NORTH SEA – SUSTAINABLE ENERGY PLANNING

WORK PACKAGE 3/ACTIVITY 3.4
EXAMPLES OF ALTERNATIVE HEAT & POWER IN PUBLIC BUILDINGS INCLUDING ALTERNATIVE ENERGY ROADMAP

NORTH SEA
Sustainable Energy Planning

NORTH SEA SUSTAINABLE ENERGY PLANNING

North Sea – Sustainable Energy Planning

Work Package 3

Activity 3.4

Examples of

Alternative Heat & Power in Public Buildings

Including Alternative Energy Roadmap

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ABERDEEN CITY COUNCIL

Author

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The Interreg IVB North Sea Region Programme

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Content

Summary

North Sea Sustainable Energy Planning is a transnational EU funded project, partly funded within the North Sea Region Programme, Interreg IVB.

Within this project there was a need to collate information on how alternative energy technologies are being utilised in public buildings across Europe. Data was collected via an electronic questionnaire as well as through transnational partner workshops. This has meant partners in North Sea Sustainable Energy planning share good and bad experiences to a broader audience and compare methodologies, encouraging transnational cooperation and learning.

The local examples of good practice which feature in this report are:

- County Hall, Province of Drenthe, the Netherlands
- Townhall and police station, Tynaarlo, the Netherlands
- Marischal College, Aberdeen, Scotland
- District Heating, SödraLjunga, Sweden

Key Recommendations

Taking account of the case studies and the information from the workshops some key recommendations for increasing the use of low/zero carbon technologies in public buildings can be drawn. These are as follows:

- It is important to gain strong commitment & ensure early public engagement
- Use the project to empower the local economy
- Plan for trial and error for long term improvement– not everything will work first time but learn from mistakes

1 Background

1.1 Interreg IV b North Sea Sustainable Energy Planning

This report is the conclusion from a study carried out within the project North Sea Sustainable Energy Planning (North Sea - SEP). The project is a transnational EU funded project, partly funded within the North Sea Region Programme, Interreg IVB.

The North Sea – SEP project was initiated by a group of interested specialists from different fields: green industry, regional planners and stakeholders of regional and municipal development. The idea was to design and implement a project in the energy sector that mainly focuses on the specific problems municipalities and counties face in the field of renewable energy and energy efficiency.

During recent years the cost of fossil energy resources has been increasing rapidly. It is obvious that costs will remain high in the medium to long term. One possibility to absorb rising costs is to critically question the status quo of energy consumption in order to be able to use existing energy saving potentials.

The North Sea - SEP project aims to facilitate the development of sustainable energy regions whilst providing the tools to support regional planners, decision makers and stakeholders to take conscious decisions in all fields of regional energy planning.

1.2 North Sea SEP´s partner approach

The regions participating in North Sea SEP work on two levels: local and transnational. In the holistic approach that is significant for the North Sea-SEP project, conditions for successful energy plans include regional dissemination, building up regional networks, economic analysis and development of financial agreements (business models). This report covers the activity "alternative heat and power in public buildings". Nine partners participated by developing case studies and sharing their experience to come to transnational recommendations and output.

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1.3 Method

Activity 3.4 is of particular importance as the buildings sector accounts for 40 per cent of final energy consumption. Tackling emissions from existing buildings through improvements to building fabric and alternative methods of heat and power is key if overall emissions from the building sector are to be successfully reduced and European targets for renewable energy and greenhouse gases be met.

The case studies, on which the report is based, show best practice examples of low energy public buildings. These examples are important to show what can be achieved and demonstrate the leading role of public bodies in sustainable development. The information was gathered via a questionnaire, as well as general discussions during partner meetings. Aberdeen City Council led this piece of work and developed a case study questionnaire (See Appendix A) together with the project partners. The aim of the case study questionnaire was to capture information on how partner organisations have applied alternative heat and power supplies to public buildings. The case study questionnaire was originally sent to 9 partners across 5 countries in April 2011. Information was also gathered during partner meetings in Drenthe, the Netherlands (April 2011) and Aberdeen, UK (November 2011).

