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"ST-ESCOs"

Development of pilot Solar Thermal Energy Service Companies (ST-ESCOs) with high replication potential.

Intelligent Energy – Europe (EIE)

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Project coordinator
Vassiliki Drosou, drosou@cres.gr
tel. ++30 210 6603381
Centre for Renewable Energy Sources (CRES)

Project website: www.stescos.org
Maintained by: Elena Taxeri elena@cres.gr

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Project Consortium

Centre for Renewable Energy Sources
19th km Marathonos Ave.
19009 Pikermi, Hellas

www.cres.gr

Grazer Energieagentur Ges.m.b.H.
Kaiserfeldgasse 13/I
8010 Graz, Austria

www.grazer-ea.at

EBHE
Greek Solar Industry Association
315, Acharnon Ave.
111 45 Athens, Hellas

Politecnico di Milano
Piazza Leonardo da Vinci 32
20133 Milano, Italy

Associazione Italiana Solare Termico
Via Flaminia Vecchia, 657
00191 Roma, Italy

Agencia de Gestion de Energia de la Region de Murcia
Pintor Manuel Avellaneda 1, 1?Izda. (Antigua C/ Montijo)
30.001 – Murcia, Spain

www.argem.regionmurcia.net

Associació de Professionals de les Energies Renovables de Catalunya
Av. 453 bis, àtic 2an.
8036 Barcelona, Spain

Energiecontracting GmbH&CoKG
Herrgottwiesgasse 188
8055 Graz, Austria

www.nahwaerme.at

AIGUASOL
C / Palau 4, 2n 2a
08002 Barcelona, Spain

www.aiguasol.com

1. Introduction

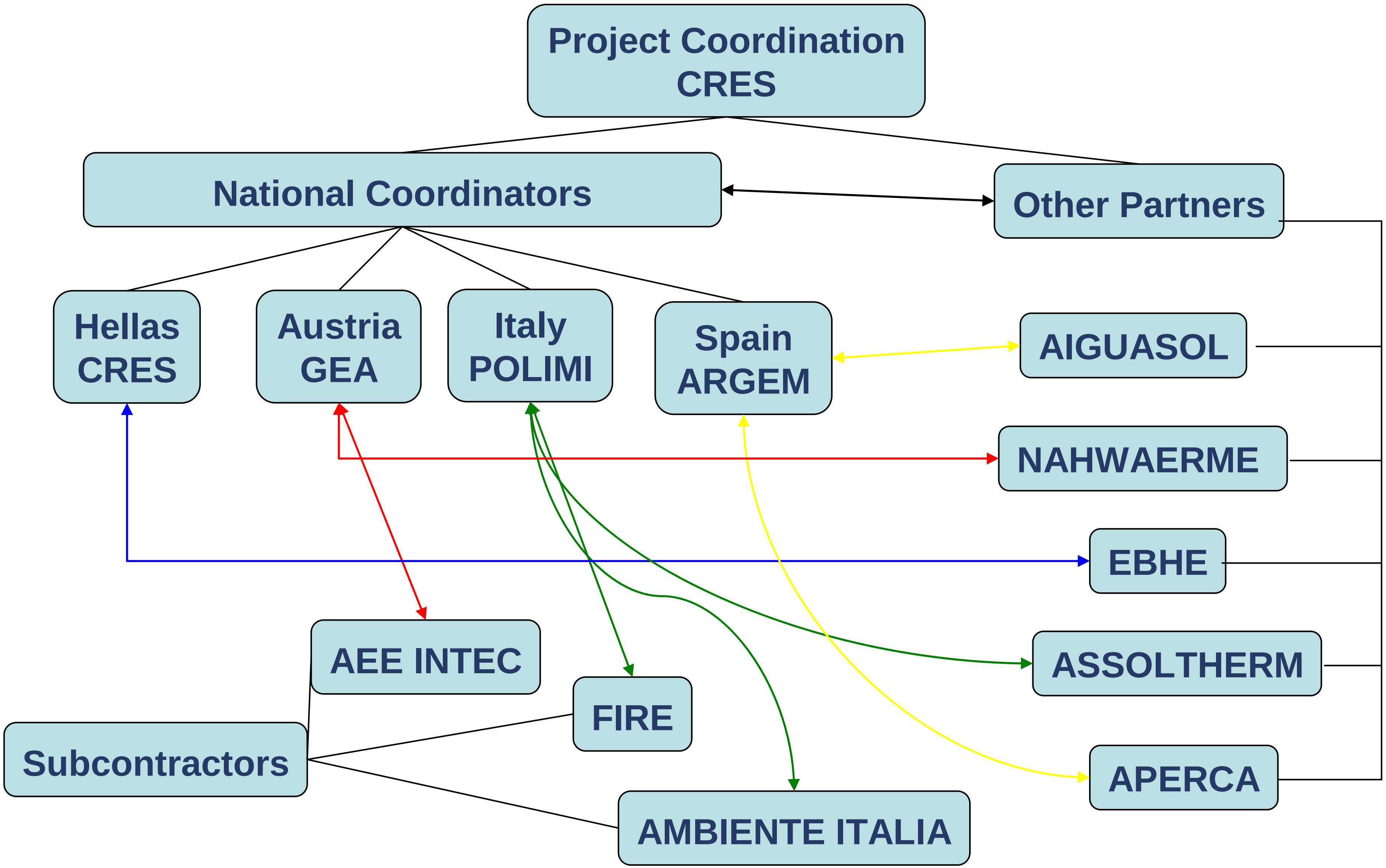
The **objective** of the project was to promote the creation and development of Solar Thermal Energy Service Companies (ST-ESCOs) and, by this, to assist in accelerating the growth of the solar thermal market in Europe. One of the most important goals of the project was to prepare detailed, real cases of ST-ESCOs agreements and try to implement them in practice. In fact, the expected final outcome was to sign at least one new ST-ESCO agreement for each participating country.

The total budget of the project was 974.714 € and it was co funded (50%) by the European Commission under the Intelligent Energy – Europe Programme and was coordinated by **CRES**.

The participating countries were **Hellas**, **Austria**, **Italy** and **Spain** while, at the same time, the project had a **European dimension**. Its organisation was as shown in Picture 1.

The actual **problem faced** by this project is that although solar thermal applications are technologically mature and economically advantageous in the long term, they have still little penetration in the European market, with respect to their potential. One of the main reasons is that end users (especially large ones) are still reluctant to face the high initial investment cost and doubtful for the reliability and durability of solar installations.

The **ST-ESCOs** can remove completely the above mentioned barriers, by **selling the solar energy (and not the solar plant)** at a competitive price and by carrying out the plant's operation and maintenance, thus opening the way for a rapid expansion of solar thermal installations throughout Europe in all potential sectors (residential, services and industry), both private and public.



Picture 1: Project Organisation

2. Achieved Project Results

The main results of the project are listed bellow:

- **Market Analysis** report. Apart from the main sectors potential identification, the following is included: description of best–practice examples, identification of key-aspects with respect to contractual, technical and risk management issues.
- **ST-ESCOs Guide** for ST-ESCOs developers, end-users and investors. It covers financial, contractual, legal and marketing aspects, technical aspects and best practices – recommendations
- **Policy Paper** for EU and National level. It includes concrete suggestions for EU measures for the promotion of ST-ESCOs, concrete suggestions for necessary state legislation.
- **ST-ESCOs quick assessment software tool**, short software instructions and run examples. The software has three different outputs: Complete analysis for internal (ST-ESCO) use, Reports for the customer and for the financing institution.
- **Project web site:** www.stescos.org that includes all the main elements and deliverables of the project such as reports, STESCO tool, Guide, Policy Paper, e-newsletters, etc.
- **Pre-feasibility and detailed studies.**
- **ST-ESCOs agreements.**
- **ST-ESCOs foundation.**

3. Market related topics for ST-ESCOs

3.1 Existing experience

3.1.1 Existing experience in Hellas

Up to now only few attempts have been made from someone to play the role of an ESCO for the application of TPF schemes. These attempts concerned Solar Thermal applications along with upgrading of thermal installations (piping insulation, heat exchangers, etc).

In two of these attempts (industrial applications) CRES was involved as described below:

- 1st case (Achaia Claus - winery): CRES was responsible for the telemonitoring equipment design / procurement, as well as for issuing the «solar bills». For this project the role of the ESCO was played by the Solar System manufacturer (SOLE LTD).
- 2nd case (Mevgal- dairy): CRES played the role of the ESCO.

Apart from CRES, only two companies (SOLE LTD and SOL ENERGY HELLAS Inc.) have made efforts in order to act as ESCOs. The second company has performed only one project (in a hotel) with the TPF method and several others with the GRS method (Guaranteed Solar Results).

The contracts of the first two projects (industrial) were in the form of Build, Own, Operate and Transfer (BOOT) while the third one (hotel) was in the form of Build, Operate and Transfer (BOT).

In the case of GRS the supplier of the solar installations provides the user with a bank guarantee linked with the monitored performance of the systems.

The structure of the existing contracts is the following:

- For the two installations (industry and hotel) for which the System providers / manufacturers played the role of the ESCO, the user paid no money for the installation of the systems, but paid the manufacturer the amount of energy supplied by the system, based on a fixed rate per kWh decided upon before the installation of the system. For the industrial project, the Centre for Renewable Energy Sources (CRES), undertook the monitoring of the system, which determined the energy supplied by the system, while for the hotel the system performance was monitored by the installer. When the user paid the initial investment of the system back, the system became the exclusive property of the user.
- For the industrial project, where CRES played the role of the ESCO, the structure of the contract was based on the provisions of the draft law *"TPF of Energy*

Investments for Energy Saving, Cogeneration & Independent Generation of Electrical or/and Thermal Energy from RES". The main elements of the project and contract are presented in Annex I. Information about the plant is given in the paragraph “Case studies”.

3.1.2 Existing experience in Austria

In Austria Solar Thermal Energy Service contracts are often combined with energy efficiency measures and/or comprehensive refurbishment (e.g. implemented with EPC models).

In the last 5 years the Austrian Energy Performance Contracting (EPC) and Third Party Financing (TPF) market has seen a quick development (Seefeldt 2003). To date the energy efficiency of about 600 to 700 buildings has been improved via EPC, as compared to almost zero in 1998; these buildings represent roughly 4-6 % of all service sector buildings. Another 300 to 400 federal buildings (about 50 % of total floor area) will get an EPC contract in the next 3 years (Leutgöb 2003). To this day a vast potential is still untapped for energy service in general, and energy performance contracting in particular. In 2001 the Austrian Energy Agency did a rough estimation of the Austrian EPC market and the market volume for the sector of private and public service is estimated as follows: Based on the assumption that around 50 % of the building stock is suitable for implementation of EPC and TPF concepts, the estimated investment volume amounts to about 300 million €. This correlates with an estimated energy cost savings of around 50-60 million € per year and associated CO2 reductions of 600.000 to 700.000 t per year.

In Austria, EPC and TPF are well established instruments to increase the energy efficiency in buildings as the framework conditions are suitable and the demand for and the supply of EPC and TPF services is growing and is clearly also an opportunity for ST ESCOs. The potential encompasses different building categories e.g. federal buildings, county buildings, municipal buildings, hospitals as well as private service buildings. The Austrian Energy Agency states “Austria is – together with Germany – the EPC pioneer in Europe” (Leutgöb 2003). Especially in the last years a further development of contracting to a comprehensive energy service (also including solar thermal technology) was reached. Innovative technologies and renewable energies, especially solar thermal plants, are integrated and a pooling of different buildings takes place.

Up to now there are about 40 ESCOs in Austria and some of them offer also solar thermal plants in combination with energy efficiency measures and comprehensive refurbishments. In recent years the role of ESCOs has become even more central in the delivery of energy services in the new liberalised energy market. The main customers and driving forces are the federal building administration, a few local governments in large cities (Graz, Salzburg) and, surprisingly, housing associations and some small and medium-sized municipalities. Currently private commercial buildings are not typical EPC or TPF customers. The Austrian ESCOs active on the EPC and TPF market have developed from different starting positions (Task X country report Austria):

- Some international companies from the building technology industries have expanded into the ESCO business
- Few civil engineers that cover the energy saving planning and management aspect of the business and engage subcontractors for the operative work
- A limited number of utilities has developed towards the energy service concept and is offering ESCO services

All these emerging ESCOs are also potential future ST ESCOs.
In Austria the regional and the national energy agencies played a crucial role in the development of energy services, small ESCOs and also ST ESCOs. The EPC projects in small and medium-sized municipalities have been supported by regional programs, e.g. in Styria, Upper Austria, and Tyrol. The increase of the Austrian EPC market is based mainly on increased know-how: energy agencies at the national, regional and local level have acted as know-how carriers and through action in public buildings drew the attention of businesses to the end-use energy efficiency market niche (Seefeldt 2003). Energy agencies play also a major role when it comes to market preparation by means of campaigns and awareness raising for solar thermal plants (small plants as well as large scale installations) and energy services. Furthermore they play a crucial role in the market development as they are seen as neutral advisors. Also the development of quality criteria and certification is building trust in the application of EPC and TPF.

At the beginning of 2003 the program “Ecofacility” by the Federal Ministry for Agriculture, Forestry, Environment and Water Management in the frame of klima:aktiv has been started that targets private commercial and service buildings (e.g. office buildings, shopping centres, hotels, etc.) through EPC, planning and comprehensive service packages. The klima:aktiv program “solarwärme” is focussed on the support of the integration of solar thermal energy.(Details about the programmes of the federal government ,known as klima:aktiv programmes, exist in Annex IV).

All these features place Austria in the premier league of ESCO and also ST ESCO developments in Europe.

3.1.3 Existing experience in Spain

In Spain, there are basically two types of Energy Services “contracting”-models which are actually being used:

Third Party Financing for heat and/or electricity delivery that was used by I.D.A.E. (Institute for Diversification and Energy Efficiency) as a financial support
Energy Performance Contracting, which is working for co-generating plants.

However until now, just a couple of attempts for ST-ESCOs are running from some companies that play the role of an ESCO for the application of TPF schemes.
At the beginning of ST-ESCOS European Project, there was not a large number of initiates of a ST-ESCOs or similar project in Spain, although there were several TPF (Third Party Financing) support by the Industry Department Grants programme, which have been operating for the last few years.

