

# Low resource district heating

**Development of criteria, design and demonstration of district heating and block heating as a cost efficient way of reducing energy consumption and CO<sub>2</sub> emissions in new and existing buildings**

- **The project runs from 1. August 2008 to 31. December 2011.**
- **The project has a total budget of about € 2,9 mill. and receives support from The Danish Energy Authority, EUDP (€ 0,7 mill.) and from Central Denmark Region's Development Forum (€ 0,2 mill.)**
- **The project is carried out by nine Danish partners: Ramboll (Consultant), Advansor (Heat pump manufacture), ARCON (Solar heat panel manufacture), Brødstrup Fjernvarme (District heating plant), Danfoss (Manufacture of control, regulation equipment etc.), Nordjysk Elhandel (Electricity trading company), PlanEnergi (Consultant), Danish Building Research Institute (SBI) and Danish Technology Institute**

## 1. Objective of the project

The objective of this project is to reduce the fuel consumption and CO<sub>2</sub> emissions related to the heating of buildings by improving the operation of heat production plants and heat distribution systems. by means of cost efficient and intelligent use of district heating and block heating together with renewable energy sources.

Approximately 45 % of Denmark's greenhouse gas emissions originate from electricity and heat production. To meet the CO<sub>2</sub> reduction obligations put forward by existing and future international protocols and EU directives the heat and power sectors play a very essential role.

This project will develop and demonstrate how intelligent and efficient use of district heating can reduce the use of fossil fuels and the CO<sub>2</sub> emissions in a very cost efficient manner, and thereby changing focus away from only saving energy within the building itself.

To reach this objective the project will develop fair criteria for low resource district heating (in relation to the Danish Building Regulations), and develop and demonstrate an optimal use of district heating, produced by renewable energy resources (partly by full scale demonstration with 100 buildings in Ring Søpark, Brødstrup in Jutland partly by simulations in relation to EnergyFlexHouse). The findings will be published in a Best practice catalogue.

The project consists of four phases:

- Phase 1: Development of a method, to include renewable energy and CHP (Combined Heat and Power) from common heating solutions (e.g. district heating and block heating) in the calculation of energy demand in buildings (Danish Building Regulations 2008).
- Phase 2: Demonstration and evaluation of the benefits and interaction when a building producing renewable energy is connected to a district heating system.
- Phase 3: Development and demonstration of a highly efficient and low CO<sub>2</sub> emission decentralised district heating system utilising the flexible and intelligent energy system.
- Phase 4: Publishing of "Best practice"/Forsyningskatalog (supply catalogue): Guidelines for highly efficient and low CO<sub>2</sub> emission decentralised district heating systems, including examples with calculations.

## **2. Background**

The large distribution of district heating in Denmark is unique in an international perspective. District heating plays a mayor role in making the Danish energy system effective. District heating will also in the future be an important part of the solution for solving the demands of an even more flexible energy system, which must be able to include a larger share of renewable energy sources like wind, solar energy and biomass in an effective manner.

However, there are currently some speculations whether district heating will be needed for the new low energy building, to be built in the future.

This project takes both challenges into account, by developing and demonstrating a more advanced and efficient use of district heating, which will be able to contribute to further CO<sub>2</sub> reductions by fitting in locally produced renewable energy into the Danish energy system in such a way, that the Danish energy system becomes more flexible.

### **District heating is necessary for a low CO<sub>2</sub> emission in Denmark**

The Danish district heating system has been one of the backbones in the Danish success in increasing our energy efficiency through development of combined power and heat supply and district heating in Denmark. The result of this increase in energy efficiency is that the total energy consumption and emissions of greenhouse gases in Denmark have been almost constant for decades even though the living standard has increased significantly. Besides, almost 40 % of the fuel used for district heating is CO<sub>2</sub> neutral. Therefore are there many good reasons for why district heating will continue to play an important role in the future – ensuring cost effective and flexible use of resources (including renewable) and further CO<sub>2</sub> emission reductions.

