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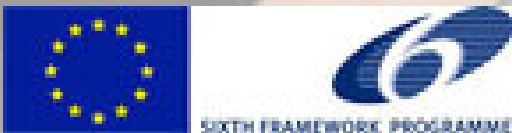
## Solar Thermal Energy

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In ARGENTINA

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Project financed by



The TECH4CDM project, developed over 2008 and 2009, and financed by the European Union under the Sixth Framework Programme of R&D, has as its primary goal, the promotion of renewable and efficient energy technologies, paying special attention to overcoming technological barriers, as well as the analysis of the Clean Development Mechanisms (CDM) of the Kyoto Protocol that may assist in projects based on wind energy, cogeneration, solar thermal and rural electrification through renewable energies.

Both European and Latin American institutions participate in the project, which is coordinated by the Spanish Institute for Energy Diversification and Saving (IDAE). The technological partners participating in the project include: the European Photovoltaic Industry Association (EPIA), the Spanish Wind Energy Association (AEE) and the Solar Thermal Industry Association (ASIT). In the case of cogeneration, the participation of COGEN Spain is essential, as well as that of the Spanish Office for Climate Change (OECC) for the part related to the CDM.

The 5 countries where the project activities are being carried out are Argentina, Chile, Ecuador, Mexico and Peru, and in each of these, local partners contribute, assuring the maximum use of these collaborating forces. Participating entities include: the Secretariat of Energy and the Industrial Union of Argentina, the National Energy Commission (CNE) of Chile, the Ministry of Electricity and Renewable Energy (MEER) of Ecuador, the National Commission for the Efficient Use of Energy (CONUEE) of Mexico and the Centre for Energy Conservation and Environment (CENERGIA) of Peru.

Project activities include the completion of a series of studies of the technologies situation in each country. This document summarizes the main features.

More information at [www.tech4cdm.com](http://www.tech4cdm.com)

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## 1. ARGENTINA

Most relevant information of Argentina is shown on the next table:

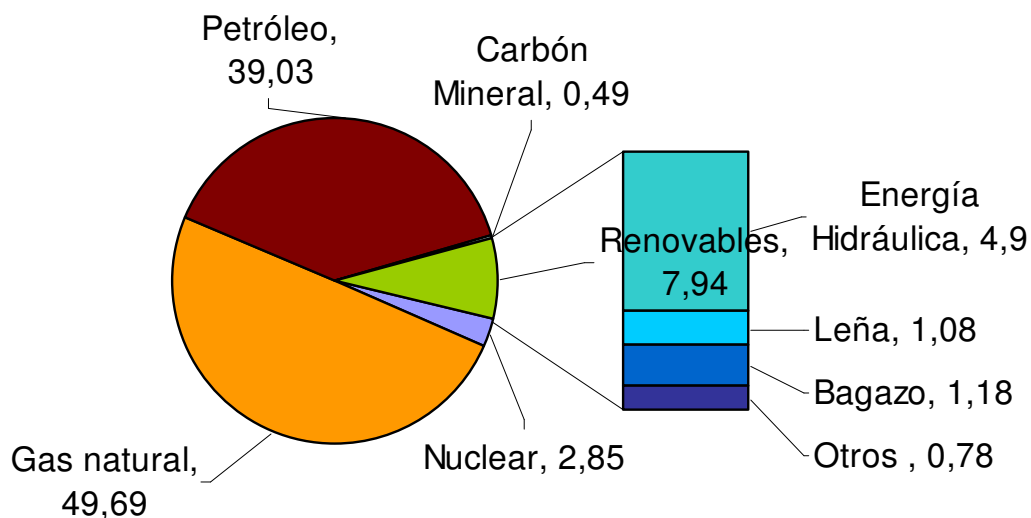
ARGENTINA	2000	2005	2007	2008
<b>General Data</b>				
Population, total (millions)	36,90	38,75	39,50	39,88
Population growth (annual %)	1,1	1,0	0,9	0,9
Surface area (sq. km) (thousands)	2.780,4	2.780,4	2.780,4	2.780,4
<b>Energy and Environment</b>				
Energy use (kg of oil equivalent per capita)	1.678	1.639	..	..
CO2 emissions (metric tons per capita)	3,7	3,9	..	..
Electric power consumption (kWh per capita)	2.087	2.418	..	..
<b>Economy</b>				
GDP (current US\$) (billions)	284,20	183,19	262,45	328,38
Agriculture, value added (% of GDP)	5	9	9	..
Industry, value added (% of GDP)	28	36	34	..
Services, etc., value added (% of GDP)	67	55	57	..
GDP growth (annual %)	-0,8	9,2	8,7	7,0
Inflation, GDP deflator (annual %)	1,0	8,8	14,2	19,5
Exports of goods and services (% of GDP)	10.418	5.265	6.462	..
Imports of goods and services (% of GDP)	53	98	82	..
Foreign direct investment, net inflows (BoP, current US\$) (millions)	284,20	183,19	262,45	328,38