Some important Enterprises have been contacted in the recent months about their participation in ST-ESCOs formulas and none positive response is obtained yet. Their arguments are related to the different barriers and uncertainties this project model means.

However, some solar thermal collector fabricators have positively stated that could be interesting to lead a ST-ESCOs project, in order that the beneficiaries to obtain some benefits and after a few years also to be owners of the facility as well as they use these singular experiences in order to promote their own companies. Fabricators are looking for new model to increase their sells.

3.1.4 Existing experience in Italy

In spite of a large diffusion of ESCO activities in Italy in the last two years, linked to the implementation of the legislation on the “white certificate” system (Annex VI, legislative background), few are the experiences concerning solar thermal applications.

Among the few ST-ESCO applications an example is given by a company based in the Milan area, involved in energy services provision. The company, namely Calore Energia Impianti CEI, installed in 2006 a solar thermal plant (Rivadavia) on a multi family house in Sesto San Giovanni (MI). The installation integrates a fossil fueled existing plant for the production of domestic hot water.

The installation belongs to the end user and the solar thermal plant has been included in an existing energy services contract with the ESCo. Following some characteristics of the Rivadavia system:

- the solar thermal plant is a precise request of the end users;
- the investment costs have been partially covered, 30% of the total cost, with subsidies provided by the regional government;
- on the contract there is no difference between the solar thermal plant and the conventional (existing) system for heat generation: no differences in the operation and management (ordinary and extraordinary maintenance) and in the definition of the energy price;
- the plant is guaranteed for 5 years through the Guaranteed Solar Results.

3.2 Barriers - Reasons for success or failure

One of the main barriers for ESCOs development has been the lack of advantageous governmental policy and support measures. The proposal for a directive of the European Parliament and of the Council [Directive, 2004] on energy end-use efficiency and services and a legal push in terms of integrated energy services and energy management specific legislation in combination with mandatory national and sectoral energy consumption reduction targets would possibly take-off the EPC market especially from utilities and big companies handling a pool of potential clients. The issue of a law for ESCO business operation would clarify the operational environment.

The major problem, in terms of ESCOs market development, is identified on the magnitude and the long-term engagement of the capital required for a big energy project as well as the uncertainty regarding the expected energy savings. This uncertainty reflects technological risks as well as investment risks related to the recovery of the invested capital. Therefore, the supply of a form of State warranties or State participation in a financing network for the private sector is proposed to act as a security means. A possible way of doing this is to create a special financing group with the participation of banks, industrial companies, ESCOs and the State. An alternative and easier way is the initiation of specialized investment banks as well as commercial banks with dedicated project financing departments.

Some other barriers include:

- The missing of a legal consolidation of ESCOs. Legal and tax problems are arising from TPF implementation.

- The project financing, investment, design, construction and insurance mechanism is not well defined. No guidelines were available up to now[1].
- The direct economic benefits for the end-user become negligible if the ESCO needs high IRR or short contract duration.

Some preliminary aspects related to the reasons for success or failure could be highlighted:

- The technical solutions applied should be as simple as possible without, however, sacrificing the systems' reliability. A subsequent paragraph is dedicated to this aspect.
- The contract between the ESCO and the end-user has to be clear and simple but should cover, possibly, all aspects concerning billing, end-user consumption along the future, insurance and risks management.
- The heat supply contract should contain all technical prerequisites and conditions that are requested in order to assure a sound operation and the expected energy supply of the solar system.
- The contract must fix the minimum amount of energy that the customer is going to use. Provisions have to be taken for the case that less energy is consumed by the customer than the minimum amount that is agreed in the contract. In case of lower consumption, either a basic price or a penalty fee may be charged to the customer. In some cases it might be sensible to fix a profile for the range of the consumed energy over the year. This could be helpful for matching and optimization between the available and the consumed energy.

On the other hand, the contractor is usually asked to guarantee a minimum energy output of the plant over the period of one year. Alternatively, instead of guaranteeing a minimum energy output, the contractor might opt for guaranteeing a minimum power output of the plant. This is most reasonable if the consumption profile of the customer does not seem to be reliable, and bad effects are expected for the plant power output. In order to avoid troubles, it is recommended to define the customer's energy consumption as detailed as possible.

As regards the technical operation of the plant as it was designed, it is indispensable to exactly define all interfaces between the solar company and all other parties involved in the plant's location or operation by any kind of way. This applies not only to the technical interfaces, but also includes ownership structures of any kind.

[1] A Guideline with (among else) financial, contractual, legal, marketing and technical aspects is one of the deliverables of ST-ESCOs project.

In the heat supply contract, all kinds of ownership questions related to the solar thermal plant have to be clarified. One of the most important things to clarify is the rental circumstances (for the rent of the required collector area in the customer's or somebody else's site or building).

It is strongly recommended to sign at least liability insurance for the plant. Sometimes, this insurance is already included in the customer's site or building which bears the solar collectors.

Another important feature is the timeframe for the solar plant; this should include the beginning of the energy delivery and the period for energy measurements consulted for the compliance with the guaranteed energy output. Also, the timeframe for a possible service and maintenance of the plant must be defined. It is a good idea to include a service and maintenance contract for the plant in order to guarantee a sound operation of the system. Not to forget, all juridical questions and responsibilities related with the installation, the operation and the ownership should be addressed in order to avoid unclear situations in the operational time of the solar system.

Financial institutions and schemes

Past successful implementations of solar thermal ESCO plants have shown that the contact with the financial institute which shall carry out the financing of the investment costs is a crucial aspect, especially when it comes to the time that elapses between the project idea and the completion of the third party financing contract. In all successful ST-ESCO examples, the contact to small, local financial institutions with flat command structures have shown to be the most promising way. Personal contacts to the upper management of a small bank with the appropriate person being positive about the project, has turned out to be a good approach.

In the case that solar thermal projects shall be implemented internationally, it probably makes most sense to start at the same level where the first third-party-financed solar thermal projects started, i.e. at small, local banks with good contacts to the bank director. In order to minimize the financial risk for the contractor, a suitable bank must also be chosen for the bank guarantee for the solar plant. This bank guarantee becomes effective in case the customer is unable to pay the TPF fee to the contractor.

3.3 Opportunities and Threats (O&T)

The opportunities from the ST-ESCOS agreements are divided in two main categories: those for end-users and those for developers[2].

Opportunities for end users:

- No risk of initial investment
- Increased security of energy supply
- Low and more stable energy price - Reduced dependency on oil price variations
- Avoid of service and maintenance troubles
- New opportunities by using the specialised know - how of the energy service companies
- No lack of human resources since planning and investments are carried out by the ST-ESCO
- Better living quality and appreciation of buildings (energy labelling)
- Service package from one source
- Reduction of pollutant and CO_2 emissions
- Environmental friendly image
- Impulses for the local economy

Opportunities for the ST-ESCOs developers:

- The development of the ST-ESCOs market represents a new field for investments on the energy sector.
- ST-ESCOs market has a wide and promising potential.
- Long term contracts with high IRR are possible.
- Developers of ST-ESCOs business will achieve an Environmental Friendly Image with direct marketing and indirect economical benefits.

In what concerns threats, these regard mainly the possible ST-ESCOs developers and could be summarised as follows:

1. The usual threat of poor quality solar thermal systems.
2. The “on and off” of the subsidies that may destabilise the market.
3. The possibility to face a serious and persistent load reduction by the end user.

[2] Obviously major part of the opportunities and threats are country specific.

Follow some comments on how these three threats are (or could be) faced:

1. The first threat (poor quality of systems) is automatically reduced by the nature of ST-ESCO contracts. In fact, it is only the quality and high efficiency of the solar thermal systems that really ensures benefits for the ST-ESCO developer.
2. The second point (interrupted and unstable subsidies) is a serious problem. The solar thermal market destabilization due to this problem has been experienced in European countries like Italy and Germany; it can be faced only with appropriate policy measures.
3. The third threat (load reduction) is the most specific for ST-ESCOs. In fact, the thermal load should be as constant as possible in the long term since generally there is no possibility to divert the thermal energy produced to other end-users or to a network (as it is the case with electricity). Of course, the ST-ESCO contract can always face a load reduction by setting a "minimum compulsory consumption" that has to be paid even if the user has consumed less thermal energy in reality. However, the end-user may consider these contracts' terms as particularly risky and this may become a serious barrier for the diffusion of ST-ESCO agreements. In order to minimise the above risk, the following measures should be taken:
   a. Examine carefully the end-user's load in the long term.
   b. Seek for a minor participation of the End-User in the initial investment (e.g.15%, equal to the cost of the non *removable parts of the plant*).
   c. Ensure, as far as possible, the modularity of the solar thermal plant. This aspect is further examined in the paragraph on "appropriate technology for ST-ESCOs".

3.4 Technical framework (monitoring, billing, tools etc.)

3.4.1 Appropriate technology for ST-ESCOs

A minimum collector area of a few hundreds of square meters (e.g. 200 m²) is advised for TPF solar thermal projects.

The most suitable solar technologies should have the following characteristics:

a) Proven and robust technology
b) Economically affordable
c) As flexible as possible in installing, uninstalling and modifying.
d) Both hydraulics and control should be as simple as possible.
e) The telemonitoring and control system should offer the following:
   i) Appropriate information in order to minimise the need for on-site visits (e.g. regular confirmation of good operating conditions by an SMS).

ii) Appropriate information and control possibilities in order to optimise the system operation (especially in the first period after commissioning and after any important modification).

In order to achieve the above properties, solar plants should have design principles similar to the successful European plants, especially those called large-scale solar heating plants (more than 100 m^2 of collectors' area). Some of the basic principles are following:

a) Use of flat plate collectors if the temperature needs do not exceed 100º C.

b) Use of absorber with selective surface (very little additional cost, quite high efficiency improvement).

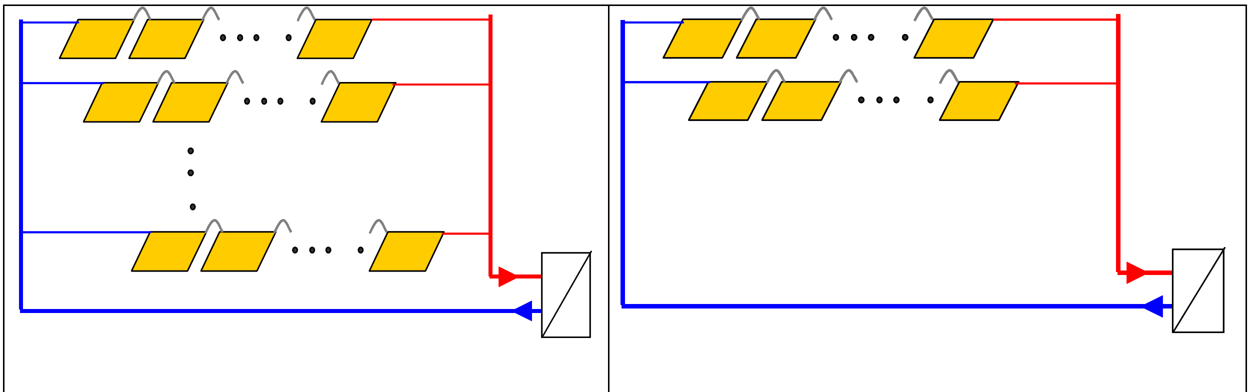
c) Use of Large collector modules (e.g. modules of 12 m^2) that minimize the installation time thus permitting quick and low cost modifications.

d) Adopt the so called "low flow rate" in the collectors primary circuit (i.e. about 10-12 $l/(h*m^2)$ instead of the usual 50 l/(h*m2). This principle, if correctly applied, results in the following positive plant characteristics:

   i) Simple hydraulics and the smallest possible tube diameters

   ii) Stratification in the solar accumulator vessels.

The common characteristics of Large Scale Solar Heating Systems are better depicted in Picture 2; the similarity of two plants with a large size difference (but with the same design principles) is evident.



Marstal (DK-9040 m^2) Collectors modules=12,6 m^2 , modules/row=10, Flow=2-20 $l/m^2,h$	Melegnano (IT- 200 m^2) Collectors modules=12,5 m^2 , modules/row=8, Flow=6-20 $l/m^2,h$

Picture 2 Similarity of the characteristics for two "Large" but different size plants

As many solar system components as possible should be pre-assembled by the solar company; this includes first of all the pump and heat exchanger substations.

Some advantages of the pre-assembling are listed below:

- helps to reduce the error rate of components
- keeps the system simple on the plant site
- reduces the costs for operation and maintenance
- increases quality while decreasing the system price
- reduces the work-load on site

A focus should also be set on the control of modern solar thermal plants; a complete control system has several tasks. Among else,

- maximises the system's energy output
- indicates possible malfunctions (e.g. leakages)
- helps to avoid failures by advanced warning on bad system values (e.g. too high pressure drop in a heat exchanger may indicate upcoming troubles…)
- is connected to nearby system components/sensors such as the temperature sensors of district heating, energy meter of the backup system, etc.

Usually, modern control systems have the possibility to be remotely controlled. A tele-monitoring and tele-control system is important to optimize the energy output and reduce maintenance costs.

Some sources with available material for design and maintenance guidelines are the following:

- Design and maintenance guidelines maxi-brochure (for solar thermal plants in industrial processes) of project PROCESOL II (ALTENER project - coordinator: CRES).(En)
- Solar –supported heating networks in multistory residential buildings, (A planning handbook), AEE INTEC, downloadable (En).
- Ambiente Italia: Design and maintenance guidelines; downloadable, in Italian

3.4.2 Quality, monitoring, billing

All the applicable standards for the solar thermal systems, are also valid for the ST-ESCOs case. It is worth mentioning that an increasing number of manufacturers are involved in the implementation of the SOLAR KEYMARK. This quality mark has been developed by the European Solar Thermal Industry Federation (ESTIF) with the support of the European Commission and aims at harmonizing TEST & QUALITY certification procedures for solar thermal collectors and systems in Europe.

Regular service and maintenance of the solar system are indispensable features in order to guarantee the maximum energy output of the plant. The possibility for tele-monitoring and tele-controlling of a plant help to reduce the costs for service and maintenance to a great extent and to improve the energy output.

