Musmanni (2011) mentioned "each four years this country reinvents itself" meaning that each Administration has different priorities and usually dismiss old programs to establish its own.

Finally, the author identifies that the SEM (i.e. the main planning entity of the system) has an agenda for promoting the rational use energy which basically consist of incentivizing EE projects and encouraging consumers to implement energy saving practices. It is clear, although, that they are not aware of the importance of promoting the systematic inclusion of DSM criterion in the planning process; it is not in the agenda.

- **Lack of a monitoring and enforcement agency**

Overall, it is perceive that the actors of the sector are fragmented and no one takes real responsibility for the complex whole. The SEM lacks the administrative capacity and political influence to monitor the enforcement of the policies and to harmonize the actions of the sector's institutions. As a result several objectives stipulated in the Energy National Plan are just in paper, and Law 7447 is hardly enforced (Ramírez & Mora 2010). The coordination level is very low; thus as it was concluded by CEPAL (2009) the energy conservation efforts of the country are individualistic, short-term, and the monitoring and assessment of the programs are insufficient or inexistent.

Solera (2011) and Castillo (2011) fully recognize that MINAE's administrative structure in the energy sector is very weak; also they argue that SEM is not an enforcement agency. Indeed, in compliance with decrees 34582 and 21351, the SEM was created as an advisory, coordinating and planning entity of MINAE. SEM has to be the leading entity in the policy and decision making process for a comprehensive planning of the energy sector.

On that line, Solera and Castillo, explained that it is not SEM's responsibility to implement the legal framework; they have a legal mandate to obey, and do not have enough resources to carry out their functions plus enforcing energy related regulations and programs. For instance, according to the Law 7447, big consumers have the obligation to implement energy conservation programmes. Considering that distribution companies are themselves big consumers, they should enact energy saving programmes. However, MINAE does not have the capacity to enforce it and therefore distribution companies can get away with not doing it. ARESEP, the regulating entity that is in charge of monitoring the supply and quality of service, has access to the data on daily operation of the electric supply, and could potentially put pressure on the utilities through the authorization of tariffs to implement energy conservation programs, but the entity criteria is that the law does not clarify the entity who has to enforce this obligation, and as it does not explicitly says that is ARESEP, they cannot intervene (Ceciliano, 2011; Ramírez, E., 2011). In conclusion, the country lacks a functioning compliance system.

Given this context, SEM' position is that they can contribute in raising awareness about the situation: there are several objectives linked to general policies that cannot be meet because the lack of resources.

4.3.2 Utilities

This section is mainly based on ICE and CNFL perspectives. At first, as it was aforementioned they are the main utilities in Costa Rica. Therefore, if they do not act over the demand the effects will be very little. Additionally, they probably have a stronger financial situation and administrative capacity than the rest of utilities. Thus, if they have difficulties implementing DSM, it is likely that the rest of utilities will face the same or similar barriers.

Nonetheless, it is important to underline that there are important differences among the utilities in the electric sector in Costa Rica, which probably influences their judgement about DSM. For instance ICE generates roughly 70% of the energy that it distributes, the other firms do not generate more than 10% of the electricity they distribute and have to buy from ICE the rest of the electricity to cover their needs. Also, they have different subsidies levels when buying electricity from ICE, and there are important differences in the areas they serve, e.g. rural or urban, and the end-use sector that they supply.

- **Uncertainty embedded in DSM programs**

Often there is a belief that DSM programs increase investments risks because of uncertainties about their costs and performance. Naturally, this discourages utilities away from implementing DSM. It is commonly believed that uncertainty permeates different stages of the program: estimation of demand and energy forecasts, determination of DSM impacts, which could be induced by operating assumptions, projections of program participation, estimation of the technical potential of DSM projects, and the calculations of costs of the program e.g. program marketing, and free riders (Vine & Kushlers, 1995; Hirst, 1993)

The above reflects some of ICE's preoccupations regarding DSM, De la Cruz (2011), explains that as planners of the electricity supply for the whole country, they have a big responsibility. Thus, if they make false assumptions and miscalculate demand projections, later they would not be able to guarantee a reliable supply of the demand. This explains why they are very careful, and why they have chosen to focus in supply options.

- **Traditional management and supply bias mindset**

The paradigm that generation capacity is the only effective way of meeting the demand for electricity, and that any power is better than none, is traditionally embedded in the national discourse and is strong and widespread. Moreover, it constantly pressures utilities to invest in adding generation capacity without considering how to balance via demand-focused options (D'sa, 2004).

Blanco considers that ICE has done its job: 99. 3 % of Costa Rica's households have electricity and the whole country has a reliable electricity supply. However, the energy paradigm has changed, nowadays, it is important to introduce in the equation the negawatthours. Here, ICE is lagging behind; they are a big institution that remains trapped in its successful but outdated planning model, and this is because ICE lacks a long-term vision to manage the demand.

On the other hand, ICE personnel have recognized that within the institution there is a fair amount of reluctance to develop this topic. It is a long-term approach and at the same time is very complex because it encompasses several uncertainties. Moreover, not everyone envisions the advantages, and DSM cannot be implemented without a full agreement and support from the director's board.

Demand side options are designed to reduce the electricity consumption and, since the utilities business is to produce and/or sell electricity, they might think DSM programs can affect the profitability of their firm. If there is a lack of policy mechanisms put into place to avoid this situation, managers may be inclined to increase power usage levels at all times so as to ensure a healthy cash flow for the company (Kim & Shcherbakova, 2011). Solera (2011) and Musmanni (2011), agree that this can be a barrier for DSM implementation. De la Cruz (2011), also commented that at some point in the electricity planning direction of ICE, implementation of time-of-use-tariff has been proposed, however, the person in charge of tariffs did not think that they could bring positive results to the institution. In the end it was decided it was more important to implement a program to modify the tariffs structure.

Finally, ICE considers that DSM can be helpful to at least reduce the demand during summer (De la Cruz, 2011; Salazar, 2011; Ramirez, M., 2011). The author identifies that this reduces the business case to implement DSM because, indeed, DSM can also help to reduce the daily peak loads that are currently being supplied with fossil fuels.

- **Financial constraints or DSM implementation costs**

One of the main barriers to initiating a DSM program is the utilities' financial constraints. Elaborating an effective DSM program can be quite expensive and a labour-intensive processes. More often than not, utilities have no surplus budget for planning and research and are mostly preoccupied dealing with day-to-day problems rather than looking for ways to invest time and resources in long-term options such as demand side measures. Thereby, and very often, the main bias towards supply options is entwined with administrative and financial issues which hamper the development of DSM (D'sa, 2004; Lave & Spees, 2007).

The lack of resources was one of the cornerstone reasons why ICE managers decided to postpone DSM. De la Cruz (2011) commented that the institution did not have enough resources; not to mention that the necessary initiative to continue with the process was not very strong. As a result, they decided to work in the elaboration of technical standards, restructuration of tariffs, and building a brand, which were key conditions for facilitating DSM projects in the future. Later, with the crisis in 2007 the financial situation of the institution turned really tough; ICE was not receiving the revenues they needed. Thus, the tariffs issue became a fight for survival and the focus of their actions; there was not much time left to think of DSM. Also, at this point the situation in the supply side got complicated as well because all of the sudden the system did not have enough power to supply the demand.

Literature has identified that if there are no formal measures aimed at facilitating the recovery of initial investment, and the firm is not certain that will be able to recoup its initial costs, it is very likely that it will not invest in a DSM program. Nevertheless, Solís (2011), from CNFL, recognized that Costa Rica has a monopoly regime, thus if their expenses are legitimate and well justified; utilities have legal means to recover DSM investments through tariffs. However, there are projects that need funding, if the institution has low financial resources availability, they need a set of authorizations to seek for external funding and get in debt; this can complicate the business case for DSM projects.

- **Lack of DSM technical capacity**

ICE, which is a big institution, received training in DSM for more than one year, and they still find DSM implementation technically challenging. The other electricity utilities, which are smaller companies and have a smaller budget, probably will lack the suitably qualified human resource to drive DSM to take the relatively complex decisions associated with DSM.

- **Difficulty to find profitable DSM projects**

Taking as a standpoint ICE's DSM approach and experience, DSM projects have to be financially sustainable and profitable. Basically, they have to approve the same controls and authorization process than supply projects. Additionally, they have decided that the proposed projects have to be related with EE because studies have shown that what the system needed was an overall reduction in the demand load curve instead of displacing consumption for short periods of time. Also, they main target sectors were the residential because that is the one which affects the demand load curve the most (De la Cruz 2011; Ramirez, M., 2011; Salazar 2011).

Then, according to De la Cruz (2011), Ramirez, M. (2011), Salazar (2011) ICE found it really challenging to identify projects that meet those requirements. Besides the legal framework conditions and the availability of EE technology in the market, there were two other factors that added difficulty to find DSM projects:

- Individual households consume a relative small amount of energy (45% of the households have an average monthly consumption of 250 kWh). The transaction costs of projects in the residential sector are very high, and the impact can be quite small. Essentially, these programs cost more and are less profitable, which diminish their attractiveness. [23]

[23] The IEA (2010) also recognizes that to encourage households and small enterprises (MSEs) to participate and to modify their energy consumption enough to make a significant impact on overall energy use can require a lot of effort, coordination and micro loans (IEA 2010).

- Costa Rica's weather is another factor that makes DSMs profitability less evident, and makes it harder to find projects because there are no immediately apparent changes in temperature; that is, throughout the year the temperature it is quite stable. Thus, for example there is not need for heating or strict insulation measures; this reduces the lists of programs that can be implemented.

There is little evidence that a set of projects will have immediate profitability. The build-up of financial constraints and scepticism about DSM benefits encompasses the main reasons why ICE abandoned the idea to develop a DSM infrastructure (De la Cruz, 2011; Salazar, 2011; Ramirez, M., 2011).

- **Verification issue, difficulty to evaluate, measure, and monitor DSM projects**

The few actions that have been launched in Costa Rica have been implemented but are not evaluated. Moreover, programs are not controlled throughout their implementation time. Therefore, it is unknown if the objective was achieved or not. According to Ramirez, M. (2011), this makes it impossible to implement effective DSM practices. Solis, from CNFL, commented that overall programs' results are very difficult to assess. The CNFL has specific case studies in industries, which can showcase this DSM programs as effective; regardless, he mentioned that DSM have a strong manage support.

ICE's case is different. Salazar (2011) and Ramireaz (2011) claimed that after the serious and consistent training received from Manitoba Corporation; they realized that it is not possible to maintain a DSM program without an adequate monitoring and evaluation system. The issue was that ICE did not have the administrative capacity to assess the projects' results. First, they did not have the data to build the baseline. This is mainly because ICE has little access to information directly from the costumer; thus they did not have a technical and detailed characterization of their clients' habits or consumption patterns. Then, the evaluation of projects in absence of a baseline is unreliable. Here is where the DSM programs fell down because it was not possible to argue that they could remain economically sustainable. Finally, they explained that ICE was not ready to perform the big investment needed to create the administrative capacity to evaluate, monitor, and verify the results of DSM programs. For instance, smart grids and smart metering systems can help the utility to monitor real-time usage patterns of individual users; also, they can facilitate the identification and marketing of DSM projects, as well as its evaluation. Nevertheless, it is a very expensive technology. The slow market penetration of this technology has been identified as one of the central barriers to DR spread (Kim & Shcherbakova, 2011).