Argentinean information (Source: World Bank).

## 2. ARGENTINE ENERGY CONTEXT

The ratio in percentages of the domestic primary energy supply for 2006 by energy type is shown in the following graph:

**Oferta interna de energía primaria, 2006 (%)**

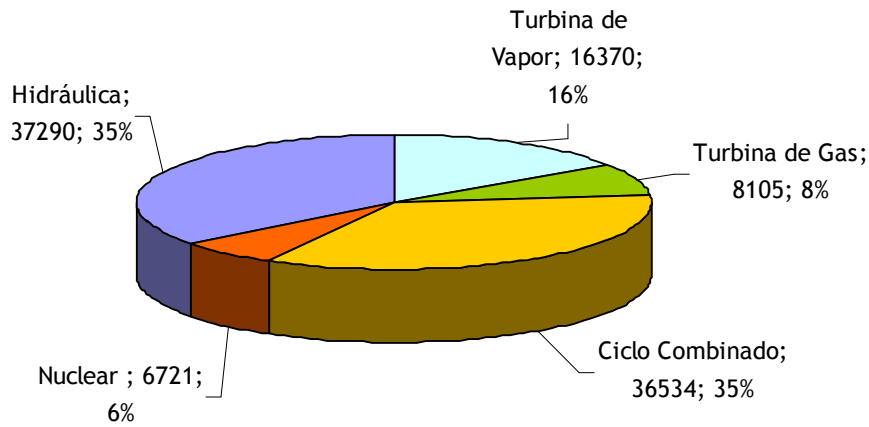


Domestic primary energy supply in 2006 (Source: Ministry of Energy)

The share of fossil fuels in the Argentine energy matrix is some 90%, with natural gas having nearly a 50% share and oil 40%. Only 8% of the share corresponds to the use of energies from renewable sources.

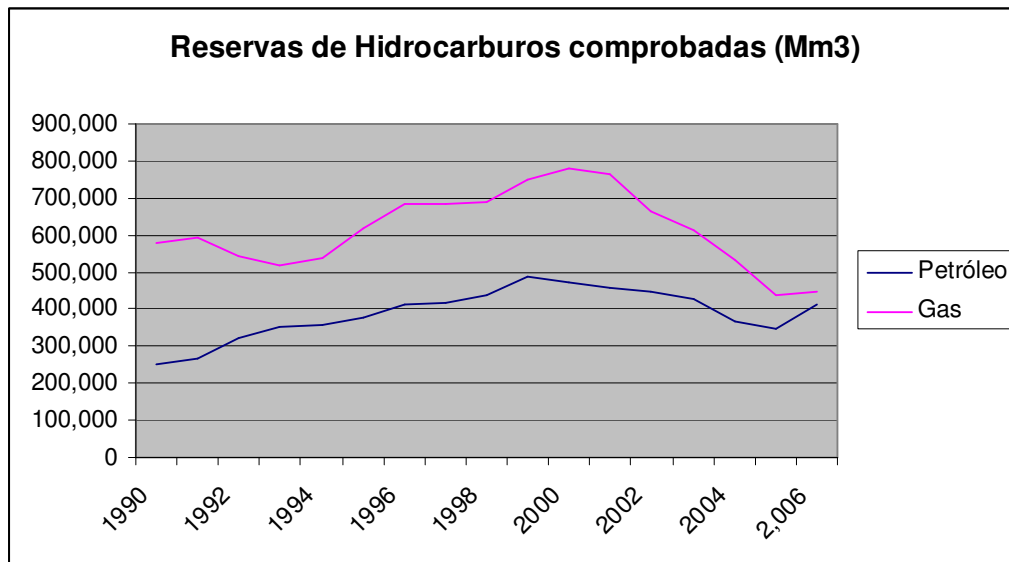
An analysis of the production of power shows that nearly 60% of electricity originates from conventional thermal systems: gas turbines, steam turbines or combined cycles. Renewable energies represented a significant share – 35% of the production – thanks to hydropower generation. Although not included in the figure below, there is a small share of wind and photovoltaic energy (31 MW and 10 MW of installed power, respectively).