1.4 Local Examples

Project partners were asked to provide information on real life, local examples of alternative heat and power supplies for public buildings through the case study questionnaire. A total of four examples were received. Partners were asked to describe the project aims, motivation, financial model, technologies used as well as the successes and challenges.

The resulting information has been collated and comparisons and differences drawn in order to produce recommendations for increasing the use of low/zero carbon technologies in public buildings. The section below explains the following case studies in more detail:

- County Hall, Province of Drenthe, the Netherlands
- Townhall and police station, Tynaarlo, the Netherlands
- Marischal College, Aberdeen, Scotland
- District Heating, SödraLjunga, Sweden

It is important, before continuing to identify what is meant by a public building. Therefore the following definition is used throughout this report.

'A **public building** is a building which is owned and/or operated by public authorities and institutions providing services to a large number of persons and therefore frequently visited by these persons'.

2 Province of Drenthe, the Netherlands, County Hall

2.1 Background

The county hall of the province of Drenthe was built in 1973 and houses approximately 600 employees. The employees are for the most part office based and spend their time in the county hall, making plans and providing policy advice.

2.2 Project Scope

The county hall (office building) will be rebuilt as a sustainable building. The province of Drenthe aims to be a leader of climate friendly and energy-conscious acting. The technical infrastructure of the buildings is also a reason to rebuild.

The building is about 19.000m².

Start date: 6th July 2010

Completion date: May 2011

Other parties involved: Architect, Consultancy, Engineering, building contractor, Office installation, outfitting business, hinges and locks, (construction).

2.3 Aim

The aim of the initiative was to create an inspirational environment for their employees by rebuilding the main office headquarters in a more sustainable manner. This meant constructing a low energy building using insulation and sensor technology.

2.4 Motivating Factor

The province of Drenthe wants to be a leader in sustainability and will demonstrate this through rebuilding the county hall. The organisation wants to use this project as an example to inspire others. The new workspace will give support a new, smarter way of working and accessibility and safety will be improved.

2.5 Organisation, governance and finance

The members of the executive board (and provincial) were has overall responsibility for the project.

Project Cost: € 4,300,000

Source of Funding: budgets reserved

Payback period: 30 years.

2.6 Technologies Used

Solar panels - not tried and tested before

Thermal storage – not tried and tested before

Sensor technology - new technology, not tried and tested before

Separate sanitation (and wash with rainwater),

Absorption chiller (heating, cooling and ventilation) – was already in use but usage has been increased

The benefits of using these technologies are that the sustainability of the building is increased as well improving energy performance.

2.7 Results: successes and lessons learned

The major success of the project was achieving a 91% reduction in gas consumption, resulting in a 92% reduction in CO_2 emissions. The use of water was reduced by more than 50%, by use of rainwater and saving.

	Use of energy 2010	Use of energy 2011
Electricity:	1.749.776	1.660.499
Gas	135.000 m3	8.407 m3
Water	3849 m3	1475 m3

Estimated current energy use per m2 of floor area

Gross Floor area is 18.000 m2 incl. basement, excluding extensions.

Electricity: 1.660.499 KWh => 92 KWh / m2

Gas: 8.407 m3 => 0,47 m3 / m2

Water: 1475 m3 => 0,08 m3 / m2 (Note: this only concerns tap water)

At the time of the report, the submission of an energy label was in process.

Lessons Learned: Ensure technology is compatible with site as problems were encountered when placing wind turbines on roofs. The dimensions of the turbine did not conform to the roof dimensions and the capacity was to high/low. For the moment there is no solution, so this option is on hold.

Future Challenge

The energy suppy can still be improved by a better balance in the thermal storage. At this moment the system uses more heat than cooling. The balance is needed for a sufficient regeneration of the ground.