IEA (2010) also points out that several DSM programs even achieved their objectives, as it is difficult to quantify their total energy savings due to a lack of a unified evaluation approach, their full potential is often not realised. It constitutes a barrier for DSM implementation because this data is crucial from a government or managerial perspective.

4.3.3 Consumer

- **Consumer knowledge**

The World Energy Council (2008) recognizes that one of the main causes of low consumer participation level is due to asymmetrical information, meaning the availability of good information for consumers about EE equipment and devices. Seeking out price and consumption information can get exhausting for consumers, and it can discourage them from energy-saving behaviour even in presence of cost savings. Moreover, financial barriers as initial costs, fear of hidden costs and higher risk exposure can also disincentivize consumers to implement DSM measures (Yu 2010, Kim & Shcherbakova, 2011).

In a regional study performed in the process of preparing the Central America EE strategy, Bun-CA (2007) identified that the lack of knowledge about technologies and good practices associated with EE is a barrier that has to be overcame. In line with this, Musmanni (2011), asserts there is a natural scepticism, thus it is absolutely necessary that someone incentivize, inform and orient consumers through the different EE options and practices; EE will not happen on its own because people are used to getting a service in a way that they have become comfortable with, and if they already receive the service, e.g. air conditioner, they stop looking for new and more efficient opportunities. In addition, Ramírez, E. (2011) thinks that the energy topic is rarely well understood by managers. Finally, Blanco says that in Costa Rica the lack of standards and labels make harder for consumers to choose the more energy efficient option.

- **Energy efficiency invisibility**

EE is embedded in products that are designed to provide the energy service. Few customers have the time or are willing to calculate the hidden costs of energy efficiency investments, this constitutes a barrier for EE expansion (Lave & Spees, 2007; Nielssen, 2007). In that regard, Musmanni (2011) sees that consumers typically do not think from a life cycle perspective. They do not project EE investments into time and quantity, thus they do not account all the benefits of the EE equipment or appliance in their decision making processes.

- **Availability of energy efficient appliances**

The limited commercial availability of EE products and their high costs are important barriers (WEC, 2008; Kim & Shcherbakova, 2011). On one side, Bun-Ca (2007) identified that in Central America the offering of and demand for EE equipments and services is fairly small, which reflects the poor development of the EE markets. On the other hand, it was also evident that it is difficult for the productive sector to access funding in order to further develop EE investments.

- **Lack of incentives and unattractive potential savings**

Incentives are essential in engaging consumers in demand side options. Nonetheless, providing financial incentives is not always enough to influence consumers' behaviour. The potential impacts of savings on overall financial expenditures of the consumer are also important. If the consumer thinks that the range of these savings is too low; it may act as a disincentive for consumers to seek information and invest in demand side programs (Kim & Shcherbakova, 2011). Ramírez, E. (2011) explains that enterprises greatly value the cost of investment and its recovery period. Taking into consideration that electricity bills usually represents 1.5% to 3% of the companies' total expenses; managers can easily think that it is not worth the effort to replace equipment.

It is recognized that the incentives established in the Law 7447 are not working, they are, therefore, under evaluation (Musmanni, 2011; Castillo, 2011). In 2007 Bun-CA identified that it was a necessity to identify opportunities to define fiscal incentives and to generate experience in the commercial banking sector in order to better structure EE investments, as well as to promote financial mechanisms e.g. leasing, ESCOs. In 2009, Bun-CA (2009) underlined that incentives are still an issue, and that Central America still had a set of political barriers that were necessary to remove in order to boost the EE regional market. Blanco, one of the authors of the reports above mentioned, says that until now in Costa Rica, there have not been big improvements on the EE incentives.

Lastly, at the present time, improvements have been made in some of the barriers that ICE found in 2000-2001, for instance:

- The quality and availability of EE products in the markets have increased since 2000. This fact was recognized by Salazar (2011) and Ramirez, M. (2011).

- In 2010 Law 8829 began to be enforced and restored the financial incentives for materials and equipment that contribute to the conservation and rational use of electricity.

- Since 2008, electricity prices have increased significantly. Currently, people are starting to pay more attention to their electricity consumption, thus campaigns have seen better acceptance as exemplified by the acceptance of fluorescent compact lights, it seems that a cultural change is happening in some areas.

- Multinational corporations are leading the EE process and encouraging national industries to do the same. This can help to reduce the natural resistance or scepticism mentioned before.

- Nowadays, Costa Rica has 15 voluntary EE standards that are the cornerstone for campaigns promoting the replacement of equipment and the use of labels e.g. ENERGICE. The process to develop more standards is continuous.

However, there still remain important barriers that have to be overcome in order to easier the path towards DSM implementation, and the alternatives to get over those hurdles will be explore in the next chapter.

5 Exploring a roadmap to DSM in Costa Rica

Acknowledging the outlined barriers that are hampering DSM implementation in Costa Rica; this section explores the different policy options that Costa Rica's government could use to kick-start a DSM culture in Costa Rica. This chapter has three sections, first, it points out two actions, which are required conditions to implement and maintain a DSM program over time (5.1). Then, sections 5.2 and 5.3 explain the core elements of the proposed DSM scheme (5.2). The fourth section explores the complementary measures (5.4), which encompasses the portfolio of policy actions that contribute to facilitate DSM implementation, and therefore, they should be part of the strategy. Figure 5-15 shows the main elements discussed in this chapter.

At first, each of the following sections explains the different policy options that could be implemented. Also, efforts are made to identify the merits and demerits of each options taking into consideration the reality of Costa Rica electricity sector. Additionally, through the different sections intend to pay attention to the actors involved and their roles. It is distinguished between the policy tools that are appropriate for a market based oriented DSM approach or a public policy based DSM approach.

Lastly, as it was aforementioned, Costa Rica is discussing the restructuration of its electricity model, but it still quite uncertain how the electricity market will be regulated. For instance, currently the Congress is analyzing six bills with different proposals. It is foreseen that the process to pass this law can take from six to seven years (Aguero, 2011a; 2011b). Due to this uncertainty, it was not possible to make conclusive statements for all the policy options explored.

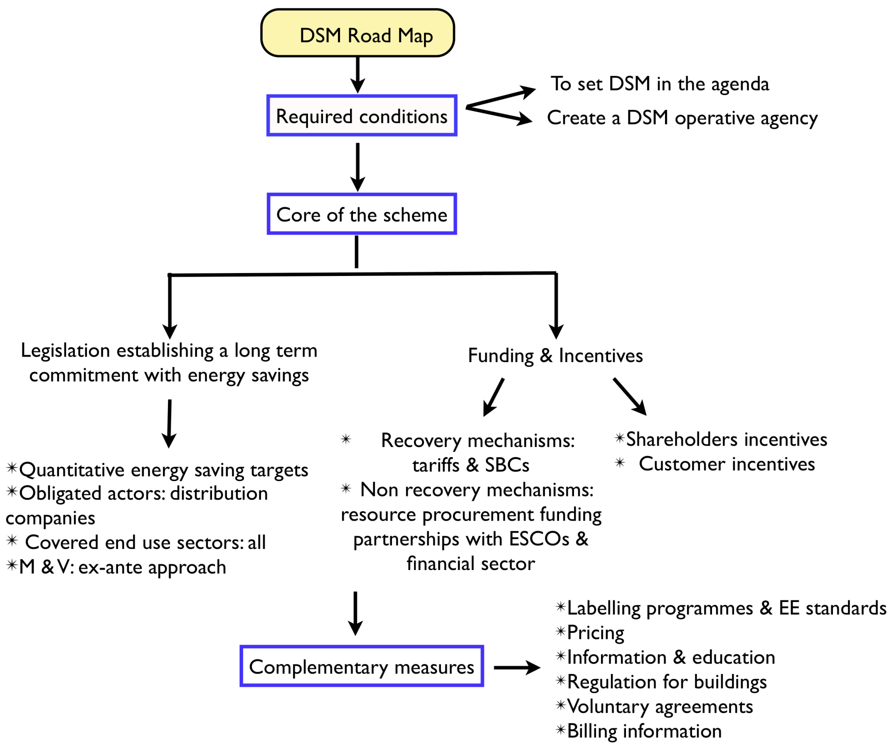

Figure 5- 15: Proposed DSM road map for Costa Rica

5.1 Required conditions

5.1.1 Setting DSM in the agenda

In Costa Rica, there is a lack of knowledge about DSM. Indeed, the lack of political will and allocation of financial resources for the energy sector are often pointed out as major barriers. Both barriers are interconnected, and have some roots in the lack of knowledge of the subject.

Lastly, nowadays, it is a good time to talk about energy issues and suggest new alternatives. Often, big institutional changes are taken only when there is some sort of crisis or a sense of urgency (Karmacharya, 2008), and Costa Rica may be facing that now; it is imperative that paradaigm shift occurs. It has been forecasted that if actions are not taken now the country will have electricity shortages in 2014. Therefore, the Government and legislators are more receptive. For example, the Government has just proposed (May 2011) a bill to eliminate some legal barriers for privatizing electricity generation, and strength MINAE as the governing entity for the electric sector by giving it more financial capacity (it is supposed to be a contingency measure meanwhile the Electricity Bill is passed) (Aguero, 2011a).

Therefore, the first action is to properly introduce DSM into the national agenda. Initially, the concept of DSM should be institutionalized in SEM. In compliance with legislation, SEM is called to be an active player and can use its authority to establish visionary and strategic policies. Additionally, a policy change, in this case national energy resource planning, needs a strong commitment at the highest levels, starting from the central government. Nevertheless, this agency does not seem interested or prepared to lobby a systematic incorporation of DSM in the planning process for the energy sector; at least their agenda does not have any concrete action in this direction (Castillo, 2011; Solera, 2011).