**Energía eléctrica generada, GWh (2007)**



Power generation in GWh in 2007 (Source: CAMMESA).

Argentina is an hydrocarbon-producing country but – as shown in the graph below from the Secretariat of Energy – in recent years the hydrocarbon reserves have been shown to have decreased, especially the reserves of gas. In contrast, the demand for energy is constantly growing, and so the country's ability to meet its own needs could become compromised.



Hydrocarbon reserves horizon (Source: Ministry of Environment and Sustainable Development)

## Key Agents in the Argentine Energy Sector

### **Secretariat of Energy (Spanish acronym SE):**

The Secretariat of Energy operates under the auspices of the Ministry of Federal Planning, Public Investment and Services of the Argentine government. The Secretariat of Energy's main objectives are to propose and implement the national energy policy, while promoting policies encouraging competition and efficiency in the assignment of resources and respecting the rational exploitation of resources and the conservation of the environment.

### **CAMMESA (Wholesale Electric Market Management Company):**

CAMMESA is a public purpose privately managed company. Its main functions include coordinating dispatch operations, being responsible for establishing wholesale prices and administering the financial transactions done through the National Interconnected System (Spanish acronym SIN).

### **National Electricity Regulatory Board (Spanish acronym ENRE):**

The ENRE is a self-governing agency charged with regulating the electrical sector and monitoring sector companies (the power generators, transporters and distributors Edenor, Edesur and Edelap) to ensure their compliance with the obligations set forth in the regulatory framework and in the concession contracts.

### **ENARSA (Energía Argentina Ltd Co):**

It was created on 29 December 2004 by National Law 25.943. The company's purpose is the exploration and exploitation of solid, liquid and gas hydrocarbons, the transport, storage, distribution, sale and industrialisation of these products and their derivatives and to provide public service transport and distribution of natural gas, for which purpose it may produce, process, refine and purchase them. It may also generate, transport, distribute and sell electricity, and carry out business activities linked to energy-related goods.

### **National Institute of Industrial Technology (Spanish acronym INTI):**

The INTI operates officially under the auspices of the Secretariat of Industry of the Ministry of Economy. Matters linked to energy and the environment are the responsibility of the Department of Energy, whose mission is to develop, implement and support techniques aimed at the efficient and rational use of the different types of energy used in production processes, transport and the residential, business and public sectors, with a special emphasis on those energies that increase the energy efficiency of equipment and the conservation of the environment.

#### **Argentine Industrial Union (Spanish acronym UIA):**

The UIA - founded 7 February 1887 - is a non-profit civil business trade association. Its mission is to represent Argentine industry in conjunction with provincial and sectorial organisations, with the aim of promoting the country's development in its economic-social and territorial spheres through the generation of proposals that consistently improve the sector's competitiveness, technological development and added value, the strengthening of the domestic market and the implementation of the industry within an international framework.

### **The Argentine Energy Policy**

The main goals in terms of renewable energy and energy efficiency set by the Argentine government are:

- Ensure that energy is supplied in an efficient fashion, balancing this with available natural resources and the least possible environmental impact.
- To achieve greater energy efficiency for end users.
- To promote the use of new technologies and renewable energy technologies in order to increase supply in rural areas.
- To reduce the environmental impacts resulting from the provision of electrical services and to diversity the supply of energy.



With the goal of fostering these objectives, the government has been working on different programmes supporting efficient energy use, as well as the use of renewable energies. The regulatory and legislative frameworks are also evolving in this direction, and this can be seen in laws such as Law 26.190 on the National Programme for the Promotion of the Use of Renewable Sources of Energy Destined for Electric Power Generation approved in December 2006, or Law 26.093 on Biofuels from the same year.

