



SDHplus

Solar District Heating in Europe

WP2 – SDH enabling buildings with high energy performance

Solar district heating and high energy performance buildings

Summary report, January 2015



Co-funded by the Intelligent Energy Europe
Programme of the European Union

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INTRODUCTION

Energy performance requirements for new buildings and renovations are continuously increasing in EU countries, thanks to two EC Directives: the recast of the European Building Performance Directive and the Directive for the promotion of renewables. Both law provisions foresee a key role also for renewable energy sources (RES) heat obligations, requiring minimum shares of renewable energy to be set for heating and cooling of buildings.

District heating (DH) is one effective way to satisfy these performance requirements. Moreover, DH is an effective energy measure not only for new buildings or settlements, but also in case of renovation of larger residential areas (e.g. social housing or urban districts), where the direct improvement of the energy performance of the buildings, through e.g. improved insulation, can be sometimes difficult and costly.

First of all, this document reports information on how the two EC Directives have been implemented at national level in 12 EU countries and on the consequences (opportunities and barriers) for district heating, with a specific focus, when available, on solar district heating (SDH).

Then, in the second part, some business models for SDH in high energy performance buildings and settlements will be described, also reporting on how these models have been developed and replicated in some of the countries participating in the SDHplus project.

Main acronyms used in the document

DH: district heating

DHC: district heating and cooling

SDH: solar district heating

ST: solar thermal

CHP: combined heat and power (cogeneration)

RES: renewable energy sources

1. Legislation framework

This chapter is a summary of the main conclusions and outcomes of a much wider study carried out within the SDHplus project. The full document “*Survey of national frameworks*”, is available on the project website at the following address:

<http://www.solar-district-heating.eu/Documents.aspx>

1.1. Solar district heating and calculation of energy performance of buildings

This part describes how, in the partner countries of the SDHplus project, solar district heating can be accounted for in the legislation on energy standards in buildings, in particular in the calculation of the energy performance factor.

Limits and opportunities are shown country by country, as well as potential improvements and suggestions for modifications are reported. In spite of the national differences, one general remark that should be done is that, most of the times, the energy and environmental benefits of using solar thermal, especially in a district heating system, are not adequately taken into account in the calculation method.

A detailed description of the calculation method used in the different countries (“*Relevant national building and DH legislation per country*”) is available on the SDHplus website (<http://www.solar-district-heating.eu/Documents.aspx>).

Country	Limits and opportunities for solar district heating
AT	The primary energy factor from DH is advantageous due to the connection with CHP, waste heat and biomass. Solar thermal only slightly influence a building’s total energy efficiency.
CZ	ST, as all RES in DH, allows to reduce primary energy factor. The existing legislation also sets minimum efficiency requirements for energy systems including solar systems.
DE	A low primary energy factor is important for DH operators, as it is needed to fulfil the law requirements for refurbishment or new construction and also to reach the optional but subsidized KfW building standards. Solar thermal energy, which has a zero primary energy factor, helps reducing the factor of a DH grid. However, the generally low primary energy factors of district heating systems with CHP imply that already a high share of the German existing district heating systems reach compliance with the standards as they are. The practical calculation shows nonetheless that the combination of solar thermal and CHP is needed in order to achieve the better KfW standards.
DK	There are no immediate opportunities to take the SDH in the calculations. However the 0.6 factor foreseen for DH in 2020 requires further expansion of RES.
ES	The current methodology for energy efficiency in buildings does not explicitly include SDH. The most important barrier for the evolution of SDH is that the presence of heating and cooling networks is still very low. However, in addition to a high solar resource, the heating and cooling networks are increasing and, therefore, new SDH systems could be expected in the medium and long term.
FR	It is more profitable for a building company to install ST systems on a building rather than developing SDH plants. The need to go through the “titre 5” process is also a barrier for new DH, and hence new SDH which represent an interesting opportunity in new Eco district. For example, the project submission must include the list and characteristics of all the buildings that will be connected to the network. This implies for the DH operator to obtain

	signed agreements for the connections beforehand from all builders, without being able to communicate which “green bonus” they will get by doing so, or even to guarantee if they will get one.
HR	A feasibility study for alternative systems for buildings with useful area above 1000 m ² is mandatory but the implementation of the study results is not obligatory for the investor, rather just informative. Alternative systems particularly refer to decentralized energy supply systems that use renewable sources, cogeneration, district heating, heat pumps or fuel cells.
IT	Decree no. 28/11 contains an article that promotes DH, prescribing development plans in cities with more than 50,000 inhabitants to promote renewable energy sources for DH and cooling. For smaller towns these plans can be developed in a membership form taking advantage of the coordination action of the provinces. Furthermore, builders who connect their buildings to DH are exempted from the obligation on the minimum share of renewable energies. 2012/27/UE European directive for energy efficiency will bring to a larger share of renewable energy sources and a shift of obligation from builders to DH suppliers. The connection to DH does not imply relevant changes in the primary energy factor value determination/calculation, in comparison with the reference case (condensation gas boiler and solar thermal collector for domestic hot water). The benefits of using solar thermal in DH network is not adequately reflected in the calculation of primary energy factor.
LT	The software tool for calculating the energy efficiency class of the building does not take into account the use of RES. The main factors affecting the energy efficiency class are the efficiency of heat generating source and ventilating system with recuperation. Currently updated methodology for Construction Regulations and the updated software tool will assess non-renewable and renewable Primary Energy Factors for heat generating source.
PL	Heat distributors are legally obliged to purchase any heat generated by RES in the amount not exceeding the demand of entities receiving heat from the company. Furthermore, a rule derived from the act allows any alternative suppliers, producers and receivers an unblocked access to grid infrastructure by Third Party Agreement.
SE	Solar heat is treated differently if it is directly supplied in a building or via DH systems. Law requirements encourage the use of solar heat in buildings connected to DH, but they do not stimulate the use of solar thermal energy in DH systems.
SI	Opportunities for solar can be found in DH systems which do not satisfy the minimum renewable energy share and where the primary energy use is too high. The growth of SDH is limited by current legislation which supports more the decentralized use of RES.

Country	Possible improvements for the current legislation
AT	Conversion factors for CHP plants and waste heat are currently very low. This has positive effects on building’s total energy efficiency. If these conversion factors increased, plant operators would have incentives to realize ST feed-in systems to increase a DH network’s advantage. A different conversion factor for DH systems which includes ST would be also beneficial.
CZ	The current requirements seems appropriate for deploying SDH.
DE	The limits for the heat losses transmission factor already represent a rather strict requirement and do not allow a large choice between taking measures on the building’s envelope or improving the energy supply. As the first must be done anyway, the second is still too often less necessary to fulfil the requirements.