### **District heating and block heating as an important part of the flexible energy system**

Another major benefit of district heating is the ability of the large systems to encompass a great variety of heating sources such as solar energy, various forms of biomass, biogas, heat pumps etc. Even more important is that the district heating systems and block heating systems, contrary to individual heat sources, are flexible. In periods with high prices on electricity the heat can be produced on CHP facilities producing both power and heat. In periods with very low prices on electricity (e.g. in periods with excess of wind energy) the heat can be produced by efficient, large heat pumps and electric boilers (in short periods with excess of wind energy). Likewise, heat can be produced by large solar plants producing all heat in summer periods but also a significant amount of heat during the middle seasons. Also, the heat can utilise surplus heat from large waste incineration CHP or even industries.

The increasing share of wind energy gives some special challenges due to the fluctuating electricity production. Therefore it is an unsound and inefficient solution if a certain part of the electricity production and consumption is tied to the heat production in a fixed form, as it is for small scale heat pumps and micro CHP in small individual solutions. The plan is to increase wind power in Denmark, and therefore it will become more and more difficult to incorporate the increasing fluctuating wind power production in an efficient way. Consequently flexible and integrated energy systems are needed in the future to incorporate Danish and international wind power, CHP, solar energy and other renewable energy sources in an optimal and flexible way. District heating as well as large block heating is a very important part of the flexible energy system. Efficient and flexible energy systems developed in Denmark can be exported to other countries, which also experience the same challenges as we do.

### **District heating is also very relevant in the future**

Despite the fact that most new buildings are very energy efficient, most existing buildings in Denmark use a significant amount of energy for heating purposes. The average energy consumption for heating per building in existing buildings is almost twice the amount of energy used for new buildings. Regulations put into force in the summer 2007 oblige energy distribution companies to promote energy savings at consumer level. Even so, experience and studies show that (heat) energy savings in many buildings (especially in existing buildings) are obstructed by high prices on construction materials, lack of knowledge and motivation. In fact, energy savings at building-level in district heating areas are not

always the most feasible solution in order to reduce gross energy consumption and CO<sub>2</sub> emissions. In many cases the use of surplus heat, renewable energy sources and optimising the overall efficiency of the district heating system are far better solutions environmentally, economically and socio-economically.

At present many buildings in Denmark – especially outside district heating areas - are heated by CO<sub>2</sub> polluting oil or gas boilers. Recent and ongoing studies have shown that many of those oil and gas boilers should be replaced by district heating in order to reduce gross energy consumption and CO<sub>2</sub> emissions<sup>1</sup>. E.g. in the Copenhagen region district heating solutions will be able to replace an annual natural gas consumption of more than 1,000,000 MWh with great benefits for the consumers, the overall society and the environment.

District heating can often supply heat for new and existing buildings today and in the future in the most cost efficient and environmental sound way. However, existing building regulations will within a few years obstruct further developments of district heating systems. The potential shortcomings of district heating happen as a consequence of the fact that the building regulation in Denmark favours individual heat production solutions. The regulations allow only on site heat production by renewable solutions (e.g. placed within/on the building) to be excluded from the overall energy balance – allowing the thermal efficiency of the building to be lowered (e.g. using less insulation), whereas renewable from district heating cannot be included. This principle in the present building regulations may seem reasonable when looking only at the individual building, but it seems irrational when broadening the view to a whole area of (new) buildings, because in practice it excludes larger and much more cost efficient central renewable energy solutions and CHP. Hence, new buildings which can be supplied by large efficient district heating or block heating system cannot take this efficient supply into account, and therefore individual, less efficient heat production solutions, often based on fossil fuels, has to be installed.

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<sup>1</sup> E.g. preliminary results from the project: Varmeplan Danmark, which is supported from Danish District Heating Association F&U office, shows that it is feasible to increase district heating from the current 60 % to 75 % of Denmark's heat use.

## 4. Project description

The Danish district heating system has the potential to continue its role as the spine of the Danish energy system. District heating is the most cost-effective way of fitting in surplus heat from waste incineration, CHP and industry and different types of renewable energy technologies into the energy system of the future and gives the possibility of including more electricity from wind and other renewable sources. District heating creates the possibility for flexible energy usage and can act as storage for the fluctuating energy production, and can fulfil the need for heat and cooling in buildings.

