Input WP 1.1 GEA and nahwaerme

1 Introduction

1.1 What is an ESCO and what a ST-ESCO

The objective of ESCOs is to improve the effectiveness of energy management in order to achieve measurable economic effects while taking care of the quality of the environment. ESCOs come in where energy is wasted either due to the awareness of it, or due to the lack of finance for modernisation measures required. Yet, it should not be interpreted literally: for a professional ESCO, the slogan „the worse things look, the better for us" does not apply. On the other hand, it is difficult not to admit that the greater the losses, the greater the savings are; this entails smaller investment risk, shorter payback period, and, consequently, lower costs of the investment.

While using ESCO's services one has to remember that the company is not a charity organisation intending to solve one's problems with energy efficiency for the sake of protecting the environment. ESCO is a commercial entity and, as such, acts according to the rules of the market.

Its success is conditioned by the implementation of the most effective projects ensuring the shortest possible cost return time. Work on each project is preceded by an in-depth energy audit aimed at the estimation of the current level of the losses and the identification of the optimum measures for technical infrastructure modernisation. Also of the possibility of balancing the investment costs with the planned financial savings in case of Energy Performance Contracting is analysed. The cost reduction effect does not apply solely to the field of energy efficiency. Such measures are also possible in other sectors. However, the lack of knowledge of possible saving methods very often strongly limits local governments' interest in modernisation processes.

The objective of ESCOs is to improve the effectiveness of energy management in order to achieve measurable economic effects while taking care of the quality of the service. Energy services that include financing schemes make a rational energy utilisation possible.

ESCO projects can be applied in different fields:

- reduction of energy costs
- optimisation of heating and air conditioning
- high efficiency lighting
- efficient motors

- improvement and modernisation of buildings
- reduction of CO2-emissions etc.

The offered services of ESCOs are:

- Investment and financing
- Consulting and design
- Operation management, maintenance and troubleshooting service
- Bearing of the economic and technical risk
- Operation-, performance- and cost- guarantee
- Installation
- Bidding

There are a lot of possibilities which services an ESCO offers for a project. The main parts are the guarantees, to bear the risks and the operation management and maintenance.

Basically two Types of contacting-models are used:

- Third Party Financing for heat and/or electricity delivery
- Energy Performance Contracting

There exist different types of services but they have some aspects in common:

- a comprehensive service package is provided (including planning, installation of facilities, maintenance, plant operation, financing, monitoring etc.)
- they use the saved energy costs as a source of income to provide the financing for the investments (Energy Performance Contracting)
- they guarantee a certain service level for the energy facilities or the whole building

Benefits for the client are:

- Reduce medium and long-term energy costs
- Upper limit of energy costs is guaranteed
- Realisation of energy savings without employing it’s own capital
- Modernisation of buildings and/or technical facilities
- Increase of comfort, working conditions etc.
- Reduction of CO2- and pollutant-emissions
- Outsourcing of the technical and financial risks to the ESCO
- No longer has to handle support and maintenance services themselves

In addition, the society gains benefits from the resulting reduction in environmental pollution and from the stimulation of the regional economy.

1.2 Why to promote ESCOs and why an EC project on ESCOs

Energy services like Third Party Financing offer a lot of benefits for customers. However, the full potential is still not tapped and a lot of persuasion is necessary to start new projects.

One important reason why energy services are not used to a greater extent is that customers, building owners and decision makers are not well informed about energy service companies and the concept of performance-based contracting. There is still a lack of confidence in the functioning of such models.

Besides high quality offers target-oriented marketing activities are required to make ESCOs better known and to convince potential clients. The objective of ESCOs is to improve the effectiveness of energy management in order to achieve measurable economic effects while taking care of the quality of the service. Energy services that include financing schemes make a rational energy utilisation possible.

Goals of such activities are:

- To improve the knowledge of potential clients and decision makers about ESCOs
- To help start new projects with target-oriented information and persuasion

1.3 Why we need a background study

In Austria Third Party Financing is a well established instrument to increase the energy efficiency in buildings. About 40 ESCOs offer energy services for public or private building owner. A long range of projects have been implemented so far. It is really necessary to know the hole background, to reach the different target groups and to promote ESCOs. It is recommended to use different instruments.

On the one hand general information about energy services is required to make the related models and services known. On the other hand personal and direct marketing activities are necessary to initiate concrete projects.