Figure 1: Building site (County Hall)

Figure 2: Solar Panels

Figure 3: Commissioning of separate sanitation and wash with rainwater

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3 Municipality of Tynaarlo, the Netherlands, Townhall and police station

3.1 Background

The Municipality of Tynaarlo is a local government responsible for 32,458 inhabitants. It consists of 3 larger villages and 15 smaller villages.

Figure 4: Town Hall of the municipality of Tynaarlo in Vries

Figure 5: PV-cells on the roof of the town hall

3.2 Project Scope

Type of building:Townhall and police station

Date of delivery: 1998-2005

Area: gross floor space: 10.200 m2

Volume: 45.000m3, in a 150m long building in 3 layers.

Site: location 5304'4'' (N) 6034'58'' (O). At the border of the village of Vries, next to the local road, situated in a green, low density setting.

Other Parties: Architects Felix Claus and Dick van Wageningen of Claus and Kaan architects

Contractor:PlegtVos

Constructor:Blaauw and Partners

Installations: Van der Weele, Groningen

3.3 Aim

To reduce energy use in order to lower energy costs by using more efficient building techniques and technologies.

3.4 Motivating Factor

In 1998 the three municipalities Eelde, Zuidlaren and Vries merged into 1 larger municipality. The new Town hall accommodates the officers who were previously spread over three locations. The development of the building stimulated the development of policies on the environment and sustainability for the new municipality. It was also a good moment to show the sustainable ambitions of the new municipality. It is important to note that the ambition of sustainability not only focussed on energy, but also on biodiversity and the setting of the building in a landscape with high quality.

The Townhall was the first new building delivered by the new municipality of Tynaarlo. Later the municipality developed multifunctional accommodation in the residential area TerBorch. The experience gained from building the Town Hall was used to improve the energy concept in other projects.

3.5 Organisation, governance and finance

The Board of the municipality had overall responsibility for the project. They hired an advisor in construction management to lead the project.

Project Cost: €9,700,000 euro of which €2,526,000 was spent on energy efficient technologies and installations.

Source of funding: The project was funded by the municipality. The province provided a subsidy for the energy measures as they were very innovative at the time of development.

Payback Period: To make choices, three different scenarios for energy concepts were developed by an energy consultant. Some of the measures had a payback of 5-10 years but for other measures such as the PV system and the sedum roof, the innovative attributes and visibility were more important than the payback period.

3.6 Technologies Used

Geothermal heat system - developed in the period 1998-2005, this was the first geothermal system for heating and cooling in a building in Drenthe. A heat pump supports the traditional heat recovery. The heat pump is not the primary heat source. In the Town Hall, the heat pump is used as a pre-warmer for the central heating system.

PV-solar panels – for a high-end air-refreshment installation.

Thermal solar collectors for hot water for the kitchen Sensor controlled lighting – which automatically turns on and off based on movement-detection. The amount of electrical lighting is related to the available amount of daylight.

Green roof - parts of the roof are covered with sedum beds which act as a water buffer and insulation layer.

The technology was tried and tested before in other projects in other places. However, this was the first project in the province of Drenthe using open-source geothermal system combined with a heat pump. The benefits of using such a technology are low energy use, increasing the performance of the heat recovery with a more stable temperature.

3.7 Results: successes and lessons learned

One of the main successes of using heat pump technology in conjunction with ground storage is the substantial reduction in gas consumption.

Energy performance Tynaarlo town hall
Energy label certificate label A with EPC 0,82 (21-04-2008)

Produced energy since installation (21-2-2004) 94.935 kWh

Lessons Learned

The Townhall was a pioneer project and as a result the municipality gained a lot of experience and knowledge about energy efficient buildings. Consequently a policy has been developed which stipulates that all new public buildings will be developed to achieve an energy performance which goes beyond the legal minimum. The experience was utilised in other projects such as the multifunctional building Borchkwartier.

Other points to note include:

- Installation is more complex than a traditional energy supply. For example the ventilation, air control, heat pump and end users must reach a balance.
- Use low temperature heating instead of radiators for high temperature;
- Ensure the energy source is regenerated by a balance in the need for heat and cooling;
- Maintenance costs are often higher than traditional technologies.

