SWH Market Assessment

Regional Report

Developed by: Organization of Energy of

Latin American and the Caribbean

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1. INTRODUCTION

The Latin American Energy Organization (OLADE) and the United Nations Environment Program (UNEP) have committed to work together in the project entitled ¨Solar Water Heating Market Transformation and Strengthening Initiative¨. The principal objective of this project is to promote and accelerate the commercialization of the thermal solar panels as a renewable and sustainable alternative for water heating. In this manner, the projects seeks to reduce the current use of electricity and fossil fuels for hot water preparation in residential, private service sector and public buildings and, when applicable, industrial applications. It will build on the encouraging market development rates already achieved in some GEF program countries and seek to further expand the market in other GEF program countries, where the potential and necessary prerequisites for market uptake seem to exist.

OLADE as a regional partner in the solar water heating (SWH) project will serve as a knowledge regional hub to generate knowledge products and services to ensure that developmental experiences and benefits of knowledge that can be effectively disseminated to the Mediterranean/North African countries.

In order to accomplish these objectives, one of the first phases of the project was to gather information regarding the following aspects: climatic conditions of each country; economic, political, institutional, social and financial conditions that promote or discourage the demand of this product; conditions of the thermal solar panels market (information about the demand, supply and costs); political actors (NGO´s, government institutions, fabricators, business associations, universities, etc.) that encourage the commercialization of solar thermal panels through investigations, projects or other methods. As a result of this information gathering from 24 countries of Latin America and the Caribbean (Argentina, Barbados, Bolivia, Brazil, Costa Rica, Cuba, Colombia, El Salvador, Ecuador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Nicaragua, Panama, Paraguay, Peru, Dominican Republic, Surinam, Trinidad & Tobago, Uruguay, Venezuela), six countries were selected according the amount of

information delivered by each country and according to the state of art of the institutional framework for renewable energy (policies, legislation and specific agencies), amount of specific regulations on SWH, availability and accessibility to information on SWH activities. This report is based on the information gathered from the six countries and it seeks to describe the state of art of these countries and it also seeks to analyze the solar water heating market barriers and the priorities of action of each country as well as the overall gaps of the region and the priorities of action.

This document is structured in the following manner: first, the state of art of the market and institutionalism of each country is described (Argentina, Barbados, Brazil, Colombia, Nicaragua, and Peru). This state of art is described by analyzing the principal factors of the market (demand, supply, costs and economic and financial incentives) and institutionalism (political and institutional framework). Second, after this description, it is analyzed the gaps and barriers of each country and a recommendation of the priorities of action of each country is also provided. In the last section of the document, an overall conclusion is provided by analyzing the state of art of the market and institutionalism of all the six selected countries; thus, mentioning the gaps and barriers and priorities of action for these six countries.

2. METHODOLOGY

In order to gather the necessary information, a questionnaire was elaborated by OLADE with all the questions that needed to be addressed. This questionnaire was e-mailed to all the National Coordinators of OLADE, who work in the Ministries or Secretaries of Energy of each country. This questionnaire was filled out by these National Coordinators and send to OLADE. If some of the questions were not filled out, then OLADE contacted other public and private institutions willing to fill out such questionnaire and it also took the initiative to research and thus gather more information.

Nevertheless the several initiatives undertaken by OLADE to gather the accurate information, during this process, the organization encountered several difficulties considering that most information can be found in private entities and not in public institutions. Therefore, the public entities provided very few information. Moreover, taken into consideration that OLADE is an inter-governmental organization, it has closer relationship with public entities than private entities and also due to the lack of willingness from the private entities to provide such information, it was difficult for OLADE such process.

The questionnaire can be found in Annex A of this report. The information provided by the Secretary of Energy can be found in the following Annexes.

3. COUNTRY ASSESSMENT OF ARGENTINA

3.1.Market of Solar Panels

3.1.1. DEMAND

3.1.1.1. Residential Areas:

In Argentina, the economic sector that consumes in greater amount heated water is the residential sector. In 2007, the estimated consumed energy of heated water in this sector was of 3,000 ktep per home, whereas in the commercial and industrial sector, the estimated consumed energy was of 1,100 ktep and <2,700 ktep respectively, as shown in table 1. Moreover, the average home uses close to 25% of the total consumed energy for water heating to have access to sanitary water, wash clothes and dishes, preparation and consumption of food and for pools.

Sector	**Uses**	**Traditional Sources**	**Estimated energy consumption in 2007**
Residential	Sanitary water, washing clothes, preparation and consumption of food, pools	Natural gas, Liquified Petroleum gas, Wood, Electricity	3,000 ktep
Commercial, Services and Public	Sanitary water, washing clothes, pools, and others	Natural gas, Liquified Petroleum gas, Wood, Electricity	1,100 ktep
Industrial	Hot water and vapor for several industrial processes	Natural gas, Fuel Oil, Biomass	<2,700 ktep

Table 1: Classification of consumption of heater water and vapor per economic sectors in Argentina

However, many houses do not use solar panels for water heating despite its high efficiency and the low CO2 emissions. The traditional sources of energy for water heating in the residential sector are natural gas, liquefied petroleum gas, wood, and electric energy. In 2007, the demand of energy for water heating in the residential sector was structured in the following manner: 85% used natural gas for water heating, 12% used liquefied petroleum gas, 2% used wood and 1% used electric energy, as can be seen in table 2.

	Demand of energy for water heating (%)
Use of natural gas for water heating	85%
Use of liquefied petroleum gas for water heating	12%
Use of wood for water heating	2%
Use of electric energy for water heating	1%
Total	100%

Table 2: Demand of traditional energy sources for water heating in 2007.

The primary reason for the demand of natural gas to be so high in the residential sector is due to the low cost of this traditional energy sources, especially compared to the high initial cost of solar water heaters. As stipulated in this section, in which the costs are analyzed, for a residence the cost of natural gas varies from $ 0.54 – 1.45 / kep, and for the southern zones of Argentina which receive subsidization, the cost varies from $ 0.22 – 0.55 / kep, according to the categories of residential consumption. Whereas, only the investment cost of an average solar water heaters is approximately of $ 1,600 / m2.

Moreover, certain zones of Argentina and sectors of the economy have a greater demand for heated water. The demand for heater water is greater in the more temperate zones of Argentina than in the arid/cold zones and the warmer zones. In the temperate zones, the demand corresponds to 66% out of the total demand for heated water, while in the arid/cold zones it is only 25% and in the warmer zones the demand corresponds to 9%. In the urban zones of Argentina there is also a greater demand for heated water than in the rural sectors. In the urban sector, the demand of energy for heated water represents 97% of the total energy demand for

heated water, while in the rural sectors; there is only a small demand that represents 3% out of the total energy demand for heated water in the country.

Also, the demand of energy for heated water is also concentrated in certain sectors of the population. In the medium income sectors, 48% of the energy demand for heated water corresponds to this sector, while 17% and 34% of the demand corresponds to the high and low income sectors of the population, respectively.

Most importantly, the zones and the sectors that have access to heated water mostly use natural gas. Out of the total demand for heated water, 84% of this total consumption is generated with natural gas, while only 16% of this demand is generated from other sources.

In synthesis, the homes in urban areas with temperate and cold/arid climates represent 80% of the total energy consumed for heated water. The greater consumption is registered in sectors of medium income and temperate climate zones, which are located in urban areas and which have access to natural gas.

3.1.1.2.Commercial, Service and Public Sector:

As in the above-mentioned sector, in the commercial, service and public sector of the economy, the source of energy used for water heating is principally natural gas. The sources of energy used in the sector for water heating are: natural gas representing 85% (965 ktep) of the total energy consumed for water heating; liquefied petroleum gas representing 12% (136 ktep); wood representing 2% (25 ktep); and electric energy representing 1% (11 ktep), as shown in table 3. Thus, as can be observed, the principal source of energy for water heating in the commercial sector is natural gas as in the commercial, service and public sector.

Source	Water Heating	
	%	ktep
Electric Energy	1%	11
Natural Gas	85%	965
Liquefied Petroleum Gas	12%	136
Wood	2%	25
Total	100%	1,137

Table 3: Consumption of energy by source for water heating in the commercial, service and public sector in Argentina 2007.

The energy demand for heated water in this sector of the economy is also concentrated in certain areas. The energy demand for water heating is mostly concentrated in health institutions (33.6%), hotels (31.8%), public administration and defense institutions (25%), other services (17.4%), in schools and/or universities (14.9%), among others.

3.1.1.3. Industry:

As in the other sectors of the economy, natural gas is the principal source of energy used for water heating. In 2007, natural gas represented 45% of the energy used for water heating (6,265 ktep); 34% represented electricity (4,724 ktep); 5% represented bagasse; 3% represented liquefied petroleum gas; and other types of energy represented even less in the consumption pie. In regards to solar energy, it represented 0% in the consumer pie in the year 2007, as shown in table 4.

Source	Consumption of energy	
	%	ktep
Solar	0%	-
Residual Fuel Oil	1%	184
Other Secundaries	3%	420
Other Primaries	3%	398
Non Energetic	2%	245
Metalurgical Coke	1%	103
Wood	1%	124

Kerosene	0%	-
Gasoline Fuel	0%	-
Gasses	2%	313
Natural Gas	45%	6,265
Liquefied Gas	3%	405
Electricity	34%	4,724
Diesel	1%	85
Vegetal Carbon	0%	-
Mineral Carbon	0%	-
Biodiesel	0%	-
Bagasse	5%	684
Total	100%	13,952

Table 4: Energy consumption by source in the industrial sector of Argentina, 2007.

A very strong reason for having the industrial demand of solar energy at 0% is because the range of temperatures needed for several industrial procedures are very high. Solar water heaters are not able to generate heater water at extremely high temperatures; and that is why these systems are only able to generate heated water for procedures that need water at lower temperatures, such as for boilers. It is estimated that the demand of heated water for boilers in Argentina is of roughly 19% of the total demand of heated water in the industrial sector. Therefore, only 19% of the demand can be provided through solar energy in the industrial sector. For this type of activity, the most adequate solar panels are the ones with an empty vase.

There are certain industries which have a greater participation of boilers and thus have a greater demand of heated water. Such industries are the food industry which has a 76% participation of boilers in its industrial procedures; the textile industry which has a 66% participation of boilers in its industrial procedures and the Non-Metalic Minerals which have a 45% participation of boilers. This analysis can determine which industries have a greater probability of penetration of solar water heaters into their industrial procedures.

3.1.2. SUPPLY

In Argentina, there is an important number of providers and a few producers of thermal solar panels. Some of the principal providers and producers are outlined in table 5.

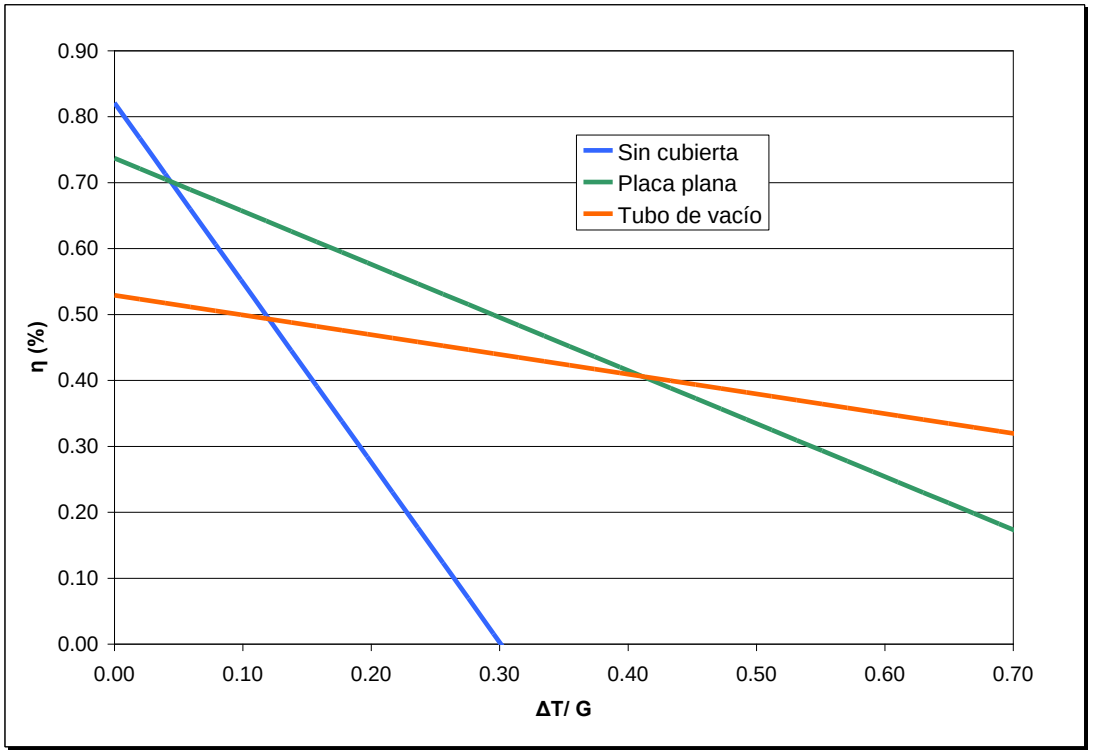
Fabricators	***Distributors***
Benvenutto Ingeniería Solar	ET Solar
Tecno Energía	Energía Nueva
Viento Solar	Solar Pool
Delta Morphosis	Arquitectura Bioambiental y Solar
Solutronic	Enalta Solar
Termosol,	Alsun
Sansolar	Atermec
Guillermo Pallissó	Solarcenter
Vademarco SA	Elece Argentina
TecnoSolar	Enersol
	Autosuficiencia
	Torresolar, Sansolar
	Ecosolar S.A.
	Clean energy
	Agro El Desvio SA
	Tecnosur Ingeniería
	Karp International SA
	EMCISA S.R.L.
	Sun Air

Table 5: List of fabricators and providers of thermal solar panels in Argentina.

Unfortunately, it was not possible to gather information regarding the amount of thermal solar panels that are fabricated in Argentina annually, and the amount of solar panels that are imported to Argentina. The only information that we were able to gather regarding

manufacturing and imports is the following: flat solar panels of high quality are fabricated in Argentina, while the solar panels of empty pipe are imported.

The efficiency of the thermal solar panels that exist in Argentina is not very good. There are three types of thermal solar technologies that are used for water heating at relatively low temperatures (<95%C): panels with no cover; panels of flat plate with cover; and panels of empty pipe. The panels of empty pipe (tubo de vacio) are the most efficient systems under conditions of low temperature and wind (high heat jump); panels with no cover (sin cubierta) are most convenient in high temperatures where there is a greater solar irradiation (reduced heat jump), these systems are very efficient at heating up water in pools; panels of flat plate (placaplana) with cover can be found in an intermediary position between the two previously mentioned solar panels, as can be seen in the following graph.



Graph 1: Qualitative behavior of the efficiency of according to the type of solar panel and thermal jump

Moreover, the quality of the solar collector not only depends on its technical efficiency but also in the thermal losses that occur in the process of conveyance and storage of heated water. It is estimated the above-mentioned solar panels loss up to 10-15% of the energy. In this way, if the solar collectors only withhold 55% of the solar radiation in an effective manner and around 10%-15% is lost due to the inefficiency of the systems, only 45% of such energy can be used for water heating.

3.1.3. COSTS

Another important factor in the market of thermal solar panels is the cost of this technology. The prices of the solar panels are a very significant factor in the consumer´s decision-making process of buying a solar panel. In Argentina, the costs of solar energy are incredibly high considering that the low cost of natural gas. In the following table 6, the costs of different energy sources ($/kep) in 2008 is demonstrated with its variation ranges:

Source	**Natural Gas**	**Liquefied Petroleum Gas**	**Oil gas**	**Fuel Oil**	**Wood**	**Electric Energy**
Residential R1	0.54-0.65 (0.22)	3.67	-	-	5.43-7.41	1.39-3.51
*Residentual R3 4**	1.35-1.45 (0.55)	5.26 (3.88)	-	-	5.43-7.41	1.39-3.51
Commercial and Public	0.57-1 (0.23)	5.26 (3.88)	3.66-5.94	-	4.07-5.56	1.39-3.51
Industrial ID	0.30-0.38	-	2.51-4.08	1.56-2.93	0.51	1.46-4.80
Industrial FD	0.88-2.20	-	2.51-4.08	1.56-2.93	0.51	1.46-4.80

Table 6: Prices of the different energy sources in Argentina in 2008 ($/kep)[1] In parenthesis are the costs for the southern zones of Argentina, which receive subsidization.

[1] In relation to natural gas, the graph from above demonstrates that the price varies according to the level of consumption and the type of user, but also according to the different regions in the country. There are several categories of consumption in the residential area: R1, R2 1º, R2 2º, R2 3º, R3 1º, R3 2º, R3 3º, R3 4º. The industrial consumption is divided into firm service (FD/FT) and interruptible service (ID/IT). There are 12 companies of natural gas in Argentina, each with a different tariff according to the type of

As can be seen in the table from above, natural gas is the most convenient source of energy considering the costs of all sources of energies. The liquefied petroleum gas is roughly 4 times more expensive than the natural gas. The oil gas, fuel oil and electric energy are between 2 and 5 times more expensive than natural gas. Therefore, natural gas is the most convenient energy resource from only an economic point of view (cost analysis).

Besides, there is another important factor, which is the cost of investment of a solar panel. As pointed out in the following table, there is a very important difference in prices according to the technological characteristics, the size and the origin of the product. In 2008, the prices of some of the solar panels available in the market were:

Technology	**Company**	**Brand**	**Origen**	**Price of collector + tank ($/m2)**	**Comments**
Plastic	Tecnoautomat	Sunnyday	Italy	470-600	
	La Inesina	Transsen	Brazil		
	EnEco	Heliotek	Brazil		
	Solarpool	Transsen	Brazil		
	Solarpool	Powermatt	Mexico		
Flat plate	Vademarco	Vadermaco	Argentina		
	Innovar	Terrasol	Argentina	1,400-2,400	
	Enersol		Argentina		
	Tecnoautomat	Soletrol	Brazil	4,100-5,500	
	La Inesina	Transsen	Brazil	3,100	
	Eneco	Heliotek	Brazil	2,200	
	Ecosolar	Rehau	Germany	5,500-8,300	
	Enersol				
	Sursolar			1,500-3,200	
Empty pipe	Fiasa	Sun Air	China	1,100	U-pipe
	Fiasa	Sun Air	China	1,600	Heat-pipe
	La Inesina	Jiangsy Sunrain	China	1,800-2,000	Heat-pipe
	La Inesina	Jiangsy	China	750	U-pipe

user, province, subregion. There is also a different subsidy in each zone of Argentina, causing the price variation.

		Sunrain			
	Alsun		China		

Taking into consideration these prices, the low cost of natural gas in Argentina, the lack of incentives to consumer to buy clean energy, it is not PROFITABLE for the consumer to buy a solar panel for water heating. As shown in the following table 8, after a financial analysis is considered under the RETScreen model, from an economic and financial point of view it is not logical for the consumer to buy a solar water heater.

Case and Energy Source	**Price of energy source**	**Annual inflation of energy price**	**Subsidization of the solar equipment**	**Time of recovery of investment (years)**
Natural Gas 1	0.27$/m3	0%	0%	> lifetime
Natural Gas 2	0.27$/m4	0%	50%	> lifetime
Natural Gas 3	0.27$/m5	15%	0%	17.8
Natural Gas 4	0.27$/m6	15%	50%	14.3
Natural Gas 5	0.64$/m3	0%	0%	> lifetime
Natural Gas 6	0.64$/m3	0%	50%	17.6
Natural Gas 7	0.64$/m3	15%	0%	11.4
Natural Gas 8	0.64$/m4	15%	50%	8.5
Liquefied Petroleum Gas 1	3.2$/kg	0%	0%	7.5
Liquefied Petroleum Gas 2	3.2$/kg	0%	50%	4.4
Liquefied Petroleum Gas 3	3.2$/kg	15%	0%	4.9
Liquefied Petroleum Gas 4	3.2$/kg	15%	50%	3.2
Liquefied Petroleum Gas 5	2.25$/kg	0%	50%	6.5

Table 8: Time of recovery of investment of a solar panel residential installation. (Lifetime of a solar water heating systems is of 20 years.)

It is clear from this analysis that for a resident, if there is a lack of incentives and if only the financial point of view is taking into consideration, the installation of a solar water heater is not convenient. Taking into consideration the price of natural gas 0.64$/m3 for residential user R3

4* in relation to the prices of solar panels, the investment of the latter will be recovered in less than 20 years, if the price of natural gas rises at a 4% rate along the 20 years. If the price of natural gas does not increase in the next years, it is needed up to a subsidization of 50% of the investment cost of the solar water heater for the investment to pay off in less than 20 years. If the price of natural gas is 0.27$/m3 for a residence under the category R1, the subsidy has to be greater than 90% for the time of recovery of investment to be inferior than 20 years.

However, from a financial point of view, for the user of liquefied petroleum gas, the use of solar panels instead of the liquefied petroleum gas it is more convenient. If a solar panel is bought for solar water heating, the investment of this equipment is recovered in 10 years in relation to the price of liquefied petroleum gas. The reason for this is because as mentioned earlier, the price of liquefied petroleum gas is 4 times more expensive than natural gas. Therefore, for these users, the transition to thermal solar panels for water heating is more viable.

3.2.Institutional and Legal Framework:

3.2.1. INSTITUTIONAL FRAMEWORK:

In Argentina, there is a strong institutional structure, which is able to promote the use of renewable energies at a large scale. At the government level, there are several entities focused on the promotion of rational use of energy and the environment, and thus of the use of thermal solar panels. These are mentioned above:

- *Secretaría de Energía del Ministerio de Planificación Federal, InversiónPública y Servicios (MPFIPS),* which elaborates and executes the energy national plan and the regulatory scheme, studies and analyzes the energy market behavior, and it elaborates the strategic annual governmental plan, promoting politics to increase competitiveness, efficiency and achieve a better use of resources.
- *Dirección General de Planeamiento y Coordinación de Políticas Energéticas de la Secretaría de Energía,* which assists in the design of the annual strategic energy plan.
- *Dirección Nacional de Promoción de la Subsecretaria de Energía Eléctrica (DNPROM) de la Subsecretaría de Energía Eléctrica (SSEE),* which elaborates proposals and

strategies that promote the rational use of energy and the development of the renewable energy sources.

- *Coordinación de Energías Renovables (ER) de la DNPROM de la Subsecretaría de Energía Eléctrica (SSEE),* which promotes the development of renewable energy sources. This institution is currently undertaking and engaging in projects and programs to encourage the development of the solar water heating market. An example of a project is the study undertaken with the IDB, which seeks to analyze the state of art of the solar water heating market and the potential of this energy source.
- *Unidad para el DesarrolloEnergéticoSustentable (UDES) de la Jefatura del Gabinete de Ministros (JGM),* which promotes, evaluates and implements politics, programs and projects that are related to the analysis, promotion and development of renewable energies.
- *Coordinación de Eficiencia Energética (EE) de la DNPROM,* which defines politics and programs that promote the use of energy in an efficient manner.
- *Secretaría de Ambiente y DesarrolloSustentable (SAyDS) de la JGM*, which assists in the implementation of environmental politics. As can be seen, there are several institutions that promote the development of renewable energies in Argentina and thus the solar energy sector.

Argentina is also institutionally strong in terms of entities involved in the area of science and technology, and other organizations. Some of the most important institutions currently involved in the promotion of renewable energies and thus of solar energy are several.

- *Agencia Nacional de PromociónCientífica y Tecnológica (ANPCyT*), which works under the umbrella of the Ministry of Science, Technology and Innovation. It has the objective of promoting scientific development and technological innovation. In particular, it promotes investigation of projects that are related to renewable energies. It counts with two funds to carry out its programs: Fondopara la InvestigaciónCientífica y Tecnológica (FONCYT) / Fund for Scientific and Technological Investigation and the FondoTecnológico Argentina (FONTAR) / Technological Fund of Argentina.

- *Consejo Nacional de InvestigacionesCientíficas y Técnicas (CONICET),* which is the principal organism dedicated to the promotion of science and technology in Argentina.
- L*aboratorio de Ambiente Humano y Vivienda (LAHV*) which works under the umbrella of the Instituto de Ciencias Humanas, Sociales y Ambientales (INCIHUSA). The laboratory is a unit of investigation dedicated to improve the regional human habitat. Thus, the investigations are highly related to the use of renewable energies.
- *Instituto de Investigaciones en Energía No Convencial (INENCO*), which carries out investigations in the field of renewable energies and elaborates and executes programs and plans for the study of the problems in this subject area.

Argentina is also institutionally strong in terms of the several universities that have their faculties and/or group of researchers who dedicate their time to the investigation of solar energy. Some of the universities which have dedicated their time and resources to research, capacitation and thus the promotion of renewable energies such as solar energy are the following:

- *Universidad Nacional de Salta (UNSa):* The university formed a group interested in the subject of renewable energies in 1974, after the energy crisis in this year. In 1981, an agreement was signed with the CONICET to form the Institute of Investigations in Renewable Energies (INENCO), under the direction of Dr. Luis Savaria and Dr. Graciela Lesino. The Institute is dedicated to the investigation, development and transference of technology, in order to deal with the economic and social problems related to the production of energy in the region. It dedicates its research and provides assessment in regards to several areas, and one of these is the production of heated water by using thermal solar panels. It receives donations from several institutions to finance these investigations. Currently, it has a calibration laboratory of thermal, electric and solar radiation instrument, etc. The Institute provides assessment to the University and collaborates in the teaching of the B.A., M.A. and M.S.c., and PHD Programs of Renewable Energies. This University is the only that offers the complete education in the subject.