	There is still improvement potential in allowing and facilitating sub-accounting areas within single district heating systems, or at least achieve clarification on the subject.
DK	There are already legislative initiatives that are helping to promote SDH, for instance the "Agreement of 13 November 2012 on energy companies' energy saving efforts", where DH companies have the possibility, within the required energy savings activities, to be rewarded financially when realise large-scale solar heating systems in the period from 2013 to 2015. An extension of this period could help keep the development on track.
ES	The potential for improvements concerning SDH is high, considering that, until recently, there was not an official tool for the evaluation of buildings connected to DHC systems. Furthermore, the existing tool is very generic, and a specific calculation methodology for ST does not exist.
FR	The builder should obtain the same benefit with a SDH connection as with a solar installation on the building. The necessity to adapt the building code to zero energy building by 2020 gives an opportunity to get out of the current approach which takes only the building into account, towards a wider approach including the surrounding buildings and the district, hence giving more opportunities to DH and SDH.
HR	Amendments of the methodology and changes of the regulation, aimed at facilitating the implementation, are ongoing.
IT	To improve the position of DH, it would be necessary to include the substations in the incentive measures which can benefit of the tax deduction. To improve the calculation method of primary energy factor in order to take into account the benefits of using solar thermal in DH network.
LT	No specific improvements are foreseen for SDH development.
PL	The most crucial need is an economic support for ST investments.
SE	The current regulations must be reviewed to include RES in DH. How bought energy is produced should be relevant when evaluating building's energy performance. The use of weighting factors for different energy sources in the assessment of building's energy performance can be a solution.
SI	Possible improvements especially refer to the inclusion of a wider and integrated approach in the design of energy supply.

1.2. Consequences for solar district heating: opportunities and barriers

From the analysis of the different national legislative framework, several general conclusions can be drawn regarding both opportunities and barriers for district heating and, in some cases, with a specific focus on solar thermal for district heating.

The opportunities can be summarized as follows:

- DH is very often included in the laws on energy efficiency in buildings, because it is considered as an energy efficiency measure; therefore it is eligible to meet the nearly-zero energy requirements.
- Local energy and climate policies tend to consider RES DH development as a powerful mean to tackle greenhouse gas emissions.
- A DH network which is dimensioned for the present demand may be oversized in the future if the heat demand decreases due to energy efficiency measures. However, this surplus capacity allows to extend the DH network to additional areas without the need to upgrade neither the pipes or the production power. Therefore, in countries where DH has a low heat market share, their densification and development can, despite lower heat demand per building, lead to a need for new plants.

- DH grids could also be used as heat storages, at least on a daily basis.
- To reduce DH additional infrastructure cost, it should be included in the general building cost or, even stricter, include RES DH as an essential building service and therefore have an obligation to build it.

The main barriers which must be highlighted are:

- General competition between DH and low energy houses, also due to high connection costs.
- Lack of specific incentives for developing new DH grids or for renovating existing ones.
- Regulated price for DH in some countries.
- Negative image for DH, sometimes associated with the concept of large industrial polluting infrastructure on the territory.
- Market saturation in some countries.
- Competition with electric heat (e.g. by heat pumps) sometimes due to low electricity prices.
- Specific barriers for SDH:
 - competing technologies are often cheaper (also because more supported) and more well-known and therefore more easily bankable;
 - not many potential installation sites show both high solar radiation and existing DH grids.

1.3 Relevant regulations and subsidy schemes

Besides the national and regional legislation on energy efficiency in buildings, further regulation could affect the development of DH and SDH. Moreover, subsidy schemes may foster the development of some technologies.

General comments about regulations and subsidies which may influence DH development are:

- Lower VAT (Value Added Tax) for DH:
 - what will happen if it will be removed in the future?
 - should this lower VAT be, as in France, subject to specific requirements, for instance minimum share of RES in DH?
- Green certificates for CHP can favour RES DH.
- Obligation for connection to a high-efficiency DH system (e.g. with a 50% RES share), if available in an area.
- Subsidies:
 - For RES DH, solar is sometimes not included in the “green energy sources”.
 - For the renovation of old DH grids.
 - Direct contributions for ST plants, but they are usually introduced for small systems.
 - General trend towards the cancelation of subsidies, due to both economic crisis and increasing RES economic competitiveness.

1.4 Competing technologies

Within the DH sector, the solar energy source faces a continuous and tough competition with several technologies.

Some general considerations can be underlined from the analysis carried out at national level:

- Main competing technologies, depending on local resource availability, price and subsidies, are:
 - biomass;
 - natural gas;

- geothermal (through heat pump technology);
 - coal;
 - waste incineration;
 - industrial excess heat;
 - heat recovery from CHP.
- Solar is often considered one of the less viable solutions due to:
 - high investment cost;
 - zero or low subsidies;
 - not well-known and therefore not bankable;
 - sometimes considered as technologically complicated;
 - cheaper in operation but not that much (it could be competing even with electric boilers in some countries);
 - it cannot cogenerate;
 - low fraction compared to biomass meaning a low influence on CO₂ emission (e.g : 50 g CO₂ emission / kWh ⇔ 79% solar fraction) and more difficult to make it beneficial.

2. From business models to implementation

2.1. European experiences at a glance

The SDHplus project partners have collected several models and experiences of how the supply of solar district heat for new or existing and renovated buildings and settlements with high energy performance or even at nearly zero-energy standard can be a business opportunity for DH companies and other stakeholders. Models were collected through direct interaction with the stakeholders involved in the models themselves.

This document just reports a very short summary of the collected experiences, while a full description of all the models listed here is available at:

<http://www.solar-district-heating.eu/Documents/SDHBusinessmodels.aspx>

Sweden	Net-metering of heat in distributed solar plants
Denmark	TEAKS - Technical Efficiency of CHP Systems
Denmark	Implementation of SDH in CHP Systems
Lehen, Austria	Microgrid Stadwerke Lehen
Slovenia	Financial grants and financial credit
Balma, France	Centrale solaire de Balma
Denmark	Cooperative ownership in the DH sector
Crailsheim, Germany	Allocating SDH to new buildings in order to fulfill the Renewable Heat Law
Hamburg, Germany	Feed-in model by Hamburg Energie
Hamburg, Germany	E.ON Feed-in model for solar thermal heat in Hamburg
Lithuania	Solar heat
Germany	Bioenergy villages using solar thermal
Bornholm, Denmark	Implementation of new district heating grids
Austria	SOLIDInvest

2.2. Different business models

1. Net-metering of heat in distributed solar plants – Sweden

An increased number of building owners connected to district heating in Sweden have expressed an interest to use solar collectors on their buildings. A model based on net-metering of heat in distributed solar plants has been developed, by which the solar heating system is connected to the district heating main circuit and the district heating system is used to distribute excess solar heat to other buildings. A net-metering contract with the district heating provider is developed. The distributed plants are in principle operated on their own and are commonly designed based on the available space and the existing dimensions of the district heating branch on site and not on the actual load in a specific building. The plants have no storage as they can utilize the district heating network (as long as they provide a small amount of heat in comparison to the total load in the district heating system).

