ZEE Centre for Renewable Energy

Working Paper 03 - 2011

Solar Thermal Water Heaters in Argentina

Market Characterization and Analysis of Barriers to Diffusion

Björn Nienborg

UNI FREIBURG

Published by:

Centre for Renewable Energy
Zentrum für Erneuerbare Energien

University of Freiburg
Tennenbacher Str. 4
79106 Freiburg
Germany

Tel.: +49 (0) 761-203-3689
Fax: +49 (0) 761-203-3690
E-Mail: zee@zee.uni-freiburg.de
Web: www.zee-uni-freiburg.de

ISSN online: 2191-0685
ISSN print: 2191-0677

In 2010, the Centre for Renewable Energy initiated its work on a series of working papers. The primary objective of these papers is to stimulate discussion in the field of sustainable energy in Europe as well as on a global scale. An accurate citation of the findings, interpretations and opinions included in these papers must be ensured. They reflect the work of their authors and do not reflect the opinions of the Centre for Renewable Energy or the University of Freiburg. We welcome feedback from readers and request that they convey their comments and criticisms directly to the authors.

Author(s):
Björn Nienborg

Centre for Renewable Energies
Tennenbacherstr. 4
79104 Freiburg
b.nienborg@yahoo.com

Björn Nienborg is a graduate of “Environmental Engineering” at the University of Applied Sciences Hamburg. Since 2006 he works at Fraunhofer Institute for Solar Energy Systems. Between 2008 and 2010 he studied the Master’s degree “Renewable Energy Management” at University of Freiburg. In frame of his Master thesis, which serves as base for this article, he analyzed the Argentine market for Solar Water Heaters.

Acknowledgment

I would like to express my utmost gratitude to the staff of Fundación Bariloche (FB) for making the thesis which underlies this paper possible. My special thanks go to Gustavo who invited me to FB and guided me through the thesis, although we haven't even met in person. Also without these colleagues the work would have been much harder and less pleasent: Rocío helped me greatly in fine tuning the Spanish resume of the thesis which was distributed among the companies who participated in the survey. Hilda kept me up to date on the actual development in Argentinean energy politics. Daniel facilitated me a working place at FB's Buenos Aires branch. Javier was there any time for a chat and laugh to clear my mind when I was stuck. Paula always had some motivating words for me. Nelly guaranteed a restful lunchtime which Osvaldo sweetened by sharing his many culinary secrets. The last but not least person I will keep in good memory from FB is Fernando who made me look forward to turning 89 years old :-)

Further thanks go to all others who gave me advice and support, among them the companies who took part in the survey. I also greatly appreciate the help by Sebastian Möller, Florian Mehling and Hanno Dietrich who supported me by proofreading, printing and binding this work. Of course I am grateful to Prof. Bollin and Prof. Oesten for supervising the thesis on the side of the University of Freiburg.

Above all, I thank Anna, who stood beside me and encouraged me and my family, who has always supported me.

Finally I would like to acknowledge the financial support by the German Academic Exchange Service.

Abstract

As countries all around the world Argentina has begun to diversify its energy mix in order to reduce the dependency on fossil fuels. Solar water heaters (SWH) can contribute to this goal but little data is available on the actual market. This paper provides a characterization of the actual situation based on a survey and describes the potential, the barriers and possible solutions for the technology.
The survey shows that most commercialized product is thermosiphon system, with almost 2000m² of installed collector area registered for 2009. One third of it was imported, the rest produced locally. The systems are mainly installed in family houses in the north of the country substituting bottled gas and fire wood, because of good profitability and a noticeable increase in comfort.
The potential for hot water preparation in the residential sector is 6’150’000 m² and another 2’260’000 m² in the public and service sector. The main barriers to diffusion are the limited profitability of SWH due to unfavorable politics and insufficient awareness of the potential of the technology. Quality assurance is another issue to be tackled in the future. An essential step to overcome the barriers is the formation of a solar thermal industry association in order to coordinate actions and increase their impacts.

Contents

1. Introduction

Due to increasing fuel prices and the climate change discussion countries all around the world have intensified their efforts to shift to renewable energies. In Argentina the transition from a fuel exporting to an importing country in recent years provides additional motivation for a change. As a consequence the government has set targets for renewable electricity production (National law 26.190) and for biofuels (National law 26.093). However the potential for renewable heat is still generally ignored by the national authorities.

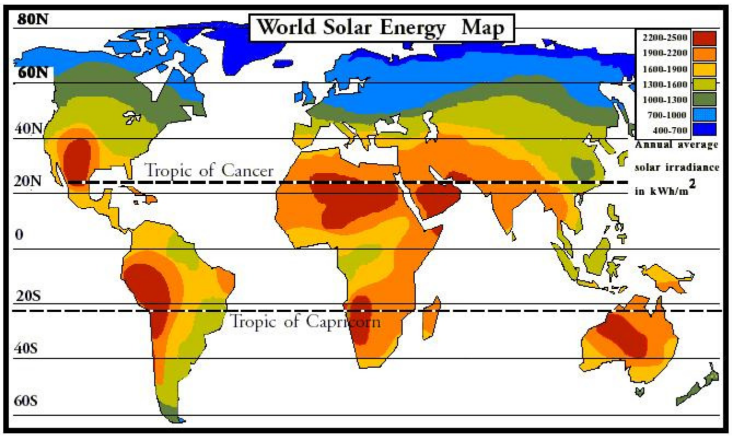

Figure 1.1: Average annual irradiance in the world in kWh/m²; Source: INFORSE

The north of the country is among the top six regions in terms of solar irradiation and also in the rest of the country the annual radiation values are well above those in central Europe. Despite the resulting potential for solar water heaters (SWH), the technology is hardly used in Argentina. While over 180 GW_{th} of solar thermal capacity are installed worldwide (29 GW_{th} in 2009 alone in China!) Argentina is not mentioned in the global solar thermal status report [SM10, WM10]. Comprehensive information on the market situation is not even available on the national level. Yet the fact that various companies and research institutes work with the technology proves that there is a certain activity in the sector. This study proposes itself to fill the knowledge gap by characterizing the present market for SWH.

Recent studies on renewable energies have revealed a number of barriers which hinder the market entry of new energy technologies. [NBD09, CBG09]. Therefore another aim of this thesis is to analyze the barriers that apply to SWH and to develop a proposal for solutions based on experiences from other countries.

The overall objective thus is to provide profound data on the actual market which will facilitate the development of adequate solutions to the actual hurdles for the technology. Likewise it will allow defining indicators in order to measure the impact of potential incentive and/or promotive actions. The timing of the thesis is in line with actual developments: At the present there is an initiative headed by the National Institute for Industrial Technology (INTI) with the aim to get renewable energies on the agenda of politicians. The fact that INTI plans to push the introduction of a bill on the utilization of solar thermal energy in the Argentine National Congress additionally underlines the topicality and relevance of the presented study [E-R09].

2. Background – The Energy Sector in Argentina

2.1 The Energy Mix in Argentina

Figure 2.1 shows the distribution of the Argentinean primary energy sources according to the National Energy Balance [Sec09]. Evidently the vast majority is covered by fossil energy. In 2005, the last year for which consistent data is available, the largest share of it (51%) and with increasing tendency was met by gas, followed by oil (37%). The contribution of the remaining sources to the energy mix in absolute numbers has been rather constant since 1990. In 2005 hydro-power accounted for approximately 5% and nuclear power for 2.5%. Coal, bagasse, wood and other, which includes agricultural residues used for incineration and wind power, constituted around 1% of the primary energy mix each.

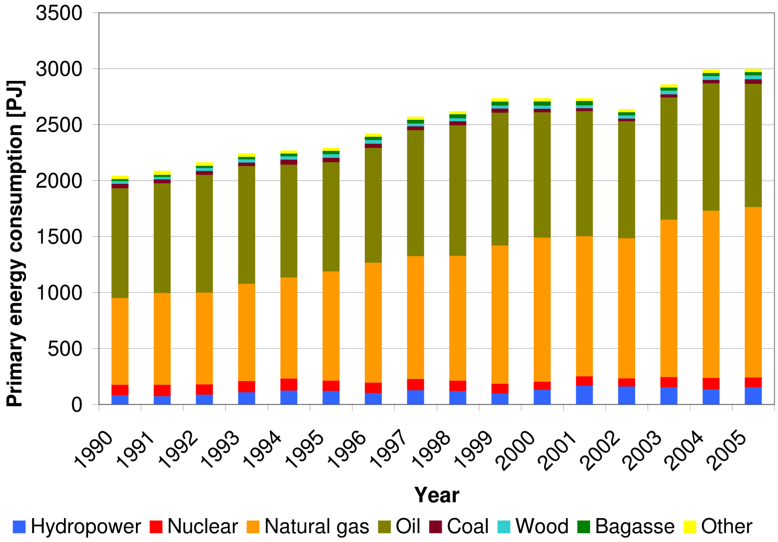

Figure 2.1: Development of the primary energy consumption in Argentina; Source: [Sec09]

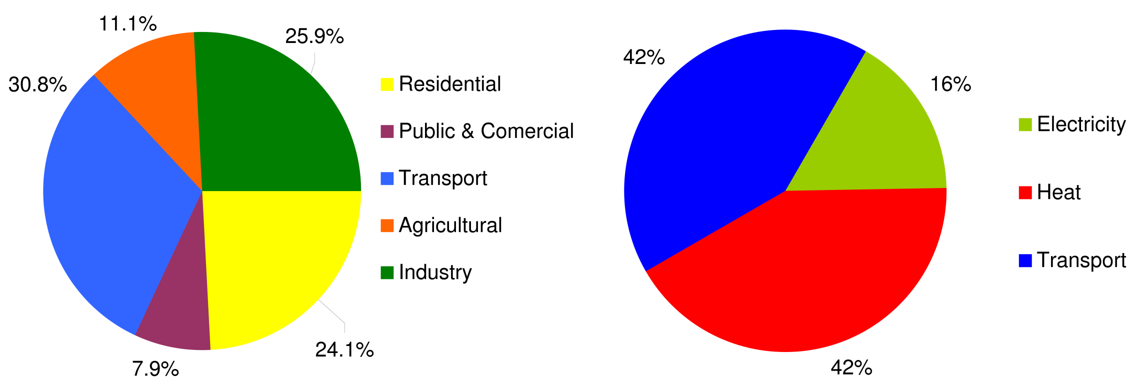

Figure 2.5: Final energy consumption in Argentina by sector in 2005, excludes non-energetic uses; Source: [Sec05]

The structure of the demand side is displayed in figure 2.2. Transport (including 10% agriculture) and heat constitute 42% of the final energy consumption respectively. Only 16% of the final energy consumed consists of electricity [Sec06]. It makes up around 20% of the domestic, 54% of the public and commercial and 27% of the industrial final energy use. At the end of 2007 Argentina's installed electric power capacity was 24,352 MW. 54% of the electricity consumption was derived from thermal generation by fossil fuels, 42% from hydro-power and 4% were provided by nuclear power generation [MG09]. The contribution of renewables was 0.57% (27 MW in 2007) by wind power and mere 0.0001% by photovoltaics [Sec08b]. Their growth rate is also low - by 2010 e.g. the installed wind power capacity has only increased to 29.8 MW [Spi10].

2.2 Renewable Energies in Argentina

Around 8% of the primary energy demand of Argentina is covered from renewable energies in 2010. This remarkable value mainly emanates from two sources: hydro power (two very large plants with 5.1 GW nominal power in total in the north of the country and several large plants with a total of 6 GW nominal power in the southern Andes) accounts for nearly two thirds (62%) of it and thus covers around 42% of the total electricity demand. The remaining 38% can be attributed to the thermal use of biomass and agroindustrial waste [REC06a, MG09].

In the last decade there were efforts to expand the utilization of renewable energies in order to meet the growing demand despite declining reserves:

- As a consequence of increasing prices for fossil fuels, energy scarcity (especially in winter) and climate change the government stated its intention to increase the share of renewables in the Argentinean power mix. This effort is most clearly expressed by the national law No. 26190 which came into force in 2006 with the objective to increase the share of renewable electricity other than large hydro from currently 1% to 8% within 10 years [Con06]. On its basis in 2009 the government announced the program GENREN, a tender procedure for 1,000 MW of renewable electricity. Subsequently in June 2010 the construction of 895 MW of renewable electricity was allocated. The majority corresponds to wind energy (754 MW), followed by bioenergy (110.4 MW). 10.6 MW of small hydro power and 20 MW of photovoltaic projects make up the remaining share [Sec10].
- In order to reduce pressure on conventional energy resources in 2006 the national law No. 26.093 was approved. It dictates that from 2010 onwards all liquid fossil fuels must contain at least 7% of bio-fuels [Win09].
- Another noteworthy initiative to implement renewable energies is the PERMER project which was initiated in 1999 has been extended until 2011. Originally its only objective was to provide the 5% of the Argentine population that has no access to the grid with electricity to satisfy basic requirements [AH07]. This is done by assigning concessions to independent contractors providing subsidies and fixed tariffs. The original project phase did by far not reach the set goals (2235 instead of 314'000 households and 556 instead of 6000 public institutions provided with electricity). Still the project's has a significant dissemination effect for which it was prolonged until 2011 and extended to solar thermal applications such as solar cookers and solar water heaters [Loy07].

The mentioned initiatives provide evidence for efforts to promote the use of renewable energies - but only for electricity production and mobility. Although thermal energy makes up the largest share of the final energy consumption, there is no national incentive to use renewable heat - among it solar thermal - in order to reduce the dependency on conventional energy.

2.3 Past Development and Status Quo of the Argentine Solar Thermal Market

The weak situation of solar thermal in Argentina is already reflected by the little data available. As a consequence of the oil crisis in the 1980s there was a rather important (scientific) movement in favor of solar thermal energy. Eventually this led to the release of a number of national norms for the certification of components of solar thermal systems e.g. [Ins85]. In the 90s the public interest in solar thermal energy decreased considerably leading to a cut in many activities in that field [NBD09].

For years the cause of interest in the technology shifted towards another purpose: In 1994 it was found that solar thermal technology among other renewable energies can help to alleviate poverty in rural Argentina [LAAB94]. This idea was also pursued by other actors. The non-governmental organization EcoAndina based in the poor northern province of Jujuy has been using different solar thermal technologies to help improve quality of life in rural Argentina [MS04]. In the frame of the project Renewable Energy Technologies (RET) of the Global Network on Energy for Sustainable Development (GNESD) the potential of different renewable energy solutions to combat poverty was analyzed in 2005 [BSD05]. Solar thermal was found to be the most attractive technology for reaching the goals in terms of technical availability and costs (small wind generators being the second option) [NBD07].

In 2004 a report on renewables by the Argentinean Ministry of Energy states that “the solar thermal energy could reach a great development if an adequate subsidy scheme is established and ... if certain measures for its promotion ... among potential users are taken” [Sec04, p.46]. One year later the potential of the installation of solar water heaters in private household in order to create emission reduction certificates was estimated. A maximum of 1.8 million square meters of collector area by 2015 were considered possible if appropriate measures were taken. Unfortunately none of these reports led to a noticeable initiative to foster the technology [Rod05].

An estimation within the RECIPES project from 2006 states that 12’000 installations with 2 m^2 each were in operation in that year, either in remote locations without access to fossil energy sources or for “ideology/ fashion reasons” [REC06b, p.21].

A study on the target group for both photovoltaic and solar thermal energy by the German Chamber of Commerce contains a short survey among 10 companies. It reveals that companies see a high potential for the use of solar energy. The impeding factors are the lack of incentives and the low prices of the conventional fuels [Thi07].

Based on the RET report the Institute of Energy Economics (IDEE) of the Fundación Bariloche (FB) later elaborated another document on solar thermal in Argentina consisting of three parts. Part one is an assessment of the potential for the technology for domestic hot water production and space heating derived from the estimated actual consumption. According to this estimation around 890’000 m^2 of collector area could be installed in private households replacing liquefied petroleum gas (LPG). The next part gives an overview of the actual state of the market including producers, research activities, realized applications and legal framework. Finally the deficits of the actual situation are illustrated in part three and a proposal for an incentive program is given [NBD09]. Although the factual basis especially for the potential study contains many estimations and there is little resilient data of existing installations this report seems to give the most comprehensive overview on the status quo of solar thermal energy in Argentina.

Other studies on the state of the art of renewable energy in Argentina and/or South America focus on electricity production. So does the official study on the actual situations of renewable energies published by the Ministry of Energy only a few months ago. In a survey among producers and researchers in the field of renewables, the study does not even distinguish between photovoltaic and solar thermal energy. Nevertheless it awards solar thermal technology a considerable potential for substituting other fuels, especially bottled gas, but does not specify the potential. Also it is expressed that the divulgence of the technology at present is limited to “certain niches with high income and some stores .. which use bottled gas” [CBG09, p.12]. Also in Kissel’s study on renewable energy law for emerging markets in South America the term “solar energy” just stands for photovoltaics and solar thermal energy is not even mentioned [KHK09].

In 2009 the National Institute for Industrial Technology (Instituto Nacional de Tecnología Industrial, INTI) initiated a program to foster the research on and application of renewable energy technologies. For solar thermal this includes a number of activities:

- The Plataforma Solar was set up, a testing facility for nationally produced SWH where they are analyzed in terms of performance and quality.
- Companies receive assessment on their outside presentation.
- The elaboration of a draft legislation on the use of solar thermal energy. In this frame INTI claims to offer a space for discussion among all interested actors of the sector.

These activities and the first normative initiatives on municipal level in Venado Tuerto and Rosario (both Santa Fé Province) and Bragado (Buenos Aires Province) nourish the hope that solar thermal energy finally receives the official support it needs to succeed [NBD09].

3. Survey among Solar Thermal Companies in Argentina

3.1 Objectives

The aim of the survey is to provide comprehensive and consistent data on the actual market for SWH. It was designed to answer the following questions:

- What are the structure of the solar thermal business sector and the background of the companies active in it?
- Which products and services are available in the field of solar water heaters? What is the effort undertaken for quality assurance?
- What was/is the market volume in the past/present? What are the expectations for the future?
- Which are the actual target groups for SWH?
- Which barriers hinder the diffusion of SWH? Which measures are considered adequate to overcome them?

3.2 Methodology

Target Group

The survey was directed exclusively towards companies working with solar thermal because of several reasons. Due to the little market development, up to now there is no comprehensive information on the solar thermal market. Evidently the companies are most suitable to provide data on products and services, market volume and target group. As the total number of companies in the solar thermal business was expected to be low (the initial estimation was around 40), the survey was oriented to all producers, importers and installers of solar thermal equipment likewise. This way an integral image of the market view could be reproduced.

The list of companies which were contacted was gathered using various sources: an existing compilation of companies working in the field of solar energy in general (PV and/or ST) available from the INTI website served as a basis. It was complemented by extracting solar thermal companies from a list of more than 1500 respondents of a former survey on renewable energies for electricity production by Fundación Bariloche. Additionally an extensive internet search was performed including reviews of online mercantile directories and companies selling SWH on MercadoLibre, a South-American equivalent to Ebay. Finally companies encountered at various events on renewable energies and construction were included. In total the list sums up 72 companies.

Formal Aspects

There are three forms to conduct a survey [Dil07]:

- **Personal interviews** allow for a detailed results and further inquiries in case of unclear answers. Their disadvantage is that they are complicated to obtain, time consuming and costly because of travel expenses.
- **Telephone interviews** basically offer the same advantages as personal ones. Practice has shown that it is significantly more difficult to get interviewees to participate and

answer all questions. As (automated) telephone interviews are very common in Argentina, there is a widespread dislike towards this form of survey.

- **Written surveys**, usually with standardized questionnaires, are cost effective, time saving and easy to administer. Their negative is that they may be rapidly forgotten or discarded as “spam” and thus have the lowest degree of return.

Because the targeted companies are spread all over the country personal interviews were rapidly excluded. For the mentioned reluctance and because some questions may require some thinking time also telephone interviews were found inappropriate. Therefore it was opted for a written survey. In order to minimize the stated disadvantages, before sending out the questionnaires, the companies were called and informed about the survey.

The Questionnaire

The questionnaire was preceded by a short introduction stating the objective. In this context the support by two well-known national institutions (FB and INTI) as well as the German University of Freiburg was mentioned and full confidentiality of the answers guaranteed. Finally the respondents were informed that they would receive the results of the survey once it is finished. Of course the questions themselves were elaborated according to recognized recommendations: clearly and unambiguously [Por00, Por01, Dil07]. Because of different computer skills and preferences participants were given two possibilities to answer the questions. An online version of the questionnaire was prepared on www.kwiksurveys.com, a free survey tool. As an alternative participants were sent a Microsoft Word version of the questionnaire.

According to the stated objectives and after reviewing related surveys from other countries the questionnaire was designed in four thematic sections [Leb06, Chi06, Dir09, Esk09]. The first part is dedicated to general information on the company: besides contact data the business areas, the year of initiation of (solar thermal) activities and the number of employees are asked. Thus the structure of the solar thermal sector and the position of the single companies in it are revealed.