- *Universidad Nacional de Catamarca (UNCa*), in which there is the Solar Energy Group which started its activities in the 1970s under the direction of Dr. Adolfo Iriarte. It carries out several investigations in several topics, and one of these is solar energy in rural areas. It also elaborates and executes several programs for the community.
- *Universidad Nacional del Nordeste (UNNE),* in which there is the Group of Renewable Energies. This group started its activities in 1999. It´s two permanent integrants are Dr. Arturo Busso and Dr. Noemi Sogari. It carries out investigations, development programs and others, especially in solar energy. One of the main topics that it tackles is water heating with solar energy and the education to several segments in the population regarding renewable energies.
- *Universidad Nacional de la Plata (UNLP),*which has the Environmental Studies Group (GEMA). This group was formed recently in the university, which mostly dedicates its time to investigate and teach classes regarding the rational use of energy, renewable energies, especially solar energy, etc. One of the principal entities of the GEMA is the IDEHAB, which was created in 1986 under the direction of Arquitect Elias Rosenfeld, who leads several investigations regarding renewable energies. One of the many projects led by IDEHAB has been the first solar house in the city La Plata, which has several innovations in the field of solar energy.
- *Universidad Nacional de Rosario (UNR*), in which there is a special entity dedicated to the investigation and the development of programs of renewable energies, which is the IFIR (Institute Rosary of Physique). Within this entity, there are two divisions: 1) Laboratory of Renewable Energies led by Dr. Miguel Lara; 2) Division of Physics of the Atmosphere led by Dr. Ruben Placentini. These divisions dedicate the majority of its resources in the investigation of solar radiation and the use of energy in an efficient manner.
- *Universidad Nacional San Luis (UNSL),* in which there is a group of researchers, which dedicate a lot of their time and resources to the study of solar panels. There is also the Universidad TecnológicaNacional (UTN), in which there are several groups of scientists and researchers working on the subject of renewable energy; however, a recent program

has been created named Integrated Program in Renewable Energies, which tries to coordinate all entities and investigators working in this subject matter. Its general objectives are: to generate an integrated project at the national level about renewable energies by using the network of contacts that the UTN has; develop projects of renewable energy in a coordinated manner and at the investigation and implementation level, developing equipment and elaborating normative.

- *Universidad Nacional de Buenos Aires (UBA),* in which within the Faculty of Arquitecture, Design and Urbanism, a group of research dedicate their time to the investigation and the elaboration and execution of projects of renewable energy in arquitecture. This group was later consolidated and was named ¨Centre of Investigations, Habitar and Energy (CIHE)¨, which currently works under the direction of Arq. John Martin Evans and Silvia de Schiller. This group carries out several investigations and programs related to the rational use of energy in buildings, houses and other installations.
- *Universidad Nacional de Lujan (UNLu),* in which within the department of Basic Sciences and the Division of Physics, a group dedicated to the investigation of renewable energies has formed under the direction of Dr. Hugo Grossi. He has a great and wide experience in the field of renewable energies in Argentina and Latin America. He has elaborated several radiation maps and has carried several investigations regarding solar energy.
- *Universidad Nacional de Tucuman*, in which within the Faculty of Arquitecture and Urbanism, several projects related to renewable energies are carried out. This Institute is directed by Dr. Guillermo Gonzalo, and in this entity carries out several investigations and projects related to renewable energy. This entity also counts with an equipped laboratory, which undertakes thermal studies, and it also counts with three houses that are all equipped with solar technology to achieve greater rational use of energy in households. Therefore, as can be concluded, Argentina is highly prepared in the research area of solar energy and thus of solar energy.

In fact, due to the highly institutional level there is at the universities in the field of renewable energies, several universities have undertaken and implemented innovative projects in regards to solar energy besides only dedicating its resources to investigations. An example of this is the bioclimatic buildings that were constructed by the universities. These buildings are mostly designed by scholars and have several environmental techniques such as walls and windows that accumulate the heat from the sun, solar water heating panels and others. Several of these buildings constructed and designed in the universities are the following:

Table 9: Bio-climatic buildings in Argentina

Grupo	Comitente	Tipo de edificio	Lugar	Observaciones
LAHV (Mendoza)	Ministerio de Educación	Escuela Yapeyú	Departamento San Carlos	Reciclaje bioclimático
	Ministerio de Educación	Escuela Elpidio González	Departamento Lavalle	Reciclaje bioclimático
	Secretaría de Urbanismo y Vivienda(OEA)	Vivienda Solar Laboratorio experimental	Ciudad de Mendoza	Varios sistemas bioclimáticos Área: 150 m^2
	Ministerio de Educación	Escuela Técnico Agraria	Departamento de San Martín	Varios sistemas bioclimáticos Área: 1300 m^2
	Ministerio de Educación	Escuela Nicolás Avellaneda	Departamento Junín	Construcción bioclimática Área: 400 m^2
	Ministerio de Educación	Escuela Medrano	Departamento Rivadavia	Construcción bioclimática
	Viviendas Solares	Arroyo Claro	Departamento Tunuyán	Construcción bioclimática Área: 120 m^2

Grupo	Comitente	Tipo de edificio	Lugar	Observaciones
	Ministerio de Educación	Escuela Marcelino Blanco	Departamento La Paz	Construcción bioclimática Área: 1136 m_2
	Ministerio de Educación	Escuela Albergue Yapeyú	Departamento San Carlos	Reciclaje bioclimático
	Ministerio de Educación	Albergue de la escuela Scalabrinbi	Departamento San Rafael	Diseño bioclimático Área: 302 m^2
	Ministerio de Educación	Escuela petroleros del Sur	Malargüe	Reciclaje bioclimático Área: 310 m^2
Grupo E. Solar (Catamarca)	Ministerio de Educación	Escuela de Antofalla	Antofagasta	Construcción bioclimática
	Turismo	Hostería de Aconquija	El Alamito, Depto. Tinogasta	Construcción bioclimática
	Turismo	Complejo Termas De Fiambalá	Depto. Tinogasta	Construcción bioclimática
	Ministerio de Educación	Escuela Albergue Laguna Blanca	Depto. Belén	Construcción bioclimática
	Vialidad de la Provincia	Campamento de Vialidad, Paso San Francisco	Depto. Tinogasta	Construcción bioclimática
	Vialidad de la Provincia	Antofagasta de la Sierra	---	Construcción bioclimática
INENCO Salta	INTA, Jujuy	Casa director Estación Abra Pampa	Quebrada de Humauaca	Construcción bioclimática, Área: 200 m^2

Grupo	Comitente	Tipo de edificio	Lugar	Observaciones
	Provincia de Jujuy	Puesto Sanitario Castro Tolay	La Puna, Jujuy	Construcción bioclimática, Área: 120 m^2
	Instituto de vivienda, Salta	Barrio de 17 viviendas	Cachi, Salta	Construcción bioclimática, Área: 120 m^2 c/u
	Ministerio de Bienestar Social, Jujuy	Hospital en construcción	Susques, la Puna, Jujuy	Construcción bioclimática, Área: 700 m^2
Instituto de Acond. Ambiental Tucumán	Universidad	3 prototipos	Ciudad de Tucumán	Construcción bioclimática
Grupo de E. Solar La Pampa	Ministerio de Educación	Escuela Algarrobo del Águila	---	Construcción bioclimática, Área: 357 m^2
	Universidad Nacional de la Pampa	Pabellón de ecología, Facultad de Agronomía	Santa Rosa	Construcción bioclimática, Área: 315 m^2
	Universidad Nacional de la Pampa	Residencias Universitarias 12 viviendas	Gral. Pico	Construcción bioclimática, Área: 840 m^2
	Universidad Nacional de la Pampa	Auditorio de la facultad de Ciencias Exactas y Naturales	Santa Rosa	Construcción bioclimática, Área: 634 m^2

Grupo	Comitente	Tipo de edificio	Lugar	Observaciones
	Universidad Nacional de la Pampa	Residencias Universitarias	Santa Rosa	Construcción bioclimática, Área: 480 m^2
	Ministerio de Educación	Escuela EGB3	Catriló	Construcción bioclimática, Área: 1050 m^2

Source: Segunda Comunicación Nacional de la Argentina a la Convención Marco de las Naciones Unidas sobre Cambio Climático (UNFCC).

Also, Argentina is institutionally strong at the civil society level. Some of the organizations and groups which have acted as the main actors in the solar energy sector, promoting the development of this market, have been the following:

- *Instituto de Energía y DesarrolloSustenable,* which dedicates its time to the investigation of renewable energies and the identification and evaluation of energy projects that have the capability of mitigating climate change and which can be presented as mechanisms of clean energy.
- *GrupoEnergía Solar,* which started its activities in 1976 and since then has dedicated to the acquirement of knowledge and techniques to convert solar energy into electricity and heated water. This is how; it created the first solar panel that met the requirements established for the space.
- *Asociación Argentina de Energía Solar (ASADES)* which was created in 1975. It seeks to form a network of all the actors involved in the solar energy market. Since it was created it has dedicated to maintain and encourage several investigations.

3.2.2. LEGAL FRAMEWORK

Despite the strong institutional framework that Argentina has, its legal framework is extremely weak.

- A law that is very general and that does not directly incentivize the solar water heating market is the *Decree 140 of 2007*. This Decree declares of national interest and thus a government priority to use rationally and efficiently the energy; and establishes therefore establishes several measures to accomplish such goal. Therefore, there is no other law that incentivizes the solar water heating market in a DIRECT manner.

3.3.Conclusions:

3.3.1. **GAPS**

3.3.1.1. Demand

- The demand patterns of heated water and natural gas in the residential, commercial, public and industrial sectors of Argentina point out that the energy demand in Argentina is concentrated mostly in the use of natural gas. In the residential and commercial and public sector, 85% of the demand for heated water is located in the use of natural gas and in other conventional energy sources.

- Moreover, as can be seen from tables 2, 3 and 4, the demand of solar water heaters for water heating is basically non-existent in Argentina considering that in this tables.

3.3.1.2.Supply

- The greater gap that was found was the lack of information regarding the market supply, demand, imports, exports, fabrication, etc; and the low efficiency of the solar water systems.

- The efficiency of the solar water heaters in Argentina is not very good. As mentioned earlier, roughly 45% of the solar radiation energy can be used for water heating due to the losses of solar radiation after the system withholds only 55% of the solar radiation.

- Moreover, as in Brazil, there are no standards and/or certifications and/or labels established for the fabrication and installation of solar water heaters. Because of this, fabricators in Argentina do not meet with certain quality and efficiency requirements; and also consumers are not able to know which system is better in quality and efficiency than others.

3.3.1.3.Costs

- The primary reason for the demand of natural gas to be so high in the residential, commercial and public sector and also the industrial sector is due to the low cost of this traditional energy sources, especially compared to the high initial cost of solar water heaters. As stipulated in this section above, in which the costs are analyzed, for a residence the cost of natural gas varies from $ 0.54 – 1.45 / kep, and for the southern zones of Argentina which receive subsidization, the cost varies from $ 0.22 – 0.55 / kep, according to the categories of residential consumption. Whereas, only the investment cost of an average solar water heaters is approximately of $ 1,600 / m2.

3.3.1.4.Institutional Framework

- In Argentina, there is a strong institutional framework which is able to promote the development of the solar water heating market; however, this advantage is not used strategically by the actors involved in the solar water heating sector. Several institutions work for the development of this technology, such as universities, government entities, business associations, fabricators, etc; however, these do not work together. Thus, there is

no exchange of knowledge, no sharing of information and other key factors that are crucial for the development of this technology.

3.3.1.5.Legal Framework

- One of the greater gaps in Argentina is the poor legal framework. Currently, there are no laws that directly incentivize the development of the solar water heating market, as mentioned earlier in the legal framework section. There are only laws that under general terms promote the development of this energy source.
- Also, as in Brazil, there are no technical norms which establish the requirements that need to be met for installation and fabrication of solar water heaters, such as the PBE Label and the Qualisol certification which exists in Brazil that set the standards of fabrication and installation, respectively.

- Also, there is no law which stipulates that by government decision all new buildings need to be constructed with solar water heaters in their installations; nor laws which act as financial and economic incentives, as the ones mentioned previously; among others.

3.3.2. PRIORITIES FOR ACTION

a) In Argentina, there has to be a stronger legal framework which would directly affect in a positive manner the solar water heating market. There are few laws that promote the development of this conventional energy source, especially considering that the legal framework is one of the most important drivers for the development of these energy sources. The laws that are most important are:
   - Laws that regulate the fabricators and distributors
   - Laws that act as financial and economic incentives

b) In Argentina, there are no economic and financial incentives and this is a priority policy for the countries that seek to encourage the development of renewable

energies. Economic and financial incentives help achieve the renewable energy industry *economies of scale*, which are needed to compete where the cost of, for example, thermal solar panels is above the cost of conventional energies (as in Argentina case, in which natural gas and electricity are higher). In this manner, due to these policies, the cost of solar energy falls to meet the cost of grid electricity and thus energy independence is reached, innovation and high technological efficiency are achieved, among others. Some of the economic and financial incentives that can be implemented in Argentina are:

a. Investment subsidies (the authorities refund part of the cost of installation of the system). For example, the government should implement a subsidy for the national fabricators of solar thermal panels to lower the costs of these systems for consumers and thus to shorten the time of recovery of investment of solar water heaters. The subsidy can be provided by the government as a cash subsidy, for each solar panel fabricated and sold, the government can cover up to 30% of the costs of fabrication of each solar panel.
b. Feed-in-tariffs/net metering (the electricity utility buys solar thermal panels from the producer under a multiyear contract at a guaranteed rate);
c. Solar renewable energy certificates (RECS) (allows to set the price of the solar generated solar panel subsidy).
d. Abolishment of the subsidy for natural gas and implement instead a consumption tax on natural gas, as of 50%-60%, to shift the demand from conventional energy sources to clean energies and thus promote the use of thermal solar energy.
e. The government can also implement a policy of tax deduction to the sectors of the economy where there is a greater demand for heated water considering that the probability of penetration is higher. For example, a policy can be implemented so that in the residential sector, the urban and middle-income households can be able to deduct from their income taxes the total cost of solar water heaters. In the commercial and public sector, the hotels and the

public administration and defense institutions can also receive the benefit of being able to deduct from their taxes the total cost of solar water heaters. In the case of the industrial sector, the food and textile industries can also benefit from this incentive.

f. Also, as in Barbados with the Fiscal Incentive Act, the government can also provide an incentive to the manufacturing sector by providing the fabricators import preferences and tax holidays (exemption of solar water heaters raw materials like tanks, collectors from the 20% import duty, which can lower the cost of a SWH by more than 10%).

g. Also, the government, more specifically the Coordinacion de Energias Renovables y Eficiencia Energetica de la DNPROM can provide loans to consumers with low interest rates and long-term facility payments for consumers which wish to buy a solar thermal panel.

c) There is a strong institutional framework established in Argentina which can become the main driver for the development of the thermal solar panels in this country. In order to become the main driver and actor, a platform for dialogue and coordination between the several actors (NGO´s, government institutions, universities, laboratories, and others) has to be created. Currently, each entity is generating its own knowledge; but they are not sharing among each other. Therefore, it is essential to create a platform to share information, knowledge and thus propose and elaborate national policies and programs which can lead to the development of this market. The institution which can be in charge of creating such platform can be the Coordinacion de EnergiasRenovables in conjunction with the Universidad Nacional de Salta and the GrupoEnergia Solar and the Asociacion Argentina de Energia Solar. Together, these entities can form a strong network of actors that are involved in all sectors of the solar water heating market and can also form several platforms for incentivizing dialogue among these actors. Some of these platforms can be symposiums, conferences and courses, where information sharing and dialogue will the objective of each. Also, a

national website can also be created, where information can be uploaded, shared among all actors involved in the sector and where ideas and comments can be shared. In this way, several spaces will be created where dialogue and coordination will be incentivized and as a result, efficient policies and programs will be proposed and elaborated.

4. COUNTRY ASSESSMENT OF BARBADOS

4.1.Market of Solar Panels

4.1.1. DEMAND

Since 1974, there has been a great demand for thermal solar panels in Barbados. In this year, twelve units were installed and in the next year, it increased up to twenty-one. This gradual upward trend continued until 1979, when the number of installations that year reached 541 units. Overall, from 1974 and 1979, 961 SWH systems were installed. This rate of installation boomed in the 1980s due to the tax incentive to homeowners that was introduced, and that is why 879 SWH systems were installed that year. In 1981 and 1982, 1,143 and 1,251 SWH systems were installed respectively those years. Thus, from 1974 and 1992, 23,388 SWH units were installed and that is why by 1997, more than 28,588 systems were installed in homes, hospitals, hotels, restaurants, guest houses, schools, commercial and industrial operations in Barbados. As a result of this increasing demand over the years, in 2000, over 32,000 solar water heaters have been installed, from which 25,000 systems have been installed in homes and the remainder in hotels and other tourist accommodations. In 2001, a total of 34,000 systems were installed, from which over 30,000 SWH systems were installed in households, thus reaching at least 39% of all households in Barbados with SWH services. In 2008, there were roughly 50,000 SWH installed. Thus, as can be seen, in Barbados there is the highest rate of installation of SWH in the region, as can be seen in the following table. To date, the adoption rate for the installation of units with the construction of new buildings stands at 88%.

Year	Annual Units	Cumulative Units	Annual Gallons	Cumulative Gallons
1974	12	12	660	660
1975	21	33	$ 1,170	1,830
1976	46	79	$ 2,060	3,890
1977	128	207	$ 5,880	9,770
1978	217	424	$ 11,890	21,660
1979	545	969	33,516	55,176
1980	879	1,848	55,152	110,328
1981	1,143	2,991	80,830	191,158
1982	1,251	4,242	98,838	289,996
1983	1,210	4,452	75,403	365,399
1984	1,415	6,867	92,708	458,107
1985	1,329	8,196	90,700	548,807
1986	1,578	9,774	105,812	654,619
1987	1,715	11,489	110,198	764,817
1988	2,445	13,934	167,638	932,445
1989	2,857	16,791	177,392	1,109,847
1990	2,579	19,370	168,708	1,278,555
1991	2,250	21,620	147,186	1,425,741
1992	1,768	23,388	117,176	1,542,917
1993	900	24,288	56,148	1,599,065
1994	1,000	25,288	62,387	1,661,452
1995	1,000	26,288	62,387	1,723,838
1996	1,100	27,388	68,625	1,792,464
1997	1,200	28,588	74,864	1,867,328
1998	1,300	29,888	81,103	1,948,430
1999	1,350	31,238	84,222	2,032,652
2000	1,400	32,638	87,341	2,119,993
2001	1,400	34,038	87,341	2,207,335
2002	1,400	35,438	87,341	2,294,676

Table 10: Summary of annual and cumulative SWH installations (1974-2002)

Despite the high demand of solar water heaters in Barbados, electric systems are still the norm in this country. Around 78,000 households are still connected to the national grid. Also, the electricity demand in the domestic and commercial sector has grown steadily since the 1970s. In recent years, the electricity demand has grown at an average annual rate of more than 4%.

Currently, total annual electricity consumption is about 735 GWh or slightly less than 2700 KWh per capita. This consumption is higher than other island countries within the region with the exception of Trinidad & Tobago. Electrical connections have also increased steadily with the population and the expansion of the economy. Since the mid-1980s, new domestic and commercial connections have increased at annual rates of 2.5% and 3.3% for domestic and commercial consumers, respectively. Despite the fact that the solar energy available in Barbados is much greater than in any other countries (the solar radiation received in a square meter in Barbados, is of about 7KWh of solar energy in a clear day during the dry season, a 430 meter of surface kilometer island like Barbados receives 3 billion KWh on such a day; this is 1.08 X 10^{16} joules or the energy equivalent of about 1.87 million barrels of oil), as shown in the following table, electric energy is still the norm in this country as mentioned earlier.

Table 11: Solar Radiation in kWh/m^2 in Barbados.

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adams Airport, Barbados	5.1	5.6	6.0	6.2	6.1	5.9	6.0	6.1	5.7	5.3	5.1	4.8

Therefore, with the intensity of solar energyy received in Barbados, this country has to use in a greatly manner this energy source.

4.1.2. SUPPLY

Currently, in Barbados, there are very few fabricators and several distributors of thermal solar panels, as shown in the following table.

Fabricators	***Distributors***
Solar Dynamics (founded in 1974)	Modern Living

SunPower (founded in 1977)	Home Center
AuaSol (founded in 1981)	Cave Sheperd
	Furniture Ltd

Table 12: List of fabricators and providers of thermal solar panels in Argentina.

The main manufacturers are Solar Dynamics (founded in 1974), SunPower (founded in 1977) and AquaSol (founded in 1981). Solar Dynamics has about 55-60% of the Barbadian market with the remaining divided more or less equally between Sun Power and AquaSol. Solar Dynamics is the main manufacturer of SWH in Barbados, considering that it was the first company that started to manufacture these systems in the early 1970s and it was the first company that developed a solar water heater unit that was able to meet the requirements and expectations of the homeowners, in terms of performance and appearance. Currently, Barbados accounts for over 60% of the solar water heaters that are used in the region and is responsible for the manufacture of 80% of them. Therefore, Barbados is exporting their products to several countries in the Caribbean region. Compared to the amount of manufacturers there are in Barbados, there are several providers in this country. The main distributors are Modern Living, Home Center, Cave Sheperd, Furniture Ltd., etc.

The supply of SWH is highly advanced in terms of technical efficiency and technical capacity. Solar Dynamics became the first company that was able to manufacture a SWH system that met with the standards of the consumers of the region. This SWH system was able to: a) water at approximately 135 degrees Fahrenheit, cope with salt air, tolerate the calcium-laden hard water of Barbados, withstand hurricane conditions, and compensate for the occasional lack of sunshine or overcast conditions and aesthetically pleasing. Moreover, some of the other innovations that this company have done are: the use of glass with a greater heat tolerance in the construction of solar panels; improved welding techniques for a more professional finish; improvements in the flow pattern of water through the solar collectors with larger headers to facilitate the calcium build up and prolong collector life; the provision of different tank sizes and

collector combinations to match end-user hot water demand preferences; improved modular component designs so as to expedite installation time; and product standardization to guarantee the desired output temperature on hot water emerging from its systems. Also, Solar Dynamics was the first company in the local industry that was able to guarantee a certain output temperature on hot water emerging from its systems. As a result of these innovations that provided great advancements in manufacturing and installation techniques, Solar Dynamics became the market´s leader of the region.

As a result of the high demand for SWH units and the high technology quality of these products, Solar Dynamics was the first company in Barbados that started to export their products, and was later followed by Sunpower and Aquasol. To some of the countries in Latin America to which these companies export to are: Antigua & Barbuda, the Bahamas, Belize, Grenada, Guyana, Jamaica, Montserrat, St. Vincent & the Grenadines, Trinidad & Tobago, and many other countries in Latin America and Europe. That is how Barbados in 2000 accounted for over 60% of the solar water heaters that are used in the region and is responsible for the manufacture of 80% of them. As a result of the high quality manufacture of the SWH systems, Barbados does not import any thermal solar water heaters and any electric water heaters.

The types of technology of SWH that are offered in Barbados are all open loop systems, the majority is domestically manufactured thermosyphon systems and some integrated collector systems. The thermosyphon systems, which are the ones mostly used in this country, consist of a flat plate collector and a separate tank. For this system to operate the tank is installed above the collector and as the solar collectors heats the water, it rises into the tank. Cooler water in the tank flows down tubes to the bottom of the collector creating the circulation. A typical thermosyphon system consists of a roof-mounted solar collector, roof-mounted tank, associated plumbing, and a backup electrical heating system in the tank. System sizing guidelines suggest an allocation of 15 to 20 gallons of hot water per person per day. Depending on the size of the collector, these systems can heat water to about 130 to 140 °F.

4.1.3. COSTS

As mentioned previously, from all the solar water systems that can be found in Barbados, the thermosyphon systems are the mostly used units in this country. These households systems are typically 300 liters and cost approximately $ 1,800 each, or $6.00 per liter of capacity. With a Gross National Income in Purchasing Power Parity per capita of over $ 15,000, many people are relatively well equipped to pay the up-front costs of SWH systems. Furthermore, affordability is usually not an issue for most buyers of SWH systems who pay income taxes, as they can take advantage from the 100% income tax rebate. Therefore, these thermal solar water heater systems have a strong cost advantage, considering also that electric tariffs are extremely high in Barbados. In 2004, the average rate was of USD $ 17.5 cents per KWh ($BD 0.3531/kWh) and these prices have kept on rising throughout the years due to government policies.

Taking into consideration these costs, from the homeowners perspective it is more beneficial financially to buy a solar water heater. In Barbados, the payback period is considerably less than in other countries such as in the United States where the SWH pays for itself in 4 to 8 years, due to the higher electricity rates and the higher year-round insolation levels. Payback periods are calculated for the range of SWHs available to homeowners (40 to 80 gallons). Below is the data for the approximate installed cost, energy saving, average electric rate, and annual savings assuming the SWH would replace an electric water heater.

	System Size (gallons)			
	40	***52***	***66***	***80***
Cost ($BD)	2250	2400	2850	3500
Energy (kWh)	2379	3093	3926	4758
Price ($BD/kWh)	0.3531	0.3531	0.3531	0.3531
Savings ($BD)	840	1092	1386	1680

Table 13: Approximate installed cost, energy savings, average electric rate, and annual savings assuming a solar water heater is replaced by an electric water heater (2003)

If taken into considerations these costs, energy savings and the radiation levels in Barbados found in table 2, if a solar water heater is replaced by an electric water heater, the payback periods would be the following displayed in table 5.

