~ Project ~

Tech4CDM

Solar Thermal Energy

In CHILE

Project financed by

SIXTH FRAMEWORK PROGRAMME

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

Contents

1. CHILE

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

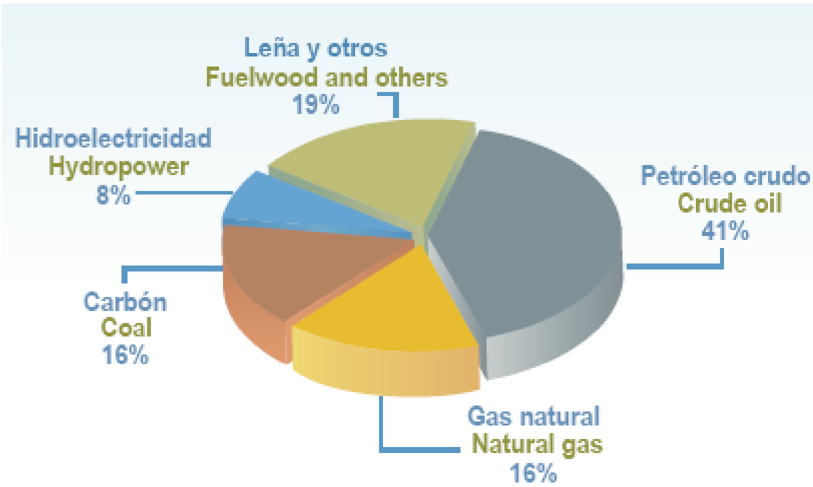
CHILE	2000	2005	2007	2008
General Data				
Population, total (millions)	15,41	16,30	16,59	16,76
Population growth (annual %)	1,2	1,1	1,0	1,0
Surface area (sq. km) (thousands)	756,6	756,6	756,6	756,6
Energy and Environment				
Energy use (kg of oil equivalent per capita)	1.684	1.813	..	..
CO2 emissions (metric tons per capita)	3,9	4,1	..	..
Electric power consumption (kWh per capita)	2.488	3.074	..	..
Economy				
GDP (current US$) (billions)	75,21	118,25	163,88	169,46
Agriculture, value added (% of GDP)	6	4	4	..
Industry, value added (% of GDP)	38	42	47	..
Services, etc., value added (% of GDP)	55	54	49	..
GDP growth (annual %)	4,5	5,6	4,7	3,2
Inflation, GDP deflator (annual %)	4,6	7,6	5,1	0,2
Exports of goods and services (% of GDP)	32	41	47	..
Imports of goods and services (% of GDP)	30	33	33	..
Foreign direct investment, net inflows (BoP, current US$) (millions)	4.860	6.984	14.457	..

Chilean information (Source: World Bank).

2. THE CHILEAN ENERGY CONTEXT

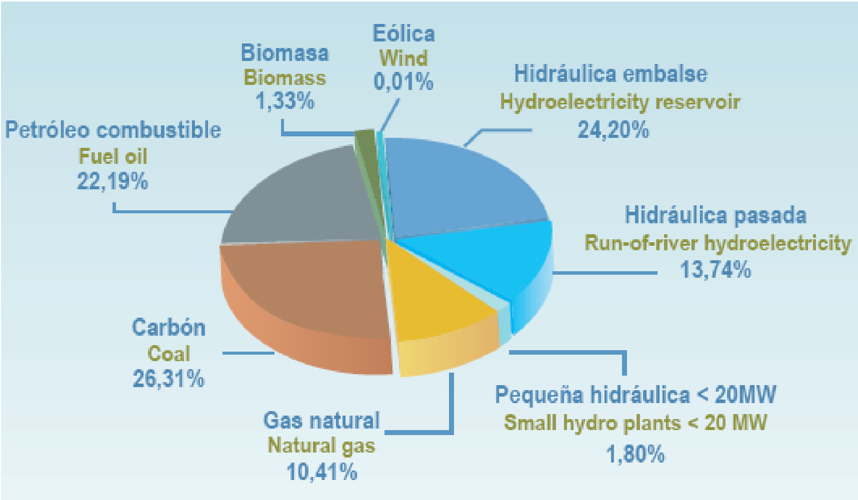
Even if the contribution of non-conventional renewable energy sources (NCRE) in the Chilean energy mix is small, it starts being significant. As a matter of fact, in four years' time the country has ranged, for its installed capacity for electric power generation, from 286 MW to 600 MW.

But as shown in the following figures, the country has a tight dependence on fossil energies. Around 73% of the primary energy generated in 2007 belonged to fossil energy sources (petrol, natural gas and coal). Apart from these sources of a fossil origin, hydropower and fuel wood, among others, made the energy offer of the country to reach 301,381 GWh.



Primary energy offer, year 2007 (Source: CNE).