Part two aims at collecting details on the products and services provided by the specific company. Special attention is dedicated to quality-relevant topics such as certification of the products, warranty and after sales services.

The third section consists of questions on the actual market activities. At the risk of remaining unanswered, concrete data on the market volume, target groups and geographical distribution is surveyed. This allows to derivate the most promising market sectors as well as those with most need of support. Thus this information is important to develop a target-oriented road map for market deployment. Likewise the knowledge on the actual situation will facilitate the monitoring of the development and the impact of possible future policies.

The final part deals with market barriers. On the one hand the participant is requested to evaluate the importance of different barriers. On the other hand he is given free space to provide suggestions on how the barriers can be overcome. At the very end of the survey there is some free space so the respondents could leave comments on the survey.

According to the objective of revealing the actual market situation for SWH, the questionnaire contains mostly closed or half-open questions, sometimes complemented by a space for remarks. Only the very last question asking for suggestions on how to remove market barriers is an entirely open question. The emphasis of this survey is a qualitative investigation in order to provide a comprehensive characterization of the market. Yet some quantitative data is used to round off the overview. The Microsoft Word version of questionnaire can be found in Annex B.

Evaluation of the Results

Before the actual evaluation the results were checked for consistency. If there were evident contradictions or mistakes in a response these were corrected. In specific cases companies were contacted and asked to resolve the doubts.

The revised results of the survey were evaluated graphically. In a first step they were analyzed individually. Subsequently - wherever sensible - the answers to different questions were interlinked. In certain cases they results are also combined with data from external sources, in order to facilitate their interpretation.

3.3 Results

In total the questionnaire was sent out to 72 companies between May and July 2010. Three email addresses turned out invalid. 35 questionnaires were returned (many of these only partly completed). Compared to reference values from literature for written surveys the resulting 49% of return are very satisfying number.

Many of the companies that did not answer could not be reached by phone or said they would complete the questionnaire later on but never did. Only three contacts refused to answer. One considered his contribution irrelevant due to his modest knowledge of the local market, the second feared competition “from abroad”. The third stated that the company was only just initiating solar thermal activities and therefore was not able to answer the survey yet.

3.3.1 Companies

Geographical Distribution

Looking at the regional distribution of the companies that took part in the survey a clear concentration around the capital can be observed. 15 of the 35 businesses are located in Greater Buenos Aires[1].

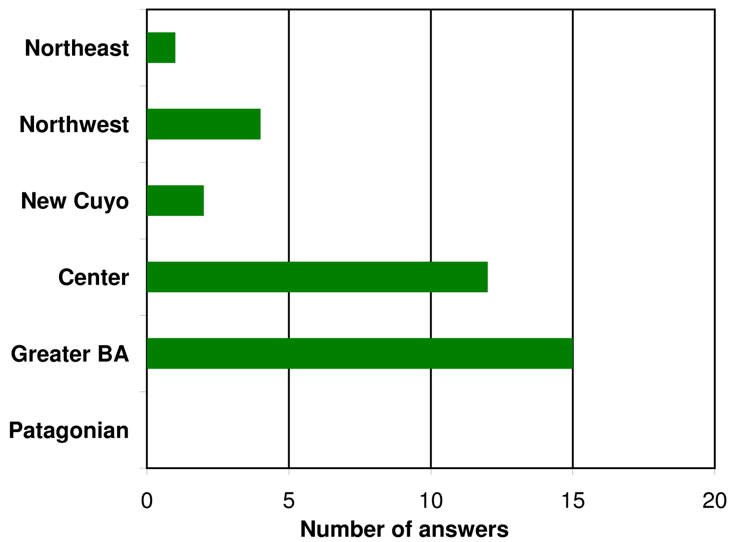

Figure 3.1: Geographical distribution of the participating companies; BA=Buenos Aires

[1]The Greater Buenos Aires (*span.*: Gran Buenos Aires) comprises the Autonomous City of Buenos Aires and 24 surrounding municipalities located in the Buenos Aires Province

Another 12 companies are based in the rest of the central Argentinean region[2], whereas the nine sunny Northern provinces only sum up five solar thermal companies. From the Patagonian region no answer was received. This - at first sight seemingly very unbalanced - distribution looks more even if correlated to the number of inhabitants per region.

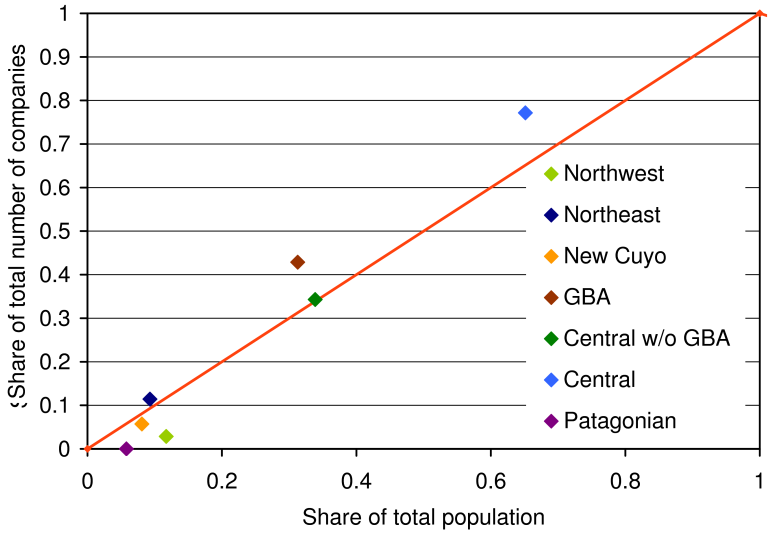

Figure 3.2: Correlation between population density and geographical distribution of the participating companies; Source of population data: INDEC

The resulting graph indicates a very high density of solar thermal companies in Greater Buenos Aires. This can be related to the centralized commercial structure of the country, with the most important trade port being located in this zone. The products are distributed all over the country from here, which hinders comprehensive after-sales services. The absence of solar thermal companies in the South can be attributed to the lower availability of the solar resource. Despite the high irradiation values in the North West of the country this region shows a very low share of solar thermal companies.

Renewable Energy Business Areas

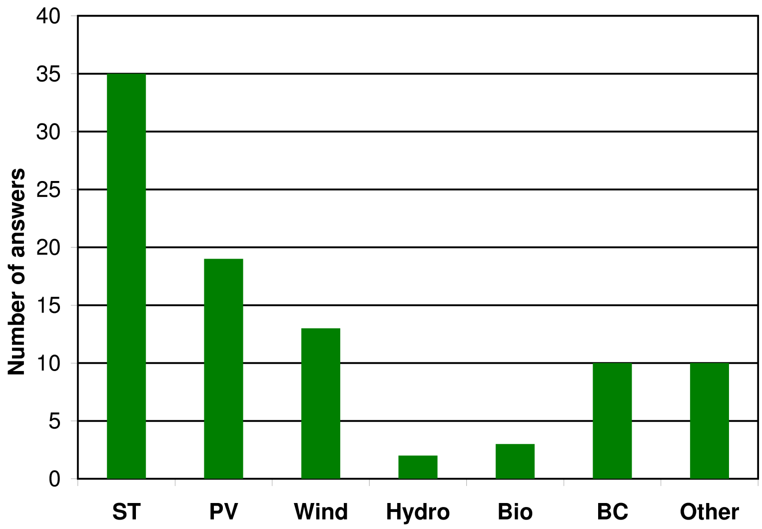

Figure 3.3: Overview on renewable business areas covered by the participating companies; ST=Solar Thermal, Bio=Bioenergy, BC=Bioclimatic Construction

[2]A map of Argentina and its regions can be found in Annex C

For 13 of the participating companies solar thermal energy is the only renewable energy they are dedicated to. Almost all others offer PV equipment, followed by wind energy and bioclimatic construction. Few companies work in the field of bioenergy, which is scarcely developed in Argentina for the residential sector. The respondents' engagement in hydro-power is also low. This can be explained by the fact that the construction of hydro-power plants requires experience in hydraulic engineering and therefore is done by few specialized companies.

Other activities pursued by the respondents are generally from the field of engineering and include: metal working (2x), industrial ventilation, industrial boilers, waste handling and fire protection.

Initiation of Solar Thermal Activities

Two companies started their solar thermal activities before 1980 (the first in 1977). In the following two decades the number of solar thermal companies increased very slowly. Only after the year 2000 the rise in the number of market actors accelerates and turns out almost exponential in recent years.

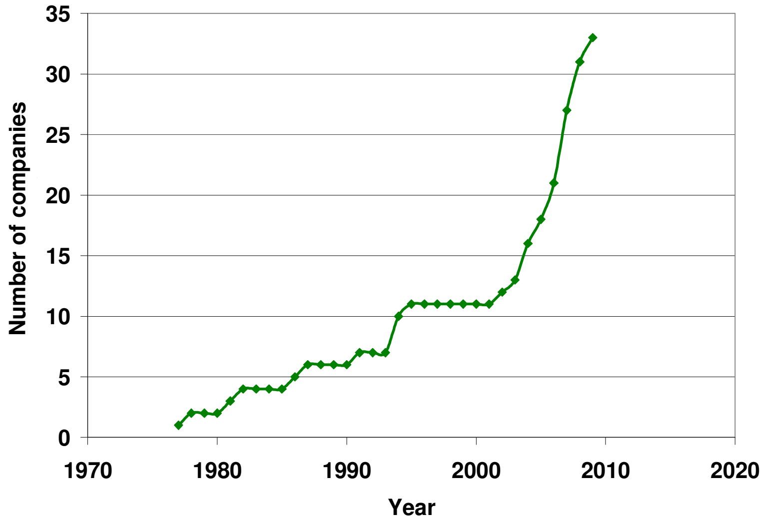

Figure 3.4: Overview on years of initiation of solar thermal activities

This development clearly points to an (expected) substantial increase in the demand for solar thermal equipment.

Size of Companies

27 of the participating companies declare to have between one and five employees and thus are micro-enterprises[3]. Five out of the remaining seven companies have their main business activities outside the renewable sector, which implies that solar thermal is only a marginal business for them. Evidently the solar thermal sector is still in the fledgling stages, despite the steep rise in the number of companies.

[3]In Argentina micro enterprises are defined by the annual sales volume. Since this data is unknown the European definition is adopted, according to which enterprises with up to 10 employees are micro enterprises.

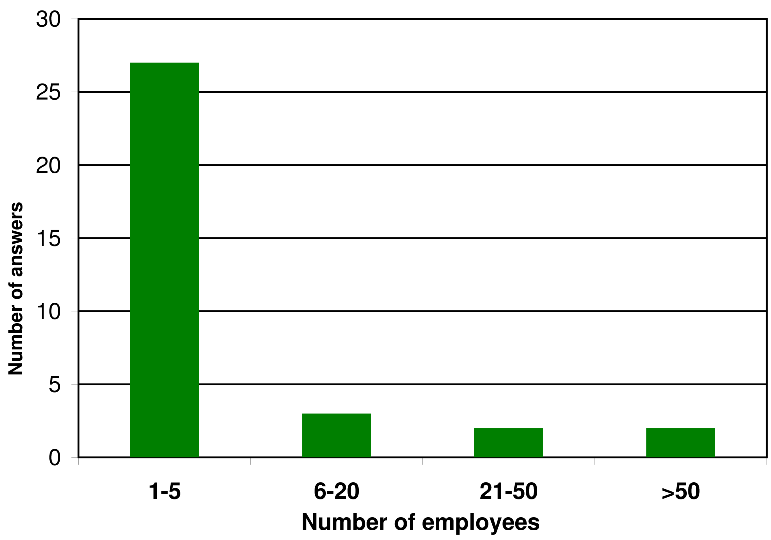

Figure 3.5: Number of employees of the participating companies

3.3.2 Products and Services

Solar Thermal Business Areas

Two companies did not answer this section. One striking result is that more than half of the participating companies (18) claim to produce collectors, even though four of the twelve producer contacts provided by INTI have not answered. Partly this high share can be attributed to the fact that producers probably are more engaged with the technology than mere importers or resellers and thus show more interest in this study. Besides it points out the strong will to supply the market with national products.

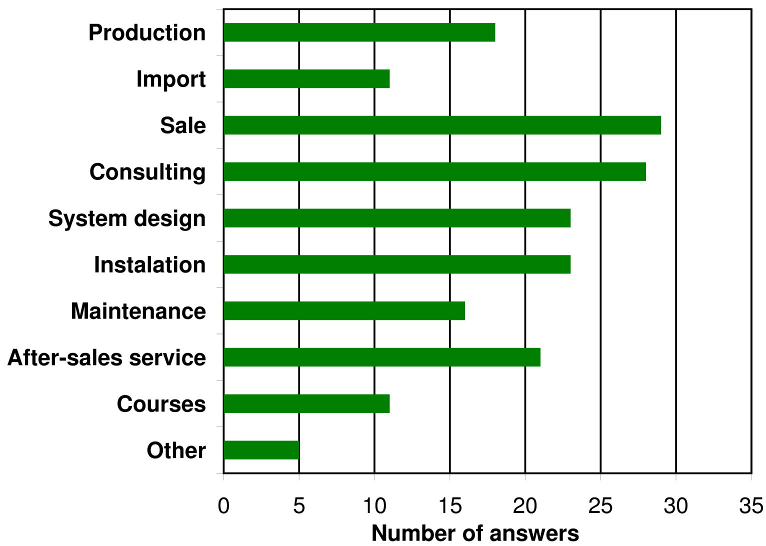

Figure 3.6: Solar thermal business areas attended

A worrying fact is that the number of companies selling solar thermal systems exceeds the one of those providing consultancy (or offering system design and installation services). Thus a certain share of the customers is left alone with the product which leads to the risk of deficient installation if he/she is not proficient in this technology.

Further weak spots can be found in maintenance and after-sales services. Almost 30% of the companies selling solar thermal equipment do not offer any after-sales services. The same finding holds for maintenance: although one would expect that at least the executing companies (installers) offer servicing for their systems, only around two thirds do so.

Available Products

Most of the companies offer flat plate collectors, more than half (14) refers to self-constructed products. Imported brands include Ariston, Rehau and Schüco. Besides 14 companies have at least one type of vacuum tube collector in their product line. Mostly these are imports of Chinese no-name products. Two companies claim to assemble the collectors themselves on the basis of imported vacuum tubes. Only few respondents work with unglazed and air collectors.

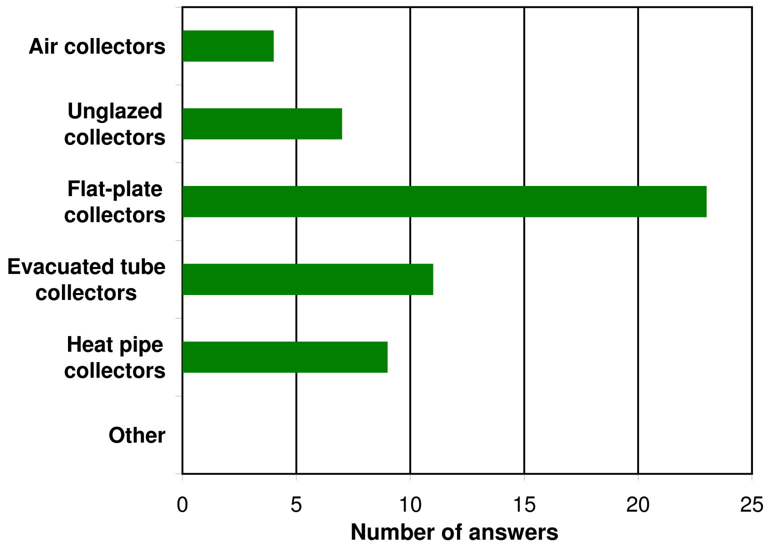

Figure 3.7: Overview on the commercialized collector types

The most predominantly marketed system type is the thermosiphon system, followed by the pumped DHW system and the combisystem. Five companies say to offer swimming pool heating as well. This number can be corrected to ten if we assume that all companies offering unglazed collectors apply these for swimming pool heating. Other uses are for industrial applications and climatization of livestock breeding facilities.

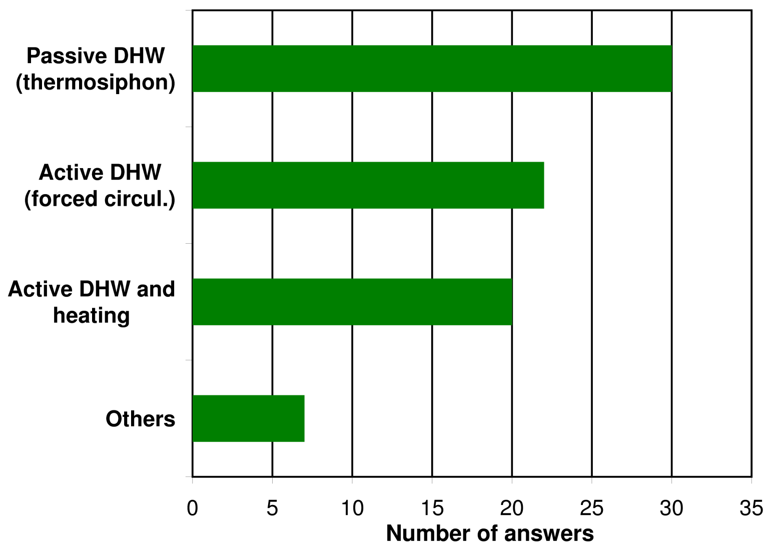

Figure 3.8: Overview on the marketed SWH systems

Quality Assurance

As unreliable products cause a lasting damage to the market, product quality is essential for the market deployment of a new technology. Therefore three quality indicators were surveyed.

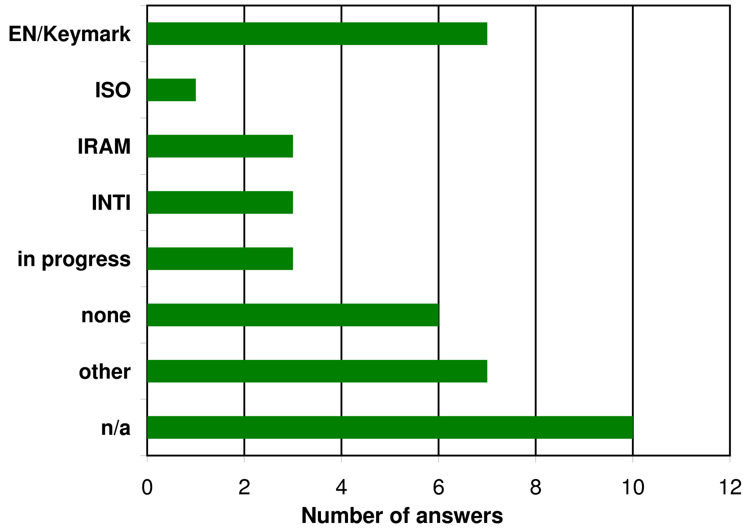

Figure 3.9: Certification of market available products

The certification of a collector or solar water heating system assures the durability and performance to the user. The fact that six companies say to market uncertified products and another ten of the respondents give no or an unspecific answer expresses that this topic is widely undervalued. Only nine questionnaires give evidence of a certification according to at least one of these: EN, ISO or Argentinean IRAM standard. In three cases certification is in process. Three more companies are working with INTI to improve the quality of their products. Several respondents named certifications which are not specific for solar thermal equipment such as ISO 9001, ISO 14000 and CE - these are included in “others”.

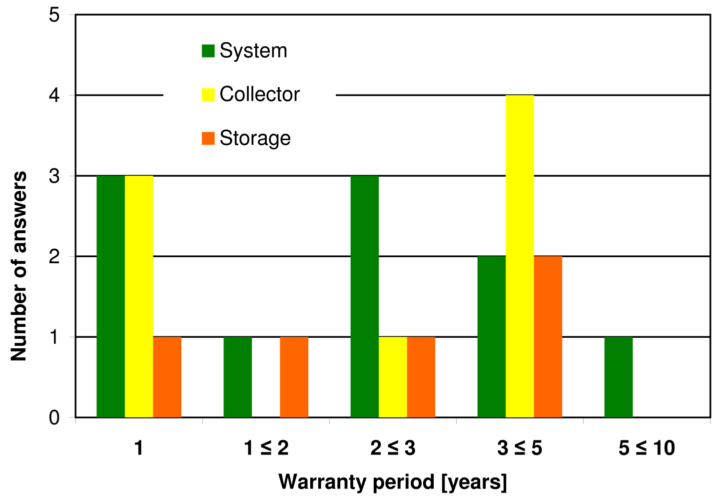

Figure 3.10: Overview on offered product warranty

Another proof of quality is given to the client by the product warranty. This indicator evidently is more appreciated by Argentinean companies: only seven companies give no answer on this topic. All others confirm that there is a warranty for their products, although six of the remaining 28 do not specify the period of time (“by the manufacturer”).