Decision makers and multipliers play an important role in establishing energy services and should therefore also be considered.

2 World-wide experience on ESCOs

INITIATIVES FOR MARKET DEVELOPMENT in Austria

2.1 Programs of the federal government

Program “klima:aktiv”

The climate protection program "klima:aktiv" (more information: http://www.klimaschutz2004.at/article/archive/594), lead by the Federal Ministry for the Environment, has been commenced on the federal level in 2003.

The central instruments included in the climate strategy (subsidies, fiscal political measures etc.) are supported and completed by the klima:aktiv program. Klima:aktiv will change the technology and service market in a specific and sustainable way in the sense of the climate protection.

The klima:aktiv goals:

- To lower the energy consumption and support the CO2 neutral energy use
- Improvement of the start chances and increase of the market share of climate protecting products and services
- Strengthening of the business location Austria: future oriented and innovative
- Activation and networking of the important actors

The strategy

klima:aktiv programs last over several years and are comprehensive collections of co-ordinated actions in one topic field with the goal to make climate protecting Concerning Contracting models three programs have already started the Contracting-Initiative for Austria's Federal Buildings, the program Ecofacility and the program solar:wärme.

The project “Contracting-Initiative for Austria's Federal Buildings” is headed by a co-operative association of the Federal Ministry for Economy and Labour (BMWA), the Federal Ministry for Land and Forest Management, Environmental and Water Management (BMLFUW) and Bundesimmobiliengesellschaft (BIG), the federal real estate agency. In the past, energy-saving investments in federally owned buildings often had to be postponed in favour of urgently necessary repair measures. The federal government was not able to provide the budgetary funds in the required amount at short notice. For numerous buildings, the operating maintenance has been eliminated for cost reasons this project has been started to avoid this.

After nearly two years project management, remarkable results can be seen. For about 100 buildings suitable ESCOs were already found. Average savings of 20% of the

annual energy costs are guaranteed for these buildings within the contract period (ten years). More information: http://www.bundescontracting.at

Ecofacility is an initiative of the Austrian Ministry for Agriculture and Forest Management, Environment and Water Management. The management of the program was taken over by the Austrian Energy Agency, which carries it out in co-operation with several partners (like e.g. Graz Energy Agency). The middle-term and the long-term objective of the klima:aktiv - program Ecofacility is to improve the quality of reconstruction in private service buildings and to lower the operating costs in these buildings effectively.

The main emphases of the proposal are:

- creation of a network of qualified contracting consultants
- information and marketing activities for target groups
- setting quality standards for enterprises of contractors
- improving organisation within public building administration in order to facilitate contracting projects
- linking the Impulse Program with the promotion of contracting in private sector service buildings through a regionally organised program on raising environmental awareness.

A lot of projects could be realised successfully within Ecofacility see: http://www.klimaaktiv.at/index-programme.

The program solar:wärme started 2004. The action program solar:wärme involves a several years lasting program in Austria with defined main points. The aim is to reach an average increase rate of 18 % of the yearly installed solar thermal collector area from the year 2004 till 2010. More information http://www.klimaaktiv.at/index-programme

2.2 Related EU projects (especially those where some of the consortium partners have participated

EnergyProNet

Aim of EnergyProNet is to stimulate the market for energy services and to support mediators (like energy agencies and similar institutions) who play an important role as facilitators of energy service projects.

EnergyProNet was initiated within the SAVE-Project „Best Practice of Energy Services in Public Buildings – from Pilot Projects to Market Penetration“, supported by the European Union.

More information under http://www.energy-pro.net

IEA-DSM TASK X

The objective of this project work is to facilitate the use of performance contracts and other energy service company (ESCO) contracts. Performance contracting is, in some markets, a well-established mechanism for promoting the installation of energy efficient building equipment and systems. For example, facility owners and energy service contractors use this method to retrofit equipment to save money on building operations. The savings in energy bills due to the installation of this more energy efficient equipment is then shared between the facility owner and the ESCO under the terms of the agreement they entered. In this scenario, the ESCO has taken on the project's performance risk by guaranteeing a specified level of energy savings. Its compensation for this risk is directly tied to achieving savings. The financing for such a project could come from the ESCO, the equipment supplier or a third-party company.