	Payback period (years)		
Systems size (gallons)	**Without Incentives**	**25% tax bracket**	**40% tax bracket**
40	2.7	2	1.6
52	2.1	1.6	1.2
66	2	1.5	1.1
80	2	1.5	1.1

Table 14: Estimated simple payback period for solar water heaters in 2003.

As can be observed in this table, the payback periods are calculated without the effect of the homeowner tax deduction and with the homeowner deduction for the two tax bracket – 25% and 40%. For a 40 gallon system, the payback period would be of about 2.7 years without the tax deduction and two or less years depending on the tax bracket. Because of the greater energy savings relative to the installed cost, payback period for the larger systems are less. For the system size 52 gallons, the payback period is about 2.1 years without tax deduction. The payback period falls into 1.6 years if the homeowner is in the 25% tax bracket and 1.2 years if it is in the 40% tax bracket.

4.2.Economic and Financial Incentives:

4.2.1. ECONOMIC INCENTIVES

The economic incentives that the market of solar water heaters in Barbados has received are few; however, these have been effective. During the 1960s, the Barbados Institute of Management and Productivity (BIMAP), the Christian Action for the Development of the Caribbean (CADEC) played a crucial role in providing an economic incentive to the manufacturers. These entities provided several funds to one company in Barbados (Solar Dynamics), from the BIMAP, and USD$ 4,200 from CADEC. This initial effort allowed the emergence of a small group of entrepreneurs, which later formed one of the main companies of

Barbados, SolarDynamics. By providing these funds, the government facilitated the manufacturers to establish their businesses and this is how the market of solar water heaters started to emerge in the late 1960s and the beginning of the 1970s.Moreover, in 1975 -1977 and in 1988 – 1992, the government purchased several solar water heating systems as part of a housing development project. In 1975 – 1977, the government bought 84 units (Oxnards project) and in 1988-1992, the government bought 300 units (Venezuela project). These purchases provided a great economic incentive and support for the market of solar water heaters considering that these incentivized the manufacturing of these units and facilitated these systems to several homeowners. These two projects caused a major increase in the demand rate in those years and thus increased the total cumulative units installed, reaching a total of 207 units installed in 1977 and a total of 23,388 units in 1992.

In addition, the manufacturers have also granted economic incentives to consumers, by giving guarantees from 2 up to 5 years to the consumers that buy new SWH.

4.2.2. FINANCIAL INCENTIVES

The financial incentives that the producers and consumers of solar water heaters have received are several. Some of the fiscal policies that were undertaken by the government to promote the production and consumption of solar water heaters were: first, in 1974, the Fiscal Incentive Act was implemented, which allowed the manufacturers to benefit from import preferences and tax holidays (exemption of SWH raw materials like tanks, collectors from the 20% import duty, which lowered the cost of a SWH by 5 to 10%); second, in the same year, the government started to promote the competitiveness of solar water heaters by placing a 50% consumption tax on imported gas and electric units; third, in 1980, the government approved the Homeowners Income Tax, which allowed consumers to deduct the full cost of the solar water heater system from their income taxes. These tax benefits were suspended from 1993 until 1995 due to the international economic recession, which caused government to reduce economic incentives. However, since 1996, these tax benefits were reinstated and were more holistic considering that consumers were not only able to deduct tax the full cost of the system but also the repairs, renovations, water saving devices, and others.

In the following graph is a chronology of events in the development of the economic and financial incentives of the Barbadian solar water heater industry.

Year	***Event***
1960-1970	CADEC loan to help establish Solar Dynamics and incentivize the market of solar water heaters.
1974	Promulgation of the Fiscal Incentives Act - exemption of SWH raw materials (tanks, collectors) from the 20% import duty (lowered the installed cost of a SWH by 5% to 10%) and a 50% consumption tax placed on conventional electric water heaters and imported gas.
1975-1977	Government purchase of 84 units for a housing development project (Oxnards project)
1980	Income Tax Amendment provided a specific line item to deduct the full-cost of a SWH installation. SWH deduction was in place from 1980 until 1992.
1988-1992	Government purchase of 300 units for a housing development project (Venezuela project)
1993-1995	Suspension of tax deduction for SWHs as part of a structural reform, due to the international economic recession which occurred in 1990 until 1994.
1996-present	Reinstament of SWH deduction as part of a personal home improvement allowance deduction of up to BD$ 3,500 per year of mortgage interest, repairs, renovations, energy or water saving devices, solar water heaters and water storage tanks.

Table 15: Chronology of events in the development of the economic and financial incentives of the Barbadian SWH industry.

4.3.Legal and Institutional Framework:

4.3.1. INSTITUTIONAL FRAMEWORK

At the government level, there is a slightly strong institutional framework in place, which has promoted the use of solar water heaters in Barbados.

- *Ministry of Finance and Economic Affairs and Energy has the Renewable Energy and Energy Conservation Unit*, which have been working in a very important project, the Solar House Project. This initiative has been undertaken to create greater awareness of renewable energy and the benefits of using various energy conservation technologies for enhanced energy efficiency.
- *Ministry of Agriculture and Rural Development,* which have dedicated some of their resources to promoting the use of solar water heaters in rural areas.
- *Cabinet-appointed National Commission on Sustainable Development (NCSD),* which is a commission pointed in 1994, comprised of 30 members representing government and all major groups including non-governmental organizations, community-based organizations, academic community and private sector entities. The role of this commission is to advise government on measures required to integrate environmental and economic considerations into the decision-making process and also to advise government in global issues of sustainable development; and thus facilitating national level co-ordination mechanisms on sustainable development; promoting greater understanding and public awareness of cultural, social and economic policy opportunities to attain sustainable development in Barbados, etc.
- *Energy Division of Barbados*, which elaborates and recommends policies in the energy sector and promotes the rational and efficient use of energy in the country through the enactment, assessment and implementation of policies and programs.
- *National Council for Science and Technology*, which is a department within the government that promotes the industry, commerce, and innovation. It has promoted the market of solar water heaters through several programs throughout the years.

At the private, organizational and civil society level, there is also a strong institutional framework in place, which has provided support throughout the years to the initiative of solar water heaters.

- *University of the West Indies*, which is one of the main universities in Barbados, which has led several investigations, projects and encourages innovation in terms of solar energy. Within the university, there is the Centre for Resource Management and Environmental Studies (CERMES). This centre is under the direction of Professor Oliver Hadley and it leads several investigations, projects and others, especially of in the matter of thermal solar panels. In fact, the University of the West Indies has been a major actor and one of the most important drivers of the market of thermal solar water heating in Barbados. CERMES has been working in conjunction with the government of Barbados to increase the percentage of contribution of solar energy supply. In 2001, renewable energies contributed about 15% of the energy supply, from which solar thermal technologies contributed about 7.5% of the energy supply. The new target is to contribute up to 40% of the energy supply from renewable energy sources until 2010.
- *Barbados Light and Power Company* which carries out several programs and investigations regarding solar energy; however it is mostly concentrated in pholtovoltaic energy.
- The private companies have also been a primary driver in the development of solar energy, especially thermal solar energy. For example, Solar Dynamics currently has a laboratory in which research and technological innovations are always being done.

4.3.2 LEGAL FRAMEWORK

Moreover, the government of Barbados has also taken several legal initiatives, taking into considering that it plays a crucial role in sustainable development and in the increase use of renewable energies. That is why a number of policies have been developed throughout the years as a general proactive step to increase the use of renewable energy, combat the threat of climate change and become a more independent and self reliant catering country for its energy needs, considering that it imports all fossil fuel. Unfortunately, the only information available regarding the laws was the economic and financial incentives implemented for this market. Some of these laws are the following:

- *Fiscal Incentive Act:* In 1974, the government approved the Fiscal Incentive Act, which enabled the companies to benefit from import preferences and tax holidays.
- *Income Tax Amendment:* In 1980, the government approved a law which implemented a 50% consumption tax on imported gas and electricity units and allowed the homeowner to claim the cost of the solar water heater on his income taxes, fuelling growth of solar water heating to such an extent that there was an annual major surge in sales in December of the year of 1981 as people tried to beat the end-of-year deadline in order to qualify for the rebate. These tax incentives were suspended from 1993 until 1995, but were later reinstated in 1996.

4.4.Conclusions

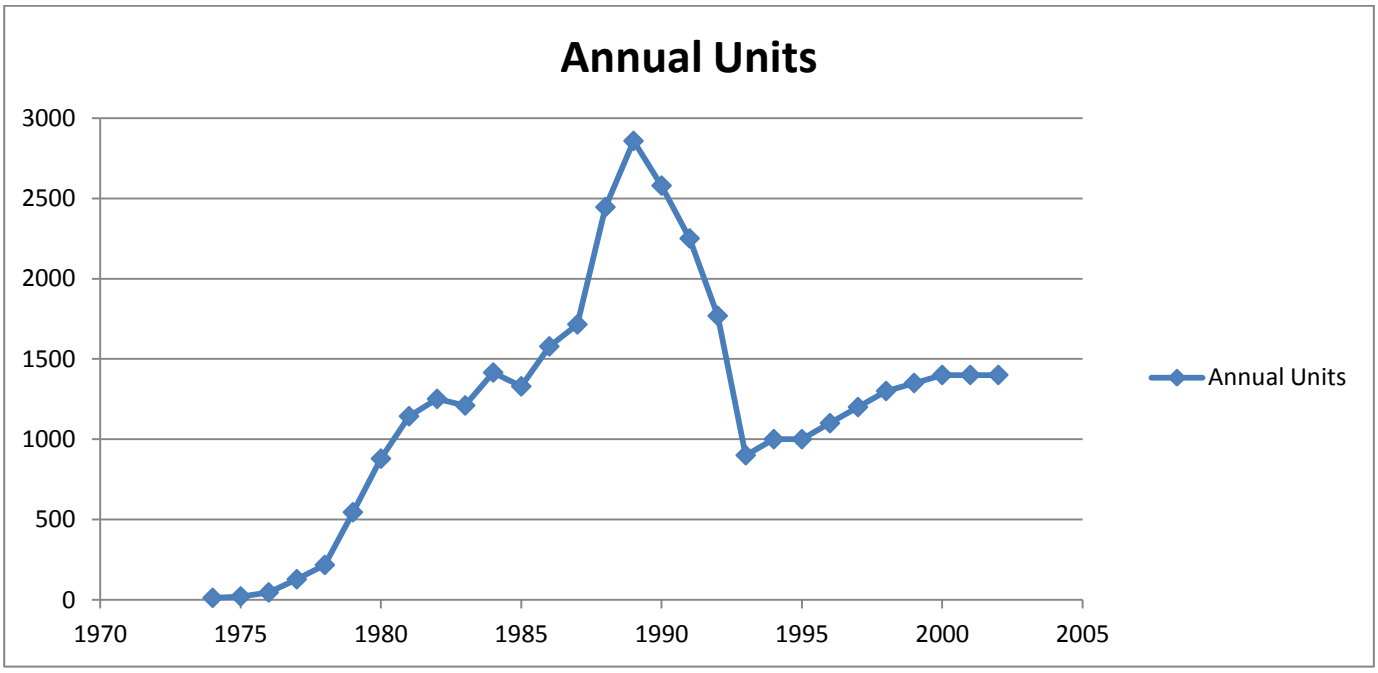
4.4.1. **GAPS**

4.4.1.1.Demand

- In 2000, over 32,000 solar water heaters were installed, from which, 25,000 systems were installed in homes and the remainder in hotels and other tourist accommodations. In 2001, a total of 34,000 systems were installed, from which, 30,000 were installed in residences. In total, 78.13% of the systems were installed in homes in the year 2000 and 88.23% of the systems were installed in residences in the following year. Therefore, the demand is highly concentrated in one sector of the economy and it needs to be diversified among several sectors of the economy. This high demand in the residential sector is due to the ´targeted marketing´ that producers, distributors and the government have done throughout the years. The marketing has only been focused and directed to this sector of the economy, thus ignoring the great potential that solar water heating can have in other sectors of the economy, such as hotels, the food industry, dry cleaners, pools, etc. The producers have mostly targeted their sales to the homes considering that most of their distributors with which they work are shops which have only merchandise for homes, such as: Modern Living, Home Center, Cave Sheperd, Furniture Ltd. Moreover, the government has also targeted its marketing to homes due to the incentives that it has provided to this sector of the sector, marginalizing and not taking into consideration the

others. The tax deduction benefit (Homeowners Tax Benefit) was only targeted to homeowners and not to commercial enterprises, industries, etc.

- Although, there is a high demand for solar water heaters in Barbados, there are still several gaps that need to be considered. The demand for SWH was steeply increasing at the beginning of 1980, and it reached its peak in the late 1980s. From then on, the demand started to decrease until 1993, when it started to increase again. However, since 1993 until 2002, demand has been growing at a very low rate compared to the 1980s, as can be seen in the following graph.



Graph 2: Annual SWH installations in Barbados (1974-2002)

The reason why the demand starts steeply increasing in the beginning of the 1980s is due to the several incentives that were provided by the government to the consumers and manufacturers and due to the world oil crisis. In 1974, the government approved the Fiscal Incentive Tax, which exempted 20% of the import duties to the solar water heater raw materials (tanks and collectors) and introduced a 30% consumption tax on conventional electric water heaters. Later on, from 1975 until 1977, the government

purchased 84 units of solar panels for a housing development project. In 1978 until 1980, there was a major increase in the oil price due to the Iranian Revolution and the Iran-Iraq War. Also, in 1980, the government approved the Income Tax Amendment, which allowed consumers to deduct the full-cost of the solar water heaters and the cost of installation. All these factors influenced the market of thermal solar panels and caused the first major increase of the demand. However, this major increase in the demand did not continued. It reached its peak in the late 1980s, and later, the demand started to decrease considering that in 1993 until 1995, the government decided to suspend the tax deduction for solar water heaters. The severe international economic recession created significant fiscal and balance of payments deficits in several countries, and as a result, the government needed to cut back on several expenditures. This tax deduction benefit was later reinstated in 1996, which caused the demand to keep on increasing, but not at the same rate due to the lack of government housing projects, awareness programs and other factors.

- Moreover, as mentioned previously in this report, despite the high demand of solar water heaters in Barbados, electric systems are still the norm in this country. Around 78,000 households are still connected to the national grid and the demand for electricity has grown at a 4% annually. Considering the high insolation there is Barbados and the high costs of electricity, solar water heaters should be the norm and not electric systems. Therefore, solar energy has to be used in a greatly manner in this country and thus demand for SWH systems has to be greater, despite the already high demand that exists in Barbados for SWH.

4.4.1.2.. Supply:

- Despite the several positive aspects described in the supply side of the SWH systems, there are several emerging needs that need to be dealt with by the government and private companies. There is an oligopoly within the SWH market considering that there are very few SWH manufacturers. The few and strongest producers of these units are:

SolarDynamics, which as mentioned earlier controls over 60% of the Barbadian market; AquaSol, and SunPower. In such a high technology demanding market, there should be several producers, which through competition will have the need to innovate to guarantee higher levels of technology, quality, and reduced prices.

- Several companies can merge with other companies in other countries, which have greater knowledge and can fabricate solar water heaters with higher technological efficiency. As in Brazil, TRANSSEN Company merged with several companies from Chile and Peru; which had a positive effect of knowledge exchange and also of best practices. The same idea can be motivated in Barbados, in order to exchange know how, human resource, best practices, and others. In this way, the other manufacturers of Barbados will be forced to innovate and reach higher technological efficiency in order to be competitive.

- Another major gap found in the supply of thermal solar water heaters in Barbados is the lack of a program similar to the PBE Label Product and Qualisol that exist in Brazil. These labels, which are posted in the solar water heating system to inform the consumer the technological efficiency of each system and to guarantee a good service provided by the company, respectively, cannot be found in Barbados, despite the strong market demand and supply there is in this country. Similar labels should be elaborated and implemented in Barbados in order to motivate a high technological efficiency of the solar water heating systems, inform the consumer and motivate manufacturers and distributors to also have a good service of installation, renovating, etc. With these labels, the manufacturers will be forced to be more competitive and reach higher technological levels in order to meet the consumers´ demand and requirements.

4.4.1.3. Costs:

- Despite the low costs of the solar water heaters and the high electricity rate, there is a gap that needs to be addressed. The low income households who do not pay taxes due to their

informality in the work field cannot benefit from the tax rebate granted by the Homeowners Tax Benefit.

- Moreover, despite the high purchasing power capacity per capita and thus the affordability of the thermal solar water heaters, the cost of these systems is considerably high, especially for the low-income households. For the medium and high-income households, the initial cost of the SWH systems is not extremely high, especially considering that these systems are tax deductable. However, for low-income households, these systems are unaffordable.

4.4.1.4. Economic Incentives:

- Despite the economic incentives that the manufacturers and consumers have received either from the government or from the producers; these have not been enough. Only in the year 1974, several organizations and government agencies provided funds to incentivize the emergence of solar water heating manufacturers. In the coming years, the government and civil society organizations have not kept on incentivizing this market throughout the years in order to create a boost the demand rate more and more every year.

- Also, there have only been two development housing projects in Barbados, from which one was of a very small scale, considering that only 84 units were installed in houses.

- Moreover, there have only been economic incentives for the manufacturers and not for the consumers, which are also extremely important in the market.

4.4.1.5. Financial Incentives:

- However, despite the several financial incentives that the SWH market has received in comparison to other countries, these have not been enough to the producers and the

consumers. There is only one financial incentive for the producers, which is the Fiscal Incentive Tax, which exempts 20% of the import duty to SWH raw materials and which implemented a 50% consumption tax on conventional electric water heaters and imported gas. This incentive was implemented in 1974 and since then, the government has not undertaken another. Moreover, the only financial incentive for the consumers has been the tax deduction of the full cost of the solar water heater system, which was reinstated in the 1990s and since then no other incentive has been granted to the consumer.

4.4.1.6. *Institutional Framework*

- Despite the slightly strong institutional framework, which has been an important driver for the development of solar energy in Barbados, there are still several gaps in these regards that need to be addressed. An investigation about the legal framework has to be undertaken to identify the gaps and needs there are in this area; and thus be able to provide a good assessment about the legal framework in Barbados.

- There is lack of greater interaction, integration and information exchange between the institutions that dedicate their resources to the development of renewable and solar energy. This is due to the lack of an existing platform, which can incentivize dialogue and coordination between several actors (NGO´s, government institutions, universities, laboratories, manufacturers and others). A lot of knowledge can be found in the universities such as in the Universities of West Indies; however, this is not shared often among the several actors.

- Moreover, at the governmental level there is lack of leadership of an institution, which would incentivize the development of solar energy and thus of solar water heaters. Most of the institutions dedicate their resources in general to renewable energies and not specifically to solar energy.

4.4.1.7.Legal Framework:

- Despite the several fiscal incentives (laws) there are in Barbados, there are not laws which regulate and control the market (manufacturers, producers, consumers, etc) of solar water heaters.

- There is also a lack of laws which incentivize and promote the development of the solar water heating market on a greater scale. For example, in Brazil, there is a municipal law which indicates that all new buildings and houses need to have installed a solar water heater.

4.4.2. **PRIORITIES FOR ACTION:**

a) Stronger Legal Framework:

- In Barbados, despite the strong and buoyant solar thermal market, the legal framework still has to grow tremendously.
- Laws that would control, regulate and encourage the development of the solar water heating market need to be approved and implemented. A very good example of some of laws that can be a good idea for elaboration and implementation in Barbados are the municipal laws that are currently being implemented in Brazil, which states that all new buildings need to have installed solar water heaters.
- Another regulation, from which ideas and format can be drawn from to elaborate and implement a similar one in Barbados, are the regulations stated in the PBE Label and Qualisol Label in Brazil. These labels establish norms regarding the technological efficiency that each solar water heater needs to reach and establish the norms that a distributor, installators, designers need to meet.
- Also, a national policy should be elaborated and implemented such as the law of Rational and Efficient Use of Energy in Colombia, which under one of its decrees it disposes to promote the rational use of

energy in the electric sector by using transformers and solar water heaters.

- Under the umbrella of such law, a program to incentivize the use of energy efficiency can be promoted, such as in Colombia with the PROURE. This program can focus on promoting development projects focused only on solar energy, considering that Barbados strongest renewable energy source is solar. In this way, greater housing development projects and others can be promoted, such as the ones in Colombia, which seek to install solar water heaters to new houses and the cost of the system becomes part of the cost of the house. Thus, the cost of the system becomes part of the loan provided for buying the house and the interest rate is low and the payment payback time is in long-term. In this manner, the cost of the solar water heating system is not felt by the consumer.

b) Economic and Financial Incentives:

- Also, laws that would provide economic and financial incentives should be approved, such as laws that would provide tax deduction benefits to hotels, pools, hospitals and other commercial entities and industries, which install solar water heating systems.
- Also, under the umbrella of the national policy, which would seek to motivate the rational and efficient use of energy, a decree can mention that manufacturers should be incentivized through economic incentives, such as loans. These funds that would be administered by the Energy Division of Barbados, would have a low interest rate and long term payment. These funds would be provided to new emerging manufacturers which would seek to enter the market in order to tackle the oligopoly that currently exists in Barbados.

c) Institutional Framework:

- A strategic alliance or a platform for dialogue has to be incentivized between the private sector, government and civil society in order to share all the information and experience that is generated in every institution. In this manner, a comprehensive plan can be elaborated by these entities which would increase the demand rate even higher than in the 1980s years. This alliance can be directed by the University of the West Indies, which has a great amount of knowledge, the Energy Division of Barbados, which elaborates and implements policies and the Solar Dynamics Company, which has the technological, manufacturing knowledge due to the in-house laboratory and the highly trained engineers that it has. Through this alliance, information can be shared, policies and programs can be proposed. Moreover, a platform for dialogue can be created among these actors, which can have a direct and positive impact on the legal framework.

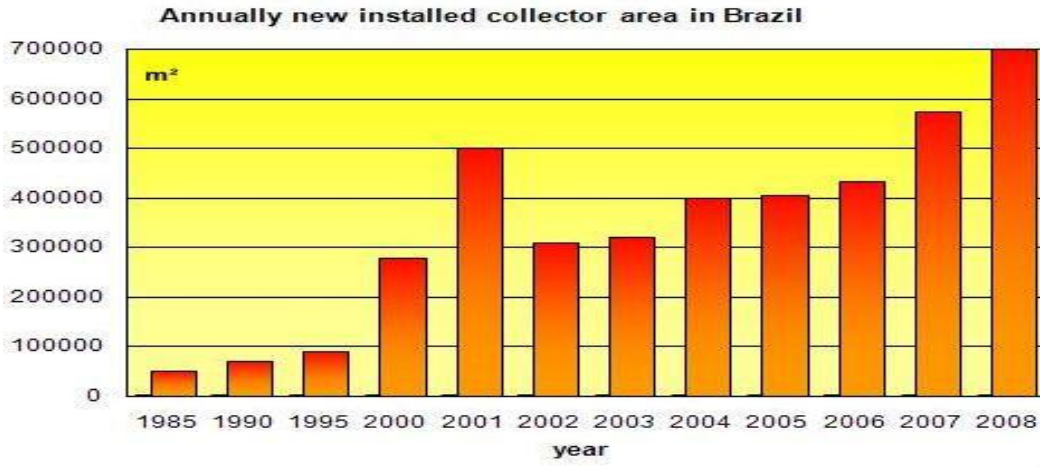
5. COUNTRY ASSESMENT OF BRAZIL

5.1. Market of Solar Panels:

5.1.1. DEMAND

In Brazil, the demand for solar water heaters has increased at a high rate throughout the last couple of years. In 2000 and 2001, the demand peaked incredibly in Brazil and in the least year, there was a 50% increasing rate. This rapid shift from conventional energies to solar energies and thus increase of solar thermal panels was due to one of the worst energy crisis that Brazil faced in the last couple of decades. The drought conditions caused a decline in water levels in the reservoirs of Brazilian hydroelectric power plants. Since then, the country realized the need to use alternative energy source and the power of diversification the energy sources, instead of mostly relying in hydroelectric power plants. That is why, the coming years, the demand kept on increasing significantly; however, not at the same rate as in 2000 and 2001 due to the lacking emerging need to use alternative energy sources to supply heated water. In the next five years, until 2006, the average area of annually installed collectors was of 360,000 m2. The demand kept on increasing due to the several programs and laws that were undertaken by the government to incentivize the growth of this market. For example, in 2000, the government approved Law No. 9,991, which established that all electricity generating companies had to invest at least 0.5% of their annual revenues in alternative energy sources. Most of the companies invested in solar thermal panels. Later on, in 2007 and 2008 there was another peak, considering that the solar water heating market grew above average, with an annual expansion

rate from 22% up to 32%, which corresponded to 590,000 m2 of new installed collector in Brazil in 2007 and 700,000 m2 (490MW) in 2008, as shown in the graph below.



Graph 3: Annually new installed collectors in Brazil (1985-2008).