The offered warranty times range from one to ten years (the minimum established by Argentinean law is six months [Con93]). All but one companies offer less than 5 years of

warranty. This is far less than the average offered by producers in developed markets: about 6 years in Brazil and China and around 9 years in Europe [Epp09]. Since the systems are expected to function during at least 15 years an extension of the warranty period would most likely increase trust in the products.
The question on after sales services has 60% of answers, all of them positive. The following services are offered:

- Function control of the installed system
- Maintenance and detection of failures
- Supply of spare parts or in-house reparation of equipment (in these case it is not specified which party covers the transportation costs)

3.3.3 Market

This section on the market volume and target group is the least answered part as many companies consider the information confidential. The guarantee of confidentiality of the data could not convince them to provide (all) the data. Nevertheless this section provides a valuable insight on the actual market. The collector surface[4] is unraveled according to applications and target groups for the year 2009.

Market Volume

Four of the eleven companies which claim to import collectors did not specify the area they import. The provided data proofs expectations for a 2.5-fold increase in imports from 2009 to 2010. The majority of the imports refer to vacuum tube collectors, where heat pipe technology is advancing.

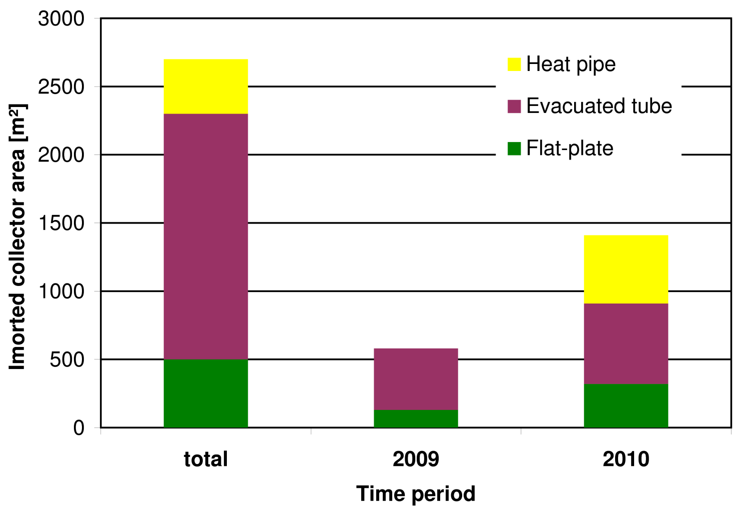

Figure 3.11: Imported collector area by type in total until July 2010 and in the years 2009 and 2010

Only half of the companies which produce collectors reported the corresponding collector surface. At the present flat plate collectors make up around 90% of the volume. The rest

[4] The term collector surface/area was not defined in the questionnaire. A random test showed that some manufacturers provided the data as gross area, others as aperture area. To avoid overestimating the total area, all given values are assumed to refer to the gross area. This is not in line with recommendations by IEA and major solar thermal trade associations which specify the market volume by the aperture area [Int05]. A rough estimate for the conversion from gross to aperture area gives a factor of 90% for flat plate and 75% for evacuated tube collectors.

corresponds to unglazed collectors. Air collectors are not produced at the present. The forecast increase from 2009 to 2010 is 80%.

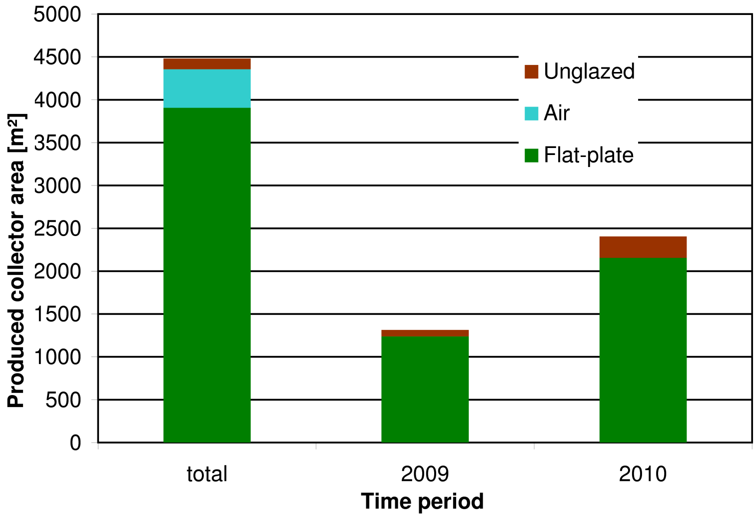

Figure 3.12: Locally produced collector area by type in total until July 2010 and in the years 2009 and 2010

According to the survey close to 2000 m² were installed in 2009. Over to thirds refer to flat plate technology, followed by conventional direct flow evacuated tube collectors. Unglazed collectors make up close to 4% and vacuum tube collectors with heat pipe contribute a mere 1%.

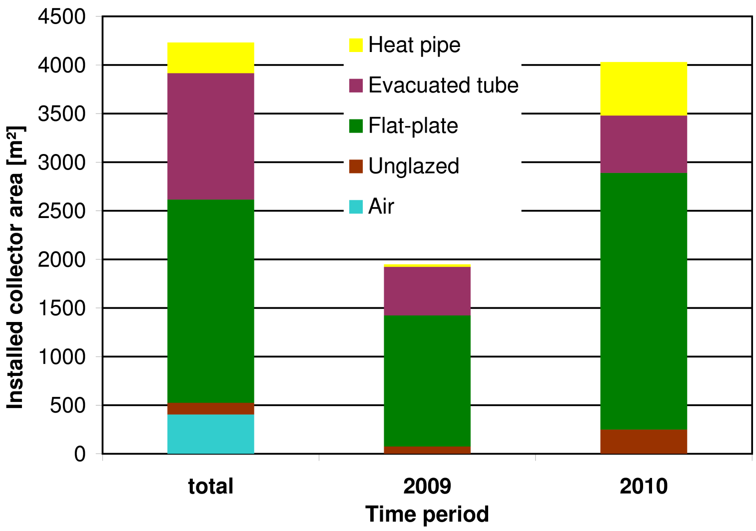

Figure 3.13: Collector area installed in Argentina by type in total until July 2010 and in the years 2009 and 2010; comprises only equipment installed by participating companies and final clients

For 2010 a doubling of the installed area is expected. Heat pipe evacuated tube collectors are predicted to practically catch up with direct flow ones, which will increase only slightly. Flat plate technology is forecast to maintain its leading market share of two thirds which corresponds to a 96% growth. The share of unglazed collectors will increase by 230%.
The fact that the sum of imported and produced area does not correspond to the value of installed area, can be explained by two reasons:

a) Not all importers, producers and installers have taken part in the survey. Thus the values only reflect the shares installed by the participating companies or their final client.

b) Stock may shift from one year to another (differences are: -55.3 m², -215 m² and 2950 m² for 2009, 2010 and the total area respectively).

Market Development

The opinions on the market development are quite homogeneous. In the past it was seen as poor to moderate, at present it is between moderate and neutral and for the future a good development is expected.

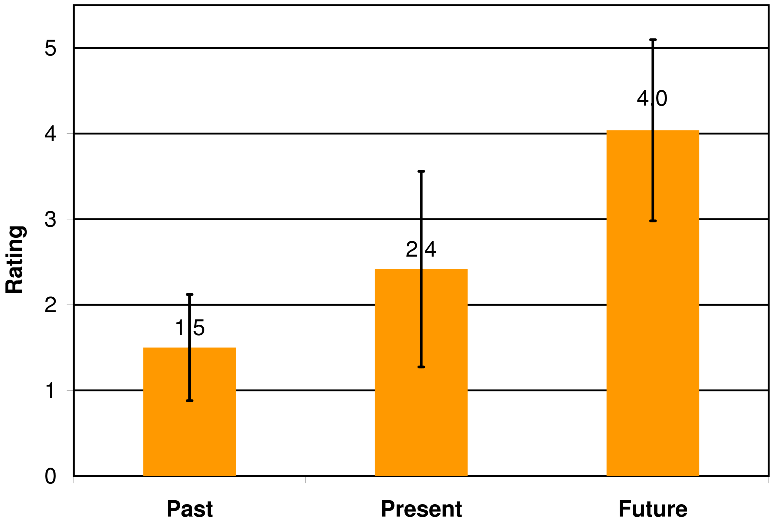

Figure 3.14: Evaluation and expectation of market development; 1=poor, 2=moderate, 3=neutral, 4=well, 5=very well

The fact that this valuation is practically identical to the one revealed by a survey of the German Chamber of Commerce (Außenhandelskammer, AHK) three years earlier among 10 solar companies (PV and ST), unfortunately puts into doubt the expectations for the future [Thi07].

Installers

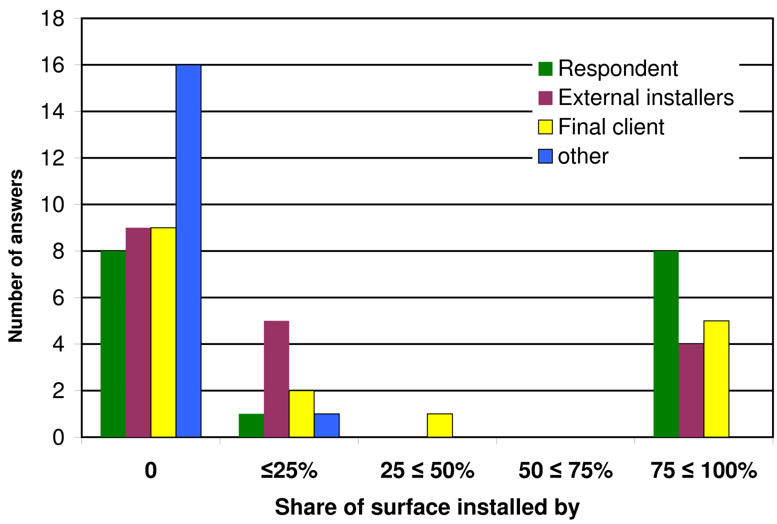

Figure 3.15: Overview on installers of collector area

The question as to who installs the commercialized SWH was answered by 18 companies. Eight of these companies stated that they install at least 75% of the area themselves (five install 100% themselves. Four have over three quarters of the area installed by external companies (three even 100%) and another five sell more than 75% directly to the customers (four even 100%). Thus only one company remains which serves all three groups quite evenly.

Five companies accounting for over 90% of the installed collector area completed both the section on market volume as well as on the installers. If combined the following scenario is revealed for 2009: The responding companies install 58% of the area themselves. 38% are sold directly to the final client and only 4% are left to external installers.

Place of Installation

Twelve respondents provided data on the destination of the collector area, this corresponds to 72% (1393 m²) of the total surveyed installed area. Over half of it is delivered to the two Northern regions: 35% to the North West and 22% to the North East. The highly populated central region makes up 21%. 15% are installed in the "Nuevo Cuyo" region and 7% go to the Patagonian region.

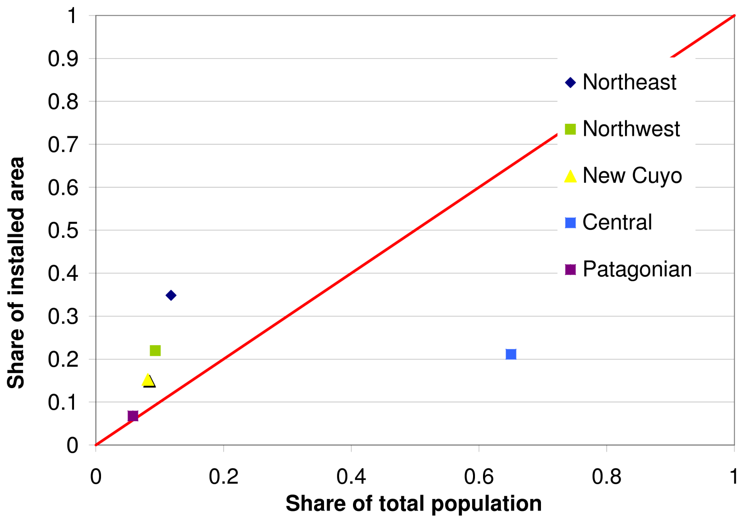

Figure 3.20: Comparison of population density and specific installed collector area by geographical region; Source of population data: INDEC

If we link these numbers to those of population the pattern looks totally different to the one produced by the distribution of companies. The installed collector area per person is by far the lowest in the central region. In the North West it is almost ten times higher!

Price and Configuration of an Exemplary System

The ranges of prices[5] per collector area provided by 20 respondents clearly show the dilemma for Argentinean manufacturers. They face a big competition of imported Chinese evacuated tube systems, which on an average cost 40% less than national products. The imported high quality flat plate collectors are around 50% more expensive and therefore are no direct competition. The recommended system size for a 4-person household varies greatly: collector areas from 1.25 m² to 8 m² and storage sized from 100 l to 400 l are suggested.

[5]Some respondents specified the system price in foreign currencies (three in US dollars, one in Euro); the assumed exchange rates are: 3.9 Arg$/US$ and 5 Arg$/€ which is approximately the average exchange rate of the first half of the year 2010.

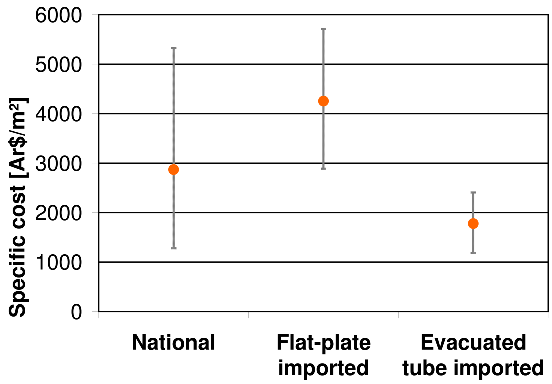

Figure 3.21: Overview on specific final customer prices for SWH (derived from a system for DHW preparation for a 4 person household)

Clients' Motivation

The motivation for clients to install a solar water heater, as the 31 responding companies see it, is shown in the figure 3.22. The variation in the answers is indicated by the standard deviation. The option "ecological image" was mentioned by three companies in the space for comments. Another motive given is: "good option for hot water in remote areas".

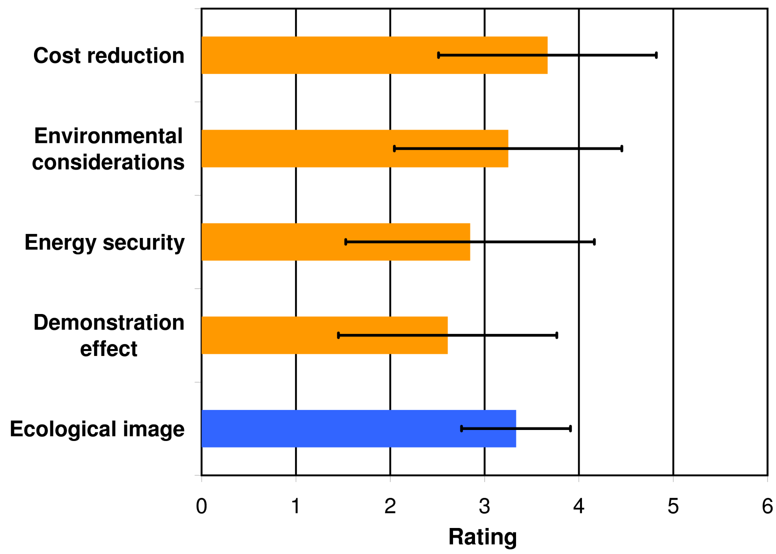

Figure 3.22: Overview on clients' motivation to choose solar thermal; 1=not important, 2=little important, 3=neutral, 4=important, 5=very important

3.3.4 Barriers

Evaluation of Barriers

The importance of market barriers from the companies' point of view is given in the following graph (31 answers). Again standard deviation is used to indicate the variance among answers. Not surprisingly for a survey among companies there is a strong agreement that important barriers are on the side of the authorities: lack of incentives, unawareness of the solar thermal potential among politicians and the failure of energy policy to guarantee energy security.
High investment costs are and unawareness among the general public are typical barriers encountered by renewable energies. The ranking of the lack of demonstration projects is also a

consequence of the need for a wide public perception of the technology. These findings are congruent with the results of the survey by the AHK [Thi07].

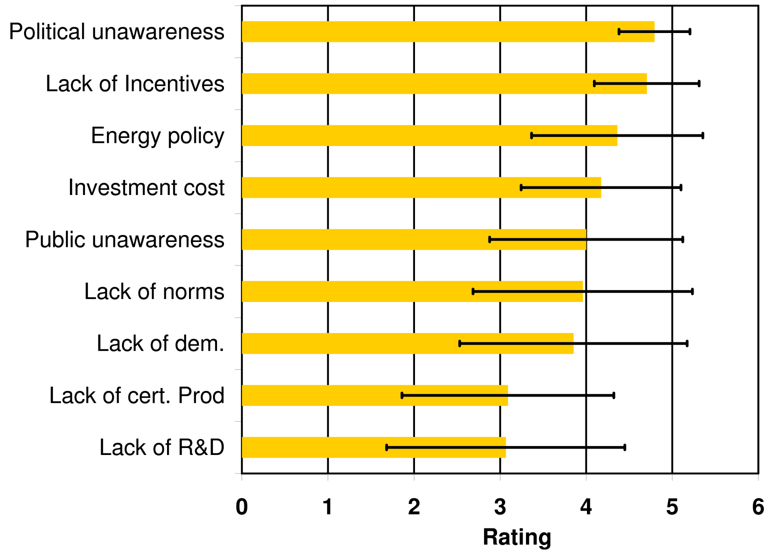

Figure 3.23: Evaluation of the importance of barriers; 1=not important, 2=little important, 3=neutral, 4=important, 5=very important

An important result is that companies rank the availability of certified products rather low. Although practice has shown that certification is indispensable for quality assurance and thus for a healthy market development, especially new and small manufacturers often underestimate this topic. This topic requires a comprehensive convincing of the companies [Amt10].

Additional barriers named by the respondents are the subsidies for fossil fuels (2x), the lack of soft loans for local manufacturers (1x), ignorance by the media and the unsustainable way of life of mankind (1x).

Suggestions for Overcoming Barriers

With 28 answers the section on suggestions for overcoming barriers found a good acceptance. Half of the respondents demand subsidies for users of SWH, be it in form of tax exemption, soft loans or direct subsidies. The second spot of recommendations aims at the general public: more presence in media and systematic awareness rising are suggested.

Four participants wish a solar obligation as established in Spain. Three measures are proposed with the objective to strengthen national manufacturers: soft loans (2x), reduction of sales tax for producers (3x) and control of import of SWH (2x). The following suggestions were named once each:

- Inclusion of SWH in social construction
- Foster a change in life style
- Training of professionals for system design
- Training of installers
- More presence in stores
- Foster the inclusion of SWH in new buildings
- Prepare new buildings for the future inclusion of SWH

Two contributions considered off-topic because not specific or not applicable for SWH are “consider embedded emissions" and ”introduce a feed-in tariff“.

3.4 Conclusions

3.4.1 Methodological Observations

The high rate of return of the survey speaks for its success. The telephone contacts before sending out the questionnaire have proven very helpful. Around 60% of the companies which had been contacted by phone previously replied whereas only one third of those which could not be reached by phone answered.

3.4.2 Resume of the Findings of the Survey

The survey provides a comprehensive overview on the actual state of the market for solar water heaters in Argentina.

The available product portfolio includes all types of collectors. In 2009 close to 2000 m^2 of installed collector surface were surveyed. Flat plate collectors constitute two thirds of the market with a large share of national products. Imported collectors mainly rely on direct-flow evacuated tube collectors. Passive systems for DHW preparation are most frequently chosen and preferably installed in rural houses, followed by urban houses. Although the majority of the companies are located in the Central Region (most concentrated in Greater Buenos Aires), the Northwestern Region has the lead in terms of installed collector surface, followed by the Northeast.

In the past and the present the market development evidently stayed behind the sector's expectations. Yet various factors give proof of the great expectations that the market volume is about to skyrocket. For 2010 the companies expect the installed area to double in comparison to 2009. The overall share of flat plate collectors is expected to remain constant, whereas heat pipe collectors are forecast to push aside direct-flow technology.

With regard to these expectations for the future both, the private and the public sector, should undertake steps to assure they are met. The least government must do is to remove the competitive disadvantage of solar thermal due to the high subsidies on electricity and gas. For full exploitation of the potential to reduce pressure on conventional energy sources, create local added value and reduce green house gas emissions, a series of other measures are necessary: e.g. additional incentives or a solar obligation.

On the side of the companies it is essential to assure overall product quality (equipment, system dimensioning and installation) in order to avoid a setback as a consequence of unreliable systems and unsatisfied customers. The surveyed topics indicate that there is still need for improvement in this field. For local manufacturers an additional challenge consists in the cheap competition from China.