The generation of electric power for that same year was 55,914 GWh: 38% comes from hydropower plants, 10% from natural gas, 26% from coal, 22% from fuel oil and 3.1% from ERNC (small hydro, biomass and wind):



Electric power offer, year 2007 (Source: CNE).

Key agents in the Chilean energy sector

National Commission of Energy (CNE)

The National Commission of Energy (CNE) is a public, decentralised body, whose main function is to draft and coordinate the necessary plans, policies and regulations for the good running and development of the country's energy sector, apart from watching over that all the issues related to energy are complied with, both in terms of production and use and in the promotion of its efficient use.

The Ministry of Mining

It has competences to define policies, plans and regulations in the field of hydrocarbons, nuclear energy and geothermal energy.

The Ministry of Economy, Promotion and Reconstruction

As regards the electric power field, it issues decrees on prices for services, it grants concessions, and it establishes the energy transport and rationing services among other questions.

Superintendence of Electricity and Fuels (SEC)

This is a decentralised public service whose function is to supervise and oversee the pursuance of legal, statutory and technical regulations on liquid fuels, gas and electric power. It is under the supervision of the Ministry of Economy.

Technological Development Corporation *(Corporación de Desarrollo Tecnológico)* (CDT)

CDT is a private law Corporation created by the Chilean Chamber of Construction in 1989, whose present mission is to promote the innovation and technological development of the firms in the construction sector through four development or service areas: Technological Dissemination, Sectorial Studies, Coordination of Technological Interest Groups and Technological Transfer.

Production Improvement Corporation *(Corporación de Fomento de la Producción)* (CORFO)

CORFO is the organism of the Chilean State in charge to foster the national productive activity. Besides supporting companies and already existing groups, CORFO also promotes the sprouting of new businesses, that renew and diversify the growth opportunities.

The Chilean Energy Policy

The main objectives of the Chilean government in the field of energy are:

- Security: To rely on the necessary energy in a suitable and affordable way.
- Efficiency: To obtain energy at the lowest possible cost and use it rationally.
- Sustainability: Ensure that sources and uses are sustainable in time (particularly in relation to the environment).

- Equity: Guarantee the access to energy to all sectors (both social and geographical).

In order to reach these objectives, the government has established the main guidelines to follow in the field of energy policy, as described next:

Institutional strengthening

The design of the appropriate institutional framework is essential for the right implementation of the energy policy. With a view to improving the current Chilean institutional structure, a series of various actions are being carried out, such as the Bill on the Creation of the Ministry of Energy, the strengthening of the management capacity of the various organisations in the sector through organisational and budgetary adjustments, apart from developing supplementary structures as the future Chilean Agency on Energy Efficiency and the Centre for Renewable Energies. In like manner, the strengthening of international relationships with the main international bodies in the energy sector is one of the actions undertaken so far.

Promotion and Backing of Energy Efficiency

It is essential that Chile should consolidate the efficient use of energy as a strategic objective of sustainable development, as a way to stand up to the challenge of keeping the demand at the necessary minimum level. The action lines defined to promote an efficient use of energy amount to four:

- Establishing the institutional bases for energy efficiency.
- Developing the suitable knowledge for decision-making.
- Enhancing energy efficiency in all sectors.
- Regulating markets, particularly the electric one, so as to stimulate efficiency.

The institutional base for the implementation of all the energy efficiency actions has been the *Programa País de Eficiencia Energética (PPEE),* (Country Programme for Energy Efficiency), whose mission is to consolidate efficient use as an energy source, thus contributing to Chile's sustainable energy development. This programme, created in the year 2005 under the auspices of the Ministry of Economy, started joining the National Commission of Energy in the year 2007, and became fully incorporated in 2008 with a strong budget increase, which remained so along 2009.

Optimisation of the Energy Mix

The optimisation of the country's energy mix is basically based on the three following actions: backing to the execution of competitive investments, promotion of electric power generation with non-conventional renewable energies (NCRE) thanks to the improvement of the regulatory framework, direct support tools to investment initiatives in NCRE or by providing information of the sector for investment purposes; and an opening to international energy integration.

Reconciliation with Sustainable Development

The current evolution of the Chilean energy development is largely tending to sustainable development. The proof of it is the many efforts carried out in the field of energy efficiency, which seek the reduction of the country's energy consumption, as well as the significant inclusion of energies based on natural renewable resources with a less negative impact (biofuels, solar thermal, NCRE).

Support of an Equity in Use

Energy equity is an essential pillar for social equity, allowing the sectors with lower incomes or more isolated ones to have access to services that will improve their standard of living and take advantage of economic opportunities at an affordable cost. In this sense, the rural sector is one of the most deprived ones and that is why since 1994 the Rural Electrification Programme (PER) has been running. The use of NCRE is being backed within this programme so as to take advantage of all the natural resources in every region.

Ready for Eventualities

Contingencies entail an important security problem for the country. Even if there is a forward trend towards suitable long-term development, it is always possible to meet unexpected situations; it is therefore necessary to be prepared to minimise their impact.

