

WP 1.1: Background study – CRES

1 Definitions

1.1 What is an ESCO and what an ST-ESCO

Main sources for the current chapter are [IEA DSM, Task X–Hellas, 2003] and [Butson, 2001].

As a starting point, some existing definitions for the ESCOs are given (obviously, they include the case of Solar Thermal ESCOs).

The first definition is taken from the “Proposal for a Directive of the European Parliament and of the Council on energy end-use efficiency and energy services” as it has been communicated from the General Secretariat of the European Union Council to the Delegates, the 23rd September 2004 ([Directive Proposal, 2004]).

"Energy service company" (ESCO): a company that delivers energy efficiency measures in a user's facility, and accepts some degree of technical and sometimes financial risk in so doing. The payment for the services delivered is based (either wholly or in part) on meeting quality performance standards and/or the achievement of energy efficiency improvements.

It is also interesting to see the (following) definition of “Energy Service” from the same source since it offers some clarifications on the same issue.

"Energy Service": the physical amenity for energy end-users derived from a combination of energy and energy using technology and/or the operations, maintenance and control necessary to deliver the service (examples are indoor thermal comfort, lighting comfort, domestic hot water, refrigeration, product manufacturing, etc.). Energy services meet quality performance requirements and improve energy efficiency, are contracted for a fixed period of time and paid for directly by the customer or agent who benefits from them.

It is also useful to report here the definition given by the (United States) National Association of Energy Service Companies (<http://www.naesco.org/meminfo.htm>):

“An ESCO, or Energy Service Company, is a business that develops, installs, and finances projects designed to improve the energy efficiency and maintenance costs for facilities over a seven to 10 year time period. ESCOs generally act as project developers for a wide range of tasks and assume the technical and performance risk associated with the project.”

As seen from the above, an ESCO provides not only the finance but also the technical expertise and experience to implement the energy performance project and also operates and maintains the plant that is installed for this reason. The ESCO may be independent of both equipment suppliers and energy utilities, and so is free to choose the best technical and commercial options for each client. However, some equipment suppliers, construction groups and utilities may act as ESCOs, or may be closely associated with them. In some cases, especially where the projects are large, the

ESCO can be a specially created joint venture company involving (for example) an equipment manufacturer, a construction company and a finance provider.

An ESCO is capable of offering a “one stop shop” service to the client covering typically the following stages of a project:

- **Project Preparation** : identification and appraisal of projects (e.g. technical feasibility studies), followed by definition of the project and preparation of a technical specification and financial plan at the level needed to secure funding;
- **Project Funding** : provision of finance for capital investment and (if appropriate) initial operating costs, generally through grants and/or loans from different sources (the ESCO may also provide all the funding from its own resources, which may include its retained profit and global loan facilities that it has negotiated with a bank or parent company);
- **Design and Construction** : all aspects of project implementation (design, specification, procurement, installation, commissioning) to the point of handover of the new plant to the operator (in this case the ESCO will also be the operator);
- **Operation and Maintenance** : management and operation of the energy services (generally both old and new plant);
- **Revenue and Profit** : collection of revenues and generation of the expected return on capital employed.

The options available for operating contracts in general include:

- **Build, Operate and Transfer (BOT)**, in which the contractor constructs and operates the facility for a specified period. The client pays the ESCO a fee, which may be a fixed (e.g. monthly) sum, linked to output (e.g. energy sales) or, more likely, a combination of the two. The fee will cover the operators fixed and variable costs, including recovery of the capital invested by the contractor. In this case, ownership of the facility rests with the End User;
- **Build, Own, Operate and Transfer (BOOT)**, which is similar to BOT except that the contractor owns the facility up to the point of transfer. In practice, this is the most common form of operating contract;
- **Build Own and Operate (BOO)**, in which the contractor constructs the facility and then operates it on behalf of the End User. The initial operating period (over which the capital cost will be recovered) is defined, but there is no requirement to transfer ownership to the client at the end of that period. As an alternative to transfer, a further operating contract (at a lower cost) may be negotiated.

In all of these cases (including TPF) the contractor provides a wide range of different resources, including manpower, technical expertise, project finance, operating experience and all the associated management and commercial skills. Since the contractor is responsible for operation as well as project implementation, performance guarantees are inherent in the approach. If the contractor does not provide the service

(defined in terms of specific standards such as room temperatures, volumes of domestic hot water etc.) he does not get paid, and indeed may be required to provide an equivalent service using an alternative facility at his own expense.

The above definitions and analysis present some ambiguity in terms like the degree of financial risk (or the percentage of the investment) that has to be undertaken by an ESCO. Therefore it is useful to make some clarifications and restrictions that are specific to the ST-ESCOs (and the nature of their contracts) that the current project should deal with. More specifically, the ST-ESCOs agreements that we are looking for should have (among others) the following characteristics:

1. Although it is possible for the End-User to undertake a part of the initial investment, this has to be restricted (e.g. 20%).
2. Apart from the possible (restricted) initial payment, the End User pays for the energy that receives. The ST-ESCO has responsibility to provide the heat in the price agreed with the End User; this price does not depend on the solar gains. However, the price (as it has to be defined in the contract) may be subject of some restrictions that the End User has to fulfil (like a minimum load).
3. The plant to be built according to an ST-ESCO agreement, may include some energy saving measures or some energy sources other than solar; however, the percentage of the thermal load covered by the solar plant, at least in the case of hot water production¹, has to be important (the exact minimum percentage is still to defined and may depend on the final use; a possible value could be 50%).

