THE SAMSØ ENERGY ACADEMY

Arkitema

A MUTUAL DEVELOPMENT TRAINING AND RESEARCH CENTRE

The island's many positive results implementing renewable energy have lead a growing number of international students, teachers and to some extent research workers to choose Samsø as a RE-case. A RE centre will therefore be established to house the RE Academy, research projects, and the island energy organisations.

RESEARCH

A broad range of research studies can be intimated, depending on further elaboration by the participating scientists themselves, for example:

* International research has shown great interest in Danish planning methods and consumer organisations, a tradition rooted in the Danish co-operative movement. A succession of 'green majorities' in the Danish parliament have for the last 25 years supported a general energy policy which, supplemented by selective government subsidies, has in effect revamped and realigned core areas of Danish energy production and energy planning strategies. Similar trends are now evident in the EU and several of the associate member states. The new Danish energy policies (after the 2001 election) will also affect Samsø. This radical change in policy will make comparisons of national energy strategies an obvious focal point, and the lessons learnt will be shared with other countries/regions via centre activities.
* A recurrent theme in many inquiries is the sociological aspect: how do different population segments relate to and respond to the RE island project, how are divergent attitudes and opinions expressed? Are relations strained between consumers who join initiatives and those who decline?
* The energy island project uses large quantities of biomass (primarily straw and wood chips) from agricultural sources. Rapeseed oil may soon be used in our transport sector, pig manure treated to extract methane gas, etc. Does this influence the ecological balance? Are there ecologists who consider certain aspects of the RE island project to be detrimental to the environment?
* Samsø has an impressive array of local media channels: two radio stations, a TV station, two regional newspapers with local correspondents and a daily newsletter distributed to a large majority of the populace five days a week. A prolific raw material for project studies from day one in 1997!
* Samsø can also offer interesting case material for economic studies. Project objectives have focused in part on changing the cash flow from import of fossil fuels and coal-generated electricity to local cash flows and our island now has an economy with an appreciable energy production for local consumption. How does this transition affect the local economy, from energy imports to a local energy production which over and above local consumption also exports appreciable amounts of energy, thus ultimately generating income and jobs. How many jobs are created locally, regionally, nationally and internationally by this transition?
* Research on international relations with regards to global energy and environmental issues will have excellent access to several international networks. RE Samsø participates in several EU and global networks and Samsø hosts the co-ordinating office for an international island organisation. These many contacts will allow follow up on issues of energy conservation and the transition to RE as an alternative to scenarios of further increases in energy consumption and increased reliance on fossil fuels and nuclear power.
* Nature conservation interests often have ambivalent attitudes to RE production facilities. They tend to abhor new plants on agricultural areas and these facilities are generally more voluminous than those based on fossil fuels. On the other hand the RE facilities produce clean, CO2 neutral energy as far as atmospheric emissions are concerned. What is the bottom line opposite to nature conservation interests?
* RE-technology. There are a large number of traditional RE installations on the island, but there are also experimental or demonstration facilities. There will be abundant opportunity for further R&D: the use of hydrogen and rapeseed for transportation purposes, beefing up methane gas production by developing new kinds of crops to use as additives to boost production and the general goal to make RE installations so affordable that they will sell without government subsidies.

THE ENERGY ACADEMY

Samsø's energy guests and students need an overall introduction to the processes entailed in a transition to RE, and instruction in how to get started. The Energy Academy has developed a 'toolbox' of implementation models and assessments of concrete project experiences from the many local island projects.

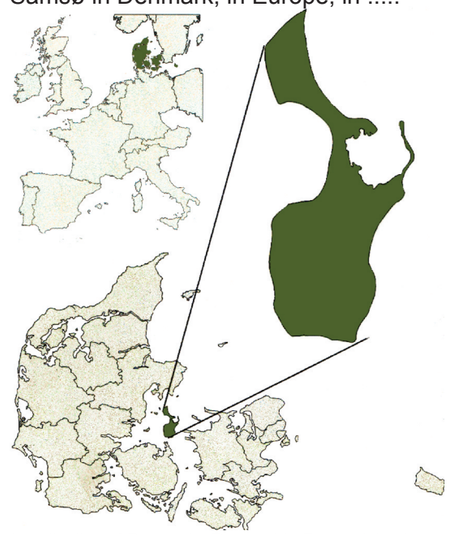
A visit to the centre will revolve around these basic tools, about how to get your best foot forward in the work for a sustainable RE development. Visits can be supplemented with seminars which work out regionally planning strategies for whatever RE sectors are appropriate, describing their potential, etc. Drawing upon the participants' knowledge of their respective communities and government policies, as well as the written material sent to us by participants in advance, we examine these specific conditions. In this way, it will be possible to prepare a RE action plan in the course of a single seminar. This plan of action is the first step towards the transition to 100% RE.