All these benefits should be considered in a time where district heating is under pressure from energy saving measurements in existing buildings as well as a declining need for heating in all new building, and simultaneously taking into account an increase in the need for cooling in numerous buildings. The intensification of the energy savings effort is true fuel-saving measurements and consequently obtaining reduced CO<sub>2</sub> emissions. One-sided focus on a reduction of the energy need in new building will enforce a distortion of the entire energy system, undermine the basis for the flexible energy system, and simultaneously be a very expensive method to reduce the fuel need and coherent CO<sub>2</sub> emission.

This project will clarify these big challenges, both with regard to creating new standards of how to exploit and include the benefits of district heating supplying new and existing buildings and with regards to generating new technological concepts for district heating which, beyond application in Denmark, also is applicable for export. An increased use of flexible district heating and district cooling abroad/the EU is assessed to be absolutely necessary, if the scheduled deadlines for energy saving measurements, renewable energy and deriving CO<sub>2</sub>-reductions are to be achieved within the fixed time limits.

This project consists of four phases, Project management & dissemination:

	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32	M33	M34	M35	M36	M37	M38	M39	M40	M41	M42
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Phase 1: Development of a method to include renewable energy and CHP from common heating solutions (e.g. district heating and block heating) in the calculation of energy demand in buildings (Danish Building Regulations 2008).

Phase 2: Demonstration and evaluation of the benefits and interaction when a building producing renewable energy is connected to a district heating system.

Phase 3: Development and demonstration of a highly efficient and low CO<sub>2</sub> emission decentralised district heating system utilising the flexible and intelligent energy system<sup>2</sup>.

Phase 4: Publishing of "Best practice"/Forsyningskatalog (Supply catalogue): Guidelines for highly efficient and low CO<sub>2</sub> emission decentralised district heating systems, including examples with calculations.

Project management & dissemination

The main aim of the project is to focus on new buildings, however there are also relations to existing buildings:

1) The new building regulation is also in force for total rehabilitation of existing buildings and heating installations

2) For new buildings or rather a group of buildings in districts without district heating there is an opportunity to establish block heating and use more efficient production of renewable energy from the block heating plant. Thereby there is an opportunity to supply neighbouring individually supplied existing buildings from this block heating plant. As the plant thereby, by definition, will be a district

<sup>2</sup> Note: A part of the demonstration project included in phase 3 has been granted by the Vækstforum Midtjylland. The Vækstforum Midtjylland has expressed great faith in and high expectations for this project to become a state-of-the-art solution of the flexible energy system. A more precise description of the granted part is given in 4.3.

heating plant. The plant could be the beginning of a new district heating system in the city district. Therefore it is even more obvious that the developer of the new block heating system should consider to let one of the nearest district heating companies take care of operation of the plant and eventual also assist in implementing the block heating.

3) It is not feasible to install district heating in some areas with existing building today, but the development of a more efficient low resource district heating, with low CO<sub>2</sub> emission, can result in that it in the future is feasible (economically and environmentally) to install district heating in those areas with existing buildings.

**Phase 1: Development of a method, to include renewable energy and CHP from common heating solutions (e.g. district heating and block heating) in the calculation of energy demand in buildings (Danish Building Regulations 2008).**

Existing Danish Building Regulations (BR08) does not encourage the use of highly efficient and renewable energy-based district heating and bloc heating and thereby does not encourage an efficient use of fuels for heating. The method to include different energy sources in the method to calculate the energy demand of buildings (BR06) is only stated by the Danish Energy Authority. Accordingly, existing regulations allow low energy class 1 & 2 (LE1 & LE2 according to the BR08) buildings to be exempted from even very efficient and/or renewable energy based collective heat supply systems. Furthermore, building regulations state that renewable energy produced within the building/property can be subtracted from the total energy consumption of the building, whereas heat produced on larger and more efficient renewable energy units placed on another site/land register cannot be included. The dilemma is illustrated below:

Renewable energy solutions	Primary energy factor <sup>3</sup>	Energy factor used in BR08
Individual solutions	0	0
Collective solutions (district heating, bloc heating etc)	0	1

This means that currently:

**Heat produced on efficient, large-scale district heating and bloc heating units based on surplus heating or renewable energy with no CO<sub>2</sub> emissions is significantly hampered by the building regulations in place, favouring the utilisation of less efficient and expensive individual heating solutions. This is impeding a convenient development of a flexible energy system with many different renewable energy solutions.**