Next table shows the capacity energy targets on renewable energy sources to install:

► CLASIFICACIÓN DE LOS PROYECTOS DE ENERGÍAS RENOVABLES (2009)						
CLASIFICACIÓN DE PROYECTOS	SOLAR FOTOVOLTAICA	SOLAR TÉRMICA	EÓLICA	BIOMASA	GEOTÉRMICA	MINI-HIDRO
Proyectos y/o potencial identificado	5 kWh/m <sup>2</sup> día media anual al Norte Río Colorado	100 MW al año 2015, 1000 MW <sup>25</sup>	5000 MW	422 MW	4 Reservorios	430 MW
Proyectos en Desarrollo	1,2 MW en San Juan + PERMER (1 MWp)	0.5 MW	0,9 MW (PERMER) + 2850 MW	156 MW	30 MW en Copahue	30 MW
Potencia instalada	10 MWp (PERMER + Otros estimados dispersos)		29,76 MW + 0,6 MW baja potencia + 0,2 Chubut y otras	720 MW	0,67 MW (sin servicio)	380 MW

Targets of renewable energy projects (Source: SE).

## Actions and Programmes in the Renewable Energies and Energy Efficiency Sectors

With the goal of achieving the goals established in the energy policy, the government has implemented different actions, in both the field of renewable energies as well as in efficient energy use:

### Renewable Energies Programmes:

- GENREN: Programme for Power Generation from Renewable Resources:

The government, via this "Renewable Generation" Programme launched on 20 May 2009, and through ENARSA (Energía Argentina Ltd Co), invites tenders for the purchase of renewable energy totalling 1,015 MW. The contracts will be for 15 years, and they will be awarded in modules of up to 50 MW.

- Renewable Energies in Rural Markets Project (Spanish acronym PERMER):

The main purpose of this project – which is financed by the federal government and managed by the Ministry of Energy – is to supply electricity to a significant number of people living in rural homes and to approximately 6,000 public services of all types (schools, emergency rooms, police stations, etc.) located outside of the reach of power distribution centres.

#### **Energy Efficiency and Savings Programmes:**

- National Programme for the Rational and Efficient Use of Energy (Spanish acronym PRONUREE):

The rational and efficient use of energy is declared to be of national interest and priority through this programme.

The PRONUREE, which is implemented by the Ministry of Energy, was approved via a Decree on 21 December 2007 and proposed a number of actions to be carried out in the short, medium and long term.

The short term objectives are to change the time zone, carry out a massive educational campaign on the issue of the rational use of energy and energy efficiency and to develop standards for minimum energy efficiency to be applied to the sale of energy-consuming equipment.

The medium and long term actions proposed are structured in the following areas: industry, business and services, education, cogeneration, energy efficiency labelling, regulation of energy efficiency, lighting and traffic lights, transport, housing and climate change.

It is hoped that by 2016 a savings of 10.6% in terms of the country's total demand tendency can be achieved.

- Electrical Appliance Quality Programme (Spanish acronym PROCAE):

The main objective of this programme is to reduce electricity consumption by using more efficient electrical appliances. To do this, the energy labelling system is being implemented.

- Energy efficiency projects in Argentina:

Since the end of 2003, the Secretariat of Energy is promoting energy efficiency projects in Argentina that could be part of a programme that may receive financial assistance from the Global Environmental Facility (GEF), with the World Bank as the implementing institution.

- Programme for Savings and Energy Efficiency in Public Buildings (Spanish acronym PAYEEP):

The country's public buildings, as well as those in provincial states and municipalities represent a potential energy savings similar to that of the potential of commercial buildings. The Secretariat for Energy has stated its priority is to start a specific programme for energy efficiency in the national government office buildings open to the public.

From 1999 to 2005, the Secretariat for Energy carried out another programme in the area of energy efficiency, the "Programme for Increasing Energy and Production Efficiency in Small and Medium Argentine Businesses" (Spanish acronym PIEEP). This project operates along with the German Cooperation Agency (German acronym GTZ) and its principal objective is to improve the competitive conditions of small and medium businesses (SMEs) in Argentina, promoting the implementation of energy, production and environmental management in industrial plants and service companies in the SME sector.

## Regulatory and Legislative Framework

The most relevant laws and standards related to the renewable energies and energy efficiency sectors are listed below. Among all of them, the one that stands out the most is Law 26.190 on the National Programme for the Promotion of the Use of Renewable Sources of Energy Destined for Electric Power Generation, whose objective is to produce 8% of the electricity from renewable resources by 2016.