Courses and seminars will benefit from our experience with the implementation of the Samsø RE action plan. This plan will be examined, and in collaboration with the requisite expertise the groundwork for a similar planning process can be laid during the course of a seminar. This initial plan can be further developed and commented using internet-based networking and communication facilities. One internet-based services will be online background information and evaluation reports on associated projects. Questions can be posed to all participants to minimise research time on queries already raised in existing projects.

Academy consultants can be engaged to assist with implementation processes on site by working out communication strategies, producing campaign materials, establishing local citizens' groups, organising training programmes for local firms etc.

The Energy plan 1997

Samsø in Denmark, in Europe, in .....


Localization of Denmarks Renewable Energy Island

Samsø's windmills

1) The Brundby wind-mill, a post windmill first erected on Endelave island about 1600. Moved to Samsø in 1683.

2) The Kolby windmill, a Dutch model originally built on the mainland Jutland in 1859. Moved to Samsø in 1899.

3) First generation of an 11 kW wind-turbine from 1979, near Ørby village.

4) Second generation 150 kW BONUS wind-turbine from 1989, placed on North Samsø.

5) 1 MW turbines near Brundby, erected in 2000

AN ISLAND CENTRE
Background

Samsø has been Denmark's RE island since 1997. As such, Samsø is a Danish and European example of a strategy for the reduction of CO2 emissions based on a massive utilisation of renewable energy. Our RE Energy Plan from 1997 showed how island electricity and heating supplies could be converted 100 % to RE. Establishing an offshore windmill park near the island could compensate energy consumption in the transport sector.

ORGANISATION

A radical transition to RE is only feasible if the local population is actively involved in this transition. To assure this involvement, a group of citizens founded "Samsø Energy and Environment Association" in 1997. This organisation's objective has since been to offer citizens impartial information about investments which can contribute to a variety of viable and environmentally sound energy supply systems.

In 1998 the Energy and Environment Association, the local island council, the farmer's association and the chamber of commerce founded "Samsø Energy Company". This company was to implement the energy plan by co-ordinating the physical and organisational planning, taking whatever initiatives deemed necessary to further the specific projects.

Both the energy association and the energy company hired professional assistance to run their respective offices, and the two organisations have since then co-operated on the implementation, the promotion and demonstration of the many RE plants, projects and initiatives.

1998 - 2002, STATUS AFTER 4 YEARS

The first four years encompassed both energy conservation initiatives and RE production schemes.

ELECTRIC POWER

Denmark is well known for it's windmill industry , and the Samsø RE plan focuses naturally on wind-power. There are many areas in the country with strong wind conditions, and the Danes have used wind powered flour-mills for centuries. Danish windmills have been producing electricity for almost 100 years.

Samsø has used wind-power for several centuries and island windmills have produced electricity the last 20 years. By 1997, nine small-scale windmills produced 5 % of the island electricity. Authorities did not encourage increased production because of the large tracts of land on the island protected by nature conservation restrictions.

The decision made by the island municipality in 1997 to prepare a RE plan for Samsø implicitly implied a general increase in wind-power production, a consequence accepted at the regional level.

About 20 farmers offered to finance windmills, and they suggested approx. 50 potential sites, scattered across the southern half of the island. The nature conservation areas are primarily farther north. Several of the island windmills were co-operatively owned, and the largest co-operative (running 3 smaller windmills rated in total at 360 kW) also indicated an interest in expanding.

The municipality and the county made several suggestions to resolve the central question of deployment. Two localities (the windmills were to be grouped in clusters) fell due to protests. But by the fall of 1999, deployment and the windmill size and power ratings were resolved: Three clusters with all told 11 identical 1 MW windmills.

Nine farmers and the windmill co-operative (for two windmills) signed a contract with BONUS ENERGY by the end of 1999. The windmills were erected in March and August 2000, and since then Samsø has been 100% self-sufficient with electricity produced by renewable energy.