In Borchkwartier the same techniques were used again but the design was improved due to the previous experience. This development has a better balance between heat and cooling to regenerate the geothermal source, low temperature heating and the heat pump as a basis and heat recovery only for peak use.

Another point to note is the importance of optimising on ‘moments of change’ in people’s lives to encourage individuals and organisations to adopt more environmentally sustainable behaviours. As demonstrated by the merger of the three municipalities Eelde, Zuidlaren and Vries into 1 larger municipality.

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Links to further information:
www.architectuur.org/clauskaan09.php
http://www.adviesbureauvanderweele.nl/Presentatie%20gemeentehuis%20Tynaarlo.pdf
http://www.youtube.com/watch?v=2FLwvTZg0RU

4 Aberdeen, UK, Council headquarters, Marischal College

4.1 Background

Aberdeen City Council is a local authority employing over 10,000 people and is the largest employer in the City. Aberdeen is a coastal city in North East Scotland famous for the prevalence of the oil and gas industry. However during the mid-18th to mid-20th centuries, Aberdeen was known for its granite industry and many of the City's buildings incorporated locally quarried grey granite. The City is often nicknamed “The Granite City”.

Marischal College is an A-listed building[1] founded in 1593 and is the 2nd largest granite building in the world, surpassed only by El Escorial Palace, outside Madrid. The building was unoccupied and left to deteriorate for 12 years before the Council began the renovation work.

4.2 Project Scope

The project involved the renovation of a 16,200m^2 granite building in the centre of Aberdeen turning it into the Local Authority Head Quarters. The building accommodates 1,300 employees and achieved a BREEAM Excellent standard[2] which is a worldwide environmental assessment method for best practice in building design, construction and operation.

4.3 Aim

To provide suitable, fit-for-purpose accommodation from which to deliver the council's services. In addition to this, Marischal College is an iconic building and its conversion will improve the heritage of the city. The development allowed the Council to create an environmentally sustainable landmark building and show that we are serious about being the energy capital of Europe into the future.

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[1] An A-listed building is a building deemed of national or international importance, either because of its architecture, history or if it is a good example of some particular period, style or building type. (Approximately 8% of listed buildings in Scotland are category A).

[2] BREEAM is the world's foremost environmental assessment method and rating system for buildings. It sets the standard for best practice in sustainable building design, construction and operation. BREEAM Excellent was the highest standard at the time of building Marischal College. However this has now been superseded by BREEAM Outstanding.

4.4 Motivating Factor

Aberdeen City Council staff worked in a building (St. Nicholas House) that was constructed in 1966 with a calculated 30-year life span – it is now in its 41st year of use. The Administration agreed that St. Nicholas House did not provide staff with a suitable working environment, nor did it give the opportunity to be energy efficient and utilise renewable energy.

The option of continuing with the previous office accommodation was simply not sustainable. The council would have to undertake significant major capital investment over the next five years to provide suitable office accommodation.

Marischal College provided the best-value option and was not the most expensive of the three proposed options - new green field development, refurbishment of St. Nicholas House or conversion of Marischal College.

4.5 Organisation, governance and finance

Project Cost: £65,800,000 (€80,821,800) – well within the original approved budget of £80.4 million.

Source of Funding: The project was funded by the Local Authority but also received some European funding.

4.6 Technologies Used

Ventilation / Cooling - Water loop heat pumps with heat recovery and free cooling

Heating - Air source heat pumps and biomass boiler. The biomass boiler provides up to 30% of the heating requirement of the building.

Domestic hot water - Re-circulated direct gas fired water heaters

Electric supply - 2.2MVA connection to the public grid.

4.7 Results: successes and lessons learned

One major success was integrating the biomass boiler into the building design as the initial plan to install solar panels was prohibited by Historic Scotland[3]. Forward planning has also ensured that the building was designed in such a way that the boilers can easily connect to the City's combined heat and power network, when the pipes are in place in 2012/13.