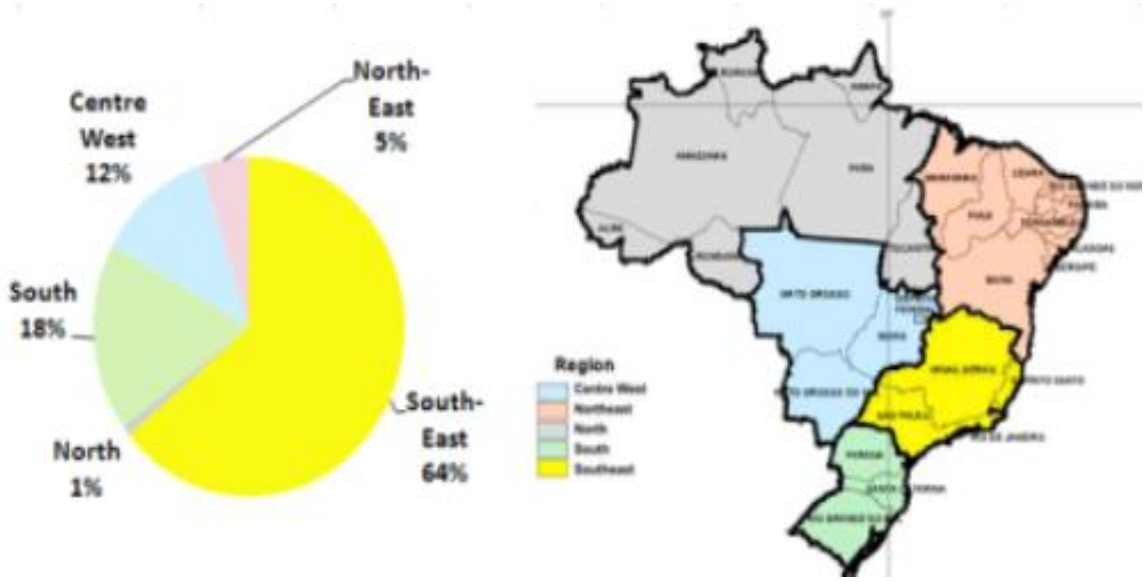
This increase, in the last few years, has been mostly due to the law of Sao Paulo No. 15.459, which was approved in 2007 and its Decree No. 49.148, which obliged all households to have at least 40% of the annual heating demand to be provided by a solar system. Also, this peak was due to the ¨My Home, My Life¨ program, which was a program that the Brazilian government launched in 2008 with the goal of building 1 million homes with their solar water heater for low-income families. By the end of 2008, 40,000 low-income families benefited from this program.[2] Moreover, in 2009, despite the economical difficulties that faced Brazil throughout this year, the demand for solar collectors grew 19%. As a result of this, by 2009 there were more than 5 million m2 of installed of solar water heaters in Brazil, as shown in graph 4.

[2] This programme came into force by the publication of the so called ¨Medida Provisoria¨ No. 459 on March 2009. One of the program´s intents is to increase the number of solar water heater installations in the new houses that are to be built because of it. Equipped with a total budget of Brazilian Real (BRL) 34 billion, the program aims at constructing 1 million single family homes by the end of 2011. Two different categories can benefit from it: the ones with 0 to 3 minimum wages in cities with over 100,000 inhabitants will receive subisidies for constructing the house, setting the monthly repayment rate to around BRL 10 per month or at least BRL 50 over ten years. Families with income of 3 to 6 minimum wages will be offered low-interest loans, limiting their repayment rate to no more than 20% of the monthly income.

Graph 4: Evolution of the Solar Water Heating Market in Brazil (2001-2009)

That is why; Brazil is currently among the countries that has the greatest demand for SWH worldwide, among China, USA, Germany, Turkey, Japan and Australia. In China, around 21 GWth (30 million m2) of thermal capacity was sold in 2008 and that is why China currently corresponds to 8'% of the world global market. In Germany, the second biggest market in the world, in 2009 the total newly installed capacity was of 1.13 GWth (1,615,000 m2) and that is why currently 38% of the market share corresponds to this country. In the third position is Turkey, with a solar thermal market which is estimated at 785 MWth (1,120,000 mw2). Besides these front-runners, India, Brazil, Austria, Greece, USA, Japan, France, Italy, Spain and Australia are countries which reached a market volume greater than 70 MWth (100,000 m2) in 2007. This high demand is due to all the incentives and the strong legal framework there is in Brazil, which is later discussed in this report.

The demand in Brazil is concentrated in certain areas of the country. Currently, the sectors that had the highest demand in 2009 are the South-East, South, Centre-West, North-East and North, respectively from highest to lowest, as can be seen in graph 3. In the South-East area of the country, 64% of the demand is located; in the South area of the country, 18% of the demand is located; in the Centre West area of the country, 12% of the demand is located; in the North-East area of the country, 5% of the demand is located and in the North area of the country, 1% of the demand is located.



Graph 5: Demand of Solar Water Heaters by sectors in Brazil in 2009.

In the South-East and Southern region of the country is where there is the greatest demand, considering that in 2009, 82% of the market activity was located in these areas of the country. The reason why there is the highest demand in the South-East region of the country is because in the South-East region, the cities of MinaisGerais, Sao Paulo, Espirito Santo and Rio de Janeiro are located. This region of the country is where there is the greatest population density, greater urbanization, greater hospitals, houses, schools, and others. Therefore, the demand for solar water heaters is higher. There are other reasons besides the amount of population and the level of urbanization that have caused this region to be the leading region in the country in regards to

solar water heating. In some of these cities, several programs and laws have been undertaken, which incentivize the growth of the demand. For example, in MinaisGerais, the COHAB project was undertaken. This program which was elaborated and implemented among the Housing Company of the Brazilian state of MinaisGerias (COHAB-MG) and the state-wide energy utility of CEMIG - (Energy Company of MinaisGerais) – due to the Law No. 9,991 – installed more than 15,000 solar water heaters in residences during 2009. In the following figure is a picture of residence with a solar water heater due to this program,

Figure 1: Solar Water Heaters in Minas Gerais

In the city of Sao Paulo, the law, which stated that all new buildings needed to have solar water heaters, was approved. In the state of Rio de Janeiro, a similar law was implemented, and it is actually the first city in which this norm was approved and implemented. Therefore, due to all these initiatives that the government has undertaken, the South-Eastern region is the currently where the highest solar water heating activity occurs. A map of Brazil can be found in the following chart to facilitate the location of the cities and regions mentioned in this report.

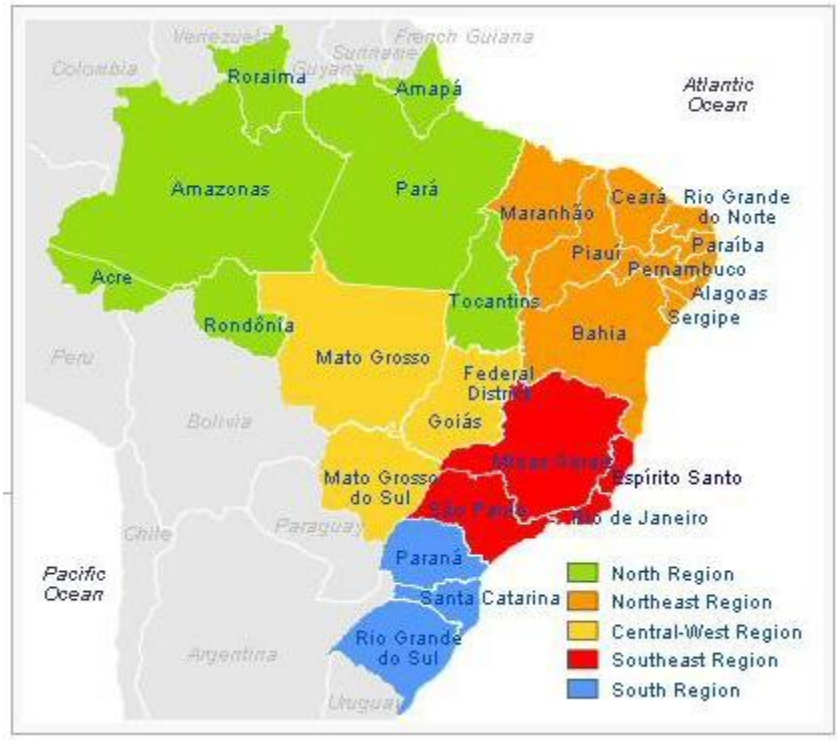


Figure 2: Map of Brazil which highlights the regions and the states.

In Brazil, the demand for solar water heating will keep on increasing at a high rate, compared to other countries in Latin American and the Caribbean. It is expected that the demand keeps on growing at a rate from 15% - 20%, and in other Latin American countries it is expected that the demand will keep on increasing at a rate of 5% - 10%.Therefore, despite the crisis of the global economy, Brazil´s economy remain positive and thus the market of solar water heating. As several solar exporters have mentioned, even though Brazil has felt some of the global economic woes in its export trades (especially primary products), the state still possesses enough monetary reserves to support the Brazilian currency (Real) and stimulate demand through tax reductions and social housing programmes. Thus, the solar thermal industry still has enough reason to look optimistically into the future.

5.1.2. SUPPLY

In Brazil, the fabrication and distribution of solar water heaters has become a great business considering the large demand that exists within the country and in neighboring countries. Currently, there are more than 200 companies that are dedicated to the fabrication, sale, installation, design, maintenance and consultancy of solar water heaters. In 2009, the production grew by 18.9%, which has resulted in these companies producing approximately USD $ 500 million per year. Some of the companies that are:

Companies that fabricate equipment of SWH for bathrooms	**Companies that fabricate equipment of SWH for pools**
ALBACETE	FABRICANTE
APARELHOS	ARKSOL
TERMICOS TECNOSOL	ATILA
AQUATHERM	CLIMATIC
AQUECEMAZ	E2SOLAR
ARKSOL	ENALTER
BOSCH	GET
BOTEGA	HELIOTEK
CONITNI & PORTO	HELLIOS
COLSOL	LARESOL
CUMULUS	MAXTEMPER
DECORSOL	NAUTILUS
E2SOLAR	PANTHO
ENALTER	POLISOL
EXCEL METALURGICA	RAYSOL
GET	SDR
GIRASSOL	VINIL
HELIOTEK	SERVOL
KONLOG	SOLAR MINAS
L.A.M.	SOLETROL
MELLONI	TRANSSEN
MASTERSL	TUMA
MASTEMPER	
NGK-RINNARI	
OURO FINO	

PANTHO	
PRO-SOL	
SOLAGUA	
SOLAR ENERGIAS RENOVABLES	
SOLAR MINAS	
SOLAR NOBRE	
SOLETROL	
SOLTEC	
TEGULA	
TECNOSOL-SP	
TERMOTRON	
TOSI	
TRANSSEN	
TUMA	
UNISOL	

Table 16: List of Fabricators of solar water heaters in Brazil.

In Annex A, you can find a list of the fabricators with the type of solar water systems that are fabricated by each. As noted, the industry of solar water heaters in Brazil is in a very strong position, compared to other countries in Latin America and the Caribbean. Besides, considering that Brazil has a ***comparative advantage*** in relation to solar energy due to the high levels of radiation (in Santa Catarina, where there is the lowest radiation level; the radiation received in this city is still 30% superior than the medium radiation level received in Germany), the production of solar collectors in this country is constantly increasing.

The technical efficiency that the suppliers have reached throughout the years in the fabrication of solar water heaters has been astonishing. Currently, there are two quality programs in Brazil. The first is the Brazilian Labeling Program to Solar Equipments (PBE) – established in 1998 to test the solar collectors and heat reservoirs and the second is Qualisol – Labeling Program to Suppliers, designers, dealers and installers of solar heating systems. The first Labeling Program Program is a power conservation program that uses informative labels to inform about the power efficiency of some products sold in the country. Besides the product power efficiency classification, the PBE Label contains information such as the brand name and

model, power consumption cost (electricity or gas) or power yield (%) and a few technical specifications. As can be seen in the following chart, the upper part of the label shows the manufacturer name, the product brand and model, and the kind of gas used. The average classification of the tabletop burners is highlighted in that area of the label. The letter A indicates that the project achieved the BEST efficiency rate; the B means it is a little less efficient, and so on down to letter E, which stands for the lowest efficiency level. The percentage indicates the average efficiency rate of the tabletop burners (it means the gas power efficiency in transferring heat to the pot). The following section of the label represents the oven inner capacity in liter and its maintenance consumption, that is to say how many kilos of gas per hour are needed to maintain the oven at a certain pre-establishment temperature. The letter A indicates the most economical oven and the E, the last one[3]. The lower section of the label has the INMETRO and the CONPET (National Program for the Rationalization of the Use of Oil and Natural Gas Byprodutcs) signatures.

[3] In order to receive a ¨A PBE label¨, the products are sent to laboratories accredited to carry out the respective performance test: the IPT Sao Paulo or the Green Solar at Belo Horizonte. The results of the subsequent performance tests determine the solar collector´s rating between A and E. The tests are repeated periodically under a programme called ACP (monitoring of production), in order to adjust the final source. Its intention is to motivate manufacturers to achieve better performance levels compared to previous evaluations.

Figure 3: Label of the Labeling Program to Suppliers

The Power Efficiency Seal indicates that the labeled product achieved the best performance results in their category. This means that these products were awarded as the best in terms of specific power consumption aspects and makes their distinction to the consumers.

Figure 4: Power Efficiency Seal

Due to the PBE label, fabricators are now forced to reach high levels of technical efficiency in order to receive the best PBE classification considering that the consumers´ decision-making in buying a SWH is mainly driven by the quality of the SWH unit indicated in the PBE label. Thus, this label has been a very important driver for the development of the solar energy market in Brazil because it has increased the trust of the consumers in the quality of solar heating

technology and it has encouraged companies to reach higher quality levels in their products considering that PBE seeks to provide information to consumers, which will enable them to evaluate and select products with a higher energy output. As a result of this label, high standards in terms of efficiency, technology, warranty and a minimum of solar fraction have to be achieved by the solar water heaters. For example, in Sao Paulo, solar water heaters have to achieve a minimum of 40% of solar fraction.

As mentioned earlier, due to the PBE label, several manufacturers have been forced to obtain the maximum efficiency levels to meet the consumers´ expectations. As can be seen in the following chart, from the 242 solar collectors that were labeled in Brazil by June 2010, the majority fall under the A category.

Label category	Glazed flat plate collectors	Unglazed collectors for swimming pools
A	100	46
B	52	27
C	10	2
D	1	2
E	1	1

Table 17: Number of labelled collectors in the two categories glazed and unglazed by June 2010. PBE labels are also available for refrigerators, light bulbs or washing machines. Source: Inmetro

From the 242 solar collectors that were labeled, 100 glazed flat plate collectors and 46 unglazed collectors for swimming pools fall under the A category, which accounts for more than 60% of the solar collectors labeled in 2010. The other 22% of the solar panels fell under the B category, which still indicates a high level of technology.

The second label, the Qualisol certification, has also been a major driver in reaching high levels of efficiency in the solar water heating market in Brazil. The Qualisol certification was created between ABRAVA, PROCEL INMETRO and Eletrobas. This program has the objective of guaranteeing to the consumers:

- High quality installations and thus satisfaction of the final consumer;
- A better reputation and confidence of the solar water heaters;
- A growing interest and capacity of the providers in terms of installation.

Considering that the distributors and installers also influence the decision-making of producers, this certification was created to incentivize the good customer-provider relation and to promote distributors to offer high quality service. The label can be seen in the following graph:

Figure 5: Qualisol Certification

Due to the PBE label and the Qualisol certification, the solar water heating market in Brazil has reached high standards considering that fabricators and distributors are forced to acquire these certifications.

Considering that there is a large amount of SWH fabricated in Brazil and these have a high quality standard, SWH fabricated in Brazil are exported to other countries. TRANSEEN, a leading company in Brazil recently became a multinational company by opening branch offices in Chile and Peru. This company exports to several countries in South and Central America and

also to several African countries. Also, there is the Monier Group, which has become a multinational company also and which is exporting to several countries.

Moreover, several foreign enterprises have tried to export their SWH systems and sell their products in the Brazilian market. However, many of these companies have not been successful considering the price: the price tag for systems that are exported from European or North American countries is very high. That is why; most of the foreign enterprises seek to form joint ventures with a national company. In this way, these companies seek to become more affordable because of the technology transfer that goes hand in hand with an increase in manufacturing quality and the development of new applications.

5.1.3. COSTS

In Brazil, the costs of conventional energies are not that cheap as in other countries. The cost of natural gas is between US $ 3.15/MMBtu and US $ 3.60/MMBtu, not including US $ 1.50/MMBtu, extraction and transportation costs. In Argentina, the cost of natural gas ranges from US $ 0.30 – 1.45 per kep. Therefore, the Brazilian population is not as incentivized to consume natural gas.

However, the cost of electricity in Brazil is lower than natural gas and that is why electricity is consumed in greater amounts than natural gas. Taking into consideration the energy matrix, the final consumption of electricity in 2009 was of 18%, while natural gas was of 5%. The other 77% is divided among petroleum and its derivates (45%), carbon and its derivatives (4%) and biomass (28%). The cost of electricity for the residential and industrial sector is shown in the following table:

Table 18. Average Cost of MWh – R$

Flujo	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Electricidad Industrial	47,7	43,2	40,6	46,4	58,4	99,2	122	141,4	144,5	142
Electricidad Residencial	112	97,7	91,2	100,5	118,2	168,3	188,5	209,4	210,2	201

Source: ANEEL, 2010

In Brazil, the cost of solar water heating systems is considerably low. A typical domestic SWH system, which is an open-loop thermoshyphon with 2-3 m2 of flat plane solar collectors with a 200-liter tank, costs approximately US $840 per system, including the installation (US $4.20 per liter).

Taking into considerations these costs and the fact that in Brazil there are no subsidies provided by the government to natural gas and electricity, it is more convenient, financially, for the consumers to buy a solar water heater. In fact, the payback time for a SWH system is between 1 and 4 years. The maximum payback time is five years is we are talking about some industrial applications for which electricity and gas tariffs are very low. Thus, in Brazil, solar water heaters can certainly compete with electricity and gas and its makes sense to substitute these kinds of fossil energy sources.

Moreover, it is more rentable to buy a solar water heating system and thus use solar energy as the energy source. After a study of 5 years in which energy was monitored and water bills, the conclusion was is that it is financially more rentable to buy a solar water heating system for households. In the following table one can see the promising results. The following table shows the summarized results after 5 years of monitoring energy and water bills. The complete study is part of a doctoral thesis published in 2006

	Families with solar water heater	Families without solar water heater
Average monthly energy consumption	81 kWh	145 KWh
Average energy savings	44 %	0 %
Value of the monthly bill for electricity [US$]	19 US$	49 US$
Increase in monthly income [US$]	30 US$	0 US$

Table 19: Summary of the costs of solar water heaters and conventional energy sources of a 5 year study

Households with solar water heaters were able to reduce their electricity consumption by 44 %, which corresponded to a monthly saving of US$ 30. If US $ 30 is saved every month, the solar water heating system can be paid in approximately two years and a half, if a thermosyphon system with 2-3 m2 of flat plane solar collectors with a 200-liter tank, which costs US $ 840, is bought. After the system is fully paid, the US $ 30 means an increase of income of almost 21% to households which have income between 1 and 2 minimum wages, which is approximately US $ 140, in 2006. Thus, solar water heaters are not only beneficial in terms of reducing CO2 emissions but are also beneficial in the long-term to the income of the population due to the energy saving.

5.2. Economic and Financial Incentives:

5.2.1. FINANCIAL INCENTIVES:

In Brazil, there are several financial incentives to the solar water heating market. All the companies that fabricate solar collectors and solar boilers receive the benefit of being exempted from corporate tax and value added tax (VAT) until 2011. In regards to the former, corporate tax

in Brazil in 2010 was of 34% (the tax consists of a basic tax of 15%; surtax of 10% for annual income of over BRL 240,000, which is about USD $ 110,000; the additional 9% are added for social contrinution on net profits), which is an extremely inflated tax compared to other countries and that is why it is considered to be a great fiscal incentive for manufacturers of solar water heaters. In regards to the latter, the VAT for manufacturers is of 12%, which is called the Impostosobreprodutosindustrializados (Tax over industrialized products), also known as the IPI. To provide a clearer idea of this tax, if a solar water heater costs USD $ 2,000, the SWH system plus the tax will cost USD $ 2,250; thus, increasing the price by USD $ 250, which means a high increase, especially for medium-income households, which are the ones that use the most. The exemption of taxes is a great incentive for the manufacturers and the consumers. For the manufacturers is a good incentive because by keeping a low price, consumers are more incentivized to buy more SWH systems. For consumers, it is a good incentive because the price is kept low, thus more accessible for medium-income households, which is the sector where there is the highest demand for SWH.

Another fiscal incentive is the high tariff that the government has maintained for solar water heaters that are imported into Brazil. Thus, national producers are benefited because nationally fabricated solar water heaters have a price advantage over imported systems.

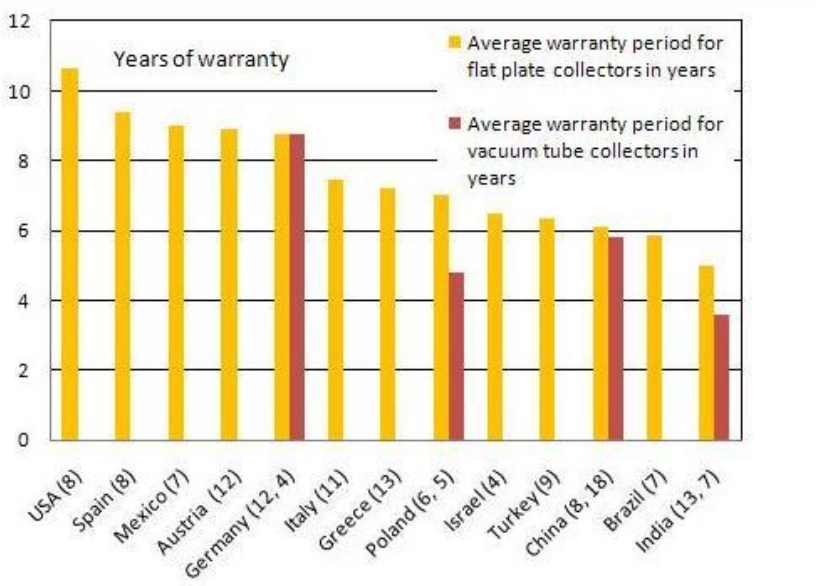
As a result of the exemption of taxes in Brazil to fabricators of solar water heaters and the high tariffs on imported systems, the government has created the perfect imbalance for the solar water heating market, in which the domestic market has greater advantage than the international market. Thus, from a financial perspective, imported solar water heaters are not competitive in terms of costs in the market considering that their prices will be higher than the solar collectors produced in Brazil.

5.2.2. ECONOMIC INCENTIVES:

Moreover, in Brazil, there are also several economic incentives which have been the drivers of the solar water heating market. The government, by approving Law No. 9,991 in 200, has made it a requirement for the energy generating companies (such as hydroelectric plants,

petroleum plants, etc) to invest 0.5% of their turnover in energy-saving measures. The majority of these companies invest in projects with solar water heaters for low-income households. To have a clearer idea of how much was spent in such type of projects for low-income households or other energy-saving measures; from the local utilities of USD $ 500 million produced in 2009 by energy generating companies, 0.5% of this total is USD $ 2,500,000, which was spent in energy-saving measures. An example of this platform has been the COHAB project, in which the Housing Company of the Brazilian state of MinaisGearis (COHAB) and the CEMIG (Energy Company of Minas Geris) worked together to install several solar water heating systems in new houses that were built for low-income households. CEMIG donated the solar water heating systems and COHAB and the government donated the residences. Considering that the majority of SWH companies spend this money in solar energy systems, they are incentivizing the market themselves.

Another great economic incentive that the market has is the long-term warranty that the manufacturers are offering to consumers. Currently, Brazil is among the 15 countries worldwide, which grant one of the longer warranties and it is the only Latin American country in the following list.



Graph 6: Years of Warranty of the Solar Water Heaters in Brazil

As can be seen in the chart below, the United States is the leading country that grants the longest warranty to consumers, with an average of 10 years. While, Brazil, for a 150 flat plate solar collectors grants a warranty of 7.4 years and for the vacuum tube solar collectors, the average if 6 years of warranty.

5.3. Legal and Institutional Framework;

5.3.1. INSTITUTIONAL FRAMEWORK

In Brazil, at the government level there is a strong institutional framework, which has become one of the main pillars and promoters of renewable energy and solar energy. In this section of the report, a list of the most important governmental institutions will be provided, and a description of the main tasks of each will also be given in order to provide the reader a clear idea of how these entities have been a major driver in the development of renewable energy and thus of solar energy.

- *National Energy Policy Council (CNPE*), which was established by Law No. 9478. It has among its goals to: preserve national interests;promote development, expand the labor market and enhance energy resources; protect consumer interests in regards to price, quality and supply of products;protect the environment and promote energy conservation;determine the most appropriate solutions for supplying electricity to the different regions of the country;use alternative energy sources, through the efficient use of available resources and applicable technologies;promote free competition;attract investments for energy production;augment the country's competitiveness in international markets;and others. Currently, the CNPE advises the President of the Republic in regards to the formulation of national energy policies and guidelines.
- *Ministry of Mines and Energy (MME*), which is one of the primary entities that regulates the energy sector considering that it carries out planning and implements the measures established by the Federal Government in the realm of national energy policy. MME was established in1960 with the purpose of investigating and taking care of all matters

relating to mineral and energy production. Companies linked to the MME are Eletrobras and Petrobras, which are semi-public corporations.