Furthermore, SEM should coordinate an effort to create a public dialogue surrounding DSM. This process should aim at involving other government entities, utilities, larger power consumers, research institutes, and universities. The dialogue activities should encompass international exchange and cooperation, training courses, pilot studies and research. Said activities are of core importance to building the business case for DSM. This means to quantify the potential and benefits of DSM, not just at a national level, but also in a case-specific context for utilities. For instance, following the IEA ("IEA DSM Implementing Agreement", 2009) it is necessary to:

- Collect data on customer needs and characteristics
- Perform a market assessment and market penetration analysis
- Identify and screen DSM alternatives to define measures and programs for evaluation
- Assess the technical, economic, and viable DSM potential
- Perform cost-benefits analysis of a resource portfolio with and without DSM

The assimilation of DSM should be a collaborative effort with an integrative approach. Thus, the different stakeholders can form an opinion about DSM, and hopefully support and promote it. In the interest of effectiveness, the government should make full use of existing organizations. In this light the National Energy Conservation Commission (NECC), which congregates representatives of main stakeholders in the electricity sector, can be a good forum to discuss DSM and perform some of the tasks previously mentioned. According to Castillo and Musmanni (2011), the NECC will start work soon. The countries research universities can also be strategic partners. For instance, the University of Costa Rica will be hosting an Energy Efficiency Centre. This Centre aims to create a knowledge database related to cutting edge EE technologies, and to train a wide range of professionals in this area (Vindas, 2010). The

Industrial Association can be a good ally as well. It has an EE and renewable energies department, and it is also interested in developing training programs that expand knowledge to promote public and private investment in EE

Moreover, Costa Rica can consider joining an international forum, which would generate and share information about DSM or EE. For instance, the International Energy Agency has a DSM programme. Currently, it has 18 members[24] and open membership to any country that is interested in joining. This programme promotes the creation of network among its members and, in turn, their individual institutions. Also, it allows member nations to have access to an extensive and specialized database on the subject. It encourages the use of standard terminology, units of measurement, methodologies, and procedures to make interpretation and comparison easier, among other benefits ("IEA", 2010?).

5.1.2 Creating an operative DSM agency

An operative DSM agency is essential in order to sustain, over time, effective national efforts to implement DSM. An operational DSM agency is understood as a body with a clear mandate and the capability to design, implement, and evaluate DSM programs and measures. It also should function as a coordinating engine of all the central government DSM initiatives with corresponding counterparts in a decentralized administration or the private sector. Additionally, for its effective functioning it should have adequate and stable funding, as well as human and technical capacity.

According to the last World Energy Council (WEC) survey (2010)[25], about two thirds of the survyed countries have a national energy efficiency agency. Most of these agencies are independent from its corresponding ministries, but there are exceptions, and for example, in Denmark, Canada, and the U.S. such agencies are part of a Ministry. Another trend is to assign this responsibility to a non-profit organization. It is the case of the state of Oregon in the U.S. where the Energy Trust of Oregon (ETO), a non-profit organization funded through public purpose charges, and is in charge to contract the Conservation Potential Study. ETO also sponsors energy efficiency outreach, marketing and incentive programs for utilities, rebates for efficient appliances, and custom projects to improve the efficiency of industrial processes (ICER 2010). Besides that, ETO coordinates the creation of annual EE deployment plans with the four utilities, which have to outsource their energy efficiency efforts.

Based on the above, Costa Rica has two discernable options:

- To strength and extend SEM's responsibilities by giving it enough administrative and financial capacity to be not just a planning entity, but also an operational one. For the sake of security and stability, this decision should be strongly embedded within the country's legal framework, namely SEM creation decree. This option is advantageous because as it does not imply major changes, it can be easily implemented. Another benefit of this alternative is that the DSM operative body can work closely with the energy planning entity. On the downside, if this body remains in the public sector, it runs the risk to become bureaucratic, political, slow, and inefficient.

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24 Australia, Greece, Norway, Austria, India, Spain, Belgium, Italy, Sweden, Canada, Republic of Korea, Switzerland, Finland, Netherlands, United Kingdom, France, New Zealand, and United States.

25 It describes and evaluates EE trends and policies around the world. The document covers about 90 countries were covered. A survey was conducted out in circa 70 countries and a literature review for the remaining countries.

- To create an independent, non-profit organization. Musmanni (2011) emphasizes this option; he thinks that one of the key actions to improving EE implementation is the creation of an independent, apolitical, national funded entity or centre that has a constant and stable mandate to promote EE measures. Among the advantages are that it can be more efficient because it will not have the usual characteristic and ties that a public administration has to act within. However, the funding aspect can be complex, its funds have to be created and authorized by law. This can be difficult because Costa Rica has had bad experiences in the past managing special purpose funds (Ramírez, E., 2011). Nevertheless, this could be solved by establishing clear and strong accountability mechanisms.

Furthermore, the relationship of this DSM operative body with the utilities, the entity responsible for planning the electricity sector, and the regulator have to be explicitly explained in a legal instrument. For instance, utilities should be compelled to annually report to the DSM operative agency their future demand and energy saving projections. The DSM operative agency should share this information with the entity responsible for planning the entire electricity system (currently, it is ICE, but if the market opens, this responsibility will probably be assigned to another institution). Then, the institution responsible for planning the national electricity supply should be compelled to perform this responsibility according to the guidelines established by the Government in the National Energy Plan, the directives issued by the Executive Power, and the recommendations of the DSM operative agency.

Overall, the creation of an engaged and independent agency with its own agenda will give stability and continuity to the DSM implementation. It will contribute to overcome the lack of a functioning compliance system, and will reduce the influence that ICE has over the energy policy. Additionally, it is likely that it will also contribute to identifing key policy interventions to support DSM implementation; this, was another identified barrier. It also can continuously contribute to reducing the knowledge-gap problem among utilities, government entities, and consumers. Moreover, said agency can cooperate with utilities to increase their DSM technical capacity which is needed in order to find profitable projects and implement them. For instance it would to be responsible for developing methodologies to assess cost-effectiveness of DSM programs, which should include a cost-benefit analysis that takes into consideration the impact for the account ratepayer, utility, the participants, and society as a whole.

In conclusion, for a DSM programme to work there has to be at least one interested entity that is constantly and systematically pushing DSM forward. Considering the responsibilities that this entity is called to do, the author agrees that it is probably a good idea to create an independent, apolitical, non-profit DSM organization, even though it can be more politically challenging.

5.2 Legislation required to establish a legal and long term commitment to energy saving

An overarching legislative and regulatory architecture is necessary to develop a DSM culture. If the Government aims to translate policies into practice, it has to issue suitable and clear legislation that appoints demand side measures as a priority option, and establishes specific obligations for the different actors. Reality cannot be fixed simply by writing a law; the ineffectiveness of Law 7447 is a life example of that. However, laws are tools to set stable commitments. A law establishing energy savings commitments can provide a long lasting context for DSM. It also can contribute to avoiding the “stop-and-go” effect caused by the different priorities of each new administration.

Furthermore, a law that establishes energy saving commitments is fundamental to overcome other important barriers:

- It shows unequivocal commitment of the Government with DSM. It establishes a clear policy action line to develop other complementary policies to DSM implementation.
- It can reduce inaction from the different stakeholders. If the law clearly sets the "rules of the game", it would pressure and/or incentivize stakeholders (utilities, consumers, energy companies) to act.
- DSM encompasses a cultural change. Therefore, it needs long-term commitments and actions. A law would incentivize stakeholders to take long-term actions.
- It would force utilities to leave behind the supply biased mindset, and move towards more efficient planning methods.
- It can assure multiyear funding for DSM measures, which is essential to maintaining a DSM program in the long term.
- If proper recovery mechanisms are set, it will help utilities to face demand side measures implementation costs.
- The allocation of commitments and obligations can mobilize actors for large-scale EE projects. This can propel the development of EE markets, as well as energy services and performance contracting.
- If appropriate incentives are included, they can contribute to overcoming other market barriers; e.g. cost barriers for consumers, inherit conflict for utilities between the motivation to increase sales and the goal of reducing sales through DSM activities.

EE obligations are measures whereby energy companies (supplier/retailer or distributor) have a legal obligation to promote and stimulate energy savings. EE obligations have appeared to be successful in EU Member states. Indeed, according to WEC (2010) EE is expanding in those countries that have implemented them, and are also being adopted in new countries. Around 20% of the surveyed countries have established regulations on the preparation of energy savings plans for consumers, generally within industry. EE obligations in Europe have proved to work whether in a monopoly or fully liberalised environments (WEC, 2008; 2010).

This paper understands EE obligations as energy savings. The main reason is that energy savings also encompass load management activities and not just EE. Moreover, a strong enough reason has not been identified as to why an initiative to change the traditional electricity management model has to be limited to EE. Even though it is likely that in Costa Rica DSM has an emphasis within EE, demand response actions can also generate energy savings and bring other important benefits; thus they should be included in the scheme.

If energy companies are allowed to buy or sell the energy saving credits, the scheme is known as Tradable White Certificates (TWC). TWC have some similarities with DSM activities since there is an obligation on energy companies to implement EE activities with their customers. However, an important difference is that the obligations approach focuses on outcomes (i.e. energy saving targets) more than money spent and, as a result, has developed a much cheaper monitoring and verification systems.

In compliance with TWC (2010), EE obligations can work better for developing countries. Until now the experience in Europe with TWC is considered positive; although, it is considered limited. Moreover, this type of scheme requires certain maturity in the financial infrastructure, and market with knowledgeable and skilled players. Nevertheless, a DSM program in Costa Rica could use some aspects of the TWC scheme; particularly in the evaluation and verification stage.

An eventual law enacting a national DSM programme and energy saving obligations should be as clear and comprehensive as possible. The following sections will discuss some of the main aspects: obligated actors, obligations or targets, covered end-user sectors, monitoring and evaluation system. However, there are other aspects that need further development and are not included; e.g. penalties, how long the energy savings should be defined for (the two extremes are simply an annual energy saving and lifetime energy savings), and whether the energy savings should be discounted over time to reflect the time value of money. Funding and incentives should also be part of the legislation, but because they are a fundamental aspect of the scheme, they are discussed in an independent section.

5.2.1 Obliged actors

Policy makers can consider different approaches to imposing energy saving obligations. If the monopoly over the electricity model continues, the more obvious option is to establish mandatory energy saving obligations on the distribution companies in a way that it would be the distribution companies' responsibility as to which DSM programs they want to implement in order to achieve the target. Utilities could also decide if they implement the programs by their own or procure the services. If they do not achieve the standards they could be financially rewarded or penalized, and large part of the funding would come through tariff adjustments. Here, utilities will still have to search for programmes that are cost effective, but with the backup of legislation or policies that help them to implement the task.

If the restructuration of the electricity model leads to a liberalized electricity market, there are at least two options. At first, the energy saving obligations can still be imposed on the distribution companies and retailers (if authorized). This option also requires companies to implement DSM programmes observing basic principles of least-cost and planning. Therefore, it essential to have a resource cost assessment methodology or test, and shareholder incentives (this point is elaborated with greater detail in section *5.2. Funding and incentives*).

The second option is to rely on the free market to deliver DSM by promoting the development of the ESCO industry. It does not seem an appropriate option for Costa Rica. First, because introducing this regimen in a newly open market can be difficult and ineffective. In Costa Rica the electricity market has remained a traditional monopoly and the ESCOs market is inexistent. Additionally, previous experience shows that ESCO mainly delivers their services to the medium- large commercial and industrial sector. Usually, the household has little relevance for ESCOs due to the expected low profits, high transaction costs, and legal complications. This is an issue because in Costa Rica the residential sector is the largest electricity consumer. Moreover, an analysis has to be made to determine if the commercial and industrial sectors are big and strong enough to support the development of an ESCOs market (WEC, 2008). This alternative also involves the creation of a strong administrative and technical capacity to certify and accredit the energy auditors and energy managers.