In course of the evaluation of the results it turned out that the following additional questions would have been interesting:

- Which type of thermosiphon systems are marketed, direct or indirect ones?
- What is the relation of inquiries on SWH to systems actually sold?
- What are the reasons for which interested people do not buy a SWH?

A certain limitation of the survey - especially of the market overview - is the fact that it contains only a part of the market data; many contacted companies did not return the questionnaire at all, others only partly. Also it is possible that not all active companies were identified. Non-commercial institutions such as universities that install SWH may also have been omitted.

4. Potential and Economics of Solar Water Heaters in Argentina

This part of the thesis provides a compilation of material on the potential and the profitability of solar water heaters in Argentina.

4.1 Profitability of Solar Water Heaters

4.1.1 Literature Values for the Profitability of SWH

Most studies measure the profitability of SWH by the pay back time although "all economic textbooks note that this criterion is the worse possible, for it ignores completely the economic life of an investment after its pay back time. Its only merit is simplicity but it is most often misleading.... it leads to prefer an investment with 2 years pay back and 3 years lifetime to an investment of 3 years pay back but 10 years lifetime, while the latter would be more profitable with all credible discount rates.[Phi06, p.17]"

In the case of Argentina there is another reason for the use of this criterion: historically the country has experienced some kind of economic crisis about once a decade. Often times they have been linked with intensive inflation impeding long time financial planning.

Table 4.1: Overview of pay back periods in years for SWH in residential applications specified by different sources; inf.= above expected useful life

Electricity	Bottled gas	Natural gas	Year	Source
5-6	-	10-12	n.a.	[Bio09]
	1.5	3-4	11/2008	[Inf08]
0.5	1.5	4.25	01/2010	[FIA10]
3-4	3-4	12	12/2005	[Rod05]
-	4.9-7.9	11.5 - inf.	05/2009	[NBD07]
-	-	inf. (>150)	2005	[REC06b]

Table 4.1 gives an overview of the pay back times found in various studies. The notable variability among the values of one category is a consequence of different locations, configurations and cost figures. A general finding is that SWH substituting bottled gas and electricity pay off around two to three times faster than when using natural gas.

4.1.2 Calculation on Profitability of SWH

In order to incorporate actual cost data and to deduct recommendations for the promotion of SWH the profitability of different configurations in varying scenarios is assessed using the software RETScreen[6].

[6] "The RETScreen Clean Energy Project Analysis Software is a unique decision support tool... The software, provided free-of-charge, can be used worldwide to evaluate the energy production and savings, costs, emission reductions, financial viability and risk for various types of Renewable-energy and Energy-efficient Technologies (RETs)." www.retscreen.net

Analyzed Cases

The profitability of SWH is analyzed exemplarily for a small system. The characteristics are adopted from the potential study by Fundación Bariloche and shown in table 4.2 [NBD09].

Table 4.2: Configuration data of the analyzed SWH system; Source: NBD09

Description	Unit	Value	Comment / Source
Daily hot water use	l/day	200	
Temperature	°C	50	
Operating days per week	d	7	
Slope	°	35.0	Latitude of Buenos Aires
Azimuth	°	180.0	
Gross area per solar collector	m²	2.00	
Aperture area per solar collector	m²	1.80	90% of gross area
Fr (tau alpha) coefficient		0.74	
Fr UL coefficient	(W/m²)/°C	5.83	
Miscellaneous losses	%	3.0	
Heat exchanger efficiency	%	90.0	
Miscellaneous losses	%	7.0	
Storage capacity	l	216.0	
Efficiency electric boiler	%	90	[BB09]
Efficiency gas boiler	%	50	[BB09]

For the financial analysis the cost figures shown in table 4.3 were included. As the objective is to provide the market with locally produced equipment, the system price corresponds to the average of the prices for national products. The useful life time of a SWH heater is a compromise between high price equipment (in Germany installations are expected to function at least 20 years) and values experienced with less-advanced equipment in Greece (7 years) [TM10]. The intermediate value of 15 years was considered realistic for simple systems of Argentinean production. The inflation rate is a hot topic in Argentina. Official numbers (around 11% annually) are strongly mistrusted and estimations by private institutions sometimes double them. Under these circumstances a value of 15% was adopted for the calculations.

Table 4.3: Fixed data for the financial analysis

Description	Unit	Value	Comment
Specific system costs	Arg$/m²	2830	avg. price national products (survey)
Installation cost	Arg$	560	10% of system cost
Cost of reference gas boiler	Arg$	900	avg. Price on MercadoLibre
Cost of reference electric boiler	Arg$	450	avg. Price on MercadoLibre
Cost of internal electric heater	Arg$	150	Wulcon
Lifetime of SWH	years	15	[TM10]
Inflation rate	%	15	-
Exchange rate	Arg$/US$	3.9	-

As system costs the actual price as well as a hypothetical direct grant of 50% were evaluated. As fuel prices are kept constant in Argentina at the present but increase on the world market two fuel price escalation rates (FPER) were analyzed: 0% and 10%. For the backup two configurations were studied: it can be an external heater which runs on the fuel to which the SWH is compared. Alternatively it can be an electric heating element which is integrated into the top part of the storage and controlled by a thermostat. In practice this option requires a careful storage design and a moderate adjusting of thermostat, else the heater may be active constantly and significantly reduce the solar yield. The advantages are the reduced cost (150 Arg$ vs. 450 Arg$ and 900 Arg$ for an external backup powered by electricity or gas respectively) and less installation effort.

The operation costs are analyzed for three different cases:

- In the capital Buenos Aires the prices for electricity and natural gas are the lowest of the entire country. This case stands for a “worst-case” scenario of the status-quo (from a pro-solar point of view).
- In the interior of the country energy prices oftentimes are a multiple of those in Buenos Aires. The city of Baradero in the Buenos Aires Province (130km from the capital) therefore serves as an additional, more favorable scenario for the evaluation of the profitability of SWH at the present.
- Energy in Argentina in general is highly subsidized and costs less than half of the regional and international average [Mon10]. This obviously undermines the profitability of SWH. Therefore it is evaluated in a third scenario with estimations of unsubsidized energy prices (reference price).

The same set of climate data (Buenos Aires) is used for the three cases. This is valid due to the geographical proximity of the two locations and the estimative character of the calculations.

The reference price for natural gas is derived from the actual price for imported LNG in the port of Bahía Blanca since SWH would reduce the necessity to import gas. The value is above the actual price of natural gas imported from Bolivia (6.36 US$/MMBtu) but well below the maximums reached in 2008 (8.54 US$/MMBtu for imported gas from Bolivia and above 14 US$/MMBtu for LNG). The reference (lower) heating value for natural gas in Argentina is 8300 kcal/m³ or 9.661 kWh/m³ [Sec09]. The resulting price per kilowatt hour is incremented by an assumed 5% for transport and the applicable taxes (national, provincial and municipal), which are 29% in Buenos Aires and 47% in Baradero. The end user prices originate from the monthly energy report by Montamat [Mon10].

Table 4.4: Prices for natural gas used in profitability analysis

Item	Value	Unit	Comment	Source
Reference Buenos Aires	0.135	Arg$/kWh	LNG Bahía Blanca + 5%	Revista Intergas
Reference Baradero	0.164	Arg$/kWh	LNG Bahía Blanca + 5%	Revista Intergas
Buenos Aires	0.028	Arg$/kWh	Including 0.061 Arg$/m³ tax	Montamat
Baradero	0.032	Arg$/kWh	Including 0.1 Arg$/m³ tax	Montamat

The prices for bottled gas reflect a wide range. Since 2005 the government subsidizes small bottles (10 kg to 15 kg) [Sec08c]. For 2010 it fixed prices to 16 Arg$ and 25 Arg$ respectively. This measure called “garrafa social“ (engl.: social gas cylinder) was introduced in order to help poor families. Prices for larger, unsubsidized units are much higher, for a 45 kg bottle the client has to pay from 130 Arg$ to 250 Arg$ being 190 Arg$ a realistic average price. Due to high demand for heating in winter prices oftentimes even rise beyond that. This leads to increased demand also for the small subsidized units. As a consequence also their cost goes up (in July 2010 a maximum of 60 Arg$ was reported for a 10 kg cylinder[7]) and there are serious supply shortfalls.

Table 4.5: Prices for bottled gas used in profitability analysis

Item	Value	Unit	Comment	Source
Reference	0.327	Arg$/kWh	Bottled gas 45 kg (medium price)	Internet
Subsidized	0.124	Arg$/kWh	Bottled gas 10 kg ("garrafa social")	[Sec08c]

End user prices for electricity are grouped by the monthly consumption; Small consumers pay less per kilowatt hour than large ones. The same holds for the monthly base fee. The prices for the two cases are end user prices for a household with a consumption of 450 kWh per month. As the SWH decreases the electricity consumption (annual electricity savings are 1545 kWh), these systems fall into a group of lower consumption. Surprisingly this means an increase in the specific cost per kilowatt hour in Buenos Aires. The reason therefore is that the specific proportion of the monthly base fee per kilowatt hour rises although its absolute value decreases (20.09 Arg$ to 18.97 Arg$ bimonthly). This effect overcompensates the drop in the variable charge for the energy consumed (0.047 Arg$/kWh to 0.045 Arg$/kWh).

No data is published on the absolute electricity price without subsidies. Therefore it is estimated on basis of the monomial price which the distributors pay for the energy [NM10]. This price is corrected by the surcharge by utilities for distribution, investment in infrastructure etc. The average price for electricity thus adds up to approximately 80 US$/MWh [Rab10].

All listed prices contain the 21% sales tax as well as other applicable taxes (national, provincial and municipal). In Baradero the tax load sums 45.6%, in Buenos Aires it is 27.98%. The unsubsidized price is determined with the respective values.

Table 4.6: Prices for electricity used in profitability analysis

Item	Value	Unit	Comment	Source
Monomial price	180.9	Arg$/MWh	Average 2009	[NM10]
Reference Buenos Aires	0.399	Arg$/kWh	incl. 27.98% tax	-
Reference Baradero	0.454	Arg$/kWh	incl. 45.6% tax	-
Buenos Aires	0.089	Arg$/kWh	450kWh/month incl. 27.98% tax	EDENor
Buenos Aires SWH	0.095	Arg$/kWh	<400kWh/month incl. 27.98% tax	EDENor
Baradero	0.369	Arg$/kWh	450kWh/month incl. 45.6% tax	EDEN
Baradero SWH	0.353	Arg$/kWh	<400kWh/month incl. 45.6% tax	EDEN

Results

The profitability of the SWH is evaluated by the equity payback time (EPBT) and the internal rate of return (IRR). The first gives the period of time after which the initial investment is recovered, considering the external changes such as inflation and fuel price escalation rate. If

[7]See: http://www.diariohoy.net/accion-verNota-id-95649-titulo-Denuncian_sobreprecios _en_los_valores_de_la_

the EPBT is higher than the lifetime of the product this is a knock-out criterion as the investment would not be recovered before the replacement would be required. The IRR expresses the profitability of the investment over its lifetime and is recommended as easy-to-use decision instrument [FH04].

As the total number of studies cases is 68 only selected results are shown here. The list with all results can be found in the appendix D. For each location two cases are presented: the status quo (subsidized fuels, no fuel price escalation, no subsidies on the system) and the most favorable scenario analyzed (unsubsidized fuels, 10% of fuel price escalation rate and 50% grant on the system cost).

Table 4.7: Selected results of profitability analysis in RETScreen; LT=life time, BA=Buenos Aires, Bar.=Baradero

Fuel type	Fuel price	FPER	Backup	Grant	IRR	EPBT
-	by location	%	-	%	%	years
Natural gas	**Buenos Aires**	**0**	**external**	**0**	0	<0
		10	**external**	**50**	<0	>LT
	Baradero	**0**	**external**	**0**	<0	>LT
		10	**external**	**50**	<0	>LT
	w/o subsidy BA	**0**	**external**	**0**	<0	>LT
		10	**external**	**50**	19.1	6
	w/o subsidy Bar.	**0**	**external**	**0**	1.2	13.7
		10	**external**	**50**	21.4	5.4
LPG	**w/ subsidy**	**0**	**external**	**0**	<0	>LT
		10	**external**	**50**	15.8	6.9
	w/ subsidy BA	**0**	**internal**	**0**	3.6	11.5
	w/ subsidy Bar.	**0**	**internal**	**0**	<0	>LT
	w/o subsidy	**0**	**external**	**0**	11.3	7.1
		10	**external**	**50**	37.4	3.2
	w/o subsidy BA	**0**	**internal**	**0**	17.5	5.2
	w/o subsidy Bar.	**0**	**internal**	**0**	15.8	5.6
Electricity	**Buenos Aires**	**0**	**external**	**0**	<0	>LT
		10	**internal**	**50**	4.0	12.2
	Baradero	**0**	**external**	**0**	4.9	10.5
		10	**internal**	**50**	29.2	4.1
	w/o subsidy BA	**0**	**external**	**0**	5.4	10.1
		10	**internal**	**50**	30.1	3.9
	w/o subsidy Bar.	**0**	**external**	**0**	7.4	8.9
		10	**internal**	**50**	33.5	3.5

The results for natural gas clearly show that its substitution by SWH is unfeasible under the present conditions because of the high subsidies. Neither in Baradero nor in Buenos Aires the technology is profitable even if fuel price escalation of 10% and a 50% grant on system cost are assumed. Under these circumstances a fuel price of 0.035 Arg$/kWh would be necessary to reach profitability. In Buenos Aires also without subsidized fuels it is necessary to consider either fuel price escalation or a grant on the system price to reach amortization. The higher tax load in Baradero allows for amortization even in the base case but the very low IRR still makes the investment unattractive.

In systems running on LPG with external backup it is unprofitable to use a SWH if it is compared to the highly subsidized "garrafa social". Only if a 50% grant or a fuel price escalation of 10% is considered profitability is reached. In both cases pay back times are around 10 years. A special phenomenon can be observed in Buenos Aires: due to the extremely low electricity prices systems with internal backup heater amortize even if the subsidized gas cylinder is used. Yet at least one of the two favorable factors is necessary to obtain a reasonable IRR to compensate inflation.

Wherever unsubsidized gas cylinders are used, the use of solar thermal energy is within the profitability zone. Under present conditions the system will pay for itself within little more than seven years and yield an IRR of 11.3%. In the most favorable case (10% FPER and 50% grant) amortization time falls below 40 months with an IRR of 37.4%.

The cost figures also show that it is an interesting option to completely replace DHW preparation by LPG and use a SWH with internal electric backup. In the scenario without subsidies for the fuels pay back time is below six years in both locations. If additional grants and/or fuel price escalation is assumed maximum IRRs of 50% and payback times around 2 years can be obtained. Yet an internal electric backup heater is not entirely recommendable for two reasons. Firstly, because a possible malfunction may not be noticed and seriously reduce the solar yield. Secondly, because it is disadvantageous in terms of primary energy compared to a gas heater.

In the case of DHW preparation with electricity the profitability strongly depends on the location, because of the high differences in final client prices. In Buenos Aires electricity is so cheap that only the most favorable calculations make it into the profitability zone. The lower electricity price in the higher consumption group additionally penalizes the SWH option; e.g. in the case with internal backup, 10% FPER and 50% subsidy the EPBT would decrease to 11.7 years and the IRR go up to 5% of constant prices were assumed.

In Baradero the SWH pays off already under present circumstances - although only after around 10.5 years at a low IRR. If conditions for solar thermal improve, be it because of increasing energy prices or financial incentives, the profitability increases.

If unsubsidized electricity prices are considered SHW are profitable in both locations. As the tax load is much higher in Baradero the system will pay off sooner there. The option of an internal backup heater additionally increases feasibility in all cases as it reduces investment costs.

4.1.3 Comparison of Results

As the preceding analysis has shown it is decisive to look at the specific circumstances in order to evaluate the credibility of the profitability study. Many of the values found in literature give only one value which implies that they refer to a specific case. If the corresponding assumptions are not given the results cannot be trusted.

The comparison of the pay back times form literature with the calculated values shows that the latter are generally among the higher values. This can be attributed to the conservative assumptions concerning technology (efficiency and losses) and costs. As experience has shown that theoretical analyses tend to be too optimistic, this seems justified.

4.2 The Market for Solar Water Heaters

4.2.1 Actual Market Volume

The survey shows that the installed collector area in 2009 totaled almost 2000 m², which is four times the surface estimated by INTI [Ins09]. This number obviously is still below the real value because of various reasons: around 50% of the identified companies have not participated in the survey and another 22% did not answer the questions on the market volume. Additionally, despite the effort made to detect all solar thermal companies, it can not be guaranteed that all the relevant actors have been included into the list, more so as the number of companies is rapidly increasing in recent years.

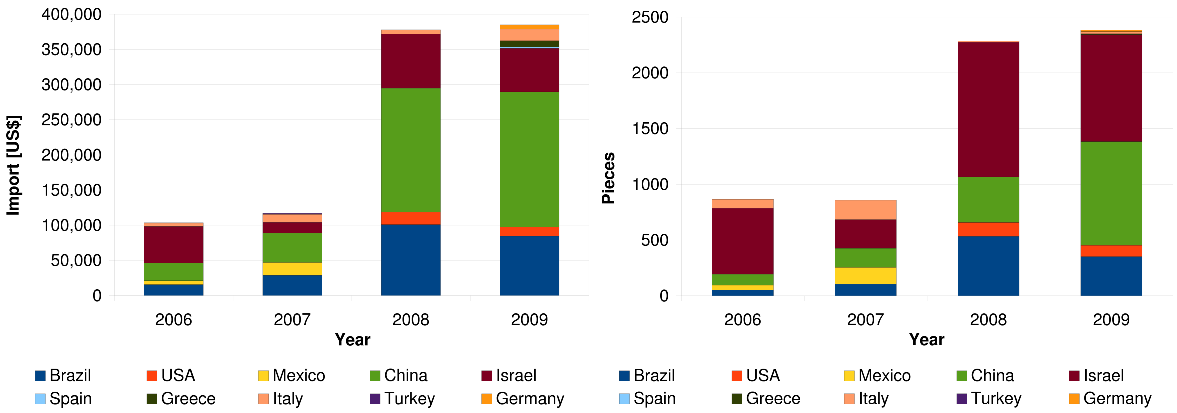

Figure 4.1: Import of solar thermal collectors in US-dollars and pieces; Source: INDEC

Therefore customs data on the import of SWH is consulted as a complement to the survey (customs number: 8541.40.16.000). Although import volume cannot be set equal to sales volume, this can be considered as a good indication of the actual numbers of imported equipment commercialized. Nevertheless the numbers must be regarded with reserve as there are two objections:

- One inconsistency appears when comparing export data from the USA based on a survey among producers. They state that in 2007 289 m² were exported to Argentina [U.S10], whereas INDEC data does not declare any import from the USA for that year.
- According to a note in an internet forum[8] SWH with internal electric backup heater - which is common among thermosiphon systems - must be declared as electric heater with another heating process. This means that actual import numbers of SWH are higher than those reported under the customs number for solar collectors.

Surprisingly there is a steep increase in imports between 2007 and 2008. A change in the definition of the customs number for solar collectors could be an explanation, especially as the difference between 2008 and 2009 resembles the one from 2006 to 2007. Yet a corresponding inquiry to INDEC did not confirm this explanation.

As China is known only as exporter of evacuated tube equipment it seems reasonable to assume that the import numbers from that country refer to the named technology. Assuming

[8] http://ar.groups.yahoo.com/group/customsaduana/message/35231, accessed August 20th 2010

that the 931 units imported have an average surface of 2 m² the actual amount of imported evacuated tube equipment is four times larger than shown by the survey.

The average specific price for equipment from Israel in 2009 is 65 US$ per unit which implies that this share is refers to cheap unglazed pool collectors. If we assume that their average surface is 3 m² this corresponds to a surface of approximately 2850 m² which is not registered in the survey.

Assuming that the remaining 498 units also have an average collector surface of 2 m² they sum another 1000 m² of imported technology - whereas the survey only reveals 130 m².

Following these assumptions the total market volume (import and production, rounded numbers) in 2009 is:

Table 4.8: Corrected estimation of market volume for SWH in 2009; Sources: INDEC, survey

1’850 m²	of Chinese evacuated tube collectors
2’850 m²	of Israeli unglazed collectors
1’000 m²	of other imported collectors
1’240 m²	of locally produced flat plate collectors
75 m²	of locally produced unglazed collectors
7’015 m²	of available gross collector area

Extending the given assumptions over the period with available import numbers (2006 to 2009) and assuming that all the imported surface has been installed we obtain the following numbers for installed area:

Table 4.9: Corrected estimation of total installed collector area; Sources: INDEC, survey

3’200 m²	of Chinese evacuated tube collectors
9’050 m²	of Israeli unglazed collectors
3’550 m²	of other imported collectors
3’900 m²	of locally produced flat plate collectors
125 m²	of locally produced unglazed collectors
19’825 m²	of installed gross collector area

It can be supposed that the actual value is even higher, since import numbers before 2006 are not considered and a part of the imports are registered under the customs number for electric heaters. Also the values for local production exclude shares of companies which did not contribute to this section of the survey. Export numbers are negligible in the considered years, e.g. 6 units in 2009. Once more it is repeated that the numbers are to be considered under reserve because of the named assumptions and inconsistencies!