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[3] Historic Scotland an executive agency of the Scottish Government charged with safeguarding the nation's historic environment.

Results:
Heat energy demand: 270 kWh/(m2a)

Primary energy demand: 982 kWh/(m2a)

Cooling energy demand: 124 kWh/(m2a)

U Values:

Exterior wall: U-Wert: 0.3W/m²K

Windows: Uw-value: 1.8 W/m²K

Roof: U-value: 0.24 W/m²K

Energy Performance Certificate: B+

Carbon Dioxide Emissions (kg per m^2 of floor area per year): 21

Approximate current energy use per m2 of floor area: 58 kWh/m^2

Lessons Learned: Ensure energy efficiency and renewable technologies are considered at the design stage as trying to retrofit technologies can be problematic and costly.

Also ensure any technologies used are correctly specified at the design stage. Again this will avoid problems when in use and will avoid extra maintenance costs.

Another point to note is the importance of training the end users how to operate the building effectively. Particularly if the systems used are newer technologies.

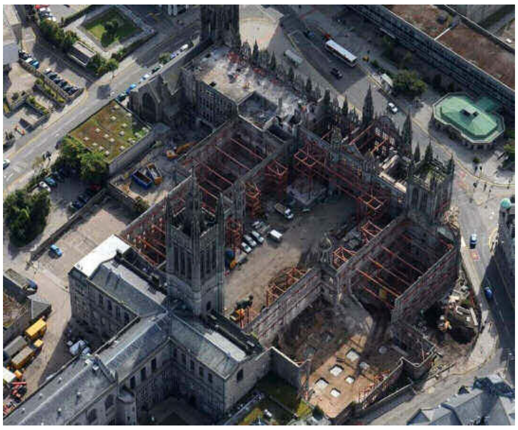

Figure 6: Birdseye view of Marischal College

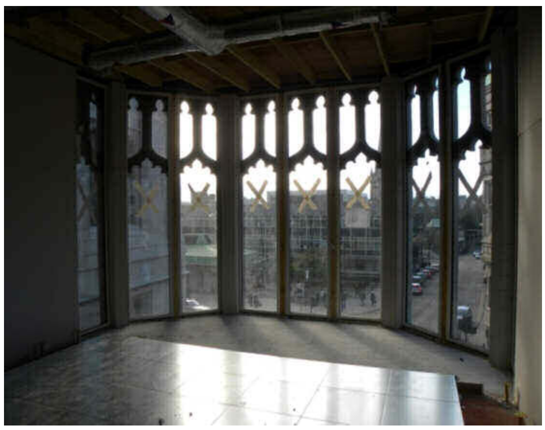

Figure 7: Renovation of original features

Figure 8: Front Entrance

Figure 9: Front façade

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5 SödraLjunga, Sweden, District Heating Network

5.1 Background

The Energy Agency for Southeast Sweden was established in 1999 as an EU project under the Association of Local and Regional Authorities in Kronoberg. The reason was the increased global and European focus on climate change, reinforcing the need for qualified and impartial players in the energy and transport field.

The Energy Agency is working to initiate, coordinate and implement projects aimed at improving the energy efficiency and increased supply of renewable energy in all sectors of society.

One such project is the District Heating Network in SödraLjunga, a few kilometres south of Ljungy in Småland, Sweden, the first district heating plant and network owned and operated by farmers in the region.

5.2 Project Scope

The idea was born in 2006 when different ways of making the village more attractive for people to move to were discussed during a meeting. The local school was threatened to be closed and the different ways of making the village more popular to live in was discussed. The idea of a local district heating network was born. The farmers received consultative guidance from the federation of Swedish farmers, as well as the Energy Agency for Southeast Sweden (pre-study as a feasibility study), and shortly thereafter they decided to build a district heating plant fuelled with woodchips and pellets.

The farmers implemented the plant from start to finish and today are energy supplier and operator. There are two boilers fired with wood chips and woodpellets. Properties connected to the district heating network include four one family houses, a house with 6 apartments, the church and the local school.