- *Energy Research Company (EPE),* which is linked to MME and it was created to provide services in the area of studies and research to bolster planning in the energy sector, such as with electricity, oil, natural gas and its derivatives, mineral coal, renewable energy sources and energy efficiency, among others. Fourth, there is the General Coordination of Alternative Sources (CGFA) within the Department of Energy Development (DDE) of the Secretary of Planning and Energy Development (SPE). This coordination elaborates, coordinates and implements politics, plans and programs of alternative energy, seeking to expand its participation in the national energy matrix; it also promotes the access of renewable energies to remote communities, promotes strategies and actions for the development of renewable energies, promotes investigation and technological development of renewable energies, elaborates studies on renewable energies, and promotes the professional capacitation on renewable energies.
- *Energy and Environment Coordination (CEMA) of the Department of Climate Change (DEMC) of the Secretary of Climate Change and Environmental Quality (SMCQ),* which is under the umbrella of the Ministry of Environment (MMA). This coordination formulates and proposes politics, norms and defines strategies for the well-being of the environment; promotes the use of renewable energies; provides assessment to the government in regards to the use of energy and promotes the coordination and dialogue among several public and private actors seeking to promote a more clean energy matrix; develops studies, projects and supports initiatives that have the goal of promoting the use of clean energy.

Moreover, at the organizational level, there is also a strong institutional framework, which has been a major driver in promoting the use of solar water heaters. . In this section of the report, a list of the most important institutions will be provided, and a description of the main tasks of each will also be given in order to provide the reader a clear idea of how these entities

have been a major driver in the development of solar energy and thus of the solar water heating market.

- *Association of Brazilian Refrigeration, Air Conditioning, Ventilation and Solar Heating (ABRAVA),* which has the National Department of Solar Heating (O DASOL – DepartamentoNacional de Aquecimento Solar da ABRAVA). O DASOL gathers throughout Brazil several actors that are focused on the promotion, dissemination, development and adoption of solar thermal energy. For over 17 years, O DASOL has acted on several fronts to form a network of companies, institutions, universities, government agencies, NGOs and citizens in pursuit of sustainable development of Brazil through the implementation and responsible use of energy, which puts Brazil in a prominent position in the solar thermal theme, acting as a benchmark to other countries. The programs and activities of O DASOL have coverage throughout Brazil and are accessible to all who want to use solar energy in a responsible, efficiency and as a solution for generating thermal energy for water heating. O DASOL´s vision is to be recognized as a major player in the consolidation of awareness and use of solar heating in Brazil and preserving natural resources and environment. Its mission is to represent the interests of the solar heating industry in Brazil, create best practices in the industry, encourage research and development, support the formation of public policy and financial incentives, remove barriers to the growth of technology in Brazil, and be sensitive to changes in the market to support our members defending their interests. O DASOL is a very important actor in the solar energy market; for more information regarding O DASOL, please visit its website: http://www.dasolabrava.org
- *NORMASOL*, which is an organization which was created with the support of the Ministry of Science and Technology and the Financer of Studies and Projects, with the objective of revising and developing norms related with solar energy in Brazil. The norms that are revised and developed are related to the following subjects: test of the components and construction characteristics, products and technological products; design requirements; installation of solar systems, etc. In this manner, by creating these norms,

NORMASOL seeks to establish greater standards in the solar energy market and provide benchmarking initiatives for the rest of the Latin American countries which seek to reach higher quality levels in their solar energy market.

5.3.2. LEGAL FRAMWORK

In Brazil, there is also a very strong legal framework, which has been an important driver in the development of renewable energies and the solar energy sector. The laws that promote the use of renewable energies and establish certain parameters to achieve greater energy efficiency are the following.

- *Law 10.438 of 2002* creates the Program of Alternative Sources for Electric Energy (PROINFA) and the Energy Development Account (CDE); and proposes that 15% of the annual growth of the electric market has to come from renewable energies between 2006 until 2019.
- *Law 10.295 of 2001*, which allows the Government to establish maximum and minimum levels of energy consumption in order to achieve greater levels of energy efficiency according to technical and economical parameters.
- *Amendment to Resolution No. 77/2004* was approved by ANEEL in 2005, which granted exemptions from paying TUSD and TUST for generation projects involving wind, biomass, small hydroelectric plants, solar or cogeneration with capacity below 30 MW and which had gone into operation up until December 31, 2003. Fourth, Law 11.488, of June 15, 2007, extended the 50% discount on TUST and TUSD to operations that generate power with the use of wind, biomass, small hydroelectric plants, solar and cogeneration with injected power up to 30 MW.

On a more specific note, the laws that are more related to solar water heating are several and are mentioned in the following paragraph.

- New building codes have been approved by the municipalities, stipulating that new built residential and non-residential buildings (applying the by-law to hotels, sport clubs,

schools, swimming pools restaurants, etc) have to install SWH on their premises. This law has been implemented in 12 cities of Brazil and has caused a tremendous positive response. Some of the cities that have implemented this law in Sao Paulo and Minas Gerais, and as a result these cities have become leaders in the solar energy market and that is why these are now dubbed ¨CiudadesSolares¨. There are still 5,000 cities in Brazil in which there are the need to implement this mandate; thus, there´s still a long way ahead for Brazil. Second of all, there is the law of Sao Paulo No. 15.459 since 2007 and Decree No. 49.148 which obliges from January 21st, 2008 for all households to have at least 40% of the annual heating demand provided by a solar system.

- Law No. 9,991 of 2001, which obliges the energy generating companies to invest 0.5% of their utilities to the development of energy efficient programs, projects and investigations.

The side-effects of these laws and decrees have been extremely positive. The solar building code campaign ¨CiudadesSolares¨, for example, has been extremely successful. Once this law was approved in Sao Paulo, other municipalities started to approve it and implement it. That is how, since the first law was passed, there has been the approval of 30 laws – 21 in the Southeast region, 6 in the South, 2 in the Mid-west and 1 in the Northeast. At present, there are also 94 draft laws going through the approving process – 61 in the Southeast region, 20 in the South, 7 in the Mid-west and 6 in the Northeast. There has not yet been any activity in the North region of the country. Moreover, the state of Rio de Janiero undertook the initiative to approve in 2008 a binding regulation, which required public building and publicly financed projects, such as schools, swimming pools, hospitals, asylums and rehabilitation centers to install solar water heating systems. The next state to approve such law is the Sao Paulo state. Also, as mentioned by several solar energy professionals, the Sao Paulo law has had a positive influence in the increasing demand rate of 3% to 4%. However, as mentioned, it still needs time to achieve its full potential.

5.4. Conclusions

5.4.1. **GAPS**

5.4.1.1. Demand

- Despite this very promising development of the SWH market in Brazil, there is still a long way ahead in the market of solar water heaters. The economic sector – residential sector – where there is a greater demand for solar water heaters is growing at a larger rate than the increasing rate of solar water heaters; thus, the average of solar water heaters installed per residence is decreasing. Currently, only 1.5% of the Brazilian households have a solar water heater; however, this average will keep on decreasing because as mentioned before the number of households in Brazil is booming at a higher rate. At the end of 2008, the national statistics showed that there were 1.79 million more households than at the end of 2007. In the same year, only 142,621 residential SWH with an estimated 4m2 each were installed, which means that only 7,69% of the new houses installed SWH. Considering that 85% of the total of SWHs is residential systems, it is not a significant growth considering the boom that the residential sector has had in the past few years in Brazil.
- Moreover, electric showers are still the norm in the residential sector of Brazil. In the last poll done in 2005, 40 million electric showers were registered to be installed all over the country. These electric showers consume about 6% of all electricity produced in the country and account for almost 18% of the demand of the national electric system, which corresponds to 200,000 MW produced by the hydro and thermal power plants, which accounts for a high level of consumption of electricity for only needing to turn on electric showers. Also, in Brazil regardless the considerable solar potential, within the electricity matrix production, more than 82% of the installed capacity for electricity generation comes from hydroelectric power plants, the remainder 18% is generated by thermoelectric plans, from which 15.1% comes from fossil fuels and biomass and 2.9% comes from thermonuclear fuel.

- Moreover, another downside is that the demand is mostly concentrated in the residential sector and it is not booming at the same rate in the commercial, industrial and public sector. About 85% of the whole collector area installed in Brazil is used by private households; which accounts for almost 730,000 households that heated their water with SWH by the end of 2007; which accounts for 1.5% of the 55 million Brazilian households. Only 15% of the annually installed collector area corresponds to the industrial and commercial sector.

- Another downside is that the demand for solar water heaters is currently concentrated in certain areas of the country. As mentioned before, the demand is concentrated in the South-Eastern and South areas of the country, where roughly 82% of the market activity is located. The demand is not as high in the other areas of the countries due to the lack of municipal incentives (Law approved in Sao Paulo to install SWH in all new buildings) and development programs (COHAB program), compared to the cities located in the South-Eastern and South.

- Moreover, the demand is not located in the areas where there is a greater solar radiation. As mentioned earlier, the demand is located mostly in the Southeastern region of the country and the highest solar radiation is located also in other regions of country: Southern region (North of Minas Gerais, North of Sao Paulo); Central Western region (South of the Federal District, Moto Grosso de Sul); North Eastern region (West of Bahia, South of Piau).

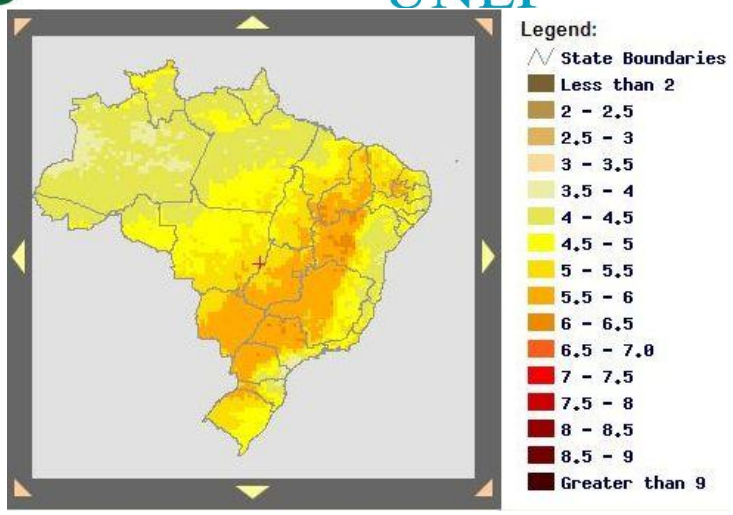


Figure 6: Levels of Solar Radiation Brazil (kWh/m2).

Figure 7: Map of Brazil

- In Brazil, there is still a high demand for electric showers. According to the federal electric company Eletrobas, this technology is installed in more than 67% of homes and accounts for 6% up to 8% of the total electricity consumption in the country. This is mostly due to the low initial cost; currently, roughly USD $ 10 are needed to install an electric shower. However, the long term cost is extremely high, and is a factor which is not taken into consideration very much by the population. An average home invests around USD $ 900 in electricity generation and distribution.

5.4.1.2. *Supply*

- Despite the high levels of technical efficiency and the large amount of SWH fabricated in Brazil, there are still a few needs that need to be addressed. The PBE label only considers the collectors´ performance, but does not include quality issues, such as durability, quality of materials, glass resistance, etc. It is therefore possible for a manufacturer to receive an A label simply by reducing the thickness of the glass cover, hence increasing transmission levels. Therefore, the possible instability of the collector, however, is not taken into account. As a result, it would be essential to create another certification label which would acknowledge the other standards that are necessary for a solar water heating system. Some of these shortcomings of the PBE labeling programme may be corrected through a new Brazilian standard very similar to European ones, NBR 15 547, which is expected to come into force in 2011.

- Moreover, the labeling programs are still voluntary in Brazil and not mandatory. What can happen is that several consumers that are obligated to install a solar water heater system in its residence, may chose the most economical system and one which does not meet with the requirements stated in the labels. This can have a negative effect on the population´s perspective regarding the efficiency of the solar water heating systems and as a result can have a negate repercussion on the market of thermal solar energy. Moreover, these labels should be mandatory to motivate greater competition, which always to innovation, and greater technological advances.

5.4.1.3. *Costs*

- Despite the positive aspects of the solar water heaters in Brazil, there are some needs that need to be addressed. For the poorer sectors of the population, the INITIAL cost of the solar water heating system is too high. As mentioned earlier, in 2006, the minimum wage was of US $ 140. Taking into consideration this wage and the initial cost of solar water

heaters, for the low-income households seems impossible and unaffordable to buy a SWH system. Thus, a national policy that can be implemented is to have differentiated costs for the SWH according to the income of the household in order to motivate the low-income sector of the population to use solar energy as an energy source. Thus, the government would have to subsidize for a proportion of the cost of the SWH system. In this manner, In this way, the government would also provide the opportunity for low-income households to have the opportunity to buy a solar water heater, and thus the low-income households would not rely entirely on the programs and projects promoted by the energy generating companies, which most of the time invest o.5% of the utilities in buying solar water heaters for low-income households.

- Currently, the cost of natural gas is extremely high; but as mentioned before, the cost of electricity is still low and that is why several Brazilians prefer to install an electric shower than to buy a solar water heater. In order to shift the demand of electric showers, which is still predominant in the water heating sector, to solar panels, the government needs to implement a similar consumption tax in electricity as the government of Barbados did in the year of 1974. In this year, in Barbados, the government implemented a consumption tax of 50% on electricity costs; this incentive had a strong impact on the demand of solar water heaters. A similar consumption tax can be implemented in Brazil.

5.4.1.4. Economic Incentives

- There are not much financing mechanisms, either for consumers or manufacturers to either buy a solar water heater or open a new business. Therefore, the private or public banks should have loans specifically for this kind of market. These loans should have a low interest rate and a long term payment facility.

5.4.1.5. Financial Incentives

- There are several incentives in the Brazilian market; however, one that is missing and which has had a good effect in the penetration of solar water heaters in the market is tax deduction. In Barbados, the government approved the Homeowners Tax Benefit, which allowed homeowners to deduct the total cost of the solar water heating system from their taxes. A similar approach should be undertaken in Brazil, but one in which the system is tax deductable to all consumers and not only homeowners.

- Also, there is no government subsidy for the low income households. This is extremely crucial for the low-income sectors of the population considering that it is unaffordable for this sector of society to buy their own SWH system.

5.4.1.6.Institutional Framework

- Despite the slightly strong institutional framework, which has been an important driver for the development of solar energy in Brazil, there are still several gaps in these regards that need to be addressed. An investigation about the legal framework has to be undertaken to identify the gaps and needs there are in this area; and thus be able to provide a good assessment about the legal framework in Brazil.

- There is lack of greater interaction, integration and information exchange between the institutions that dedicate their resources to the development of renewable and solar energy. This is due to the lack of an existing platform, which can incentivize dialogue and coordination between several actors (NGO´s, government institutions, universities, laboratories, manufacturers and others). A lot of knowledge can be found in associations as ABBRAVA; however, this is not shared often among the several actors of this market.

- Moreover, at the governmental level there is lack of leadership of an institution, which would incentivize the development of solar energy and thus of solar water heaters. Most of the institutions dedicate their resources in general to renewable energies and not specifically to solar energy.

5.4.1.7. *Legal Framework*

- Despite the several legal incentives, there are still several gaps. The laws which state that solar water heaters need to be installed in all new buildings is not yet approved in other cities of Brazil, which is more than 5,000 cities. There are only a few cities that have approved and implemented this law, like Sao Paulo.

- Also, Brazil does not have a national building code to allow for compulsory use of solar heating in the whole country and the federal government does not understand technology as a priority policy of the energy and the environment.

5.4.2. PRIORITIES FOR ACTION

a) The solar water heating market in Brazil is developing extremely well at the moment; however, the government and manufacturers should take advantage of this momentum and cause a booming effect in the demand, especially in those sectors where there is less demand and where there are the highest levels of solar radiation. Brazil should take advantage of the high solar radiation there is in the following sectors: Southern region (North of Minas Gerais, North of Sao Paulo); Central Western region (South of the Federal District, Moto Grosso de Sul); North Eastern region (West of Bahia, South of Piau). In order to incentivize the demand is in these regions of the country, the municipal government should elaborate, approve and implement a similar law like the one of Sao Paulo, which states that all new buildings should install a solar water heater. In fact, all the 5,000 remaining cities should implement such law, in order to shift the demand from electric showers to solar water heaters.

b) The other crucial priority action in Brazil is creating another certification which would consider in its standards the collectors´ performance, but does not include quality issues, such as durability, quality of materials, glass resistance, etc. Some of the shortcomings of the PBE labeling programme may be corrected through a new Brazilian standard very similar to European ones, NBR 15 547, which is expected to come into force in 2011.

c) Also, in Brazil there is the need for greater economic and financial incentives in order to shift the demand from electric showers to solar water heaters. This can be done by implementing a subsidy for those low-income houses, which do not afford to buy a solar water heating system. Thus subsidy can cover up to 20% of the investment cost of the system. The rest can be paid by the consumer. Another good financial incentive that can be implemented is a tax deduction, as the one implemented in Barbados, which allows homeowners to deduct from taxes the full cost of the solar water heating system.

6. COUNTRY ASSESSMENT OF COLOMBIA

6.1. *Market of Solar Panels:*

6.1.1. DEMAND

In Colombia, the demand of solar water heaters is concentrated in the city of Bogota. As indicated in the solar thermal collectors´ census, there are more SWH in this city than in any other cities of Colombia. In the census of 1984, there is a total of 20,189 square meters of solar panels installed in Bogota, whereas in Medellin there is a total of 2,990 square meters installed, in Bucaramanga there is a total of 50 square meters installed and in Manizales there is a total of 12 square meters installed.

Type of Use	**Cities**					
	Bogota	**Medellin**	**Bucaramanga**	**Manizales**	**Others**	**Total**
RESIDENCE	18849	2840	50	12	26	21777
RECREATIVE	1225	150	0	0	159	1534
INDUSTRIAL	115	0	0	0	0	115
Total	20189	2990	50	12	185	23426

Table 20: Square Meters Installed per city according to its use. Colombia. 1984

As can be seen from the chart above, out of the total 23,416 square meters of solar water heaters installed, 86.1% is installed in Bogota, and 1.27% is installed in Medellin and the rest in other cities. In 1993, the city of Bogota was still the city with the greatest square meters of SWH installations, as can be seen from the chart below.

City	**Square Meters of Installation**	**%**
Bogota	31596.5	64.6
Cali	2480	5.1
Manizales	798.8	1.5
Medellin	9820	20.1
Others 1	924.8	1.9
Others 2	3280.9	6.7
Total	48901	100

Table 21: Square meters installed per city. Colombia 1993

In 1993, in Bogota there is 31,596.5 square meters of installations, which accounts for 64.6% of the totally installed SWH. Medellin continued being the second city with the most installations considering that there were 9,820 square meters of installations, which accounts for 20.1%.

City	Number	%
Bogota	7903	90.6
Cali	292	3.3
Manizales	164	1.9
Medellin	250	2.9
Others 1	114	1.3
Total	8724	100

Table 22: Distribution of the number of SWH in each city – Colombia 1993

Numerically speaking, in Bogota there are 7,903 solar water heaters, which account for 90.6% of all the solar water heaters that existed in 1993 in Colombia. In Cali, there were 292 solar collectors which accounted for 3.3%, as can be seen in the chart above. Therefore, as can be seen from this analysis, the installation of SWH systems is highly clustered in one city of the country: Bogota.

Moreover, as can be seen from the charts, the demand for solar collectors is greater in the residential sector than in the commercial and industrial sector. The table 1 indicates that in 1984, out of the 23,426 square meters installed of SWH in Colombia, a total of 21,777 square meters were installed in residences and 1,534 square meters were installed in the recreational areas, and 115 square meters in the industrial sector. This indicates that in 1984, 92.9% of the installations were located in the residential sector, whereas 6.5% were located in the recreational areas and 0.49% were located in the industrial sector. The same pattern can be seen in 1993, as can be seen from the chart above.

City	Type of System							
	Domestic		Industrial		Recreative		Total	
	No.	%	No.	%	No.	%	No.	%
Bogota	7800	98.7	71	0.9	32	0.4	7903	100
Cali	279	95.5	11	3.8	2	0.7	292	100
Manizales	152	92.7	2	1.2	10	6.1	164	100
Medellin	196	78.4	9	3.6	45	8.0	250	100
Others 1	28	53.8	12	23.1	12	23.1	52	100
Others 2	32	51.6	4	6.5	26	41.9	62	100
Total	8587	97.3	109	1.2	127	1.5	8723	100

Table 23: Distribution of SWH per city according to its use, Colombia 1993

The graph demonstrates that in 1993, 8,587 SWH were installed in the residential sector, which accounts for 97.3% of the SWH; whereas in the recreational sector 127 SWH were installed, which accounted for 1.5% of the SWH and in the industrial sector 109 SWH were installed which accounted for 1.2% of all the SWH in Colombia. This ratifies what is mentioned in the questionnaire filled out by the Ministry of Energy of Colombia, which mentioned that there is a greater demand for SWH in the households than in the commercial and industrial sector. Also, as mentioned in the questionnaire, there is a greater demand in recreational activities such as in tourism and pools than in the industrial sector. Hospitals are another sector of the economy which use in a greater manner SWH, as mentioned in the questionnaire.

The total amount of SWH installed has always been increasing since 1979 until 1993; however the increasing rate has not maintained stable. As can be seen from the graph above, the increasing average of square meters every year from 1979 until 1993 is of 2,010 m2; however, this has not maintained stable. There are years in which there is an increase of 1,000 m2 and others there is an increase of 4,000m2.

Year	Area (m2)
1979	1150
1980	1902
1981	4375
1982	652
1983	-
1984	4000
1985	4863
1986	1200
1987	2676
1988	3210
1989	278
1990	3120
1991	1399
1992	898
1993	1334

Table 24: Historic Relation of Installed Area of SWH, Colombia 1993

The increasing demand has not maintained stable because the demand for solar water heaters has been driven mostly by massive housing programs, which seek to install SWH in several residences, and by energy crisis, which have led actors involved in the energy sector to seek alternative energy sources.

Unfortunately, in Colombia there is no updated information regarding the solar water heating market. The last census was done in 1994 and that is why the information in this report is from 1993.

6.1.2. SUPPLY

In Colombia, there are very few companies that are dedicated to the fabrication, commercialization, distribution and installation of solar water heaters. Approximately, there are 25 up to 30 companies that are dedicated to thermal solar energy. As shown the graph below, the majority of the companies are located in Bogotá, in which in 1993, there were 15 companies, accounting for 53.6% of all the companies. The other companies that were located in Cali were

6, which accounted for 21.4%, in Manizales there were 2 companies which accounted for 7.1% and in Medellin there were 5 companies, which accounted for 17.9% of the market.

City	# of Companies	%
Santafé de Bogota	15	53.6
Cali	6	21.4
Manizales	2	7.1
Medellin	5	17.9
Total	28	100

Table 25: Distribution of the companies of thermal solar collectors according to cities – Colombia 1993

Some of these companies are:

- AIRETECNICA S.A.
- AGUACALIENTEGRATIS-ENERGÍA SOLAR
- AMERICAN POOLS
- AVITECNICA
- BONSOLAR
- CALENTADORES SOLARES PROSOLAR
- ENERGIA EOLICA Y SOLAR DE COLOMBIA
- ENERGIA SOLAR INGESOLAR
- ENERGIA SOLAR LAS GAVIOTAS
- ENERSOL
- EQUISOLAR
- INTEGRA
- PTV
- SOLAR CENTER LTDA.
- SOLAR Y MICROHIDROELECTRICAS.

The technical efficiency and the technology of the solar water heaters in Colombia have to improve. The efficiency of the heating water systems, especially of the flat plane

thermosyphon systems, ranges from 20% to 40%, whereas the efficiency of the electric systems is of 80%, as can be seen in the following table.

Item	Magnitud
Efficiency of the solar collector	20% - 40%
Efficiency of the electric system	80%

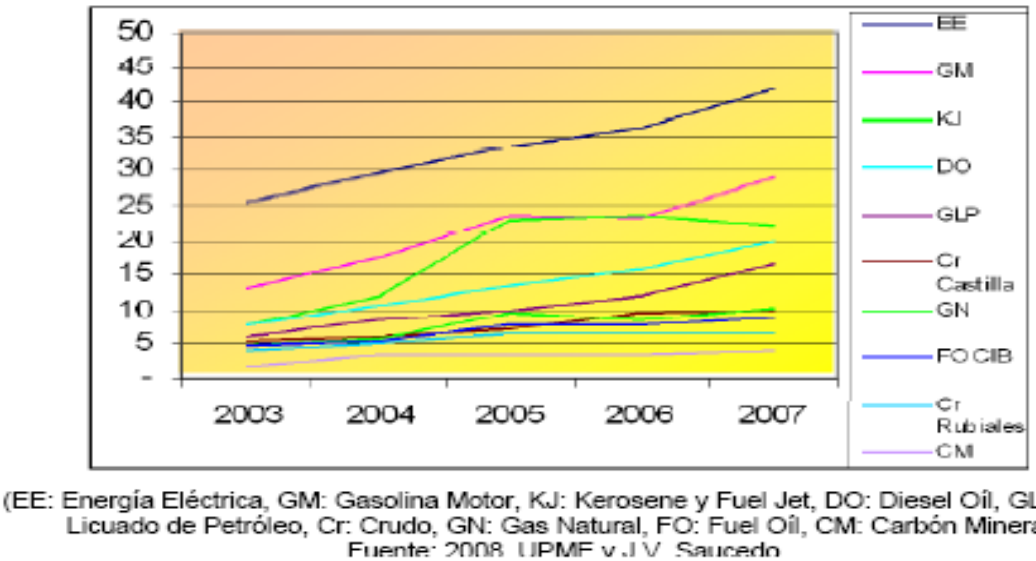
Table 26: Efficiency of the solar collector and electric system

As a result of this efficiency, the 31,000 solar collectors that were established by 2009, these solar thermal collectors produced a total of110, 973 kWh / year and there is an average loss superior to 4W/m2. Moreover, the average temperature of the water with SWH is of 30 degrees Celsius or lower. Therefore, the efficiency of solar collectors has been one of the major reasons why consumers prefer electric systems rather thermal solar panels. That is the reason why several consumers that bought solar water heaters decided to stop using this system and switched to electric systems.