4.2.2 Market Potential for Solar Water Heaters

The analysis of the market potential for SWH is realized by using two different sources. A basic theoretical potential is estimated by using data on living conditions of the Argentinean population and production numbers of related equipment obtained from the National Institute of Statistics and Censuses (Instituto Nacional de Estadística y Censos, INDEC). This theoretical potential is then compared to the market potential estimated in other studies.

Literature Values for the Market Potential

The market potential for SWH has been studied by different groups with varying methods and degrees of detail. In 2005 the consulting firm MR Consult analyzed the potential in a study on the reduction of green house gas emissions by means of renewable energies. It assumes that adequate financial incentives and information campaigns could lead to 0.05 m² of installed collector surface per person or 1’800’000 m² in 2015 [Rod05].

The authors of the RECIPES[9] report on Argentina state a theoretical market potential of 5’000’000 SWH. When it comes to the real (technical and economic) potential they calculate with a constant growth rate of 200 installations per year in a base scenario and variable growth rates up to 12% in case of a rural development scenario - the only sector the attribute a significant potential for the use of SWH. The projected number of total installations by the year 2020 therefore is 15’000 (30’000 m²) in the base scenario and 31’000 (62’000 m²) in the most optimistic case [REC06b].

For an energy scenario until 2025 it was estimated that by then 0.085 square meters of collector area per inhabitant could be installed by then in Argentina, replacing 13% of the energy consumption needed for water heating. This process would start in 2008 and take place if policies supporting sustainable development were adopted [Fun07]. The resulting collector area would be 4’000’000 m².

The most detailed investigation on the market potential for SWH has been pursued at Fundación Bariloche in 2009 [NBD09]. The hot water demand is subdivided into three sectors: residential, the public and services and industry. The first is further sectioned by

- three climatic zones
- three income groups
- rural and urban use
- energy source used for hot water preparation at the present

The demand in the public and service as well as in the industrial sector is also related to specific uses.

Taking into account energy prices and technical figures an economic potential of 890’000 m² for residential domestic hot water was determined. This refers only to LPG users as the substitution of natural gas is found unprofitable and other sources are ignored because of their little share. For hot water preparation another 500’000 m² could be installed in public institutions and the service sector, while a potential of 230’000 m² is identified in industry. Under the assumption that only LPG applications are economically feasible, FB estimated that another 800’000 m² could be installed for residential heating purposes and 270’000 m² for heating in the public and service sector.

Additional Estimations of the Market Potential

As the detailed study by Fundación Bariloche only takes into account the substitution of LPG applications, the existing data base was used to estimate the potential if all energy sources were taken into account.

The final energy demand for water heating by climatic region and energy source is shown in table 4.10.

[9]The RECIPES project was carried out in 2005 and 2006 with the aim to contribute to the implementation of renewable energy in emerging and developing countries. RECIPES stands for: ’Renewable Energy in

Table 4.10: Useful energy consumption for domestic hot water in terajoule; Source: Fundación Bariloche 2009

Climatic zone	Natural gas	Electricity	LPG	Fire Wood
Warm	1’758	250	2’947	185
Temperate	36’563	679	3’321	166
Cold	13’864	16	1’092	253
Total	52’186	946	7’360	604

The corresponding collector area was estimated following the basic methodology of the original potential study using these assumptions:

- It is assumed that 100% of the rural and 50% of urban consumers install SWH.
- The system configuration and demand profile is identical to the one used by Fundación Bariloche and in the profitability analysis (see table 4.2).
- The performance of the SWH in each climatic zone is determined in RETScreen for a reference location. The chosen locations are Comodoro Rivadavia for the cold, Buenos Aires for the temperate and Tucuman for the warm region. The latitude of the respective location is used as inclination of the collector. The obtained (rounded) values are 35%, 50% and 65% for the solar fraction and 0.55 MWh/m², 0.7 MWh/m² and 0.8 MWh/m² for the annual yield respectively.

Of course the system performance depends strongly on the efficiency of its components, on the configuration and the load profile. The calculations were performed with rather conservative values. A more efficient SWH of the same size will lead to a higher solar fraction and yield and thus save more conventional fuel.

Table 4.11: Potential for SWH by substitution of conventional fuels in the residential sector in square meters of collector area

Climatic zone	Natural gas	Electricity	LPG	Fire Wood
Warm	198’372	28’249	362’117	41’207
Temperate	3’626’663	77’359	377’466	32’377
Cold	1’225’167	1’582	143’906	38’816
Total	5’050’202	107’190	883’489	112’400

The difference in the potential collector area for substituting LPG are a consequence of the fact that the study by FB relies on manually determined yield data and a non-RETScreen data set for the Buenos Aires climate. This results in slightly different values for the solar fractions and annual solar yields. As the objective of the estimation is to reveal the order of magnitude of the potential this difference is considered negligible. Rounded to tens of thousands the total potential thus sums up to 6’150’000 m² of collector area for the preparation of DHW!

The key data of the re-estimation of the potential in the public and service sector is shown in table 4.12. The transformation from net to real potential is done by applying the conversion efficiencies of the respective boiler [BB09]. As no information is available on the geographical distribution of the demand, the results are calculated with the annual solar yield of the temperate zone (0.7 MWh/m²).

developing countries: Current situation, market Potential and recommendations for a win-win-win for EU industry, the Environment and local Socio-economic development’, see: www.energyrecipes.org

Table 4.12: Estimation of the potential for SWH in the public and service sector; Source of net potential data: Fundación Bariloche

Source	Net potential	Conversion eff.	Useful potential	Collector area
Unit	[TJ]	%	[TJ]	m²
Electricity	103	90	9'268	36'768
Natural gas	9'092	50	454'606	1'803'579
LPG	1'924	50	96'177	381'570
Fire wood	425	25	10'618	42'124

The potential in the service and public sector adds up to 2'260'000 m² of collector area. The determined potential for substituting LPG and fire wood is around 420,000 m². The difference to the value given by FB is a consequence of the different value for the specific yield per collector area and because of the distinction between the efficiency of a wood and a gas boiler (FB calculated both with an efficiency of 50%).

The determined total potential in both sectors therefore is 8'410'000 m². Related to the estimated actual population (40.1 million [Int09a]) this is a potential of 0.21 m² of gross collector surface per inhabitant (0.0005 m² at the present). Currently the leading nations are sunny Cyprus and Israel (0.93 m² and 0.71 m² of aperture area per inhabitant) [WM10]. This proves that it is actually possible to reach such high values.

The additional potential in industry surely is considerable but is not quantified here as the lack of resilient data would require many assumptions and would therefore lead to a high degree of uncertainty. Most promising applications for temperatures below 100℃ are the food industry (drying, washing, heat treatment), the textile industry (washing, bleaching) and the pre-heating of boiler feed water in general [Eur06b].

Space heating is another field with a significant potential for solar thermal technology. As it must go along with energy efficiency measures in construction the available data is insufficient to determine the potential.

4.3 Macroeconomic Impacts of the Diffusion of SWH

Direct Financial Impacts

Under the present conditions the substitution of conventional energy sources by using SWH will lead to substantial savings on subsidies. The system analyzed in chapter 4.1 saves 1.39 MWh of useful energy per year. Corrected by the conversion efficiency of the respective boiler, this corresponds to a saving of 1545 kWh of electricity or 2780 kWh of gas.

Table 4.15: Savings on subsidies by substituting conventional energy sources from one 2 m² SWH

Fuel	Location	Specific savings	Annual savings
-	-	Arg$/kWh	Arg$
Electricity	**Baradero**	0.059	90
Electricity	**Buenos Aires**	0.243	374
Natural gas	**Baradero**	0.090	249
Natural gas	**Buenos Aires**	0.090	250
Bottled gas	**w**	0.160	445

In Baradero, where prices for electricity are already close to its real price the annual savings are lowest for this fuel (about 1.5% of the assumed investment cost of 5.660 Arg$). In all other cases the annual savings are much more pronounced and vary between 5% and 8% of the investment cost. This fact can be used as an important argument for a financial incentive to promote the technology.

The other factor to have in mind is that the reduced consumption of conventional fuels will reduce the tax revenues. The energy prices used in the profitability calculations contain the applicable sales taxes which is 10.5% for the ”garrafa social“ and 21% for the remaining energy sources. To electricity and natural gas additionally a series of other national, provincial and municipal taxes apply. The absolute tax value is derived from the end user prices by discounting the net price tax. The yearly tax loss is then determined by multiplication with the annual net energy saved as shown in table 4.16.

Table 4.16: Tax losses due to fuel savings by SWH; Sources: EDEN S.A., EDENor S.A.

Fuel	Location	Taxes on net price	Specific taxes	Yearly tax loss
		%	Arg$/kWh	Arg$
Electricity	**Baradero**	45.60	0.111	171
Electricity	**Buenos Aires**	27.98	0.021	32
Natural gas	**Baradero**	46.95	0.010	29
Natural gas	**Buenos Aires**	29.33	0.006	18
Bottled gas	**w**	10.50	0.012	33
Bottled gas	**w/o**	21.00	0.057	160

The savings on subsidies and the tax losses do not directly offset each other because they belong to different public budgets. Yet it makes sense to compare them and get an impression of the relation between cost and benefit for the public. Only in one case (electricity in Baradero) the tax losses exceed the savings on the subsidies. In fact this means that the national governments subsidies are redirected to the provincial and municipal budget and do not reach the final clients. In all other cases the losses are constitute about a tenth of the savings.

A detailed estimation of the obtainable savings and the resulting tax losses is not possible with the available data because the price structure varies highly within the country. Yet it seems evident that the funding of an incentive scheme can be compensated by the reduced expenses for subsidies. The diverse structure of the taxes applicable on energy additionally assures that the burden of a reduced tax income is distributed rather evenly among the national, provincial and municipal governments.

Other Impacts

Besides the direct fiscal impacts of a significant SWH market there are positive effects for the labor market, because the sale, installation and maintenance are labor intensive [Eur10a]. In 2009 in Germany around 20’000 persons worked in the solar thermal sector despite the financial crisis and a high degree of automation. At 1.55 million square meters installed this corresponds to one job every 77.5 m^2. Solar Sterling reports that one job is created every 50 SWH installed. Considering also indirect and induced employment impacts, they calculated that every sixth installed system leads to the creation of an additional job [Jon06].

The given data for Germany cannot be extrapolated directly because as the surface values refer to aperture area, the production is highly automated and the country is an important exporter of solar collectors. Using a conservative estimation of man-year every 200 m² of installed gross collector area the potential of 8.4 million square meters corresponds to 42'000 man-years.

As the survey shows (see 3.3.1) most of the companies in the solar thermal sector are micro enterprises. Therefore they play an in important role in economy providing diversification, innovation and flexibility [Org98]. The importance of this fact is strengthened by the fact that the solar thermal industry counts with values of national value creation above 75% [Bun10b].

The further the technology is diffused the more the dependency on conventional resources such as gas and electricity will diminish. This may contribute to a reduction in gas shortages and thus prevent losses to productive sectors of the economy.

Beside the purely economic effects the diffusion of SWH will also have a positive impact on the environment. Since the solar thermal technology substitutes part of the fossil energy needed for water heating, less carbon dioxide is emitted. The applicable emission savings per saved kilowatt hour net energy are shown in table 4.17. As fire wood is considered a renewable source its emissions are zero.

Table 4.17: Emissions factors for combustion of conventional fuels; Sources: [Uni10, Sec08a]

Fuel	Specific emissions	Unit
Natural gas	0.20	kgCO_2/kWh
LPG	0.23	kgCO_2/kWh
Electricity	0.43	kgCO_2/kWh
Fire wood	0.0	kgCO_2/kWh

If these emission factors are combined with the specific yields and solar fractions for the three climatic zones and the conversion efficiency of the conventional boiler, as described in chapter 4.2.2, the specific emission reduction values shown in table 4.18 are obtained. The weighted average is obtained from the potential for each zone above.

Table 4.18: Specific and total annual emission reduction from a 2 m² SWH by type of fuel and climatic zone

Climatic zone	Unit	Natural gas	Electricity	LPG	Fire Wood
Warm	kgCO_2/m²	322.56	382.22	374.4	0
Temperate	kgCO_2/m²	282.24	334.44	327.6	0
Cold	kgCO_2/m²	221.76	262.78	257.4	0
Weighted avg.	kgCO_2/m²	272.05	347.55	340.24	0

As specific emission reduction factors for the public and service sector the values for the temperate climate are to be assumed as the potential is calculated with this data also. The total annual emission reduction potential for hot water preparation is 1.7 million tons of CO_2 per year in the residential sector. This equals one quarter of the total emissions from this application and 6% of the total emissions of the residential sector[10]. Another 640'000 tons of CO_2 can be

[10]The total emissions by sector were calculated on the basis of the national energy balance of the year 2005 [Sec06]. The emissions factors named above were adopted for the given fuels, for other fuels IPCC default values were used [Uni10].

avoided in the public and service sector. This corresponds to about 5% of the total emissions of the sector. The emission reduction potential is even higher if solar thermal heat is used in the industry and for space heating.

The emission reductions can additionally create income if the substitution of conventional fuels is incorporated into a project with the frame of the Clean Development Mechanism (CDM). Assuming a useful lifetime of 15 years every system of 2 m^2 saves between 6.7 and 11.4 tons of CO_2. At an average price for Certified Emission Reductions[11] of 15 US$ per ton of CO_2-equivalent this corresponds to approximately 7% and 12% of the average investment cost for national products (as used for the profitability analysis).

[11]Certified Emission Reductions are a type of tradable emission units used within the CDM of the Kyoto Protocol. In the European Emission Trading Scheme, which is linked to the Kyoto mechanisms, in 2009 the average price per ton of CO_2-equivalent was around 14 € (see www.eex.com).

5. Barriers to Diffusion and Recommendations for Market Development

5.1 Methodology

An initial set of barriers was identified by a literature review on a national [NBD09, GL07] and international level [KKS05, Phi06]. In the frame of the survey the participants were then asked to evaluate their importance and to add possible further obstacles they perceive. Finally the list was completed by two informal personal interviews. The compilation of possible solutions to the identified barriers was elaborated again using the inputs from the survey as well as a literature review. Sources used were: existing national and international legislation, national case studies, technology roadmaps and best practice reports. Once more the informal personal interviews contributed to understanding the details and especially in relation to the local situation. Although many barriers are interconnected, in this first step they are analyzed separately, in order to assure a profound understanding.

In the second part solutions are recommended according to the actual legal, economic and societal situation in Argentina. The proposed measures are interlinked, weighted by their relevance and put into a temporal context. The product of this work is an outline of a solar thermal technology roadmap for Argentina on a sector level. This type of a strategic planning tool was chosen because it [AD10, p.10]:

- comprises a variety of stakeholders such as companies, research institutions, governmental agencies
- aims at establishing a common vision of the sector
- considers different types of market constraints
- is well-suited to develop long-term development scenario
- is used "for lobbying lawmakers for making favorable policies"
- intends to communicate to a broad audience with varying levels of knowledge about the issue

For these reasons this tool has been applied also in various solar thermal markets in different development stages around the world, e.g. in Germany, Austria, New York State and Europe.

5.2 Analysis of Barriers

The barriers solar water heaters face during market penetration can be divided into four major groups [Gel07]:

- Policy barriers
- Quality-related and technical barriers
- Economic barriers
- Behavioral, social and other barriers

In the following the single factors within these groups are explained and possible measures are pointed out.

5.2.1 Policy Barriers

Political Failure to guarantee Energy Security

In recent years Argentina has transformed from a net energy exporting country to an importer. Besides peaks in demand occasionally cannot be covered and lead to energy shortage or even cuts. Decreasing reserves of oil and gas are additional proof the political failure to guarantee future energy security. The inclusion of energy efficiency measures and renewable energies into the national energy planning will contribute to assure energy security by decoupling economic development from energy consumption. Being a relatively simple technology which can be produced locally, solar thermal technology can play a significant role in an innovative energy scenario. Establishing national targets for renewable energies is the pre-condition for a comprehensive solar thermal (or renewable) action plan [Gel07].

Lack of Regulation

”Regulations can be the single most important means to promote the use of solar thermal energy“ [Eur07a, p.3]. The term refers to two areas of action. On the one hand it aims at the removal of administrative barriers such as permitting. In a second, more progressive step it comprises the obligation to include solar thermal in new buildings or those under refurbishment. The evident objective is a continuous transformation of the building stock to renewable heat supply. As the life time of a building usually exceeds 50 years this measure has a long time impact. The regulation can be effected on different level. Israel is the pioneer in national solar obligations, where the legislation requiring a SWH dates back to the 1980s. In Europe the city of Barcelona was the first to implement a corresponding ordinance on a local level and is cited as example in many places around the world [Eur07a]. An example of such a policy in South America can be found in Uruguay. Argentina’s small neighbor country passed a corresponding law just last year [Dir09]. At the present the only regulation of this type in Argentina is the Ordenanza 3633/08 in the municipality in Venado Tuerto [NBD09]. It was approved by the municipal council in 2008 and requires all public buildings which are constructed from 2015 onwards to implement SWH.

A confined kind of solar obligation is the requirement for all publicly financed social construction projects to count with SWH.

High Subsidies for Conventional Energy

In 2009 Argentina spent over 16 billion Pesos (approx. 4.3 billion US$) in subsidies [Gil10b] on energy. The country has the highest subsidies on energy among its neighboring countries. According to Montamat electricity costs about 32% and natural gas a mere 20% of the regional average prices [Mon10]. These low prices seriously penalize the renewable energy technologies (among them solar thermal). In order to foster innovation it is necessary to phase out subsidies on conventional energy or at least apply them to renewable technologies likewise. To take full advantage of the renewable technology the real inflation and the increase in international energy prices must be reflected in national energy prices as well. The negative effect on consumers must be attenuated be removing the subsidies gradually and adapted to the level of consumption and type of activity. Energy efficiency programs can also contribute significantly to moderate the financial impact on consumers; an example could be a program for exchanging old refrigerators for new highly efficient ones.

5.2.2 Economic Barriers

High Initial Capital Cost

Compared to conventional equipment, renewable energies generally require a higher specific initial investment which scares off users. Therefore different incentive programs have been introduced around the world. In the case of renewable electricity production feed-in tariff like the German Renewable Energy Act have proven to be most effective [BKL08]. For the decentralized and autonomous operation of small solar water heaters this option is impracticable. The following incentive measures have been implemented around the world for SWH:

- Direct grants have been implemented in many countries. A successful example is the German Market Stimulation Program. Formerly all solar thermal installations for DHW or ”superior“ uses (e.g. heating support, process heat) received up to 105 per installed square meter of gross collector area or part thereof if the used collectors met certain criteria. Since July 2010 the aid does not apply to mere DHW systems anymore as they are considered state of the art and was lowered to 90/m² for ”superior“ systems. Additional bonuses are paid for the installation of highly efficient pumps and condensing boilers [Bun10a]. The administrative effort which such a grant scheme requires can be an important impeding factor as experiences from other countries (e.g. Italy) show. Also the fact that the annual budget is capped and may be exhausted before the end of the year can lead to a market downturn.
- Another way of providing financial aid is tax deductions. One option is to credit the aid against property tax. Thus the owner is exempted from paying the tax for a certain period of time. Alternatively the owner can be entitled to deduct a certain share of the investment costs when filing the tax-return. As this is usually done only after the completion of a calendar year the money is refunded to the owner with a significant delay. This mechanism is used in France where 50% of the material costs can be deducted [ADE05]. In Chile a similar mechanism is directed towards construction companies and housing developers. Depending on the property value they can deduct up to 100% of the total investment cost [Min09].
- Low interest loans for SWH are hardly used in practice. For small systems the administrative effort is quite high. For medium and large scale systems this measure is seen as a reasonable complementary measure [Eur06a].
- Tradable certificates are another means to reduce the restraining effect of high initial costs. The energy saved by the SWH creates certificates that can be sold. To reduce the transaction cost it is recommendable to fix an average value for the savings during the lifetime of a product which can be attributed at the moment of the sale [Eur06a]. Carbon credits in frame of the Clean Development Mechanism (CDM) of the Kyoto protocol is a special case of such certificates. Due to the high overhead costs there has been no such project up to know. For this reason the UNFCCC created a simplified framework for small scale CDM projects [Tec10].
- So far the idea of third party financing has not been implemented for SWH in any country. Still experiences with rural electrification have shown its feasibility which may also be valid for certain thermal applications [Rod06, Gel07].