More information under: http://dsm.iea.org/NewDSM/Work/Tasks/10/task10.asp

Soltherm

Soltherm is the central action network to stimulate market growth of solar thermal products. All European campaigns and actions that contribute to this goal can participate and thus support the EC's Kyoto targets for CO2 emission reduction.

More information under: http://soltherm.org

Optisol

Within the scope of a width test the „OPTISOL" know-how transfer project is aimed – ten optimised solar-supported heat networks are implemented for storied residential buildings – on the one hand at housing associations and on the other hand especially at the expert planners involved and companies performing the work (facility management planners, architects, plumbers and plant operators). In this respect the focus is not just to see the solar plant as an individual component but rather to optimise the overall energy supply system in a holistic manner and to define a model plan of procedure for other projects. Apart from the successful motivation of housing associations, the identification of the expert planners with the technology in question has proved itself to be a decisive factor for success. More information under: http://www.hausderzukunft.at

Ship

Ship is a project for

- Evaluation of the potential of solar process heat in participating countries
- Integrating solar thermal systems into industrial processes

- Collector development and optimisation (up to 250 °C)
- Numerical models for solar process heat applications
- Monitoring of pilot plants

Further information under: http://www.solarpaces.org

3 National Background

3.1 Legislative, financial, contractual and marketing framework

Economic potential

In Austria many public buildings (federal, county, municipal) are suited for energy services.

During the last years the financial scope of municipalities has become very little. The Maastricht criteria do not permit a new public indebtedness of more than three percent of the gross domestic product (BIP), as well as a total indebtedness of the public budget more than 60 percent of the BIP. According to type and the classification of the municipal task, investments influence the public indebtedness and the public deficit. To raise a loan to invest in projects increase the indebtedness of the public hand, whereas leasing agreements are not shown up in the indebtedness. Therefore, the municipalities try to avoid financing structures by loan. Thus, new organisation and financing structures have to be considered. The transfer of municipal tasks to private service providers represent itself as an alternative financing model. The integration of private capital and private know-how provides that municipalities do not have to invest with public money anymore. An immediate realisation of projects and a greater attraction for efficient economics are forced. The organisational relief of the public administration acquires remarkable cost savings.

Legal framework

The secure, sustainable, and socially balanced supply of energy has been a focus of Austrian energy policy for the last two decades. The permanent promotion of renewable energy sources and the enhancement of a rational utilisation of energy are the basic strategic aspects of this policy. The positive development is to be attributed also to a traditionally high level of environmental consciousness of the Austrian population, having supported the concept of energy efficiency and an enhanced utilisation of renewable energy sources.

Awareness of a global climate change as a result of greenhouse gas emissions lead to a series of activities in respect of climate protection in the 90ies, culminating in the

agreements concluded within the framework of the Kyoto-protocol. Austria has actively participated in the negotiations for the Kyoto-protocol, both on UN-level and within the European Union, and has undertaken to reduce emissions of the six "Kyoto-greenhouse gases" (CO2, CH4, N2O, H-CFC, CFC, SF6) by 13 % by the target period 2008 to 2012 as compared to the 1990 values.

In order to attain this ambitious goal, the National Council adopted an "Austrian Climate Strategy 2008/2012"(http://www.accc.gv.at/englisch/e-strategie.htm, combining the efforts on the part of the Federal Government and the Laender into a co-ordinated strategy. The Climate Strategy is the basis for different special programmes.

In Austria the legal framework conditions for contracting projects are the same as for every other legal contract. However, difficulties can occur by awarding performance contracts. The law of public procurement regulates the award of contracts by contracting authorities on the basis of a ”model approach”. In case of a private purchaser, the project in question can be negotiated and awarded without the obligation to observe the provisions of the law of public procurement.

The measures taken in connection with a more efficient supply and utilisation of energy are various and diverse. This results in a variety of different implementation "models" and consequently leads to a range of different goods and services offered. This in turn determines the type and number of the parties involved, the required contracts and the types thereof, the financing terms, etc.

General Legal Framework For Awarding Contracts

In particular in Germany and Austria, a number of energy service projects have been implemented in the field of public administration. There are still some uncertainties.

The general legal framework for contract awarding by public clients can be assessed as „predominantly positive". On principle, the regulations for awarding contracts do not provide any obstructions for the use of energy services by public clients. There are certain „problem areas", however, such as classifying Third Party Financing projects within certain categories of orders. It is therefore recommended that attention is paid to the relevant legal framework during the organisation of the project.