- Law 26.093 on Biofuels: Programme for Regulating and Promoting the Sustainable Production and Use of Biofuels. This establishes the compulsory mix of 5% of biofuels into petroleum derivatives by 2010 and is also supported by tax incentives and fiscal stability for the production of fuels for a 15-year time period, giving priority to projects for small and medium businesses.
- Law 26.123 on Promotion Hydrogen: The objectives are to develop and strengthen the scientific-technological structure aimed at generating the knowledge needed for taking advantage of non-conventional energy resources as well as incentivising private participation in hydrogen generation and production. It is one of the world's first laws on hydrogen.
- Law 26.190 on the National Programme for the Promotion of the Use of Renewable Sources of Energy Destined for Electric Power Generation: The law, published at the beginning of 2007 in the national Official Gazette, complements Law No. 25.019 on the National Programme for Wind and Solar Power published in 1998 by covering the other renewable sources.

It declares the generation of electricity based on renewable sources destined to providing public service to be of national interest, and establishes a goal of renewable energies having an 8% share of national consumption to be reached by 2016.

In 2009, ENARSA, via the GENREN programme, launched an invitation to bid for buying electricity generated with renewable energies whose purpose is to fulfil

the legislative requirements set forth in Law 26.190. Provision will be done through these generation centres, which will be connected to the Argentine Grid Connection System (Spanish acronym SADI) and whose modules together have a power greater than 1 MW and less than 50 MW. The purchase of energy will be ensured for a total of 15 years, and the total power offered for tender totals some 1,015 MW, which are distributed as follows:

SOURCE	POWER
Wind	500 MW
Thermal with biofuels	150 MW
Solid Urban Wastes	120 MW
Biomass	100 MW
Small scale hydropower	60 MW
Geothermal	30 MW
Solar thermal	25 MW
Biogas	20 MW
Solar Photovoltaic	10 MW
<b>TOTAL</b>	<b>1,015 MW</b>

Distribution by sources of energy offered for tender

## Argentine Electrical System

The publication of Law 24.065 in 1992 began the process of reform in the Argentine electrical sector through which it was separated into different segments of the electrical sector industry. The aim of this reform was to increase competitiveness within the sector.

Currently, the electrical market maintains the structure defined in Law 24.065, in which the following electrical market agents are defined: generators, transporters, distributors, large users and sellers. This system is coordinated and administered – from both the operational (physical dispatch) and economic (financial dispatch) perspectives - by the Wholesale Electric Market Management Company Ltd Co (CAMMESA).

The Secretariat of Energy is the entity establishing the system's rules and the National Electricity Regulatory Board – which is self-governing – is charged with regulating the electrical sector and monitoring the businesses operating in the sector.

There are three different types of grid-connected power generation in the country: Power generation plants that, under national jurisdiction, are connected to each other and with the country's main consumption centres through inter jurisdictional transport lines or grids that comprise the SADI (Argentine Grid Connection System) and cross the country's provinces at high voltages (500 kV, 220 kV, and 132 kV). Independent generation, which is frequently associated with electricity distribution systems located in different provinces that are not linked to the SADI. Lastly, there is distributed generation, which provides energy to a scattered rural population. This service is provided under local jurisdiction through small scale individual generation units or collective services based on wind, solar, biomass, micro-hydropower facilities, small diesel generators, etc.

With respect to the transport system, the main transport grid works at 500 kV and is operated by TRANSENER S.A. There are also other transport grid using lower voltages (220 and 132 kV) operated by DISTROS (Trunk Line Distribution Transporters). By law, the transport companies are subject to federal jurisdiction.

The companies comprising the distribution system have a direct relationship with the end user and are subject to local jurisdiction. The distribution systems are classified into: electricity distribution systems linked to the SADI and independent distribution systems. These latter usually integrate power generation and distribution also under local jurisdiction, located in different provinces and not connected to the SADI.

Large users are consumers with power greater than 50 MW and contract their consumption with a generator or a seller, and not with distributors.

With regard to the country's electrical rates, it is point out their low prices. Due to the crisis in 2001, a policy of freezing rates has been followed since 2003, thanks in

part to the significant subsidies the country offers to energy. Thus, the actual costs derived from the generation of electricity are not reflected in the current rates.

### 3. ANALYSIS OF THE SOLAR THERMAL ENERGY SECTOR

#### Solar thermal energy in the world and in Europe

The exploitation of the sun's energy can be achieved in two ways: without the intervention of mechanical elements, that is, in a passive way, or with the intervention of the former, that is, in an active way.