2 Selection of material from the worldwide experiences

2.1 ESCOs state of art

This paragraph is dealing with the *state of art* of the Energy Service Companies (ESCOs) in general (i.e. not specific on solar thermal). It is a short presentation; the sources for the text that follows are mainly [Bertoldi, 2003] and [Vine, 2003].

The results of a worldwide survey outside the United States [Vine, 2003] have shown that the number of ESCOs in each country varies, ranging from just a few ESCOs (e.g., Belgium, Nepal, Thailand, and South Africa) to over 50 (e.g., Brazil, Germany, Korea, and Switzerland). Based on the survey data, the total amount of ESCO activity outside the U.S. in 2001 is calculated to be between \$560 million and \$620 million.

¹ In the case of space heating delivery the percentage of the load covered by the solar plant may be quite restricted; otherwise it is difficult to reach favorable economic conditions.

The development of the ESCO industry is still in its infancy in many countries. On the other hand, in a few countries (e.g., Canada, Sweden, and the United Kingdom), ESCOs were created in the late 1970s and early 1980s. However, most ESCO activity occurred in the late 1980s and 1990s and the creation of the “first ESCO”, for some countries, is continuing today.

In what concerns the United States, there is a substantial growth of ESCOs. Recent studies have examined the growth and potential market for the ESCO industry in the United States (Goldman et al. 2002; Vine et al. 1999). For example, based on an a database of nearly 1500 case studies of energy-efficiency projects, it was estimated that ESCO industry revenues for energy-efficiency related services in the U.S. ranged from \$1.8 to \$2.1 billion in 2002 and that ESCO revenues increased at an average annual growth rate of 24% during the last decade (Goldman et al. 2002).

Coming to Europe, the European Commission has been promoting the ESCO concept since the mid 80s, through legislation, pilot projects and other promotion activities since it has always considered ESCO as a central player for the promotion and implementation of Energy Efficiency.

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 European Energy Service Companies’ (ESCOs) market has been estimated to be 150 million Euro per annum in 2000, while the market potential has been estimated to be 5 to 10 billion Euro per annum [Bertoldi, 2003].

There is a big difference in ESCOs’ activities among EU Member States. Table 1 bellow, shows the ESCOs activities in some EU countries.

EU Country	Date of first ESCO	Number of ESCOs	Total Value of ESCO Projects in 2001 [USD (\$)]
Austria	1995	25	\$7 million
Belgium	1990	4	Unknown
Germany	1990-95	500-1,000	\$7 million
Sweden	1978	6-12	\$30 million
UK	1980	20	Unknown

Table 1. ESCOs activities in some EU countries. Source [Vine, 2003]

In what concerns the sectors that are targeted by ESCOs, Table 2 summarizes the results of Vine’s survey at a worldwide level.

Sector	Key Countries Targeting This Sector
Industrial	The highest percentage of ESCO activity within a country is in this sector for many countries. For example, ESCOs in Bulgaria, Egypt, Kenya, Philippines, Thailand, and Ukraine targeted at least 70% of their activity in this sector.
Commercial	Many ESCOs targeted 10-40% of their activity in this sector. ESCOs in India, Japan, and Mexico targeted at least 50% of their activity in this sector.
Municipal	ESCOs in several countries targeted this sector. In particular, ESCOs in Austria, Canada, Czech Republic, Hungary, Italy, Lithuania, and Poland targeted at least 50% of their activity in this sector.
Residential	Many ESCOs did not target the residential sector. ESCOs in 7 countries targeted at least 10% of their activity in this sector, including Nepal (30%) and South Africa (15%)
Agricultural	ESCOs in only two countries targeted this sector: Estonia, and South Africa.

Table 2. Sectors Targeted by ESCOs. Source: [Vine,2003]

2.2 Barriers and opportunities for ESCOs development

The main source for the following text is [Vine, 2003].

There exist some persistent **barriers** that inhibit many cost-effective energy-efficiency projects and prevent the full development of the ESCO industry internationally. From Vine's survey, the key categories of important barriers were found to be the following: financing, perception of risk, information/awareness/knowledge, expertise of energy performance contractors, access to energy-efficiency equipment and technology, administrative, reliability, and credibility/confidence/trust. In addition to these barriers, the respondents mentioned the following key barriers that are more policy related: lack of governmental policy and leadership on energy efficiency and ESCO industry; low cost of electricity and other energy carriers; lack of budgeting and standardized public procurement rules, contracts, procedures, and guidelines for ESCO services; large economic and political uncertainty; conflicts with other government policies; unfavorable tax regimes; and lack of an existing legal framework for protecting the interests of customers.