Another option that could work in both scenarios (regulated or deregulated market) is to impose the energy savings obligations on a quasi- governmental organization. It would act as a DSM program administrator, and its main purpose would be to implement or/and oversee the implementation of DSM activities. This option requires the creation of a funding mechanism, commonly a surcharge on the electric bills of all customers collected by the distribution company. The program administrator would implement programs targeted to all customer segments within a particular emphasis placed on customers that are typically not included in the private-sector programs. In this case, the operative agency aforementioned will also be the program administrator (Wikler, 2000).

In conclusion, the author considers that it is a good and cautious approach to impose the energy savings obligations on the distribution utilities whether Costa Rica has a competitive or a monopoly regime in the electricity market. One of the reasons for this is that distribution companies have direct contact with the consumers, and can more easily affect consumption. In addition, TWC schemes impose EE obligations mostly on distribution companies and have proven to be successful in both competitive and monopoly regimes. Moreover, the author considers that an added value of DSM is that it forces utilities or energy companies to include a long-term perspective in the electricity supply planning, which is a key practice to ensure the reliability of the system. The lack of long-term planning is a bottleneck for the sustainability and success of policies in developing countries. Therefore, it is important to develop this culture, and any policy tool that contributes to achieve that should have priority.

5.2.2 Obligations and targets

(a) Targets

The nature and size of the targets usually vary depending on the country. The targets and obligations are a key operative aspect of the regime. Next it will be discussed if it is enough to set a general obligation to perform demand side measures or if the law should compel the actors to meet a quantitative target.

- *General obligation with DSM*

The obligation can take several forms: (1) A disposition that broadly establishes the obligation for the identified parties to perform demand side activities in order to achieve energy savings. (2) An obligation that compels utilities or energy companies to invest a percentage of their net operational revenue in DSM options. For instance, every electricity distribution company that operate in Brazil must invest at least, 0.5% of their net operational revenue in EE projects. These projects must conform to rules set by the program administrator and receive the approval from the energy regulator. (3) A disposition which establishes that before constructing transmission or distribution projects, the utility must demonstrate that the need giving rise to the proposed project cannot be met through a more cost effective manner, including through DSM measures; e.g. Vermont (ICER, 2010).

In the case of CR, in order to operationalize the first option, the law would have to explicitly require the regulatory entity, currently ARESEP, to deny the approval of utilities' budget or the request to increase tariffs, that is, if the utilities do not implement demand side measures. The disadvantage is that this regulation gives too much discretion to one institution. ARESEP would have full power of discretion to decide what constitutes demand side measures, and how intensively the utilities should work to get energy saving results, which brings uncertainty and instability to the entire scheme. Furthermore, ARESEP is characterized for having a traditional and formalistic mindset. Consequently, this option is not considered appropriate.

The second option could reduce evaluation and monitoring costs. Additionally, the regulator still has a key role in this option, but its discretion is greatly eliminated. The third alternative does not include generation projects. Under the assumption that generation projects are covered for the obligation, this would add another bureaucratic stage to an already complex authorization process, and could contribute to delay projects even more. Nevertheless, if generation projects are excluded from the regulation the impact of the disposition gets quite blurry because the distribution and transmission works are not as common as the generation projects.

- *Quantitative target*

According to WEC (2010), an increasing number of countries are adopting national EE programmes with quantitative targets. It is the case of 70% of the 60 countries surveyed in 2009. The advancement of this policy tool can be observed in all regions, except Africa. Additionally, there is a predominance to opt for targets on energy efficiency improvements or energy savings (about 60-80% of the surveyed countries). There are two main types of quantitative targets: (1) a rate of energy savings or efficiency improvement, (2) a specified energy saving in GWh or Mtoe[27].

Moreover, the targets can cover different end-user sectors, and the methods to establish them can vary. For instance, for the industry and commercial sector the targets are usually set in relation to the volume of electricity distributed. Meanwhile, in the residential sector, it is commonly used a proxy of customer numbers (WEC 2008).

The failure of PRONACE (National Program for Energy Conservation) illustrates why it is important to establish quantitative targets. The energy conservation actions included in PRONACE were agreed by consensus. Moreover, PRONACE did not have any quantitative objective. This was pointed out as one of the core obstacles to enforcing an effective monitoring mechanism for the program (Chanto, 2011). For this same reason, one can be critize the EE regulation included in the Contingency Plan Bill recently presented to Congress, it just establishes that distribution companies have the obligation to develop EE programs according to the criterion established by SEM.

Both quantitative and qualitative targets have pros and cons. If a baseline and evaluation mechanisms can be set, establishing a quantitative target can be effective because the actors would have a clear understanding of what is expected from them. The target could be a progressive percentage of energy savings. As an illustration, because obviously the definition of the energy saving requires further analyisis, the target could be of a 5% energy reduction for the time period from 2012 to 2017, where year 2012 the energy saving target will be at least 1%. Moreover, it would be important to analyze with more detail, if the intensity of obligations should vary for certain actors. For instance, ICE and the other three public energy companies (CNFL, ESPH, JASEC) have quite a different business case than the electricity cooperatives, primarily because the electricity cooperatives' main user sector is the residential in the rural areas.

(b) Obligations

Besides meeting the targets, the obliged actors have other obligations, which should be clearly stated in the law. Utilities have to be compelled to report to the operative DSM agency their demand and energy savings projections. Following the DSM proposal from Maharashtra State, India (BEE, 2099), and in order to help utilities to systematically introduce DSM, it also seems important to ask utilities to implement the following actions: (1) load research and consumer surveys; (2) conduct of DSM potential studies; (3) submit an annual DSM Plan to the operative agency; (4) progressive development and maintenance of a centralized database to aid DSM planning, design, evaluation, and verification, among others.

5.2.3 Covered end use sectors

A covered end use sector is one where the obligated actors have to promote energy savings. It is a flexible aspect that varies depending on the country consumption pattern and the DSM approach being implemented. It can include all the sectors or discriminate some. In the case of Costa Rica, the household sector should be included because it highly influences the demand load curve.

5.2.4 Monitoring and verifying of energy savings attained

Monitoring and verifying the generated energy savings with the demand side measures implemented is essential for the sustainability of any DSM program. It is assertively said that is not possible to handle what cannot be measured (Mundaca, 2008). Following this line of thought, it is essential to set up mechanisms to monitor demand side measures energy savings. Additionally, if the scheme recognizes incentives for shareholders based on the energy savings generated, their transparent accountability is of paramount importance.

The monitoring and verification methods for energy savings have always been a contentious issue; it has been partially solved by TWC by recognizing three types of evaluation methodologies ex-ante, ex post, and a hybrid method (Mundaca 2008; IEA- DSM, n.d.):

- Ex –ante or deemed savings: it uses a pre-calculated savings amount for commonly used EE measures. This approach has been implemented in Europe, and some states in the U.S. such as Pennsylvania & Texas.
- Ex- post energy savings or project-specific approach: it evaluates the implementation of measures and \monitors their impacts using indicators.
- Hybrid method: also called engineering, which requires some on-site monitoring and verification, but also relies on simplified ex-ante methodologies.

According to WEC (2008), most of the utilities use the ex-ante approach, or in the case of industrial and commercial measures, by scaling engineering estimates of proven energy savings. For example, in the household sector measures are being adopted as long as the average energy saving has been set up, although it is recognized that energy savings vary among the different households. The rationale behind is that the use of an estimate or extant savings will represent the real situation due to the large numbers of households involved.

The advantage of this approach is that it substantially simplifies the monitoring and verification process, freeing up more resources for the implementation of other tasks. The drawback of the ex-ante approach is that it can also introduce uncertainty to the system. It is difficult to establish an accurate baseline, and to monitor and evaluate the actual energy performance of the project in order to allow the comparison between the lifetime energy savings accredited in advance and the real savings (Bertoldi & Rezessy, 2007). Nevertheless, the ex-post evaluation approach significantly increases validation efforts and verification costs. A solution hybrid method can more accurate than the ex-ante measurement but less costly than a full ex-post, but this tool is not well developed yet (Mundaca, 2008).

In the case of Costa Rica, if a quantitative target is established the ex-ante evaluation approach is a recommended option. The ex-ante evaluation approach can be beneficial because it facilitates the implementation of energy saving obligations in the residential sector, which already has as a high transaction costs barrier for utilities. To implement this option, the eligible measures have to be defined in advanced by a DSM operative entity, which shouldpromote the participation of the energy companies or utilities. The law should explicitly compel the operative agency to keep an updated the list of measures (annually). Additionally, the law should give utilities the possibility to propose new measures if the savings are demonstrated through appropriate technologies and methodology.

5.3 Funding and incentives

5.3.1 Funding

To have a secure and long-term stable funding source is absolutely necessary to establish and maintain DSM. Generally, an effective development of DSM requires funds to cover the administrative costs of the DSM operative agency, especially to maintain the monitoring and compliance system. Additionally, funds are essential in order to provide incentives to energy companies and consumers for the implementation of DSM measuress, and/orto develop the required conditions to thrive an ESCOs. Moreover, funding is needed for education, awareness, publicity, training, and capacity building activities.

There are several popular sources of funding: tariffs, system benefit charges (SBCs), resources procurement funding.

- Tariffs: they integrate program funding as an element of the overall cost of service approved by regulators for recovery rates. Utilities are expected to account for all projected and actual costs and submit them for regulatory approval of periodic rate adjustments (McLean, 2009). If the energy savings obligations are imposed on distribution companies in a centralized monopoly market, it is the most obvious way to recover DSM implementation costs. However, it is commonly insufficient, thus it should be complemented with other sources.

- System benefit charges (SBC): this policy tool provides direct subsidies from power sector funds. It consists of a small charge on the electricity bill paid by all consumers to support DSM activities. It can be a flat charge (e.g. 1% to 3% of the electricity bill) or a small charge per each kilowatt-hour sold. In the United Sates around 20 states have impose SBCs through a small surcharge on all kilowatt- hours sold. These systems are usually administered by a state agency or authority, the utilities, or by a third party. The main advantage is that SBCs provides stable program funding for DSM. Other countries that have adopted this approach are: Norway, Spain, Denmark and Thailand (Yu, 2010).

- Resource procurement funding: this source of funding is enacted through developing partnerships between public institutions and private investors, e.g., banks or ESCO's. Financing for the investments can be provided by the ESCO from its internal funds, by the customer, or by a third party funding. In this option the financial institution gives a credit whether to the ESCO or directly to the client (WEC 2008).