Compared to individual solutions common heating solutions as bloc heating and district heating posses as number of extraordinary benefits:

- More efficient units due to large-scale production
- More cost-effective units (for renewable energy solutions, the investments of large scale production facilities are typically less than one fifth of individual facilities)
- Reduced emissions and less use of fossil fuels
- Flexible solutions allowing swift change among most appropriate fuels/resources depending on the actual wind speed, amount of water in the big dams of Scandinavia, the price of the power, the amount of sun etc

The flexibility of the district heating systems related to the use of energy resources becomes even more important as the need for a flexible energy system increases. A predominant requirement of e.g. enhancing the wind power production in Denmark is that the heating production sector becomes capable of using power for heat production (e.g. on heat pumps) in situations of surplus production of electricity, and that the sector is able to produce electricity power when the electricity is needed.

<sup>3</sup> The relation between the amount of gross energy used to produce the heat and the heat produced.

The overall goal of several EU directives, including the Building Directive from 2002, is to reduce not only the heat consumption but the gross energy consumption, used to produce the heat. Furthermore, the Building Directive states that measures taken to increase the energy efficiency of buildings shall include not only local environment and indoor climate, but also the climate in general AND cost efficiency. Hence existing Building Regulations (BR08) in Denmark does not comply with the overall goals of EU legislation, because it is hampering the benefits of low resource/CO<sub>2</sub> cost-efficient district heating.

In order to make it possible to choose the most cost effective reductions of greenhouse gas emissions and gross energy consumption, this project aims at developing a scheme introducing primary energy factors of renewable energy solutions placed outside the site/land register of the building, and demonstrating how to reduce the primary energy factors on a common, decentralised natural gas-fired plant in Denmark.

This part of the project will develop and prove a method based on primary energy factors, including renewable energy from district heating/bloc heating in the calculation of energy demand in buildings (Class Low Energy 1 & Low Energy 2 in Danish Building Regulations 2008 (BR08)), and setting up criteria for low resource district heating, and how it is fitted into LE1 & LE2 and the practical use of the Building Regulations.

Relevant players like the Danish Energy Authority, the Danish Enterprise and Construction Authority and SBi will be involved in the progress, and a report will as soon as possible be published.

The criteria for low resource district heating will be developed by using the primary energy factors and hereby assessing the fuel used to produce the heat taking into account the use of surplus heat from waste incineration and industry, heat from CHP production, solar heat, geothermal heat etc.

The criteria will subsequently be tested and calibrated as described in **phase 3**.

#### **Tasks in phase 1:**

**Task 1.1: Development of criteria for low resource district heating based on primary energy factors (PRF)**

**Task 1.2: Testing of the methods and criteria put forward**

**Task 1.3: Assessment of the economical consequences**

**Task 1.4: Implementation plan for use of low resource district heating**

## **Phase 2: Demonstration and evaluation of the benefits and interaction when a building producing renewable energy is connected to a district heating system.**

The project will utilise the coming *EnergyFlexHouse*<sup>4</sup>, built by Danish Technological Institute by simulating the connection of a district heating system. The simulation will be used partly for testing and demonstrating how a low energy building can cooperate well with a district heating system, partly for presenting the concept in relation to the 'UN Climate Change Conference' in December 2009.

It is expected that a more advanced/efficient use of the district heating network as both technical and economical buffer will support the construction of low energy buildings, which are producing renewable energy.

Is it a good idea to connect low energy houses, which are producing energy to district heating? Demonstration and evaluation of the benefits and interaction when a building producing renewable energy is connected to a district heating system. (District heating as a part of the *EnergyFlexHouse*) Establish objective evaluation criteria for renewable district heating low energy solutions.

The development and demonstration of the *EnergyFlexHouse* connected to district heating will of course interact with "Brødstrup full scale demonstration" (Phase 3), so developments, methods and experiences are shared.