The development of this kind of systems was pioneered by the municipal service building's owner and the district heating provider in Malmö (E.ON, former Sydkraft) in 2001 and has resulted in a number of systems in other cities. The development of a prefabricated solar district heating sub-station in co-operation with an established system component company has been a major facilitator in this development as it provides common boundary conditions for the systems.

2. TEAKS (Technical Efficiency of CHP Systems) – Denmark

Created in 2008 by Braedstrup District Heating and the consulting company Ramboll, this model aimed at ensuring an optimum operation of all the elements of the production and distribution systems, all the way from the natural gas into the production plant to the last radiator at the consumer's installations. The project was also supported by the Danish District Heating association. One of the prerequisites for the project was to calculate the savings from a reduced temperature on the return flow line. The calculations showed that, for every °C the return temperature can be reduced, the savings of the overall system (production and pipelines) is 55 c€ per MWh heat consumed.

3. Implementation of SDH in CHP systems – Denmark

The Danish model for SDH implementation in CHP systems has been developed gradually since 2004.

The first step was a change in the feed in tariffs for CHP-plants where plants with more than 5 MW_{el} should change from a triple tariff to the Nordic electricity market. That meant that natural gas fired CHP-plants might stop in summer periods and heat would be produced by gas boilers. The next step was calculations of the economic feasibility for the Braedstrup plant, one of the most efficient in DK, and the result was a lower heat production price and reduction in emissions, also due to the very high tax on natural gas (app. 25 €/MWh at that time).

The third step was that the Danish Government in 2005 accepted to let a commission investigate the social economic consequences by integration of solar thermal in natural gas fired CHP-systems. The result was that SDH in natural gas fired CHP-plants could be an economically and environmentally good solution.

Therefore the first two full scale demonstration plants in Braedstrup and Strandby, both with 8000 m² ground mounted solar thermal collectors, were built.

4. Microgrid Stadtwerke Lehen – Austria

This solution was implemented in 2010, thanks to the collaboration of the utility Salzburg AG, the City of Salzburg, two social housing companies and one commercial housing company.

It is linked to the following initiatives: refurbishing of the district Lehen, Concerto project Stadtwerke Lehen, Salzburg regional housing subsidies, Klimafonds funding for large scale solar thermal systems, programme on detailed monitoring of user behaviour.

The solar thermal system of over 2000 m² collector area has to supply the newly erected housing and commercial buildings at minimum 30% solar fraction of annual heat demand. A buffer storage of 200 m³ is used. Additional heat comes from heat pump of 170 kW nominal thermal power in shoulder seasons and Salzburg district heating in winter.

Each customer has a transfer station for domestic hot water and room heating in his apartment or office with heat meter. For non-solar heat the customers pay the same tariff as other DH customers. The over 30% of solar heat are not charged as the solar system was financed with the construction of the buildings and is included in the rent.

5. Financial grants and financial credit – Slovenia

The legal framework for financial grants and credits is the "Regulation on energy savings ensured to final customers", by which all energy suppliers have to ensure energy savings on their customers (1% of supplied energy) by carrying out programmes (energy efficiency measures and use of RES).

The regulation was adopted by the national government in 2009 and it is linked to support scheme of financial grants and credits which is running from 2004 and is conducted by Eco Fund (Slovenian Environment Public Fund).

Large suppliers prepare their own programmes, while for smaller suppliers programmes are prepared by Eco Fund.

6. Centrale solaire de Balma – France

Balma eco-district was designed in 2010 and several energy concepts had been studied.

The chosen concept includes a DH grid, fed by both a wood boiler and a gas boiler, together with a solar thermal field.

COFELY, as DH operator proposed a solution to reach expectation of the stakeholders, good economical balance and innovative project. For local authorities, the goal was to develop sustainable urban planning, to make environmental policy a reality, to respect Agenda 21 and regional roadmap commitment. For urban planner and developer, the aim was to build an innovative eco-district, to push for renewable energy use, to support a “social and sustainable” energetic approach. For builders and property developer, the goal was to get low energy consumption building labels, to take the benefit of public incentives, as well as to propose a competitive energy solution to their client.

The SDH is not different from common heating networks, working with common temperatures between 55 °C to 105 °C. The solar plant is made from about 5,000 vacuum tubes and heat pipes, based on two solar loops, for a nominal power of 300 kW, producing up to 475 MWh / year.

COFELY builds, owns and operates the district heating network and the heat production plant.

7. Cooperative ownership in the district heating sector – Denmark

Denmark has a long tradition for consumer-owned companies. It started in the middle of the 18th century in the agricultural sector and has since evolved to include among others power companies and district heating companies.

In mid-1980s purely political initiative was taken to change the power production structure in Denmark from a highly centralized structure with relatively few but large power plants to a production based on local DH grids. Almost all of the new small local plants were and are directly owned by the consumer themselves – that is the “Danish cooperative model”.

A consumer-owned company is not making money for investors, thus meaning that there is no pressure from investors to generate profits.

The authorities issued a special law for heat supply companies to verify that all heat prices are reasonable and a profit from one year shall be included in the price of heating for the coming year to a possible reduction of price. All district heating prices in Denmark are published in a special website.

In connection with the massive expansion of large-scale-solar in combination with district heating in Denmark it can be seen that the consumer-owned model has ensured rapid and courageous decision-making processes in relation to the large investments in new technologies.

8. Allocating SDH to new buildings in order to fulfill the Renewable Heat Law – Germany

The model, initiated by Stadtwerke Crailsheim, the utility of the City of Crailsheim, has not been implemented yet as there are some legal questions to solve first.

It is linked to the German renewable energies law (EEWärmeG) defining the share of renewable energy supply in a new building.

Stadtwerke Crailsheim operates the biggest solar thermal plant in Germany, feeding into the district heating net. To comply with the EEWärmeG about renewable energies in new buildings, an industry constructing a new building in Crailsheim has to have a certain amount of its heat and hot water produced with solar thermal. The Stadtwerke Crailsheim’s approach is to sell them

certificates, if the new building is connected to the district heating net, stating that a certain amount of the solar heat from the net is allocated to this particular building.

This would enable the Stadtwerke to sell more heat and avoid the industry the costs of installing solar collectors.

It is still not sure that this will be accepted as compliance with the EEWärmeG law.

Stadtwerke Crailsheim as the district heating net and solar plant operator would be initiator and manager of the model and sell heat, solar heat, and certificates to the industries, who would then comply with EEWärmeG requirements for new buildings.

9. Feed-in model by Hamburg Energie – Germany

Hamburg Energie is a utility supplying electricity and it is operating a local district heating system, currently under construction, in the town district of Hamburg-Wilhelmsburg, with a total heat capacity of 5 MW in the first construction phase (20 MW in total are planned). Hamburg Energie's electric power comes entirely from RES and its natural gas contains a certain share of biogas, which makes it consequently the next step in generating heat from RES.

Hamburg Energie buys the surplus heat from its customers at a price of 4.5 c€/kWh, when the heat is produced by solar, bio-energy or heat pumps.