HEATING

In northern Europe, houses have been heated for thousands of years using local bio-mass. The use of fossil fuels to this end is more recent, culminating this last century. Danish RE planning emphasises once again the importance of RE, CO2 neutral bio-fuels. This trend is also integral to the Samsø RE plan, in which these bio-fuels are supplemented with solar heating, methane gas and heat pumps driven by wind-generated electricity.

In 1997, about 25% of Samsø's heating supply was based on renewable bio-fuels: a straw-based heating plant in Tranebjerg, numerous straw burning furnaces on farms, and many more wood burners in private homes. The heating plant was built, and is still operated, by a regional electric utility company, NRGi.

By 1999, new bio-fuel units had been installed in a number of homes, and the planning for new district heating plants was well under way. At the same time, energy conservation measures helped reduce energy consumption in many homes.

In the spring of 2002, NRGi opened the first new heating plant. This plant heats the villages Nordby and Mårup on the north of the island. Solar heating panels and locally produced wood chips are the renewable resources used in the plant.

Only a few months later, in November 2002, the next heating plant was opened in the village Onsbjerg. This locally organised heating plant heats 80 houses. A local entrepreneur manages daily operations.

By the end of 2002, the approximately 250 new individual bio-fuel, solar heating and heat pump systems and the two new heating plants had increased heating coverage with renewable energy to 57 %.

At the moment, local parties are working on the next straw-fired district heating plant, to meet heating needs in Brundby and Ballen. Construction will begin in 2004.

Nordby/Mårup heating plant, constructed by NRGi in 2001/2002

2.3 MW off-shore turbines south of Samsø, erected by Samsø Off-shore Wind Inc

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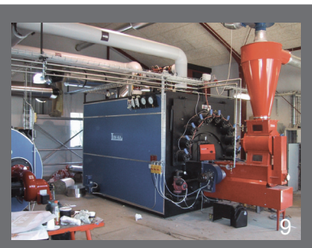

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6) Tranebjerg heating plant, constructed by the Energy Company NRGi in 1993

7) Wood pellet boiler in a private residence

8) A municipal solar heating plant at Mårup Harbour, established in 2001

9) Onsbjerg heating plant, constructed by a private Samsø firm in 2002

TRANSPORTATION

The 1997 energy plan suggested that establishing an offshore windmill park could temporarily compensate for energy consumption in the transport sector. This strategy has since been effectuated.

Planning began in 1998, and three proposed sites were investigated. One of the three was chosen for further studies a year later, a placement on an underwater ridge 4 kilometres south of Samsø, Paludan Flak.

In 2001, an EU invitation for tenders was announced, and four companies were chosen to participate in a Turnkey competition won by the Belgian company DREDING Inc. The construction of the windmill foundations and the windmills themselves began in the spring of 2002, construction on site started in October, and by the end of the year the 10 BONUS windmills were bolted down to their mono-pile foundations. In the first quarter of 2003, the sea cables were completed, the windmills trimmed and tuned, and a stable, continuous electric production was added to the grid.

ECONOMICS

The first four years of the project can be summarised as follows:

Energy

Gross	GWH/year 1997	GWH/year 2003
Electricit	28.20	26.2
Absolute; RE	1.56; 5.5 %	26.2; 100 %
Heating	67.25	58.0
Absolute; RE	16.75; 25 %	33.2; 57 %
Transport, consumption	55.15	52.8
RE compensation		77.8; 147 %

Energy consumption and percentage of RE - production 1997 - 2003

Emissions

	1997	2003 Reduction
CO2 (1000 tons)	46.0	-19.2; 142 %
SO2 (tons)	85.3	23.9; 72 %
NOx (tons)	338.1	200.8; 41 %

Emissions and reductions, 1997 - 2003

Economy

	1997	2003
Annual energy imports	7.3 mill €	4.1 Mill €

Reduction in energy imports, 1997 - 2003

The reduction in energy imports generates local production or represents energy consumption savings for 3.2 mill €/year, thus improving the local economy. The import of coal-generated electricity and liquid fossil fuels is now replaced with wind-generated electricity, biomass and solar heating. This in turn increases turnover in local businesses, creates new jobs and improves the municipal tax base.

