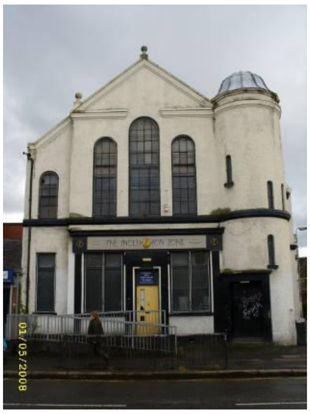
DISCUSSION DOCUMENT FOR SUSTAINABLE MEASURES

THE INCLUSION ZONE, DONEGALL PASS

September 2008



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CONTENTS

1.0 INTRODUCTION

The following report has been prepared to accompany the preferred building option for a new building community centre located in Donegall Pass, Belfast.

It will detail options for Energy Conservation Measures for possible integration with the design of the new centre.

The new community centre will be a four storey building comprising a community internet cafe, public toilets, offices for the Donegall Pass Community Forum, flexible conference areas, meeting rooms, and incubator units, an Information Technology suite, and a dedicated crèche facility.

The building design is taken to RIBA Stage C, positioning it for further funding.

The purpose of this report is to review proposals for sustainable and energy conservation measures to enhance the operating performance of Building Services installation.

2.0 GRANTS AVAILABLE

From 1st April 2008, under Phase 2 of the Low Carbon Buildings Programme (LCBP2), as managed by BRE, Organisations can apply for 50% of the cost of installing approved micro-generation technologies. Grants are available to those Organisations which are NOT an "Undertaking" as defined within the meaning of the rules on State funding laid down under the EC Treaty. Applications are currently being accepted and it is anticipated that fund will be committed through to mid 2009 (although this will depend on the rate of applications).

The Grant must be used to fund the supply and installation of a renewable energy scheme at a permanent building located in the United Kingdom. Only costs related to the installed equipment and work are eligible.

Grants will be available for installations up to a maximum of 50kW (electricity) and 45kW (heat) per property, with installations selected from the pre-specified products list shown on the LCBP2 Web Site. The following technologies are covered:-

- Solar Photo-voltaics (with an installation capacity of more 0.5kW) – 50% grant
- Micro-wind turbines (with an installation capacity of more 0.5kW) – 50% grant
- Solar Thermal – 50% grant
- Ground source Heat Pumps – 50% grant
- Biomass – 50% grant

Although only applications that meet the stated limits will be accepted, LCBP2 may contribute to the first 45kW or 50kW of larger installations that use multiple products.

Application will be assessed against set benchmark costs for saving a unit quantity of Carbon Dioxide over the expected lifetime of the installation.

A maximum of three eligible technologies for each proposed building can be applied for. Also, Organisations can apply for a maximum of up to £1.0M in grant funds.

Should grant aid be made available the grant offer will specify a deadline, usually within 12 months of the letter of offer, by which time the installation of the technology must be complete. All technologies have to be installed by BERR approved "Framework Installers".

3.0 PROPOSALS FOR HEAT SOURCE PLANT / ELECTRICITY

There are a number of options currently available to provide heat source for the Building. These include:-

(a) Oil-fired Boiler Plant
(b) Wood-pellet burning Boiler Plant
(c) Ground Source Heat Pumps
(d) LPG-fired Boiler Plant
(e) Natural Gas

Other fuel sources for consideration include the following Renewable Technologies. These are covered in greater detail in Section 4.

(f) Photo-voltaics for on-site generation of small-scale electricity
(g) Solar Water Heating for Domestic Hot Water (DHW)

3.1 Oil-fired Boiler Plant

This technology is considered as the traditional means of providing Heat Source.

Plant comprises a boiler unit or units, fitted with a matched oil-fired burner set to operate with the suitable fuel, generally 28 seconds or 35 seconds Redwood Scale. Low Pressure Hot Water (LPHW) is generated at 82°C and is distributed via a number of pumped circuits to serve heat emitters. These emitters can be radiators, fan convectors, ceiling panels, underfloor heating or other product.

The plant is relatively simple to operate, being similar to a domestic type Boiler.

The main disadvantage at present with oil-fired Boiler Plant is the uncertainty over the cost of oil. Recent increases have resulted in Crude Oil being sold on the Spot Market at $130 per barrel, resulting in Heating Oil costing upwards of 66p/litre. (6.5p/kWhr)

Although space is extremely limited for the installation of an external Oil Tank, a tank can be accommodated provided that suitably fire-rated walls separate the Tank from any part of the Building.

The CO2 emissions for Heating Oil are 0.27kg per kWhr used.

Oil-fired Boiler Plant has an Economic Life of approximately 25 years.

There are no Grants available for oil-fired technology.

3.2 Wood Pellet Boiler Plant

This technology is very new, but is becoming more popular.