There is no minimum capacity but, as the customer have to pay the heat exchanger for the feed-in, the solution is not viable for small solar systems of single homes. The minimum temperature is 75 °C on frost-free days and higher when frosty.

Customers who produce more heat than they need for themselves can feed the surplus into the net, but they are only allowed to supply less than 20 % of their own heat demand to the grid. Furthermore, Hamburg Energie reserves the right to provide at least 90 % of the grid heat with its own facilities during the first construction phase. When the grid has been extended to the planned 20 MW, this figure will decrease to 75 %.

The model is mainly targeting housing enterprises.

10. E.ON Feed-in model for solar thermal heat in Hamburg – Germany

The main actor is E.ON Hanse Wärme, operator of the district heating net in eastern Hamburg.

E.ON opened the district heating net in eastern Hamburg for feeding-in solar heat. Operators of ST plants larger than 100 m² can feed their heat into the net and store it there. During 8 months, the producer continues to own the heat, and can use it. This means that solar heat produced in the summer can be used in the winter. When the solar heat is not needed by other customers at the time it is supplied to the grid, it can be stored in a 4 100 m³ underground tank. For this storage service, E.ON will charge the producer and the price announced was 2,1 to 2,5 Ct/kWh.

There are two main possibilities:

- The solar plant is built on a building (mostly in the frame of a retrofitting). The housing enterprise owning the plant is producing the heat, storing it in the net and using it later
- The solar plant is built at another location along the net by a third party: the plant operator. The plant operator produces the heat, stores it into the net and sells it to the housing enterprise.

E.ON Hanse Wärme is the operator of the net and offers the storage service. The main target group for this model are housing enterprises.

E.ON Hanse Wärme initiated the project and also built the demonstration (and only one for the moment) collector plant feeding in the net.

The housing associations can buy a storage service from E.ON if they build a solar plant and feed-in the net, or buy solar heat from another operator feeding in the net. In this second case, the operator of the solar plant is the one to use E.ON's storage service.

11. Solar heat – Lithuania

Solar collectors were installed on the roofs of boiler-houses of 2 district heating companies:

JSC "Ignalinos šilumos tinklai" district heating company implemented project "Modernization of heat production and supply infrastructure in settlement of Dūkštai". This district heating company installed at its own expense.

Kaunas DH Company has installed solar collectors to produce domestic hot water for the needs of company building only.

DH "Kauno energija" implemented solar collectors at their own efforts.

The stakeholders involved in the model operation are: District heating company JSC "Ignalinos šilumos tinklai". Engineering Services and Construction Company JSC "Alvora".

District heating company JSC "Ignalinos šilumos tinklai" announced tender for the project "Modernization of heat production and supply infrastructure in settlement of Dūkštai". JSC "Alvora" won this project tender and carried out the works.

District heating company JSC "Ignalinos šilumos tinklai" is contracting authority. JSC "Alvora" was the contractor, which designed and carried out the works.

12. Bioenergy villages using solar thermal – Germany

The first bioenergy village was established in 2006 and then the model was replicated over 130 times. Bio energy villages are self-powered: 100% of the electricity demand as well as at least 50% of the heat demand are covered thanks to locally produced renewable energy. Usually the initiator is not a company but dedicated citizens in co-operation with the community, local craftsmen, building companies and consulting engineers. Registered co-operatives are the most frequent form of organization because they offer the citizens a high degree of co-determination and influence in combination with a limited liability risk. The financial ambition is not profit maximisation but achieving a long-term favourable price using RES.

Though the exact concept depends on the surrounding conditions, the villages have one thing in common: a district heating network for a collective heat supply. A very frequent model is a fermentation plant producing biogas out of agrarian substrata. A cogeneration plant is feeding the generated electrical power into the electric grid to gain compensation and the waste heat is distributed by a district heating net. Wood chips boilers in combination with solar thermal collectors represent an alternative to fermentation plants for supplying heat. The first bio energy village using biomass and solar thermal energy in Germany is located in Büsingen. For electric power supply, photovoltaic and/or wind power are usually used.

The supply with biomass, the heat and electricity production and the distribution can be run by the residents of the village.

13. Implementation of new district heating grids – Denmark

Model Bornholm for implementation of new district heating is developed by the utility Bornholms Forsyning. Bornholm is an island with low income, especially in the villages, therefore a model for introduction of DH including financing was developed.

A heat plan was elaborated in 2007 showing that DH with biomass was the best solution for 9 municipalities and villages.

For each village, a project proposal showing economy for all stakeholders has to be elaborated and politically approved by the municipality before it can be realised. Then a local working group including representatives for local associations, business and Bornholms Forsyning follows the project and have regular meetings.

Information leaflet and preliminary agreement is sent to all households. The project will be realised if a certain share (for instance 60 %) accepts to be connected to DH.

When the minimum share has accepted to connect preliminary agreements are changed to contracts and implementation starts.

The plant including pipes is financed 100 % with loans with municipal guarantee (25 years annuity loans with low interest rate).

The results are that new district heating is implemented in 7 cities and villages since 2008. A new heat plan including another 6 villages and cities was political accepted in 2013. In 2014 four district heating plants supply 6,000 customers on the island.

14. SOLID Invest – Austria

SOLID is well known for realizing ESCO concepts for the customer, where the customer pays not for the installation but for the kWh of solar heat, mainly for solar district heating plants. Due to changing financial framework conditions in Europe, it has become more difficult for SMEs to get loans for new projects. Therefore in November 2013, SOLID has launched a new investment model for solar thermal systems with public participation, called “SOLID Invest”. This model provides citizens the opportunity to take responsibility for renewable energy developments by supporting the realization of new solar thermal projects on regional and global level. SOLID Invest works on the Lending-based-Crowdfunding (=Crowdlending) approach. Instead of one big investor many small investors lend us their money. In return they get back an interest yield every year and in the end of the binding period they get back their loan. The monetary backflow is guaranteed by the ESCOs. More information at www.solid.at/invest (at the moment in German, only).

2.3. From models to implementation

The above described business models have been studied and analyzed by SDHplus partners, which have then replicated these models, after an adaption to the specific conditions, in their countries.

In the following, therefore, a description of which models and how they have been put into practice is reported, focusing on six countries: Austria, Denmark, France, Germany, Italy and Sweden.

2.3.1. Collective large solar thermal plants – Austria

The business model and its replication potential

A completely new business model was elaborated and implemented in Austria thanks to the initiative of the company “SOLID”.

SOLID is well known for realizing ESCO (Energy Service Company) concepts for the customer, where the customer pays not for the installation but for the kWh of solar heat, mainly for solar district heating plants. Due to changing financial framework conditions in Europe, it has become more difficult for small and medium enterprises to get loans for new projects. Therefore, SOLID has launched a new investment model for solar thermal systems with public participation, called “SOLID Invest”. This model provides citizens with the opportunity to take responsibility for renewable energy developments by supporting the realization of new solar thermal projects on regional and global level.