Nevertheless, important opportunities exist for the ESCO projects development since there are numerous advantages resulting from their implementation. Some of those opportunities and/or advantages have been identified by [Task X, 2003] and are listed below:

1. In many cases there is a concrete high savings potential, often between 20-40%. Case studies have shown occasional energy savings up to 50%. About 1,600 cases in the US NAESCO database point at average savings of 23% of the total electricity bills and of 47% for lighting-only projects.
2. The public sector seems to present a high potential for ESCOs implementation. In fact, substantial energy savings are possible in many public

buildings, especially in municipality buildings and ESCOs seem to be the solution for the realisation of those savings.

3. The ESCO can contribute financial solutions when there is a lack of necessary funds in the building owner's organisation.
4. There is a clear demand for more efficient heating and air conditioning in the services sector. Again, ESCO seem to be the right tool on this direction.

Some particular opportunities for the End –User are listed bellow:

- More rapid implementation than in a “conventional” energy project implementation.
- Transfer of management responsibility to ESCO.
- Better quality and reliability of energy services.

Finally, the profit for both parts (ESCO and Final-User) is an obvious opportunity for the sector's development.

2.3 Positive Policy examples for ESCOs

The source for this paragraph is [IEA DSM Task X, 2003].

Table 3 provides a summary of different policy measures for selected countries examined in IEA DSM Task X and for the EU.

	<i>Fin-land</i>	<i>France</i>	<i>Italy</i>	<i>Japan</i>	<i>Nether-lands</i>	<i>Nor-way</i>	<i>Swe-den</i>	<i>USA</i>	<i>EU</i>
Government programmes & policies:									
Procurement adaptation								X	X
Public buying	X	X	X	X		X	X	X	
- Work out standard contracts	X	X	X				X	X	X
- Energy audits	X	X		X	X	X			
- Energy agency or equal facilitating	X		X	X	X	X	X	X	
- Compulsory regulations			X						X
- Financial mechanisms		X		X	X		X		
Subsidies	X	X	X	X	X				
- Tax benefits			X						
- M & V								X	X
- Changes in laws			X	X	X			X	
- Information	X	X	X	X	X	X	X	X	X

Table 3. Overview of national government EPC programmes & policies. Source [Task X, 2003].

Basic information for policy examples of some countries is given bellow.

In *Finland*, subsidised energy audits for buildings are an important action. About 5,000 such energy audits have been carried out. Tax incentives have not been used, but a 10 per cent subsidy on implementation costs is available.

In *France*, the SOFERGIE firms have initiated certain measures to implement energy efficiency programmes. They specialise in the financing of investments generating

energy conservation. A large programme for CHP (Combined Heat & Power) introduction has been very successful. A new national programme for energy conservation, FIDEME, has been launched. The French agency ADEME, the Caisse des Dépôts et Consignation and the Dutch bank ABN-AMRO are involved in this programme.

Different models of subsidies are introduced or considered in *Japan*. These subsidies, which can be about one third of the cost, are promoting the introduction of high-efficiency energy systems in houses and buildings and for local energy conservation efforts.

In *The Netherlands*, Novem has been operating a large and ambitious Energy Efficiency and Environment programme for a number of years. Many initiatives have been taken in efficient equipment labelling.

In *Norway*, the energy taxes were doubled between 1997 and 2001, but then lowered again. Investment subsidies and trade with energy certificates are being considered, and the new energy organisation ENOVA SF has been established.

In *Sweden*, the use of standard contracts and demonstration projects is being discussed within the Swedish Energy Agency. The possibility of providing a government guarantee for EPC activities is also being investigated.

In the *United States*, there are a number of federal initiatives, and state programmes have been introduced in the form of clarification of procurement rules, and actions to enable government and state organisations to enter into long-term contracts up to 25 years. Many actions have been taken with guidelines etc. in order to facilitate the use of EPC contracts. Other federal programmes of interest include programmes run by the Army Corps of Engineers, the "Energy Star" and "Rebuild America" schemes. Many states have established a Systems Benefit Charge (SBC), and at least four states have developed standard performance contract documents.

An EU Directive for the Energy Performance of Buildings has been adopted in the European Parliament and Council and it came into effect as of January 4th, 2003. The Directive includes measurements of energy, methodology, minimum standards and energy certificates. Member governments are in the process of developing and stimulating the use of performance contracting, including the provision of government information.

2.4 ST-ESCOs state of the art

The ST-ESCOs state of the art in the partners' countries is presented in the country reports. As can be seen in these reports, Austria is the country with the richest experience on ST-ESCOs among the participants. In what concerns countries outside the consortium, it seems that there is no source available for the specific category of Solar Thermal ESCOs as in the general case of ESCOs. Therefore, only some limited information is available for the moment.

A well documented case is that of **France**: the fact of having many breakdowns of solar thermal systems in the end of 80's has been the driven force for creating the well

known GSR (Guarantee of Solar Results). A technical pool (consultant, installer, manufacturer and operator) sign a 4-5 years contract of “guaranteed results” (under certain conditions) with the consumer.

In particular [Adnot, 2003], during the verification phase (1 year), the installation must prove its capacity to supply the amount of energy guaranteed. If this is not the case, the pool must improve the installation at its own expense. During the confirmation phase (3-4 years), the stability of installation’s productivity will be checked. If it is not the case at the end of the contract, the team must compensate financially the client in relation to the deficit in solar energy supply.