Law of public procurement

The law of public procurement is the dominating law within the legal framework conditions for Energy Performance Contracting (EPC) and Third Party Financing (TPF). At least public authorities, who want to increase the energy efficiency of their buildings and who were the main target group for EPC and TPF until now, have to follow the rules of law.

However, among public authorities the phenomenon of legal uncertainty frequently occurs with regard to the award of performance contracts. The law of public procurement regulates the award of contracts by public authorities on the basis of a "model approach". In the case of a private purchaser, the project in question can be negotiated and awarded without the obligation to observe the provisions of the law of public procurement.

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Market situation

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 CO_2 reductions of 600.000 to 700.000 t per year.

In Austria, EPC and TPF are a well established instrument 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. 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 was reached. Innovative technologies and renewable energies are integrated and a pooling of different buildings takes place.

Up to now there are about 40 ESCOs in Austria. 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

In Austria the regional and the national energy agencies played a crucial role in the development of energy services and small 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). Except in one region, no direct subsidies from public money have been allocated to EPC projects. Instead, public money has been used for information and marketing activities and for advice to potential EPC customers (Seefeldt 2003).

Building owners and administrators got increasingly convinced that EPC and TPF are helping them in solving day to day problems in facility management. The focus has therefore been on competent advice on how to use the EPC/TPF approach in practice. Especially the energy agencies play a crucial role in the market development as they are seen as neutral advisors. Furthermore 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. It is estimated that at least 20 % of the operation costs can be saved. A market analysis showed that the CO2 emissions of private service buildings can be reduced by 520.000 t/year by means of conventional remediation, EPC and TPF. At the same time approximately 2.500 full time jobs can be created (klima:aktiv)

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

Existing contracts

The heat supply contract is one of the core pieces of the contractual work of a solar thermal ESCO. This contract is concluded between the customer (the end-user of the solar energy) and the operator of the plant. The usual term of a TPF contract is between 15 and 20 years.

In the following, the main features that a heat supply contract should contain are stated. This is divided into technical, economical and miscellaneous items. The energy supply contract also needs to include references to other relevant contracts, or it encloses these other contracts as annexes. See the "Miscellaneous part" for details.

Technical part

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.

First of all, 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.

Economical part

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 to adjust 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.

Miscellaneous part

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). See the "Technical part" for details.

It is strongly recommended to sign at least a 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.

Barriers

From nahwaerme's experience with TPF projects, the lack in relevant dissemination activities towards all parties involved can be denoted as the main barrier that complicates the implementation of such projects on a broad basis. In many cases, both the end-user and the financing institute lack sufficient know-how about the state-of-the-art in solar thermal technology and about the technical and economical maturity that large solar thermal plants show today. This fact is even more important as TPF projects are to be implemented in new markets by companies lacking references, or if a company already owning reference projects wants to enter new markets with a possibly different technical framework. The most important topic to be addressed by a company on a sound technological level remains to convince the financiers. Usually, the solar company is required to assume the full technical responsibility for the solar plant!

The technical and the economical barriers should be faced jointly: 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.

In many countries, the local price for fossil fuels and thus for district heating is still very low – in some cases supported by special subsidies. Even very good solar thermal plants with low investment and low operating costs have difficulties for being competitive when compared with heavily beat-down fossil fuel prices.

Large solar thermal plants are usually supported financially by some kind of subsidy. The subsidies may stem from a regional, a national or an European source, and therefore the extent of the subsidy that becomes effective for a project may vary quite heavily. On the long term, however, solar companies can not always count on subsidies to aid in the project implementation. Actually, as the prices for fossil fuels rise and solar thermal technologies become more widespread, it is more realistic to count with a decrease in subsidies for solar thermal projects. This is clearly an obstacle towards the implementation of TPF projects on a broader basis.

Some juridical aspects have to be removed in order to enable the implementation of a TPF project. The ownership structure of the building bearing the collectors must be checked to allow for the solar plant remaining the property of the solar company. In many countries, the legal conditions are such to convert all objects firmly fixed to a building (e.g. the solar collectors fixed on the roof) to the owner of the property. This would make it impossible to install a TPF project with the solar plant remaining in the solar company's property.