Solar district heating plants still are a niche market, even though the potential is really large. Clients often prefer the ESCO model where they just pay for the produced kWh of solar heat instead of the whole turn-key system. Very often financing is the most challenging part of the projects due to a combination of a lack of awareness of the technology and the current financial conditions for bank loans. People are looking for options for well spent investments and renewable energy is an ecologically worthwhile topic. Therefore, depending on the company (ESCO expertise) and on the local market, especially the legal and financial framework conditions, alternative financing models as SOLID Invest, have a high replication potential in many European countries.

The stakeholders and their roles in the model

The stakeholders who must be involved for the realization of this business model are:

- investment company
- private investors
- financial market supervision authority

- energy purchasers
- public funding authorities, private banks

One major stakeholder is SOLID International GmbH, the company which takes the loans from the investors. It has to manage the invested money responsibly and supervise the ESCO companies. It also has to communicate with existing and future investors and to pay the annual interests to the investors, as well as to pay back the loan after the end of contract.

The minimum duration of the contract is five years. After this period, the contract can be cancelled by each party.

The private investors are also a very relevant stakeholder group. A target group of well-off, green minded individuals was defined. This target group was reached by marketing events in the city of Graz and its surroundings, as well as through media campaigns. Typical investments for each individual are from minimum amount of 2.000 € up to 25.000 €. For most of the people investments up to the amount of about 16.000 € are favorable due to Austrian tax rules.

As all financial business is under the auspices of the financial market supervision authority, the lending based crowd funding model has to comply with the rules of the Austrian Finanzmarktaufsicht (FMA). The chosen model requires no control from FMA.

Another important stakeholder group are the future energy purchasers of the energy service companies: the regional utility of Styria, a large industrial company and a heat supplier in Upper Austria. The energy purchasers must show a financial commitment to the project in the beginning and also give guarantees for a long term heat purchase, usually 8 to 20 years.

All invested solar plants are planned to be financed only partly by the relatively expensive crowd funding. Currently SOLID Invest is at an annual interest rate of 4 %, while bank loans have much lower interest rates. For the 1st edition, which started at November 14th 2013 and ended an May 31st 2014, the interest rate was even at 4.5 %. For the business plan of the ESCOs, the crowd funding is regarded as equity and is supposed to have a share of 15-20% of the total investment. The remaining 75-80 % will be financed by public funding for renewable energy installations, the energy purchaser and mainly by bank loans. Therefore public funding authorities and private banks are also major stakeholders.

The goals

The final aim of the implementation of this model is an easier and faster realization of large scale district heating plants in general, and especially solar district heating plants. Many solar district heating projects are blocked in the project development phase because the customer, most of the times energy utilities, are not willing to invest in such renewable energy projects. Even though there is the alternative of an ESCO solution, the big challenge within this solution is that SOLID does not get the loan from the banks for investing in these projects or the conditions for the interest rate are too high. If SOLID uses the loans from the citizen as one part of the whole financing package, it is easier to get the rest of the money with better conditions from the banks.

The first milestone was to collect 1.5 million € with the public participation model SOLID Invest and this target was reached by mid of May 2014. The capital is used for financing several large scale solar thermal projects. Part of this money is currently used for realizing a SDH plant in Graz with an extension of 2,000 m² solar collector field. Furthermore, some additional projects are in the development phase.

The overall target is to manage the challenges of the financial sector for financing new projects. This includes being flexible with the model and constantly working out a balance between supply (financing existing and new solar projects) and demand (existing and new investments of private investors).

More details are available at www.solid.at/invest (at the moment in German only).

2.3.2. How to initiate new district heating grids – Denmark

The business model and its replication potential

The "Bornholm model", described above in no. 13 of paragraph 2.2., is considered in Denmark as a business model with replication potential for initiating new district heating grids in cities and villages.

The model is based on the simple principle that new customers should not pay large up-front investment costs for new district heating grids. Instead the costs for the district heating plant and for the main pipe network are covered through the heat bill and therefore spread out over a long payback period. The heat price is calculated as follows: a part is linked to variable costs such as the fuel demand for the district heating plant and the second part is due to fixed costs such as the repayments for both the district heating plant units (boiler, storage, etc.) and the main pipe network.

Furthermore, the loans for the district heating company are depreciated over 25 years with a low interest rate because the municipality guarantees for the utility.

To give an example of a cost calculation, a house with a consumption of 2,000 litres of oil for heating can be considered as the reference case. For such a house, the yearly cost for heating is:

- District heating with hotline and service visit every 3rd year: 1,931 €/year. Of this amount, 1,155 € are variable costs (assuming 14 MWh heat consumption).
- Alternative solution with oil heating 3,347 €/year (of which 3,067 € is the cost for oil).
- Alternative solution with electrical heating: 2,912 €/year.

New customers pay an investment cost, which usually have a special price for agreeing to connect to district heating before the pipes has been installed).

In earlier examples from Bornholm the cost has been 2,200 € for the connection pipe, a heat meter with leak alert, a district heating unit with hot water tank and shunt regulation for heating. The price also includes installation of the components and removal of oil boiler and old hot water tank, and removal or emptying of oil tank. For electrically heated houses the connection fee is zero. This is done to make it more interesting for these houses to be connected because most likely they need a new internal heating system thus requiring other investment costs to be able to use district heating. No investment costs are paid before the first district heating is supplied.

The model can be easily replicated if it is possible for the district heating utility to finance the investment in connection pipes and house installations during implementation.

A variety of the model is used in different Danish district heating companies. Some utilities operate with a mix where some of the investment cost in the district heating plant is paid by the customers and the rest is covered by the heat bill (i.e. paid back over time). Bornholms Forsyning operates with the most distinct separation between their investment cost and what is required as start-up costs for new customers.

The stakeholders and their roles in the model

The main stakeholder is the local utility in Bornholm, Bornholms Forsyning, which first tested this model. Since there is no need for changes in the legislation for this model to be implemented there is no need to involve local authorities.

End users play also a key role because the initiative will go on only if a certain share (for instance 60 %) of them accepts to be connected to DH. When the minimum share has accepted to connect, preliminary agreements are changed to contracts and implementation starts.

Therefore, to reach this aim, an information leaflet and agreement paper is sent to all households in the proposed district heating area informing about the following points:

- 60 % of the houses have to be connected if the project is to be realised.
- A specific information meeting will be held soon.
- Example of the feasibility calculation detailing investment costs and savings.
- Promotion of district heating.

- A map of the area involved.

Similar information is published in local newspapers with a reminder about the public information meeting.

The main points used for convincing people to sign up are usually:

- Compact heating unit easy to regulate.
- Nearly no maintenance.
- No smoke and noise from oil boiler.
- CO₂ neutral heat with local biomass.
- Low energy cost.
- Service and leakage alert is included in the heat price.
- The plant is prepared for solar thermal.

The goals

The final goal of this business model is to have as large network connection percentage as possible and also a large solar fraction, as well as to improve the reputation of district heating in general which as an overall goal aims to reduce greenhouse gas emissions in the heating sector.