Investments

Capital costs, distributed	
Investments, local	40 mill €
Investments, mainland	6 mill €
Subsidies, the Danish Energy Agency	3 mill €
Investments, total 1999 - 2002	49 mill €

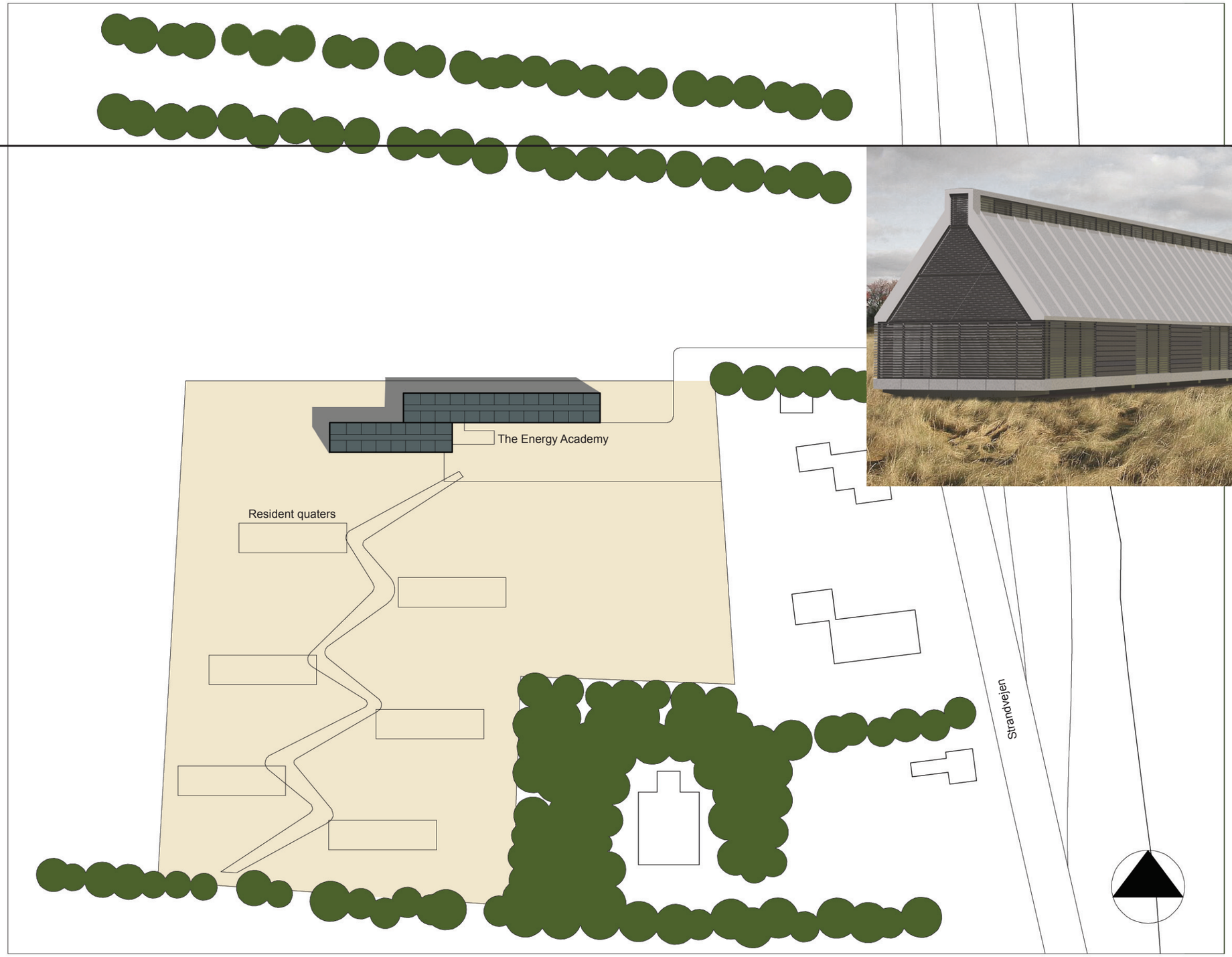
Investments in RE units, 1999 - 2002

THE ECOLOGICAL BUILDING

The Energy Academy building itself respects the following ecological principles:
- Minimal disturbance of the flora and fauna on the dry marsh where the building is placed.
- The use of natural, recyclable building materials requiring a minimum of maintenance.
- A comfortable, toxin-free indoor climate refreshed by the natural ventilation system in the office landscapes and the larger open rooms.
- Minimal water consumption using water conserving fittings, etc. Rainwater from the roof is used in the toilets. Excess rainwater is lead through a small pond and drained back to the grounds.
- Minimal heat consumption by extensive insulation and integrated solar heating. The local district-heating plant uses straw. Its distribution piping is highly insulated twin piping, with the lowest known rate of heat loss yet achieved in Denmark.
- Electricity consumption is minimised by using class A armatures and energy bulbs, plus optimal use of daylight. Electricity is generated on site by 200m2 roof-integrated solar panels, supplemented with island wind-power.
- Garbage disposal is minimised by sorting into 8 categories, of which several are recycled. Organic vegetative waste is composted on the site.