### **Tasks in phase 2**

**Task 2.1: Flexible district heating low energy concepts in general and for the *EnergyFlexHouse***

**Task 2.2: Simulation of district heated *EnergyFlexHouse* for Climate conference 2009**

**Task 2.3: Evaluation and conclusion of district heated *EnergyFlexHouse* for Climate conference 2009**

## **Phase 3: Development and demonstration of a highly efficient and low CO<sub>2</sub> emission decentralised district heating system utilizing the flexible and intelligent energy system**

In case of large (centralised) combined heat and power plants the primary energy factor can be lower than 0.5 due to a large usage of surplus heat from waste incineration, industry and efficient power production. Decentralised district heating plants on the contrary do have rather high primary energy factors due to a compulsory use of natural gas and the absence of surplus heat from industry and large-scale CHP production.

This part of the project (Phase 3) will aim at developing and demonstrating a low resource system/concept, which with regards to low resource factors/primary energy factors will be at the same level as large central district heating plants. The entire district heat supply chain from production to use will be optimised and demonstrated. The project will include efficient heat production with renewable energy, optimising the district heating system (reducing heat loss by using extra insulated pipelines, optimising dimensions and length of the pipelines, better and more intelligent control systems), and involving the users.

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<sup>4</sup> *EnergyFlexHouse*

Danish Technological Institute is building three houses, called *EnergyFlexHouse*, which will demonstrate how it is possible to make low energy houses, which are producing renewable energy in various ways at house level. A family will live in one of the houses, so the interaction also is tested.

The objective of the *EnergyFlexHouse* is to establish unique test and demonstration facilities for renewable low energy solutions. Especially the *EnergyFlexHouse* aims to present Danish solutions in relation to the UN Climate Change Conference in 2009 ('Climate 2009 Climate conference').

*EnergyFlexHouse* is supported by The Danish Ministry of Science, Technology and Innovation

## District heating for Brødstrup, Ring Søpark 1

A project like this with decentralised solar energy placed at various sites in the area has never been done before. Similarly, CO<sub>2</sub> heat pumps inserted in a district heating system must be considered as innovation. The outlined district heating project is thus to a great extent a development project as no similar, optimised CO<sub>2</sub> neutral systems have ever been built before. Therefore the system can be characterised as 2<sup>nd</sup> generation of district heating. Consequently, a more detailed analysis is needed for development of technological and feasible solutions. Some of the components are well-known technology, but the combination and the interaction between them and the controlling system is new.

The district heating system developed in this phase will consist of:

- Approximately 15 decentralized solar heating panels each around 70 m<sup>2</sup> integrated in the roof of private houses
- 2.000 m<sup>2</sup> collective solar heat panel
- 1.000 m<sup>3</sup> storage tank
- 1 MW heat pump

The 15 decentralized solar panels will be integrated in the roof of private houses in an architectural beautiful way. The solar panels will a lot of the time produce more heat that the house itself uses. The surplus heat will be put into the district heating system so other houses can use the heat. This way area for solar panels can be saved. The decentralized solar panels will be supplemented with a 2.000 m<sup>2</sup> collective solar heat panel, a 1.000 m<sup>3</sup> storage tank and a 1 MW heat pump. This new district heating system will be connected to Brødstrup District Heating plant (in Jutland, Denmark), which is a CHP with a 8.000 m<sup>2</sup> collective solar panels.

All the renewable energy elements (decentralized and central solar panels, storage tank and heat pump) will result in a low energy factor, and the combination with the CHP will ensure secure heat supply.

The new district heating system will supply both existing building (60) and new buildings (100).