Actions and programmes in the renewable energies sector and energy efficiency

1. Renewable Energies

The implementation of support measures to NCRE in Chile is something recent and dates back to the year 2004. It basically consists of the two action lines that the Chilean government is undertaking: the improvement of the regulatory framework of the electric power market and the introduction of mechanisms to provide direct support to NCRE investment projects.

It is essential that the regulatory framework that rules the electric market should take into account the special features that NCRE show with a view that its share in the electric market may rise. The first change that took place in the electric legislation was the amendment of the General Law on Electrical Services (LGSE) through *Ley Corta I* and *Ley Corta II* (Short Law I & II) in 2004 and 2005, respectively, until 2008 saw the advent of the enactment of Law 20257, also called Non-Conventional Renewable Energies Law.

With regard to the second action line, various action lines have been implemented also since the year 2004, which consider instruments promoting private investment and instruments of public information generation that may guide and ease investment decision-making related to projects.

As well as these two action lines, work is also been done to create a Renewable Energies Centre whose main task will be to act as a technological “aerial”, enabling to make the most of the world’s technological development.

Last, in the rural electrification sector, there is a remarkable project of *“Remoción de Barreras para la Electrificación Rural con Energías Renovables”* (removal of barriers for rural electrification with renewable energies), whose main objective is to do away with the existing barriers hindering the inclusion of NCRE towards the rural electrification of Chile.

2. Energy Efficiency

As stated in the former point, the efficient use of energy is a strategic issue in the Chilean energy policy. The creation in 2005 of the PPEE and the projects that are taking place under the auspices of this programme show it so. Next are described the most outstanding projects in the various sectors:

Energy efficiency policy

The actions that are taking place in this area mean to develop the strategic guidelines that are needed for energy efficiency in the mid and long term to become a pillar within the national energy policies:

- National Plan of Energy Efficiency Action 2010-2020.
- Energy Efficiency Market Study in Chile.
- Energy final use studies.
- Assessment of Energy Efficiency policies and programmes.
- Coordination and proposal of an institutional design for the Chilean Agency for Energy Efficiency.

Public Street Lighting

The aim of the programmes on public street lighting is to improve energy efficiency in these systems by means of incentives that may enable municipalities to add new technologies to their public street lighting as well as technical assistance projects all over the country.

Vive con buena energía (Live in good energy)

Vive con buena energía is an initiative that seeks to implement Energy Efficiency concepts in households with a view to reducing to the minimum energy expenses, improving habitability and comfort in the house. Some of the projects under way in this field are:

- Allowance Allocation Project and Start of Thermal Refitting Works in Houses, which benefit the population belonging to most vulnerable population segments.
- Thermal Improvement Pilot for 400 social houses.
- House Energy Performance Certificate.
- Social Housing Design and Energy Efficiency Contest.
- Design guide for Energy Efficiency in social housing.

Public Buildings

Under the initiative of public buildings a series of projects are carried out, seeking to integrate the efficient use of energy in public buildings, through the establishment of inter-sectorial work groups, meant to provide technical support to public institutions. These develop the standards for the design, building and operation of their buildings. In parallel, energy diagnoses are done which give an account of the saving potential of the various buildings, apart from proposing implementation measures for each specific building.

Energy Efficiency Labelling in Electric Devices

Work is being done with the Electricity and Fuels Superintendence to develop and maintain an energy efficiency labelling system for domestic electric appliances.

***Transporta con buena energía* (Transport with good energy)**

The main aim of the projects developed under this initiative is the updating of the lorry fleet, the technical assistance of cargo transport firms, as well as contributing to drivers' training.

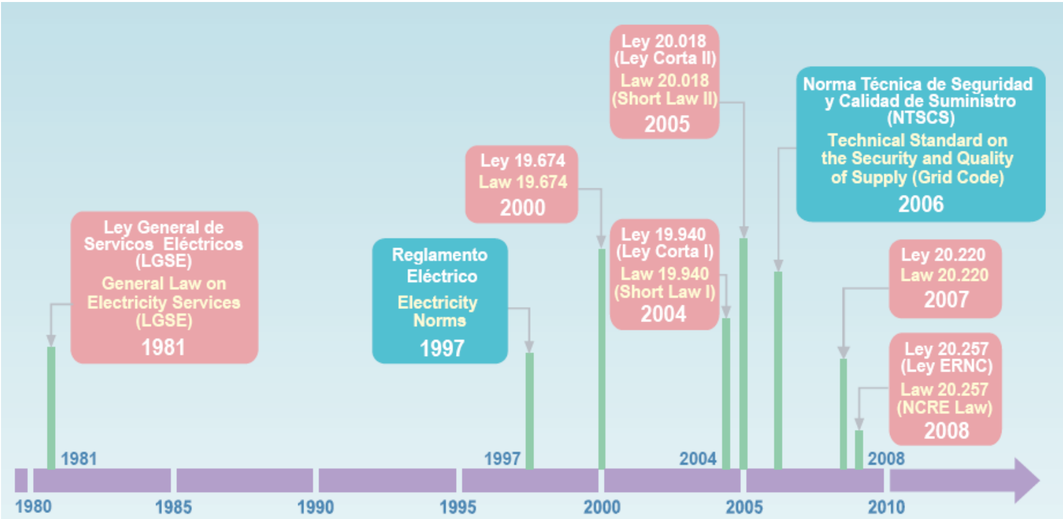
Regulatory & legislative framework

Electric grid:

The Chilean electric grid main characteristic is that it is a system where generation, transmission and electric power distribution depend on private firms. The State performs regulation, supervision and guidance functions on the generation and transmission investments, basically through the CNE and the SEC.

There are four independent electric grids in Chile: the Interconnected System of Norte Grande (SING), the Interconnected Central System (SIC), the Aysén System, and the Magallanes System.

Until year 2004 no difference in the legislation of the Chilean electric sector was made for the NCREs. The following table shows the evolution of the electric sector legislation in relation to NCRE use to produce electric power:



Legislative evolution of the electric sector (Source: CNE & GTZ).

- **Decree in Force of Law No 4, General Law on Electricity Services (LGSE)**

The legal body that regulates the electric sector's activity is currently the Decree in Force of Law (DFL) No 4 enacted in 2006. This Law stems from DFL No 1, which was amended in the year 2004 and lately in 2005 with the enactment of Laws 19940 y 20018, also called Short Law I and Short Law II respectively.

DFL No 4 regulates the production, transport, distribution and award of electric power fees. This legal body includes the award, rights, prices, quality and security conditions of the facilities, machinery and instruments as well as the relations with the firms with the State and individuals.

- **Law 19940 (Short Law I)**

It was enacted by the Ministry of Economy, Promotion and Reconstruction and was published in the Official Gazette on 13th March 2004.

The main objectives of the Short Law I, as of March 2004, are meant to guarantee consumers higher levels of security and supply quality at reasonable prices and endow the electric sector with a modern regulatory and efficient framework which will give the certainty and stability required for the rules of the game in a strategic sector for the development of the country.

Moreover, the conditions for the development of small non-conventional energy plants are significantly improved, basically renewable energies, by means of the opening of electricity markets to plans of this kind, the establishment of the right to let out their energy through the distribution systems and the possible exemption from payment of tolls for using the trunk transmission system.

- **Law 20018 (Short Law II)**

Short Law II, dated May 2005, occurs due to the uncertainty in connection with Argentinean natural gas availability, which may make it difficult to estimate future price levels and income levels for energy sale.

- **Law 20257 (Law NCRE)**

Law 20257 was enacted on 1st April 2008 and amends Law LGSE regarding the generation of electric power generation with NCRE sources.

The law establishes that the electric firms that trade with energy in the electric systems with an installed capacity over 200 MW are obliged to accredit a percentage of the whole energy that has been traded with every year, which may either have been poured into the electric grid by means of generation with non-conventional renewable sources of their own or else hired. This percentage is of 5% from 2010 to 2014. From 2015, the obligation is increased gradually by 0.5% a year until reaching 10% in the year 2024.

- **Law 20220 to safeguard the supply security to regulated customers and the sufficiency of the electric systems**

Enacted on 14th September 2007, it amends the LGSE with regards to the safeguard of the supply security to regulated customers and the sufficiency of electric systems. It takes into account lawsuits for contract terminations and bankruptcies.

Cogeneration

Co-generation facilities are regulated by the laws stated above and by the Electric Regulation as of 1997. Regarding facilities of this kind and in its capacity as generators, that is, when energy surpluses are poured into the grid, the Regulations do not make a difference from conventional generators.

Moreover, co-generators may have recourse to a Load Economical Dispatch Centre (DEC), and therefore, trade with their energy if only they just have an installed generation capacity over 9 MW. This restricts the access to the grid of these actors as the large majority of co-generation potentials are found in the 0.1-5MW scope.

Geothermal energy:

This energy is regulated by the Law on Geothermal Energy Concessions (Law 19657 as of 2000) and a further amendment. The Law on Geothermal Energy Concession sets forth that geothermal energy is a State asset that can be explored and exploited by means of an administrative concession.

Low-temperature solar thermal energy:

- **Law 20365 "establishing the tax exemption in relation to solar thermal systems"**

The aim of this Law is to create the necessary conditions for the market development of the solar thermal systems to yield sanitary hot water (SHW) in newly built houses, thanks to a tax allowance instrument.