These ecological adaptations will be highlighted for demonstration purposes using brochures, interpretative posters and displays so guests are informed about the ecological considerations.

A perspective of the Energy Academy near Ballen



SITE PLAN
1:1000

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The centre is located on Samsø's east coast, just north of the harbour village Ballen.

The centre site is an open meadow, once covered by the sea. The centre's two buildings stand perpendicular to the coast, floating over the grasses on their invisible pillar foundations.

The centre is lifted above the ground level to leave as much as possible of the original grasslands unspoiled, as well as to minimise foundation work.

The architectural design with two parallel wings running east-west is inspired by the Danish, and especially traditional Samsø building sites.

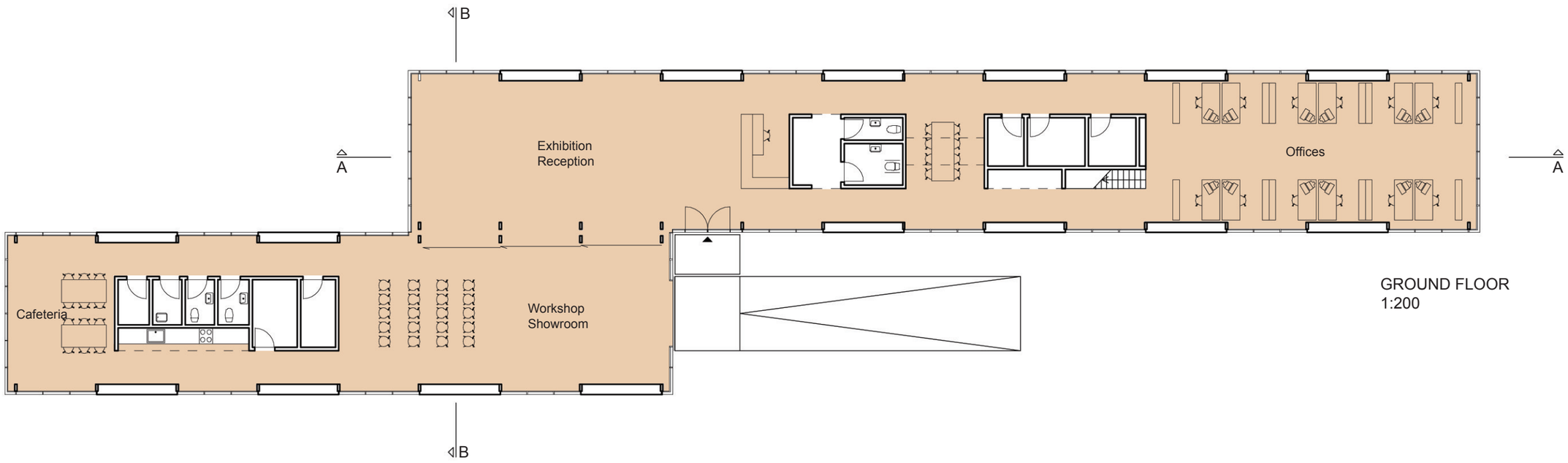
The interior of the buildings is a high lofted, open space enclosed by a roof construction of lightweight materials.

The longest wing houses the reception, exhibition facilities and office landscapes, while the other has a showroom, workshop, kitchen and cafeteria. One end of the building will have a large doorway to allow even the largest exhibition displays access. Specially constructed heavy brick cores equipped with permanent installations such as toilets, storerooms, servers, and kitchen facilities etc. are placed under the roofs.

A staircase from the office landscape will provide access to a floor level on top of the brick cores in the longest wing. This will be the library, with study niches and meeting facilities.