The international performance measurement and verification protocol (IPMVP) might be a good approach to standardize the internationally different ways to measure the energy output of a solar thermal (TPF) project. However, the complexity in the implementation of such a measurement protocol must not create expenses which make the system economically unattractive or much more difficult to implement. An internationally similar approach to the monitoring and verification of a solar thermal plant might also be an important topic when it comes to homogeneous European guidelines and subsidies for TPF solar thermal projects.

Along with the determination of the plant’s energy output, the basis price of the delivered energy per MWh or per kWh has to be fixed in the heat supply contract. Of course, the energy price is a very sensitive part of the heat supply contract. It can be fixed individually with the customer, but usually orients by the local prices either for district heating or for an available form of fossil fuel. One option is to link the price of the solar thermal kWh to the price of a fossil fuel, e.g. the cheapest available fossil fuel.

The energy price is usually linked to some price index, such as the consumer price index. Some kind of link with a conventional energy form might be a good feature to include. This allows the adjustment of the solar energy price to a mean energy price level which is expected to increase more rapidly than the consumer price index alone.

Also, the economical importance of a premature exit from the heat supply contract on the part of the customer should be addressed in the contract. This can be the case if the customer is not interested in the plant anymore or is not satisfied with the technical quality, or if the customer goes bankrupt. E.g., the costs for disassembly of the plant’s technical equipment plus a fee for the loss of the earnings out of the plant might be charged. Another possibility is the arrangement of a bank guarantee to cover the financial risk linked with the described case.

4 ST-ESCOs Guide for ST-ESCOs Developers, End-users and Investors

4.1 Identification of target group

The target group consist mainly of large building owners, housing associations, elderly homes, hotels, industry (textile, dairy ...) etc.
To keep it simple – building owners with large buildings or industrial processes which use low temperature heat and a high energy demand are the best suitable targets for ST-ESCOs.

Target groups:

- Housing-companies
- Municipalities and local governments
- Tourism industry
- Private building owners
- Companies and industrial firms
- District heating network operating companies

Buildings and facilities, which are suitable for large solar thermal plants:

- Multifamily residences (existing and new buildings)
- Tourism facilities (e.g. hotels)
- Hospitals and old people's homes
- Sport centres (gymnasia, swimming pools, etc.)
- Industry buildings, especially food and beverage industry, textile and chemical industry
- Office buildings
- District heating networks (feeding-in)

These buildings have in common, that they need lots of hot water and mostly independent of the season.

4.1.1 Addressing the potential customer

Addressing the potential customer (within the target group) by means of:

- Newsletter & Email contact
- Personal information
- Showing of best practice examples (study tours if possible)
- Solution to overcome existing barriers (additional planning and information, financing model etc.)
- Consulting in energy relevant aspects
- Solar workshops and information events

- Creation of an info point (e.g. web site)

Having identified a target group, e.g. housing company, a marketing concept to reach the following goals has to be elaborated:

- Initiation and support of solar projects in larger residential buildings
- Starting a marketing campaign for solar systems in larger residential buildings

The first steps to promote solar systems e.g. in multi-family houses are:

- Direct marketing
- In-house presentation by housing companies
- Info-events for housing companies, planners, architects, plumbers, etc.
- Direct mailings
- Marketing-support packages for housing companies, architects, planners (e.g. best practice examples)

4.1.2 Concrete information about a contracting project

Therefore it is of particular importance:

- to know how to identify buildings that are suitable for contracting projects
- to clearly establish the targets to be reached by the project
- to know which points to consider when awarding a contracting contract
- to know which elements should be included in this contract (Sample contracts!)
- to know what will be the duties of the local government
- which support/subsidies can be obtained
- to establish a good and close cooperation with the building owner

4.1.3 Concrete project acquisition, project development / support by local energy agency or independent consultant

- Acquisition of projects (addressing the potential costumer)
- Selection of a suitable project
- Energy audit – building or industrial process specific assessment and evaluation of the status quo (heat supply system …)
- Identification of customer needs and requirements
- Quick assessment of suitability of the project for an ESCO, quick check of the economic situation (probability of success, risk for ESCO, secondary aspects such as economic situation of the customer, …)
- Project monitoring by means of an independent consultant if necessary and desired (e.g. energy agency)

- Technical design (heat demand, secondary network dimensioning parameters, defining interfaces)
- Identify cost for management
- Description of supply tasks
- Requirements of heat supply and solar thermal system
- Definition of the contractor's service requirements
- Design of contract (heat supply contract)
- Invitation of tenderer
- Elaboration of offers (of the potential contractors)
- Discussion and evaluation of received offers
- Contract negotiations
- Finalisation and signing of the contract

4.2 Financial, Contractual and Legal Aspects

4.2.1 ST-ESCOs Financial Analysis and Principles

In the following ST-ESCOs financial analysis and principles are described.

<u>Financial mechanisms / schemes</u>

In general there are no fixed rules for agreements between the customer and the ESCO for what concerns the financial schemes, i.e. the payback of the investment (from ESCO's point of view) or the payment of the energy (from customer's point of view).

The choice of financial scheme largely depends on the financial reputation of the ESCO and on the conditions it can get at a financing institution; these conditions might vary (in the range of 100%) and depend on personal contacts with the bank.

Anyway, there are three different schemes for billing the solar energy between the customer and the ESCO. Most schemes which are implemented in real projects follow one of these schemes or a mix of these:

- Energy price only:
- Energy price and basic price:
- Energy price and connection fee:

Independently of the model chosen, a certain amount of money (penalty fee) should be agreed upon in the case the customer wants to exit the energy supply contract before the agreed validity period of the contract.

In the financial negotiations with the customer, if the ESCO decides to foster a certain model, the ESCO should also keep in mind the technical background of the project: there is none financial scheme which is best suited for all types of projects. E.g. if the ESCO trusts the customer (both technical preconditions and financial situation) than it may opt for lowering the basic price and instead go for a somewhat higher energy price. On the contrary, if the customer seems not very trustworthy, then the basic price should tried to be kept high as this – together with the option of a bank guarantee – assures the payback of the plant to some extent. Of course, projects with a too high risk should simply be declined by the ESCO!

Conditions and guarantees

There are certain preconditions usually included in the energy service contract (see respective section) which have the task of guaranteeing favourable conditions for both contracting parties. The detailed scope of these conditions depends on the technical characteristics of the project as well as on the specific situation of the customer and of the ESCO (financial questions). Technical and financial prerequisites and conditions fixed in the contract are closely related and are crucial for the economic feasibility of a solar thermal ESCO project. This is going to be even more important in future when the size of an average large-scale solar thermal system is going to rise, and therefore economical questions such as the return-on-investment and the cash flow situation of the investment (i.e. the solar plant itself) become much more important than they are today.

Technical guarantees

System operation guarantee of the ESCO: In most cases, the customers demand the ESCO to guarantee for the correct operation of the system; this includes the solar plant behavior in the case of stagnation. Usually, the compliance with the respective security standards suffices this demand.

Energy supply guarantee: Most customers demand a guaranteed energy output (kWh/m²*year or MWh/year for the whole plant) from the solar plant to see that the system will suffice their energy needs and also to provide for an appropriate backup system. If the ESCO not only installs and operates a solar thermal plant but is responsible for the whole energy service of the customer, a guarantee for the energy supply for the whole year must be given. E.g., the ESCO could also install and operate (or buy the energy from) a biomass boiler or buy energy from a district heating net, and then sell this energy to the customer thus providing for the total customer's energy need.

Financial guarantees

In general, the bank or financing institution has the right to take over the solar system if the ESCO goes bankrupt. This is a crucial aspect at negotiating about the financing plan of the solar system with the bank.

Bank guarantees: Bank guarantees are an important tool for a larger ESCO which has already gathered a vast experience with the contracting, the operation, the installation and the maintenance of large-scale solar thermal systems. A bank guarantee allows such an ESCO to head for projects with a higher risk (e.g. very large projects with large investment amounts to be financed in advance or projects with a more difficult technical background, or projects abroad where many conditions may be different).

Appropriate financial institutions

In general financing institutions expect that ST-ESCO financing should have a pay back time below 5 years. Loan contracts for more than 10 years are especially with large Austrian Bank institutions not realizable. Bank institutions have problems because of their rigid hierarchy so therefore access via local, smaller banks is probably more successful. The attitude of a bank towards solar ESCOs seems to be largely depending on the internal structure and the personal experience of the decision makers with renewable energy projects. Investors groups are of interest when realizing a close cooperation with companies that work in the environmental or ecological sector.

4.2.2 Insurance Schemes

As a matter of principle, a solar thermal system built by a system provider and run by a solar thermal ESCO is generally insured by the ESCO, and not by the system provider (i.e. the engineering company that built the plant). This is due to the fact the ESCO buys the plant from the system provider and only the plant *owner* can insure against the various risks. I.e., the insurance holder must be the owner of the solar plant.

Insurance schemes required

Following a list of the points that an insurance scheme (under an ST-ESCOs agreement) has to cover:

1. Insurance of equipment.
2. Insurance of the investments done and the economic obligations stated in the contracts.
3. The insurance scheme should have a clear reference to the fact that there are two different owners involved in the ST-ESCO agreement: a) the owner of the solar plant (ST-ESCO) and b) the owner of the building (place) were the solar plant is installed (the End-User).

Aspects that insurances cannot cover are the following:

- Damages that may occur due to casual external factors (e.g. animals that may damage the pipes' insulation or collector sensors).
- Generally speaking, casual events that are not well defied in the insurance scheme cannot be covered.
- Damages that the solar plant may cause to the building or people (e.g. damage on the roof due to leakage, injury against people in case of a falling solar system component etc.). All these aspects should be subject of another scheme that should be a "Third party Liability" scheme. (note: In Italy this is a must - always requested)

Improvements of existing insurance schemes

The following insurance options could be adapted to suit the particular needs of an ESCO:

Insurance type	**Importance for solar thermal ESCO**
windstorm, fire and hailstorm	almost always included insurance value should be the same as solar system investment cost
vandalism	almost always included insurance value should be the same as solar system investment cost
lightning	almost always included ESCO should make sure the solar system provider installed all necessary means of protection!
Damages by flood	usually included only if plant is situated in high-risk area (often affected by inundations)
public liability insurance	always included ESCO should consider including insurance against environmental damage, roof damage and gradual loss,

	injuries against people in case of a falling solar system component
loss-of-use insurance	covers ongoing costs and loss of profit importance for ESCO depends on details of the energy supply contract (commitment or right of energy delivery)

4.2.3 Equipment Ownership and Future Purchase Options

Equipment ownership and future purchase options offered to the end-user, once the contract has terminated, are described in the following.

Possible solutions for equipment ownership / future purchase options

Obviously, the ESCO should try to fix the longest possible term for the energy supply contract with respect to the technical costs (service and maintenance fees) which are supposed to increase over the years.

There are different economic possibilities for an agreement between ESCO and customer after the end of the energy supply contract. Basically, these are the possibilities that an ESCO currently has:

1. *The customer pays a fixed part of the investment at the delivery of the plant:* In part, this can be interpreted as a connection fee, but in contrast to that it also includes a fee to cover the uninstalling process and those parts of the equipment which can not be uninstalled
2. *The customer pays a flexible part of the investment at the end of the contract:* In this model, the customer contributes no or little to the investment at the delivery of the system. In return, the financial guarantee for the ESCO lies in the following approach: depending on the number of years that the customer remains under the energy supply contract, he is charged a variable fee at the exit of the contract.
3. *Combine one of the above mentioned financial models with a mobile energy solution which can easily be installed and removed:* This variant consists of a mobile and easily transportable technical equipment group which is directly connected to the solar collector field and serves as the solar tech room.

A list of possibilities after the (first) energy supply contract has run out can basically be reassumed as follows:

1. *The solar plant must be uninstalled:* This is actually the worst solution for the ESCO as it means the ESCO has to bear a high cost for the uninstalling the system. This variant should be avoided!
2. *The solar plant passes on to the customer:* This is the standard variant: after the end of the (first) energy supply contract, the customer takes over the solar plant and is therefore the owner.
3. *The ESCO keeps the ownership of the plant, the contract is renewed:* This solution is often asked by the customers as it guarantees them a continuation of the energy supply. Moreover, as the plant has already been paid back, the ESCO may offer a very competitive price to the customer, a price low enough to convince the customer to renew the contract, but high enough to cover for all operation, service and maintenance expenses of the ESCO.

4.2.4 Contractual Principles and Structure

Structure of an Energy Supply Contract

The energy supply contract is one of the core pieces of a solar thermal ESCO project. It fixes all important issues between the ESCO (the energy supplier) and the customer (the energy consumer). An energy supply contract is always an integral part of a solar thermal ESCO project. Its contents are crucial to the economic feasibility of the particular project, but also for the economics of the ESCO in general and on a long term. The energy supply contract fixes several important topics that are related to the risk accepted by the ESCO in acquiring the project.

These are the main topics to be covered by the energy supply contract:

1. Subject of the contract

Fixes the basics of the solar energy supply:

- who is the ESCO, who is the customer
- general information on the system integration of the solar thermal plant
- start of the energy supply, usually fixed within a certain period of time or with a latest starting date. So if the plant has not been completed yet, the ESCO takes the responsibility and the risk for the completion in time!

2. Duration of the contract

Fixes the beginning and the end of the energy supply, and additionally:

- exit clauses and exit terms for contracting out of the agreement for both contractual parties. This can be a tricky paragraph, and it is important to negotiate conditions which assure long-term stability for selling the solar energy!

- might include the relations between the customer and its other partners (e.g. if the customer is not the owner of the building or the area which is going to bear the collectors)

3. Installation of the solar plant, property line
    - who is responsible for the installation of the technical equipment
    - describes in all detail where the limits of performance are drawn, in particular the customer's responsibilities are defined. Moreover, the energy delivery point (usually position and integration of heat exchanger) is specified
    - certifications requested
    - who pays the electrical energy for pumps and other equipment?
    - who cares for the ongoing service and maintenance of the solar plant?
    - property structure of the areas which are going to be affected by the solar plant in some way (tech room, roof, space for piping,...)

