

# Renewable Energy Islands The Danish Energy Way

## Samsø-100% RE island

In the Danish Action Plan, Energy 21 from 1996 it was decided that the government should work on the designation of a local area which should change its supply of energy to local RE sources.

As a result of this commitment the Danish island Samsø was chosen in 1997 among five competing islands, to be powered and fuelled by renewable energy only - including the transport sector-within the next decade. On Samsø they are busy planning and carrying through the ideas, in order to provide the island with renewable energy sources and to live up to the expectations involved in the appointment.

Being chosen as a renewable Energy Island does not mean that the energy agency/ Government decides and pays everything. Without the contribution of the population, there will be no RE island.

There has been local involvement in all the projects. For instance, local workshops have been set up in the district heating areas. Working groups use their influence on the projects concerning ownership. Also in relation to wind turbines, citizens meeting are being held concerning ownership, visual impact on offshore wind farms, etc.

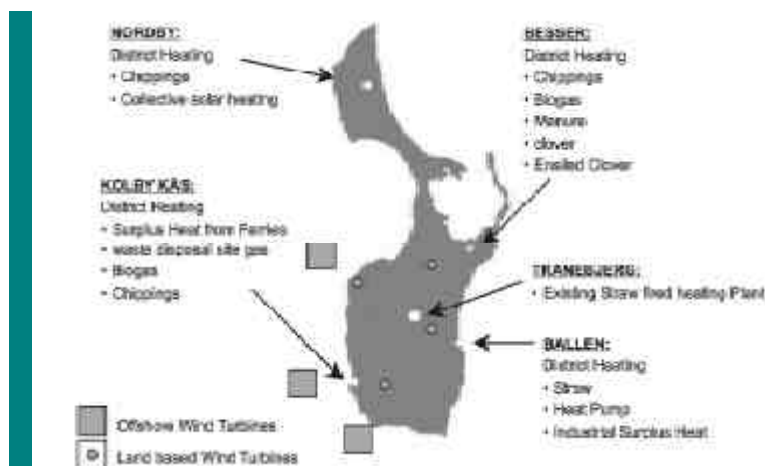
In 1999 Denmark covered approximately 10% of its energy consumption (840 PJ), with renewable energy (80 PJ). These 80 PJ were originated as follows: 317 TJ solar energy, 10.9 PJ wind energy, 20 PJ bioenergy wood, 13.7 bioenergy straw, 2.6 PJ biogas, 29 PJ waste, 3.6 PJ heat pumps.

Denmark has one officially nominated Renewable energy island, Samsø, a county in Jutland that is covering more than 100% of its electricity consumption with wind, and several other renewable energy societies and RE-technologies are flourishing in the backgarden.

Of course, the RE island Samsø will be of interest in this matter and so will our other self-grown RE societies such as Ærø. We find information and dissemination of results of great importance, and we have already had a European RE island conference on Samsø in 1998, with representatives from 14 countries and presentations from 10 islands all over Europe. A global conference with focus on RE in island states took place on Ærø in September of last year. Both conferences were supported by the Danish Energy Agency and the EU Commission. The island of Læsø is also working with RE-plans for the future energy solution.

## The Samsø plan

Samsø is an island of 114 km<sup>2</sup> with a population of approx. 4,400 people. There are ferry routes to Sealand and Jutland, and the island is visited by a large number of tourists. Total energy consumption is about 900 TJ/year, corresponding to about 4.8 tonnes oil equivalent per person per year. Converting the energy supply system



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to renewable energy is therefore a big task, and success depends on the use of many different technologies.

Roughly 340 TJ of energy consumption is used to heat buildings. Intensive cuts involving additional insulation and renovation of buildings, as well as the introduction of energy control in companies and public buildings, will make it possible to reduce the heating requirement by 20 %. Before the plan, 13% of the heating requirements were covered by a collective strawfired heating plant in the main town, Tranebjerg. Establishing 4 new plants would make it possible for collective plants to cover 65% of the islands heating requirements.

The plan consists of five cornerstones:

- 1) Energy saving and increased efficiency: (20% cut in the 340TJ for heating in buildings)
- 2) Expansion of collective heating supply systems with 4 locally based systems fuelled with RE (wood chips, central solar, biogas)
- 3) Expansion of individual heating systems using heat pumps, solar heating, biomass, etc.
- 4) Establishment of land based and offshore wind power plants to cover the electricity consumption and to compensate for use of fossil fuels in the transport sector.
- 5) Savings in the transport sector and gradual conversion of the transport sector from petrol and oil to electrical power. (5% reduction of traffic, 15 % reduction of energy consumption by using electric vehicles. Still this leaves 250 TJ fossil fuels. (1/3 for the ferries). 75 % should be produced by wind turbines the rest by biomass and solar cells.