[Adnot, 2003] refers to some a few cases where “ Third Party Financing is associated to GSR in order to constitute a Solar Results Purchasing (SRP) contract. In this way, a customer can use a solar system without any investment or risk. Therefore, the client pays for a package “kWh + O&M” to the ESCO in charge of the project until the return on the capital investment (with interests) is achieved.”

However he considers the ESCO case far more complicated and less frequent.

It is expected that in countries with numerous large solar plants installed (from hundreds to thousands m²) there should be some examples of ST-ESCOs implementations. Among these countries we mention Germany, Sweden and Denmark as those having the largest plants. However, the ST-ESCOs examples and experience in those countries is subject of a further research that has not been done yet.

3 National Background

3.1 Legislative, financial, contractual and marketing framework

Note: main sources for chapters 3.1.1 and 3.3.4 are [Task X–Hellas, 2003] and [Butson, 2001].

3.1.1 Related legal background in the public and the private sector for TPF and ESCOs. Insurance schemes required.

Following the basic goals of national energy policy for a) the secure energy supply at a reasonable cost, b) the enhanced market competitiveness and progressive liberalization c) the environmental quality improvement and d) the independence from external energy factors, the government has been engaged to adopt activities that include :

- The drafting and issue of legal acts,
- The design and implementation of pilot and subsidy programme actions,
- The introduction of upgraded energy management infrastructure,
- The implementation of structural subsidy programmes for the rational exploitation of indigenous energy sources including Renewable Energy Sources (RES), for the

broad promotion of Rational Use of Energy (RUE), for the penetration of natural gas to all end-energy uses and for the application of cogeneration of heat and power (CHP).

The Hellenic government has especially recognized the large and increasing magnitude of energy consumption and the high energy saving potential of especially the public building sector. From 1997 onwards, following the provisions of EU SAVE Directive 93/76/EEC, a specific focus has been given on the stimulation of TPF/EPC mechanism for energy efficiency investments in the public building sector (for energy efficiency, CHP and solar heat supply investments in hospitals and pools of public administration buildings). The general analysis of energy use in public administration buildings indicates that up to 30% energy savings can be achieved if an overall energy management strategy is adopted and appropriate energy conservation measures are implemented on the basis of well organized auditing, monitoring and targeting activities. The procedure for the implementation of energy saving or/and alternative and efficient energy supply measures in public administration facilities should refer to a considerable life cycle economic and environmental benefit as well as to the subsequent quality of offered services and to human comfort. Existing structural deficiencies of Hellenic public budgeting favour the option of EPC when deciding for public investments in energy efficiency. A distinction must be pointed out between the regime of state-owned and of rented public administration buildings. Possible proposals for EPC/TPF projects must be primarily oriented to proprietary public buildings administrations.

In relation to the national energy efficiency policy and specifically for Energy Performance Contracting, the legal framework includes:

- Two circulars of the ministry for public administration (1997) and the joint ministerial decision (JMD) 21475/4707 on the reduction of CO₂ emissions via improved building energy efficiency (1998), which have introduced the TPF/EPC option in the public building sector within a mandatory, well defined energy management procedure with complete energy auditing, monitoring and targeting actions.
- An infrastructure study assigned by the ministry of the environment regarding the organisation of energy management offices and the specification of the TPF mechanism procedures for energy saving investments for the public building administration, on the basis of JMD 21475/4707/98 mandates.
- An informative guidebook introducing EPC/TPF for public buildings which has been elaborated by the work team of MIPAD and CRES in order to be delivered among public administration energy management units.

- The implementation of OPC (Operational Program of Competitiveness) 2000-2006 Actions 2.1.1 (design, promotion and support activities) and 2.1.4 (public sector part) of the OPE 2000-2006, as detailed in the OPC Programming Supplement, which foresee the design and application of a special financial support scheme for the performance of energy investments (RUE/CHP/RES) in the public sector via the mechanism of TPF/EPC provided from private ESCOs
- Elaboration and public presentation of the final draft and of complementary documentation on the new Law on *"TPF of Energy Investments for Energy Saving, Cogeneration & Independent Generation of Electrical or/and Thermal Energy from RES"* (2001). This Law, when issued, will establish formally the TPF mechanism and primarily the framework for ESCOs operation in Hellas for the performance of private sector investments (including investment subsidy opportunities from the EU 3^d Community Support Framework for Hellas-Operational Programme for Competitiveness (OPC) 2000-2006 / Actions 2.1.3, 2.1.4 for the private sector energy (RUE/RES/CHP) investments, or from other financial aid source). This Law will not tackle in particular the open topic of guaranteed energy saving contracting process in the public sector, but it will be relevant to public sector EPC as it will establish legally the ESCO business in Hellas.

3.1.2 Principles and structure of existing contracts

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 were only concerned Solar Thermal applications along with upgrading of thermal installations (piping insulation, heat exchangers, etc).