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

Quality and monitoring

In Austria no special monitoring certifications are officially required for the implementation of a TPF project. The only topic which has to be handled with some care is the choice of the heat meters utilized for the measurement of the plant's energy output. These heat meters do not only have to be positioned in the correct spot, they are also required to be officially calibrated according to an appropriate standard.

Benchmarking

Of course, it is always advantageous to employ components which bear some kind of quality certification, e.g. local environmental labels, or to choose products being manufactured according to some ISO certification, e.g. ISO 9001. The benchmarking of technologically similar solar thermal projects in terms of kWh per m² collector area might be a good approach to the comparison of different companies. A good benchmarking value for several plants requires a steady quality control and can thus be interpreted as a quality characteristic for the solar company.

Tele-monitoring

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. See section 3.2 "Software tools" for details.

Standardization of measurement and verification protocols

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.

Appropriate technology

General remarks

A minimum collector area of 200 to 300 m² is advised for TPF solar thermal projects. Thus, large scale solar collectors with high efficiency and long-term stability in efficiency should be used.

Large-area solar collectors…

- Allow quick mounting, dismounting and transport; they are thus more economical
- Reduce heat and pressure losses
- Must use absorbers with selective coating

The collector field should be designed for low flow rates, as this allows minimizing the dimensions of pipes and pumps and thus reduces system costs. Series connection of several large collectors helps to reduce or avoid problems of bad flow distribution (see “Hydraulic connection”). The correct dimensioning of all pump work is an essential topic.

If roof-integrated collectors are chosen, then attention has to be paid to the planning and the design of the buildings bearing the collectors. The orientation of the buildings should be orientated south-east to south-west, and if several subfields are installed on several buildings, the buildings should stand close together in order to minimize pipe length and to maximize energy output.

Other design conditions include:

- The flow in the collectors should not be too low; otherwise laminar flow might occur in the absorber leading to a drastically reduced heat transfer to the heat transport medium.
- Take care for high temperature durability of all parts possibly exposed to steam (during system stagnancy).

- Use high-quality metals and stable constructions for the collectors' substructure.

Pre-assembling

As many system components as possible should be pre-assembled by part of the solar company; this includes first of all the pump units.

The pre-assembling…

- 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

Hydraulic connection

In short it can only be said: Keep it simple! This is true for all solar thermal plants and all the more for large systems financed by TPF. It is strongly preferable to rely on simple proven hydraulic schemes than to experiment with some highly sophisticated connections planned to increase the energy output by a few percent, if this increases the risk of system malfunctions or if it increases the cost for operation and maintenance.

One of the most important topics (and one of the most frequent system failures) is an even flow distribution through all solar collector subfields. If the flow velocity is too low, the fluid becomes too hot, so the collector efficiency and the energy output drop, and this decrease in energy output is directly linked to a reduced financial income for the ESCO.

Control system

A focus must be set on the control of modern solar thermal plants; a sophisticated control system has several tasks.

It is required to…

- increase the system's energy output
- indicate possible malfunctions (e.g. leakages)
- help to avoid failures by advanced warning on bad system values (e.g. too high pressure drop in a heat exchanger may indicate upcoming troubles…)
- contiguous control system components such as the temperature levels of district heating, energy output of the backup system, energy delivered by the boiler, etc.

No modern control system can go without the possibility to be remotely controlled. A tele-monitoring and tele-control system is important to help optimize the energy output and reduce maintenance costs. See section 3.2 “Software tools” for details.

Operation and maintenance guides

It must be taken for granted that a guide for operation and maintenance of a solar thermal plant must be available in all companies offering solar thermal systems and in solar thermal ESCOs if they provide service and maintenance for the plants. The content of such a guide reflects both the thoroughness and the experience of the ESCO.

Software tools

With the implementation of several successful third party financed and numerous large-scale directly-sold solar thermal projects in Austria nahwaerme has gathered valuable technical and economical know-how. Based on this know-how, so far it has not been necessary for nahwaerme to employ special simulation tools such as T-Sol or TRNSYS for large scale solar plants. However, without any doubt the use of a TRNSYS calculation for simulating the behavior of a large solar thermal plant under different customer and climatic conditions could be a valuable tool for improving the system dimensioning and the design of various system components.