In literature no clear preference for a specific incentive scheme can be determined. However all studies stress that

a) a continuous support policy is essential as ”stop-and-go policies have proven disastrous for emerging markets“ [Phi06, p.22].

b) incentive schemes must be well-designed and consistent in order to assure ”continuous growth and stability in the market, enabling the development of a domestic manufacturing industry, reducing the risk of investing in a technology, and making it easier to obtain financing.“ [Saw04, p.26].

Failure to Account for External Costs of Conventional Energies

The lack of internalization of environmental externalities like air pollution and climate change as a consequence of burning fossil fuels and persistent radiative danger in the case of nuclear power are a global issue. International treaties like the Kyoto protocol or the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter by the International Maritime Organization are first steps to changes this but there still remains a long way to go.

Weak Position of Argentinean Solar Thermal Companies

Barriers encountered by Argentinean solar thermal companies, especially manufacturers, are typical for small and medium enterprises (SME). Generally banks demand high interest rates on credits for new markets which they associate with an increased risk. Therefore the companies face **high credit costs**. A special credit line for green SMEs provided with governmental support can solve this problem. As a complementary measure the **high tax load** can be tackled by a temporary tax reduction (or even exemption) for this target group.

In the case of the competition between locally produced systems and imported products there is a conflict of interest. As many imported products - especially simple evacuated tube systems from China - are cheap due to mass production and lower labor costs, Argentinean producers long to restrict the **import of low price mass products**. This can be done by a quota e.g. in the case of a solar obligation for social housing. A more rigorous and questionable option are increased tariffs. This clearly contradicts the demands of dealers of imported products which deplore the high tariffs (20%). The fact that photovoltaic modules are subject to reduced tariffs (12%) shows the possibility to influence this value [Thi07].

5.2.3 Quality-related and Technical Barriers

Lack of Adequate Standards

Standards to assure the quality and performance of SWH are essential in order to assure the buyer that the equipment will fulfill his expectations. In Argentina a set of IRAM[12] norms on solar collectors exist. They date back to the mid-eighties and thus require adoption to the actual state of the art. Inspiration can be obtained from other international norms such as EN 12575 to 12577 or ISO 9459 and 9806 (currently under revision).

Lack of Certified Products

As the survey reveals many products, particularly national products, are not certified. This barrier can be reduced by setting up national accredited testing labs. This can be done by

[12]Argentinean Institute for Normalization and Certification, the exclusive Argentinean representative for international standardization organizations

upgrading existing testing facilities at several national institutes (e.g.: Grupo de Energía Solar of Universidad de Río Cuarto, Laboratorio de Estudios Sobre Energía of Universidad Tecnológica Nacional and Plataforma Solar at INTI). In case of a financial incentive program a quality and performance certificate must be a pre-requisite for eligibility. Local manufacturers could be supported in obtaining certification, e.g. by extending the work being done at INTI at the present [E-R09].

Lack of Qualified Personnel for Design, Construction and Maintenance

Experience has shown that the quality does not only depend on the product but on the planning and execution of the installation as well. Therefore it is recommendable to set up training courses and a certification for the people involved in the different stages of a SWH project. Motivation to take part in such a training can be stipulated by requiring certified installers to access possible incentives, as happened e.g. in Portugal [Min04]. The French Qualit'EnR system goes one step further: it does not only include requirements for the installer but also an audit of an installation executed by him. In case a faulty installation is encountered the installer's certificate is suspended - which means that the installer is no longer admissible to the incentive program - until the errors are fixed [Aso10].

Additionally free information and planning material will increase the average level of proficiency of all stakeholders.

Lack of Demonstration Projects

Demonstration projects can contribute to increase public awareness and credibility of a new technology. Therefore it is recommendable to realize projects in public buildings (e.g. hospitals, schools, sports clubs) in order to produce a significant impact. Private companies can additionally benefit from the marketing effect. Although Argentina is no member of the International Energy Agency (IEA), it is possible for local entities to participate in IEA Tasks with the objective to promote certain technology solutions and thus benefit from exchange with international research institutes and companies.

Lack of Research and Development

Research and development (R&D) is an important factor in fostering innovation towards more efficient and profitable products. Although solar collector technology nowadays is considered mature there is a vast potential for further development. New materials, new production technology, process heat and (building-)integrated components are to be named as main fields for investigation. Progress can be fostered by increased public financing for such projects and a more intense industry engagement in research. International cooperations again can provide a fruitful framework [Phi06]. In the long run R&D will contribute to decrease the cost of SWH significantly.

Lack of Data on Consumption

Incorrect data on the hot water consumption leads to a faulty system design which may cause deficient operation of the plant and reduced solar yield or performance. For small single family systems measurements are too costly so it is most feasibly to work with standard values for urban population (30...60 liters of water at 45°C per person and day depending on habits). For medium and large scale systems a more specific approach during planning phase is required as the economic risk is higher. Yet this barrier can not be solved on a general level but must be dealt with in each individual case.

5.2.4 Behavioral, Social and Other Barriers

Unawareness and Distrust of General Public

Obviously it is necessary to inform potential clients about the existence of SWH and convince them that these work reliably and thus are beneficial for them. Media campaigns targeted towards potential consumers has proven successful in Europe [New10]. The incorporation of the topic into the scholar curriculum also tackles sustainable awareness rising. A public website which provides comprehensive information on the topic is a further measure to foster public interest.

Unawareness of Authorities

As every incentive program needs official support (and financing) it is crucial to raise awareness among authorities of the benefits of SWH. Emphasis can be made on any combination of the following aspects [Ren]:

- Solar Water Heaters reduce the consumption of conventional energy sources and form part of a solution to future energy scarcity.
- For the same reason the technology contributes to the diversification of the energy supply thus increasing energy security.
- Being a clean technology it is beneficial for human health as well as local and global environment.
- A significant SWH market gives prospect to a specialized industry creating jobs and welfare (see chapter).
- In view of rural areas with no or difficult access to energy sources, SWH can help to increase living standard.

In order to put solar thermal energy on the agenda of authorities it is inevitable to pursue intensive lobby activities. This can best be done by a consortium of stakeholders such as solar thermal companies, research institutions, non-profit and government agencies. Examples for such associations are the European Solar Thermal Technology Platform (ESTTP), the Solar Table (Mesa Solar) in Uruguay or the Brazilian Association of Solar Energy (Associação de Energia Solar), among others. The Argentine Renewable Energies Chamber (XX) in its present constellation does not seem appropriate for this objective since it mostly represents the biofuels industry. The Argentine Association for XXX also seems inadequate in the actual constellation since most of the members are scientific institutions.

Unawareness of Professionals in the Construction Sector

The insufficient knowledge on the technology among architects causes that solar thermal is oftentimes not considered during initial planning of a building although this is when it can be integrated most easily into the project. In later stages it requires higher effort, causes extra costs and is therefore rejected. Free information material and courses with best practice examples will help to overcome this barrier. An additional incentive can be a prestigious award for the most innovative construction that incorporates renewable energy technologies.

Split Incentives in Rental Market

The rental market implies the problem that the owner needs to invest in a SWH while the benefits are reaped by the tenant. Thus the owner has no incentive to switch to the new technology. Since the rental market comprises a significant share of the residential market it is essential to address this issue in order to provoke a broad technology shift. This issue is analyzed worldwide. The proposed solutions -especially for existing buildings - are [GSH07]:

- Integration of energetic aspects in (official) comparisons of prices charged for rent.
- Guaranteed yield as a important tool to rise confidence in the technology
- Creation of means of allocation (e.g. solar contracting)

For new constructions and renovation this problem is solved most easily by a solar obligation.

Conflict of Interests in Multi-family Houses

Another conflict arises from different attitudes of parties in a multi-family-house. If hot water is provided from a central system a general agreement of all occupants is needed for a move to solar thermal. Experts therefore believe that solar thermal is only feasible in cases of new construction or complete retrofitting [Phi06]. If the hot water preparation takes place within the single housing units it may be practicable for the occupants of the top floors to install single SWH units. This entails conflicts as the space may be demanded by other parties for their SWH or other purposes (e.g. drying of clothes). Again this issue is avoided most easily by a solar obligation.

Unclear Profile of Solar Thermal Sector

As the market for SWH is very small up to now there is no orderly representation of the sector as a whole. This leads to many isolated points of actions. A united, coordinated modus operandi will have a much more significant impact. A round table which conglomerates different stakeholders is a first step to define a common position. The formation of a solar thermal (industry) association will further increase the effectiveness hence the impact of any lobby activities.

Unprofessional Business Management within Solar Thermal Companies

A related problem can be detected on the company level as well. Many of the small enterprises lack a detailed business plan. This results in a blurry presentation towards customers, which may throw business expectations back [Gil10a]. A support program for small solar thermal enterprises to develop consistent and comprehensive business plans can greatly contribute to professionalize the sector.

5.3 Recommendations for SWH Market Development

This section consists of two main parts: Initially the targets to be reached and the expected impacts are detailed. Subsequently the necessary steps to be taken are explained. Although it is not specified due to the focus of this report, it is clear that the named measures should be a part of a paradigm shift from fossil based to a more sustainable society. This implies the promotion of renewable energies and energy efficiency (RE&EE) in general and an intensive effort in conscientization.

5.3.1 Targets and Impacts

Goals for Installation

The target values for the installed collector area are based on the extended potential estimations in chapter 4.2.2 which refer to the energy consumption in the year 2009. For a detailed projection it is necessary to consider the dynamic of the potential: factors such as population growth and a possible extension of the natural gas network (leading to the substitution of LPG) must be incorporated.

In the first step SWH are to be installed in applications where they are already profitable or close to it (substituting LPG and electricity) and significantly contribute to improving living standard (replacing fire wood). This is reached by an incentive program which assures the profitability of the SWH and a comprehensive, targeted information campaign. According to the requirement of the target group the majority of the installed systems in this stage are passive (thermosiphon) systems which facilitates quality assurance. Nevertheless larger scale (active technology) demonstration projects in the public sector will be executed and thus prove the feasibility of the technology and contribute to its promotion.

This initial period allows for several measures to be taken and to take effect: quality assurance will be broadly established and R&D will lead to more efficient technology at lower prices. The general public will become aware of the technology and will seek its benefits. This development will be fostered by stable and positive legal and institutional framework.

As profitability increases the use of solar thermal energy will extend to residential natural gas consumers. By means of incentive and obligatory measures 30% of the potential of residential natural gas users will be covered by 2025. Likewise the technology will penetrate the service and public sector. Because of good profitability all installations running on fire wood, electricity and LPG will be complemented by solar energy in 2025. In applications using natural gas within this sector 30% will be complemented with a solar thermal installation. This development goes along with an increasing share of active systems and a rising average collector area per system.

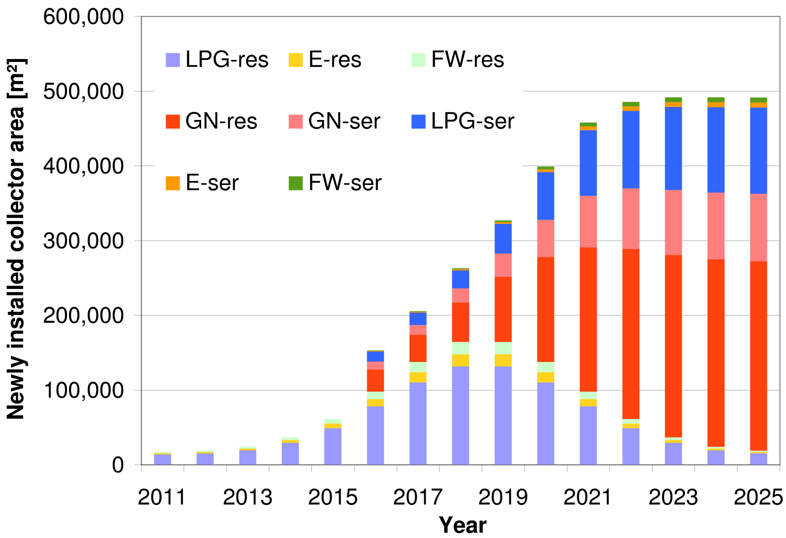

Figure 5.1: Targets for annually installed collector area in the residential, public and service sector; NG=natural gas, FW=fire wood, E=electricity, res=residential sector, ser=public and service sector

By 2025 two thirds of the installed collector area will be in residential applications (of which 39% complement natural gas, 22% LPG and 3% fire wood and electricity respectively). The remaining share will be installed in the service and public sector, most of it in LPG and natural gas installations. The annually installed collector surface will total approximately 500,000 m². As the potential for solar thermal in DHW preparation in the residential, public and service sector is being covered, other opportunities open up for solar thermal technology. For the time beyond 2025 the significant potential that lies in solar heating and cooling as well as in process heat for the industry is yet to be determined and must be included into future targets.

Economic Impacts

As described in chapter 4.3 a sustainable solar thermal market brings various advantages for the national economy. In Germany in 2009 the sector had a turnover of 1.2 billion euro and provided direct jobs for over 20,000 persons. Depending on the share of imports and the degree of automation, the target of 500,000 m² of yearly installed collector area will provide jobs for around 5,000 persons. The steep increase in the number of solar thermal companies in recent years (see survey) indicates that the sector is willing to take the challenge and to exploit this potential.

These facts in addition to the savings on subsidies assure that the necessary expenses for market stimulation measures will yield a high rate of return.

Environmental Impacts

Considering the specific emission reduction factors as derived in table 4.18 in 2025 the annual emission reduction will exceed 1,000,000 tons of CO_2. This equals almost 1% of the Argentinean direct CO_2 emissions from burning fossil fuel in the year 2000 - a significant contribution to climate protection [Gir05].

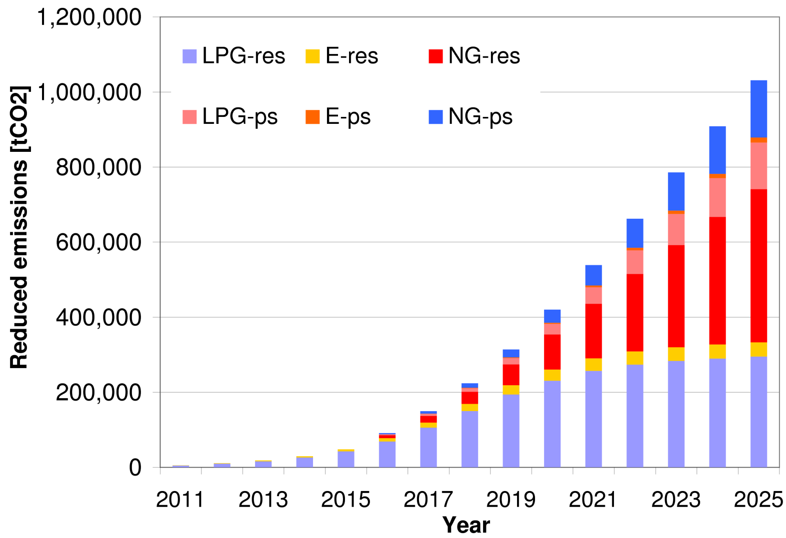

Figure 5.2: Annual emission reductions due to diffusion of SWH

Once the full potential for hot water preparation in the residential, public and service sectors is exhausted, the savings will increase to 2% of the CO_2 emissions from burning fossil fuel in 2000. The substitution of fossil fuel burning for space heating, cooling and industrial process heat will further increase the emission reduction.

5.3.2 Solar Thermal Roadmap

The necessary steps in order to foster a sustainable market growth are exposed in four thematic groups. The overview on page 52 puts them into a time frame and specifies the responsibilities.

Awareness Rising and Marketing

A fundamental step to promote the technology is the formation of a solar thermal association (STA) which unites relevant actors from industry, research and academia. Although it is most likely that there are some different opinions among the single actors, it is essential to define a common position and coordinate public action. On one hand this increases political influence in seeking support for the technology. On the other hand it facilitates campaigning and thus enhances trust among customers. The STA can also support the industry members, which are most likely microenterprises, in developing a consistent business plan and thus improve the basis for public relations. In order to refine the goals and actions described in this outline of a technology roadmap, the consortium ought to analyze the actual market potential including insider information provided by the industry.

Based on the market potential and considering the feasibility as well as the profitability an incentive program for SWH must be developed. Due to the dynamic Argentinean economy a scheme based on direct grants is preferable over tax deduction with the resulting delay in refunding. In order to achieve pay back times below 10 years a grant of 50% on the system cost seems reasonable (see chapter 4.1). As the market develops and subsidies on fossil fuels are abolished the grant rate can continuously be reduced. Obviously it is essential to avoid abuse on the one hand and excessive administration on the other hand.

A crucial accompanying measure to the incentive scheme is the marketing campaign. Its objectives are to inform potential customers on the solar thermal technology, convince them of its reliability and highlight the incentive program. A comprehensive set of guidelines for developing such a campaign has been developed in the project Soltherm [vdRM03]. Simultaneously a comprehensive concept to include renewable energies and energy efficiency - among the solar thermal - in the curriculum of schools is to be developed and implemented. An internet site with free information on different levels of detail (directed to general public, professionals, etc.) can contribute to spreading and deepening the knowledge on solar thermal technology. The didactic material on the site of the Ministry of Energy [13] could be an exiguous start. The initial funding for the campaigning should come from the government. Once the market is growing, the industry could contribute a small share of its revenues.

Once the incentive scheme is enacted and the information campaign running it is important to monitor their success. On the supply side an annual industry survey is an evident means. If all companies within the association commit to report their annual production, import and sales volume the effect of the adopted measures can be evaluated. A customer satisfaction survey is an adequate way to scrutinize if changes are required to assure the measures' success.

Quality Related

Product quality is a key factor for a successful solar thermal market development. It assures that the product will provide the promised benefit during the projected period of time. Elsewise the users' trust in the technology is undermined which leads to a downturn in market

[13] see: http://energia3.mecon.gov.ar/contenidos/verpagina.php? idpagina=2967

development. According to Amtmann the quality of SWH is built upon three pillars: the product itself, the system design and its installation [Amt10].

In the first step a minimum requirement for collectors and SWH should be a binding standard the STA agrees on. In a second step it should be extended to a quality label. This not only refers to technical requirements to be met by the equipment but also includes the production process. An example is the European Solar Keymark label[14]. It not only requires the certification of the product according to actual European Norms (EN) but also demands [Nie09]:

- that the production line has a quality system according to the ISO 9000 standards
- an initial inspection of the manufacturing site by an independent party
- a periodic surveillance by an independent party

Obviously the certification requires accredited testing centers which can be based in existing facilities.

The quality during the planning stage and of the installation itself must be assured by requiring well-trained, accredited planners and installers for access to the grant. Thus it is necessary to develop the respective training courses and certificates. Likewise educational institutions must be accredited for issuing the certificates.

The main source of financing for the named actions should come from the government which can request support from international or binational development agencies like United Nations Development Program (UNDP) or German Kreditanstalt für Wiederaufbau (KfW). A small cofinancing could be required from industry in order to assure their commitment.

Quality assurance also implicates a strengthening of the competitiveness of Argentinean producers over cheap (Chinese) imports. A part of the simple (and lowest-price) products can be excluded from the market by certain technical requirements. The obligation to integrate “getters“ into evacuated tubes assures lasting vacuum stability. Another means is an exigent hail test. For locally produced equipment these requirements present no strong restraints as they are not applicable (in the case of getters) or have been mastered already without major damages. As the installation will be executed by certified installers the risk of unprofessional installation - which occurs mainly with cheap import products directly sold to the final client - also diminishes.

Research and Development

The area of R&D offers many opportunities between research institutions and the private sector. In the first step it needs to push the development of national products in order to meet the standards necessary for quality assurance and possibly to increase performance. On the way to a larger scale market the production process itself needs improvement in terms of efficiency (concerning material, energy, time and personnel). This way the production capacity increases while specific costs decrease.

Demonstration projects can serve to support awareness rising among the general public. At the same time they are predestined for a close collaboration between research (monitoring) and industry (material supplier) and usually bring about lots of findings for further improvement.

On the long run further fields of investigation such as new materials and innovative technologies need to be approached in order to prepare the technology for the future.

[14] see: http://www.estif.org/solarkeymark/index.php

The Austrian way of supporting investigation in the field of solar thermal has turned out very successful and is recommended. Fundamental research is supported with up to 100%. As technology develops and approaches practice and market deployment the subsidy is decreased reaching a minimum of 25% for demonstration projects [Bau10]. The funding goes along with the stimulation of applied research in cooperation between institutes and industry.

Institutional and Legal Issues

On the side of the government it is indispensable that renewable energies in general are given a higher significance in view of future challenges. While renewable energies and energy efficiency in general play only a marginal role in the actual energy scenario until 2025 (7% of the primary energy to be covered by renewable electricity excluding large hydro and biofuels) renewable heat is not even mentioned in it [LG08]! Considering the fact that thermal energy accounts for 42% of the national final energy consumption, this leaves a huge potential to substitute conventional sources by sustainable alternatives untouched [Sec06]. Solar thermal energy must be included into future planning. The scenario elaborated by Fundación Bariloche as input to the above mentioned report provides a great outline (see chapter 4.2.2) [Fun07]. It is about time to incorporate ambitious targets into the future energy scenario!