5.3 Aim

One of our missions is to foster initiatives concerning renewable energy. The small community SödraLjunga is a part of the municipality of Ljungby, which partly owns the Energy Agency for Southeast Sweden.

5.4 Motivating Factor

The local school was threatened to be closed and different options of making the village more popular to live in were discussed. The number of inhabitants of the village is approximately 150 persons. In addition, before the installation the connected houses were reliant on fossil fuels and used about 60 m^3 of oil for heating.

5.5 Organisation, governance and finance

The four farmers started the company SödraLjungaBioenergi AB. Our way of fostering the project was mainly the realization of the pre-study.

Project Cost: approximately €250 000

Source of Funding: Mostly private investments via loans from the bank, but partly (approximately 20%) via investment support from the county administrative board.

5.6 Technologies Used

One 300 kW woodchip boiler is used for the combustion as well as a 250 kW wood pellet boiler.

5.7 Results: successes and lessons learned

One of the most important success factors is that all involved parties in this project know each other very well, and did so before the project started. Therefore there were no problems of cooperation and no trust issues arose during the project implementation.

The fact that the farmers in charge of the operation of the plant live and work nearby makes it easy for them to attend to any problems that arise.
The fuel is supplied locally and therefore availability is not a problem.
The project has led to good publicity for the village as well as fossil fuel free heating and relatively cheap heating for the ones connected to the network.

A survey was sent out to all potential customers early in the project, followed by visits from the responsible farmers. This made it possible for the customers to think about the suggested installations for a while and then get answers to their questions from the right person straight away, thus avoiding misunderstandings.

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Figure 10: Göran Ottosson, Lars-Erik Karlsson, Andreas Karlsson, Anders Filipsson distribute heat to the school, church and a growing proportion of the inhabitants of Småland, South Ljunga.

Figure 11: Boiler room.Lars-Erik Karlsson atone of the boilers.

Figure 12: The shareholders have different skills. Anders Filipsson is not just a farmer, he is also an electrician

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6 Key recommendations

As well as gathering information through the case study questionnaire, information was also gathered from experts with first hand experience in installing alternative energy technologies. This information was mainly gathered through a workshop held in Aberdeen in November 2011. Taking account of the case studies and the information from the workshops some key recommendations for increasing the use of low/zero carbon technologies in public buildings can be drawn. These are as follows:

“It is important to gain strong commitment & ensure early public engagement”

- Utilise public pressure to encourage political backing. A demonstration building can be seen as an image building tool, to show best practice;
- Use enthusiastic staff in administration to champion projects;
- Positive examples reflect well on the image of the organisation;
- Projects increase the level of knowledge within the public authority or the municipality.

“Use the project to empower the local economy”

- Centralised to centralised systems may not be the answer as this is unsustainable;
- A locally produced energy mix is required, using locally sourced products where appropriate;
- If using a new technology / technique, gain a guarantee from the supplier if it doesn’t work. That way any element of risk is shared together.

Some financing mechanisms to consider:

- ESCO (Energy Service Company) / public /private partnerships;
- Not-for-profit distributing co-operatives;
- Pre-financing – payback through higher rents or sale of property;
- Rent the technologies for example PV;
- 3rd party financing.

Examples include:

- Sweden: The Government provide a set amount of money to each municipality to reduce fossil fuel use and increase energy efficiency. Each municipality then develops a 3 year action plan (within a 5 year timescale).
- The Netherlands: The regional authority co-finances initiatives from municipalities (up to 50% co-financing). Both the municipalities & regional authorities sign a climate contract.
- The Netherlands: The national building authority will only hire buildings with optimal energy consumption. The energy reduction is based on energy labels. This is a simple idea which makes private money available for refurbishment of properties.
- UK: The local authority in Aberdeen has entered into an agreement with an external company to supply, fit, test, support and maintain photo voltaic panels on a minimum of 90 Council owned buildings by 2013. The Authority will benefit by receiving cheap electricity whilst decarbonising its electricity use.