Up to now, nahwaerme has not made use of TRNSYS for its everyday project implementation due to the increased engineering costs. Rather, nahwaerme has relied on its own Excel tools for calculating basic technical data such as pressure drops or economic cost effectiveness. These tools do definitely not present the best approach to the optimization of the plant technically along with a good method for increasing the economic efficiency. In this area, some improvement in the available software tools should be achieved, keeping in mind that all kind of software must pay off within one project, i.e. the economic and / or technical advantage stemming from the software must be higher than the possible increase in the engineering costs.

For billing purposes, no special software is used for nahwaerme’s solar thermal TPF projects. Attention has to be paid upon the positions in the hydraulic pipe work where the heat meters are mounted. Afterwards, billing can be done with the help of the tele-monitoring system with the use of a simple excel sheet. Again, we see possibilities for improvement in this area, keeping in mind that possible software tools for billing via remote access must be reliable and robust.

Tele-monitoring system

A tool which has shown to be of good value in order to increase the energy output, decrease the cost for operation and maintenance and prevents possible malfunctions is a tele-monitoring and tele-control system.

A tele-monitoring system that provides remote monitoring and control of important solar plant parameters helps to insure that unwanted system conditions can be detected early and can be corrected prior to detrimental system malfunctions. This provides both system security and improved solar energy output. The tele-monitoring system assists in increasing system security, optimizing energy output and reducing costs for the operation, service and maintenance of the plants, since many adjustments can be done from the office without the need of sending technicians to the spot. In case of malfunction of the solar system, the control system can actively send out warning messages to ensure a quick readjustment.

The tele-monitoring system should include the potential for data storage. The objective is to provide a constant record of key system data such as temperature and energy curves which gives the opportunity to perform a deeper analysis of the system and thus enhance the optimization process. The data storage feature could include the possibility to download the stored data locally through an internet connection to the tele-monitoring system.

3.3 Case studies

Arnold-Schwarzenegger-Stadium Graz

The solar plant at the “Arnold Schwarzenegger Stadium” Graz (Austria) was put into operation in June 2002 and can be considered as the pilot project of feeding solar thermal energy directly into a district heating system. From the technical point of view, the main reason for the construction of the solar system was to develop and optimise the engineering for feeding solar energy into an urban district heating net. As a result, this solar plant is Europe’s Premiere for solar district heating.

Technical aspects

The solar collectors were mounted on a steel substructure on the roof of the skating hall of the Arnold Schwarzenegger Stadium in Graz. The collector area of 1,407 m² is arranged in 11 rows, each bearing 9 collectors in series. The employed collectors are 14.3 m² large area flat plate collectors of the type “Gluatmugl”. These collectors are especially designed for high temperature use, which means that they have increased insulation in order to lower heat losses below approx. 3.0 W/m²*K. The gained solar

energy output reaches about 560-600 MWh per year (Graz has a yearly solar radiation of 1130 kWh/m²).

The district heating net in Graz has a minimum consumption of 10 MW also in summertime, and this solar plant reaches a maximum output of about 800 kW. The solar energy is directly transmitted to the heating net by an external heat exchanger. Large storage tanks are not necessary due to the constant energy consumption. Concerning CO2-emissions, this plant saves about 250 tons CO2 a year when compared with an oil fired boiler with a total efficiency of 70 %.

Economical aspects and partners

The plant is operated and financed via a third-party financing model. This pilot project is moreover supported by the city of Graz, the Steirische Wirtschaftsförderung and the Kommunalkredit Austria.

The project was developed in collaboration of the following 3 partners:

- S.O.L.I.D. Gesellschaft für Solarinstallation & Design mbH
- nahwaerme.at Energiecontracting GmbH & CoKG
- ÖkoTech Produktionsgesellschaft für Umwelttechnik mbH

S.O.L.I.D. was responsible for the design and the construction of the plant. The company nahwaerme.at took over the financing and operation of the plant by a third-party financing concept. The collectors were produced and mounted by the company ÖkoTech (Graz), they received the Austrian Environmental Award.

As this project is based on a third-party financing model, the operating company nahwaerme.at took over the total costs of construction including the integration in the district heating net. The operating costs of the solar plant (e.g. maintenance, power etc.) are also taken over by the operating company.

Between the company nahwaerme.at and the stadium administration a user agreement for the roof was signed. Also, between nahwaerme.at and the Grazer Stadtwerke (district heating section) a heat delivery contract concerning the feeding of solar heat into the district heating net was signed. The duration of the contract is 15 years with an option of prolongation.