The funding source, or sources, is/are closely related to the actors that have the obligation to implement the energy saving obligations, as well as the conditions of the electricity market (centralized monopoly or deregulated market). Following that argumentation line, the main funding alternatives for implementing DSM in Costa Rica will be discussed according the obliged actors. As discussed in a previews section they can be: a non profit organization and distribution companies. A non-profit organization that acts a program administrator for DSM necessarily has to be funded through SBCs, regardless of whether the electricity market is regulated or deregulated. Nevertheless, for the energy savings imposed on distributed companies there are three ways to go whether to allow them to use a recovery mechanism, not to allow recovery mechanisims, or a hybrid option.

- Recovery mechanisms (public policy based DSM approach)

As it was explained before, one of the main obstacles that hampered the establishment of a DSM strategy in ICE was related to the costs of implementing DSM, and the uncertainty surrounding the profitability of the projects. Therefore, if quantitative energy savings are impose on distribution companies, regardless of whether the market is a monopoly or not, it seems important to authorize them to recover investments through tariffs and/or SBCs.

The tariff recovery mechanism is useful, but it could be insufficient to fulfil all the funding necessities to kick-start a DSM culture in Costa Rica. Therefore, the creation of a SBC scheme can be important. SBCs ensures multiyear funding, this can provide market stability to utilities, which is crucial to encourage them to develop the infrastructure needed to develop DSM programmes. Furthermore, it could incentivize them to implement long-term planning, as well as to invest in programs that have high upfront costs (McLean 2009). Additionally, it would provide money to the DSM operative agency to execute all its responsibilities. Moreover, the energy companies or the government are in better position to finance EE measures through subsidies or grants (ICER 2010).

Nevertheless, creating a DSM public welfare fund can face political opposition. At first, according to Ramírez, E. from ARESEP, since special funds have a negative image in Costa Rica because, in the past, and due to bad management, it has been a way to misappropriate public monies. Secondly, SBCs may cause public discontent because of the consequential increase in electricity prices. However, in the long run the competitiveness of Costa Rica is not based on low electricity prices based on subsidies, but in its efficiency and energy security. Additionally, SBC has a characteristic of equality; the more the clients use electricity the more they need to pay for the surcharge. Moreover, to offset the impact of the induced rising cost of power the Government could set a five-year subsidy action plan for some vulnerable sectors, e.g., low income households and some vulnerable industries. The subsidies could at their highest in the first year, and then gradually fall to zero at the end of the fifth year. Then the enterprises have a period to introduce change and promote the EE.

- Without recovery mechanisms (market based DSM approach)

If the energy obligations are imposed on distribution companies in a competitive electricity market but without any recovery mechanisms (tariffs or SBCs), the companies will only implement programs that have economic value for the utility. Moreover, they would be left to mainly to recur to partnerships with ESCOs and the banking sector or resource procurement funding. This spending is typically part of the utility's revenue requirement and might appear to the customer as part of the supply or fuel charge, explicitly or embedded (McLean, 2009).

This alternative does not alleviate the Government from allocating money to develop a DSM culture. International experience worldwide on the development of ESCO based energy efficiency market illustrates the need for governmental policy interventions (Kumar, 2009). India's case study illustrates key governmental action lines to contribute to the growth of DSM.

For utilities outsourcing services from ESCOs can be an attractive capital source for program delivery. To rely on the experience and expertise of the ESCO staff can allow the utility to achieve a more cost-effective and sophisticated approach to energy management, as well as to implement large-scale programs with modest costs (Didden & D'haeseleer 2003).

Nevertheless, in the context of Costa Rica, where the household sector is the main end-user consumer, and the industry sector is not characterized for being energy intensive, the financial costs to create the conditions to overcome the main market barriers to contribuite the blooming of an ESCOs market can also be considerable. Further analysis would be required to determine if this would be viable.

• Hybrid approach
A hybrid approach such as the one implemented for UK could be discussed. They have a government-mandate program with recovery mechanisms, i.e., SBCs, to promote DSM in the residential and small business sector. Additionally, they have a market-based program for the larger commercial and industrial costumers, which is supposed to be driven solely by the interests of the private sector (Didden & D'haeseleer, 2003). In Costa Rica, and since the last decade, the commercial sector has been growing significantly (MINAE, 2009) and this can represent a business opportunity for the ESCOs industry.

Moreover, even if a public policy DSM approach is implemented in Costa Rica, the ESCOs industry should be promoted as a way to depressurize the government and consumer budget. ESCOs have proven to be a cost-effective way to identify energy efficiency potential (WEC, 2008) For this it is important to identify the barriers for the financing of energy efficiency projects, design of appropriate policy interventions to overcome these barriers, capacity building of banks and financial institutions, awareness amongst public and policy makers (Bun-Ca, 2009).

5.3.2 Incentives

Besides a stable funding source for demand side projects, incentives are necessary to overcome important barriers that hinder DSM implementation. They can be analyzed in two levels: incentives for the shareholders and incentives for consumers.

• Shareholder incentives
In Costa Rica it was recognized for some stakeholders a conflict between the incentive to increase sales and the obligation to implement demand side measures to generate energy savings. Therefore, it is important to explore options that contribute to disconnect profits and fixed costs recovery away from sales volumes. Moreover, following McLean (2009) rewarding shareholders can flatten the field and allow for a fairer economically comparison between supply and demand side resource alternatives. Common frameworks towards this include: decoupling, modified rate structures, fixed customer charges, and loss-based revenue (LBR). The all have pros and cons, and tradeoffs should be taken into consideration when defining the rate structure.

Decoupling is the most commonly discussed rate structure. It separates the recovery of utility return on equity from volume. In other words, it prevents a utility from increasing its earnings by increasing delivered volume because additional charges collected in this event are refunded to the customer. Complementing these frameworks are incentives for the utilities which they will aggressively pursue EE (McLean, 2009). Decoupling has been used in the U.S.A and Italy. California law now requires that the state's investor-owned utilities use modest regular adjustments in electric rates to delink the utilities' profitability and the volume of electricity sold. California Public Utilities Code Section 739.10 establishes that "the commission shall ensure that errors in estimates of demand elasticity or sales do not result in material over or under collections of the electrical corporations" (Yu, 2010). The details on how to decouple can be quite complicated and are open to debate. Experience implementing this rate structure is limited. Regulators need accurate forecasts and have to be very cautious to avoid an unjustified impact on the ratepayers (McLean, 2009).

The modified rate structure can be another form to reward utilities. Here, the revenues are linked to the number of customers instead of sales. It can also be used as an escalation formula to forecast the fiexed-cost renvenue requirement over time. An LBR framework could be another alternative. It replaces revenue lost because of reduced sales associated with program implementation. It makes the utility whole for their investment in energy-saving programs (McLean, 2009).

If Costa Rica approves this type of incentives for shareholders, it is of key importance to develop a rigorous measurement and verification infrastructure. This is also illustrated with California's case study, which has set strict protocols defining the schedules for earnings recovery and terms and conditions for the measurement and verification of costs and benefits. Then, ARESEP, or the regulator entity, would have to authorize the adjustment in the electricity prices based on the results of the measurement and verification protocols.

Furthermore, there are other incentive mechanisms as the one proposed in the Contingency Plan Bill. Here the utilities can claim the benefits of the energy savings achieved with the implementation of those projects to pay the investment costs.

- Consumers

Incentives motivate consumers to invest DSM actions by reducing the costs associated with EE investments or by increasing the costs associated with energy use. Fiscal and financial incentives are the two main categories in which economic incentives can be sorted out. Popular examples of incentives are: grants and subsidies, subsidised audits, low-interest loans, and tax exoneration for the purchase of energy-efficient equipment (ICER, 2010). Usually, economic incentives, i.e., subsidies, are the preferred option by countries. In compliance with WEC (2010) two thirds of countries have subsidy schemes.

It was mentioned before that in Costa Rica some market barriers as investment costs, risk exposure, and information asymmetry hinder consumers DSM actions. These barriers show that when the market is left alone there could be little investment in EE (Yu, 2010). Incentives are policy tools that could be designed to address them. Incentives are usually understood as temporary measures to mobilise consumers, to prepare them for new regulations, or to promote EE technologies by promoting the expansion of a market than would not exist otherwise. In principle, incentives apply to actions that are cost effective from the collective point of view, but which would not otherwise be undertaken by consumers. Investment subsidies to consumers are being used since the 1970s and early 1980s, and they have faced important critiques. This led to a more cautious use of them. Currently, subsides and grants are better target to limit the number of beneficiaries, for instance, low income households, or restricted to a certain kind of equipment (WEC, 2008). For example, in California, funding for traditional rebates was reduced and supplemented by Standard Performance Contract (SPC) programmes for the commercial and industrial sector, where savings and incentives were based on measured performance (Vine, Rhee, Lee, 2006).

In the case of Costa Rica, before establishing a direct financial incentive, it is important to conduct a fair evaluation about the practicality of the subsidy (effectiveness, efficiency, equity, flexibility, feasibility) in the social, economical, and political dimension. Then, the law would have to authorize the operative DSM agency to approve the use of ratepayer funds to promote these activities.

Direct subsides are just a part of a financial resource to develop DSM. Participation from the financial sector is another important component of the financial resource. The banking sector plays a key role in the financial resource allocation. Traditional financing mechanisms have rigorous standards such as quick rates of return, which disincentivize EE investments (Yu, 2010). The involvement of the banking sector requires strategic governmental intervention to promote new EE financing mechanisms. Moreover, it is essential to establish and maintain a practical, operationally focused dialogue between the banking sector and the EE practitioners (Taylor et. al. 2008). Soft loans are less popular than subsidies; less than 40% of all surveyed countries had such schemes (WEC, 2008). Nevertheless, if it is decided to be implemented in Costa Rica a more market-based DSM approach in order to strength the banking sector participation would be imperative.

Lastly, it was aforementioned that Costa Rica provides tax exoneration to some energy efficiency equipment and materials.

5.4 Complementary policy actions

There are other policy actions that the Government can consider to facilitate the development of a DSM culture in Costa Rica. Roughly, some of them will be commented on.

5.4.1 Labelling programs and efficient standards

Labelling programmes and efficiency standards are powerful methods for transforming the market because they limit the choices consumers can make. Energy labels and standards are complementary tools, and are one of the main complementary measures for the success of DSM.

Labelling helps manufacturers to differentiate themselves and stimulate the introduction of new models. Moreover, labels can modify consumer's selection criteria by providing them with information, which can allow them to compare appliances and make more informed decision. Indeed, there is a trend to increase the number of appliances, equipment and buildings covered by efficiency standards (WEC, 2010). However, labelling programmes cannot sufficiently transform the market, thus, in the great majority of countries they are usually complemented by minimum performance standards. The aim of performance standards is to enhance the EE of appliances by enacting a minimum energy efficiency rating to remove the least efficient products from the market. They are necessary to eliminate certain inefficient but inexpensive products from the market. Standards are also useful in areas where the selection criteria of consumers exclude EE considerations, e.g. television sets. Labelling programmes and performance standards should be frequently upgraded in order to maintain their effectiveness (WEC, 2010; WEC, 2008).