4. Details on the energy supply and the operation of the plant
    - fixes all details between the ESCO and the customer that are related to the solar energy supply service:
    - for the ESCO, is there an obligation or a right to deliver the system's energy output to this specific customer?
    - for the customer, is there an obligation or a right to buy the solar energy?
    - eventually, fix energy consumption limits (minimum required)
    - what about the integration of the solar plant into the existing energy supply system of the customer?
    - what about the behaviour of the customer to all other possible sources of energy or energy savings which could compete with solar thermal? E.g. the customer uses other energy sources even though solar energy is available, so the ESCO does not sell the produced solar energy.
    - all the risks concerning damage of the solar plant and damages or consequential damages that are due to some improper operation of the plant, are for the ESCO's account
    - date for earliest and / or latest begin of the energy delivery to the customer

5. Solar energy price

This part specifies all questions related to the tariff model of the solar energy. It is completely arbitrary for both contract parties to agree upon a model which serves both sides' interests.

- same price for the whole year or difference between summertime and wintertime?
- solar energy indexed to consumer price index / some other energy / any other reasonable factor? What's the effective date that serves as a basis for the indexing calculations?
- What happens if one of these factors changes drastically? New definition of this part of the contract?
- What happens if solar energy prices are related to other fossil fuel prices?

6. Measurement and charging of the solar energy
    - how is the solar energy measured?
    - any prerequisite for the measuring facilities or the measurement system in general?
    - how is the solar energy going to be metered and charged to the customer?
    - who calibrates the measurement equipment?
    - term of payment for the solar energy invoices

7. Other contract clauses
    - how are withdrawals from the energy supply contract handled? States all circumstances under which one of the contract parties could exit the contract without legal consequences.

8. Legal venue
    - fixes the legal venue for any misconceptions between the contract parties

Usually, there are appendices to the energy supply contract. Most commonly, the following appendices are included:

- hydraulic scheme of the energy delivery station with integration of the solar plant
- hydraulic scheme of the solar thermal plant

4.2.5 Methodology for billing the solar yield

In Austria, the solar yield of solar thermal plants is measured with the aid of ultrasonic heat meters installed in the systems. To actually measure the solar energy delivered to the customer, the heat meter is installed in the secondary circuit (i.e. after the heat exchanger solar to the customer). The ultrasonic heat meters are the technical state-of-the-art today: they contain no moving parts, are therefore non-wearing and have long durability, and that means little maintenance costs for the ESCO.

In nahwaerme solar plants, the energy delivered to the customer is automatically measured by means of a tele-monitoring system. Then, it is charged to the customer by means of an energy bill about once every month (in summertime) or once every 2 months (in wintertime). A fully-automatic billing program would be a desirable development.

There are three different schemes for billing the solar energy between the customer and the ESCO. Most schemes which are implemented in real projects follow one of these schemes or a mix of these:

Energy price only: the customer pays a certain energy price per kWh of solar thermal energy. The energy is usually billed once every month or once every two months. This means that the payback for the ESCO works only by means of the energy sold, and a big share of the customer's payments arrive in summertime. Usually, for domestic hot water the ESCO and the customer agree for a different summer and winter price (summer price higher, as conventional boiler systems have lower efficiency in summertime, thus specific end energy prices are higher). Usually for space heating the energy price is every month the same. This scheme is generally favourable for the customer.
Monthly amount charged to customer[3]: $MA = SEm \times SEPh$

Energy price and basic price: Additionally to the cost per kWh, the customer is also charged a basic monthly price which he is asked to pay regardless of the energy delivered. In return, the energy price for the kWh of solar energy is lower. This model provides some more security for the ESCO as it will get the monthly payments in any case. Moreover, the ESCO gets some money out of the system also in wintertime, when the earnings based on the solar energy output are close to zero.
Monthly amount charged to customer[4]: $MA = BP + SEm \times SEPl$

Energy price and connection fee: Similar to the installation fees which a customer is charged for being connected to a district heating net, in this scheme the customer pays (some share or 100% of) the installation cost of the system. This amount of money is often denominated a connection fee and may be calculated based on the kWh delivered per year or based on the installed collector area and

[3] MA = montly amount paid by customer and earned by ESCO
SEm = solar energy in MWh in current month
SEP = solar energy price per MWh solar energy (high)
[4] BP = basic price paid by customer every month
SEP = solar energy price per MWh solar energy (low)

system design. In return, the energy price for the customer is reduced, so the ESCO needs to perform a very thorough economic feasibility calculation.
Monthly amount charged to customer: MA = SEm × SEPl
Connection fee has to be paid once at the delivery of the solar plant.

The solar energy price is usually linked to the consumer price index (general index which reflects the course of the inflation); this does generally not create any problems in the financial negotiations. With the current development of the world's primary energy prices in mind, it is also a good idea to link the solar energy price to the price of oil or gas. Here is one possible model: the oil price of a defined date is taken as reference, and every month (or every year) the oil price increase is measured relating to the reference date. The solar energy price may be increased by a certain percentage of this oil price increase.

4.2.6 Call for tenders material

Steps of a tendering procedure

The tendering procedure involves in general three steps:

1. Pre-selection of qualified ESCOs:

The first step includes the preparation of project information, public advertising and informing potential bidders and evaluation of all documents sent by the ESCOs. Based on the results of the evaluation a recommendation of qualified ESCOs will be given to the building owner.

2. Call for tenders - documents:

The second step includes the development the solar thermal energy service contract, preparation of the documents for the call for tenders and sending the documents to the ESCOs.
The Call for tenders material is based on a number of documents, which are the following:

- Hints for tender preparation and awarding principles
- Bidding form and short questionnaire for offer
- Energy Service Contract for solar thermal plant with annexes
    a. Description of the building with abstract of cadastral register, plans and photos
    b. Description of performance
    c. Capital expenditure and structure of investment, List of measures, list of products
    d. Service offering of energy controlling system
    e. Formula to calculate the guaranteed solar yield per year (reassessed)

3. Selection of the best offers and negotiations:
The last step of the tendering procedure includes the evaluation of the bids, negotiation of bids and contract with the 3 best ESCOs and the final assessment of the bids and recommendation (report).

Evaluation of tenders
In the tendering documents the basis for the evaluation of the tenders is defined.
The criteria are:
- Overall costs per year: capital costs for investment + yearly price for service + yearly price for energy (hot water) supply
- Quality of the technical solution and guaranteed solar output
- Concept of the energy management

These criteria are weighted, that means in the evaluation a maximum of 100 points is possible and e.g. the overall costs are with max. 80 points, the quality of the technical solution and the energy management are each with max. 10 points valued.

4.2.7 "Solar Focused" Audit Procedure

The boundary conditions, under which a ST-ESCO will need to consider and to decide about the installation and operation of a solar heating plant, will be rather variable. Processes will be different for a large ground mounted plant feeding into a district heating net than for a system, mounted on a residential building. Nevertheless ST-ESCO need a structured and reliable solar focused audit procedure as technical base for feasibility studies, decision making and planning. The audit procedure presented in this section recommends the following steps:

1. At first, the initiator of the ST-ESCO project, this can be the object owner or the ST-ESCO itself, carries out a **base data collection** in order to get an overview on the general situation and possibilities for installing a solar thermal plant and for entering as a ST-ESCO into the project
2. An **energy concept** for the object is elaborated, presenting the integration of the solar heating plant with other renewable energy, energy efficiency and conventional technologies.
3. A **visit to the object** or construction site is organized together with all partners involved in the realization of the project.
4. If necessary a **short term measuring program** (6 - 8 weeks) is carried out in order to verify the load assumptions made in the base data collection

4.2.8 *Crucial Aspects of Measurement and Verification (M&V) Procedures*

Examine crucial aspects of measurement and verification (M&V) procedures.

Objective of plant measurement and verification (M&V)

ST-ESCOs operate and maintain solar plants on longer periods and bill the produced solar heat to the customer. This role of the ST-ESCO implies particular objectives and requirements on the measurement and verification procedure applied to the solar heating systems.

The specific objectives of M&V are:

1. cost effective control of the plant
2. monitoring of an optimal plant operation
3. measurement of the heat to be billed to the customer
4. rapid fault detection

Corresponding requirements are

1. remote availability of data of the system status and remote access to the controller parameters
2. certified heat meters with sufficient accuracy
3. fault analysis routines incorporated in the controller software

Simple plant tele-monitoring and control techniques

Controllers used for large solar heating plants

The control of solar heating plants is in general not complicated; however, several particularities regarding their control strategies have to be taken into account and obeyed in order to safeguard an optimal operation.

In principle two type of controllers can be used for solar heating plants:

- freely programmable mainframe controllers
- freely programmable solar controllers

Mainframe controllers offer the maximum freedom regarding their configuration and extension to data acquisition, processing and remote access. However, in many cases the choice of this type of controller led to practical operation problems, since the solar specific particularities were not satisfactorily programmed due to the lack of expert knowledge of the programming personnel.

Freely programmable solar controllers, produced by specialized manufacturers, offer pre-configured routines for these particularities and thus ensure a more robust operation. Several commercial products are available and extendable for data acquisition, processing and remote access.

Solar radiation measurement

Solar radiation is the basic energy input to the solar heating system and needs to be measured, in order to assess the heat output of the system. Radiation data are mainly used for daily, monthly or yearly system yield verifications, therefore no high-level measurements are needed.

In most cases, only total radiation is measured (no separation of beam and diffuse radiation).

Two sensor types are available on the market:

3 PV sensors, which due to their wavelength-dependent sensitivity have a rather limited accuracy

4 Pyranometers working more accurate based on a thermal effect. The accuracy classes are defined in ISO 9060 resulting in accuracies for the measured daily radiation of approximately ±3% for secondary standard, ±5 % for first class instruments and ±10 % for second class instruments. Pyranometers are sensitive against sensor pollution and have to be cleaned at regular intervals, depending on the actual and local pollution conditions.

An alternative to radiation measurements can be data obtained from satellite pictures. These data can show high deviations for instantaneous measurements but produce fairly good agreements on a monthly base. Accuracies versus ground measured data of < 5 % are reported. A satellite radiation data base was developed under the Satel-Light project www.satel-light.com.

Temperature measurement

The availability of temperature measurements at several locations within the system are useful for detecting possible faults and error sources (e.g. too high return temperatures of the collector field circuit).

Most commonly used temperature sensors are Platinum-resistance-thermometers of the PT 100, PT 500 or the PT 1000 class. Basic recommendations for the installation of temperature sensors are:

- Sensors must be in good thermal contact with the measuring medium (well insulated immersion sensors rather than clamp-on)

- Sensors and cables installed in the collector circuit should be resistant up to 200 °C
- 2-wire-cables are sufficient for control purposes. For measuring purposes 4-wire-cables are recommended, in order to eliminate cable length influence.

Heat metering

The ultrasonic heat meters are the technical state-of-the-art today: they contain no moving parts, are therefore non-wearing and have long durability, and that means little maintenance costs for the ESCO.

The heat energy transported in a pipe is measured by means of the following formula: $Qp = Vp \times rho \times cp \times DeltaT$. So, the heat meters have fixed values for rho and cp (it is essential to input the correct volume fraction of antifreeze!), and they measure Vp and DeltaT via supply and return temperatures. The Vp is measured without any moving part by an ultrasonic pulse (measurement of the signal transition time), the temperatures are usually measured with PT100 or PT500 temperature sensors, depending on the specific model.

Pump and valve status monitoring

In case time series are taken from radiation and temperature data, it is recommended to also monitor the status of pumps and valves in order to identify any controller strategy mismatch.

Online functioning verification

Most controllers have the feature for an online plant functioning verification, i.e. relevant temperatures and statuses are continuously verified against functioning criteria implemented in the controller software. In case one of the criteria is not matched a warning is sent to the plant operator, in order to immediately recognize any operation problem. Examples for such criteria are:

- significant irradiance, but the pump is deactivated
- night time, but the pump is activated or the collector is warm
- the pump is activated and the temperature difference between flow and return pipe of the collector circuit are excessive
- the pump is activated and the temperature difference between collector and collector circuit flow pipe are excessive
- the system pressure is low (if measured)

Daily plant yield verification

A plot of the daily plant yield versus the daily radiation allows for a simple verification of the plant efficiency. During regular operation periods, measuring points should row up close to a linear dependency of these two quantities. Reasons for low measured plant yield can be either days with significantly lower heat loads than expected or plant operation problems. In both cases the ESCO should be notified in order to verify the cause.

Programmes like TSOL or TRNSYS allow to produce more refined correlations between the expected system yield, the radiation, the load and other relevant quantities. Such correlation allow to better assess the actual efficiency of solar heating systems. This kind of verification can be automated and implemented into the controller software.

5 Policy Paper in EU and National Level

Solar thermal technologies are, among other renewable energies, a central part of the European Unions energy strategy since the late nineties. As expressed in the White Paper: Energy for the future - renewable sources of energy [COM(97) 599 final] and in the Green Paper on security of energy supply (2000) the goal is to reach 100 million m^2 of solar collectors by 2010 in the European Union (EU 15).

Solar energy contributes significantly to the main pillars of Europe's energy policy, which are to enhance the security of supply through reducing the share of fossil energy imports, to combat climate change through CO2 free energy and to make Europe's economy more competitive. Especially the rising oil and energy prices over the past few years make it even more attractive to implement solar energy systems.

The solar thermal potential from an economical and technical point of view has been estimated to be about 6% of EU final energy consumption. Only about 1% of the potential has been reached according to Sun in Action II [ESTIF, 2003]. Therefore a huge potential exists.

Solar thermal applications in Europe have been basically limited to the residential sector (that is, in any case, far from being saturated). They are mostly small to medium size systems. In Austria, for example, about 15% of all single family houses have a solar system compared to only 1% in multi-family houses. Solar plants have also not yet penetrated the services and industry sectors as well as the public sector.

There exists a huge potential especially for large-scale solar plants (from hundreds to thousands of m^2) which is untapped!

Besides in large real estates, large-scale solar systems can also be implemented to feed heat into district heating networks, to provide the energy for seasonal storages or for cooling purposes. However, they are very rarely encountered although they offer numerous advantages (as through the economy of scale).

It is well known and agreed by experts that the development of Solar Thermal Energy Service Companies (ST-ESCOs), respective the implementation of energy service models, would result in a substantial growth of solar thermal plants in Europe. It is the sector of large-scale solar plants, which is most suitable for ESCO models.