The shift towards renewables must then be underlined by gradually removing subsidies on fossil fuels and electricity. Elsewise the competition with renewable alternatives is distorted and their profitability unnecessarily reduced.

As an additional measure an obligation to cover a certain share of the heat demand by solar energy (or other renewable sources) must be envisaged for the future. Once a healthy market is established driven by the above named incentives and quality assurance is in its place, it can be enacted. This allows a smooth shift from an incentive driven to an obliged market. In a first phase such an obligation would focus on newly constructed buildings and refurbishment. In a second phase it would be extended to all existing buildings. Step by step also non-residential applications should be included.

Risks

The key to the success of the presented roadmap is the governmental support. If official politics keep betting on fossil fuels and ignore the need for renewable energies also for heat production the solar thermal sector will not be able to push the technology to a significant market. To obtain this political support requires the unified action of all involved actors which leads to the next risk: the conflict potential within the solar thermal sector. At the present there are a variety of small enterprises and research institutes working on the topic but they are not united. INTI's plataforma solar longs to provide a space to gather, discuss and coordinate actions. Until the present this initiative has been criticized by some and ignored by others. The underlying incongruences must be overcome if they are fundamental and set back if they are of secondary importance. The objective must be to define common targets and campaign for them together.

Once an adequate incentive scheme and institutional framework is on the way, it must be assured that it is clear, well-targeted and does not require much administrative effort. Else its impact may be low, as various European markets have shown. Comprehensive quality assurance is another crucial factor for a sustainable solar thermal market.

For local producers it will be a challenge to obtain a significant market share. International companies have a competitive advantage for their experience in developed markets and are only waiting for new markets to penetrate. Mexico is an example of a country where national industry is struggling to recover market share of imported competition [Com09].

Field of action	Short term (1-2 years)	Resp.	Mid-term (3-7 years)	Resp.	Long term (8-15)	Resp.
Quality related	Agree on binding quality standards for collectors and SWH	I, R, A	Review of quality standards	I, R, A	Review of quality standards	I, R, A
	Set up accredited testing facilities for collectors and SWH	R, A	Review training course for planners*	I, R, A	Review training course for planners*	I, R, A
	Provide financing for setting up accredited testing facilities	G	Review training course for installers*	I, R, A	Review training course for installers*	I, R, A
	Develop training course for planners*	I, R, A				
	Develop training course for installers*	I, R, A				
	Introduce certification for planners/installers	G				
	Accredit selected institutions for trainings	G, A				
Awareness and Marketing	Formation of a Solar Thermal Association	I, R, A, G	Update website	I, R, A, G	Update website	I, R, A, G
	Determinte market potential for solar thermal technology	I, R	Continue customer satisfaction survey	I, R, A	Continue customer satisfaction survey	I, R, A
	Start targeted marketing campaign	I	Review marketing campaign	I	Review marketing campaign	I
	Perform industry survey	I	Review incentive program	G	Phase out incentive program	G
	Perform customer satisfaction survey	I, R, A	Continue industry survey	I		
	Develop and enact incentive program	G	Incorporate education on RE&EE in scholar curriculum	G		
	Create website with information for general public and professionals	I, R, A, G				
	Develop concept for education on RE&EE (including ST)	G				
Research and development	Increase quality of national products to meet standards	I, R	Investigate new technologies and materials	I, R	Investigate new technologies and materials	I, R
	Decrease production costs	I, R	Investigate new applications	I, R	Investigate new applications	I, R
	Investigate new technologies and materials	I, R				
	Stimulate applied investigation	G				
	Set long term goals for R&D					
	Provide partial financing for demonstration projects	G				
	Initiate demonstration projects with wide perception	I, R				
Institutional and legal issues	Incorporate ambitious RE in general (and specifically ST) goals into energy scenario	G, R	Enact solar obligation for new buildings and refurbishment (1)	G	Enact reviewed solar obligation	G
	Gradually remove subsidies from fossil fuels	G	Review solar obligation and extend it to heating demand	G	Develop solar obligation for industry	G
	Develop solar obligation	G	Phase out subsidies on fossil fuels	G	Enact solar obligation for industry	G

Figure 5.3: Solar Thermal Technology Roadmap - Overview on tasks and time frame; Responsibilities: I=Industry, R=Research, A=Academia, G=Government

5.3.3 Conclusion

In this chapter the reasons for the poor development of the solar thermal market until present are reviewed and possible solutions are given. Although the existing barriers seem rather overwhelming, experiences in other countries have shown that they can be overcome if the right set of measures is applied. Therefore a proposal for the necessary steps to take is presented in form of a solar thermal technology roadmap. The main action to be taken are on the side of the government is to provide a favorable environment for solar heat. The companies must contribute to improve the quality of the SWH. Of course these measures must be accompanied by a campaign to raise public awareness on the topic.

At the present various initiatives are on the way to push solar thermal technology: the municipality of Venado Tuerto has passed the first solar obligation of the country to come into force in 2015. INTI is cooperating with national companies to improve their products. These activities must be coordinated, bundled and extended.

6. Conclusions

6.1 Summary

The presented Master thesis provides a comprehensive overview of the actual state of the market for solar water heaters in Argentina. Additionally it outlines a perspective for the future including profitability calculations under different scenarios and recommends solutions to existing barriers. The key information was gathered by a survey among companies. It was complemented with literature data from all over the world. In the following the findings are resumed.

Companies in the Solar Thermal Sector

72 companies that work with solar water heaters could be identified. Almost half of them (35) participated in the survey which provides the following image of the sector: the number of companies is rapidly increasing, a third of them started solar thermal activities in 2008 or later. The companies are most concentrated in the Greater Buenos Aires zone, with another important share in the rest of the Argentinean Central Region. Most of them have less than six employees and thus are highly dynamic micro-enterprises. The activities of the companies range from mere sales to production and turnkey projects.

Available Products and services

All kinds of low temperature collectors are available on the market. According to the survey, flat plate collectors, mostly produced locally, are the most common technology. In the second place are direct-flow and heat pipe evacuated tube collectors, where the latter are booming. Thermosiphon systems are the most commonly offered, followed by active systems for DHW preparation. Heating support and other uses such as swimming pool heating are much more seldom. Customs data imply that the share of imported collectors is much higher: unglazed collectors from Israel and evacuated tube technology from China seem to take the lead.

As to quality assurance it seems that product certification and after-sales service are underestimated by a significant share of the companies. The warranty appears much more appreciated although the terms are rather short compared to international values.

Market Volume

Based on the survey a market volume of approximately 2000 m^2 of installed collector area in 2009 could be identified. Around two thirds of it refers to locally produced flat plate technology, the rest are mainly imported evacuated tube collectors. If customs data on collector imports are considered, the market value can be extended to 7000 m^2. 40% of this number corresponds to imported unglazed collectors. Chinese evacuated tube and other imported collectors make up another 40% of the market (25% and 15% respectively). The remaining 20% (1300 m^2) are national products, mostly flat plate collectors. For 2010 a duplication of the market for DWH is expected with shares of national and imported equipment remaining constant.

While the survey reveals 4200 m^2 of installed gross collector surface, the extended estimation considering customs data is 20'000 m^2. Half of this value refers to imported unglazed collectors. The rest is divided in almost even parts between nationally produced flat plate collectors, Chinese evacuated tube technology and other imported collectors.

Target Groups

The survey shows that SWH are mostly installed in single family houses for hot water preparation. Thermosiphon systems take the lead and substitute mainly LPG and fire wood. The primary destination of the systems lie in the North of the country. Besides customs data imply that solar swimming pool heating - presumably for high income customers - is another a attractive application.

Market Potential and Impacts

The market potential for the preparation of DHW is 6'150'000 m² in total of which less than 0.2% are in place at the present. Over 80% of this potential refers to the substitution of natural gas. 880'000 m² can be installed replacing LPG, and 110'000 m² each substituting fire wood and electricity.

Within the service, commercial and public sector a potential of 2'260'000 m² is determined. Again 80% correspond to natural gas. 380'000 m² of the remaining potential refers to replacing LPG and 40'000 m² each to the substitution of fire wood and electricity.

If the total potential was exploited over 40'000 man-years of labor were created and more than 2.3 million tons of CO_2-emissions were saved every year!

Profitability

The profitability depends highly on the substituted fuel and on the location, which strongly influences the pricing. Unsubsidized LPG is most profitable at present (7 years pay back time and 11% IRR) followed by electricity in the interior of the country. Cheap electricity in the capital and low prices for natural gas in general make SWH uncompetitive for these fuels. Only if investment cost fall significantly or fuel prices increase in the future, the installation of a SWH will pay off in the future.

Barriers and Solutions

Major barriers to the diffusion of SWH were identified in the areas of policy, economics, quality and society and analyzed on the basis of experiences from more than 20 countries around the world. The creation of a solar thermal industry association appears as an important starting point for coordinated solutions. It will facilitate lobbying for political support on all levels which is a key factor for the success of technology. Political will is necessary to promote the technology and introduce incentive programs for increasing profitability. These measures must be combined with awareness raising and education. Additionally efforts to assure the quality of the equipment and train planners and installers are required, in order to obtain lasting financial and environmental benefits.

6.2 Outlook

Despite the discrepancy between survey and customs data it is clear that the market volume is diminutive. Also other findings of this thesis show that Argentina has still a long way to go in order to become a "solar thermal nation". More so as experiences from many countries show that the market does not run by itself but it needs continuous attention. Yet looking at the numbers and talking to the companies one clearly gets the impression that the diffusion of SWH is about to take off. Once the market has reached a certain impetus surely some larger players, e.g. from the national boiler industry, will jump on the bandwagon which will further push its development. The challenge for the Argentinean industry will be to supply a significant share of the market with national products.

In the future, a more competitive environment will require companies to search for additional applications which are only marginally treated in this study. Heating support and industrial process heat are two very promising sectors, which will multiply the determined potential. Solar cooling, building integrated systems and the combination with photovoltaics open up additional dimensions which can be approached in the future.

At the moment the key issue is to reach a critical mass within the sector, which is able to put the topic on the political and public agenda. I hope the sector accomplishes this step soon!

Bibliography

[AD10] Muhammad Amer and Tugrul U. Daim. Application of technology roadmaps for renewable energy sector. Technological Forecasting and Social Change, In Press, Corrected Proof:–, 2010.

[ADE05] ADEME. Crédit d'impôt, 2005. http://www.arecpc.com/espace-particulier-poitou-charentes/credit-impot-energie.htm, accessed August 3rd 2010.

[AH07] Robinson Alazraki and James Haselip. Assessing the uptake of small-scale photovoltaic electricity production in Argentina: the PERMER project. Journal of Cleaner Production, 15(2):131 – 142, 2007. Optimising Reform: The Sustainability of Electricity Market Liberalisation in Less Developed Countries.

[Amt10] Personal interview with Martin Amtmann, Gesellschaft für technische Zusammenarbeit Mexico, on May 12th, 2010.

[Aso10] Asociacion Qualité Energie Renovable. Qualit'EnR organisation and labels, September 2010.

[Bau10] Ingrid Bauer. Solarthermieforschung im Ländervergleich: ÖSTERREICH. Forschungsförderungsgesellschaft, January 2010. DSTTP Solarthermie-Technologiekonferenz.

[BB09] Sander van Egmond Wilfried G.J.H.M. van Sark Bothwell Batidzirai, Erik H. Lysen. Potential for solar water heating in Zimbabwe. Renewable and Sustainable Energy Reviews, 13(3):567 – 582, 2009.

[BBBG07] Marlett Balmer, Joan Beall, Hannelore Bergler, and Michael Grupp. An overview of international experience in manufacturing and promotion of solar water heating systems with price comparisons and lessons for South Africa. Energy for Sustainable Development, 11(3):11 – 16, 2007.

[Bio09] Energía Solar Térmica, 2009. http://www.biodisol.com/energia-solar/energia-solar-termica/ accessed May 14th 2010.

[BKL+08] Veit Bürger, Stefan Klinski, Ulrike Lehr, Uwe Leprich, Michael Nast, and Mario Ragwitz. Policies to support renewable energies in the heat market. Energy Policy, 36(8):3150 – 3159, 2008.

[BSD+05] Víctor Bravo, Nicolás Di Sbroiavacca, Hilda Dubrovsky, Guillermo Gallo Mendoza Roberto Kozulj, Gustavo Nadal, and Héctor Pistonesi. RETs I Final Report on Renewable Energy Technologies in Argentina, December 2005.

[Bun10a] Bundesamt für Wirtschaft und Ausfuhrkontrolle. Richtlinien zur Förderung von Maßnahmen zur Nutzung erneuerbarer Energien im Wärmemarkt, July 2010.

[Bun10b] Bundesverband Solarwirtschaft e.V. Statistische Zahlen der deutschen Solarwärmebranche (Solarthermie), June 2010.

[CBG+09] Daniel Cameron, Luis Beuret, Ezequiel García, Francisco Elizondo, and Mónica Servant. Energías renovables - diagnóstico, barreras y propuestas, Junio 2009.

[Chi06] Estudio del mercado solar térmico en Chile, November 2006.

[Com09] Comisión Nacional para el Uso Eficiente de la Energía, Río Lerma 302, Col. Cuauhtémoc, Del. Cuauhtémoc, C.P. 06500, México, D.F. Programa para la Promoción de Calentadores Solares de Agua en México (Procalsol). Avances 2007-2009 y Plan Operativo 2009-2010, September 2009.

[Con93] Congreso de la Nación Argentina. Ley Nº 24240: Ley de Defensa del Consumidor, September 1993.

[Con06] Congreso de la Nación Argentina. Ley Nº 26190: Régimen de fomento nacional para el use de fuentes renovables de energía destinada a la producción de energía eléctrica, 2006.

[Dil07] Don A. Dillman. Mail and Internet Surveys. The Tailored Design Method. John Wiley & Sons, 2nd edition edition, 2007.

[Dir09] Dirección Nacional de Energía y Tecnología Nuclear, Montevideo, Uruguay. Energía solar térmica en Uruguay - Resultados de entrevistas con productores e importadores de Colectores Solares, February 2009.

[E-R09] Los colectores solares ya tienen su primer informe, November 2009. http://www.inti.gob.ar/e-renova/erSO/er11.php, accessed March 3rd 2010.

[Epp09] Bärbel Epp. World map of solar thermal industry 2009. Solrico, 2009.

[Esk09] Eskom Distribution. The South African Solar Water Heater Industry, August 2009.

[Eur06a] European Solar Thermal Industry Federation. Financial Incentives for Solar Thermal - Guidelines on best practice and avoidable problems, 2006.

[Eur06b] European Solar Thermal Industry Foundation. Solar Industrial Process Heat – State of the Art, August 2006.

[Eur07a] European Solar Thermal Industry Federation. Best practice regulations for solar thermal, August 2007.

[Eur10a] EurObserv'ER. Solar Thermal Barometer, May 2010.

[FH04] Günter Franke and Herbert Hax. Finanzwirtschaft des Unternehmens und Kapitalmarkt. Springer-Verlag, Berlin Heidelberg New York, 5th edition edition, 2004.

[FIA10] FIASA. ABC sobre calefones solares FIASA, January 2010.

[Fun07] Fundación Bariloche. Asistencia Técnica para la elaboración del "Plan Estratégico de Energía de la República Argentina", September 2007. confidential.

[Gel07] Ibrahim Abdel Gelil. Framework Conditions for Solar Thermal Energy Use in the Southern Mediterranean Countries, December 2007.

[Gil10a] Personal interview with Gustavo Gil, Instituto Nacional de Tecnología Industrial, on April 22nd, 2010.

[Gil10b] Carlos Gilardone. Cada segundo, 254 pesos. La Nación, 2010. Sunday, July 25th.

[Gir05] Leonidas Osvaldo Girardin. Inventario Nacional de la República Argentina de fuentes de emisiones y absorciones de Gases de Efecto Invernadero, no controlados por el Protocolo de Montreal. Fundación Barioloche, September 2005.

[GL07] Fabián Garreta and Sebastián Lastra. Energía Solar Térmica en la Ciudad Autónoma de Buenos Aires - Barreras y posibilidades para su implementación. Universidad Tecnológica Nacional, August 2007.

[GSH07] Frederik Moch Susanne Berger Christoph Urbschat Tatjana Tupy Hartmut Rößler Dirk Mangold Bodo Grimmig Marion Elle Marc Thiem Olivier Drücke Gerhard Stryi-Hipp, Martin Schnauss. GroSol - Studie zu großen Solarwärmeanlagen. Bundesverband Solarwirtschaft e.V. (BSW), November 2007.

[Inf08] Calefón solar, November 2008. http://infouniversidades.siu.edu.ar/noticia.php?id=244 accessed May 14th 2010.

[Ins85] Instituto Argentino de Normatización y Certificación. IRAM 210001 - Colectores solares, 1985.

[Ins01] Instituto Nacional de Estadística y Censos. Hogares y población censada en ellos por tipo de vivienda. Total del país., 2001.

[Ins05] Instituto Nacional de Estadística y Censos. Estadísticas de Productos Industriales (EPI), September 2005.

[Ins09] Instituto Nacional de Tecnología Industrial. Guía para desarrollar herramientas de comunicación, October 2009.

[Ins10] Instituto Nacional de Estadística y Censos. Estadísticas de productos industriales (EPI) - Artículos para el hogar, March 2010.

[Int05] International Energy Agency. Recommendation: Converting solar thermal collector area into installed capacity, August 2005.

[Int09a] International Energy Agency. Renewable Energy Essentials: Solar Heating and Cooling, December 2009.

[Jon06] Dell Jones. Solar thermal energy - New light on a mature and market ready technology. Sterling Planet, December 2006.

[JR05] Li Junfeng and Hu Runqing. Solar thermal in china: Overview and perspectives of the chinese solar thermal market. Refocus, 6(5):25 – 27, 2005.

[KHK09] Johannes M. Kissel, Rolf Hanitsch, and Stefan C.W. Krauter. Cornerstones of a renewable energy law for emerging markets in south america. Energy Policy, 37(9):3621 – 3626, 2009. New Zealand Energy Strategy.

[KKS05] J.K. Kaldellis, K.A. Kavadias, and G. Spyropoulos. Investigating the real situation of greek solar water heating market. Renewable and Sustainable Energy Reviews, 9(5):499 – 520, 2005.

[LAAB94] T.A. Lawand, J. Ayoub, R. Alward, and E. Brunet. Renewable energy activities in rural argentina. Renewable Energy, 5(5-8):1334 – 1341, 1994. Climate change Energy and the environment.

[Leb06] The Lebanese Solar Energy Society (LSES). Solar thermal systems survey for the Lebanese market, April 2006.

[LG08] Juan Legisa and Guillermo Genta. Elementos para el Diagnóstico y Desarollo de la Planificación Energética Nacional 2008-2025. Grupo de Planeamiento Estratégico, Secretaría de Energía, República Argentina, December 2008. confidential.

[Loy07] Detlef Loy. Energiepolitische Rahmenbedingungen für Strommärkte und erneuerbare Energien: 23 Länderanalysen - Kapitel Argentinien, September 2007.

[MG09] Peter Meisen and Catalina Ruiz Gutierrez. Renewable Energy Potential of Argentina. Global Energy Network Institute, November 2009.

[Min04] Ministério das Actividades Económicas e do Trabalho, República Portuguesa. Portaria n.o 1451/2004: Manual de Certificação de Técnico Instalador de Sistemas Solares Térmicos, November 2004.

[Min09] Ministerio de Hacienda, República de Chile. Ley N°20.365 que Establece una Franquicia Tributaria respecto de Sistemas Solares Térmicos, August 2009.

[Mon10] Montamat & Asociados. Informe mensual de precios de energía, 50 edition, June 2010.

[MS04] Christoph Müller and Klemens Schwarzer. Nutzung von Sonnenenergie zur Verbesserung der Lebensbedingungen im Altiplano/Argentinien, 2004.

[NBD07] Gustavo Nadal, V. Bravo, and H. Dubrovsky. RETs II Final Report on Renewable Energy Technologies for Poverty alleviation in Argentina - Solar Water Heaters and Wind Energy Converters, March 2007.

[NBD09] Gustavo Nadal, Victor Bravo, and Hilda Dubrovsky. Estudio del estado del arte en el uso de la energía solar para calentamiento de agua. Fundación Bariloche, May 2009.

[New10] New York Solar Thermal Consortium. New York’s Solar Thermal Roadmap, May 2010.

[Nie09] Jan Erik Nielsen. Specific CEN Keymark Scheme Rules for Solar Thermal Products. Solar Keymark Network, December 2009.

[NM10] Horacio Naibo and Emiliano Marinozzi. Informe anual - Datos relevantes Mercado Eléctrico Mayorista. CAMMESA, April 2010.