As it was explained previously, in Costa Rica there is a consciousness of the importance to develop an EE standards system, and there is a process to create EE voluntary standards. However, there is not enough political support and financial resources to set a proper standards and labelling system. The creation of a DSM operative agency, a SBCs, and an overarching legal commitment with energy savings can contribute to overcome this obstacle.

5.4.2 Pricing

If prices do not communicate accurately the value of electricity, they can discourage demand side measures investment. Costa Rica needs to continue the process to rebalance the tariffs and to reduce subsides. Moreover, it can study mechanisms to move distribution companies from flat tariffs to time-of-use- tariffs, which is a tariff setting system that reflects better the costs of saved or un-served energy (D'sa, 2004).

5.4.3 Information and education

Information, education, and awareness campaigns targeting the different stakeholders are essential not just to promote support towards DSM but to increase the impact and effectiveness of the adopted policy measures. Information and awareness are important to overcome barriers in the different levels: structural, utility, and consumer.

For instance, supply bias and the lack of political will to allocate resources to the energy sector can be eliminated or reduced by generating research and disseminating information and quantitative studies that show the DSM business case. Regarding the fear to implement DSM because of the uncertainty embedded in DSM programs, Hirst (1993) points out clearly that DSM programs impose risks on utilities. However, supply side options also have inherent uncertainties: future prices of fuels, availability of supply side plants, considering major forced and unforced outages of base load plants; operating costs of plants, licensing and construction time frame, and public opposition, among others. Therefore, the issue is not if DSM brings risks or not, but how relevant is the effect brought by the risks related to DSM measures, considering the other risks associated to the remaining resources in the portfolio. In principle the evaluation of demand side resources may be no more uncertain than the evaluation of supply side resources. Nevertheless, all these issues need objective and systematic analysis. Sensitivity analysis can illustrate that the inclusion of supply options in the resources portfolio reduces risk. That is an example of analysis that should be performed (Vine & Kushlers, 1995; Hirst, 1993). Moreover, awareness campaigns and benchmarking are crucial to tackle several of the identified consumer barriers: asymmetrical information, EE invisibility, and fear of exposure to higer risks.

5.4.4 Regulations for buildings

The Bar of Engineers and Architects has been working for several years in the development of a voluntary EE efficiency regulation for new buildings, and the process is in its final stage (Bermudez, 2011). Most European countries have set up mandatory energy efficiency standards for new buildings. Building standards have a slow impact on the short term because new buildings represent a small share of the existing stock; nevertheless, it can become significant in the long future. A recent trend is to extend regulations to existing buildings by imposing the exchange of energy efficiency certificates each time there is a change of tenant or a sale (WEC, 2008).

5.4.5 Voluntary agreements

Voluntary agreements are another tool that the Government can use to mobilize some sectors to implement DSM practices. It implies consultation and negotiation, but such commitments are supposed to deliver results faster or in a more cost-effectively manner than mandatory requirements. Although voluntary agreements can take different forms, most of them are between policy makers and industry actors. They usually encompass a non-binding target for EE improvements, and can be introduced in exchange of recognition, economic incentives or regulatory forbearance. Voluntary agreements are generally sustained by performance indicators and benchmarking among participants. Here the Industry Association in Costa Rica has to be a strategic partner (ICER, 2010).

5.4.6 Billing information

Information is a powerful source to move consumers to act. A measure that can contribute to that is to ask distribution utilities to provide certain information to their consumers in their electricity bill in order to increase their awareness of energy consumption. This information can include the level of consumption, which can be articulated by different aggregations of hours or the contemporaneous level of prices or tariffs. Some channels to deliver this information to consumers can be the electricity bills or through on-line data access. For instance, a standard utility bill in New York includes a bar chart that shows customers their past energy consumption levels for each month during the previous year. Additionally, the bill gives the utility's website and phone number. Providing information to consumers not only increases market transparency, but also enables consumers to make informed choices (ICER, 2010). If in Costa Rica the electricity market opens, billing information can be a good tool for consumers to make decisions about electricity suppliers.

As it can be seen, the implementation of a DSM program in a systematic and long-term fashion can be time and resource consuming. It requires the development of an important technical and administrative platform. If the government intends to enact DSM in Costa Rica, this has to be recognized, and the process has to be gradual. Moreover, the operative DSM agency has to work with utilities to help them to build DSM capacity, and the investment costs have to be recognized for utilities.

6 Conclusions

This research was performed under the premise that a secure and reliable electricity system is of paramount importance for the development and competitiveness of Costa Rica. Additionally, it recognizes that Costa Rica is facing great challenges to extend its power and generation capacity. As a consequence, it considers rationale to explore DSM framework as an alternative that can help Costa Rica to be more efficient in its electricity consumption.

During this research process, the author has concluded that it is a good moment to discuss electricity related topics; it is mainly based on two reasons. First, often large-scale change in an institutional design will take place only after some kind of crisis. (Koppejan & Groenewegen, 2005). In light of this, Costa Rica's electricity sector is in the threshold of a crisis, which is more or less triggering the perception that the need to act is urgent. Secondly, Costa Rica is discussing the restructuring of the electricity model, which is seen as a long, political complex process. Currently, DSM is not part of the discussion. However, this attention and legislative window should be used, it would be a strategic move to include DSM in this national forum because it is likely that it can influence the structure of the power sector.

Several potential benefits that DSM could bring to Costa Rica were identified. Five key advantages can be mentioned: (1) reduce fossil fuel consumption to generate electricity, alleviating with it the macro-economic financial constraints generated by the importation of high oil prices, (2) reduce the energy problem that the country has in the dry season, (3) contribute to the achieving of the national goal to become carbon neutral by 2021, (4) free up some excess power so that it can be exported to the Regional Electricity Market at fairly attractive prices, (5) catalyse and organize the little private EE initiatives that are trying to thrive in Costa Rica.

Regarding the barriers hampering DSM implementation in Costa Rica, three general thoughts can be underlined: (1) There is a lack of policies in support of DSM. Effective legislation that compels utilities to implement long term planning and assume a commitment to systematically include demand side measures in their resource portfolio is lacking. (2) There is an important knowledge gap about DSM framework as a methodology that aims to introduce demand side measures in the electricity planning. (3) The lack of resources has been the main bottleneck for implementing rational use and energy conservation actions. Therefore, it would be also a major obstacle for DSM implementation. However, there are other important barriers that have to be overcomed in the utility and consumer level.

Based on the above, the research question aims to give light on how policies can be designed to kick-start the development of a DSM culture in CR. In short, the author concludes that, at first, it is necessary to set DSM in the agenda. Secondly, it is important to give the specific responsibility to an entity that can constantly push DSM forward. Moreover, it is important to create an overarching legislative structure that establishes a national energy saving commitment, and to enact complementary measures to increase DSM effectiveness. This is commented in four points:

I. Set topic in the agenda: The first barrier to take down is the knowledge gap about DSM. Indeed, this can be a reason that is stopping the government funding of DSM and utilities to support it. Initially, DSM should be sold to SEM because it is the governing entity in the electricity sector. Then, an integrative and collaborative process to create a public dialogue about DSM, encompassing all the interested stakeholders, should be carried out. This process also must quantify the potential and benefits of DSM, not just at a national level, but also in case-specific context for utilities. The government should make full use of existing organizations, for instance the National Energy Conservation Commission (NECC), in order to perform this task. Also, create partnerships with strategic actors as the University of Costa Rica that is currently building an Energy Efficient Centre and the Industrial Association that has within it an EE and renewable energies department.

II. To create a DSM operative agency: An operative energy agency is essential to sustain, over time, effective national efforts to implement DSM. It is absolutely required for this body to have strong technical skills and stable and appropriate funding. The SEM could be empowered to take over this function. Nevertheless, the author considers that to create an independent non-profit organization is a better option because the independence and efficiency of the organization can be better guarantee.

Some of the core responsibilities that the DSM operative agency should be in charge of are: (1) Coordinate all the central government DSM initiatives. (2) Develop the required mechanisms to establish a functioning compliance system. (3) Identify and update the energy savings eligible measures. (4) Develop methodologies to assess the cost-effectiveness of DSM programs. (5) Manage the SBCs funds. (6) Launching awareness campaigns and training programmes to reduce the knowledge gap about DSM.

III. Legislation to establish a legal a long-term commitment with energy saving: If the Government aims to translate policies into practice, it has to issue suitable and clear legislation that enacts demand side measures as a priority option, and establishes specific obligations for the different actors. A law establishing energy savings commitments can bring several benefits, but the most important is that it provides a long lasting context for DSM, and that the lack of continuity and commitment has been an important barrier to implement energy conservation actions in Costa Rica. It is suggested that this legislation explicitely refers to four topics:

(1) *Targets:* two options were discussed qualitative and quantitative targets, both of them have strengths and drawbacks that have to be further analyzed. A quantitative target could be a progressive percentage of energy savings. For example, a 5% energy reduction target for the period 2012-2017, where in 2012 the energy saving target will be 1%. In this case, a baseline and protocols of measurement and verification are essential for this option to work. The other option is to establish a qualitative target, thus, distribution companies would be compel to invest, at least, 0,3% of their net operational revenue in EE projects. In this scenario is important to clearly set the rules that these projects must conform, as well as the procedure the have to follow to receive the approval from the energy regulator.

(2) Obligated actors: Several scenarios were discussed, however, the author concludes that the best alternative is to impose the energy saving obligations on the distribution companies. This is mainly supported in two reasons. At first, it is probably easier for utilities to overcome some market barriers than other institutions because they have a closer contact with consumers, and it is also easier for them to provide incentives through the electricity bill. They can also select technologies to optimize the system's load factors. Secondly, one added value of DSM framework is that it helps utilities to systematically introduce long-term cost effective planning, which at the end can help them to be more competitive. Additionally, the lack of long-term planning is a bottleneck for the sustainability and success of policies in developing countries. Therefore, it is important to develop this culture, and any policy tool that contributes to achieve that should have priority. If the energy saving obligations are set on a non-profit organization, this hallmark would be lost. Lastly, this option has proven to wok in regulated or deregulated markets. In addition, the law should explicitly mention order

obligations in order to lead utilities to systematically introduce DSM in their management scheme.

(3) *Monitoring and verification system:* The monitoring and verification phase of the demand side projects is essential to maintain a DSM program. To develop the administrative and technical infrastructure to perform these tasks can be time and resources consuming for utilities. Thus, in the case of ICE it acted as a barrier for action. If a quantitative target is established it is essential to set up mechanisms to monitor demand side measures energy savings, and it can be useful to use the ex- ante methodology. Among the advantages of this approach is that it is popularly used, thus there is a documented legacy which was generated by the experience of other countries; that information can be used and replicated when possible. Moreover, it can substantially simplify the monitoring and verification process, freeing up resources for the implementation of other tasks. Specifically, it can facilitate the implementation of energy saving obligations in the residential sector, which already has as a high transaction costs barrier for utilities.