'Plan for trial and error for long term improvement– not everything will work first time but learn from mistakes'

- Ensure refurbishment of old buildings focuses on energy efficiency
- New buildings should focus on effective solutions for the whole building;
- Specialised buildings must not be treated like all the rest;
- Efficient facility management of a building is essential. At present there is little implementation of facilities management and no reporting standard;

7 Alternative Energy Road Map

The importance of developing a coordinated approach to the issues of energy use and carbon emissions from buildings across Europe has been recognised as a key priority for all partners. Addressing these needs will require action from all parties including those in industry and academia, as well as building users themselves.

From the case studies detailed in Section 2 we can see that variation in public buildings currently exist between partner countries, which stems from different histories of policy development, perceived needs and recent developments in technologies. Whilst it may well be possible to develop a single roadmap for all partners, it is likely that implementation will vary depending on building type, condition, industry, economic factors and political will. However, for this exercise a general road map can be established. This is shown in Figure 12.

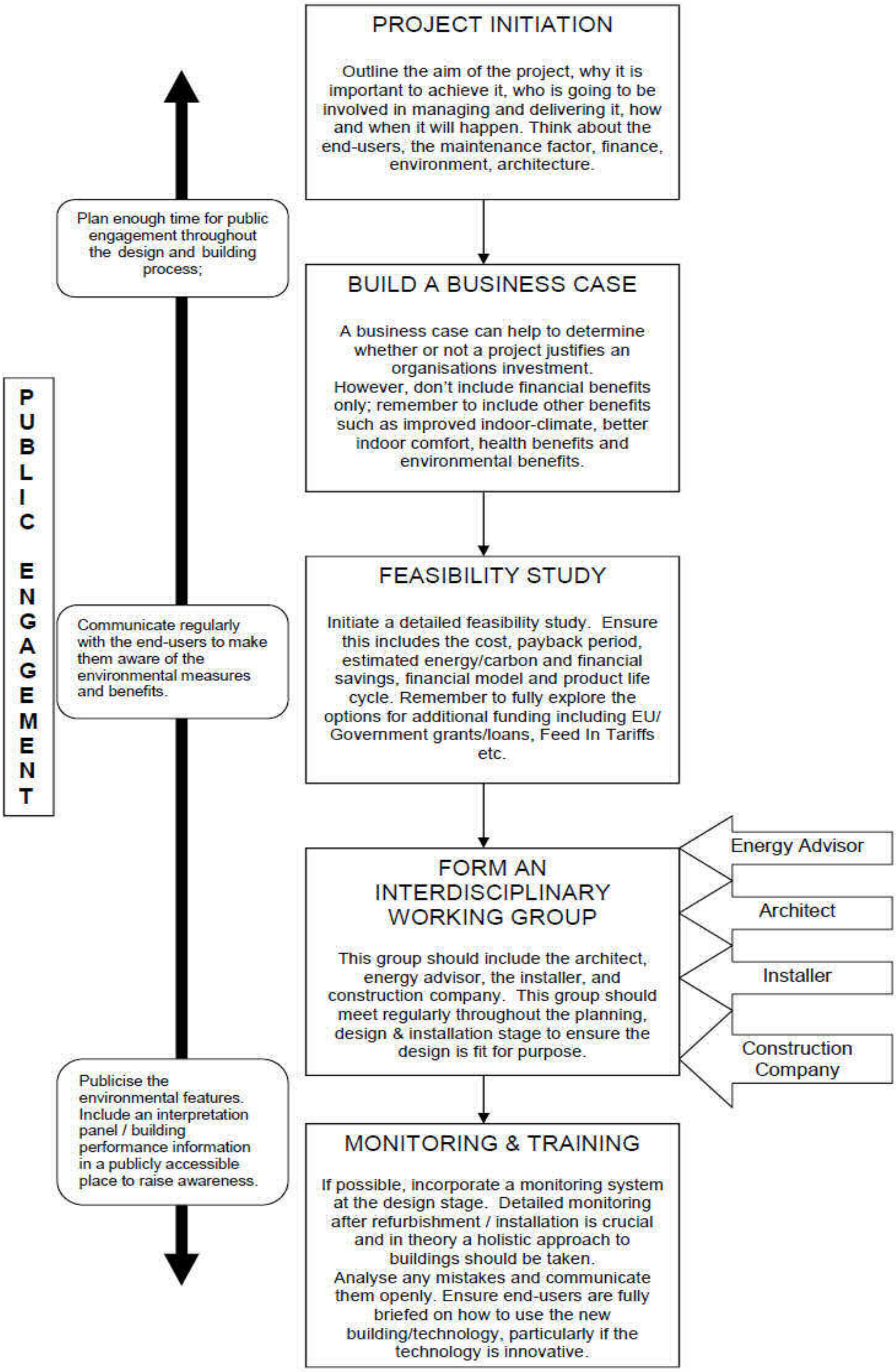

Figure 13: Road map for installing Alternative Heat & Power in Public Buildings

8 Conclusions

The importance of developing a coordinated approach to the issues of energy use and carbon emissions from buildings across Europe is important to all partners. Studies of best practice play an important role as they showcase the technology in practice and act as learning tools.

From the research carried out, it is important to note that successful projects rely on open communication throughout the project lifetime from the project scoping to the design, build and monitoring phases. It is important to engage the end user as well as the public at regular intervals to encourage support for the project and raise environmental awareness amongst citizens.

It is also essential to plan for trial and error, particularly if using innovative technologies. Not everything will work first time but it is important to learn from mistakes and communicate them to others in order to ensure development in the long term.

Appendix A

Case Study Template alternative heat & power supply in buildings

SUSTAINABLE ENERGY NORTH SEA PLANNING

WP3.4
Case study on alternative heat & power supply in buildings

Background