5.1 Strategies to develop ST-ESCOS

Strategies to develop the market for Solar Heat Services and ST-ESCOs must be seen in a broader context:

a) On one hand it is essential to promote solar thermal energy as such in order to increase the demand especially for large-scale solar systems.

b) On the other hand barriers for energy services and ESCOs must be removed and those services be made better known.

The integration of those two policies will result in a promising development of ST-ESCOs on European markets.

Existing ESCOs will integrate solar thermal energy in their portfolio. And companies in the solar thermal sector (installers, planners, suppliers etc.) will develop ESCO type services to better implement large-scale solar systems.
Concerning the promotion of solar thermal energy in general (and being part of a policy to foster renewables in a broader sense), only some references should be made:

- There exists a proposal from EREC (European Renewable Energy Council) for a European Directive to promote renewable heating and cooling: 25% of the EU heating & cooling supply by renewables in 2020.
- The European Commission has recently developed a biomass action plan [COM(2005) 628]. A more general Action Plan for renewables is considered within the Commission. Solar thermal should be an important part in it.
- Several member states have implemented instruments and programmes to promote solar thermal energy through
  - Regulation: some cities and regions have made solar thermal compulsory for certain cases (“solar ordinances”)
  - Subsidy programmes: grants or subsidised loans for the investments

- Action programmes: more comprehensive programmes including information and awareness raising activities, qualification and training etc. (e.g. the programme “solar:heat” within the Austrian climate action programme climate:active)

Based on the findings in the participated countries analyses the main barriers[5], standing in the way for a broader use of Solar Heat Services (SHS), are:

- Lack of information, knowledge and understanding of SHS on all levels
- Limited access to financing for potential ST-ESCOs
- Legal and regulatory obstacles
- Long paybacks and commitment to a contract for the end-user
- Administrative hurdles such as complicated procurement procedures in the public sector with high preparation costs

To overcome these barriers the main strategies to promote Solar Heat Services and ST-ESCOs are:

1. Information and awareness raising programmes to consumers
   In order to overcome lack of information and awareness of the end-users, information and dissemination activities – particularly through presentation of realised, positive model projects – are important. It must be better known that Solar Heat Services exist and work. This is especially true for persons responsible for the technical performance of large buildings (energy managers and financial officers) and utilities.

2. Support for project initiation
   As customers often don’t know how to start with a ST-ESCOs project, the provision of tools and support for project development and implementation will be of great help: checklist for the procedure, calculation tool (as e.g. developed in this project), model contracts, etc.
   It can be seen from the ESCO market development in other countries that support of customers by energy agencies and other experts and facilitators are of great value, as the customer often is not an expert in energy or ESCO matters. Therefore free or subsidised advice should be offered to the customer in order to give more confidence and reduce the transaction costs of project development.

5 For a discussion on barriers for a broader use of ESCO models in general see also Bertoldi/Rezessy, 2005 and IEA-DSM Task X, 2003.

3. Training
   Based on the principal technical and economical feasibility, an appropriate financing and implementation scheme must be developed. This is the point where Solar Heat Services and ST-ESCOs come into place.
   This means, that those offering or proposing, construct and maintain solar solutions must be educated so that they can provide qualified information and advice on SHS and ST-ESCOs as well as quality plants: solar industry, planners, installers, energy agencies and other organisations providing advice.

4. Integration of solar thermal plants into district heating networks
   The integration of solar thermal energy into existing district heating networks is an interesting option, where district heating networks also operate in the summer months, e.g. for providing energy for hot water. Eventually, this can be combined with seasonal storages.
   For this field of solar thermal application ST-ESCOs can provide valuable contributions: They can build and operate the solar thermal plant and deliver the solar thermal energy into the district heating network. They will get a remuneration based on the actual amount of kWh delivered. This can be combined with subsidy schemes as described below.

5. Quality standards and certification schemes of ST-ESCOs
   The introduction of quality standards, certification and/or accreditation schemes of ST-ESCOs will help to achieve better acceptance and trust in these services and therefore support a rapid and prosperous development of the market for SHS.

6. Financial instruments to support ST-ESCOs Development
   Limited access to financing opportunities and the management of financial risks can be an obstacle for companies evolving into this field, especially for new ESCOs.

7. Removing legal and administrative barriers currently existing
   In the public sector in some countries, rules and regulations sometimes do not allow or complicate the application of ST-ESCOs (e.g. complicated tendering procedures, not taking into account the specifies of energy services as a 'one-stop-shop' concept). And there is a lack of clear rules on how ESCO type projects are treated within the framework of public budgeting regulations.
   It is very important for the further development of St-ESCOs and the ESCO business as a whole that these legal and administrative barriers are reviewed and removed.

8. Further development of White Certificate schemes to include renewable options on the demand side

The introduction of white certificates e.g. in Italy has given a strong boost to the creation and development of an energy efficiency market. The mechanism foresees the compulsoriness (for gas and electric distributors) to reach a minimum level of energy saved and the sale of the certificates on the market (that represent the certified energy savings obtained).

However, at the moment the white certificates are not very suitable for solar thermal installations. In particular, for a solar plant the low "energy efficiency profitability" (saved energy for expense sustained) makes the economic evaluation for white certificates for solar systems not significant. For solar thermal applications it would be necessary to have a long enough duration of the white certificates (as is the case of other energy saving measures e.g. thermal insulation of the building envelop).

A white (or whatever colour) certificates scheme, which includes solar thermal applications in an appropriate way would support the market development of ST-ESCOs. In an ESCO type project the actual (fossil) energy saved is always exactly known as the remuneration of the ESCO is bound to the savings and in most cases the savings are even guaranteed.

The white certificates can also represent an important feature for the realisation of a solar plant, in particular from the point of view of a bank. The certificates are a certain earning for the ST-ESCO, and so a reduction of the risk. They also represent an official certification that the project can reach a minimum level of energy saved and therefore revenue from the project. This increases the securities for the financing institution.

The existing and eventually EU wide planned White Certificate schemes could be further developed to include solar thermal plants and other renewables on the demand side suitable into these schemes.

9. Include solar thermal in the implementation procedures for the Energy Efficiency and Energy Services Directive

Member States should quickly adopt and implement the Directive with appropriate instruments, which are also in favour for Solar Heat Services and ST-ESCOs. However, some amendments and a further development of the Directive for the greater use of renewables and SHS should be examined (see following chapter).

In addition, the Commission should clearly include and promote solar thermal and especially ST-ESCO models within the planned legislation to encourage the use of renewable energy for heating and cooling. (see also following chapter).

5.2 Possible solutions on EU level

In general, the European Commission, DG TREN, can act through developing proposals for new directives and strategic papers, ensuring the correct implementation of existing directives with accompanying measures and developing them further, developing action plans and agreeing with member states to jointly implement them, using the programme Intelligent Energy Europe and carrying out dissemination activities.

1. Community legislation on renewable heating and cooling
2. Energy End-Use Efficiency and Energy Services Directive
   Further issues that must be taken into account are:
   a. Integration of renewables into energy services
   b. Quality standards and certification schemes for ST-ESCOs
   c. White (or energy efficiency) certificates
   d. Financial instruments
3. Research and dissemination of good practice
4. Information and awareness raising activities

5.3 Possible solutions on member state level

Depending on the prevailing conditions in each country there are different solutions. But obviously some of the solutions might help in all countries. The national governments can act mainly through the following elements and activities, which summarise the above mentioned strategies from the points of view of the Member States and add some additional information:

1. Removing legal and administrative barriers and creating favourable conditions
2. Implementing the EEES Directive
3. Financial instruments to support ST-ESCOs Development
4. Information, advice and support for consumers
5. Training, quality standards and certification schemes for ST-ESCOs

These activities should preferable be bundled within comprehensive action programmemes either for solar thermal energy or in a broader scope to promote ESCOs and energy services.

5.4 Financial instruments to support ST-ESCO development

Suitable financial instruments could help to overcome barriers, namely the limited and sometimes difficult access to financing opportunities for ESCOs.6 This is especially true for new ESCOs on the market and for the new Member States.

Financing of SHS projects and ST-ESCOs is, due to the size of the projects, mainly a business for local and regional banks. Know-how, capacities and incentives are necessary on this level.

Financial instruments can support ST-ESCOs through

- establishing suitable funds or making access to existing funds easier in order to establish financing opportunities for ST-ESCOs;
- reducing the risks for banks providing financing through public liabilities;
- subsidy funds that are in favour of Solar Heat Services.

Sources of debt and equity financing need to be located and several financing sources are possible: private banks and lending institutions, venture capital firms, equity funds, strategic partnerships (e.g. utilities, engineering firms and equipment manufacturers). Encouraging and assisting existing leasing companies to offer solar thermal plants in cooperation with an ESCO is another option.

Two proposals for the creation of supporting financial instruments are suggested below:

(A) Creation of a Liability Fund

The creation of a liability fund dedicated to ST-ESCOs can be an interesting solution. This means that there is no direct funding of the projects out of this fund, but a deposit available for the partial cover of the guarantees required for the bank loan. The total amount, deposited for the entire duration of the loan, is decreasing in the time due to the payments by the ESCO. The money is not spent nor utilized in any way, but simply locked until the complete restitution of the debit.

Public authorities from several levels could be the responsible bodies for this fund: Municipalities, Provinces, Regions, Ministries or specific public financing institutions can be involved, depending on their strategies. The direct involvement of public authorities can also be useful to catalyze other economic resources (e.g. from foundations, banks and financial institutes, trade associations etc.) and to cooperate with subsidy programmes.

(B) Subsidies for solar thermal energy instead of investments
Considering conventional solar thermal plants (not prototype or innovative systems), subsidy schemes could be designed to support the solar thermal output of a plant instead of subsidising purely the investment.

Subsidising the investment (e.g. through a direct grant from public funds) does not take into account the efficiency of the plant and if the plant achieves its promised solar output and therefore desired benefit. Giving subsidies per kWh solar output of a solar system would provide an incentive to run the plant as efficient as possible and to maximise the solar output through high quality operation and maintenance.
This can be reached in two different ways:

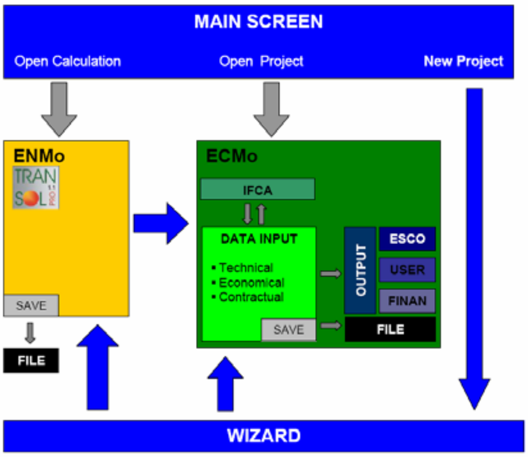
- Remuneration for the kWh produced by a solar thermal plant;
- Remuneration for each kWh bought from a solar source.

(C) Favourite V.A.T. status for solar thermal energy

Detailed analysis and information on National level is provided through the ST-ESCOs Policy Paper document available at the project's web site (http://www.stescos.org)

6 Software Tool

"STESCO" software tool was developed in order to simulate solar thermal plants and provide energetic and economic outcomes focused on ST-ESCOs projects. The flowchart of the program can be seen in Picture 3.



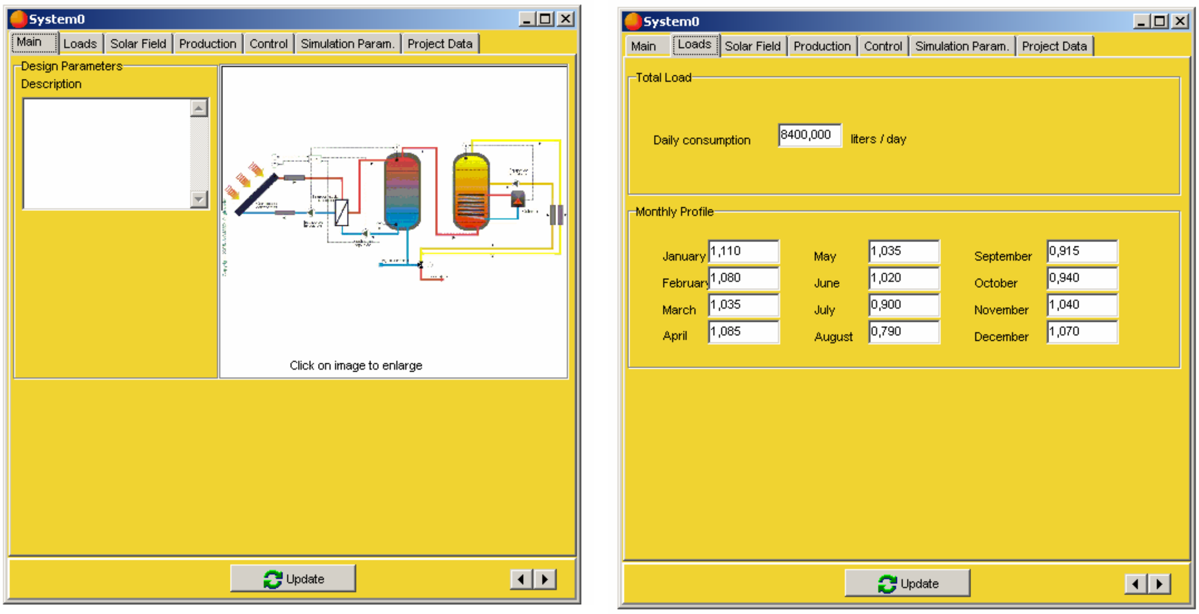
Picture 3: STESCO software flowchart

"STESCO" includes a common interface for both the energetical calculations module and the economic module. These two software tools, called Modules in the project are responsible of the energetic calculations, by solar system transient simulation, and of the economical, financial and contractual analysis. The first one is called EnMo (Energetic Module) and the second one EcMo (Economic Module).

6.1 Energetic Module

The Energetic Module is a simulation tool based on TRNSYS, with a user friendly interface where the user can introduce all technical data referred to the solar thermal system through seven different screens:

- Main
- Loads
- Solar field
- Production
- Control
- Simulation parameters
- Project data



Picture 4: Indicative software interface screens

The transient simulation tool allows the user to reach a very good estimation of the solar field production. The possible difficulties of a non expert user in the definition of the value for the parameters is solved by a correlations system that suggests to the user all the values included in the software depending of some initial definition values.