Unfortunately, information regarding how many solar water heaters are fabricated, imported and exported annually could not be found.

6.1.3. COSTS

Another very important factor in this market is the costs of the thermal solar collectors and of other conventional energies. In Colombia, the price of natural gas has maintained very low, influencing in the decision-making of consumers to consume natural gas rather than solar collectors. As can be seen in the following graph, the cost of natural gas has maintained at an average of US $ 7 / MBTU in the last few years, reaching its peak in 2007, in which it reached US $ 10 / MBTU.



(EE: Energía Eléctrica, GM: Gasolina Motor, KJ: Kerosene y Fuel Jet, DO: Diesel Oil, GLP: Gas Licuado de Petróleo, Cr: Crudo, GN: Gas Natural, FO: Fuel Oil, CM: Carbón Mineral)
Fuente: 2008 UPME y J.V. Saucedo

Graph 7: Relative Prices of Energy in Colombia (2003-2007)

Therefore, as can be seen from the graph above, natural gas is the cheapest energy source for water heating, followed by liquefied petroleum gas, which costs approximately US $ 16 / MBTU in 2007. Electric energy was the most expensive source of energy considering that its price in 2007 was of US $ 43 / MBTU. Therefore, from a cost analysis, for consumers it is a lot more beneficial to buy natural gas for water heating and that is why this source of energy is the one mostly used to generate heated water.

Another very important factor in the decision-making of consumers whether to buy a solar water heating system or to use a conventional source of energy is the investment cost of the system. Currently, a solar collector with an empty pipe and the following characteristics; 39 liters, panel of 2,10 M2, ref CUSIS 47/20) costs USD $ 479 without the tank; a solar collector with the following characteristics : 334 liters, panel of 4,32 m2, red cuscs 58/20, weight 145 kilos costs USD $ 1,500 without the tank. Moreover, a solar collector with a tank costs between USD $ 2,000 and USD $ 2,500. Therefore, it is not very affordable to buy a solar water heating system, which has such a highly initial cost and which its efficiency is below 50%.

6.2. *Economic and Financial Incentives*

6.2.1. ECONOMIC INCENTIVES

There have been very few economic incentives that have sought to promote the market of thermal solar panels in Colombia. One of the few institutions that have provided economic financing is the Central Mortgage Bank (Banco Central Hipotecario – BCH), which has been the greatest promoter. This Bank has financed more than 50% of the solar systems in Colombia. During the 1980s, this Bank undertook massive housing programs, and the apartments that it constructed it installed SWH systems. Thus, the people who bought the apartments, they received the apartment plus the solar water heater already installed; thus, they had no option of denying the SWH system. Moreover, the cost of the solar water heater was already included within the total cost of the apartment. The financing of the SWH systems was done in the same manner as the financing of the apartment, with an interest rate of 15% annually and the time for payment was 15 years. This mechanism alleviated tremendously the initial cost of the SWH.

6.2.2. FINANCIAL INCENTIVES

Also, there are few financial incentives that have sought to promote the market of renewable energies in Colombia, but there is no fiscal incentive which promotes the use of thermal solar panels. Some of the fiscal incentives that promote the use of renewable energies in Colombia are: first, the law 223 of 1995 allows for the deduction of up to 20% of the liquid rent to investments that seek to have a positive environmental impact. Second, law 788 of 2002, Art 125, allows for the deduction of taxes to donations to associations and organizations which dedicate their projects to sustainable development and environmental protection. However, as mentioned earlier, there are none fiscal incentive that DIRECTLY and SPECIFICALLY incentivizes the market of thermal solar panels.

6.3. Institutional and Legal Framework:

6.3.1. INSTITUTIONAL FRAMEWORK

At the government level, there are few institutions that are dedicated to the development of renewable energies and thus solar energy.

- *Within the National Department of Planning (DNP) of the Presidency of the Republic, there is the Coordination of Infrastructures and Sustainable Energy (DIES*), which undertakes several actions for the development of the oil and energy sector in coordination with other organisms and entities. It participates, and promotes the formulation, control and evaluation of politics, plans, programs, investigations, and investment projects.
- *Ministry of Mines and Energy (MME*), which is in charge of the national politics and plans of the energy and mining sector. It is also responsible for the transmission, generation, distribution and establishment of technical norms related to electric energy, rational use of energy and the development of alternative sources of energy.
- *Within the MME, there is the Mining and Energy Planning Unit (UPME),* which undertakes several investigations regarding the conventional and non-conventional sources of energy to provide an appropriate assessment regarding the annual energy plans. It elaborates several analysis, evaluations and studies about the situation and perspectives of the energy industry. It has elaborated the National Energy Plan, the Electric Expansion Plan and the National Development Plan.
- *Within the UPME, there is the Group of Rational Use of Energy and Alternative Energies,* which provides assessment to politicians regarding the proper use of non-conventional sources of energy; it also elaborates and recommends the formulation of politics and programs which would promote the use of renewable energies within Colombia.

- *Institute of Planning and Promotion of Energy Solutions for the Non-Interconnected Zones (IPSE), which is part of the MME*. This entity offers energy solutions to the rural communities that do not have access to electricity or other energy sources. Several of the solutions that are provided to the rural areas are through programs of renewable energies.
- *Inter-sectorial Commission for the Rational Use of Energy and Non-Conventional Sources (CIURE),* which provides assessment and support to the MME in regards to politics that incentivize the use of renewable energies.

Moreover, there are other institutions at the civil society level, which can also be an important support for the development of the market.

- *National University of Colombia*, which was one of the leading universities and entities that sought the objective of dissemination of information by organizing and teaching several courses and seminars that were open to all those who were interested in the subject of solar energy.
- *University of Los Andes*, which is one of the few universities that have an academic program on Environmental Engineering and a Masters´ Program in Environmental Management.
- *Javeriana University*, which offers a PHD Program in Environmental and Rural Studies, and in Environmental Engineering.
- *Colombian Society of Solar Energy and Alternative Energies and the Colombian Association of Engineers,* which leads several investigations and organizes several symposiums to disseminate information on solar energy and alternative energies. Also, this group seeks to create a large network between public and private actors of the solar energy sector.
- *Fundacion Las Gaviotas*, which has been one of the primary actors in the solar collectors´ market, considering that it has undertaken some very important development projects. In the following table, is a detailed list of the projects that this foundation has done installing solar water heaters in several residences, hospitals, and others. The most important projects were located in City Salitre (1065 of solar water heaters installed in

1987) and in Tunal City (4540 of solar water heaters installed in 1984 and later in 1986). This last project was targeted to the poorest sector of the population.

Table 27: Magnitude of the projects undertaken by Centro Las Gaviotas and energy and environmental impacts.

Proyecto	Lugar	Año	Número Apartamentos	Número colectores	Área (m^2)	Radiación solar (kWh/m2/día)	Energía térmica útil (kWht/año)	Energía Eléctrica Ahorrada (kWh/año)	Años servicio (años)	Energía Eléctrica Ahorrada durante años servicio (MWh)	Emisiones evitadas durante años servicio (t CO2)
Nueva Villa de Aburrá. Etapa I	Medellín	1979	536	1,072	2,152	4.80	1,508,122	2,217,826	20	44,357	16,612
Nueva Villa de Aburrá. Etapa III	Medellín	1981	384	768	1,542	4.80	1,080,634	1,589,167	20	31,783	11,903
Niza VIII	Bogotá	1981	683	2,049	4,160	4.80	2,915,328	4,287,247	20	85,745	32,111
Ciudad Tunal. Etapa I	Bogotá	1984	2,000	2,000	4,000	4.41	2,575,440	3,787,412	20	75,748	28,368
Ciudad Tunal. Etapa II	Bogotá	1985	2,030	2,030	4,060	4.41	2,614,072	3,844,223	20	76,884	28,793
Ciudad Tunal. Etapa III	Bogotá	1986	510	510	1,020	4.41	656,737	965,790	20	19,316	7,234
Nueva Santafé (Mz 5,6)	Bogotá	1987	560	1,120	2,240	4.17	1,363,757	2,005,525	20	40,110	15,021
Nueva Santafé (Mz 2)	Bogotá	1988	270	540	1,080	4.17	657,526	966,949	20	19,339	7,242
Sauzalito, Ciudad Salitre	Bogotá	1987	1,065	1,065	2,130	4.41	1,371,422	2,016,797	20	40,336	15,106
Hospital	Bogotá	1994		535	1,070	4.41	688,930	1,013,133	20	20,263	7,588
Otros	País	hasta 2009		19,311	38,622	4.50	25,374,654	37,315,668	8	298,525	111,798
Total			8,038	**31,000**	**62,076**		**40,806,620**	**60,009,736**		**752,407**	**281,776**
Mz: Manzana											

- *Colombian Institute of Technical Norms (ICONTEC)* which has been created since 1986, and which has the objective of: forming a network of the several actors involved in this market, such as private enterprises, universities, NGO´s, etc.; and elaborating norms that would seek to regulate and control several aspects of the thermal solar panels.

6.3.2. **LEGAL FRAMEWORK**

Legally, Colombia does not have a strong framework considering the few laws there are to incentivize this market.

- *Law 143 of 1994*, which was the first law that incentivized the rational and efficient use of energy in Colombia.
- *Law 164 of 1994*, with which Colombia approves the Convention of the United Nations for Climatic Change of 1992. After approving this convention, Colombia approves this law and thus obliges the country to engage in more environmental and sustainable activities and policies in order to meet the standards established in this convention.
- *Law 697 of 2001 and its Decrees.* This law is the cornerstone of the legal and regulatory framework of the Rational and Efficient Use of Energy (URE). Through this law, the government promotes the use of alternative energies and the efficient use of energy. Also, this law creates the Programme for the Rational and Efficient Use of Energy and other non-conventional energy sources (PROURE), which has the objective to gradually implement development programs. Under the umbrella of this law, there is also the Decree 2501 of 2007, which dictates several dispositions to promote the rational use of energy in the electric sector by using transformers, solar water heating systems and others.
- *Law 223 of 1995*, which implements the deduction of taxes up to 20% to the liquid rent to investments that are targeted to environmental projects (Art. 158-2).
- *Law 788 of 2002* (Art. 158-1 and 158-2), which grants the investments that seek to have a positive environmental impact the deduction of up to 20% of the liquid rent in their taxes.
- *Law 1117 of 2006*, which establishes a special regimen of subsidies to the consumers in the non-interconnected zones that use renewable energy as an energy source.

6.4. *Conclusions:*

6.4.1. **GAPS**

6.4.1.1. *Demand*

- There are several gaps in the solar water heating market in Colombia. There is lack of investigation in this area in Colombia. The last water heating solar panel census was done in 1994, and since then the information has not been updated. In order to provide an accurate assessment of the market and elaborate and propose logical and efficient policies, programs and strategies it is extremely important to undertake a thorough analysis of the solar water heating market in Colombia.

- As can be seen from the graphs, the demand is mostly clustered in Bogota. More than 90% of the solar water heaters were installed in Bogota in 1993 and more than 3% in the city of Cali and the rest in other cities. This relationship is extremely off balance; specially when there is greater solar radiation in other areas of Colombia. In Guajira and in the Atlantic Coast there is a higher solar radiation, of 2,000-2,100 kWh/m2/year and 1,730-2,000kWh/m2/year respectively. In Bogota, which is located in the Andean region, the solar radiation is of 1,550-1,750kWh7m2/year. Thus, the demand is not located in strategic areas of the country, where there is a higher solar radiation and thus where the efficiency of the solar water heaters can be higher.

- Also, the demand is highly clustered in the residential sector and the solar water heaters have not penetrated in other sectors of the economy, such as the commercial, public areas, and industrial sector. As mentioned earlier, more than 90% of the solar water heaters are located in the residential sector; while the rest is located in the recreational activities such as in hotels and pools. However, the percentage of solar water heaters that can be installed in this sector of the economy is not as high as it can be, considering that the demand for heated water is extremely high in this sector of the economy. In another

sector of the economy in which the demand can be high and where the demand is currently extremely low of solar water heaters is in the food industry.

- Another important gap in the demand sector of solar water heaters in Colombia is that throughout the years it has been mostly driven by massive housing programs undertaken either by the government, or organizations. Moreover, the demand has also been driven by energy crisis, which have led the population to seek alternative energy sources. Thus, the demand in Colombia is not driven by the interest of the consumer to replace conventional energy sources with alternative energy sources.

6.4.1.2. *Supply*

- By undertaking a thorough analysis of the supply side of the solar water heating market in Colombia, one can notice that there are several needs and gaps that need to be tackled. First, there hasn´t been done a thorough analysis of the supply side of the solar water heating market, gathering the information of how many solar water heaters are fabricated annually, from where are these systems imported, are these systems exported, etc.

- Second, the efficiency of the solar water heaters is extremely low. The efficiency of the systems ranges from 20 to 40%; while the electric systems are 80% efficient. This causes the population to prefer electric systems rather than alternative energy sources. This lack of efficiency is due to the lack of innovation and research.

- Third, there is a very small number of suppliers in Colombia. This lack of suppliers causes a lack of competition and thus there are no incentives for manufacturers to innovate, reach higher levels of technological efficiency and lower costs.

6.4.1.3. *Costs*

- The cost of natural gas and liquefied petroleum gas is extremely low in Colombia; whereas the cost of the solar water heater is extremely high. As mentioned earlier, this systems costs approximately around $ 2,000, which is highly expensive considering that the GDP per capita is USD $ 9,000 in 2010 and in 2008 most of the population was under the poverty line (46.8%).

- Another major gap found in Colombia, is that the government subsidies natural gas and electricity to the low income sector of Colombia. Considering that 46.8% of the population is below the poverty line, thus, a large percentage of the population benefits from the subsidy granted by the government and thus has no incentive to install a solar water heater.

6.4.1.4. *Economic Incentives*

- The economic incentive granted by the Central Mortgage Bank has been a major incentive in Colombia, considering that almost 50% of the solar water heaters installed in Colombia have been installed with the aid of this Bank, which granted a loan to buy a house with an already installed system. This loan had a low interest rate and granted long term payments. This economic incentive has been a major driver in the market of SWH systems and has benefited several consumers. However, there haven´t been any other economic incentives granted to the consumers.

- Another major gap is that the manufacturers have not received any economic incentive from the government or organizations, such as loans with low interest rates and long term payments.

- Moreover, the government has not granted funds to the manufacturing sector and universities to dedicate their resources to research, innovation and thus greater technological efficiency.

6.4.1.5. *Financial Incentives*

- In Colombia, there are no financial incentives that incentivize the directly the market of solar water heaters. There are only incentives that incentivize, in general, renewable energies. As mentioned earlier, there are very few financial incentives that promote the use of alternative energy sources, such as the one outlined by the laws 223 of 1996 and law 188 of 2002.

- Moreover, there are no financial incentives that reduces the cost of the solar water heaters in Colombia; thus, not incentivizing the population to buy such as system. For example, there are no consumption tax on natural gas and liquefied petroleum gas, which are the cheaper conventional energy sources in Argentina.

- Moreover, the consumers do not receive any benefit from buying a solar water heater, such as being able to deduct the full cost of this system from their taxes. Or, the population does not receive any type of subsidy that helps alleviate the cost of the solar panel.

- Also, the manufacturers do not receive any type of economic incentive due to manufacturing such systems. In other countries, the manufacturers are also exempted from taxes and can benefit from import tax deduction to items that are imported and are essential for the fabrication of the thermal solar panels.

6.4.1.6. *Institutional Framework*

- There are very few institutions that are involved in the energy sector and promote the use of renewable energies within Colombia. Thus, there is no strong institutional framework which can promote the development of such system within the country. At the government level, one of the few entities that seek to promote the development of renewable energies and thus of solar energy is the Group of Rational Use of Energy and Alternative Energies which works under the umbrella of the UPME. At the civil society level, there are also very few institutions. One of the strongest entities that seek to promote the development of this source of energy is the Centro Las Gaviotas. It has undertaken several housing programs, but it has not been such a strong actor in promoting the development of thermal solar panels by proposing, elaborating and seeking to implement policies.

- Also, the few institutions that exist in Colombia and that seek the development of renewable energies and thus of solar energy are also institutionally weak. For example, one of these entities is the Group of Rational Use of Energy and Alternative Energies which works under the umbrella of UPME. As mentioned earlier, this entity only dedicates its resources to the elaboration and recommendation of politics and programs which would promote the use of renewable energies within Colombia. This institution should engage in more proactive activities and thus have a greater impact in the renewable energy sector in Colombia. Also, at the civil society level, the few institutions that exist such as La Fundación Las Gaviotas is institutionally weak. This organizations has undertaken several development projects in Colombia, but it has not become an important driver in the development of this technology due to the lack of knowledge, human resources, financial resources and other reasons.

- Among the universities there is also a lacking leading group, which dedicates most of their resources to research, investigations, seeking innovative alternatives in the technological aspects of the solar panels and also testing already existing solar water heaters.

6.4.1.7. *Legal Framework*

- None of the laws and decrees in Colombia focuses only on the solar water heating market; these laws focus, in a more general manner, in the development of renewable energies. In fact, none of these laws have a direct effect on the solar water heating market, only the Decree 2501, which promotes the rational use of energy in the electric sector.

- Also, there is a lack of regulatory laws, such as the ones that can be found in Brazil and which set the standards that need to be reached in markets as the one of solar panels.

6.4.2. PRIORITIES FOR ACTION

a) As a result of this analysis, it can be concluded that the government needs to implement several economic and financial incentives for the solar water heating market. Some of the economic incentives that can be undertaken are: first, taking as an example the initiative of the BCH, several constructing firms, banks and governmental agencies should ally and work together to undertake a similar initiative in Colombia. Second, the government or other financial agencies can grant loans to with very interest rates, to incentivize the emergence of new entrepreneurs who wish to start their business in the solar energy sector. Moreover, the government has to implement several financial incentives that are only focused on promoting the market of SWH in Colombia. These incentives have to be targeted for the consumers and the fabricators. For

example, a perfect financial benefit for the consumer is to be able to deduct from taxes the total value of the SWH system. For the fabricators, a great incentive would be if the government stopped subsidizing natural gas and electricity and instead would subsidize solar water heaters.

b) The project that the government (Ministry of Energy) in conjunction with the civil society organizations, such as the Fundacion Las Gaviotas, should undertake is a thorough research of the solar water heating market considering that the last census was done in 1994, in order to recommend reasonable national policies, adequate information is the first and most important step.

c) The institutions need to be strengthening in order to be able to promote the development of this technology and thus become the main pillar and driver. First of all, there is the need to strengthen the few institutions that are focused in the development of renewable energies and thus of solar energy. One of these entities can be the Group of Rational Use of Energy and Alternative Energies which works under the umbrella of UPME. As mentioned earlier, this entity only dedicates its resources to the elaboration and recommendation of politics and programs which would promote the use of renewable energies within Colombia. This institution should engage in more proactive activities and thus have a greater impact in the renewable energy sector in Colombia. Second of all, at the civil society level, there are very few institutions that have the objective of promoting the use of solar energy in Colombia. The most important institution is the Centro Las Gaviotas, which with the support of the government can do more and greater projects and programs.

7. COUNTRY ASSESSMENT OF NICARAGUA

7.1.Market of Solar Panels

7.1.1. DEMAND

The demand of solar water heaters in Nicaragua has been growing in the last few years. As mentioned by the Ministry of Energy, which was the entity that filled out the questionnaire, the demand of solar water heaters is growing at a 25% rate in the year 2010. In this year, roughly 15,000 solar water heaters were imported into Nicaragua and installed in households, hotels, and in industries. It is expected that this increasing demand rate will keep on increasing at a 20% rate. Compared to the installation level of solar water heaters in the former years, the demand has grown tremendously in these last few years. Since 1993 until 2001, a total of 300 solar water heaters were installed in households and hotels, which are the economic sectors where there is the greater demand.

The demand in Nicaragua is highly concentrated in certain sectors of the economy. In the sectors of the economy where the demand is most concentrated is in the industrial sectors, such as in hotels, hospitals and the food industry.

The demand besides being concentrated in certain sectors of the economy, it is also concentrated in certain regional areas of the country. According to the questionnaire, the demand is mostly concentrated in urban areas and the rural areas where there is a greater level of demand are in Estelí, Jinotega, Matagalpa.

7.1.2. SUPPLY

In Nicaragua, there are no fabricators of solar water heaters; but there are several distributors which import these units. The solar water heater systems are imported from several countries, mostly from China, United States, Korea, Japan, India and Mexico. As mentioned before, in the year 2010, 15,000 solar water heaters were imported in total. Some of the importers and distributors are the following, as shown in the following table.

Importers and Distributors
ECAMI
SUNI SOLAR S..A.
TECNOSOL
ALERTEC

Table 28: List of importers and providers of thermal solar panels in Nicaragua.

One of the main distributors of solar water heaters in Nicaragua is TECNOSOL. This company was constituted in 1998 and since then it has dedicated to the distribution, installation and maintenance of the solar water heaters. Due to the increasing demand and the highly qualified personnel and solar water heating systems distributed by this company, TECNOSOL has become the largest distributor of these thermal units in Nicaragua and in Central America. That is why, currently, there are 17 offices of TECNOSOL in Nicaragua and they recently opened a new office in Salvador.

The supply of SWH is highly advanced in terms of technical efficiency and technical capacity. As mentioned earlier, the solar water heating systems are imported from countries, which have high technological advancements. Besides, in Nicaragua, a project was recently carried out to increase the technical efficiency and capacity of the activities that the Nicaraguan distributors of solar water heaters carry out. The NICATEC project, which was organized by the United Nations Industrial Development Organization (UNIDO) and the Austria Development Agency, sought to increase the added value that can be delivered by the distributors, which are dedicated only to the design, installation and maintenance of the solar water heaters. That is why, these organizations sought to create and increase the local capacity of the distributors by organizing six workshops, which were taught by specialists of the AEE INTEC, a prestigious Austrian institution in the field of renewable energy. As a result of the increased local capacity, standards were outlined for the design and installations of solar water heaters, which were in accordance with international standards. That is how, the guidelines for inspection of the quality

of thermal solar water heaters and the guidelines for installation of these units were outlined and undertaken by several distributors in Nicaragua. The companies that have been trained to meet these standards and guidelines are Altertech, ECAMI, and Tecnosol, which are currently the biggest distributors of solar water heaters in Nicaragua.

7.1.3. COSTS

In Nicaragua, the costs of fabricating solar water heaters are extremely high. That is the reason why; these units are imported from several countries due to the low costs that these represent in comparison to fabricated solar water heaters in Nicaragua. In this country, the cost of fabrication is high due to the materials, which are mostly all imported from other countries, such as the stainless steel sheets and the glass materials. That is the reason why; these systems are imported from other countries, where the cost of fabrication is lower such as in China, United States Japan and Mexico. The costs of solar water heaters in Nicaragua are outlined in the following table.

Year	Type of Solar Panel	Costs (USD $)	Costs (USD $) + costs of tank
2001	Thermal Solar Collector 2m2	-	1250
	Thermal Solar Collector 1.5m2	-	1400
2010	Thermal Solar Collector 2m2	380	500
	Thermal Solar Collector 1.5m2	320	600

Table 29: Costs of the Solar Water Heaters in the year 2001 and 2010.

As can be seen from this table, in 2010, a thermal solar collector with 2m2 plus the tank costs USD $ 500 and the thermal solar collector with 1.5m2 plus the tank costs USD $ 600. Moreover, as can be concluded from the above table, the costs of the solar water heaters have decreased throughout the years and in the year 2010, the costs of these systems are considerably low; thus, these systems being affordable for the medium income households and other sectors of the population.

Despite the low costs of the solar water heater, the initial cost of these systems is still high in comparison to the technology of conventional energy sources. The most significant difference can be found when comparing the costs of solar water heaters and electric showers. The costs of the solar water heaters are between 30 to 40 times more expensive than electric showers, which cost around USD $ 15 to USD $ 20. Even though, solar water heaters can produce heated water at higher temperatures, can provide heated water for several activities and the life span of the solar water heaters (20 to 25 years) are greater than electric showers (5 to 8 years), the population still prefers to buy electric showers due to the low initial cost. The other technological source of conventional energy, which is mostly used in Nicaragua, is the electric tank. The cost of the solar water heating system is between 4 to 6 times higher than the cost of the electric tank (of 50 gallons), which is roughly between USD $ 100 and USD $ 120. Despite the difference of costs is slightly lower, the population still prefers the conventional technology due to the lower initial costs that this represents.

In terms of the costs of energy production from either the conventional energy sources or the solar water heaters, the previously mentioned technology is a lot cheaper in the long run than the first one. The maintenance cost of the solar water heaters is really low and there are no monthly costs that have to be considered since these units are installed because there are no operations costs. The only operational cost that has to be considered is the cost of installation of the solar water heater, which in Nicaragua is approximately of USD $ 30 per square meter. In comparison, the conventional energy sources do have monthly costs that need to be considered. The cost of electricity in Nicaragua is of, as can be seen in the following table:

	Costs of Electricity in Nicaragua (USD $)	**Average Costs of Electricity in LA&C**
Residential	0,137 per kWh	0,115 per kWh
Commercial	0,187 per kWh	
Industrial	0,101 per kWh	0,107 per kWh

Table 30: Costs of Electricity in Nicaragua and in Latin America and the Caribbean in 2010 (USD $)

The cost of natural gas, which is another common conventional energy source in Nicaragua for generating heated water, is USD $ 2.61 per gallon.