As part of North Sea SEP work package 3.4, Aberdeen City Council has developed a case study template to capture information on how partner organisations have applied alternative heat and power supplies to buildings. The resulting information will be collated and used as a transnational learning tool for the project.

Aim

To provide case studies and concepts of alternative heat and power supplies for buildings. The information and photographs provided will be used to create a case study guide which will be presented to partners later in the year.

Please return the completed template by email before the **31st May 2011** to amysmith@aberdeencity.gov.uk. Photos and supporting evidence should also be submitted by this date.

If you have any queries regarding the template please contact Amy Smith, Email: amysmith@aberdeencity.gov.uk, Tel: +44 1224 522725.

Case Study Questions

Project description and aims	
1.	Please provide some general information regarding your organisation.
2.	Briefly describe the project scope. Please include the following details: – type of building (office, housing, industrial use); – date of project delivery; – scale by floor space index or area; – site description (city centre, renovation area, suburb, business area); – other parties involved for example consumers/users, architect, installation company, energy company.
3.	What was the main aim of the initiative in terms of energy?
History, motivation and context of the initiative	
4.	Why did your / the organisation decide to undertake this initiative?
5.	Has your / the organisation undertaken an initiative like this previously?

Organisation, governance and finance	
6.	Who took overall responsibility?
7.	How was the initiative funded? (private investment, grants, loans, subsidies)
8.	How much did the initiative cost?
9.	What was the payback period?
Design / Technology / Methodology	
10.	Please provide a description of the technology used.
11.	Was the technology tried and tested or new?
12.	Please describe the features and/or benefits gained from using this technology.
Results: success, challenges, problems?	
13.	Please give details of the energy performance – before and after?
14.	Were there any barriers encountered? How were these overcome?

15.	In your own opinion what are the advantages and disadvantages of this technology?
Lessons learned and repeatability	
16.	If you were to do this again, what would you do differently?
17.	Would another organisation be able to repeat your methodology easily? If not, why?

Contact Information	
Organisation:	
Main Contact:	
Address:	
Telephone No:	
Email Address:	
Website:	
Please provide online links of reports or other literature available:	

Please include up to 4 photos of the project.

The information and photographs will be used to create a case study guide which will be presented to partners later in the year.