3. ANALYSIS OF THE SOLAR THERMAL ENERGY SECTOR

Solar thermal energy in the world and in Europe

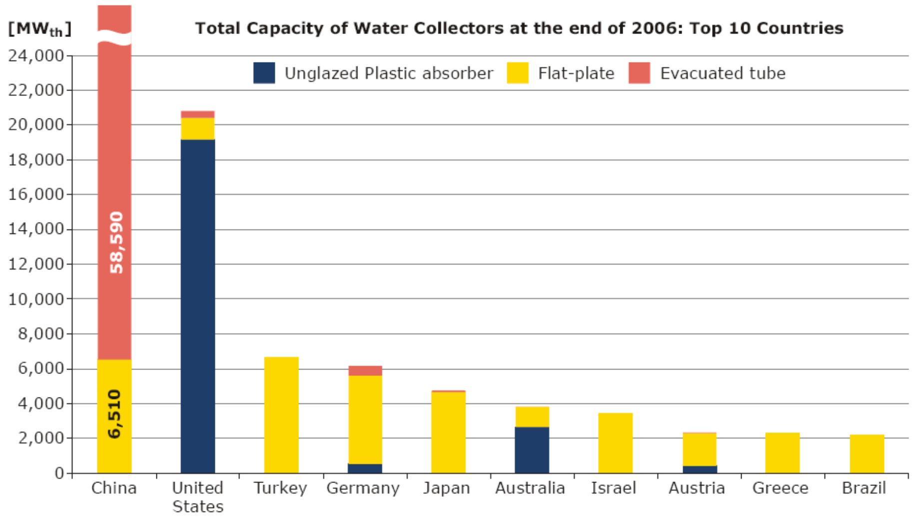
The exploitation of the sun's energy can be achieved in two ways: without the intervention of mechanical elements, that is, in a passive way, or with the intervention of the former, that is, in an active way.

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:

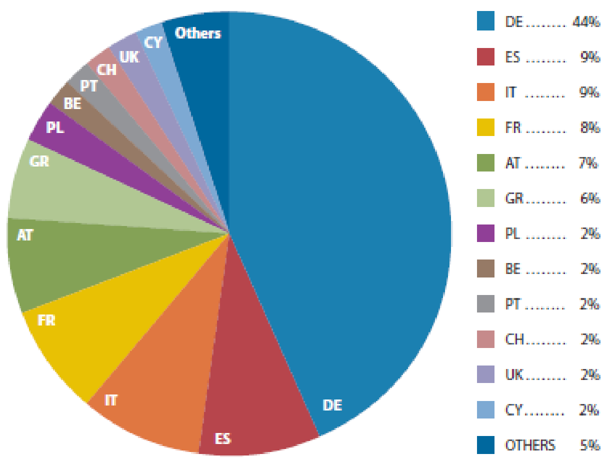
- **In buildings.** To get sanitary hot water, swimming-pool heating and heating.
- **In industrial facilities.** Also to get sanitary hot water and water parcelization for processes.
- **In farming facilities.** As a heating system in greenhouses, hot water in fish farms, etc.
- **Solar cooling.** In 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^2 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:



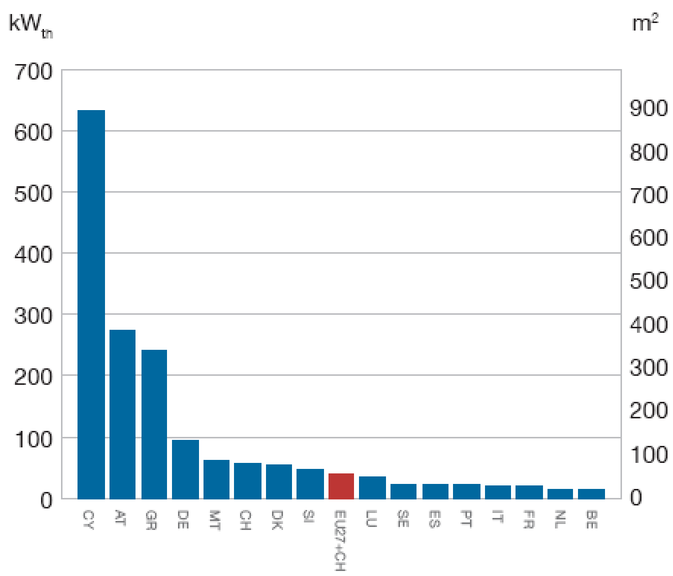
World installed capacity in 10 leading countries for low-temperature solar thermal systems (Source: ESTIF).