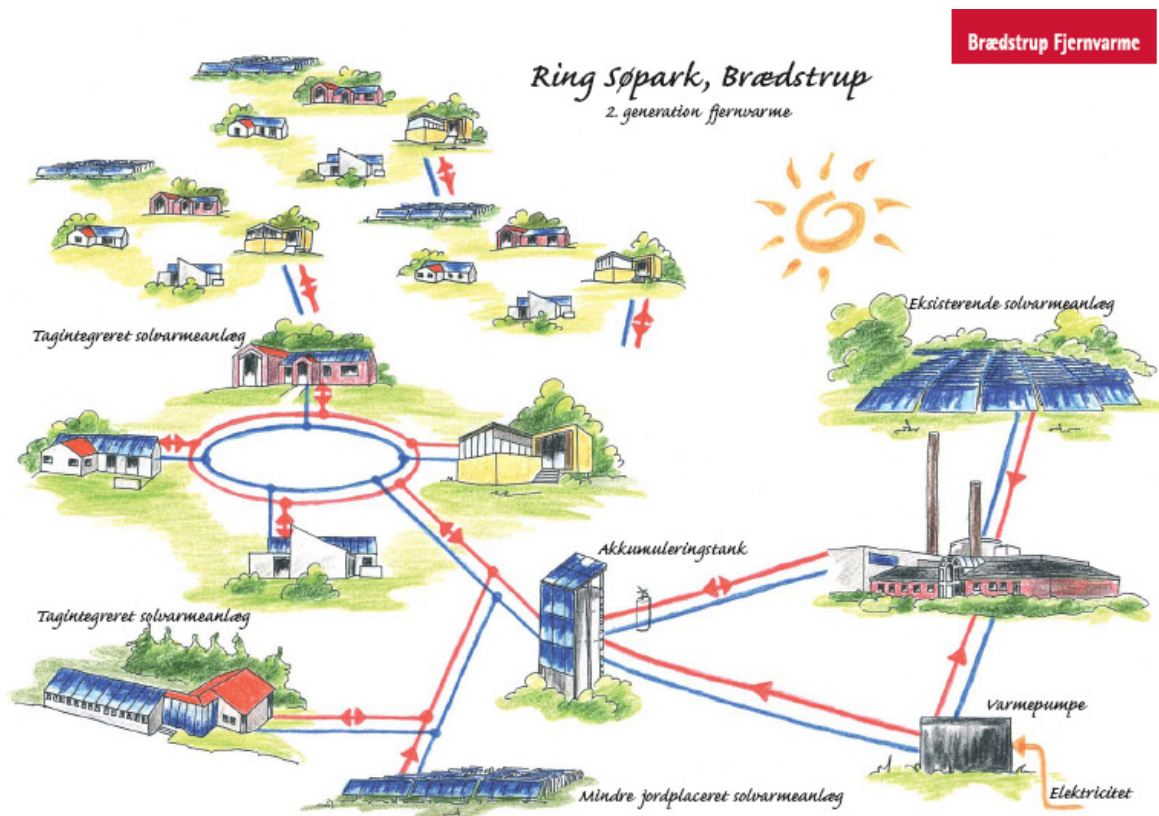


Figure 1: Illustration of the proposed new low resource district heating system Brødstrup, Ring Søpark 1

It is emphasised that this part of the project is not only relevant for Brødstrup, the technique and methods can be applied everywhere in Denmark as well as internationally where district heating can be applied.

This part of the project will develop and demonstrate a highly efficient and low CO<sub>2</sub> emission decentralised district heating system in Brødstrup. The results will be obtained by using renewable energy sources to an extent not yet seen in a decentralised district heating plant in Denmark, utilising and combining renewable energy solutions such as solar heating and heat pumps, also the district heating system and network will be optimised from production to consumer – altogether minimising the primary energy factor of marginally produced heat to a very minimum.

Typically major collective heat supply installations are many times more efficient than individual heat supply solutions (household solutions) compared to the necessary investments. A report made by Ramboll for Danish Energy Agency in 2005/2006 revealed that district heating of new housing areas built according to the latest Building Directive will be a far better solution from a socio-economic perspective than individual heating solutions based on fossil fuels, biomass fuel, solar energy, heat pumps or a combination hereof. Besides, in the actual study, no account was taken if the considerable optimisation possibilities in the district heating systems, which this project is to document.

**Fact: Several theoretical studies show that district heating with renewable energy (e.g. solar heating) has large benefits.  
[But demonstration to confirm the results of these studies is needed to support the development towards such low resource district heating systems]**

In spring 2006 Energinet.dk was leading a working group who was to draw up a report on solar energy in district heating areas. Among others, the report concluded:

*"The overall conclusion is that as well district heating consumers as the producers of energy and the environment will profit from solar energy. Solar energy in district heating areas with a high degree of environmentally friendly electricity from especially wind power, will contribute positively to the running of an electricity market where criteria for success are flexibility and ability to react on price fluctuations."*

In 2006 the Danish Society of Engineers (IDA) prepared the "Energy Plan 2030". The basis of the plan was formed at about 40 seminars, meetings and conferences with a wide participation from more than 1600 engineers and other professionals from the energy sector.