This picture illustrates the concept of the floating building complex, which leaves the meadow unscathed

The perspective from the main entrance to the Energy Academy



GROUND FLOOR
1:200

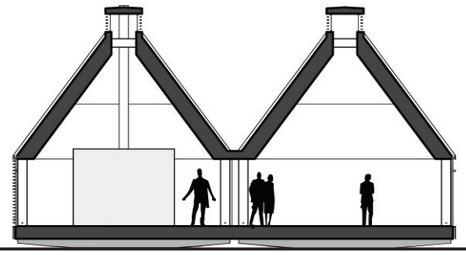
The building complex will be constructed in natural building materials: wood, bricks, paper insulation, glass and steel.

The building rests on a rectangular frame of prefabricated concrete girders supported by two rows of foundation pillars. The building floor is a highly insulated. The buildings are closed and stabilised by lightweight roof and facade constructions with large sections of glass to keep the centre open and transparent. The heavy brick cores are placed like furniture on the main floor. The outer walls and windows are highly insulated to minimise heat loss.

The outer walls are finished with domestic spruce planking. The roofing is corrosion resistant steel, which provides good support for integrated solar panels.

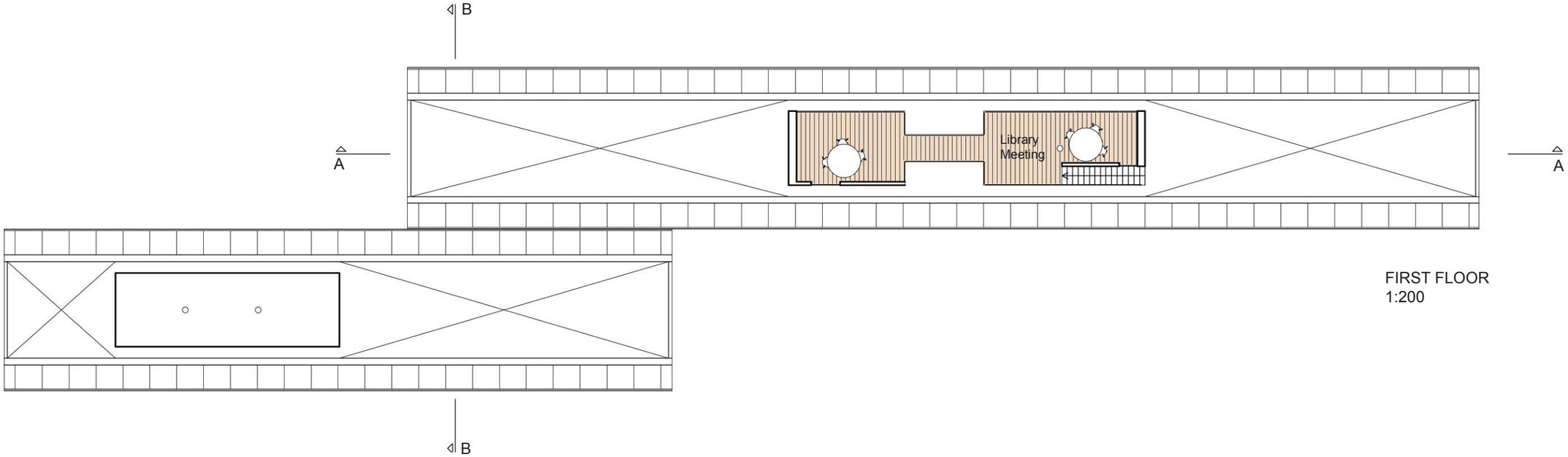
The building insulation is airtight but not impermeable. There are no plastic membranes. Both the inner and outer walls will be appropriately treated to allow diffusion. In this way the building materials' natural physical capacity to accumulate and release, and thus regulate both heat and humidity is put to use to regulate the indoor climate.

All installations will utilise lead and halogen free materials.



SECTION B - B
1:200

A perspective view from the office section in the longest wing. Research personnel and office staff work side by side. The brick cores under the roof house the permanent installations.



FIRST FLOOR
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The energy supply and ventilation needs are directly assisted by nature herself - the sun and the wind. The horizontal array of skylights underlines the basic lines of the buildings. The skylights provide diffuse daylight and contribute to the natural ventilation. This effect is accentuated as sensors automatically open or close a row of narrow windows in the outer facade in concert with the skylight windows in response to changes in the indoor climate, the wind and weather. Toilets, printers and the kitchen facilities have supplementary mechanical ventilation.

The southern face of the roof is equipped with 9 m2 integrated solar heating panels, and 200 m2 PV panels are integrated in the metal roofing. The PV panels will produce half of the centre's electricity. The rest of the electricity comes from Samsø's windmills. The local district heating plant uses straw, so biomass supplements the solar heating.