In 2008, the entire European market reached an installed capacity of 19 GW, coming from 27 million m^2. Germany, which contributed with 2.1 million m^2, 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 Chile

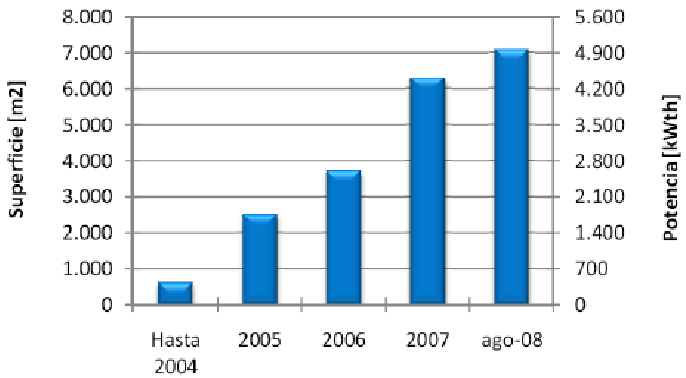
- **Present situation:**

Chile is a country that has significant natural resources and the sun is one of them. As a matter of fact, the north region of the country is one of the areas with the largest potential in the planet.

Last year's publication of Law 20365 has involved a positive change in the solar thermal industry scenario in Chile. A study carried out by the Technological Development Corporation (CDT) shows some very interesting details:

The evolution of the panel surface installed in the last years is quite remarkable, reaching as many as 7,000 m^2 in 2008 (data available as of August 2008):

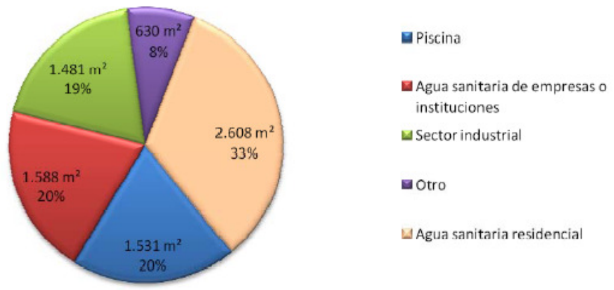
Evolution of Solar Thermal Collectors (m^2)



Annual evolution of the installed surface (Source: CNE & CDT).

Out of the various sectors where these systems are applied, it is the residential sector where there is a higher concentration of systems, which represents 33% of the whole. Swimming pools (20%), firms and institutions (20%) and the industrial sector (19%) are the sectors behind the residential one:

Surface of the Solar Thermal Collectors by sector (m^2, %)



Surface of the solar thermal panels by sector in 2007 (CNE & CDT)

So far, the main sources of energy used in Chile to produce sanitary hot water (SHW) are natural gas and liquefied gas, although if we talk about the residential sector, only 57% of the Chilean households have a SHW production device (according to the data of the 2002 census).

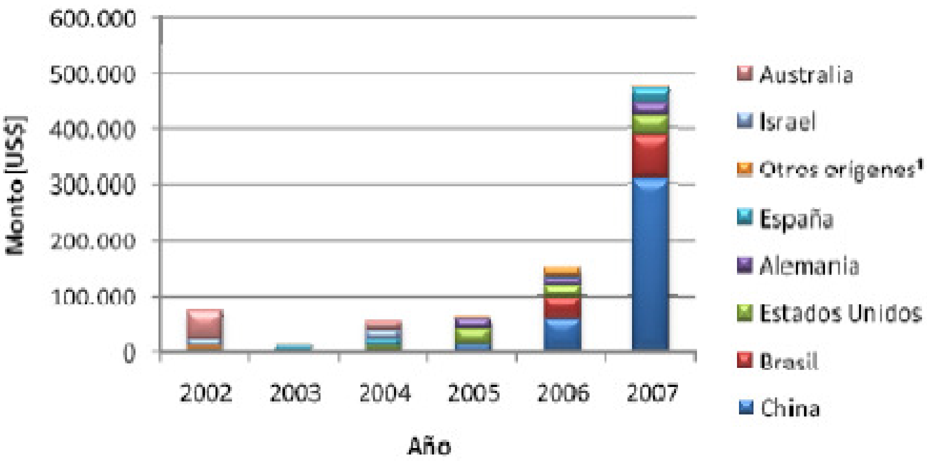
Within the residential sector and by dwelling, the following distribution of the solar thermal systems (STS) can be noticed: 73% corresponds to installations in urban dwellings, 15% blocks of flats, 7% apartments and only 5% in the rural sector.

Even if it is regions I, II and II the ones with a greater solar energy potential, it is the central areas (regions V, metropolitan region, VI and VII) the ones that in 2007 had a large number of solar thermal panels installed, precisely, 63% of a total surface of 6,307 m^2.

As regards the firms in the sector, there are at present some 100 firms that are related to STS, most of them, 81%, work and are established in the Metropolitan Region. There is hardly any difference between the activities they carry out: 100% of the firms are devoted to distribution and sale. Out of these firms, almost 90% also make the installation. The pieces of equipment are largely imported and out of these imported items, only a minority belong to international well-known makes.

As regards the provenance of the collectors that are traded in Chile, in 2007 over half of the panels came from China:

Import provenance of the of solar thermal panels (US$)



Annual import provenance of solar thermal panels (CNE & CDT).