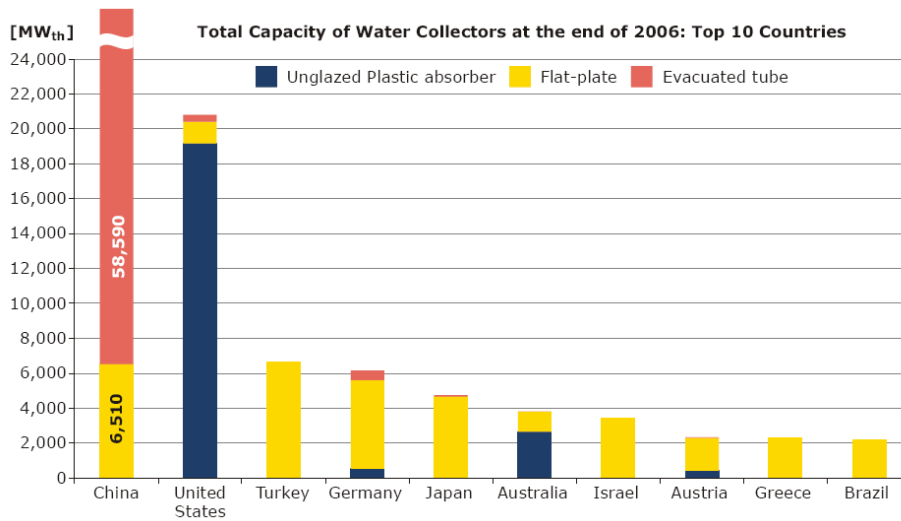
Active solar energy, in turn, can be low-, mid- and high-temperature, depending on whether collection can be direct, with a low or a high concentration grade.

Low-temperature applications, made with glazed flat collectors, the so-called solar panels, are the most common from a commercial point of view. The most interesting applications are:

- **In buildings.** To get sanitary hot water, swimming-pool heating and heating.
- **In industrial facilities.** Also to get sanitary hot water and water parcelization for processes.
- **In farming facilities.** As a heating system in greenhouses, hot water in fish farms, etc.
- **Solar cooling.** In places with cold water or cooling requirements, by taking advantage of heat in an absorption process.

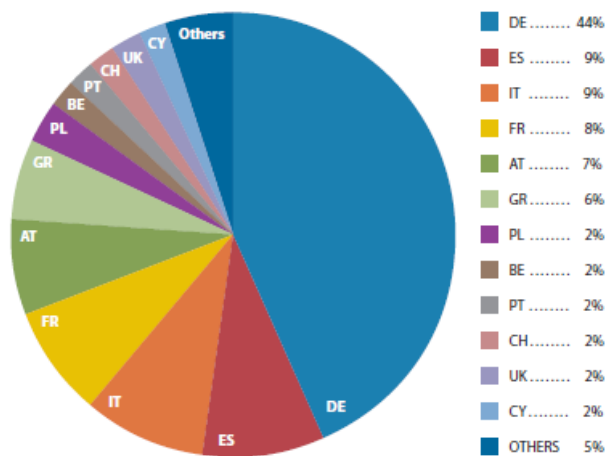
At world level, it is estimated than in 2006, the capacity of low-temperature solar thermal installations reached 127.8 GW, coming from a 128.5 million m<sup>2</sup> collector surface. Flat collectors and heat pipes are meant for SHW and heating. This technology is basically used in China, Europe, Australia and New Zealand. Plastic collectors, whose wider use is found in the USA and Canada, are meant for heating swimming pools. Comparing the use of this technology by countries, China is the one with the largest installed capacity (64% of the whole) and also with a difference with respect to the rest of the countries:





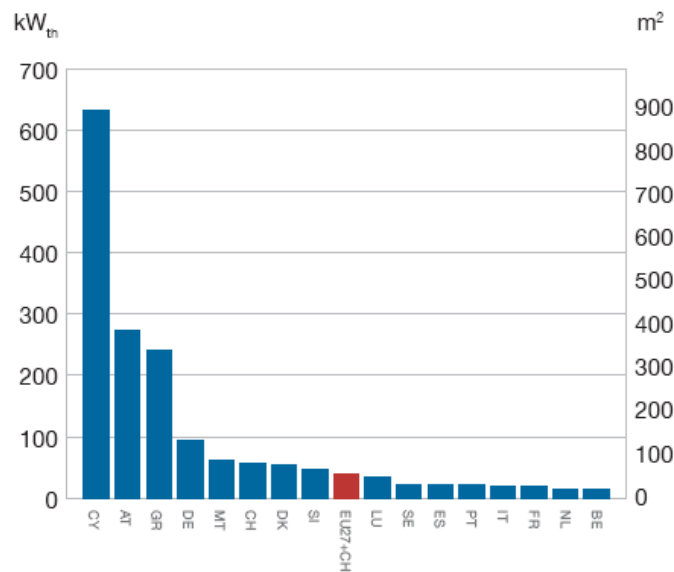
World installed capacity in 10 leading countries for low-temperature solar thermal systems (Source: ESTIF).

In 2008, the entire European market reached an installed capacity of 19 GW, coming from 27 million m<sup>2</sup>. Germany, which contributed with 2.1 million m<sup>2</sup>, is the country with the largest number of collectors installed in 2008, followed by Spain, Italy and France:



Distribution of the European market, 2008 (Source: ESTIF).

Even if it is true that Germany, with 44% of the whole, is the country with the largest amount of systems, Cyprus is the one with the largest penetration of the market (whole operational capacity per 1000 inhabitants), followed by Austria and Greece:



Operational solar thermal energy capacity per 1000 inhabitants, 2008 (Source: ESTIF).

Europe is one of the most sophisticated markets in terms of use of the various thermal applications of these systems. There are applications for SHW, single family dwelling, block of flats and hotels, district heating, apart from industrial applications and solar cold.

The most common incentives that the various European countries adopt to support the use of this technology are allowances; such is the case of Germany, or tax credits, which are applied in countries as France and Italy. In an odd case, such as Spain's, the use of this technology is compulsory in newly-built dwellings.

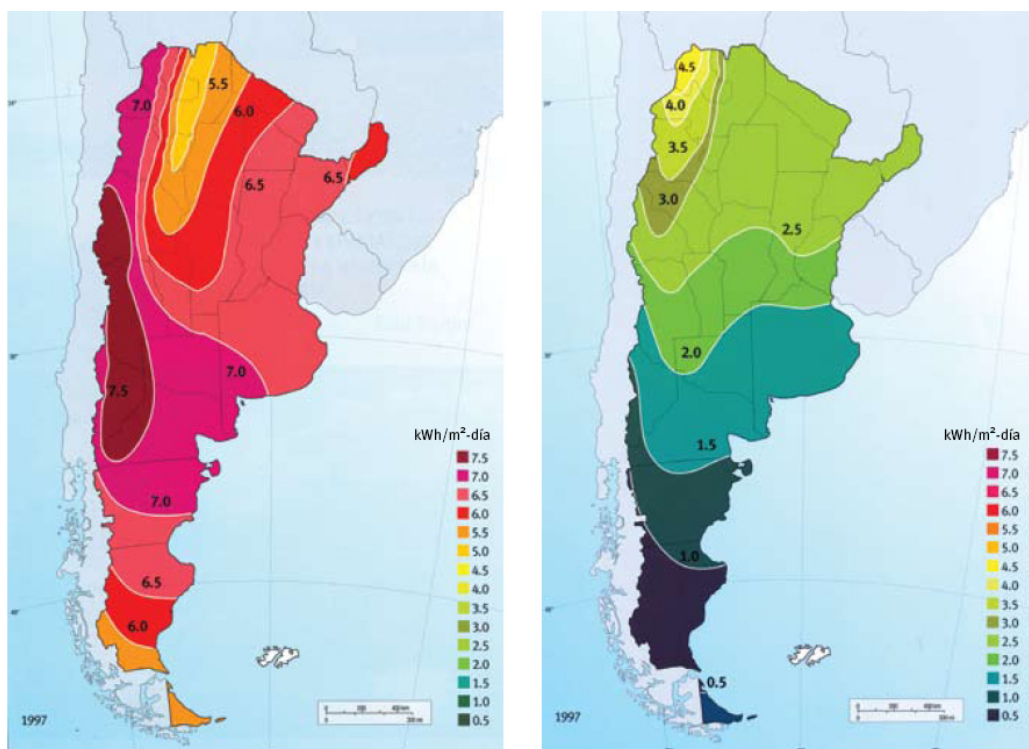
### Solar thermal energy in Argentina

- **Current Situation:**

Currently, there is considerable knowledge of available solar energy having the following geographic distribution:

The national solar energy network has only 3 measuring stations, making it necessary to continue to measure resources in order to improve the spatial coverage and the instruments used.