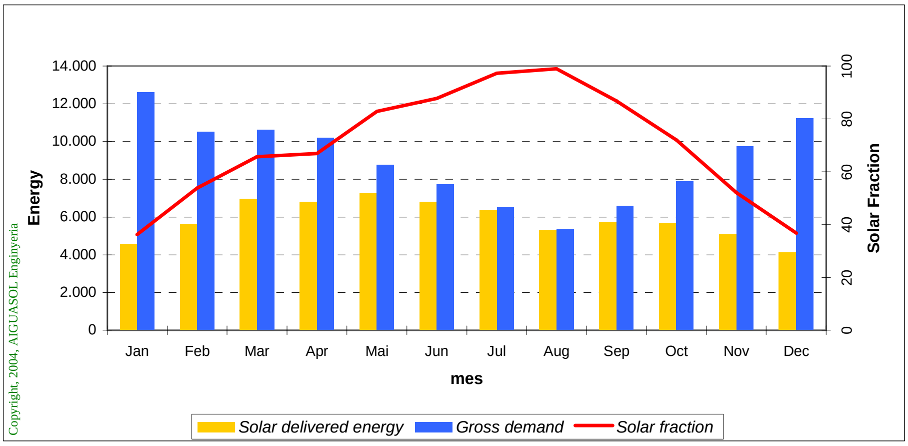
Finally, this tool generates a simulation report with all energetic data.

STESCOS_EnMO
V1.2

SIMULATION REPORT

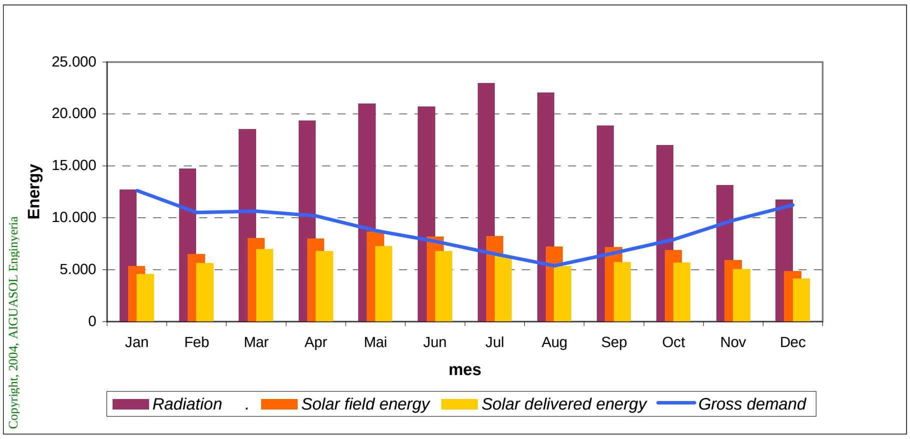
Code *ST ESCO APERCA*

Monthly energy results: Solar delivered energy, Gross demand, Solar fraction



Monthly energy results: Radiation ., Solar field energy, Solar delivered energy

Radiation .	*kWh/m²*	*1.759,4*
Solar field energy	*kWh/m²*	*703,0*
Solar delivered energy	*kWh/m²*	*581,6*



Solar field efficiency.

Solar field efficiency	%	*39,96*
Solar system efficiency	%	*82,73*

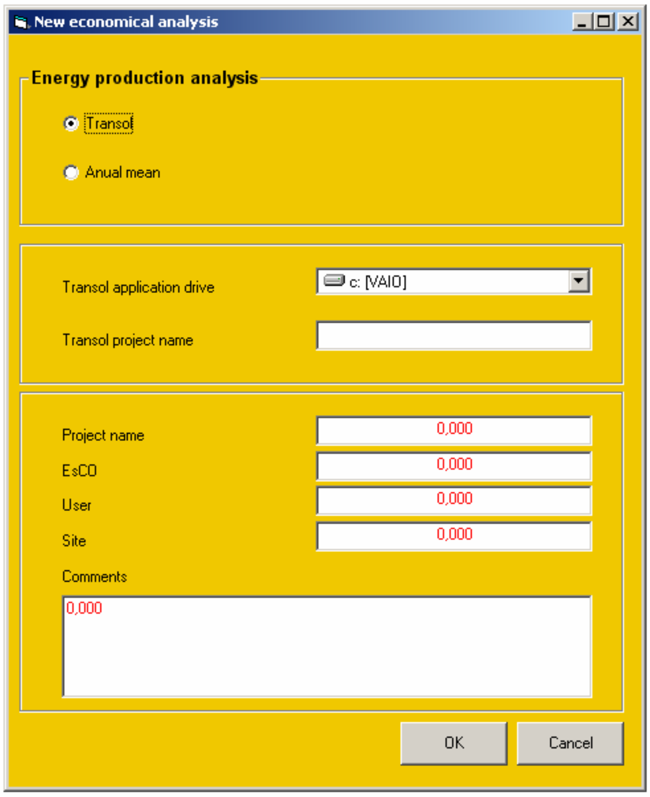
3 de 4

Picture 5: Indicative page from the STESCO energetic report

6.2 Economic Module

The Economic Module performs the economic, financial and contractual analysis, based on the EnMo results or other energetic results coming from any other energetic software.

An instruction screen allows the user to import EnMo results and to introduce other description parameters.



Picture 6: Introductory screen of the EcMo

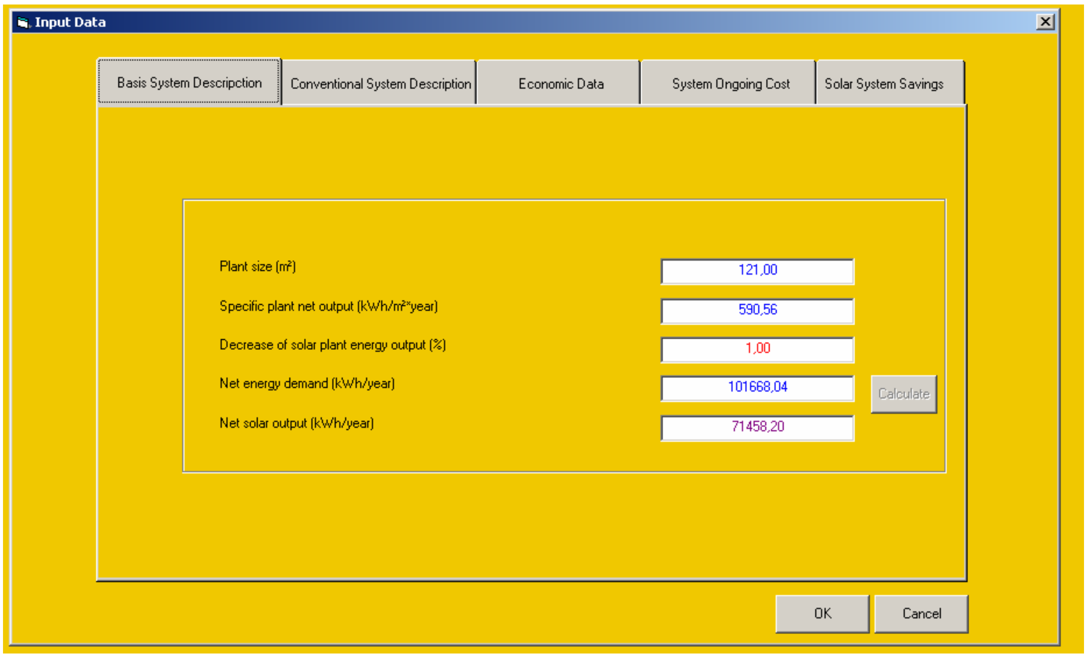
Depending on the values imported, a base project is generated and presented, where the user can set all the specific economic preferences.

The data input is organized in two different screens, and a final interactive screen for the final optimization of it all:

- Input data
  - Basis System Description
  - Conventional System Description
  - Economic Data
  - System Ongoing Cost
  - Solar System Savings

- Contract definition

- Interactive Financial Calculations



Picture 7: Indicative screen of the EcMo

Finally, this tool generates a simulation report with all economic data, including IRR, NPV and Payback graphs.

7 Pre-feasibility studies and pilot agreements

All participating countries have contacted end-users and ST-ESCO developers by various means of communication (calls for interest, direct contact, etc) in order to initiate the procedures for ST-ESCOs agreements. For this purpose, pre-feasibility and detailed studies have been performed.

In total, there have been completed 23 feasibility studies and 9 detailed studies in Hellas, Austria, Spain and Italy. Altogether 5 agreements have been achieved in the participating countries, while 2 more are under negotiation (or "call for tenders" phase) and there is one more offer from EBHE (Hellas) in order to realize a project of 200 m^2 (see Table 1).

Additionally, in the context of the project two new ST-ESCOs were founded in Austria, Solar.Nahwaerme, a company specialized in applications combining biomass and solar thermal power. Solar.nahwaerme is the ST-ESCO in the Oberzeiring project. Solar.graz, a subsidiary company of Energie Graz, is specialized in combinations of solar thermal plants and district heating networks.

	Number of carried out feasibility studies	Number of carried out detailed studies	Progress of agreements
Hellas	7 studies	2 detailed studies	One case on the preparatory phase for agreement and one case from EBHE to realize a project of 200 m^2
Austria	6 studies	2 detailed studies	Three signed agreements
Spain	3 studies	2 detailed studies	One signed agreement and one towards signing
Italy	7 studies	3 detailed studies	One signed agreement

Table 1 ST-ESCOs studies elaborated and agreements' progress

7.1 Hellas

Two calls for interest, one for end-users and one for ST-ESCO developers, were published or have been directly contacted. More than 24 end-users (industries, hospitals, hotels, sport centers, etc) as well as 20 possible ST-ESCOs developers have expressed their interest to further investigate the possibility of realizing relevant projects. It becomes apparent that ST-ESCO developers were somehow reluctant since several issues related to the financing of the projects are vague, while at the same time it seems more feasible that ST-ESCO projects should better be accompanied by other measures, mostly energy efficiency.

For the better evaluation of this specific action, four specific targeted questionnaires were developed (for hospitals, hotels, athletic centres, industries) in order to collect all the necessary technical info for the case studies in an easier and more effective way.

A short presentation of the main aspects for all cases is following.

Papageorgiou Hospital

This is an 800 beds hospital situated in Thessalonica (north of Hellas), having a mean daily consumption of sanitary water of about 91800 litres. Some basic information for the proposed solar plant is given in the following table.

Solar collectors total surface proposed	1225 m^2
Total (roof) surface needed for the collectors field	About 3000 m^2
Total storage volume of solar plant	70 m^3
Annual solar yield delivered to the user	693 MWh
Duration of contract	20 years
Overall benefit (NPV) of the User	107950 €

Eldery House Theotokos

Theotokos is an Elderly house administrated by the Church, situated in Konitsa-Ipiros, having a total heating load of 137 MWh. Some basic information for the proposed solar+biomass plant is given in the following table.

Solar collectors total surface proposed	27,5 m^2
Total (roof) surface needed for the collectors field	35 m^2
Total storage volume of solar plant	2 m^3
Annual solar yield delivered to the user	13,7 MWh
Combination with other measures	Installation of biomass burner of 150 kW for 100% (solar+biomass) heating load coverage fraction
Duration of contract	20 years
Yearly benefit of the User	2880 €

Epilektos Industry

"Epilektos" is textile industry situated in Levadeia (about 200 km north of Athens), having a mean daily consumption of water (feeding the steam boiler) of about 50000 litres. Some basic information for the proposed solar plant is given in the following table.

Solar collectors total surface proposed	1500 m^2
Total (roof) surface needed for the collectors field	3750 m^2
Total storage volume of solar plant	100 m^3
Annual solar yield delivered to the user	1160 MWh
Duration of contract	20 years
Overall benefit (NPV) of the User	432442 €

<u>Olimpion Hospital</u>

"Olimpion" is a newly constructed hospital situated in Patras (about 200 km west of Athens), having a mean (estimated) daily consumption of sanitary water of about 40000 litres. Some basic information for the proposed solar plant is given in the following table.

Solar collectors total surface proposed	200 m^2
Total (roof) surface needed for the collectors field	500 m^2
Total storage volume of solar plant	10 m^3
Annual solar yield delivered to the user	155 MWh
Duration of contract	20 years
Overall benefit (NPV) of the User	97266 €

<u>MAIC Institute</u>

MAIC (Mediteranean Agronomic Institute of Chania) is situated in Crete (Chania), having a mean daily consumption of sanitary water of about 5000 litres. Some basic information for the proposed solar plant is given in the following table.

Solar collectors total surface proposed	50 m^2
Total (roof) surface needed for the collectors field	125 m^2
Total storage volume of solar plant	2.5 m^3
Annual solar yield delivered to the user	37 MWh
Duration of contract	20 years
Overall benefit (NPV) of the User	12380 €

Hotel Porto Carras

Porto Carras is a 1200 beds Hotel situated in Neos Marmaras - Sithonia, Chalkidiki, having a mean daily consumption of sanitary water of about 65000 litres. Some basic information for the proposed solar plant is given in the following table.

Solar collectors total surface proposed	657 m^2
Total (roof) surface needed for the collectors field	1650 m^2
Total storage volume of solar plant	18 m^3
Annual solar yield delivered to the user	307 MWh
Duration of contract	20 years
Overall benefit (NPV) of the User	115020 €

Hotel Pavlina

Pavlina is a 250 beds Hotel situated in Patra, Peloponnesus, having a mean daily consumption of sanitary water of about 21000 litres. Some basic information for the proposed solar plant is given in the following table.

Solar collectors total surface proposed	120 m^2
Total (roof) surface needed for the collectors field	300 m^2
Total storage volume of solar plant	4 m^3
Annual solar yield delivered to the user	67 MWh
Duration of contract	20 years
Overall benefit (NPV) of the User	24700 €

Hotel Oceanis

Oceanis is a 318 beds Hotel situated in Kavala (north-east Hellas), having a mean daily consumption of sanitary water of about 25000 litres. Some basic information for the proposed solar plant is given in the following table.