The sector's strong dynamics and the scarcity of in- and out-market barriers make the sector yield a high rate of creation and disappearance of firms and activities. This situation is very negative for any industrial sector as in can end up raising distrust in users due to the lack of market guarantees.

- **Potential**

According to a former survey dating back to 2006 (Survey on the Chilean solar thermal market), the STS maximum demand potential in Chile amounts to 6,308,500 m^2. Most of this potential, 70.8%, corresponds to already existing houses, followed by 24.3% of the demand for newly build houses. The tourism sector and the health services show a lower percentage, 0.2% respectively.

Categoría	m²	%
Parque viviendas existentes	4.466.000	70,8%
Parque viviendas nuevas (2008 - 2015)	1.535.000	24,3%
Minería	172.900	2,7%
Avícola	70.500	1,1%
Mataderos	36.000	0,6%
Turismo	12.700	0,2%
Servicios de salud	15.400	0,2%
Total	**6.308.500**	**100,0%**

Maximum demand potential for solar thermal collectors in Chile, by sectors (Source: CNE)

At regional level and with 58% of the whole, the Metropolitan region shows a greater potential demand for solar thermal collectors.

- ### The Sector's Regulatory Framework

Law 20365 and its Regulation

Since last August 2009, the solar thermal energy sector has been regulated by Law 20365 "establishing a tax exemption in relation to solar thermal systems" and its Regulation.

With this new regulation, the building firms are entitled to deduct, out of the amount of their compulsory provisory payments stemming from the Law on the Income Tax Return, a credit equivalent to the whole or part of the worth of the Solar Thermal Systems and of their installation.

This tax exemption, on principle, is only applicable to newly built houses even if the Law, according to one of its sections, entitles the president of the Republic to establish a mechanism meant to finance STSs and their installation in existing state-subsidized houses.

The enforcement of this tax benefit started 90 days after the publication of the Regulation and will remain in force until 31st December 2013.

The amount of the credit varies proportionally to the price of the house (the house price is considered both the plot of land and the building), the year and the kind of installation (individual or collective). The relation between the amount of the credit, the house price and the year is described next:

- 100% of the whole of the value of the STS in question and its installation in buildings whose worth is not beyond 2,000 *unidades de fomento*[TN]. In any case, the benefit shall not exceed the following values:

Año	Unidades de fomento por vivienda
2009	32,5
2010	32,0
2011	31,5
2012	31,0
2013	30,0

Maximum annual tax benefit for an individual dwelling (Source: Regulations of Law 20365).

- 40% of the whole of the value of the STS in buildings, whose worth is over 2,000 *unidades de fomento* and which shall not exceed 3,000 *unidades de fomento*. In any case, the benefit shall not overcome 40% of the values on the former table.

- 20% of the whole of the value of the STS in question and its installation in buildings whose worth is not beyond 3,000 *unidades de fomento* and which shall not exceed 4,500 *unidades de fomento*. In any case, the benefit shall not overcome 20% of the values on the former table.

Should the SST be used by more than one dwelling, the maximum tax benefit to receive per year will depend on the surface of the installed collectors:

- Surface under 80 m2:

[TN] *Unidad de fomento*: Accountancy unit used in Chile. The exchange rate between the UF and the Chilean peso is constantly adjusted to inflation so that the value of the Unidad de Fomento remains constant.

Año	Unidades de fomento por vivienda
2009	29,5
2010	29,0
2011	28,0
2012	27,5
2013	26,5

Maximum annual tax benefit for a collective dwelling, collector surface < 80 m^2 (Source: Regulations of Law 20365).

- Surface over 80 m2 and under 120 m2 for :

B = (1-(S-80)/40)*(a-b)+b

Where “B” is the maximum benefit stated above for each dwelling unit, the one stated in *unidades de formento* per dwelling; “S” is the installed surface of Solar Thermal Collectors, stated in square metres; “a” corresponds to the values stated for each year of the former table; and “b” corresponds to the values stated for each year of the of the following table.

The Regulations shows the calculation procedure of the STS collectors.

- Surface over 120 m2 for :

Año	Unidades de fomento por vivienda
2009	26,0
2010	25,5
2011	24,5
2012	24,0
2013	23,5

Maximum annual tax benefit for a collective dwelling, collector surface < 120 m^2 (Source: Regulations of Law 20365).

Moreover, so that building firms may take advantage of this exemption, the systems are to contribute with a minimum percentage, which depends on the geographical area where the dwelling is and the annual average of SHW demand for the said dwelling. Chile is a country which, given its geographical distribution, has very changing solar radiations according to the region, ranging between 1900 & 2200 kWh/m^2 per year in the north area of the country and between 900 – 100 kWh/m^2 per year in the most southern area. In the areas with more solar radiation, the minimum solar contribution should reach 75%, and the said contribution in the south area of the country of 30%:

Zona Climática	Radiación Solar Global Media Anual (H)	Contribución Solar Mínima
	[KWh/m^2 año]	[%]
A	1948 ≤ H	75
B	1701 ≤ H < 1948	66
C	1454 ≤ H < 1701	57
D	1208 ≤ H < 1454	48
E	961 ≤ H < 1208	39
F	961 < H	30

Minimum solar contribution for each climatic zone (Source: Regulations of Law 20365).