There are many provinces having adequate quality resources for the use of solar heat, with sufficiently high power levels to substitute from LPG, NG and brushwood for thermal uses.



Maps of radiation levels. January on left and July on right (Source: SE).

According to the Bariloche Foundation, the potential for the use of solar energy for water heating rose to some 1,620,000 m<sup>2</sup> corresponding to 230,000 m<sup>2</sup> in the industrial sector, 500,000 m<sup>2</sup> in the commercial, service and public sectors, and

890,000 m<sup>2</sup> in the residential sector. As for the use of this technology in application to heating, the potential estimated by the foundation is of some 1,070,000 m<sup>2</sup> of aboveground capturers.

The low level of regulatory development regarding this technology is quite significant. The PRONURE is the only document on a national level regarding this energy resource. It concretely develops the following measures in the housing sector:

- New homes: “To include the optimal use of solar energy in the architectural design phase and in the building planning (both for heating and for lighting)”.
- In-use housing: “To design a strategy for the massive implementation of water heating systems based on solar energy, particularly in outlying populations”.

On a regional level, only the province of Buenos Aires has the Law 13.059/03 demanding the use of solar powered water heating systems in all public buildings and homes that do not have natural gas networks, together with the use of solar energy for heating.

- **Barriers to solar thermal energy**

**Technological barriers:**

The low-temperature solar thermal system technologies are ripe technologies and have been well-known for years, especially in the most developed countries, where the market has reached a given maturity. But in the case of Argentina, the solar thermal sector does not show a significant development mainly due to the existing technological barriers. The main technological barriers that have been spotted are those inherent to little-developed markets:

- **Lack of qualified designers, installers and maintainers:**

Due to the low demand of STS, the sector has not had the full development that would enable the availability of the appropriate professionals, which may affect the installation quality: errors in control systems, poor maintenance, incorrect

calculation of the SHW demand, incorrect sizing, and resulting installations that differ from the original project, among others.

- **Lack of technical documentation:**

There is a lack of technical documentation to carry out the design of installations (guidelines, calculation programmes, etc.) apart from the scarce dissemination of the already existing material.

**Other barriers:**

Technological barriers are not the sole ones that hinder a massive use of the STS. Next are stated the main non-technological barriers affecting the sector:

- **Financial:**

STS high initial costs, as well as the high recovery periods become a remarkable barrier to the development of this market. It is necessary to create the financial mechanisms that may encourage users to install these systems.

- **Regulations:**

The lack of a suitable regulatory framework to guarantee that systems should meet the technical requirements ensuring the appropriate running of the installation is another barrier to take into account. It is necessary to endow the market with a certification system to assess the main STS elements, as well as a control system that may check the right running of installations.

Moreover, the certification and control systems enable to increase the in- and out-barrier of the various agents in the sector. Without these measures, the former may quit the market without meeting their obligations, contributing to increasing user's mistrust for this technology.

- **Educational and information:**

The lack of knowledge of this technology on the part of users decreases the demand of these systems. On other occasions, the reason is that potential users may know the technology but do not have all the information, and therefore there may be uncertainty about using it.

## 4. RESULTS

### Proposed measures

#### **Lack of qualified designers, installers and maintainers:**

Strengthen the technical qualification of the sectors' agents through training courses. On this point, it is very interesting to be able to rely on the experience of European countries where the sector has reached some maturity, essentially because some teaching can be drawn from the learnt errors, always bearing in mind the special features of every country.

Having a certification system for installers, maintainers and engineering systems would also guarantee the quality of solar thermal installations.

#### **Lack of technical documentation:**

Drafting of design guidebooks and calculation programmes addressing architects, engineers, etc.

#### **Economics:**

There is the need for an adequate financial mechanism to motivate the use of solar energy. In some European countries, these economic incentives are made through tax credits or grants.

#### **Regulatorio:**

When designing a new regulatory framework, examples may be taken from other countries with a more developed solar thermal market and legislation. This is the case of European solar thermal market.

#### **Educational and information:**

Design information programmes on the running, maintenance and benefits of this technology, which are particularly aimed at users.

**The execution of demonstrative projects is another action that allows knowing STSs.**



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