[Org98] Organization for Economic Cooperation and Development. Globalisation and small and medium enterprises (SMEs), Volumen 1, September 1998.

[Phi06] Cédric Philibert. Barriers to technology diffusion: the case of solar thermal technologies, October 2006.

[Por00] Rolf Porst. Question Wording – Zur Formulierung von Fragebogen-Fragen. Zentrum für Umfragen, Methoden und Analysen, Mannheim, January 2000.

[Por01] Rolf Porst. Wie man die rücklaufquote bei postalischen befragungen erhöht. ZUMA How-to-Reihe, No. 9, September 2001.

[Rab10] Email interview with Gerardo Rabinovich, Instituto Argentino de la Energía "General Mosconi" in September, 2010.

[REC06a] RECIPES Project. Argentine country study: Part D – Project information, February 2006.

[REC06b] RECIPES project. Renewable Energy Potential - Country Report Argentina, October 2006.

[Reg08] Solarthermie, 2008. http://www.regioenergy.at/solarthermie accessed May 21st 2010.

[Ren] Renewable Energy Policy Network for the 21st Century (REN21). Rationale for Renewable Energy Promotion Policies. http://www.ren21.net/REPolicies/policy/rationale.asp, accessed August 5th 2010.

[Rod05] Marcelo Daniel Rodriguez. Mitigación de emisiones a través del desarrollo de la utilización de Energías Renovables - Tercer Informe. MR Consultores, Buenos Aires, 2005.

[Rod06] Délcio Rodrigues. Business Prospects for Solar Water Heating Fee-for-Service Operations in Brazil. Vitae Civilis – Instituto para o Desenvolvimento, Meio Ambiente e Paz, March 2006.

[Saw04] Janet L. Sawin. National Policy Instruments - Policy Lessons for the Advancement & Diffusion of Renewable Energy Technologies Around the World. Worldwatch Institute, January 2004.

[Sec04] Secretaría de la Nación, República Argentina. Descripción, desarrollo y perspectivas de las energías renovables en la Argentina y en el mundo, May 2004.

[Sec06] Secretaría de Energía, Republica Argentina. Balance Energético Nacional - Año 2005, April 2006.

[Sec08a] Secretaría de Energía, República Argentina. Calculo del factor de emisiones de CO_2 de la red Argentina de energía eléctrica. Año 2007, November 2008.

[Sec08b] Secretaría de Energía, República Argentina. Generación de Energía Eléctrica por tipo y jurisdicción, 2008.

[Sec08c] Secretaría de Energía, República Argentina. Resolucion 1071/2008 - Ratifícase el Acuerdo de Estabilidad del precio del Gas Licuado de Petróleo (GLP) envasado en garrafas de 10, 12 y 15 kilogramos de capacidad, September 2008.

[Sec09] Secretaría de Energía, Republica Argentina. Balance Energético Nacional - Serie 1960-2007, December 2009.

[Sec10] Secretaría de Energía, República Argentina. Programa“GENREN” - Adjudicación de Contratos de Abastecimiento con Fuentes Renovables de Energía, June 2010.

[SM10] Janet L. Sawin and Eric Martinot. REN21: Renewables 2010 Global Status Report. Renewable Energy Network and Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, July 2010.

[Spi10] Erico Spinadel. Energía Eólica en Argentina: Oportunidades Existentes y Desafíos aún Pendientes. Asociación Argentina de Energía Eólica, September 2010.

[Sri06] Sunderasan Srinivasan. Transforming solar thermal: Policy support for the evolving solar water heating industry. Refocus, 7(2):46 – 49, 2006.

[Tec10] Tech4CDM. Información básica para el desarrollo de un proyecto MDL solar térmica en Chile, April 2010.

[Thi07] Federico Thielemann. *Zielgruppenanalyse - Biomasse und Solarenergie in Argentinien*. Deutsch-Argentinische Handelskammer, Buenos Aires, December 2007.

[TM10] G. Tsilingiridis and G. Martinopoulos. Thirty years of domestic solar hot water systems use in greece - energy and environmental benefits - future perspectives. *Renewable Energy*, 35(2):490 – 497, 2010.

[Uni10] Unidad de Información Ambiental Estratégica; Ministerio de Medio Ambiente, y Medio Rural y Marino; España. *Inventario de emisiones de gases de efecto invernadero de España. Años 1990-2008*, March 2010.

[U.S10] U.S. Energy Information Administration; Office of Coal, Nuclear, Electric and Alternate Fuels; U.S. Department of Energy, Washington D.C. *Solar Thermal Collector Manufacturing Activities 2008*, January 2010.

[vdRM03] Bart van der Ree and Wilma Mert. *SolTherm Europe - Campaign Guidelines*. SolTherm Europe, February 2003.

[Win09] Tobias Winter. *Bioenergie in Argentinien*. Deutsch-Argentinische Industrie- und Handelskammer, Buenos Aires, February 2009.

[WM10] Werner Weiss and Franz Mauthner. *Solar Heat Worldwide - Markets and Contribution to the Energy Supply in 2008*. IEA Solar Heating & Cooling Programme, May 2010.

Annex A

List of Invited Companies

Company	Website / Email	Province
Affinity Steel s.r.l.	www.affinitysteel.com.ar/	Buenos Aires
Aldar S.A.	www.aldar.com.ar	Mendoza
ALP	www.grupoalp.com.ar	
Alsun	www.alsun.com.ar	Capital Federal
Alterna	www.solalterna.com	Córdoba
Alternativa Solar	www.alternativa-solar.com.ar	Córdoba
Arte Sol y Agua	www.artesolyagua.com.ar	Tucumán
AterSol	www.atermec.com.ar/	Capital Federal
Calefacciones Refelme	calrefelme@gmail.com	Misiones
Calefón Solar Térmico	www.calefonsolartermico.com.ar	Entre Ríos
CCSolar	www.ccsolar.com.ar/	Córdoba
Cenit Solar	www.cenitsolar.com.ar	Capital Federal
Clean Energy	www.clean-energy.com.ar	Córdoba
Climadesign	www.climadesign.com.ar	Buenos Aires
Diego Kostic	diegokostic@gmail.com	
e-Concept Home	www.e-concepthome.com/	Buenos Aires
EcoAndina	www.ecoandina.org	Jujuy
EcoSolar S.A.	www.ecosolar.giga.com.ar	Capital Federal
Einfach	www.einfach.com.ar	Capital Federal
El Instalador	www.elinstalador.com.ar	
EnEcO	www.enecosolar.com.ar	Misiones
Energe	www.energe.com.ar	Mendoza
Energía Natural	www.energianatural.com.ar	
Energía Nueva	www.energianueva.com	
Energia Rural	www.energiarural.com.ar	Buenos Aires
Energía Solar 3000	www.energiasolar3000.com	Buenos Aires
energias alternativas	torinoequipamientos@gmail.com	
Energías Argentinas	www.energiasargentinas.com.ar	Córdoba
Enersol	www.brillodesol.com.ar	
FIASA	www.fiasa.com.ar	Buenos Aires
FlexiTub	www.flexitub.com	
FlexSolar	www.flexsolar.net	
Geosolar	www.thermarclima.com.ar	Buenos Aires
gf Ingeniería Solar	www.gfingenieria.com.ar	Buenos Aires
Gpex	www.gpex.com.ar	Capital Federal
Guillermo Pallissó	www.guillermopallisso.com	Buenos Aires
Habitar Natural	www.habitarnatural.com	Córdoba
InnovAr S.R.L.	www.innovarsrl.com.ar	San Luis
Intihuasi Solar	www.intihuasisolar.com.ar	Buenos Aires
La Inesina Solar	www.lainesinasolar.com	Buenos Aires
La Solar	lasolarargentina@gmail.com	

M&D Ingeniería	www.mydingenieria.com.ar	
MAKIARGENTINA	www.makiargentina.com.ar	Buenos Aires
Masolvento	masolvento@gmail.com	
Mek 1	www.mek1.com.ar/	Capital Federal
Nowa	www.nowaenergias.com	Buenos Aires
Nucleo Solar	info@nucleosistemas.com.ar	
Ñuque	info@estufasnuke.com.ar	Buenos Aires
Patagonia ambient	patagonia-ambient.com.ar	
Peisa	www.peisa.com.ar	
Rehau	www.rehau.com.ar	Buenos Aires
Roca Calefaccion	www.roca-calefaccion.com	
Schüco Argentina S.A.	www.schueco.com.ar	Capital Federal
Skenta	www.skenta.com.ar	Buenos Aires
Solar Center	www.solarcenter.com.ar	Buenos Aires
Solar Gaia	www.solar-gaia.com	Buenos Aires
Solares	www.solarestandil.com.ar	Buenos Aires
Solargreen	www.solargreen.com.ar	Misiones
Solarpool BsAs	www.solarpool.com.ar	Buenos Aires
Solcram	www.solcram.com.ar	
SunAir	www.sunair.com.ar	Buenos Aires
sungreen	www.sungreen.com.ar	Buenos Aires
Sursolar	www.sursolar.com.ar	Capital Federal
Tecno’s Ingeniería	www.tecnosing.com.ar	Entre Ríos
Tecnoautomat	www.tecnoautomat.com	Buenos Aires
Termosol	www.termosol.com.ar	Córdoba
TermoSolar	www.termosolarsb.com.ar	Buenos Aires
Termosolar	nolbertoutello@hotmail.com	Córdoba
Vademarco S.A.	www.vademarco.com.ar	Buenos Aires
Vetak	vetak@gigared.com	Chaco
Vitorio	vtacchi@rodeodelasmulas.com.ar	Córdoba
Wulcon	www.wulcon.com	Capital Federal

Annex B

Survey Questionaire

Encuesta sobre el mercado de energía solar térmica en Argentina

El objectivo de la presente encuesta es relevar el estado actual del mercado de energía **solar térmica** en Argentina. En ese marco nos proponemos

- conocer el tipo de equipamiento y servicio ofrecidos en el país,
- evaluar el grado de difusión de la tecnología,
- identificar medidas necesarias para fomentar la difusión y
- en un futuro, poder cuantificar el impacto de posibles medidas adoptadas para promover la energía solar térmica.

La encuesta cuenta con el apoyo del Instituto de Economía Energética de la Fundación Bariloche (IDEE-FB) y del Instituto Nacional de Tecnología Industrial (INTI). Las respuestas serán tratadas con **absoluta confidencialidad** y los resultados se publicarán **preservando el anonimato de los encuestados.**

El tiempo estimado que se requiere para contestar todas las preguntas es de 15 minutos. Al terminarla por favor, envíela a esta dirección de email: b.nienborg@yahoo.com

En caso de preguntas, por favor, no dude en contactarnos a traves de

Björn Nienborg
b.nienborg@yahoo.com
011 4331-2021/2023

quien se encuentra realizando su tesis de fin de grado para la Maestría Internacional en Gerencía de Energías Renovables de la Universidad de Freiburg, Alemania.

Sección 1 – Empresa

1. Nombre de la empresa:
2. Responsable de la información:
3. Dirección:
4. Telefono:
5. E-Mail:
6. Página web:
7. En qué sectores desarrolla actividades su empresa?

Energía solar térmica	☒
Energía fotovoltáica	☐
Energía eólica	☐
Energía hidráulica	☐
Bioenergía	☐
Edificios bioclimáticos	☐
Otros	☐

Otros (especifíque por favor):

8. Qué servicios ofrece su empresa en el área de la energía solar térmica?

Producción de colectores	☐
Importación de colectores	☐
Venta de sistemas solar térmicos	☐
Asesoramiento	☐
Diseño de sistemas	☐
Instalación	☐
Mantenimiento	☐
Servicio post-venta	☐
Cursos	☐

Otros (especifíque por favor):

9. En qué año su empresa inició las actividades en el area ...

de las energías renovables en general?

de la energía solar térmica?

10. Con cuantos empleados cuenta su empresa?

1-5	☐
6-20	☐
21-50	☐
>50	☐

Sección 2 – Productos

11. Que tipo de sistemas para calentar agua provee su empresa?

Pasivo (termosifón)	☐
Activo sólo agua caliente sanitaria	☐
Activo agua caliente santiaria y calefacción	☐
Otros	☐

Otros (especifíque por favor):

12. Qué tipo de colectores provee su empresa? Por favor indiquar la superficie importada, producida e instalada (en metros cuadrados).

	Colector es de aire	Colectores sin cubierta (p.ej. para piscinas)	Colectores planos	Colectores de tubo de vacío	Colectores de tubo de vacío con "heat pipe"	Otros
Modelo y Productor						
Importanción total						
Importanción 2009						
Importación planeada 2010						
Producción total						
Producción 2009						
Producción planeada 2010						
Instalación total						
Instalación 2009						
Instalación planeada 2010						

Por favor especifíque otros:

13. Su empresa provee otros componentes para sistemas de energía solar térmica? Por favor indíque:

14. Alguno de los productos nombrados en esta página esta certificado? Por favor indíque cuál y según qué norma(s):

15. Su empresa ofrece garantía para alguno de los productos nombrados? Por favor, indíque producto y condiciones:

16. Si su empresa ofrece servicios post-venta, por favor indíque las condiciones:

Sección 3 - Mercado:

17. Como evalúa Ud. el desarrollo del mercado para sistemas solar térmicos en el

	Decepcionante	Moderado	Neutral	Bien	Muy bien
Pasado	☐	☐	☐	☐	☐
Presente	☐	☐	☐	☐	☐
Futuro	☐	☐	☐	☐	☐

18. <u>Para importadores/productores</u>: a quienes vende su empresa los colectores? Por favor dar porcentajes del total importado/producido.

Lo instalamos nosotros	
A empresas instaladoras	
Al cliente final	
Otros	

19. <u>Para instaladores</u>: en que aplicaciones se instalan sistemas solar térmicos? Por favor, dar porcentajes del total de instalaciones ejecutadas.

Calentamiento de piletas	
Agua caliente sanitaria	
Agua caliente sanitaria y calefacción	
Usos industriales	
Otros	

20. <u>Para instaladores</u>: en que tipo de construcción se instalan sistemas de energía solar térmica? Por favor, dar porcentajes del total de instalaciones ejecutadas.

Casa de campo	
Casa urbana	
Edificio / vivienda multifamiliar	
Hotel	
Comercios y servicios	
Industria	
Otros	

21. <u>Para instaladores</u>: cuales son las fuentes de energía reemplazadas/complementadas por sistemas solar térmicos? Por favor, dar porcentajes del total de instalaciones ejecutadas.

Ninguna	
Leña	
Kerosen	
Gasoil	

Gas licuado (GLP)	
Gas natural	
Electricidad	

22. Según su opinión, cuales son los motivos para sus clientes para comprar sistemas solar térmicos?

	Sin importancia	Poco importante	Neutral	Importante	Muy importante
Reducción de gastos de energía	☐	☐	☐	☐	☐
Consideraciones ambientales	☐	☐	☐	☐	☐
Seguridad de suministro de energía	☐	☐	☐	☐	☐
Impacto público	☐	☐	☐	☐	☐
Otros	☐	☐	☐	☐	☐

Otros (especifíque por favor):

23. Donde vende/instala su empresa los sistemas? Por favor, dar porcentajes del total vendido/instalado y indicar si se refiere

a la superficie instalada (S) ☐

o al número de instalaciones (N) ☐

Región Noroeste (Catamarca, Jujuy, Salta, Santiago del Estero y Tucumán)	
Región Nordeste (Chaco, Corrientes, Formosa und Misiones)	
Región del Nuevo Cuyo (Mendoza, San Juan, La Rioja y San Luis)	
Región Centro y GBA (Córdoba, Entre Ríos, Santa Fe, Buenos Aires, Capital Federal)	
Región Patagónica (Chubut, La Pampa, Neuquén, Río Negro, Santa Cruz y Tierra del Fuego)	
Exterior	

24. Cúal es el precio de una instalación típica para proveer agua caliente sanitaria para una familia de 4 personas? Por favor, dar precio y detalles del sistema (tipo y superficie de colector, volumen del tanque, etc.):

Sección 4 - Barreras

25. Por favor indíque su evaluación del grado de importancia de distintas barreras para la diffusión de la tecnología solar térmica:

	Sin importancia	Poco importante	Neutral	Importante	Muy importante
Alto costo de inversión	☐	☐	☐	☐	☐
Necesidad de investigación y desarrollo	☐	☐	☐	☐	☐
Necesidad de proyectos de demonstración	☐	☐	☐	☐	☐
Falta de normas de certificación	☐	☐	☐	☐	☐
Falta de productos certificados	☐	☐	☐	☐	☐
Falta de incentivos (p. ej. subsidios)	☐	☐	☐	☐	☐
Fallo político para asegurar la seguridad energética	☐	☐	☐	☐	☐
Conciencia insuficiente de parte de las autoridades	☐	☐	☐	☐	☐
Conciencia insuficiente de parte del público	☐	☐	☐	☐	☐
Falta de normativa	☐	☐	☐	☐	☐

Adicionales/comentarios:

26. Cuales son sus sugerencias para la promoción de la energía solar térmica en la Argentina?

Muchas gracias que Ud. se tomó el tiempo para participar en esta encuesta. Los resultados preservarán su anonimato y le serán enviados a la dirección de email introducida.

Björn Nienborg

Annex C

Map of Argentina

Noroeste=Region Northwest; Nordeste=Region Northeast; Metropolitana+Pampeana= Central Region; Cuyo=Nuevo Cuyo Region; Patagonica=Patagonian Region;

Source: http://www.zonu.com/imapa/americas/Argentina_Regions_Map_2.jpg

Annex D

Results of Profitability Calculations

Fuel type	Fuel price	FPER[15]	Backup	Grant	IRR	EPBT
-	by location	%	-	%	%	years
Natural gas	**Buenos Aires**	**0**	**external**	0	<0	>LT
				50	<0	>LT
			internal	0	<0	>LT
				50	<0	>LT
		10	**external**	0	<0	>LT
				50	<0	>LT
			internal	0	<0	>LT
				50	<0	>LT
	Baradero	**0**	**external**	0	<0	>LT
				50	<0	>LT
			internal	0	<0	>LT
				50	<0	>LT
		10	**external**	0	<0	>LT
				50	<0	>LT
			internal	0	<0	>LT
				50	<0	>LT
	w/o subsidy	**0**	**external**	0	<0	>LT
				50	7.9%	8.6
			internal	0	<0	>LT
				50	<0	>LT
		10	**external**	0	9.3%	9.3
				50	18.7%	6.1
			internal	0	<0	>LT
				50	<0	>LT
LPG	**w/ subsidy**	**0**	**external**	0	<0	>LT
				50	5.2%	10.2
	w/ subsidy Bar.		**internal**	0	<0	>LT
				50	<0	>LT
	w/ subsidy BA		**internal**	0	3.6%	11.5
				50	14.5%	6
	w/ subsidy	**10**	**external**	0	7.1%	10.4
				50	15.8%	6.9
	w/ subsidy Bar.		**internal**	0	<0	>LT
				50	3.5%	12.5
	w/ subsidy BA		**internal**	0	13.9%	7.5
				50	26.0%	4.6
	w/o subsidy	**0**	**external**	0	11.3%	7.1
				50	24.9%	3.9

[15] Fuel price escalation rate

	w/o subsidy BA		**internal**	0	17.5%	5.2
				50	36.3%	2.7
	w/o subsidy Bar.		**internal**	0	15.8%	5.6
				50	33.5%	2.9
	w/o subsidy	**10**	**external**	0	22.4%	5.2
				50	37.4%	3.2
	w/o subsidy BA		**internal**	0	29.2%	4.1
				50	50.0%	2.3
	w/o subsidy Bar.		**internal**	0	27.4%	4.3
				50	46.9%	2.5
Electricity	**Buenos Aires**	**0**	**external**	0	<0	>LT
				50	<0	>LT
			internal	0	<0	>LT
				50	<0	>LT
		10	**external**	0	<0	>LT
				50	3.0%	12.9
			internal	0	<0	>LT
				50	4.0%	12.2
	Baradero	**0**	**external**	0	4.9%	10.5
				50	15.5%	5.7
			internal	0	5.6%	10
				50	17.5%	5.2
		10	**external**	0	15.3%	7
				50	27.0%	4.4
			internal	0	16.2%	6.8
				50	29.2%	4.1
	w/o subsidy BA	**0**	**external**	0	5.4%	10.1
				50	16.2%	5.5
			internal	0	6.1%	9.6
				50	18.3%	5
		10	**external**	0	15.9%	6.8
				50	27.8%	4.3
			internal	0	16.8%	6.6
				50	30.1%	3.9
	w/o subsidy Bar.	**0**	**external**	0	7.4%	8.9
				50	19.1%	4.8
			internal	0	8.2%	8.5
				50	21.4%	4.1
		10	**external**	0	18.1%	6.2
				50	31.0%	3.8
			internal	0	19.0%	6
				50	33.5%	3.5