In two of these (industrial applications) attempts CRES:

- was responsible for the telemonitoring equipment design / procurement, as well as for issuing the «solar bills» for the first one. For this project the role of the ESCO was played by the Solar System manufacturer (SOLE LTD).
- played the role of the ESCO

Apart CRES, only two companies (SOLE LTD and SOL ENERGY HELLAS Inc.) have made efforts in order to act as ESCOs. The first company (the solar manufacturer) has participated as an ESCO on the first project mentioned above. 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 monitored performance of the systems.

The structure of the existing contracts is:

- 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, a third, independent party, in this case 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 third project (industrial) 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"*. Below the main elements of the contract are presented.

The project was developed in three phases

1st Phase

- Preparation and Signing of the Contract between ESCO and the Industry
- Call for tenders for the procurement of the equipment
- Final project study

2nd Phase

- Installation of the system
- Installation of the metering equipment
- Pilot operation of the system

3rd Phase

- Acceptance of the project
- Execution of measurements
- Corrections and fine tuning of the system
- Efficient operation of the system
- Final report

For this project 3 contracts were signed. These were:

- 1st Contract: Agreement between ESCO and Industry
- 2nd Contract: Agreement between ESCO and System Producer
- 3rd Contract: Contract for Energy Auditing and System Maintenance

1st Contract's main Articles

Disagreements and other Fiscal Issues

1. In cases of force majeure the obligations of the two sides will be postponed until the end of the events and within a period of 60 days
2. Both sides they have the right to denounce the contract with prior notification to the other side in cases such as:
 - a. default of obligations without the possibility of their correction
 - b. delayed payments, etc.

Contract Termination

1. With the normal termination of the contract the equipment comes to the proprietorship of the client
2. In the case of the contract denouncement the client has the obligation to buy the equipment at the real cost of the equipment subtracting the payments made from him

Transfer of Rights

1. Both sides have the right to transfer or sell their rights to a third party as long as the other party will be notified at a reasonable time and as long as that third party is competent and trustworthy

Assurance from the Client

1. The client guaranties that:
 - a. he will operate his machinery as he was until the beginning of this contract,
 - b. he will provide to the ESCO accurate and honest data and information,
 - c. he will provide an annual check guaranty equal to the remaining cost of the system until its repayment.

2nd Contract's main Articles

Scope of the Contract

1. Commission, Construction, Installation and Efficient Operation of the Solar System.

Installation of the Equipment

1. The System Producer has the responsibility to construct and install the system as it is described in the final study and to achieve the predicted supply of solar energy and within the time frame agreed with this contract.
2. When the system will build and installed will be monitored in order to verify the expected energy supply.

3. In the case that the system provides less than 20% of the expected energy supply the producer has the obligation to correct the installation at his own expenses.

3rd Contract's main Articles

Scope of the Contract

1. Technical Auditing and Maintenance of the System

Obligations Description

1. The client takes the responsibility of the auditing and preventively maintenance of the system and to notify in time the ESCO for any problems of the system where the client can not deal with.
2. The cost of the necessary actions to be taken within the scope of this contract from the side of the client will be cost and the ESCO will be notified in time in order to approve the cost.

Contract Duration

1. The duration of the contract starts with the signing of the contract and terminates with the full repayment of the system.

3.1.3 Preliminary identification of appropriate financial institutions. Related financial schemes and requirements usually adopted.

The most appropriate financing institutions are of course banks or other similar institutions such as insurance companies. In some cases utility companies could play this role. In some other cases the finance of the projects comes from the equipment suppliers (solar companies, heating plant companies, etc).

Up to now, since financing institutions are not yet actively involved on ESCO schemes and TPF projects, no specific financial schemes and requirements have been adopted.

In one of the projects CRES played the role of the ESCO. For another industrial project the finance came from a loan (Hellenic Bank of Industrial Development – ETBA). The guaranty of the loan was the contract itself.

In another case, the project was financed from the Solar System provider.

3.1.4 Identifications of the reasons for the weak development of ST-ESCOs up to now as well as the remaining barriers.

The pure ESCO industry in Hellas may be considered negligible and stable for the present. The proposal for a directive of the European Parliament and of the Council 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.

Although it is found that the size of the yearly energy bills of Hellenic public administration buildings together with the big potential for energy savings with proven energy technologies of relatively low overall pay-back times enhance the introduction and implementation of TPF mechanisms, there are still several potential barriers in the Hellenic market that delay the successful deployment of the TPF mechanism in the national market.

In Hellas, 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 legal consolidation of ESCOs
- The project financing, investment, design, construction and insurance mechanism
- Not direct economic benefits for the end-use service budget (re-allocation of public funds irrelevant to energy savings)
- Diffusion and confusion of responsibilities within public authorities for the procurement, services, works and maintenance regarding the building infrastructure
- Legal and tax problems arising from TPF implementation
- Lack of institutional regulations (e.g. where a public building owner is not its user) and warranties regarding the cooperation between TPF experts' actors.

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

3.2.1 Quality and monitoring

Quality

A list of the currently (April 2005) applicable standards is included in Appendix I. Although the standards of Annex I are not mandatory, manufacturers are voluntarily adhering and applying for certification of collectors, in order to be eligible for grants and loan guarantees. Another advantage for manufacturers is the possibility to be listed in a public database.

Finally, 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.