It will take app. 600 mio. DKK to carry out the plan over a 10 year period, and it will create 45 fulltime job in this period and 30 permanent new jobs in the island energy sector.

### Status of the activities and further activities

Individual solutions outside district heating systems

Maarup port: Solar heating plant at the harbour of Maarup, Samsø.



A public campaign for the promotion of RE energy installation together with ongoing local efforts has resulted in a strong rate of growth. About 100 thermal solar units have been installed on private houses and there are solar installations in the ports, on a youth hostel, campsite, and a holiday camp. More than 20 households have volunteered to be hosts for a new concept of combined room and domestic hot water heating from a solar heating plant. 75 biomass boilers/ovens for wood logs, pellets, wood chips or grain, about 20 heat pumps, mostly soil heat pumps, have been installed. More plants are to be installed in "the open land" in the year to come.

### Energy conservation

A national programme reimburses pensioners up to 50% of their energy conservation investments (up to a maximum reimbursement of 25,000 Danish crowns). After a direct mail campaign 92 island pensioners have participated in this programme, resulting in insulation work and the installation of new windows, etc. for almost 3 million crowns in 1999 and 2000.

### District heating plants

Citizen groups from two of the district heating areas have decided that the electricity utility ARKE (now NRGi) is going to establish the two plants. Market analysis on the local interest for joining a district heating scheme has taken place, because

an important factor will be the amount of interest from homeowners when they are asked to sign up. The Municipality of Samsø guarantees the necessary loans. In 2000 the final contracts with the interested homeowners could be signed in Nordby/Mårup area. The heating plant here will be based on wood

chips and other available biomasses as well as a solar heating system with 2500 m<sup>2</sup> solar heaters. NRGi will continue the implementation of the district heating scheme in Ballen and Brundby. Samsø Energy Company and the Samsø Association for Energy and the Environment contacted local citizen groups in Onsbjerg and Kolby/Kolby Kås to raise the issue of local district heating schemes in each respective area. Onsbjerg has decided to establish a straw-based district heating plant. NRGi and a local entrepreneur have been invited to make bids on the construction and operation of the plant. In Kolby and Kolby Kås the current question is whether or not excess heat from the Sealand ferry can be used for district heating purposes.

### Disposal site methane gas

Samsø Energy Company and a local farmer have investigated the possible exploitation of methane gas from the recently closed landfill site. With financial support from The Danish Energy Agency, the installation was established in autumn 2000. The farmer invited other islanders to join him in this economic venture, and a co-operative was born - Samsø Deponigas I/S. The methane gas runs a 15kW motor/generator. The excess heat is not (as yet) utilised. The electricity is sold to the grid (NRGi). The installation is still being adjusted, but has operated satisfactorily to date in 2001. Island officials have taken note of the positive results in this process and started another feasibility study, a larger installation at the present disposal site. The gas chimneys and piping can be established as the site is filled. The utilisation of the methane gas will depend on its volume and quality, but the second phase will heat site buildings and/or generate electricity.

### Energy Crops

20-30 hektars of Elephant grass will be planted in 2001. 12 farmers have agreed to grow these new crops on their marginal acreage. The Elephant grass will be used as biomass fuel in the district heating plants.

### Wind turbines.

The enormous local interest of establishing wind turbines on Samsø has been significant for the rest of Denmark: 40 private people have applied for permit to establish solo - wind turbine on their own land, but only 15 wind turbines was allowed by the planning authorities.

One could expect this matter to end up in a dogfight. But after a public hearing and a successful citizens meeting and negotiations, the final result is 11 wind turbines of each 1 MW installed in 2000. The turbines are a mixture of single owned and cooperative owned. This ownership model has been the driving force in the diffusion of wind turbines in Denmark. Two of the windmills are owned co-operatively by Samsø Vindenergi, while local farmers privately own nine. A planned Energy Foundation will receive annual donations from the windmill owners. These funds will be made available for public energy projects on the island.

The plan was to cover approx. 75% of electricity with RE, however, with the new turbines Samsø covers roughly 100 % of its electricity consumption with RE.