The purposes of the Energy Plan were to show how the CO<sub>2</sub> emissions could be cut by the half, how exports of energy technologies could be multiplied and how the self-sufficiency rate could be maintained in 2030. On the background of wide-scale technical analyses of systems and socio-economical evaluations of the consequences, the Energy Plan explains how the goals can be achieved – with an important and very significant economic and environmental benefit to the society. In the Energy Plan the IDA writes among other:

*"It is obvious to continue the development of large-scale solar heating facilities for district heating systems, which do not already have CO<sub>2</sub>-free surplus heat during the summer as the district heating often has heat storage facilities, and since large facilities and heat storage facilities for district heating are more cost efficient than individual solar heat systems."*

### **Tasks in phase 3**

**Task 3.1: Analysis, optimization and design of district heating in Brædstrup/Ring Søpark 1 and integration in the overall energy system**

**Task 3.2: Detailed projecting of district heating in Brædstrup/ Ring Søpark 1**

**Task 3.3: Contracting with local owners for establishing collective solar heat panels**

**Task 3.4: Establishment of the buildings and the low resource district heating system**

**Task 3.5: Initialization of the efficient low resource district heating system**

**Task 3.6: Monitoring of the system and dissemination in the area**

**Task 3.7: Do the demonstrated results correspond with the calculation?**

#### **Phase 4: Publishing of "Best practice"/Forsyningskatalog (Supply catalogue): Guidelines for high efficient and low CO<sub>2</sub> emission decentralised district heating systems, including examples with calculations**

The results from phases 1, 2 and 3, as well as Danish and international data and results will be collected, processed and assessed. Best practice for the future decentralised district heating of both existing and new buildings will be developed. It is very important to improve the current district heating, and to have public best practice guidelines for how to improve district heating, because a very large number of the decentralised district heating plants will need to be replaced or renovated within the next 10 years. Implementation of more efficient low resource district heating will result in large reductions of greenhouse gas.

It is very expensive to insulate a house, so it comply with the specifications of Low Energy House class 1 & 2 (LE1 & LE2). In general it cost about 10-15% extra to build a LE2 house compared to an ordinary BR08 house, and extra 10-15% to build a LE1 house compared to a LE1 house, and it is much more expensive to insulate existing buildings. If the criteria for including low resource district heating, which is developed in phase 1 is accepted in a new Danish Building Regulation, then it is probably better (socio-economically) even for new buildings to spend some of the "insulation money" on low resource district heating. This aspect will be also assessed in this phase.

The best practice criteria will be illustrated on different Danish district heating systems and areas with calculations and examples.

#### **Tasks in phase 4**

##### **Task 4.1: "Best practice"/Forsyningskatalog (Supply catalogue)**

## Partner description

### **P01 Rambøll**

Rambøll is Scandinavia's largest consulting engineer company; its Energy division has in many years been engaged in worldwide development of security of supply, environment, value for money as well as efficient and renewable energy solutions. Rambøll has specialised in consultancy within the area of energy and possesses expertise ranging from climate changes and the impacts of the free market forces over various kinds of energy facilities to renewable energy.

Rambøll's energy projects and assignments have given broad and international experience and not least an understanding that energy encompasses technical aspects, economy, policy and environment. Rambøll's experience covers the entire energy infrastructure, from planning, strategies and studies to procurement, design, operation, maintenance and management.

Web: [www.ramboll.com](http://www.ramboll.com)

### **P02 Advansor**

Advansor develops and produces refrigerating plant and heat pumps with natural cooling agents for e.g. heat and coldness in CHP plants, and has leading international competences in the use of CO<sub>2</sub> as cooling agent. Advansor creates solutions which pay back through operational savings. Analysis and consultancy are natural parts of our services, which always ensure our costumers optimal and adjusted solutions.

Web: [www.advansor.dk](http://www.advansor.dk)

### **P03 ArCon Solvarme A/S**

ARCON Solvarme A/S is a member of Solarcap A/S, one of Europe's leading solar heating manufacturers, who sells under the brand SONNENKRAFT. ARCON was founded in 1974 and has over the last 35 years developed a business and expertise in solar plants of middle size and large size. As a part of the Solarcap group, ARCON has today a wide range of products to solve any task regarding solar heating. ARCON has built more than 70 solar plants >100 m<sup>2</sup>, 12 of them >1,000 m<sup>2</sup>, for instance Marstal District Heating which is 18,000 m<sup>2</sup>.