Monitoring

The monitoring procedure adopted in Hellas follows the standard “ISO/WD 9459/5. Solar heating - Domestic water heating systems - Part 5: System performance characterization by means of whole system testing and computer simulation.”

In case there is formal need to certify if an existing monitoring equipment is working correctly, then a laboratory with the following certification should be involved: “ISO/IEC/EN 17025 (formerly ISO Guide 25 & EN45001) “General Requirements for the Competence of Calibration and Testing Laboratories”.

Important aspect:

Looking for the maximum certification of the monitoring procedures, cost could be very high. Therefore, there is need to search for practical methods in order to reduce the cost still having the necessary accuracy in the measurements.

Billing

There is no standard procedure for billing the solar energy in Hellas. The available national experience (as it can be seen later in the existing applications description) offers two similar billing examples:

- In the first example, the price of the solar kWh was equal to the cost of the kWh produced by the cheapest conventional fuel available (a continuously updated value).
- In the second example, the price of the solar kWh was equal to the 80% of the conventional cost of the thermal kWh for the End User (this was also a continuously updated value).

The relation between solar kWh cost and End-User consumption is also an interesting point. Figure 1 offers an applied example.

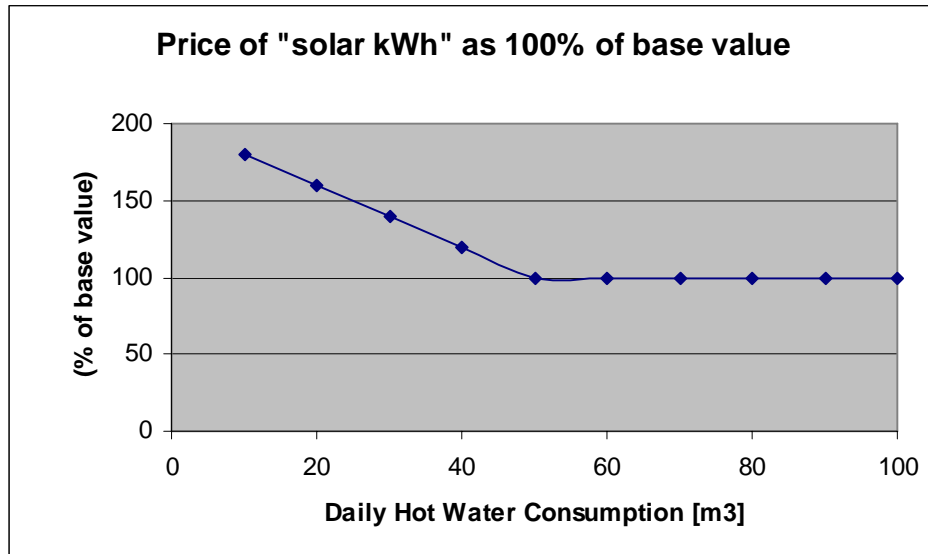


Figure 1. Solar kWh price in ACHAIA CLAUS as a function of End-User's consumption

3.2.2 Appropriate technology for ST-ESCOs

The most suitable solar technologies should have the following characteristics:

- a) Proven and robust technology
- b) Economically affordable
- c) As flexible as possible in the installation, disinstallation and modification.
- 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).

Follows a short analysis based on the above points.

In order to achieve the above characteristics solar plants should have the following characteristics:

- 1) Design principles similar to the successful European plants, especially those called large-scale solar heating plants (more than 100 m² of collectors area). Some of the basic principles are following:
 - a) Use of flat plate collectors if temperature needs do not exceed 100° 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 m² -already present in middle and Northern Europe- or at least 6m² if there are no larger in the local market) that minimize the installation time and cost 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*m²) instead of 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 Figure 2; the similarity of two plants with a large size difference is evident.

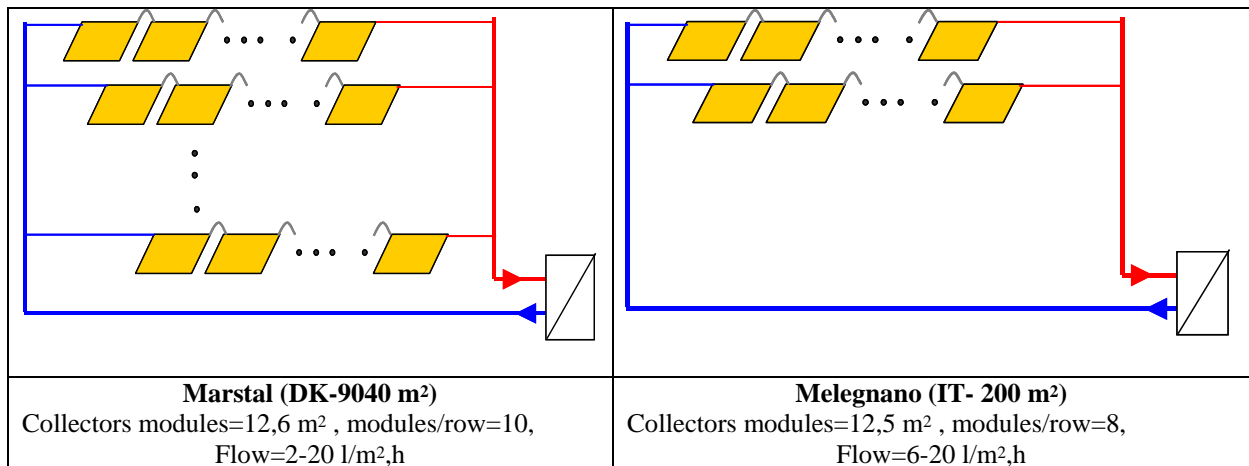


Figure 2. Similarity of the characteristics for two “Large” but different size plants