Solar collectors total surface proposed	200 m^2
Total (roof) surface needed for the collectors field	500 m^2
Total storage volume of solar plant	10 m^3
Annual solar yield delivered to the user	133 MWh
Duration of contract	20 years
Overall benefit (NPV) of the User	45700 €

A commitment for at least one ST-ESCO agreement already made !

A commitment for one ST-ESCO agreement with a solar plant of about 200 m^2 has been declared by the president of EBHE (Mr. Kastanakis) during the ST-ESCOs conference held in Athens the 6th of June 2007. EBHE (Hellenic Solar Industry Federation) will have the role of the ESCO in this realization. CRES will identify the most appropriate user and may contribute in the design and evaluation phase of the plant realization.

7.2 Italy

Following the indications from the market analysis and the indications given by contacted stakeholders, the study of real cases for ST-ESCO's applications become the main point of the project.

The strategy followed these items:

- Attention to the highest potential sectors, in terms of ST application and replication potential of the realization,
- Clear and easy technical indication for the integration of the solar thermal plant into the conventional heating system,
- Detailed economic analysis, in order to show clearly the economic potential for the application of the ESCo model, paying great attention to the realization of the studies proposed.

The prefeasibility studies were set out as following:

description of the location; definition of the heat load (energy consumption, load profile, temperatures required); definition of the solar thermal installation: the dimensioning of the system was defined, when necessary, with different configuration or components size; economic analysis in terms of NPV for ESCo and customer at the end of life of the plant (if there weren't other indication from the actors, e.g. maximum contract length), in order to evaluate the possibility of getting earnings for both with this installation.

Through the pre-feasibility studies were investigated the following sector:

- Residential: a MFH (109 flats) solar plant for DHW production;
- Sport facilities: three project for the DHW production for sport centres in Lodi;
- Industrial: in this sector were investigated:
  - a medium dimension dairy, in Caserta;
  - two galvanic industries, in different climatic zones (Rome and Bergamo) and with different heat requirements (heat temperature at 75°C and 60°C).

For the whole cases, was carried out a collaboration between Polimi and at least one actor involved (ESCO and/or customer).
The detailed studies have been chosen as the most interesting studies, in term of sector's potential and possibility of realization of the project (real interest of the actors involved), and have the following structure:

- Detailed description of the location;
- Detailed description of use (in particular temperature) and profile (daily, weekly and annual) of heat consumption;
- Energy sensitivity to the dimension of the system, in particular related to collector field and tank volume;
- Definition of contractual scenario for an ST-ESCo agreement, taking in account different hypotheses about solar energy price, contract length, subsidies availability.

Analytically the produced studies are:

Residential sector:

Casa Ecologica, realized in collaboration with Henergy srl (ESCo)
This study is related to a retrofit solar installation in a residential building (109 flats) in Milan.
The conventional heating system is well designed, characterized by a centralized DHW production plant with an easy solar integration; in particular, the existing tanks (4, for a total volume of 10m^3) are appropriate for a solar system. So the solar installation has been designed in order to use the existing tanks, in order to simplify integration, installation and, last but not least, costs. It was changed only the configuration, from a parallel to a series connection. The building is also provided of a good south facing roof.

Among the solar plant configurations considered, through an economic analysis (that considered the maximization of the NPV reached at 20 years) it has been defined a 140 m^2 flat plate collector field. This dimension restricts at only 30% the solar fraction, with an annual production of about 95 MWh/yr and a specific production of 680 kWh/m^2/yr.

Nevertheless this good system boundary condition, some restrictions are from an economical and contractual point of view;

- the conventional system works well; it's estimated an annual efficiency of 80%;
- the substituted fuel is natural gas, characterized by a low price (0.067 €/kWh);
- the customer doesn't want:
    - to pay anything as initial investment,
    - to pay the energy more than the actual price,
    - a contract length longer than 10 years;
- the absence of subsidies available for ESCOs.

At these conditions no contractual schemes are available for an ST-ESCO project. Ceteris paribus, conditions that should be acceptable for the ESCO should be, for example:

- customer co-finance of the 30%, or
- contract length of 14 years, or
- energy price 105% of the conventional, or
- subsidy for less than the 55%.

Sport facilities:

Piscine "la faustina", realized in collaboration with the Municipality of Lodi

The aim of this study was to prepare a solar thermal energy service call for tender for the DHW production in a sport center (2 swimming pools and a gymnasium). The annual energy demand for DHW is about 420 MWh, with a significant reduction in summer, when only one swimming pool is open (15-20 MWh/month), instead of 35-45 MWh/month for the rest of the year when are open the indoor swimming pool and the gymnasium.

The conventional system is obsolete, apart from the boilers. A great effort was done to define the heat load, because the only data available were the total gas consumption, both for DHW and space/swimming pool heating. Due to the crucial aspect of the heat profile in an ST-ESCo project, the estimation of this data (specifically the winter DHW consumption) has been obtained through three different elaborations:

- based on the summer consumption and evaluating the showers number of the summer swimming pool against the indoor swim + the gymnasium ones;
- based on the estimation of people access to the indoor swim and the gymnasium;
- based on the definition of the space heating through the correlation between the winter consumption and the ambient temperature.
-

While the three elaborations gave the same results (+/- 5%), the heat profile was considered reliable. Regarding the annual conventional system efficiency, two different values were considered (83% and 65%) because no information could be delivered by the general information obtained. Thus, two different scenarios were carried out in order to let the Municipality to choose the best one.

Due to the system management foreseen (the ST-ESCO as a new actor in the management of the heating system), the solar plant has been designed to be installed separately from the rest of the existing thermal plant, serving as pre-heating of the cold water. With this solution, in fact, it's possible to clearly define the specific responsibilities of the ESCO in the heating system.

Under these conditions the economic simulations (without incentives) shown the maximization of the NPV_{20} with a plant of 180 m^2, characterized by a specific production of 770 $kWh/m^2/y$. The energetic simulations showed a very low sensitivity of the annual producibility to tanks volume: it has been chosen a specific volume of 50 l/m^2_{coll}, but systems with 30 or 70 l/m^2_{coll} gave the same results (+/- 3%), due to the low solar fraction (20%).

The contractual scenarios showed that without incentives the project is hard to be realized (not impossible, because the economic analysis have been done with an estimated plant cost, of 765 €/m^2); with a 40% of incentive, some contractual schemes are available.

Industrial sector:

La baronia dairy, realized in collaboration with Eureco spa (ESCo)

The third case is characterized by favourable boundary conditions:

- The thermal load is high, about 500 MWh/y, constant through the whole year (between 36 to 44 MWh/month with a constant daily profile from 7am to 5/6 pm;
- The solar radiation is high, about 1400 kWh/m^2/annum (on the horizontal);
- The conventional fuel (LPG) is expensive, 0.085 €/kWh (without considering the conventional system efficiency);
- The system is not energy efficient: the whole heat production is made by a couple of steam generator, for low temperature uses too.

The only troubles related this study, were related to the definition of the heat load and the whole conventional system efficiency. It was define by the combination of energy bills, energy evaluation of the single step of the process, oral description of the not measured consumption (like the washing procedure).

Two different solar plant hypothesis have been investigated:

- Water pre-heating before inlet to steam generators:
  the system is characterized by a simple integration, but solar fraction is low, due to the fact that heat is still provided by steam;

- Direct utilization of solar heated water for low temperature uses:
  In this case an higher integration complexity furnish an improvement of the energy behavior of the system, thanks to the higher heat load profile (the heat load is provided in terms of m^3 of hot water, and not in steam kgs) and the operational conditions, at a temperature level more appropriate to a solar system. Moreover it requires a monitoring for non productive energy uses, that can increase the general efficiency of the whole system.

The second typology of intervention offers better economic conditions, with a solar field of medium dimension (the economic optimum has reached in about 250 m^2, but the available surfaces allow an installation of no more than 150 m^2).
The above mentioned good conditions allow many different contractual schemes. Without any subsidy or customer co-finance, a 13 years contract at the actual energy price allow good economic earnings for both the actors.

Pilot agreements:
Municipality of Lodi
Piscine "La Faustina"

It has been defined a call for tender for a "solar heat service", published in June 2007 (innovative in Italy; no other are currently in use).

It is based on the minimum the constraints for the ESCOs. It is imposed:

- Dimension of the technical room;
- Minimum annual production of the plant;
- Installation of a "custom built" system, with certified collectors (EN 12975) and a range size from 140 to 220 m^2;
- Compliance with to the current Italian standards and regulations.

All the other parameters, size of the collector field, system configuration, tank volume, type of collectors, connection to the existing system, are set free and will be chosen by the ESCO.

The Municipality will pay only the solar energy transferred to the DHW system. So the guarantee for the correct operation of the system is the ESCO scheme itself, while the ESCO earnings are directly related to its energy production.

The guarantee for the quality of the installation is given by the tender mechanism. The main parameter considered for the selection of the tender is the solar energy tariff (85% of the total score), according to an energy price growing with the specific solar producibility (constant at the tender value until the guaranteed result, linearly growing up to 0,284 €/kWh, reached at 950 kWh/m^2/y)

Such a tariff mechanism should push the ESCO to realize a plant with good quality component, since the reduction of price for the base specific production (up to 550 kWh/m^2 y) is compensated by the increased tariff for the growing specific energy production.

The base data for the tender has been obtained from the economic simulations, considering a 15 years contract (defined by the Municipality) and an energy price curve that guarantees, at simulation conditions (specific producibility: 770 kWh/m^2/yr, system cost: 765 €/m^2),

- for the ESCO a PBT of less than 12 years and an IRR of more than 9%,
- for the Municipality the 5% savings from the conventional.

Regarding the risk related to the increase of energy bill due to the price mechanism, it has been estimated that, at tender's base price, an increased specific producibility of 25% is the border value of convenience for the Municipality. With this consideration it has been accepted as reasonable risk.

As guarantee for the ESCo it has been defined a minimum monthly heat load by the Municipality.

The project is co-financed by the Municipality for the 50%, thanks to Regional facilities dedicated to solar thermal installation in Public buildings.
The call for tender has been assigned with a 10% discount on the base value.

Cascina Faustina and
"Palazzetto dello sport

Due to the Regional facilities dedicated to solar thermal installation in Public buildings, the Municipality decided to realize also the other two plants analyzed as pre-feasibility studies though the same instrument of the call for tender.
In these case the solar plants are simpler than the previous one. They're two 50 m^2 plants, with a solar fraction of about the 30% each. Such simple systems did not require a detailed energy and technical study.

However they required a deeper analysis from an economic point of view. Two the main point to solve:

- define conditions to make the solar installation convenient for an ESCO, even with these small plants;

- minimize the risk related to the summer vacation period, when the plants are closed (June/July to August).

For these reasons the economic simulations considered an high plat cost (850 €/m^2), the contract length was reduced to 10 years and has been defined an annual fixed amount from the Municipality (evaluated as the 50% of the annual installment of a loan that covers the initial investment). The energy produced is paid at different prices (fixed) growing with the specific producibility. In this case the tender was based on the reduction of the annual fixed amount.
The base value (at simulation conditions) was defined to reach a 5% save for the municipality.
The call for tender has been assigned with a 10% discount on the base value.

Casa ecologica

It isn't been signed an ST-ESCO agreement. As explained before, the ESCO contract wasn't suitable at the mentioned conditions. The only subsidy available is the one introduced by the 2007 Italian financial law, as a tax reduction of 55% of the whole system costs (divided in three years). The mechanism, straight forward for a private person, does not particularly easily applies for an ESCO.

The main problem related to the ESCO appliance of this kind of subsidy is that it is achieved through a tax reduction. But an ESCO that would install many plants any year, should have to pay a lot taxes to completely achieve the facilities!
Two possible contractual schemes has been identified to get over the problem

The first one foresees a customer co-financing of the initial investment of (at least) the 55%. In this case the ESCO significantly reduce its financial risks and the customer will pay back the investment in few years. In this case the problem is that the costumer has to invest a significant amount; and so, if it has the available fund, he prefers to realize the investment by its own.

The second one foresee that the customer doesn't have available fund and so the ESCO finance the investment. The customer will pay back to the ESCO the fiscal benefit in the bill, that in the first three years will be higher than the following. The problem related to this mechanism is due to the property of the plant: while the condition to achieve subsidies is the customer's property of the plant, it's necessary the signature of a specific agreement to ensure to the ESCO some rights on the solar thermal plant.
In this specific case the customer, scared for possible contractual troubles, preferred to finance by its own the plant (it means less than 500€ for apartment, without subsidies; the flat's owners revised their initial feared position regarding the investment!).

La Baronia dairy

Also in this case the 55% tax reduction made less attracting the signature of an ST-ESCO agreement.

But the interest of the dairy's owner was both for installation of the solar thermal plant and for the ESCO scheme. On one hand he's well disposed to pay the plant, on the other he wants the whole guarantees for a correct monitoring and functioning of the solar plant as the ST-ESCO realization achieve. A specific GSR scheme for this agreement will be produced, together with the installation of the solar plant.

The importance of this study is related to the high replication potential of the project, in the other dairy industries of the area (Caserta). So the ESCO aims to stipulate a commercial agreement with a local solar collector producer and with some local installers, in order to reduce costs and easily replicate the installation. This operation model was inserted in a program for the increasing of the energy efficiency in the productive process, extended to the whole consortium of the "mozzarella di bufala" producers.

7.3 Spain

During the development of ST-ESCOs project, some similar projects have being developed. For example in the Spanish region of Castilla y León, the Regional Energy Agency has developed the HOSPISOL project whose aim is to implement ST-ESCOs installation in all the hospitals of this region. Each installation is property of the Regional Energy Agency.

Some companies are also offering this kind of services to their customers. For example, one of them is a solar collector manufacturer that develops solar thermal installation. Another one is an engineering company that is beginning with ST-ESCOs installation in hotels located in the south of Spain.

A table with the different working installations in Spain has been attached next.