(4) *Funding & incentives*: Several possibilities were discussed; they are closely related to the electricity model that the country decides to adopt and the type of DSM approach that its willing to support (market based or public policy oriented). Therefore, there are mainly two options:

- To give utilities or energy companies recovery mechanisms: tariffs, SBCs, and other shareholder incentives.
- Restrain from recognizing recovery mechanisms and promote resource procurement funding or/and the development of an ESCOs market.

Both of these options require governmental action, and the allocation of costs. History has showed that DSM cannot be an activity completely supported by the private sector (Wikler, 2000). Therefore, considering the Costa Rican context, the author argues recovery mechanisms should be established. The creation of a SBC is key to supporting the development of a DSM culture. Here a surcharge will be imposed per each kWh sold. The money generated would help to facilitate a gradual but effective development of DSM in Costa Rica. A SBC can provide market stability to utilities which is crucial to encourage them to develop the infrastructure needed to develop DSM programs, as well as to invest in programs that have high upfront costs (McLean 2009). Additionally, it would provide money to the DSM operative agency to execute all its responsibilities. Moreover, the energy companies or the government would be in better position to finance EE measures through subsidies or grants (ICER, 2010). To offset the impact of the induced rising cost of power, the Government could consider setting a five-year subsidy action plan. The subsidies could be at their highest in the first year, and then gradually fall to zero at the end of the fifth year. However, the funding from SBC is just one part of a financial resource to develop DSM. Therefore, even if Costa Rica implements a public policy oriented DSM, the government should also promote participation by the financial sector in DSM.

Regarding the incentives, again, ICE past experiences shows that it is not enough to be able to recover costs through tariffs to change the supply bias mindset widespread in utilities. Therefore, it should be analyzed to give to the stakeholders other incentives. Popular mechanisms are modification in the rate structures to delink profits from sales volume, while the loss-based revenue can be another mechanism which has actually already been propose in the Contingency Plan Bill recently presented to the Congress.

Moreover, the Government should design incentives to overcome other consumer barriers. The most popular incentives are subsidies, rebates, and soft loans. Nevertheless, before funding a measure like this, the practicality of the subsidy (effectiveness, efficiency, equity, flexibility, feasibility) should be thoroughly evaluated in the social, economical, and political dimension.

IV. Complementary measures: Labeling programs and efficiency standards are key complementary measures for the success of DSM. They are powerful methods of transforming the market because they limit the choice of consumers. As it was explained previously, in Costa Rica there is a consciousness about the importance to of developing this tool, however, there is not enough political support and financial resources to set mandatory EE standards and a labelling system. The creation of a DSM operative agency and a SBC can contribute to overcoming this obstacle as well. Moreover, it can be underlined the importance of information and education actions towards creationing a DSM culture. For instance, important efforts have to be showcased in order to build capacity and knowledge about DSM in the utilities. It can help to reduce the supply bias mindset, e.g., the belief that DSM programs introduce too much uncertainty even though the supply side option carries inherent risks as well, and both options should be analyzed on an equal basis. Furthermore, information and awareness is important to increase consumer support and interest towards DSM programs. In addition, pricing mechanisms were also identified as key actions to contribute to DSM implementation, and the actions in this regard require further analysis.

Costa Rica's traditional supply-biased electricity planning model is exhausted. An energy crisis looms in the near future if the appropriate actions are not taken, in both the supply and the demand side. DSM can significantly contribute to improving the security and sustainability of Costa Rica electric sector in the long run. Even though, DSM is a complex and challenging framework because it requires aligning the country, the utilities, and consumers interest, it should not be a reason for avoiding to discuss DSM as an option.

There are several alternatives and combinations towards delineating a DSM scheme, the result will be a consequence of the political negotiation. Therefore, the most immediate action is to start raising awareness about the value of DSM to generate public support, and to start a public dialogue about the possibilities to implement a DSM national program.

In order to establish DSM is a cultural process the pace of change may be slow. Therefore, it is advisable to introduce DSM gradually. It can even be helpful to propose the implemention of a pilot program with a specific demand side measure in a specific sector. This will generate information that can give useful hints for the design of a future DSM scheme. However, none of this can be achieved if the government is not completely aware and willing to set a clear energy policy line in order to achieve energy savings and allocate resources to enforce it.

Recommended future research

The lack of a sound figure about DSM's energy saving potential at a national level, as well as quantitative information to build the business case for at a utility level, are a paramount limitation in the path towards starting a constructive and serious discussion about the possibilities of implementing DSM.

Also, research should be performed to identify the market barriers, and to assess the magnitude of market failure to determine if it is possible to design public policy to ameliorate these market barriers without compromising other important public policy or social values that also contribute to the general welfare.

Bibliography

Aguero, M. (2011, March 20th). Hidroeléctrica empezará a operar dos años después de lo previsto [Hydroelectric plant will start its operation two years after the forecast.] Retrieved from: http://www.nacion.com/2011-03-21/ElPais/NotasSecundarias/ElPais2718849.aspx]

Barrantes L., & Elizondo S. (2006). Informe sobre los subsidios actuales en las tarifas del sector energía. [Reports about the actual subsidies in the electricity rates]. San José, Costa Rica, Government printing office.

BEE. Bureau of Energy Efficiency. (2009). DSM Regulations. Retrieve from: http://www.bee-dsm.in/PoliciesRegulations_1_3.aspx

Bertoldi, P., & Rezessy, S. (2007). *Assessment of White Certificate Schemes and their Energy Saving Evaluation Methods.* Paper presented at the conference Energy Program Evaluation Conference, in the United States, Chicago. Retrieved from: www.cee1.org/eval/db_pdf/613.pdf

Bun-Ca. (2009). Estructura arancelaria e incentivos a la eficiencia energética en el sector eléctrico en Centroamerica. [Tariff structure and incentives for energy efficiency in the electricity sector in Central America]. San José, Costa Rica.

Bun-Ca. (2007). Estrategia de Política en Eficiencia Energética para el Sector Eléctrico de Centroaméric y República Dominicana. [Energy Efficiecny Policy Strategy for the Electricity Sector in Central America and the Dominican Republic]. San José, USAID.

BP. (2010) Statistical Review of World Energy. Retrieved from: http://www.bp.com/productlanding.do?categoryId=6929&contentId=7044622

Chanto L. (2011). Diagnóstico del PRONACE 2003-2008 y aportes para un nuevo PRONACE. Borrador Final. [An evaluation of PRONACE 2003- 2008 and feedback for a new PRONACE. Final draft]. San José, Costa Rica. Sectorial Energy Management.

Charles River Associates. (2005). Primer on Demand-Side Management with an emphasis on price-responsive programs. California: The World Bank.

Chen-Apuy, L., Herrera, A., Sauer L., & Seger S. (2001). Demand-side management for the residential sector of the San Jose, Costa Rica, metropolitan region. Energy for Sustainable Development 31 (1): 60-80.

Consortuim PREEICA, (2000). Demand side management: its concept, extension, advantages, and organization. Introduction workshop. Activity code EDT 5201. San José: ICE.

Dube, I., Beta, M., & Dihwa, S. (2005, July 11). *Opportunities for demand side management (DSM) in integrated energy resource planning and development in the power sector: the case of Zimbabwe.* Paper presented at the Inaugural IEEE PES 2005 Conference and Exposition in Africa Durban, South Africa.

De la Torre ,T. (2010a). Hacia un nuevo modelo energético para nuestro país. [Towards a new energetic model for our country]. MINAE. Government printing office

De la Torre, T. (2010b). Modelo propuesto para la industria electrica nacional. [Proposed model for the national electric industry]. (Power Point Presentation). MINAE. San Jose, Costa Rica.

Didden, M., & D'haeseleer, W., (2003). Demand Side Management in a competitive European market: Who should be responsible for its implementation?. Energy Policy 31 (2003) 1307–1314

D'Sa, A. (2005). Integrated resource planning (IRP) and power sector reform in developing countries. Energy Policy 33 (2005) 1271–1285

CEPAL. Economic Commission for Latin America (2010a). Situation and perspectives about energy efficiency in Latin America and the Caribbean. Santiago de Chile, Chile, ONU.

CEPAL. Economic Commission for Latin America. (2009b). Central America: Statistics of the electricity subsector. Year 2009. D.F., México, CEPAL.

Eto, J. (1990). An overview of analysis tools for integrated resource planning. Energy 11 (15): 969-977. Executive Power of Costa Rica. (2010). "Electricity contingency bill"

Gehring, K. (2002). Can yesterday's demand-side management lessons become tomorrow's market solutions? The Electricity Journal: 63-69.

Gellings, C. (1995). Then and now. The perspective of the man who coined the term 'DSM'. Energy Policy (24) 4: 285-288.

Hirst, E. (1994). What constitutes a good integrated resource plan? Utilities Policy 1994 (2): 141-153. Hirst, E. (1993). Do utility DSM programs increase risk? The Electricity Journal: 24-31.

India Energy Portal. (2009). Indian energy sector: an overview. Retrieve from: http://www.indiaenergyportal.org/overview_detail.php

International Energy Agency (IEA). (2010). DSM anual report. 2010. Retrieved from: http://www.ieadsm.org/Publications.aspx?ID=24

IEA-DSM.(n.d.). Demand Side Management Programme Retrieved May 15th from:
http://www .ieadsm.org/Content.aspx?ID=3#_ft

"IEA DSM Implementing Agreement". (2009). Guidebook on analytical methods and processes for integrated planning. Final report. (A Report of Task IV - Development Of Improved Methods For Integrating Demand- Side Options Into Resource Planning. Subtask IV/3). Retrieve from: www.ieadsm.org/...%20Development%20of%20Improved%20**Methods**%20for%20Integrating...

Kim, J., & Shcherbakova, A. (2011). Common failures of demand response. Energy 36: 873- 880.

Kosa, P., Kulworawanichpong, T., Srivoramas, R., Chinkulkijniwat, A., Horpibulsuk, S., Teaumroong, N. (2011). The potential micro-hydropower projects in Nakhon Ratchasima province, Thailand. Renewable Energy (36): 1133- 1137.

Kueck, J., & Kirby, B. (2004). Demand response research plan to reflect the needs of the California independent system operator. Oak Ridge National Laboratory January 2004. Consortium for Electric Reliability Technology Solutions (CERTS) and funded by the California Energy Commission, Public Interest Energy Research Program, under Work for Others Contract No. BG 99-396 (00).

McLean-Conner, P. (2009). Energy efficiency: principles and practices. PennWell Corporation: Oklahoma, United States.

Martínez, F. (2010). Evolución del sector energético, consumo, tendencias e impacto en la huella de carbono. [Evolution of the energy sector, its consumption trends, and its impact in the carbon footprint]. San José, Ombudsman Government Printing Office.