Web: [www.arcon.dk](http://www.arcon.dk)

### **P04 Brædstrup Fjernvarme**

Brædstrup Fjernvarme is a district heating company which produces heat and electricity in a Combined Heat and Power-plant (CHP). The plant is using natural gas as fuel in combination with a solar plant..

Brædstrup Fjernvarme is very engaged in developing new technologies for increasing the efficiency and the environmental conditions for both the production and the distribution systems. For example, in 2007 the company established one of the world's largest solar heating plants, which is driven in combination with a CHP. The plant consists of 641 solar modules - 8.015 m<sup>2</sup>.

It is expected, that the plant will produce 4 mill. kWh non-polluting heat-energy per year and reduce the CO<sub>2</sub> emission with 4,500 metric tons per year.

Web: [www.braedstrup-fjernvarme.dk](http://www.braedstrup-fjernvarme.dk)

### **P05 Danfoss**

Danfoss is an international company who has expertise in among others: control, regulation and surveillance of energy supply systems including heat installations.

Web: [www.danfoss.com](http://www.danfoss.com)

### **P06 Nordjysk Elhandel**

Nordjysk Elhandel A/S (NEAS) handles the sale of electricity production at the different markets from more than 100 decentralised co-generation plants in Denmark and 600 MW of wind power. Besides, it is the third largest electricity trading company in Denmark. NEAS also sells electricity to both private and industrial consumers on different types of contracts and supplies consultancy services to all consumers, producers and traders with CO<sub>2</sub> quotas. It is owned by four electricity distribution companies.

Web: [www.nordjysk-elhandel.dk](http://www.nordjysk-elhandel.dk)

### **P07 PlanEnergi**

PlanEnergi is an independent consultancy firm specialising in renewable energy, environment, sustainable systems, energy planning and technology transfer. PlanEnergi has been involved as planner/adviser in most of the Danish solar district heating systems: Marstal (18,000 m<sup>2</sup>), Ærøskøping (5,000 m<sup>2</sup>), Ulsted (5,000 m<sup>2</sup>), Brødstrup (8,000 m<sup>2</sup>), Nordby (2,500 m<sup>2</sup>). PlanEnergi has assisted SBI in implementing the European Standard for calculation of solar thermal systems in building in the Be06 calculation tool.

Web: [www.planenergi.dk](http://www.planenergi.dk)

### **P08 Danish Building Research Institute, SBI at AAU**

SBI is part of Aalborg University and performs research and development in the building area. SBI is responsible for the development of the Danish method to calculate the energy demand in buildings in relation to the energy requirements in the Danish Building Regulations. SBI is also supporting the Danish Enterprise and Construction Authority and the Danish Energy Authority in the development of the energy requirements in the Danish Building Regulations.

Web: [www.sbi.dk](http://www.sbi.dk)

### **P09 Danish Technological Institute**

Danish Technological Institute is an independent and not-for-profit institute that provides and processes research and technology-based knowledge for the Danish trade and industry and participates in development projects in co-operation with companies and research institutes in Denmark and abroad. DTI has been active in relation to technology for district heating and renewable energy since the late 1970s and has within those fields been responsible for or involved in more than 100 R&D projects. The Institute also has considerable test and calibration facilities.

Web: [www.teknologisk.dk](http://www.teknologisk.dk)

### **For further information regarding this project, please contact:**

Project Manager: Jesper Møller Larsen, Ramboll; JEML@ramboll.dk

or

Co-project Manager: Peter Holm, Ramboll; PTRH@ramboll.dk

### **Regarding phase 2: Interaction between *EnergyFlexHouse* and district heating**

Please contact: Kaj Bryder, Danish Technological Institute; kaj.bryder@teknologisk.dk

### **Regarding phase 3: District heating for Brødstrup, Ring Søpark 1**

Please contact: Per Kristensen, Brødstrup Fjernvarme; pk@braedstrup-fjernvarme.dk