Hospital	**Town**	**Beds**	**Surface (m^2)**	**Tanks volume (l)**
El Bierzo	Ponferrada	225	477,1	30.000
Nra. Sra. de Sonsoles	Avila	330	357,8	24.000
Comarcal de Medina del Campo	Medina del Campo	130	158,4	10.000

Santos Reyes	Aranda de Duero	101	110,0	7.000
General de Segovia	Segovia	375	220,0	15.000
Virgen de la Concha de León (2 instalaciones)	Zamora	350	354,2	24.000
	León	487	506,0	22.000
Virgen del Castañar	Béjar	15	17,6	1.000
Sta. Bárbara	Soria	225	176,0	10.000
Santiago Apóstol	Miranda de Ebro	127	198,0	10.000
General Río Carrión	Palencia	380	440,0	24.000
Morales Meseguer	Murcia	400	202	15.000
Polideportivo Sabadell	Sabadell		348	20.000
Polideportivo Reus	Reus		451,5	20.000
Divino Vallés	Burgos	220	176	10.000

In general, the different developed projects are located in Hospitals and in Castilla y León Región. Moreover 2 projects have been developed in Catalonia and another one in Murcia. Some of them will be exposed later.

In Spain 3 pre-feasability studies have been carried out during the ST-ESCOs project development. In the following table the various studied project are presented.

Type	**Surface (m^2)**	**Location**	**Price (€)**	**Production (kWh)**
Hotel	75	Molina de Segura	41.260	41.960
Hospital	189	Murcia	129.310	145.705
Swimming Pool	50	Espinardo	27.828	26.829

All this projects have been studied thoroughly. The results show that each of them could be carried out as the incomes are enough to pay the installation and obtain a benefit from it for the customer and the ST-ESCO.

Finally, ARGEM has been working to start before the end of this project one of them. This agreement of Morales Meseguer Hospital Installation has been signed with the Regional Health Service and is now working and being studied.
Another agreement is being negotiated between Murcia´s University and the private company SOLSURESTE S.L to install a 75 m2 solar thermal installation. This project will probably be done with a final price of the sold energy of 0,07 €/kWh.

ARGEM has been working in doing that each project is finally real and consequently only 3 pre-feasibility studies have been done instead of 6-10. But on the other hand one contract has been signed and another one will be signed in brief.

“Sabadell” tennis club

The Sabadell´s Tennis Club solar thermal installation begun to sell energy at the beginning of 2006. This 20 m3 per day of hot water are dedicated to heat a Semi-Olympic swimming pool and to cover an important part of the hot water needs. This is the first known installation in Spain.

The facility is composed by 58 solar thermal collectors, Sunmax marl with a total surface of about 340 square meters. The technology and products are supplied by Solel Company that is represented by Pasch y Co in the Spanish market.

Annually, it will produce 277.000 kWh, which will be substituting the consumption of 31.500 Nm3 of natural gas per year. The facility will avoid emitting to the atmosphere about 70.000 kg of CO_2 per year.
Summary

- Yearly hot water demand (DHW + swimming pool) : 720,5 MWh
- Collector area: 348 m^2
- Yearly expected energy production: 868 kWh/m^2

The ST-ESCO (Pasch y Cia) contracted Aiguasol Enginyeria for designing the solar plant, and the system was installed by Fototerm. The duration of the contract is 12 years, and at the end of contract the plant becomes property of the end user, without any payment for this concept. The contract includes a minimum consume for the end user around the 85 % of the expected energy production. The energy consumption until 85% of the whole production has an established price. If consumption were higher the energy price is lower. Both prices are established in the contract. The billing is made monthly via a fixed quantity, and at the end of the year regularization is done.

The project was financed via the ICO (a state-owned corporate entity attached to the Ministry of Economy) and the IDAE (a public organisation reporting to the Ministry of Industry). These public entities have coordinated a financing plan to help the implementation of renewable energy sources and energy efficiency programs. The project also received direct subsidies from ICAEN (a catalan public organisation for energy policy)

Pasch is responsible for managing, operation, and maintenance of the system. Electricity consumption is charged to ST-ESCO.

Morales Meseguer hospital

The first ST-ESCO installation developed in Murcia, is located in Morales Meseguer Hospital. As mentioned before, 20 unities of WAGNER SOLAR LBM100 with 10 m^2 per solar collectors have been installed. This installation has been studied with TRANSOL software and is expected to cover more or less 46% of the whole hot water demand.

Three hydraulics circuits have been designed. The central circuit intends to isolate the solar installation from the heat water one in order to avoid problem related to Legionnella Bacteria. Moreover the whole price of the central part is less than in case the hot water went into these tanks as their quality can be lower.

This installation is totally controlled and a data acquisition system has been connected in order to study installation behaviour. For example it will be possible to know where the main heat losses are, which is the best tanks strategy or which is the best mass flow rate at a given radiation level.

7.4 Austria

An important goal of the project was to initiate new ST-ESCOs agreements. Crucial first steps towards this goal are to work out a basis for decision for the potential customers by means of feasibility and detailed studies.
The Austrian partners developed a structure for these feasibility and detailed studies and agreed them with the other project partners.

Many stakeholders have been contacted and some potential ST-ESCOs projects have been identified. Contacts with possible end users, ESCOs and technical actors (e.g. planners) have been ongoing until the end of the project.

In Austria, 7 feasibility studies and 2 detailed studies have been executed. As a result, three agreements were signed!
Although 7 projects were investigated, it can be said that there were only 6 pre-feasibility studies and 2 detailed studies (as one was immediately detailed; of course a pre-feasibility study could have been produced out of that, as well, but making no sense).

The Austrian studies and agreements for ST-ESCO projects are:

Solar thermal plant AEVG for the district-heating network in Graz

The customer is Steirische Gas-Wärme, an energy supply company from Styria. The ESCO is nahwaerme. The solar plant is financed by a BOT model (Build Operate Transfer). The planning, construction and installation of the plant is carried out by SOLID, Graz. This solar thermal plant feeds into the district-heating network of the City of Graz. The plant has a collector area of 5900 m² and a power of 3 MW.
The contract is signed and the realisation of the project is still ongoing. The plant will start running in the third or fourh quarter of 2007.

Solar system for the housing estate 'Berliner Ring'

In this residential area with 25 buildings and 756 apartments solar energy is installed in the framework of renovation measures. In total 2.400 m² collectors are planned to be mounted onto the roofs. In a first construction phase 479 m² were already installed.
The solar heat is directly fed into the distribution net of the houses and used for hot water provision (100% solar in summer) and for support of the heating system in spring and autumn. If the collectors deliver more solar energy than can be used in the houses themselves, then this excess heat is fed into the local heating network in the area over a second heat exchanger.
Total expected solar yield is 1,000 MWh per year. Compared to the old oil boilers 300 tons CO_2 per year can be avoided. The contract is signed and the project is implemented via an ESCO model.

Solar plant in the town Oberzeiring

The planning, construction and installation of the plant is again carried out by SOLID and the ESCO is nahwaerme. This plant supplies solar energy to a small scale heating net. The energy for this heating net is delivered from two biomass and two oil boilers at the moment. Oberzeiring is a little village in an alpine region (930 m above sea level) and has about 1000 inhabitants.
The solar plant will have a collector area of 408 m². The contract is signed. However, some problems in detail concerning the subsidies and the course of the pipelines remain to be resolved.

Solar system for "cheese washing" at Berglandmilch

The customer Berglandmilch is a dairy with a production of 15.000 tons cheese per year. The solar energy is needed for heating water from 12°C to 65°C for a "cheese washing" process. The demand of 96.000 liters/day of cheese washing water is equal

with an energy demand of 1.858 MWh/a. The dairy has an existing storage tank with 100 m³ which could also be used for the solar system.
In the feasibility study a solar plant with 1000 m² solar collectors is recommended. The solar yield of this plant is about 553 MWh/year.

Solar heat for the textile producer Wolford

The company Wolford AG in Vorarlberg is a textile producer. The solar energy will be used to prepare hot water for the dyeing process (heating up the water from 35°C to 76°C). The demand of 485 m³/day of hot water is equal with an energy demand of 7.741 MWh/a. An existing storage tank could be used for the solar system.
In the feasibility study a solar plant with 997 m² solar collectors is recommended. The solar yield of this plant is about 397 MWh/year. As a result of the low energy prices for this customer an ESCO model for the solar plant is unfavorable for the ESCO and the customer. It makes more sense to make a comprehensive energy service project with necessary energy efficiency measures and a solar system.

Solar cooling for the headquarter of a bank (Steiermärkische Bank)

The customer is a regional bank in Styria and the ESCO is the company CONNESS. For the headquarter of the bank in Graz a solar cooling system is planned to be installed as part of a comprehensive refurbishment of the building, including measures at the building envelope and housing installations.
The energy of this solar plant will deliver the heat for running two absorption cooling machines, with 105 kW cooling power each. The solar plant will have a collector area of 250 m² and a storage tank with 3 m³. The absorption chillers will be backed up with heat from the district heating net if the energy from the solar system is not sufficient.
The contract is an energy performance contract; the agreement is still not signed.

Solar energy for heating, cooling and hot water in the office and residential building 'Marienmühle'

The building is a combined office and residential building. A concept for using solar energy for cooling, for the support of the heating system and for the hot water provision was worked out. The solar system would have 200 m² collector area which would deliver 79 MWh per year.
Two ESCO models were worked out and compared. The customer is still in the decision process.

8 Achieved results and lessons learned

The ST-ESCOs project led to a grater visibility of solar heat service projects and contributed considerably to the market development of these services in all participated countries. The European collaboration proved to be very successful in order to establish a know-how network and to benefit mutual from the experiences made. The elaboration of the ST-ESCOs project shows that:

The **most important faults** that can be avoided in ST-ESCOs implementation are:

- *Positive aspects of TPF project implementation*

TPF solar thermal projects should not be seen as a rival concept against the conventional sales model. Rather, the concept of third-party financing is a good model for application where the conventional sale model is not possible from the customer's side.

- *Tele-monitoring*

A tele-monitoring system via modem or GSM module allows to control and optimize the plant functions and to always have current performance data of the plant as well as a data history. This system helps to increase the system performance (in terms of energy output) while reducing the costs for service and maintenance (since many tasks can be performed from the office); at the same time, possible malfunctions or bad operating conditions can be detected in advance.

- *Customer / owner topic*

If the customer is not the same person or institution as the owner of the building which bears the solar collector field, two separated contracts have to be signed, one with each person or institution. This procedure usually results in a longer and more tedious planning period for adjusting all the technical and juridical details.

- *Energy consumption profiles*

It is important to get knowledge as exact as possible about the energy consumption profiles on part of the customer. This includes heating (and possibly cooling) loads and hot water consumption over yearly and daily variations. It is indispensable to assume a realistic load profile which accounts for both daily and seasonal changes. This data has great influence on the design and the layout of the solar system, and thus is crucial when it comes to the system efficiency and the long-term operating conditions. Another topic which is often given too little attention: the supply and return temperature levels have to be exactly defined in advance, i.e. in the heat supply contract.

- *Solar system provider*

This is definitely the most important topic to point out: the company which provides the solar system must have the necessary experience in design, construction, installation and operation of the plant, since the entire technical and economical risk is on their side. As mentioned before, all system components must be durable in time, although exposed to high temperatures. Quality in installation, construction, operation and optimization of the system are crucial.

The **most important lessons** learned in ST-ESCOs implementation are:

- From the practical experiences of the project it proved that it is necessary to raise the awareness and to arouse the interest for (large scale) solar plants – nobody needs per se an ESCO model. The question how to realize a project – with or without an ESCO model – is the second step of the project implementation.

- The crucial capability of ESCOs and especially ST-ESCOs is their technical know-how. Only a solar company able to guarantee a technologically mature and smoothly operating plant can offer the necessary energy output needed to assure an economically advantageous system and provide long-term operating and economical stability to the customer

- Although third party financing is an important motivation for many customers, financing is not the key business of ESCOs. They offer financing of the investment, or the arranging of the financing, as an added value and as a marketing instrument, but usually ESCOs do not earn money on financing.

- It is also crucial for a successful implementation of a solar thermal ESCO project to have a close connection to a small local financing institute which are preferable to large financing institutions.

- In many cases it makes more sense – from a technical and an economical point of view - to combine solar energy with a comprehensive energy efficiency or rehabilitation project. In this case also smaller solar systems will become possible and economically feasible.

- Independent advisors like energy agencies can play an essential role in opening the market for ST-ESCOs. The experience shows, that the availability of ESCO-independent advice through energy agencies reduces the entrance barrier of customers considerably.
  They provide consultancy, practical support and a broad technical background to customers, thus acting as a neutral advisor. They supply standard materials and guidelines. Energy Agencies can also take over the role of a neutral project controller and advisor in conflict situations. They do monitoring and project evaluation (if the customer has no personnel resources to do so) and they communicate experiences and best practice projects.
- In any case, especially on RES projects, it is necessary to be supported by various legislative and fiscal initiatives, such as the End-Use Energy Efficiency and Energy Services Directive, Subsidies, etc.

In all participated countries and in higher (Austria) or lower (Italy, Hellas) level some readiness for ESCO type solar projects existed already in the beginning of the action, but the project significantly increased it and more potential customers and relevant stakeholders know now about the possibilities of ST-ESCOs

In total, there have been completed 23 feasibility studies and 9 detailed studies in Hellas, Austria, Spain and Italy. Altogether 5 agreements have been achieved in the participating countries, while 2 more are under negotiation and there is one more offer from EBHE (Hellas) in order to realize a project of 200 m^2.

Furthermore, in the context of the project two new ST-ESCOs were founded in Austria, Solar.Nahwaerme, a company specialized in applications combining biomass and solar thermal power and Solar.graz, a subsidiary company of Energie Graz, is specialized in combinations of solar thermal plants and district heating networks.

	Number of carried out feasibility studies	Number of carried out detailed studies	Progress of agreements
Hellas	7 studies	2 detailed studies	One case on the preparatory phase for agreement and one case from EBHE to realize a project of 200 m^2
Austria	6 studies	2 detailed studies	Three signed

			agreements
Spain	3 studies	2 detailed studies	One signed agreement and one towards signing
Italy	7 studies	3 detailed studies	One signed agreement

Table 2 ST-ESCOs studies elaborated and agreements' progress

The ST-ESCOs partners and project website www.stesco.org will continue to provide support and information and will continue to offer their services to interested customers for the further exploitation of ST-ESCOs. ST-ESCOs II project proposal is also seriously under consideration.