- 2) Available material for design guidelines and maintenance
 - a) PROCESOL II (coordinator CRES) (both maintenance and design guidelines for solar thermal in industrial aspects; a lot of material is common and can be applied to Large solar thermal plants in general), (En)
 - b) Solar –supported heating networks in multistory residential buildings, (A planning handbook), AEE INTEC, downloadable
 - c) Ambiente Italia: Design and maintenance guidelines; downloadable, in Italian

3.2.3 Software tools available

1. For solar plants simulation the following programs are known: TRNSYS, TSOL, POLYSUN, f-chart, 3M. From the Hellenic side, TRNSYS, TSOL, f-chart and 3M are available; T-SOL being considered as the most appropriate for the purposes of the current project. Additionally, TSOL offers the possibility for a quite detailed economic analysis of the solar project.
2. In what concerns optimisation tools, the following are available:
 - a. Hook and Jeeves (algorithm in FORTRAN for up to 12 parameters, PhD A. Aidonis) used for the optimisation of the flow rate of the Large-scale solar heating plants. Can be adopted for other purposes with medium effort.
 - b. A quite flexible and complete optimisation tool owned by CRES, RES Direction; however this tool seems to be appropriate mainly for scientific data elaboration.

3.3 Case studies

3.3.1 Applications

MEVGAL S.A.

Mevgal S.A. is a dairy industry situated in Northern Hellas (between Thessaloniki and Giannitsa). Its main industrial activity is the production of dairy products (butter, cheese, butter milk, etc.). Steam is required by the various dairy processes of the plant (pasteurization, sterilization, evaporation and drying) and hot water is required for the operation of the Cleaning in Place (CIP) machine of the factory, which is used to clean and disinfect the utensils and machinery of the factory. Originally, steam was provided for by steam boilers running on heavy oil, which were fed cold water from the water supply grid. The water requirements of the steam boilers are about 75m³/day.

The plant (installed in 1999) consists of two solar thermal systems. The first system consists of 216 m² flat plate collectors with a black paint coating, located on the roof of the factory office building connected in series with 108 m² CPC collectors. The closed-loop primary circuit of the first system has two vertical, parallel, 5000 liters, closed solar storage tanks located in a specially designed room adjacent to the boiler room of the factory. The water-glycol mixture of the primary circuit heats the water in the solar storage tanks via flat-plate heat exchangers. The hot water produced by the solar system is used to pre-heat the water entering the steam boilers of the factory. The second system consists of 403 m² tube-fin, flat plate collectors with a selective paint coating, located on the roof of the cheese factory. The closed-loop primary circuit of the second system has two horizontal, in series, 2500 liters, closed solar storage tanks located on the roof of the cheese factory. Once again, flat-plate heat exchangers are used to heat the water in the solar storage tanks. The hot water produced is used to either feed the CIP machine or the solar storage tanks of the first system.

The solar plant is only a part of an installation which includes a heat recovery system from the steam boilers blow-down. Thermal energy savings are split as follows: 30% from solar and 70% from the blow-down heat recovery system.

The project was financed (with a TPF scheme) in the frame of a national programme (Operational Programme of Energy 1994 – 1999) and CRES was the contractor of the project. The bodies of project implementation were CRES and MEVGAL S.A. Subcontractor for the installation of the whole system was the company Intersolar S.A.

The operation and maintenance of the system has been arranged by a private agreement between CRES and MEVGAL S.A. Based on this agreement, CRES has the responsibility of system's monitoring, operation, service and energy measurements. Once the payback period has been completed, the system will become exclusive property of the End-User. The contract agreement sets the kWh_{th} price to be

equal to the cost of the kWh_{th} produced by the cheapest conventional fuel available (a continuously updated value). The total TPF investment for the whole application (solar plant and heat recovery measure), was about 130000 €. The mean annual energy savings are about 900 MWh and the price for each MWh equal to 25 € (in year 2005).

Table 4 presents main data of Mevgal project.

Data	Description
Dairy	MEVGAL is one of the largest dairy industries in Hellas
Year 1999	Starting operation year
75 m ³ /day	Mean consumption of hot water
727 m ²	Collectors area installed
30%	Is the percentage of savings that come from solar (the rest 70% is from the blow-down equipment)
Price of kWh	It has been defined equal to the cost of the kWh produced by the cheapest conventional fuel available (a continuously updated value)
4 months	Is the billing period

Table 4. Main data for MEVGAL application

ACHAIA CLAUS

Achaia Clauss S.A. is a winery situated on the outskirts of the city of Patras. Its main industrial activity is the production of red, white and rose wine. Hot water (60–75 °C) is required for the washing and sterilization of the bottles in the bottling factory. The hot water consumption of the bottling process is 50 m³/day. Originally, the hot water was provided for by a steam boiler running on diesel fuel, which heated the water in two parallel, horizontal, 3000 liters storage tanks (via a submerged heat exchanger) located in the boiler room of the plant according to the needs of the bottling process.