Taking into consideration the costs of the alternative and conventional energy costs, the time of recovery of the investment of a solar water heater is of 14 years, if an electric shower is not bought. If the life span of a solar water heater is between 20 o 25 years, in financial terms is beneficial to buy a solar water heater instead of an electric shower. Despite this cost-benefit analysis, the majority of the population still buys conventional energy technologies due to a lack of knowledge regarding the efficiency, cost and positive environmental impact that systems such as the solar water heating units implicate.

7.2.Economic and Financial Incentives:

7.2.1. ECONOMIC INCENTIVES

The economic incentives that the market of solar water heaters in Nicaragua has received are few. Currently, the only financing mechanism there is in Nicaragua is provided by the government. This entity only offers financing to the installation projects that are administrated and under the supervision of the Ministerio de Hacienda. This ministry grants loans to the projects which seek to install solar water heaters in Nicaragua. There are no other economic incentives that are granted to the solar water heating market.

7.3.Legal and Institutional Framework:

7.3.1. INSTITUTIONAL FRAMEWORK

At the government level, there is a slightly strong institutional framework in place, which has promoted the use of solar water heaters in Barbados.

- *Nicaraguan Energy Institute*: this institution is the regulating entity within the energy sector in this country. This entity also proposes, elaborates and assesses the policy makers in the energy sector regarding policies that need to be undertaken and

programs and projects that need to be carried out, especially those related with the demand and supply of energy, conservatorion of water, policies of prices, subsidies and related subjects.

- *Environmental Regulating Direction*: This direction woks under the umbrella of the Nicaraguan Energy Institute. This entity, aware of the need to protect the environment, it acts as the regulating entity which is always controlling if the laws, norms and others environmental standards are being respected. This branch of the Nicaraguan Energy Institute is always intervening in the execution in all the stages of a project: during the studies and assessment, it identifies and defines the environmental impacts that the project can have on the environment and vice versa, and it also identifies the measures that need to undertaken as a mitigation strategy; during the construction, its undertakes the role of a regulating entity by always doing a following up role to assure that the norms and rules are respected; during the operation of the technology, it regulates that the installations do not constitute any detrimental effect to the safety of the population living around the installation and to the environment; among other duties.
- *Ministry of Environment and Natural Resources (MARENA):* This institution is in charge of the conservation, protection of the environment and the sustainable use of natural resources. In order to reach such objectives, MARENA proposes, formulates, directs and supervises the *compliance of the national environmental policies and the sustainable use of natural resources.*
- *Ministry of Agriculture and Public Credit:* This entity grants several funding to the projects that seek the development of rural areas, agricultural industry and other initiative that pursue economic development and also have a positive environmental impact.
- *Ministry of Energy and Mines:* This institution elaborates, instates, conducts and promotes the energy and mining policies in the country, fomenting the development of this sector according to the criteria of sustainability, and verifies the compliance of the laws. Within this ministry, there is the Coordination of Renewable Energy and

Electricity, which is dedicated to fomenting the development of the alternative energy sources such as solar energy. One of the many projects seeking to foment the development of renewable energy is the EURO-SOLAR Project, which is an initiative that is carried out between this institution and the Cooperation of the Eruopean Commission (Europe-Aid), with the goal of promoting renewable energy and the human development of isolated rural communities which live under marginal socio-economic conditions where it is not viable to have access to the connection of electricity. Thus the project has the goal of installing solar systems to increase the education, health and the production levels of the isolated communities. Another major project undertaken by this entity has been the solar water heaters that were installed in the Lenin Fonseca Hospital. This project was undertaken with the objective to reduce approximately 25% of the costs that were directed to water heating with conventional energy technologies.

- *National Energy Commission:* It elaborates the strategic plans for the energy sector and the sub-sectors. It also promotes the sustainable development and the investment in the energy sector, thus guaranteeing the optimal and most efficient use of the natural energy resources.

At the private, organizational and civil society level, there is also a strong institutional framework in place, which has provided support throughout the years to the initiative of solar water heaters.

- *CMPL (Cleaner Production Centre of Nicaragua):* A non-profit organization, which promotes sustainable development in Nicaragua through the execution of innovative projects that would increase the productivity and competitiveness and it, would also have a positive environmental impact. One of the largest and most important projects carried out by this organization has been the NICATEC project, which was a project carried out between ONUDI and the CMPL organization. This project sought to increase sustainable productivity in the food industry, tourism, and metal mechanic in

Nicaragua through the development, application and installation of solar water heaters.

- *GrupoFenix:* A non-profit organization, which has as their main goals to research, develop and apply appropriate renewable energy technologies in Nicaragua. This organization seeks to contribute to the well-being of rural communities, by creating awareness through technical and cultural exchange, promotion and research in the field of renewable energy. Thus, this organization carries out several projects which promote the use of renewable energy and also solar energy with solar water heating panels. This organization also organizes courses throughout the year, with the objective to create knowledge and human capacity interested in the development of renewable energies in less developed countries.
- *Universidad Centroamericana (UCA):* The University has the Solar Station VADSTENA, which is currently undertaking several investigations regarding solar and wind sources of energy since 1983. In fact, the Solar Station VADSTENA has been the only entity which elaborated the solar map of the country, which has been used by several actors in the energy sector for the implementation of energy systems, arquitecture, ecology, climatology and other projects. This university also has the Environmental Quality Program (PCA), which has the objective to disseminate knowledge and create human capacity regarding environmental standards. That is why, this program has created several subprograms, which elaborate and teach courses regarding waste management, clean air, energy saving and water saving, and other topics.

7.3.2 LEGAL FRAMEWORK

The government of Nicaragua has undertaken very few laws that motivate and incentivize the market of renewable energy, especially the market of solar energy and water heating. Some of these laws are the following:

- *Decree No. 13-2004:* This decree approved in 2004, establishes that one of the principles of energy policy is to use in a strategic and priority manner the sources of

renewable energy within the national energy matrix; thus, the state compromises to assign the resources and necessary mechanisms to take advantage of these alternative energy sources. This decree also states that the government compromises to formulate and carry out National Energy Plans with the above-mentioned goal. It also states that the goal of the energy institutions is to promote stability in the costs of energy generation, through the greater use of renewable energies. It also states that the government should establish incentives to the investments that produce energy with reasonable costs, investments which seeks a diversified supply of energy sources and that also generate promote a clean environment. This decree also states that the government and the solar water heating market should work to promote the proposal and elaboration of laws which would establish incentives to the initiatives that seek to use alternative energy sources; it also states that the government should grant funding to the National Energy Commission so that this entity can carry out investigations regarding renewable energy in Nicaragua and thus obtain a broader knowledge regarding the potential of each technology and alternative energy source and in this way undertake the most adequate plan; and it also promotes a vision in the financing aspect which would recognize the opportunities that exist in the market and advantages in this sector.

- *Law No. 532 of 2005:* This law is the most important norm in the electric sector. It stipulates the regulating institutions in this sector, the standards that need to be met in this sector and the production plans, among others.Another important point in this law is that it mentions that one of the goals of this policy is to promote investment in renewable energy projects. That is why; it stipulates that for 10 years, since the publication of the law, the investors in renewable energy can have access to tributary benefits such as exemption to the customs duty to the imported machinery, equipment, materials, which are bought only for projects which promote the development of renewable energies.

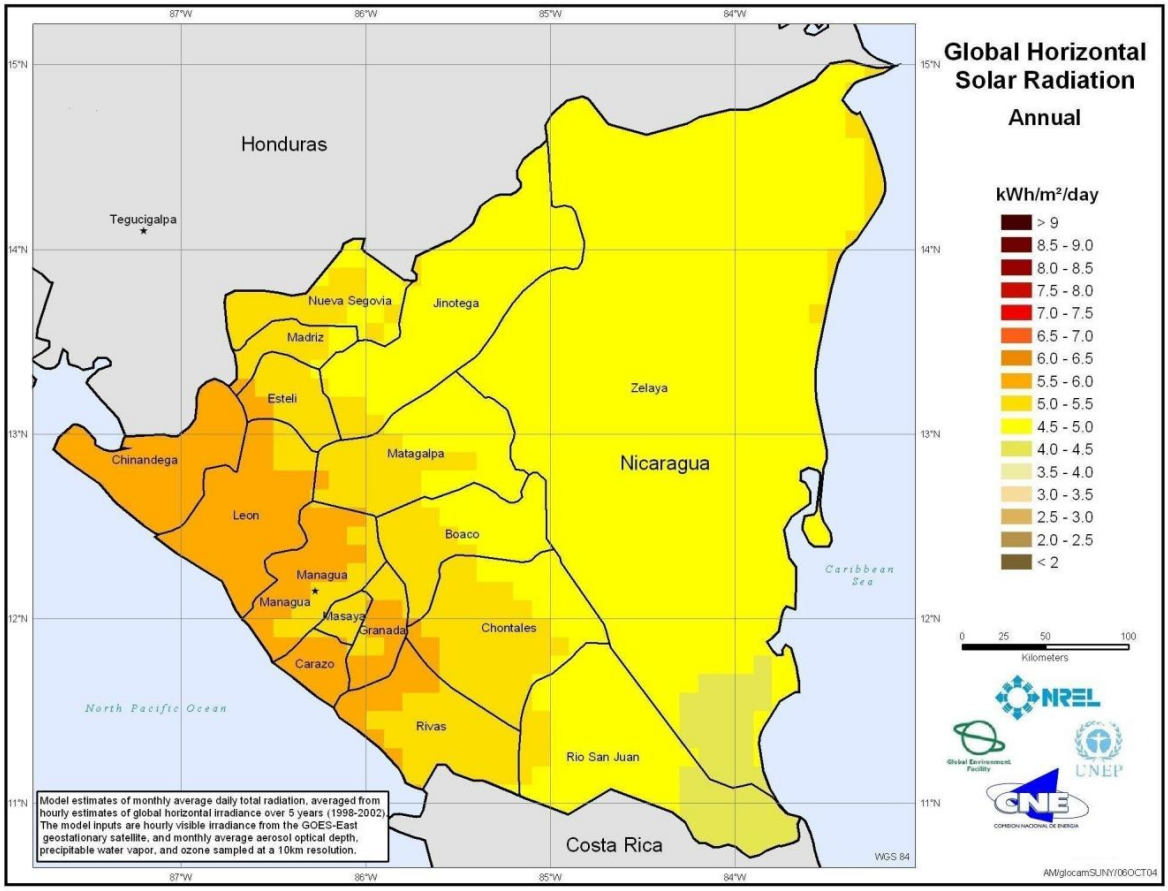
- *Law No. 217 of 1996:* This law seeks to promote programs and projects that are in accordance to the well-being of the environment; it does not specifically refer to solar energy and the use of solar water heaters.

7.4.Conclusions:

7.4.1. GAPS

7.4.1.1. Demand

- The demand is not strategically concentrated in the country areas where there are the greater levels of solar radiation.



Graph 8: Solar Radiation in Nicaragua (kWh/m2/day)

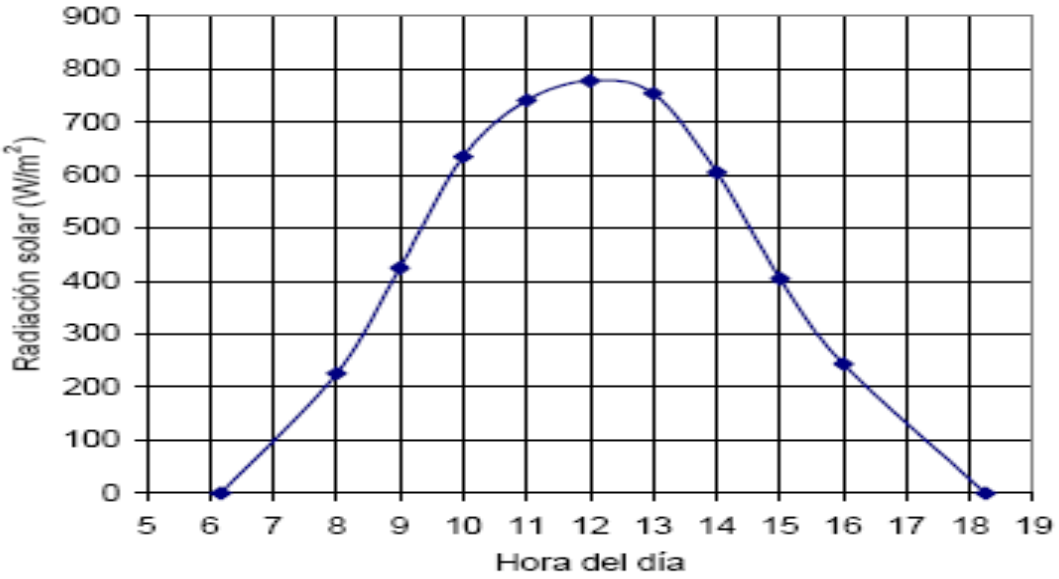
As can be seen from the graph above, the levels of solar radiation are located in Chinandega, Leon, Managua and Carazo. As mentioned before, the areas in Nicaragua are the urban zones and Estelí, Jinotega and Matagalpa.

- Moreover, the demand for solar water heaters is still extremely low. As mentioned before, there are approximately 15,000 solar water heaters installed in all Nicaragua. Thus, in a country where there is a population of 5,668,877, only 0.24% of the population has a solar water heater, which is an extremely low percentage.

- Nicaragua has not done a thorough investigation regarding the demand of solar water heaters. Only the NICATEC project is the only initiative undertaken in the country to gather information regarding the solar water heating market and thus provide adequate assessment to the policy makers in the energy sector. As a result of this lack of research, it is really hard to gather information regarding the demand patterns in Nicaragua regarding solar water heaters.

- The demand in Nicaragua is highly clustered in certain economic sectors of the country. As mentioned earlier, there is a great demand in the hotel, food industry and hospitals. However, there is lacking interest in strategic sectors such as households, where the demand can be incredibly high.

- Also, taking into consideration the extremely high levels of solar radiation there is Nicaragua and in Central America, the demand in this country is extremely and thus the government and the industry has not taken advantage of the comparative advantage this country possesses. In fact, Nicaragua is currently one of the countries that has the lower demand in regards to solar water heaters. The countries that advanced in taking advantage of this comparative advantage (the high solar radiation) are Costa Rica and Guatemala. As can be seen from the following graphs and tables, there are high levels of solar radiation in Nicaragua.



Graph 9: Solar Radiation (W/m2) throughout the day in Nicaragua

7.4.1.2. *Supply*

- There is an oligopoly in the solar water heating market considering that first, there are very few distributors of these units, and second because of the few companies there are, there is one that completely owns the market of Nicaragua: TECNOSOL. Since 1998, this distributor has installed more than 40,000 solar systems in Nicaragua (thermal and photovoltaic). This company is one of the biggest ones in installation of solar energy units; it has more than 17 offices all over Nicaragua and is the distributor that has the greatest amount of sales throughout the year of solar energy systems.

- The only company that has gone abroad and already has an office in another country is TECNOSOL. However, there has not been any international company that has sought to enter into the Nicaraguan market. Therefore, there has not been any exchange of

knowledge, human capacity, and best practices, among others. As it was concluded in the analysis of other countries, the merger of two companies has a positive impact on the market; creating greater competition, transferring knowledge, norms, certifications, human resource and others.

- Another major gap in the supply of solar water heaters is that there is no fabrication of these systems in Nicaragua. As investigated by NICATECH project, the costs o the solar water heaters that are imported from other countries where there are greater technological advancements are much lower than the ones fabricated in Nicaragua. On one hand, this can have a benefit to the consumers due to the low costs of these systems, thus reducing one important barrier that affects the level of penetration of these units into the market. On the other hand, this is also a barrier because it does not allow the national market to develop and thus fabricate national solar water heaters.

- Another major gap in the thermal solar water heater market in Nicaragua is the lack of labels such as the Qualisol label, which exists in Brazil. This label, which is attached to the solar water heating system provides information to the consumers and certifies great levels of quality installation. The certifications that have been recently elaborated under the NICATECH project do not inform the consumer if the norms are being respected by the designers and installation companies.

7.4.1.3. *Costs*

- Despite the low costs of the solar water heaters in Nicaragua, there are still several gaps that need to be addressed. As mentioned before, the costs of the conventional energy technologies are still lower than the cost of the solar water heaters in a significant manner. In countries like in Barbados, the conventional energy technologies have an extremely high cost of operation and also have a high initial cost, where the conventional energy sources have a consumption tax of almost 50% of the normal cost.

- Also, the costs of the solar water heaters for the medium and low income households are still extremely high considering that the PIB per capita in Nicaragua is of USD $ 1,201.11 and the average salary is of USD $ 75. Therefore, these systems are unaffordable for low and medium income households, the sectors where the demand can be greater.

7.4.1.4. *Economic Incentives*

- There is a lack of economic incentives in the solar water heating market in Nicaragua. The distributors have not received any sort of funding from the government or any other entity in order to start their business.

- Also, the consumers do not receive any sort of funding either to buy a solar water heater. In fact, in Nicaragua, if a consumer wants to buy a solar water heater there are no facilities granted by banks. The interest rate is the same to any type of loan, of 12 up to 15%.

7.4.1.5. *Financial Incentives*

- One of the biggest barriers in the solar water heating market is the lack of financial incentives. In Nicaragua, the government is granting subsidy to the photovoltaic solar panels and not for the solar water heating systems. That is the reason why the first mentioned technology is having a higher penetration rate in Nicaragua than the second mentioned technology. Financial incentives are primary and necessary for the development and the acceptance of a non-conventional technology in a country.

- Also, there is a lack of financial incentives to the consumer and to the distributor. First, the consumer does not receive any financial benefit for buying a solar water heater. For example, in other countries such as in Barbados, if the consumer buys a solar water heater, it can deduct the full cost of the unit from their taxes. Second, the distributors do

not receive any sort of benefit either from selling these units. For example, in other countries as in Barbados, distributors that import materials are not charged taxes. .

- Another major gap is the lack of subsidies for the thermal solar energy market. Instead, the government has benefited the conventional energies. Electricity is subsidized by the government. The subsidizers that consume greater amount of electricity pay higher tariffs to subsidize the low income consumers. In fact, the consumers that consume less than 150 kWh per month receive a transference from the other consumers and the consumers that consume less than 50 kWH per month are benefited of discounts of 45% up to 63% from their tariffs.

7.4.1.6. *Institutional Framework*

- There is a slightly strong institutional framework in Nicaragua, which encourages the development of renewable energy. However, one of the major gaps is that there is lack of institutions which are targeted and focused only to the development of solar thermal energy.

- At the civil society and university level, there is also a lack of research and project undertaking. One of the most important organizations has been the CMPL (Cleaner Production Centre of Nicaragua) and the University of Centroamerica (UCA). Besides these two entities, there is no other major institution which is committed to the development of thermal solar energy in Nicaragua.

- At the government level, there are several entities that have as one of their primary goal the development of renewable energy. However, none of these organizations is dedicated only to encouraging the development of thermal solar energy. Moreover, several of these entities have as part of their mission and vision of their institution the development of renewable energies; however, there are few projects and programs that are undertaken to promote the development of such alternative energy sources.

- Moreover, there is also a lack of greater interaction, integration and information exchange between the institutions that dedicate their resources to the development of renewable and solar energy. This is due to the lack of an existing platform, which can incentivize dialogue and coordination between several actors (NGO´s, government institutions, universities, laboratories, manufacturers and others). A lot of goals are set by the ministries and other government institutions; however, the entities do not work together to meet those standards set by the government.

7.4.1.7. *Legal Framework*

- One of the greater gaps in Nicaragua is the lack of a strong legal framework, which can incentivize and promote the development of thermal solar energy. As was seen, there are few laws that incentivize the development of renewable energies; but there are almost no laws that promote the development of thermal solar energy in Nicaragua.

- Also, there is a lack of laws that would regulate, control and set the standards that need to be met in the market of solar thermal energy and by the actors involved in this market, such as the distributors, consumers, etc.

- There is also a lack of laws which incentivize and promote the development of the solar water heating market on a greater scale. For example, in Brazil, there is a municipal law which indicates that all new buildings and houses need to have installed a solar water heater.

7.4.2. PRIORITIES FOR ACTION:

a) Stronger Legal Framework:

- There have to be more laws that would incentivize the development of the thermal solar energy market. A very good example of such law is the elaboration and implementation of laws that can encourage the development of such market as the municipal laws that were implemented in Brazil, which stipulated that all new buildings had to install a solar water heater.
- Also, a national policy should be elaborated and implemented such as the law of Rational and Efficient Use of Energy in Colombia, which under one of its decrees it disposes to promote the rational use of energy in the electric sector by using transformers and solar water heaters.
- Under the umbrella of such law, a program to incentivize the use of energy efficiency can be promoted, such as in Colombia with the PROURE. This program can focus on promoting development projects focused only on solar energy, considering that Nicaragua has a high solar radiation. In this way, greater housing development projects and others can be promoted, such as the ones in Colombia, which seek to install solar water heaters to new houses and the cost of the system becomes part of the cost of the house. Thus, the cost of the system becomes part of the loan provided for buying the house and the interest rate is low and the payment payback time is in long-term. In this manner, the cost of the solar water heating system is not felt by the consumer.

b) Economic and Financial Incentives:

- Also, laws that would provide economic and financial incentives should be approved, such as laws that would provide tax deduction

benefits to hotels, pools, hospitals and other commercial entities and industries, which install solar water heating systems.

c) Economic and Financial Incentives:

- Also, laws that would provide economic and financial incentives should be approved, such as laws that would provide tax deduction benefits to hotels, pools, hospitals and other commercial entities and industries, which install solar water heating systems.
- Also, under the umbrella of the national policy, which would seek to motivate the rational and efficient use of energy, a decree can mention that distributors should be incentivized through economic incentives, such as loans. These funds that would be administered by the Ministry of Energy and Mining would have a low interest rate and long term payment. These funds would be provided to new emerging distributors, which would seek to enter the market in order to tackle the oligopoly that currently exists in Nicaragua.

d) Institutional Framework:

- A strategic alliance or a platform for dialogue has to be incentivized between the private sector, government and civil society in order to share all the information and experience that is generated in every institution. In this manner, a comprehensive plan can be elaborated by these entities which would increase the demand rate. This alliance can be directed by the University of Centroamerica, which has a great amount of knowledge, the Ministry of Energy and Mining, which elaborates and implements policies and the TECNOSOL Company, which has the technological, installation knowledge. Through this alliance, information can be shared; policies and programs can be proposed. Moreover, a platform for dialogue can be created among these actors, which can have a direct and positive impact on the legal framework.

8. COUNTRY ASSESSMENT OF PERU

8.1. *Market of Solar Panels:*

8.1.1. DEMAND

In Peru, there is a small demand for solar water heaters. Currently, there is an annual demand of 3,000 solar water heaters of systems of cooper plates of 2 m2, average. It is estimated that today there are from 25,000 up to 30,000 thermal panels installed in Peru, the majority located in the city of Arequipa. Taking into consideration that the population in Peru is of 29,907,003, almost only 1% of the population has solar water heaters. Moreover, it is expected that the demand would keep on increasing in the next few years at a very low rate, 2%.

The demand in Peru is greater in certain regions of the country. As mentioned in the questionnaire, demand is greater in the urban areas of the country, such as in: in the Southern region, in the cities of Arequipa, Tacna, Moquega; in the Centre region, in the cities of Cusco, Puno, Huanacayo, Ica; in the Northern region, in the cities of Piura, Chiclayo, Trujillo, Cajamarca. A map of Peru is shown below, in order for the reader to locate in a better manner the cities that are mentioned in this report.

Graph 10: Map of Peru

The demand in the urban sectors is growing at a rate of 2%, while in the rural sectors the demand is not increasing at a significant rate.

Moreover, the demand in Peru is also greater in certain sectors of the economy. Thus, besides the demand of solar water heaters growing at a larger rate in the urban sector than in the

rural sector, the demand is also increasing at a larger rate in the residential, industry, tourism/hotels and pools sectors. In the residential sector, the demand is increasing at a 2% rate, in the industry it is increasing at a 1.5% rate, in tourism and hotels the demand is increasing at a 4% (the largest increase), at pools the demand is increasing at a 2% rate. In the rest of the economic sectors such as hospitals and agro-industry, the increasing demand rate is very low, in the former the increasing rate is of 0,5% and in the latter the increasing rate is of 1%. Thus, as it can be concluded from this analysis, the demand for solar water heaters is mostly concentrated in certain sectors of the economy.

8.1.2. SUPPLY

In Peru, despite the small demand for solar water heaters, there is a strong supply structure. Currently, there are several fabricators and distributors of solar water heaters in Peru. Some of these fabricators are outlined in table 1.

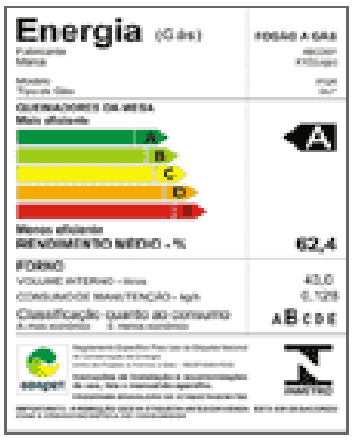
Fabricators	***Distributors***
TRANSSEN PERU SAC	BRYANT
TERMOINOX SAC	SOLE
	BRASEC
	TINSELEC

Table 31: List of fabricators and distributors of solar water heaters in Peru.