Daylight is regulated and all light fixtures are designed for low energy bulbs.

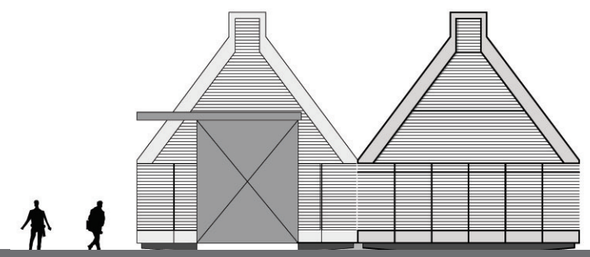
Clean groundwater is an important island resource, and to conserve this, rainwater is used to flush toilets. Surplus rainwater is drained back to the grounds.

Waste is sorted in 8 different categories.

SOUTH ELEVATION
V. BLINDS UP
1:200

PV-plant/solar collectors
are integrated in the
south oriented roof

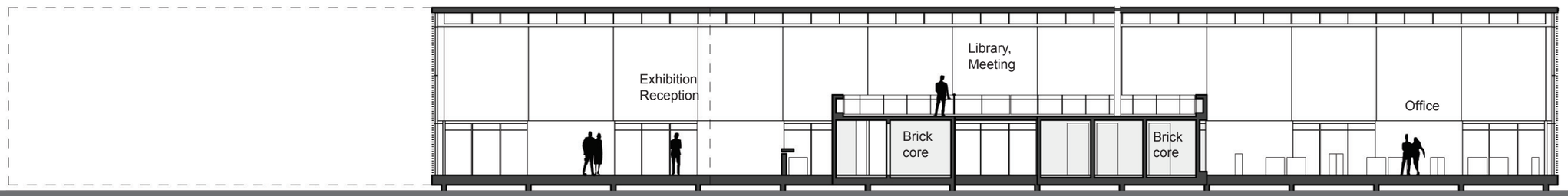
SOUTH ELEVATION
V. BLINDS DOWN
1:200



EAST ELEVATION
1:200

A perspective view of the entry hall, used for temporary exhibits.

The perspective from the top of the brick cores in the long wing. This section will function as a meeting room, library and study den.



SECTION A - A
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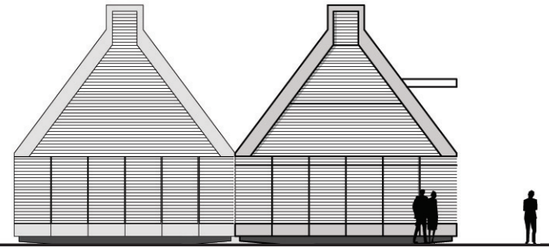
The perspective from the showroom/workshop. This facility can be a lecture hall, exhibition space, workshop, etc. The wall at the far end can be opened to give larger exhibits access.



WEST ELEVATION
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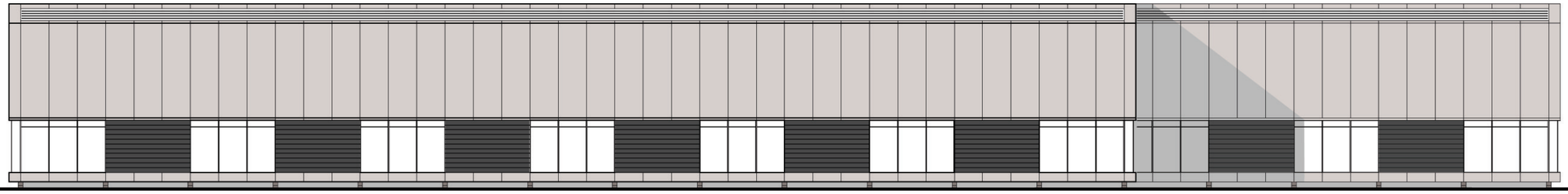

NORTH ELEVATION
V. BLINDS UP
1:200

NORTH ELEVATION
V. BLINDS DOWN
1:200

The total capital costs for the Energy Academy, 625 m2 ground area:

	Kilo €	
Price for the site, 17,000 m2	86.67	
Contract amount,	1,200.00	
Building site expenses	53.33	
Furniture	100.00	
Fees architects, engineers etc.	153.33	
Utility connections fees, district heating, sewage	20.00	
Unforeseen	46.67	
In total	1,660.00	1.66 mill. €

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