New district heating networks are planned in the towns of Svaneke, Årdsdale and Listed on the eastern coast of Bornholm. The connection campaign took place in 2014 and implementation is expected in 2015.

Regarding the involvement of final users, some additional points for convincing them to agree on DH will be added:

- High performance buildings meeting the 2015 building code requirements in Denmark will have a reduction of 50 % in connection costs (1,150 € instead of 2,300 €) and in fixed costs connected to the building (1.75 €/m² year instead of 3.50 €/m² year).
- The reason for this is that high performance buildings only cause 50 % of the burden to production plant and distribution pipes compared to standard houses.
- Solar thermal will make possible to save biomass, reduce emissions (especially dust) in the summer period where a lot of tourists are on the island) and stabilises the future heat price for the customers.

2.3.3. First solar district heating systems – France

The business model and its replication potential

All the models reported above in paragraph 2.2. have been studied in France for the country specific conditions and the conclusion is that the two most suitable experiences to be replicated are the ones from Andritz and Malmö seem to be the easiest foreign models to replicate in France, the last two being studied currently on two existing projects.

It is interesting to notice that the first French SDH project (no. 6 above) does not correspond strictly to any of these models. In Balma, a private company invests and runs the DH, without direct involvement of the local authority. This model is fairly simple, and is already being replicated in Juvignac, near Montpellier. The main concern for this business model, as there is no control of the local authority, is the tariff for end users and its future evolution.

For replicating these models, the key needs, in the short period, are:

- a specific line for SDH in the Heat Fund (national funding for RES heat);
- more information towards stakeholders (local authorities, DH operators, consultants, urban planners), the main point being changing habits regarding energy choices and temperatures;
- contract examples for selling heat from a solar plant installed on a building, or for maintaining such a plant by the DH operator.

Main evolutions needed, in the long period, are:

- better consideration for SDH in the building code (link between how solar and DH are considered, consistent with the evolutions needed for zero energy buildings) to increase the possibilities to develop solar on new buildings, and especially on new districts (builders are currently encouraged to install thermal solar on new buildings, but the performance advantage given on the building (which decreases building cost) does not exist if solar production is injected instead of used on the building);
- decreasing DH temperature; this necessity is now well known and admitted by stakeholders, but it can be technically challenging and very costly, even with the help of the white certificates scheme, which now includes this action among possible actions eligible to certificates;
- decreasing buildings' central heating temperatures (heat emitters): there is still a strong habit among heating engineers to design and run heating system within buildings with a 90/60 °C temperature range, which limits the possibility for DH to decrease its temperature.

The stakeholders and their roles in the model

Local authorities such as the cities of Toulouse, Montmélian, Châteaubriant and Chambéry have performed feasibility studies showing that either centralised (on existing DH) or decentralised production (on existing and new DH) is possible.

The operator involved is unknown for new projects as it will be chosen later on by the local authority according to public contracting procedures. SDH projects on existing DH involve until now only one operator (one of the two major French DH operators).

Châteaubriant example: COFELY is the private company who runs the DH service for the city of Châteaubriant (public utility delegation). Then it should invest and run the solar installation. Another model, where another company builds and runs the solar plant, and sells solar heat to the DH operator could also be applied and may be studied. It would be more complicated as the solar plant operator will need guarantees that all its production will be bought.

Montmélian example: a centralised model such as Andritz or decentralised such as Malmö could be applied. Being a new DH project, the possibilities are wider. On a juridical point of view, there are three major possibilities: either a public DH, run "in house" directly by the city ("régie"), a public DH run by a private operator for the city or a complete private DH, the latter being the less probable as the city is already well involved in the project.

Chambéry example: The DH of Chambéry is run by the *Société Chambérienne de Distribution de Chaleur (SCDC)*, a subsidiary of COFELY, for the city of Chambéry (public utility delegation) since 1987. The solar installation planned for the new ecodistrict Villeneuve should be integrated in this public service delegation. The foreseen model is closed to Malmö's, with an independent low temperature loop (which takes heat from the return pipe on the main DH grid) to inject solar production to DH operator.

Les Izards – Toulouse example: An important juridical evolution has occurred since the beginning of the study for this project: The Region of Toulouse ("Toulouse communauté urbaine") is now responsible for district heating development (instead of the municipalities composing the Region), following a new law published at the beginning of 2014 and concerning local authorities competencies. The business model is not chosen yet: it could be a private DH (such as Balma) or a public delegation.

The goals

The final aim is to have real cases running that can be replicated. For projects with public entities, the juridical aspects of business models have to fit within existing models but adaptations might be needed (additional clauses in contract between operator and local authority, and can be time consuming for first projects. Some organisational models from other countries are relevant and can give precise ideas of what could be done, but the juridical aspects have to be adapted locally to French legislation (and existing contracts for SDH projects on existing DH).

With French SDH plants running, solar on DH could become a classical option to be studied routinely in feasibility studies for energy supply of new districts and planning of evolution of existing DH.

For involved DH operators, the aim is to have them study internally the replicability on other DH networks they are in charge of.

2.3.4. Towards bioenergy villages – Germany

The business model and its replication potential

Bio energy villages are self-powered: at least 50% of the heat demand and 100% of the electricity demand are covered thanks to locally produced renewable energy. Becoming a bioenergy village, with a collective renewable district heating supply presents many advantages for a village:

- Fast reduction of CO₂ emissions (compared to measures in individual houses)
- Local value creation and development of the local economy
- Efficient implementation of many renewable or waste energies at large scale
- Enhancement of the social life in the community

It is a successful concept right now in Germany and more than 130 bioenergy villages have been created since 2006. It has been shown now many times that renewable district heating is economically feasible even in the rural areas with low heat demand density.

The first example of a bioenergy village with solar thermal energy in Germany is in operation in Büsingen am Hochrhein. The local energy company Solarcomplex has built and is operating the district heating plant. The 1 090 m² solar plant covers the heat demand in summer months, therefore avoiding partial load operation of the biomass boiler as well as bringing a stable fraction to the heat price on the long-term. This first solar bioenergy village is a successful project and Solarcomplex plans to include solar thermal in its future bioenergy villages when no waste heat is available.

Solites, who participated in the development of this first solar thermal bioenergy village in Büsingen, supports projects to replicate the model in several other locations with different stakeholders e.g. in Liggeringen, Rottenburg and Schopfloch.

The stakeholders and their roles in the model

The initiator of the project can be either an energy company, a local utility or a group of dedicated citizens in co-operation with the community. In all cases, the implication and support of the citizens is a very important factor since the fraction of households who decide to connect to the collective district heating net determines the economical feasibility of the project. So the initiator of the project needs to inform and implicate the citizens in the project from the very beginning. In Büsingen, it is a local energy company who has built and operates the renewable district heating net. In Liggeringen and Rottenburg, the projects are initiated by the local energy utilities. In Schopfloch, a group of citizens has founded a registered cooperative which is a frequent form of organization in bioenergy villages: it offers the citizens a high degree of co-determination and influence in combination with a limited liability risk. The financial ambition is not profit maximisation but achieving a long term favourable price using renewable energies.