TRANSSEN PERU SAC recently became a multinational company, originally a Brazilian company which later opened its doors in Peru and later in Chile, considering the high returning rate of investment that the Brazilian company foresaw in these two countries. This joint-venture in Peru between Transsen Brazil and Termoinox (a Peruvian solar energy specialist), will turn into a success story in Peru considering the technology and knowledge transfer there would be from a Brazilian based-company to Peru. Moreover, besides the several fabricators and distributors of solar water heaters there are in Peru, the supply side has a strong structure considering that it also has the advantage of fabricating its own thermal panels. As has been observed in other Latin American and Caribbean countries, the solar collectors are in its majority imported from the United States, China and Europe considering that there is not enough market

incentive and technological knowledge to have nationally fabricated solar panels. In Peru, approximately 4,000 thermal solar panels are fabricated annually, without considering the small enterprises that work without abiding normatives or regulations, which accounts for another 1,000 fabricated solar water heaters. Therefore, annually there is a total of 5,000 solar water heaters fabricated in Peru, which is a large number considering the recent boom that this market has had in this country.

In Peru, the technical efficiency and technological advancement is considered to be in a high standard. When the Project for Energy Saving (PAE) was created in 1994 under the umbrella of the Minister of Energy and Mines in Peru, with the objective of facing the potential energy deficit of 100MW due to a lack of supply in the Interconnected Centre-North System (SICN), there was the need to advance technologically in the alternative sources of energy. That is how, since then, technical efficiency of the solar water heated systems has increased, especially of those for the residential sector. Moreover, in 1998 the supply market felt another pressure to increase the technical efficiency of the SWH when another phase of PAE was approved due to a lack of energy supply in the South Interconnected System (SIS). That is how Peru has become highly technological in these systems and that is why in 2001, Peru provided support to Ecuador in the implementation of programs similar to PAE, in order to increase technical efficiency in this country. Moreover, as a result of the Law 27345 (Promotion of Efficient Use of Energy), several technical norms have been developed since 2000 through the INDECOPI regarding lighting, industrial boilers, refrigeration, solar systems and most importantly regarding water heaters. Minimum standards have been established for solar systems and wind energy systems for households, according to the Multi-sectorial Program of Energy Efficiency, which the Ministry of Energy and Mining elaborated in conjunction with the Ministry of Housing, Construction and Sanitation. As a result of this, a similar program was established in Peru as the Labeling Program that exists in Brazil, as can be seen in the following graph.



Graph11: Technical Efficiency Label in Peru as a result of the Project for Energy Saving

In this way, the Ministries have managed to increase technical efficiency, consumer satisfaction and thus motivate in a more intensive manner the market of thermal solar panels.

As a result of the high technological standards of the solar water heating systems and the over-production there is in the country, several of the nationally fabricated solar panels are exported. Roughly 40% of the solar panels are exported to several countries, such as Chile, Ecuador, Argentina and Bolivia. In numbers, a total of 3,000 – 4,000 solar water heaters are exported every year.

In Peru, there are also several imported solar water heaters that mostly come from China and European countries. Approximately, 2,000 solar water heating panels are imported every year.

8.1.3. COSTS

In Peru, natural gas and electricity are still the norm due to the costs of solar water heaters. In 2006, the cost of electricity for the residential sector was of 0.1046 US $ per kWh and the average cost of electricity in Latin American and the Caribbean in 2005 was of 0.115 US $ per kWh. In the unregulated market, the average tariff is of 0.0550 US $ per kWh. Despite the low cost of electricity in Peru, there is also a high subsidy granted by the government to the electricity consumers. In 2001, Law No. 275.010 created the Social Electric Compensation Fund

(FOSE), which established a system of subsidy for consumers that have a monthly consumption of 30 kWh up to 100 kWh receive a fixed discount and for consumers that have a monthly consumption below 30 kWh receive a proportional subsidy. The number of homes that benefit from this subsidization is superior than 2,4 million (out of the 3,6 millions of homes that are connected to the inter-connected national system). Thus, taking into consideration that more than 67% of the households receive electricity subsidization and the price of electricity is lower in Peru than in other Latin American and Caribbean countries, consumers do not have the incentive to switch their energy source from conventional to solar energy sources. Moreover, the cost of natural gas is also extremely low. For the ones that consume up to 300 m3/month, the price varies from USD $ 1- USD $ 2. It is important to mention that the price of natural gas varies according to the consumption and the distribution service. In Annex B, you can find in more detail the prices of natural gas in Peru. Moreover, the price of natural liquefied petroleum gas is also very low. Currently, for 10 kg of GLP, the price is 30 Nuevos Soles, which corresponds to USD $ 10.

Another factor that is very important in the decision-making of every consumer whether to use conventional sources of energy or solar energy for water heating is the cost of investment of the solar panel. In Peru, the costs of the most used thermal solar panels are indicated below:

Graph 12: Type of solar panel (empty tube), which costs approximately US $ 1,900 without the tank.

Graph 13: Type of solar panel (flat plate), which costs approximately US $ 200 without the tank.

While, this type of solar panel (flat plate) costs approximately US $ 200. It is important to mention that the price of the tank is not included in these costs. If the tank is included, the price range varies from US $ 800 until US $ 2,000 depending on the tank and square meters of the solar water heater. Therefore, as can be seen, the costs of the solar water heaters in Peru are high.

8.2. *Economic and Financial Incentives*

8.2.1. ECONOMIC INCENTIVES

The economic incentives that are granted to consumers and fabricators to use are very few. In the case of the consumers, the only economic incentive that consumers receive is the warranty that private companies provide them. In average, the warranty is of 5 years for these type of systems. Moreover, there is no other financial mechanism for consumers if they buy solar water heaters, rather than the regular granted by private banks. Currently, the interest rate in Peru for personal investments is of 25.3% if the loan of US $ 10,000 is paid in 12 months. With such high interest rates and no mechanism which would alleviate the high initial costs, consumers see no incentive to buy these systems. In the case of the fabricators, there are no economic incentives either.

8.3. *Institutional and Legal Framework*

8.3.1. INSTITUTIONAL FRAMEWORK

In Peru, there is a slightly strong institutional framework which can be a major pillar for the development of the solar water heating market. At the government level, there are several institutions that dedicate their time to sustainable environmental development, renewable energies and thus solar energy.

- *Ministry of Energy and Mining (MEM)*, which is the main entity within the energy sector. It formulates and evaluates the national energy policies. It also promotes the development of energy activities which seek to promote the use of energy in a more efficient manner and which promotes the use of natural sources as a source of energy.
- *General Coordination of Electricity (DGE)* which is under the umbrella of the MEM, and which proposes and evaluates policies that are related with the electricity sector. It has lead several programs to promote the rational use of energy, by incentivizing the use of renewable energies.

- *Vice-ministry of Energy*, which is under the umbrella of the Ministry of Energy and Mining (MEM). This entity directs, coordinates and supervises several projects of promotion and dissemination of renewable energies.
- *General Coordination of Rural Electrification (DGER),* which is under the umbrella of MEM. This entity promotes and executes several programs of renewable energies in rural areas of the country.

At the civil society level, there is also a slightly strong institutional framework.

- *Conservation Centre of Energy and Environment (CENERGIA),* which is a non-profit organization which was created in 1985 by the Ministry of Energy and Mines to promote the rational use of energy among the population of Peru. This objective has been accomplished by doing several investigations and implementing several projects of energy efficiency.
- *Peruvian Association of Solar Energy and the Environment (APES),* which promotes the use of renewable energies and the efficient use of energy. APES is a non-profit organization which gathers public and private institutions and several actors involved in this sector.
- *National University of Engineering* in which there is the Centre of Renewable Energies and Rational Use of Energy (CER).
- *Catholic Pontific University of Peru,* in which there is a group that dedicates its time to the research of renewable energies, especially solar energy. Moreover, there is a special course on solar energy (thermal and photovoltaic).
- *National University of San Agustin,* in which there a B.A. in Environmental Enginnering and a Masters Degree in Science and Economics, which is focused on the Regional and Environmental Development.
- *National University of Cajamarca,* in which there is the complete program (B.A., M.S.c. and P.H.D.) of Environmental Enginnerig and Renewable Energies.
- *Termoinox fabricating company of Peru*, also has a group of scientists who dedicate their time to investigation and development (I&D) of solar energy products. These

staff currently has several engineers and technical professional. It is constantly investigating, innovating and testing the efficiency of the already existing solar thermal products in its laboratory.

8.3.2. LEGAL FRAMEWORK

Peru also has a slightly strong legal framework, which can be the main pillar and promoter of solar energy within the country.

- *Law that Promotes the Rational Use of Energy (No. 27345)*, which was approved in September 2000. This law is one of the main regulations for the solar water heating market in Peru. It declares of national interest the rational and efficient use of energy, it seeks to protect the consumer, promote competitiveness in the national economy and reduce the negative environmental impact cause by the consumption of conventional energies.
- *Legislative Decree 1002 of 2008,* which seeks to promote the investment in renewable energies to generate electricity. This decree promotes the use of alternative energy sources (biomass, wind, solar, geothermal, and others when it does not exceeds 20 MW) to generate electricity by establishing the goal of reaching up to 5% of the energy consumption of renewable energies.
- *Law 28749 of 2006,* which seeks to develop renewable energies (solar, wind, geothermal and biomass) in the rural areas to provide these marginalized sectors of the population with electricity and energy.
- *Decree No. 053 of 2007*, which seeks to promote the rational and efficient use of energy.
- *Decree No. 034 of 2008,* which dedicates several measures for energy saving in the public sector and among these one of the measure for energy saving was installing solar water heaters in the public buildings.

Besides these laws and decrees there are also several programs, policies and plans which act as a major driver for the development of this sector. There is the Alignment of Long-term Policies

for the Energy Sector Plan, which is carried by the MEM. This plan proposes several plans and actions to take advantage of the renewable energy sources of the country. There is also the Referential Plan for the Efficient Use of Energy 2009-2018, which is led by the MEM. This plan establishes the goal of reaching a 15% of energy saving in the residential, productive, services, public and transport sector. It also establishes the goal of substituting: 1 million traditional kitchens; 100,000 electric heaters with solar water heaters; 30,000 electric engines; and others.

8.4. *Conclusions:*

8.4.1. GAPS

8.4.1.1. Demand

- After analyzing in a thoroughly manner the demand for solar water heaters in Peru, there are several gaps. The demand in this country is extremely low. As mentioned earlier, only 30,000 solar water heaters are installed, which means that roughly 1% of the population has one of these systems. Moreover, it is expected that demand will on increasing at a rate of 2% every year. This increasing demand rate is extremely low if it is compared to other increasing demand rates in other countries, such as in Barbados and Brazil.

- Another downside of the demand of solar water heaters in Peru is that demand is highly clustered in certain regions of the country and in certain economic sectors. As mentioned earlier, the demand is concentrated in the urban areas in certain cities of Peru (Southern region: cities of Arequipa, Tacna, Moquega; Centre region, in the cities of Cusco, Puno, Huanacayo, Ica; Northern region, in the cities of Piura, Chiclayo, Trujillo, Cajamarca). Also, the demand is highly clustered in certain sectors of the economy. As mentioned earlier, the demand is growing at larger rate in the tourism and hotel sector, pools and in the residential sector.

8.4.1.2. *Supply*

- Despite the supply side of solar water heaters is highly strong and there are several fabricators and distributors, there are still several gaps that need to be addressed in this market. There are still several solar water heaters that are imported from countries such as the United States, China and Europe. These solar water heaters with their higher technology and similar prices, are causing detrimental effects on the national fabricators considering that the imported systems are most of the time preferred over the nationally fabricated systems and thus sales of the nationally fabricated systems are significantly reduced. On the other hand, the imported systems also produce a positive effect on the national market considering that national fabricators in order to compete with the imported systems are forced to innovate, reach higher technological efficiency and reduce costs of the solar water heating systems due to the competition caused by imported systems.

- Moreover, despite the several technology efficiency that Peru has reached due to the PAE and the Promotion of Efficient Use of Energy Program there are still several gaps that need to be addressed. As in Brazil, there is no label and certifications which considers the collectors´ quality issues, such as durability, quality of materials, glass resistance, etc. It is therefore possible for a manufacturer to receive an A label simply by reducing the thickness of the glass cover, hence increasing transmission levels. Therefore, the possible instability of the collector, however, is not taken into account. As a result, it would be essential to create another certification label which would acknowledge the other standards that are necessary for a solar water heating system. Some of these shortcomings of the PBE labeling programme may be corrected through a new Brazilian standard very similar to European ones, NBR 15 547, which is expected to come into force in 2011.

8.4.1.3. *Costs*

- Until now, the use of natural gas and electricity are still the norm within the country in order to produce heated water instead of using solar water heaters. This norm has maintained throughout the years due to the low prices of the conventional energy sources and the high costs of the solar water heaters. As mentioned earlier, the cost of electricity for the residential sector is lower than the average cost of electricity in all Latin America. Moreover, despite this low cost, the low income sectors also receive subsidization for the cost of electricity. As mentioned earlier, more than 67% of the households have the benefit of receiving subsidized electricity. Also, the cost of natural gas is extremely low. These prices of conventional energies in relation to the initial cost of a solar thermal panel which costs approximately from $ 800 - $ 2,000, are from a cost analysis more appealing to the consumers.

- In Peru, as in Barbados there is no consumption tax on conventional energy sources. In Barbados, the government implemented a 50% consumption tax on electricity in order to reduce the use of this energy sources and incentivize the population to use solar water heating panels.

- Moreover, in Peru, the government is giving preference to the conventional energy sources by subsidizing the electricity. In other countries, such as in Barbados and Brazil, the cost of electricity is usually increased and is not subsidized in order to not promote the use of this conventional energy sources. This subsidy is one of the major barriers for the market of solar water heating in Peru.

8.4.1.4. *Economic Incentives:*

- In Peru, there is a major lack of economic incentives. The only economic incentive that consumers receive is the warranty that is granted by the producers. Besides this, there is no other economic incentives which motivates consumers to buy a solar water heater. As mentioned earlier, there is no low interest rate and long term payment loan. Currently, the regular bank loans grant these funds with an interest rate of 25.3% for a USD $ 10,000 loan which has to be paid in 12 months. Therefore, for the consumers it is not profitable to buy a solar water heater.

- Moreover, throughout the years and currently there hasn´t been any economic incentive for the national fabricators. In Barbados for example, the national fabricators received several funds to start their business of solar thermal collectors. This had an extremely positive impact, resulting in the opening of the Solar Dynamics company, which is one of the leading companies in Barbados and in Latin America and the Caribbean. Thus, if a new manufacturing company would want to enter the market, it has no incentives and no financial mechanisms because as mentioned before the interest rates are too high.

8.4.1.5. *Financial Incentives:*

- In Peru, there are no financial incentives for the solar water heating market. There is no subsidy received from the government to incentivize the consumer to use this green energy; there is no deduction of taxes to consumers who buy the solar panel system for water heating and there is no reduction of tariffs to imported solar water heating systems. Thus, the initial cost of these systems is considered high among the population.

8.4.1.6. *Institutional Framework:*

- In Peru, as mentioned earlier, at the government level, there is a slightly strong institutional framework. There are a few institutions that motivate and thus engage in projects and programs and elaborate and implements policies that incentivize the rational use of energy, such as the General Coordination of Electricity and the General Coordination of Rural Electrification. However, there is a lack of leadership of an institution, which would incentivize the development of solar energy and thus of solar water heaters. Most of the institutions dedicate their resources in general to renewable energies and not specifically to solar energy.

- Moreover, at the civil society level, there are very few organizations that either implement programs to incentivize the development of energy efficiency and thus solar thermal energy. These organizations also, have not become major actors in the development of solar thermal energy. At the university level, there are very few universities which dedicate their time and resources to investigations, teaching about renewable energies, especially solar energy and thermal solar panels. Therefore, besides existing few institutions at the civil society level, these entities also need to be strengthen within in order to cause a greater impact on the development of the thermal solar panel market.

- Another major gap that can be concluded in the solar thermal panel market is the lack of interaction and information exchange there is between institutions and actors involved in the solar water heating market. The only organization that is dedicated to this type of integration is the Peruvian Association of Solar Energy and the Environment (APES). Moreover, there are very few events and spaces for dialogue and negotiation created by this organization.

Only one time per year, there is a symposium on solar energy, which is organized by APES. There should be greater amounts of symposiums in Peru which deal with the topic of solar thermal energy, its programs, policies, norms, etc. Also, there is only one existing platform for communication, dialogue and negotiation, which is this symposium organized by APES every year. There is no other type of platform which incentivizes dialogue and information exchange, like through an internet web page, conferences, courses, etc.

8.4.1.7. *Legal Framework:*

- In Peru, the legal framework is really weak. Currently, there are very few laws that promote the use of solar thermal panels. For example, there are no laws that establish economic and financial incentive for this sector. Also, there is a lacking legal framework which can regulate, control, organize and incentivize this market.

- Also, there is lacking law as in Brazil which states that all new buildings need to install a solar water heater. No city in Peru has elaborated and considered the implementation of this law. As mentioned earlier, the legal framework is one of the main pillars for the development of this market. Thus, in order to incentivize its development, the legal framework has to be stronger.

8.4.2. PRIORITIES FOR ACTION:

a) The costs of conventional energy sources need to reduce in order to provide the consumers an incentive to switch from the use of electricity and natural gas to thermal solar panels. This can be changed by implementing a consumption tax, as in Barbados, on electricity and natural gas. This

consumption tax can be of 50% as in Barbados. Also, in order to decrease the costs of the thermal water heating panels, the imported materials needed to fabricate a solar panel can be tax exempted, as in Barbados.

b) The market of nationally fabricated solar water heating systems in Peru has to be incentivized. This can be done through public and private policies. For example, a private policy can be the implementation of ´green policies´ under the strategy of Corporate Social Responsibility (CSR). Thus, private companies, which already have implemented this strategic management model can dedicate more of their resources to environmental projects, such as the promotion of solar water heaters. Thus, private companies can buy nationally fabricated solar water heaters and install these in low-income households as a development project. Also, public policies that can be undertaken can be such those similar as the ones in Brazil. As mentioned before, it is now in certain cities it is now obligatory to install solar water heating panels. By implementing this policy, the national fabricators will be forced to increase technological efficiency, will reduce costs of these systems due to greater demand and thus the national fabricated systems will override and will be preferred over the imported systems. Also, an import tariff can be implemented in imported systems in order to make these systems more costly than the nationally fabricated ones.

c) A third priority for action is to strengthen the already existing institutional and legal framework by performing more projects, promoting the development of more laws, and gathering and disseminating more information.

9. LESSONS LEARNED FROM THE SIX SELECTED COUNTRIES:

One of the most important barriers in the development of the thermal solar water heating market in Latin America and the Caribbean is the lack of a strong legal and political framework. In several countries, the legal framework for renewable energies has been elaborated and implemented recently and therefore the framework is still weak and not yet holistic and integral. Most of the laws focus greatly in encouraging only the development of certain renewable energies, such as wind energy, bio-fuel, hydroelectricity, geothermal energy and solar energy for generating electricity. Thus, there is lack of laws which incentivize the penetration and commercialization of thermal solar panels for water heating in the Latin American and Caribbean market. Moreover, the laws that have been elaborated recently are very general and do not establish and set certain specific and clear standards, goals to be met, procedures to be followed and a comprehensible roadmap to be followed by policy makers, suppliers, consumers and other important actors in the sector.

As a result of the lack of a strong political and legal framework, there is an important regulatory barrier that faces the solar water heating market in Latin America and the Carribean. There is lack of a legal framework which can regulate, control, and organize this market. Thus, there is a lack of norms, standards and certifications that would determine the customs and regulations that need met in the case of, for example, fabricating solar thermal panels or at the moment of installation of such systems. In very few countries in the region there are such technical norms, the only two countries of the six analyzed countries where there are such norms are Brazil and Peru, despite the fact that there are still some certifications and norms that are missing. However, in other countries in the region as in Nicaragua, Peru and Colombia, there are no no technical norms that would determine the quality levels that need to deliver the solar thermal panels, such as guaranteeing a certain temperature of the heated water, the levels of solar radiation that is captured by the panel or the time that it takes to heat the water. Also, in other countries, there is lack of norms that would certify the standards that need to be met during the installation of the solar systems, such as guaranteeing the installation in the best location of the

residence or any other building. As a result of this lack of norms and standards in most of the countries, the quality and efficiency of the thermal solar panel is very low and the installations are also not done in an appropriate and in the most efficient manner.

A weak institutional framework has also been the one of the major barriers in the development of the thermal solar energy market in Latin America and the Caribbean. In fact, institutions are a main pillar and actor in the transforming and strengthening process of the market of alternative energy sources. Institutions stipulate the norms and rules regulating interactions between actors and the value base of various segments in society. The roles of institutions vary; some influence connectivity in the system whereas others influence the incentive structure or the structure of demand. Despite this eminent role of institutions in the development of solar thermal energy in the region, there is a weak institutional framework. From the six countries analyzed in this report, in the only countries where there are strong institutional frameworks are Argentina and Brazil at the government and civil society level. However, in the other countries (Nicaragua, Colombia, Peru and Barbados), there are lacking leading entities at the government level which can facilitate in a greater manner the development of the thermal solar energy market. Moreover, in the six countries there is a lack of greater interaction, integration and information exchange between the several institutions that work in programs and/or elaborate policies and/or dedicate to doing research regarding the thermal solar energy market. In addition, as mentioned previously, the institutional framework in these six countries is also weak considering that there is not one entity that dedicates only to the development of thermal solar energy at the government level. At the government level there are only institutions that dedicate in general to the development of renewable energies. However, at the civil society levels, in countries like Brazil, Argentina, Colombia, Barbados and Peru there are several institutions that dedicate to the development of the solar water heating market.

Another major barrier in the thermal solar energy market are economical and financial. In only few countries out of the six that were analyzed in this report, there are few economic and financial incentives for the development of solar panel market for water heating. Barbados and Brazil are the countries that have the greater amount of incentives for the consumers and

fabricators. However, in the other countries, like Argentina, Colombia, Nicaragua and Peru there are either almost none or no incentives at all. This lack of benefits that are granted and which promote the development of this market are highly related to the development of the institutional and legal framework. In countries like Brazil and Barbados where these support frameworks are developed, there are several economic and financial incentives. However, in countries where these frameworks are weak like Colombia, Nicaragua and Peru, then there are no incentives or there are very few.

Another major barrier in the development of the solar water heating market are the costs of the conventional and alternative energy sources. . In the case of thermal solar panels, the costs are high compared to the investment costs of conventional energy technologies. For example, an electric shower, or electric thermostat, or gas heater, or gas thermostat are a lot less expensive than a thermal solar panel. The only benefit of the previously mentioned technology is that there are no operational costs, or if there are, these are extremely low; whereas the operational costs of the conventional energy technologies are higher. If the two types of energy technologies, conventional vs. solar thermal energy, in the majority of the countries it is not beneficial financially for a consumer to buy a solar water heater considering that the lifetime of the solar panel is shorter than the return time of the investment. Therefore, from only a financial point of view, it is profitable for a consumer to buy a solar panel. Third, in the majority of the countries there are no financial and economic incentives granted to the consumers and fabricators of these thermal solar technologies. For example, only in some countries like in Barbados consumers have the benefit of deducting the total cost of the solar water heater from their taxes; however in the rest of the countries of Latin America and the Caribbean, there are no such benefits. In the case of the fabricators, only in countries like in Barbados, entities granted loans to the companies that wanted to start their business in he fabrication of thermal solar panels; however, other countries in the region have not undertaken similar initiatives. Fourth, the conventional energy sources for water heating are still subsidized in the majority of the countries and that is a crucial incentive for consumers to not use alternative energy sources.

Another important factor in this market is the technical barrier. First, there is not enough human and technical local capacity with the specific knowledge on the subject matter. In most of the countries, there is a lack of local human and technical knowledge considering that in previous years the subject of renewable energy and solar energy was not highly demanded by the market and that is the population did not prepare sufficiently in this subject matter. Recently, in the last few years there has been a greater preparation on this subject; but still there is a long road ahead. As a result of this, in most of the countries in the region there is a limited technical and human capacity to design and develop projects and initiatives that would encourage the development of the thermal solar energy market. As a result of this important gap in Latin America and the Caribbean, there is lack of innovation within the market and thus competitiveness, which directly causes a decrease in the demand. Moreover, there is an important lack of this local human and technological capacity due to the few capacitating institutions that can educate regarding the installation, fabrication and maintenance of solar thermal panels. In Europe, there are several of these institutions which grant the opportunity to interested people to take short and effective courses, regarding these important issues. However, in Latin America there are no such insitutions. Only at the university level there are

Another important barrier in this market is the lack of technology and knowledge transfer between countries in the region. There is an important and crucial gap between countries that have a more advanced solar thermal market and countries that have a very stagnant market. Countries like Brazil, Barbados, Chile and Mexico have advanced markets, whereas countries like Nicaragua, Peru, Colombia and Argentina are still markets that are starting to grow and strengthen. Although this may be a disadvantage to the overall development of the region, this may also be an advantage for the less developed markets considering that these can take benefit and gain from the knowledge and technology created in other countries through the transferring of such inputs. In despite of this, such technology and knowledge transfer has not occurred. The only country that benefited from such process was Peru, due to the joint venture of a Brazilian company and a Peruvian fabricating company, from which the country that benefited from this process was Peru due to all the knowledge and high technological efficiency that Brazil has created throughout these last few years.

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