Project development

The first concept of this project was made by the general managers of S.O.L.I.D. Gesellschaft für Solarinstallation & Design mbH, nahwaerme.at Energiecontracting GmbH & Co KG and ÖkoTech Produktionsgesellschaft für Umwelttechnik mbH at the beginning of 2001. Then first contacts to the energy and environmental referee, the stadium administration and the district heating section of the Grazer Stadtwerke

(non-ST ESCO running the district heating system) were established, followed by contacts to financial support institutions. After promise of financial support by the state of Austria and the city of Graz the detailed planning began in autumn 2001. The project was promoted from the beginning by the energy and environmental referee of the city Graz. Due to the good co-operation with the partner companies and subcontractors, the construction of the plant was finished by mid of June 2002.

Solar plant "Berliner Ring"

The "Berliner Ring" is a residential area in Graz-Ragnitz (Austria). It consists of 25 multi-storey buildings which comprise 756 apartments. Before the installation of the solar system, hot water preparation and heating were entirely done by fuel oil. The total consumption amounted to about 1 million of light fuel oil per year. Yet, the reasons for the construction of the plants are not only economical (high consumption of fossil fuels with the old system), but also include economical and environmental aspects.

Technical aspects

On the roof of selected buildings of the "Berliner Ring" residential area, a solar thermal plant was constructed. A second part of the plant is currently yet under construction, and a third part is in the planning phase. The completed part of the system amounts to 479 m². When completed, the collector area of the solar system totals approx. 2600 m². The system is then expected to deliver approx. 1 GWh of solar thermal energy to the district heating net per year. The same amount of energy would free approx. 375 tons of CO2 when supplied with an oil fired boiler with a total efficiency of 70 %. Primarily, the solar plant feeds the local district heating system; in the case of surplus energy available from the collectors, the solar output is fed into the large-area district heating system of the city of Graz.

Economical aspects and partners

The plant is operated and financed via a third-party financing model. The project was developed in collaboration of the following 3 partners:

- S.O.L.I.D. Gesellschaft für Solarinstallation & Design mbH
- nahwaerme.at Energiecontracting GmbH & CoKG
- ÖkoTech Produktionsgesellschaft für Umwelttechnik mbH

S.O.L.I.D. was responsible for the design and the construction of the plant. The company nahwaerme.at took over the financing and operation of the plant by a third-party financing concept. The collectors were produced and mounted by the company ÖkoTech (Graz), they received the Austrian Environmental Award. As this project is

based on a Third-Party-Financing Model the total investment costs for the construction including the integration in the district heating net were borne by the operating company nahwaerme.at.

Project development

The energy supply in the district heating net is provided by the company Wärme-Direkt-Service (WDS) of the Energie Graz (the local non-ST ESCO). WDS takes the energy either from nahwaerme.at or from the large-area district heating system of Energie Graz.

Heat supply contracts are signed between nahwaerme.at, Energie Graz and WDS. In these contracts, the details regarding the feeding of the district heating nets are laid down. Moreover, a contract is signed with the homeowner community in order to manage the usage of the roof areas.

Installation of a solar plant - Friedrich Schiller dormitory, Austria

Name and Data of the building concerned: Friedrich Schiller dormitory, Elisabethstr. 85, 8010 Graz, 72 sanitary rooms

Period covered: 15 years

Main actors involved in the implementation of the project (Contractor, Client)

Contractor: WDS

Client: Friedrich Schiller dormitory

Technology involved / Investment costs: Installation of solar collector, and installations for the domestic hot water heating system.

Amount of financial resources involved / Investment costs: 93.430 Euro

Innovative aspects: the hot water is charged per m^3 to a fixed price and there is a guarantee for the solar yield (kWh/m^2*a).

Energy Savings: 2540 Euro per year

CO2-Reduction: 9 t/a

Additional Remarks: The overall evaluation is very good and it was only possible to realise the project with a TPF model. The key element of success was the enthusiasm of the student's representative.

3.3.3 Lessons learned

This section shall only give a brief summary of the most important lessons learned in the past successful nahwaerme ST-ESCO projects and some traps to be avoided. Some of the most important faults can already be avoided by following the guidelines and remarks stated in the above sections.

- *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.