Another requirement is that the pieces of equipment or the STS goods must be new and must not have been previously installed in other buildings.

With a view to meeting all the technical requirements, the Law envisages the creation of testing laboratory and certification bodies, to be accredited through the National Institute for Standardization (INN). Moreover, the Superintendence of Electricity and Fuels (SEC) will carry out the control of products on the market, will deal with complaints and will fine the non-compliance with the enforced regulation. Importers or manufacturers of collectors have to demand the certification of their products to the certification body. It will be then guaranteed that the installations benefiting from this tax exemption meet the specifications stated in the Regulations.

Builders and developers are to meet a series of obligations:

- At the time of obtaining the municipal acknowledgment, the building firm must submit an affidavit on the kind of collector and accumulation deposit installed, and a second affidavit ensuring that the system can generate the minimum percentage of the annual average SHW demand.

- The developer must be answerable for the failures and defaults in the installed STS for a 5 year period.
- The developer must be in charge of the STS inspection, upon request of the owner.

Some of the most important technical requirements defined in the Regulation are:

- They are to have separated primary and secondary circuits.
- The design and sizing of the system is to be made with a software programme that should take into account a list of variables.
- An antifreeze mixture is to be used in the primary circuit when there is a risk of frosts.
- The design is to take overheating into account and must work under conditions of non-consumption of water and high settling.

• 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 Chile, even if it is true that the first installations date back to the second half of the XIX century, it has not been until these last years that the sector has started to undergo some growth. The 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.

- **Poor market development:**

Only around 10% of the firms in the sector are devoted to the manufacturing of collectors. This forces the country to import most of the collectors from other countries and pay technology at international prices. This low level of domestic manufacturing is also due to a poor market development. It is necessary that demand for these systems should increase and therefore, give way to the sufficient critical mass enabling the domestic manufacture of collectors to become interesting enough for entrepreneurs.

- **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 (between 8 and 10 years for single-family dwellings) 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 uses 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 unsure 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.

Poor market development:

Create the conditions for the solar thermal system market to be developed through a suitable regulatory framework that may boost the use of this technology, increase the offer and develop domestic industry. As a matter of fact, this is the objective of Law 20365 and its Regulation, to establish the technical demands of the STS as well as create an incentive; such is the case of the tax exemption.

Lack of technical documentation:

Drafting of design guidebooks and calculation programmes, acknowledged by the Regulations of Law 20365, addressing architects, engineers, etc.

Financial

It is necessary that there should be an appropriate financial mechanism to boost the use of solar energy, as it is the case of the tax exemption of Law 30365. This tool will also be used to regulate the import of quality equipment and encourage the specialisation of firms.

Regulatory:

As it was stated above, Law 20365 envisages a certification system for solar collectors and accumulation tanks. Implementing a certification system for solar collectors can be too expensive. An alternative can be using the official approval of international efficiency labels.

Moreover, the Law obliges the installations receiving tax benefits to meet the technical demands of the Regulations, and to supervise the compliance with the Regulations. For so doing, the Law envisages creating inspection bodies or other control bodies to inspect STS.

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. As a matter of fact, various projects are taking place in Chile, such as the housing development *"Juntas Podemos"* of the Lo Espejo municipality. Thanks to this project, 125 families benefit from solar collectors to generate SHW.

In general and as it was stated in one of the sections, Law 20365 and its **Regulations** are essentially meant to pull down the said barriers. On the one hand, the established tax exemption aims at reducing the high recovery periods of the invested capital. Another important aspect of this law is that it establishes the technical demands of the STS, apart from creating, on the part of the SEC, inspection bodies, testing laboratories and other control bodies. In this way it will be possible to carry out an appropriate survey of the devices to use (panels, storage heaters, etc.) and also of the correct running of the very installations. Last, the law obliges developers to guarantee STSs for five years, thus facing up to the current mistrust of users for this technology.

The existence of an **association** that gathers together all the agents in the sector is another essential measure. An association becomes an ideal place where to discuss ideas and reach a consensus for actions encouraging and improving the use and development of Solar Thermal Energy in Chile.

In this sense, the CDT (Technological Development Corporation) has created *Nodo-solar* with a view to increasing its leadership in the solar thermal area. The aim of *Nodo-solar* is to strengthen technological networks and the capacities of the solar thermal sector in response to the energy needs in Chile. By disseminating updated information on the issue, bringing the headway of this technology close to the population, as well as the effectiveness of these systems it is sought to reduce the main failures in this segment and increase its specialisation.

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