In all cases the second and most important group of the model are the citizens of the community and potential users of the district heating net. The success of the project depends on their support and commitment to connect to the future net. An important work of information and involvement of the citizens has to be realized by the initiator in order to implicate the future clients very early in the project. In the case of a citizen cooperative, the collaboration of the citizens in the project and the non-profit goal help achieve better acceptability.

The goals

This model opens new potential areas of application for renewable district heating. Until now, rural areas were considered as not having enough dense heat demand. But many examples have shown that district heating is economically feasible also there, due to lower construction costs for the heat grid.

Bioenergy villages represent a relatively easy way to develop solar and renewable district heating as creation of new networks is not so problematic as in more dense areas and the central integration of renewable energies is also usually easier and cheaper thanks to space availability and sometimes local bioenergy sources.

Even if rural areas do not represent the highest and densest heat demands, and therefore not a huge fraction of the heat supply, replicating this model is a good way to start considering central solar district heating nets as a standard solution for villages and small communities.

Different types of initiators are now involved in the different projects in development. The first project in Büsingen has shown that solar district heating in a bioenergy village is advantageous for energy efficiency and price stability. The following projects should show that it is also feasible for other forms of district heating operators, utilities or citizen cooperatives, which should in turn serve as example for further projects. It is realistic that a part of the mentioned cases will be realized in the year 2015. Regional Authorities, such as the Ministries for the Environment of the state of Baden-Württemberg and the state of Thüringen recognized this potential and started supporting solar thermal plants for bioenergy villages.

2.3.5. Decentralized feed-in of solar heat – Germany

The business model and its replication potential

Three different models described in 2.2 are business models for decentralized feed-in of solar thermal energy in district heating networks: one in Sweden and two in Germany. Decentralized feed-in allows the collector field to be placed and sized for any suitable location along the network, and to be integrated rather simply from the technical point of view, as no storage is needed. Moreover, it allows distributed ownership of the heat supply of the district heating net, enlarging the group of potential investors.

Decentralized integration appears as an interesting solution for the integration of solar heat in district heating networks, enlarging the business possibilities for SDH. The model is particularly interesting in the housing sector, when extended housing blocks are considered for solar heat supply.

At present the technical solutions are elaborated in several activities in Germany: A research project is focussing on the technical aspects of decentral integration, gathering international experience and analysing decentral feed-in in three representative net types with low, mid, and high operation temperatures.

The stakeholders and their roles in the model

In this model, the owner of the solar thermal plant can be the district heating operator, but it can also be an external investor. For some of these potential investors, the housing companies, building the solar thermal plant represents a cost-effective way to comply with new or renovated building legislation without actually having to build solar collectors on the roof and/or connect the solar plant to the heating system. But also energy service companies can be potential investors and sell the solar heat to the district heating operator or to one of their customers directly, paying a fee to the district heating operator for the heat transport. The opportunities for each plant owner, the system design as well as international experiences are presented in the guidelines for end-user feed-in of solar heat, produced within the SDHplus project.

The goals

This model represents a good opportunity to integrate solar thermal energy in particular in large district heating nets in dense areas and large cities. In Germany, the first step towards multiplication of this model would be the realization of one first project within German boundary conditions, showing its opportunities in the economical and legislative context. Solites is working together with the utility and the public housing association of a large city in Germany towards the start of this first project.

2.3.6. Third party access to district heating grids – Italy

The business model and its replication potential

In Italy there is an interesting experience of ASTEM Gestioni, the utility providing DH to Lodi, a 40,000 inhabitants town closed to Milano, where heat supplied in the network is partly bought from biomass cogeneration plant. ASTEM technicians have been interviewed and the model has been summarized in Italian in order to disseminate it towards other Italian utilities.

The main idea was to help utilities overcoming the barriers against introduction of third parties access, as third party access to DH networks would be an effective way of enhancing renewables in the DH branch and, in particular, solar thermal.

ASTEM's experience has been disseminated towards members of AIRU, the Italian District Heating Association, in the framework of the Smart Cities committee, in the meeting on June, 26th, 2013.

The strong points of this model are:

- The third parties have no production obligation, so they don't need to install any backup system.
- The DH utility (ASTEM) makes no investments for the RES integration: this pushes third parties to produce and sell heat. At the same time, this situation is balanced by the "take or pay" contract that requires ASTEM to buy a minimum of heat.
- The tariff is built through a "win win" strategy: the price of third party sold heat follows ASTEM production cost's trend, being always lower. In this way, buying heat from the third parties is always profitable for ASTEM.

At this stage an exemplary adaptation of ASTEM's model to solar thermal has been made at theoretical level, as it cannot yet been applied. The idea is to develop a model of third party access for solar thermal heat provided by an ESCO.

The characteristics of ASTEM model make it well adaptable to solar thermal heat sold by an ESCO instead of biomass sold by a third party cogeneration plant.

- With no production obligation the uncertainty of solar heat production is not an issue.
- The ESCO could incur all the initial investment costs for the solar thermal plant and secure a "take or pay" contract with the DH utility.
- The tariff could be decided in a similar "win win strategy" being lower than traditional heat production cost's but high enough to allow an acceptable payback time of the solar thermal investment for the ESCO.

The stakeholders and their roles in the model

The key stakeholders for the implementation of this model are:

- ASTEM Gestioni – utility of Lodi, running a 10 km DH network.
- Two private companies producing power and heat from biofuel and wooden biomass.
- Any company providing heat by solar thermal, also through an ESCO model.
- Other utilities with potential interest in offering their grid to third party access.

In the existing experience, the two private companies are producing heat and power from a bio-fuel and a wooden biomass plant. Heat is sold to ASTEM through a “take or pay” contract, which ensures the companies a minimum of sold heat, making the investment attractive. ASTEM does not oblige the two companies to produce heat, though. This is likely to change in ASTEM’s future projects. Heat is exchanged in ASTEM production facility.

The goals

Aim of this implementation is to gain experience with using heat provided by third parties in an economical way. This means fixing both, the technical boundary conditions to make the produced heat usable in the DH network, and the economic conditions, in order to satisfy the producer and the DH utility.

ASTEM showed an overview on advantages and disadvantages of their experiences: the main advantages for companies are:

- The fact that the two companies could show that cogenerated heat would be effectively used strongly simplified authorizations for installing their plants.
- Better profitability of the plants.
- Good image (as ASTEM is considered a sound company) and chance of replicating the same approach in other towns.

The advantages for the ASTEM utility are:

- Better environmental impact of ASTEM’s activities: the objective for the near future is to reach a renewable fraction of 50 %.
- Lower production costs: this is crucial now, as the changing energy market makes cogeneration less and less viable.
- Reduced dependence on electricity and gas market.
- Fiscal benefits for the end users might occur in the near future due to the fact that biomass heat is not taxed.