### Offshore

The first planning phase for a 22.5 MW offshore wind farm south or west of Samsø began in the autumn of 1998. The result of a hearing is a suitable area south of the island, Paludans Flak. The second phase started in April 2000 including detailed planning of the actual site, the exact wind turbine siting, environment impact studies, etc. The work is funded from the Danish Energy Agency. The study will place 10 windturbines oriented in a straight line from north to south, with the first windmill about 3½ km. south of Samsø. The choice is between 2-, 2½- and 3 MW turbines. The hearing of all implicated parties will take place in the spring of 2001. If the Agency then approves the project, the final specifications and organisational preparations can begin in the summer of 2001 and the windturbines can be erected in the fall of 2002.



WT Samsø: 3 of the 1 MW wind turbines erected at Tanderup, Samsø in 2000.

The offshore wind turbines will produce the same amount of energy as consumed in the transportsector, and thus compensate for this consumption. This energy can later on supply electric cars and hydrogen fuel cell cars.

### Future plans:

In 2003 a local heating network in Ørby is planned to be supplied from an existing strawboiler at the estate of Brattingsborg. In the year 2004 biogas and biomass plants shall be established producing hot water for district heating and electricity. The district heating areas are Besser, Langemark, Torup and Østerby.

In 2005 a hydrogen plant will be established to separate water into hydrogen and oxygen. The plant will be powered by electricity from the offshore wind turbines.

The hydrogen will then supply the transport sector. There shall also be a filling station, and the plan is to convert petrol cars to be driven by hydrogen.

Neighbourhood district heating uses smaller plants for villages, usually supplied from neighbour farms with existing boilers and a surplus of biomass production. Such plants are planned for Tanderup, Hårdmark and Pillemark.

Farmers will begin to deliver wood-chips from their own energy willow areas.

The objective for 2007 - after 10 years with the plan: 100% renewable electricity. 60-80% of heatings produced with renewables and 15-20% of transportation supplied directly by renewables.

### Ærø - tradition with RE

Ærø is an island of 90 km<sup>2</sup> with a population of approx. 7,600 people.

Ærø has traditionally been a RE island in Denmark, as it has worked with RE since the early 80s, and covers 56% of its energy with RE in 2001. Ærø, of course, joined the competition but did not receive the honour, and one could have expected that they would disregard it; but on the contrary: it seems as if the Government support for Renewable Energy Islands gave them a new start, so they continued their work with even more effort. Ærø is approx. 4 times as densely populated as Samsø - with small farms and not much surplus biomass. On the other hand there is a lot of wind and solar energy.

The project Ærø - a renewable energy island - runs from 1998 to 2008. The plan is to cover the islands energy consumption 80 - 100% with renewable energy.

The plan is:

- 1) Wind to cover 100% of the electricity consumption (5- 6 x 2 MW wind turbines = 40 mio kWh, owned by private individuals and shareholders)
- 2) Three district heating plants with some RE (Solar, straw, wood chips)
- 3) Neighbourhood heating (Solar - wood pellets)
- 4) Increasing amount of biomass (new hedges, fences energy crops)
- 5) Energy savings. (Visits to private

households, energy audits)

### Status on Ærø:

In 2000 Ærøskøbing District heating was able to supply its 550 customers with 100 % RE. The last phase of the 4,900 m<sup>2</sup> solar collectors array was opened in May 2000, and a 950 kW wood pellet boiler was installed. Together with the existing straw boiler there is no need generally for for the use of oil.

Marstal District heat was promised a grant of Euro 810,400 in order to double the area of solar collectors to 19,000 m<sup>2</sup> and to build another underground storage tank - this time a pitstore of 10,000 m<sup>3</sup>. The consumers have approved the project, and with the extension the RE share of Marstal District heating Plant will reach 30%.

In Rise Mark 3,600 m<sup>2</sup> solar collectors and a wood pellet boiler in conjunction with a 4,000 m<sup>3</sup> storage tank will supply 100% renewable energy to St. Rise and Dunkær, two villages. Rise District heating plant has now 197 members of which the school and the old peoples home will be the main consumers. The procedure with the Danish Energy Agency took approximately one year

### Wind turbines

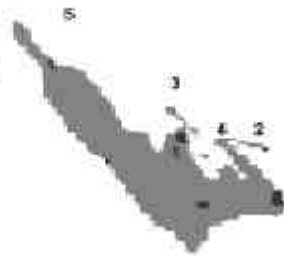
EEl report is expected in April 2001. The plan is that 5 - 6 large wind turbines shall cover 100% of the amount of the electricity needed. After the EEl report the county of Funen has to consider the project, and an additional clause to the regional plan has to

Aero-wvc: Solar panels of the 9,000 m<sup>2</sup> solar heating plant in Marstal, Ærø.