A solar system was installed in 1993 and consisted of the following items; 308 m² sandwich-type, flat plate collectors coated with black paint located on the roof of the winery; closed-loop primary circuit with an open expansion vessel and two (2) parallel, horizontal, 3,000 liters, closed solar storage tanks located on the roof of the winery. The water heated by the solar collectors was circulating in a closed loop and was heating the water in the solar storage tanks via submerged heat exchangers. Anti-freeze protection was provided on very cold winter days by activating the pump and circulating the water when the temperature dropped below a certain limit. The hot water leaving the solar storage tanks was fed to the two, original storage tanks where the auxiliary heating of the water was provided for by the steam boiler. A re-circulation branch had been included which consisted of a hydraulic branch connecting the solar storage tanks with the original storage tanks. When the water in the solar storage tanks was exceeding the temperature of the water in the original storage tanks a pump was activated, which circulated the hot water from the solar to the original storage tanks.

The system operated for 6 years yielding a mean performance of 300 kWh/year/m². One of the reasons for such a low solar yield was the poor insulation of the tanks.

Due to administrative and financial difficulties of the company, the necessary maintenance work on the system was not carried out and this inevitably led to corrosion problems and inefficient operation of the system. In 1999, the system has been shut down due to the severe corrosion problems encountered (25% of the collectors have either cracked glass covers, deformation of the plastic collector frame or rusting of the absorber plates).

The installation was financed with a TPF contract, whereby the user paid no money for the installation of the system, but paid the manufacturer the amount of energy supplied by the system on a monthly rate, based on a fixed rate per kWh decided upon before the installation of the system. A third, independent party, in this case the Centre for Renewable Energy Sources (CRES) undertook the monitoring of the system, which determined the energy supplied by the system. When the user paid the initial investment of the system back, the system became its exclusive property.

Table 5 presents main data of Achaia Clauss project including main aspects for billing the solar energy.

Data	Description
Wine	Achaia Clauss is an important wine industries in Hellas, Patras
SOLE S.A	The construction company had also the role of ST-ESCO.
Year 1993	Starting operation year
1999	End of operation
50 m ³ /day	Mean consumption of hot water
308 m ²	Collectors area installed
Solar-only	No other renewable or energy saving technology has been applied
Price of kWh	It has been defined equal to the 80% of the conventional cost of the thermal kWh for the company (a continuously updated value)
oil	The conventional fuel used

Table 5. Main data for ACHAIA CLAUS application

3.3.2 Best Practice examples

One successive example from Hellas is presented together with other 3 applications in the participating countries. All cases are presented separately (in an A4 format each) in the deliverable “Info-sheets”.

3.3.3 Lessons learned

Since the available experience on ST-ESCOs contracts is still limited in Hellas, only few “lessons learned” are currently available.

1. There must be a guarantee in an ST-ESCOs contract in the case the End-User is unable to pay (e.g. bankrupted). This problem could be overtaken with a “Bank Guarantee” initially provided by the End-User.

2. The responsible for the maintenance (one of the ST-ESCO's Company) should have relatively easy access to the plant (e.g. up to 100 km distance). Delegate this responsibility to a third person is possible only if he is an expert on solar thermal plants. The same is valid for the operational responsibility: count on a third person (e.g. a technician from the End-user) for crucial technical operational aspects, could generally create problems.

4 References

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Appendix I

List of applicable standards

EN 12975-1: Thermal solar systems and components – Collectors

Part 1: General Requirements

EN 12975-2: Thermal solar systems and components – Collectors

Part 2: Test methods

EN 12976-1: Thermal solar systems and components – Factory made systems

Part 1: General requirements

EN 12976-2: Thermal solar systems and components – Factory made systems

Part 2: Test methods

EN 12977-1: Thermal solar systems and components – Custom built systems

Part 1: general Requirements

EN 12977-2: Thermal solar systems and components – Custom built systems

Part 2: Test methods

ISO 9806-1 (1994) – Test methods for solar collectors

Part 1: Thermal performance of glazed liquid heating collectors including pressure drop.

ISO 9806-2 (1995) – Test methods for solar collectors

Part 2: Qualification test procedures.

ISO 9806-3 (1995) – Test methods for solar collectors

Part 3: Thermal performance of unglazed liquid heating collectors (sensible heat transfer only) including pressure drop.

ISO/DIS 11924 – Solar heating -Domestic water heating systems

Part 4: Test methods for the assessment of protection from excessive temperatures, pressures and potable water contamination.

Other relevant standards:

ISO 9459/1 – Solar heating domestic water heating systems

Part 1: Performance rating procedure using indoor test methods.

ISO 9459/3 – Solar heating domestic water heating systems

Part 3: Procedures for system component characterisation and prediction for yearly performance using component performance data.

ISO/WD 9459/4 – Solar heating domestic water heating systems

Part 4: System performance characterisation by means of component testing and whole system simulation.