- The model has already been implemented in 2013. ASTEM Gestioni is planning to connect other users in the near future: an organic rankine cycle plant with 200-300 kW_{el} and 1.2-1.5 MW_{th} might be connected in the next years.

2.3.7. Net-metering of heat in distributed solar thermal plants – Sweden

The business model and its replication potential

As described above (no. 1 of paragraph 2.2.), in Sweden there had been some pioneer experiences of small solar thermal plants connected both to building users and to the local district heating grid via a sort of net-metering system for heat.

In this solution, the district heating pipes are therefore used also to distribute excess solar heat to other buildings.

The distributed plants are in principle operated on their own and are commonly designed based on the available space and the existing dimensions of the district heating branch on site, not the actual load in a specific building. Solar plants need no water storage as they can utilize the district heating pipes to store excess heat, as long as they provide a small amount of heat in comparison to the total load in the district heating system.

From an economic point of view, a net-metering contract with the district heating provider is developed.

This technical solution was first developed by the municipal service building’s owner and the district heating provider in Malmö (E.ON, former Sydkraft) in 2001 and has been then replicated in a number of cities. The development of a prefabricated solar district heating sub-station has been a key element as it provides common boundary conditions for the systems.

This business model can be easily replicable, when agreements with the utility can be made for delivering heat to their heat distribution system under a net-metering contract. From an economic point of view the model is best applied in DH systems where there is not so much cheap waste heat available at summer time, for instance from CHP plants. From a technical point of view it is an advantage not to have too high temperatures in the heat distribution system.

The stakeholders and their roles in the model

Two main options can be used for ownership of the decentralized solar plants: the housing facility or the utility.

In the first case, it is usually their first initial interest to apply solar heating system in their buildings. Initial discussions then lead to investigations concerning how the option of direct connection to the existing system using roof-integrated collectors can be applied. The housing company has already a contract with the utility for the district heating supply. A net-metering contract with the district heating provider should be then added, where it is compared how much is bought from the district heating provider and how much heat is delivered to the district heating network by the housing company from the solar plants.

The housing company receives about 80 % of the district heating price bought from the utility. The balance between bought heat and sold heat can be done on a monthly basis or also on an annual basis. The technical personnel of the housing company manage the solar system and are responsible for the monitoring of its performance.

Regarding the second case, only one example exists where the owner is the utility. The utility made a leasing contract with the property owner for the roof area. Additionally, there can be a price difference in the heat produced by the solar plant and delivered to the houses and the additional heat delivered from the DH network. The utility is responsible for the operation and maintenance of the solar plant and they also take care of the billing to the customers.

Besides the 9 systems owned and managed by E.ON in Malmö, there are more than 10 systems owned by different housing companies or municipalities. Only a few of these have established cooperation between the system owner and the DH provider.

The goals

The goal in Sweden is to have this net-metering model replicated in many other situations. Therefore, there is a continuous search for interested stakeholders, even though the general interest has decreased since the subsidy for solar collectors was dropped in 2012.

However, there are already a number of these plants built from 2001 until 2010, and evaluated in 2013, to improve the interest for new developments.

For the building owner, this solution allows to change an existing multifamily building towards a zero-energy building as the solar heat can be allocated to the building, e.g. in the Energy Performance Declaration of the building.

For the DH provider, the possibility of offering this model is a way to keep a building owner connected to the DH system. The alternative could be to disconnect from district heating and use a ground source heat pump as this is favoured by the definitions of EU Directive on performance of buildings.

Furthermore, an evaluation, financed by the Swedish DH association, is ongoing, with the aim of improving system performance and cooperation between system owner and DH provider and to develop contract guidelines and templates.

2.3.8. Bioenergy villages in northern Europe – Sweden

The business model and its replication potential

As described above (no. 12 of paragraph 2.2.), the so-called “bioenergy villages” are quickly spreading in Germany pushing the use of renewable energy sources, including solar thermal, in small local district heating grids.

Such villages are self-powered, meaning that 100% of the electricity demand as well as at least 50 % of the heat demand (space heating and domestic hot water) are covered thanks to locally produced renewable energy. Usually the initiator is not a company but dedicated citizens in co-operation with the community, local craftsmen, building companies and consulting engineers. Registered co-operatives are the most frequent form of organization chosen because they offer the citizens a high degree of co-determination and influence in combination with a limited liability risk. The financial ambition is not profit maximisation but achieving a long-term favourable price using renewable energies.

The idea for replication in Sweden is to focus on heat supply through a local DH grid, thus excluding electricity generation. Such a result can be obtained by combining solid wood boilers (chips, briquette, pellet) and solar collectors and a storage tank, together with a local heat distribution system for 100 % renewable heat. The plant and the heat distribution system will further be built and operated by a local wood fuel supplier, the local municipality or a local municipal housing company.

The stakeholders and their roles in the model

The stakeholders to be involved and their roles are different depending on the initial situation:

- Case 1: Existing solid wood fuel heating plant
- Case 2: New development

For Case 1, the following stakeholders are crucial:

- Municipality, municipal housing company and/or plant owner: They should investigate the conditions (possible placing of solar collectors, need for storage tank, etc.); if the initial analysis is positive, they should start and authorize a plan to build a solar collectors system in connection to the heating plant and heat distribution system.
- Engineering consultant: They should design the solar plant based on existing and future heat demand in connected buildings.
- Municipality or municipal housing company: They should appoint contractors for building the solar plant, including storage tank, if appropriate.

For Case 2, the following stakeholders are needed:

- Municipality or municipal housing company: They should investigate the conditions (heat demand, location of heating plant, placing of solar collectors, etc.); if the initial analysis is positive, they should start and authorize a plan to build a small local heating plant and heat distribution system and the new building development.
- Engineering consultant: They should design the plant and the heat distribution system based on existing and future heat demand in connected buildings.
- Architects: They should design the buildings.
- Municipality or municipal housing company: They should appoint contractors for building the buildings, appoint contractors for building the plant including heat distribution system, appoint an operator to operate the plant, appoint a wood fuel supplier and sign heat delivery agreements with building owners if not the same owner of plant and buildings.
- Plant operator: It should operate the plant.
- Building owner(s): They should manage the buildings.

The goals

The main goal of the replication of this German model in Sweden is to be able to develop a system, as standardized as possible, which combines the use of solid wood fuel and a solar heating plant, thus providing 100% renewable heat.

Such a system should be easily replicable in small urban and country centres with similar conditions.

A feasibility study is currently ongoing for the extension, with more buildings and more solar collectors, of one existing bioenergy village, planned to be finalized by 2014. Ongoing pre-design of a new bioenergy village model for a new development is also planned to be finalized by 2014. Both projects are located in areas south of Gothenburg where there already are a number of Bioenergy villages, e.g. Vallda Heberg, initiated before the SDHplus project and put in operation during 2013. There is also a large existing village that was transformed into a bioenergy village, based on a wood chips boiler plant and solar collectors and district heating in Ellös in 2010.