### Existing renewable energy sources

1. Læsø Windpark:  
11 small Wind turbines from 1988 on 554kW.  
Monocover: 11 single wind turbines 55-480 kW across the island.
2. Marstal District Heating  
Use Woods-Boilerwater heating plant, 6000 m<sup>2</sup> solar collectors.
3. Ærøskøbing District Heating plant-Straw



### Future Projects

4. St. Rise  
Small District Heating system based on wood chips and solar heating.
5. Rise  
Small district heating system based on wood chips and solar heating.
- Other Plans:  
Plans for 4 large wind turbines  
Replacement of the old and small wind turbines on the islands.

be worked out. However, the county has given Ærø priority as one of the places where large wind turbines may be erected so even if it has taken a long time with the planning, the wind turbines will probably be erected.

*Summing up:* How close are Ærø to cover 80 - 100% of its energy consumption with RE? The share of RE installations in the open country covers approx. 21% of the islands total energy consumption of 115,000 MWh. This coverage will reach 24% when the Rise District Heating Plant is up and running. With the extension of the solar field in Marstal RE will cover 27%. The new wind turbines, which will cover 100 % of the electricity production will mean that 56 % of the energy consumption on Ærø comes from renewable energy. At the moment effect are made to improve energy efficiency in buildings, and thereby it is expected to add yet another couple of %. This is the most conservative guess, as there are probably more individual RE plants than the ones registered.

### Starting new initiatives and supporting ongoing activities

These two islands can be seen as examples of the different types of contribution from the Danish Energy Ministry in order to support and create RE islands:

The Samsø case, where a more or less virgin island as to renewables gets the

inspiration from a national competition, encouraging people to commit themselves to become 100% renewable - (by joint forces in order to reach the goal) with all the local contribution and cooperation that takes.

And Ærø, where governmental policy supports already ongoing initiatives - and the support to Ærø has not been decreased even though Samsø is the official RE island - neither has the local engagement. A third island, Læsø, might become more engaged with renewable energy if self sufficiency with RE turns out to be a better solution than a new electricity cable to the main land.

### Information - dissemination

Samsø was chosen as host for the first European Seminar on Renewable Energy islands because the island in 1997 was selected as the Renewable Energy Island in Denmark: The project will be a showroom to the many challenges which are facing the authorities, planners, and not at least the inhabitants of such communities. Being on the doorstep to this project - with several possible ways to go - Samsø was the perfect host for this seminar. The seminar was supported by the Danish Energy Agency and the EU ALTENER programme and it was an excellent playfield for the 80 participants from 14 countries to get more information about renewable energy islands and to exchange experience. Several contacts was established and the seed was put in the earth for establishment of networks and further development of existing contacts and networks between the islands.

### Renewable energy islands in Europe

The European Union ALTENER project "Towards 100% Renewable Energy on Small Islands" terminated in June 2000. Samsø, El Hierro (Spain), La Maddalena (Italy) and Aran Islands (Ireland) collaborated on a series of projects on their respective islands. Samsø Energy Company was the official coordinator. Samsø participated in this 1½ year programme with campaign initiatives about the new district heating areas, the promotion of single home renewable energy systems, and for co-operative windmills, both land- and sea-based. Some time was also invested in the exchange of experiences and reciprocal visits to energy project sites on the islands.

### A European Award

At an ALTENER conference in Toulouse in October, Samsø received an Award as "the best renewable energy island in Europe in the year 2000". This energy award is a new institution in the European Union's efforts to promote renewable energy in Europe. The award will be acclaimed biannually.

Samsø Energy Company has participated in exhibits and trade exhibitions on the island, in Copenhagen and in Toulouse. Some of the posters can be seen at the site [www.veo.dk](http://www.veo.dk)

Samsø is an exhibition window which gives special responsibilities in receiving guests, participating in conferences, etc. For instance "Samsø - a Renewable Energy Island" participated in the World Exhibition in Hannover, 2000. About 2.7 million guests visited the Danish pavilions. There is a great deal of focus on the project both nationally and internationally, and this interest is expected to increase as the specific projects are realised on the island. In the spring of 2000, Samsø Ecomuseum opened a Welcome Center where tourists can explore the cultural history of the island. These island guests are also introduced to the energy island project at the center. Thus Samsø is being visited by many people every year who wants to see the RE installations and hear about the plans.