MINAE. Ministry of Environment. (2009). Encuesta eléctrica nacional 2007. [National electricity demand survey 200]. San José, Costa Rica, MINAE Government Printing Office.

MINAE. Ministry of Environment (2008). Diagnóstico para el V plan nacional de energía. [Diagnosis for the V national energy plan 2008-2021]. San José, Costa Rica, MINAE Government Printing Office.

MINAE. Ministry of Environment. (2001). National Program for Energy Conservation 2001-2006. San Jose, Costa Rica, MINAE Government Printing Office.

Mundaca, L,. (2008). Markets for Energy Efficiency. Exploring the New Horizons of Tradable Certificate Schemes. Doctoral dissertation. IIIEE.

ICE. National Electricity Institute. 2010. Proyecciones de la demanda eléctrica en Costa Rica (2010-2033). [Projections of electricity demand in Costa Rica (2010-2033)]. San José, Costa Rica, ICE Government Printing Office.

ICE. National Electricity Institute. 2010b. Plan de Expansión de la Transmisión 2010 – 2030 [Plan for the expansion of the transmission network 2010-2030]. San José, ICE Governing Printing Office.

ICE. National Electricity Institute. (2009). Plan de expansion de generación eléctrica. Período 2010-2021 [Expansion plan for electricity generation. Period 2010-2021]. San José, Costa Rica, ICE Government Printing Office.

NISC. National Institute of Statistics and Census. (2010). Población [Population]. (Official website). Retrieved from: http://www.inec.go.cr/Web/Home/pagPrincipal.aspx

CNFL. National Lighting and Power Company.(2010). Definición. [Definition]. (Official website). Retrieved from: http://www.cnfl.go.cr/portal/page?_pageid=35,43429&_dad=portal&_schema=PORTAL

NMI. National Meteorological Institute. (2009). Segunda comunicación nacional a la convención marco sobre cambio climático. [Second national communication to the United Nations Framework Convention of Climate Change] San José, MINAE, GEF, PNUD.

Nilsson, H. (2007, September 10). Demand side management (DSM). A renewed tool for sustainable development in the 21st century. *A survey of the concept, its development and its applications.* Chairman of the IEA DSM-Programme Sweden Brugge.

Lave, L., & Spees, K. (2007). Demand Response and Electricity Market Efficiency. The Electricity Journal (20): 69-85.
Poveda, M. (2007). Energy efficiency a wasted resource. Quito, Ecuador: Latin America Energy Organization (OLADE).

Ramírez, A., & Mora, F., (2010). Políticas ambientales en Costa Rica: ordenamiento territorial y energía, 2009 [Environmental public policies in Costa Rica: land use planning and energy, 2009]. San José, Costa Rica, Ombudsman Government Printing Office.

Saini, S. (2004). Conservation vrs. generation. ReFocus: 52- 54.

Sharad, B. & Karmacharya, L. (2008). The evolution of Brazil's electricity market from textbook to regulated long term contracts. Network Industries Quarterly. Retrieved from: http://newsletter.epfl.ch/mir/newspaper-article?np_id=157&np_eid=28&catid=0

Taylor, R., Govindarajalu, C., Levin,J., Meyer A., Ward, W. (2008). Financing energy efficiency. Lessons from Brazil, China, India, and beyond. Washington DC: The World Bank.

Torriti, J., Hassan, M., & Leach, M. (2010). Demand response experience in Europe: policies, programmes and implementation. Energy (35): 1575–1583.

Unite States Government. Department of Energy. (2006). *Benefits of DR in electricity markets and recommendations for achieving them. A report to the US Congress pursuant to section 1252 of the Energy Policy act of 2005.* Retrieved from: *eetd.lbl.gov/ea/ems/reports/congress-1252d.pdf*

UNDP. United Nations Development. (2004). World Energy Assessment. Overview. 2004

Vindas, L. (July 7th, 2010). Costa Rica contará con Centro de Eficiencia Energética. [Costa Rica will have an energy efficiency center].*El Financiero.* Retrieve from: http://www.elfinancierocr.com/ef_archivo/2010/enero/10/economia2217582.html

Vine, E., Rhee, C., & Lee, K. (2006). Measurement and evaluation of energy efficiency programs: California and South Korea. Energy (31) 1100–1113.

Vine, E., & Kushlers, M., (1995). The reliability of DSM impact estimates. Energy (20): 1171-l 1779.

Villa, L. (2011, March 29). Indígenas demandan al ICE por usar sus tierras para proyecto hidroeléctrico. [Indigenous sued ICE for using their land for a hydroelectric plant]. *La Nación.* Extracted URL: http://www.nacion.com/2011-03-30/ElPais/NotasSecundarias/ElPais2730901.aspx

Villegas, J. (April 6th, 2011). Gobierno pretender expandir el uso de ethanol a todo el país [Government pretends to extend the use of ethanol to the hole country] *La Nación.* Retrieved from: http://www.nacion.com/2011-04-07/ElPais/UltimaHora/ElPais2740643.aspx

Villegas, J., & Loaiza, V. (April 5th, 2011). Gobierno extendera la restricción vehicular en San José. [Government will extend the restrictions for car circulation in San José]. Retrieved from: http://www.nacion.com/2011-04-06/ElPais/NotasSecundarias/ElPais2739285.aspx

Vizcaíno, I. (2011, April 2rd). ONU da advertencia a Costa Rica por uso de tierras indigenas para poyecto hidroeléctrico. [UN gives a warning to Costa Rica for using indigenous land for a hydroelectric project]. *La Nación.* Retrieved from: http://www.nacion.com/2011-04-03/ElPais/NotasSecundarias/ElPais2734620.aspx

Vizcaíno, I., (2011, March 30). Indígenas pretenden 10% de participación en hidroléctrica. [Indigenous community aims to get 10% of the hydroelectric plant shares]. *La Nación.* Retrieved from: http://www.nacion.com/20110331/ElPais/NotasSecundarias/ ElPais2732199.aspx

Vizcaíno, I., (2011, March 29). Eventual retraso de El Díquis ponen en riesgo el plan electrico. [Eventual hold back of El Díquis risks the electricity plan]. *La Nación*. [Extracted: http://www.nacion.com/2011-03-30/ElPais/NotasSecundarias/ElPais2730921.aspx]

Weisbrod, G. (1999). Learning from India: defining profitable demand-side management and energy service company programs for a utility. The Electricity Journal: 31-39.

WOC. Web Owner Corporation. (2011). Actualized work schedule. In forced version: 101123. Retrieved May 2011: http://www.eprsiepac.com/cronograma_siepac_transmision_costa_rica.htm

Wikle, G. (2000). Policy options for energy efficiency initiatives. The Electricity Journal: 61-68.

WEC. World Energy Council. (2008). Energy efficiency policies around the world: review and evaluation. London, United Kingdom: World Energy Council.

WEC. World Energy Council. (2010) Energy efficiency: a recipe for success London. W1B 5LT United Kingdom

Yilmaza, P., Hocaoglub, H., Konukmanc, A. (2008). A pre-feasibility case study on integrated resource planning including renewables. Energy Policy (36): 1223–1232.

Yu, Y. 2010. Policy redesign for solving the financial bottleneck in demand side management in China. Energy Policy (38): 6101–6110.

Zhaoguang, H., Xiandong, T., Fan, Y., Ming, Y., Quan, W., Baoguo, S., Xinyang, H. (2010). Integrated resource strategic planning: case study of energy efficiency in the chinese power sector. Energy Policy (38): 6391–6397.

Villegas J. (April 4th, 2011). Aprobado nuevo aumento en el precio de los combustibles. [New increase in the price of fossil fuels was approved.] *La Nación*. Retrieved from: http://www.nacion.com/2011-04-07/ElPais/UltimaHora/UH0704-GASOLINA.aspx

Laws & Decrees

Law 7447, Ley de regulación del uso racional de la energía [Rational electricity use act]. (1994). Retrieved from:http://www.pgr.go.cr/scij/Busqueda/Normativa/Normas/nrm_repartidor.asp?param1=NRTC&nValor1=1&nValor2=24436&nValor3=81361&param2=1&strTipM=TC&lResultado=8&strSim=simp

Law 7200, Ley que Autoriza la Generación Eléctrica Autónoma o Paralela. [Law to autorize private electricity generation]. (1990). Retrieved from: http://www.pgr.go.cr/scij/Busqueda/Normativa/Normas/nrm_repartidor.asp?param1=NRM&nValor1=1&nValor2=7591&nValor3=8139&strTipM=FN

Law 8829, Modificación del artículo 38 de la Ley 7447 Regulación del uso racional de la Energía, y sus reformas, Ley para Incentivar el desarrollo y la utilización de Fuentes renovables de Energía [Act to modify article 38 of Law 7447 to incentivize the development and utilization of renewable energies]. (2010). Retrieved from:http://www.pgr.go.cr/scij/Busqueda/Normativa/Normas/nrm_repartidor.asp?param1=NRM&nValor1=1&nValor2=68235&nValor3=81253&strTipM=FN

Decree 23335-MIRENEM, Crea la Comisión Nacional de Conservación de Energía (CONACE) [Creation of the National Energy Conservation Comission]. (1994). Retrieved from: http://www.pgr.go.cr/scij/Busqueda/Normativa/Normas/nrm_repartidor.asp?param1=NRM&nValor1=1&nValor2=20079&nValor3=21375&strTipM=FN

Personal communications
Bermudez, E. personal communication. February 22th 2011. Private consultor (interview & by email).

Blanco, J. personal communication. February 24th, 2011. Regional Director of Bun- Ca. (interview)

Castro H. personal communication. February 17th, 2011. Business Development, Geotecnologías. (interview & by email)

Castro M. personal communication. February 5th 2011. Electricity Planning Department of ICE. (by email).

Ceciliano, J. personal communication. February 28st, 2011. Energy Department in ARESEP. (interview)
Castillo, G. personal communication. February 21st, 2011. Subdirector of SEM. (interview & by email)

De la Cruz, G. personal communication. February 16, 2011. Director of the Electricity Planning Department of ICE. (interview & by email)

Guevara, R. personal communication. February 15th,2011. Energy expert and member of the Clean Teach Cluster. (interview).

Hidalgo, C. personal communication. April 10th, 2011. Legal advisor of PAC political party in the Congress. (by email)

Musmanni, S. personal communication. February 22nd 2011. Senior local advisor from GiZ.

Ramírez M. personal communication. February 16th, 2011. Electricity Planning Department of ICE.

Ramírez E. personal communication. February 16th, 2011. Energy Department in ARESEP. (interview & by email)

Salazar, S. personal communication. February 16th, 2011. General Coordinator of the demand side management program in ICE. (interview and by email).

Solera, F. personal communication, February 11th , 2011. Councel of the Sectoral Energy Management. (interview and by email)

Solís, H. personal communication. February 15th, 2011. Director of the Energy Efficiency and Innovation Department of CNFL (interview