### Much attention to Ærø

Much attention has been paid to the initiatives on Ærø from people outside the island - also in the last year. Ærø participates in EU's Campaign for Take Off and has in this way been chosen as one of the 100 regions in Europe transferring to RE before 2010, the so-called Flagship Communities. In September 2000 Ærø was chosen as the Solar Town of the Year, in this case Solar Island 2000 by the Danish Energy Agency. A considerable amount of people on Ærø have been most appreciative of this recognition. The latest prize which once again put Ærø on the map of the energy world was when Ærø won 1st prize in February 2001 at the Energy Globe Award in Austria.

At Marstal District Heating Plant they have throughout the years put much energy into information, among others they were represented on EXPO 2000. The plants has had visitors from all over the world. One of them was His Royal Highness Prince Henrik, and others were a delegation from the Conference EuroSun 2000.

As a follow up to the European seminar, a Global Conference on Renewable Energy Islands was held on Ærø, Denmark, in september 1999. The aim of this global conference was to bring together relevant actors from all over the world to exchange experience, to increase awareness on RE islands and to establish a platform for future cooperation and networking. The conference was very successful, and it was supported by the Danish Energy Agency, DANIDA and EU commission energy programmes Synergy and ALTENER.

### How did Denmark reach this stage

When the oil crisis came to us in the 70s it was a natural continuation of old traditions with renewable energy when an enormous activity started in all corners of the country with the old people delivering gently of

their experience with windmills, wood furnaces etc. The young ones contributed with their enthusiasm and newly acquired knowledge from the educational institutes. But another very important thing, without which we would not have been where we are today, is the government and official bodies caught the public opinion very soon, and the policy of supporting the RE development in different ways has survived changing governments throughout all the years. And without this governmental support carried out as direct subsidies, research and development programmes, information and dissemination services, without this, we would not have come so far. This dynamic Danish government policy has been successful because it supported the diversity of activity. Just as well as we can say that the wind turbine industry would probably not have become anything if the first early entrepreneurs had not bought the windmills even though the blades flew away and the investment was more than doubtful. Just as well we can say that the wind industry in the entire world would probably not have become what it is today, if the Danish Government had not subsidised the investment in wind turbines from 1979 to 1989. Danish energy politics has generally been based on a large amount of contribution from the population, as well savings as investment in RE, so for instance there has been investment subsidies for wind turbines, solar energy, heatpumps and biomass. And private people own more than 80% of all wind turbines.

*sni-stort.sol: Participants from the Global RE Island conference visit Ærøskøbing Energy Plant, Ærø.*





The Danish RE development is characterized by numerous technical universities and other institutions which have given room for the development of RE for 25 years - which have allowed the forward-looking and enthusiastic engineers to work with this interesting niche even though it was not the most profitable niche. Danish Technological institute has been among the technological leaders within the areas of biomass, heatpumps and not the least solar energy. During the last 15 years the finest goals for the test laboratories here have been to ensure the performance and quality of the RE plants as well as in the production as in the installation phase. At Solar Energy Centre Denmark the relevant solar energy partners are joining forces, and the Energy Centre Denmark carries out OPET activities (also supported by the

Commission), bringing Danish and EU policies together. Participation in this international network has led to invaluable experience and dissemination. Another example of governmental subsidiation of RE is RISØ National Laboratory. As for the other test stations and laboratories: Their importance for the development of wind turbines in Denmark and thereby for the whole world is recognised all over the world. - And without governmental subsidy in different forms it would not have had the same strength. The Danish results are based on a dynamic energy policy where governmental bodies inspire, provoke, listen to, and support a broad diversity of RE-activity all over the society, ranging from grassroots, research and technical institutes, consultants,

manufacturers etc. and vice versa. This combined with the right people on the right time and place has after all made a difference.

### Sources, Interviews:

Søren Hermansen, Samsø Energy and environmental office

Ide Seidelin, Renewable Energy Organisation, Ærø. Reports: Annual report 2000, Samsø Energy Company.

Final report, Ærø, a renewable energy island, part 2.

WEB-sites:

[www.veo.dk](http://www.veo.dk)

[www.solarmarstal.dk](http://www.solarmarstal.dk)

[www.aeroe-varme.dk](http://www.aeroe-varme.dk)