Plant comprises a boiler unit or units, complete with a suitably sized Combustion chamber where either Wood Pellets or Wood Chips are burnt. The Wood Pellets or Chips are delivered to site by Bulk Tanker and “blown” into the storage facility. The Store can comprise either a purpose-built masonry chamber, or ground-mounted storage hoppers similar to those used for storing animal feeds.

The pellets are transferred to the Boiler by means of an auger arrangement. The auger adjusts the rate of delivery into the Boiler, thus modulating the output of heat.

The plant is relatively simple to operate, although there are more moving parts than used on oil-fired Boiler Plant.

The main disadvantages with this Boiler Plant are:-

- The much higher cost of this type of Boiler (a 150kW boiler with associated fuel stores would cost approximately £64,000.00 compared with £8,000.00 for a high efficiency oil-fired boiler).
- Wood pellet plant is physically larger than oil-fired boiler plant, necessitating a much larger Plantroom (approximately 2.5 times in area)
- The larger area required for fuel storage and the “unsightly nature of these facilities, especially in an Urban environment.
- The more complex technology used.

However, major advantages include the reduced running costs (wood pellets cost approximately 1/3 less than equivalent litres of Heating Oil), CO_2 emissions being deemed as "Carbon Neutral" and the availability of pellets locally. (The main supplier of Wood Pellets is Balcas, who are based close to Enniskillen).

The Economic Life of wood pellet Boiler Plant is approximately 30 years.

This technology is Grant-aided under LCBP2, although Aid is dependent on use of registered Manufacturers and Model Ranges. As noted earlier, the amount of Grant Aid is limited to 45kW of thermal output regardless of the size of plant to be installed.

This option can be ruled out due to the storage demands in this tight urban location.

3.3 Ground Source Heat Pump

This technology is also quite recent, but is becoming more popular.

Plant comprises a Heat Pump, which operates with electricity as the Primary Fuel. Heat is extracted from pipes buried in the ground or from bore-holes at approximately 13°C and is delivered as low grade heat at approximately 45°C. The technology used is similar to a refrigerator, using a compressor / refrigerant cycle to generate the low grade heat. The Coefficient of Performance (COP) of Heat Pumps is approximately 3.0, meaning that three times the heat is produced from that used i.e. 3.0kW of heat is produced for each 1.0kW of electricity used.

The plant is relatively simple to operate, although the components used require specialist maintenance.

The main disadvantages with this Plant are:-

- The much higher cost of Heat Pumps (3 No 50kW Heat Pumps and associated boreholes could cost up to £92,000.00, compared with £8000.00 for a high efficiency oil-fired boiler).

- Equivalent output Heat Pumps are physically larger than oil-fired boiler plant, necessitating a much larger Plantroom (approximately 2.5 times in area).

- The more complex technology used.

- The low temperature of the heat produced at 43°C. (This limits the options for heating within the larger spaces to underfloor heating).

- Due to the restricted space on the site, it will be necessary to drill boreholes rather than use ground loops, incurring costs of approximately £8,000.00 per twin borehole. It may be necessary to drill a number of trial boreholes, to determine whether there is a plentiful supply of water from boreholes.

Although deemed as being more efficient, the use of electricity as the fuel source negates this in the high running cost (i.e. uses one third of the fuel for heating but electricity costs three times as much). It is possible to utilise "Off Peak" electricity to reduce the electrical costs, although this option would not be suited to the Building, where intermittent use of heating would be required.

The CO_2 emissions for electricity are 0.56kg per kWhr used.

The Economic Life of Ground Source Heat Pump Technology is 15 – 20 years.
This technology is Grant-aided under LCBP2, although Aid is dependent on use of registered Manufacturers and Model Ranges.

Similar technologies are currently being used for Air Source Heat Pumps. This involves the harnessing of heat from external air using a compressor cycle, like the Ground Source Heat Pump, with supplementary heat being provided from electric air heater batteries. This technology has a similar CoP (Co-efficient of Performance) as for GSHP units. However, present Air Source Heat Pumps available for the UK Market have small capacity, up to 13kW, and would not be suitable for this Site.

3.4 Liquefied Petroleum Gas (LPG) Boiler Plant

This technology is very similar to oil-fired boiler plant, but uses LPG as the primary fuel.

Plant comprises a boiler unit or units, fitted with a matched gas-fired burner. Low Pressure Hot Water (LPHW) is generated at 82°C and is distributed via a number of pumped circuits to serve heat emitters. These emitters can be radiators, fan convectors, ceiling panels, underfloor heating or other product.

The plant is also relatively simple to operate, being similar to a domestic type Boiler.

The main disadvantage at present with LPG-fired Boiler Plant is the high cost of LPG. This premium can be as much as 60% higher than for Heating Oil. It will also be extremely difficult to locate the external LPG tank on the Donegall Pass site due to the restricted space available. (A separation distance of 3.0m would be required).

The CO_2 emission for LPG is 1.75kg per litre used.

Although the use of oil-fired Boiler plant is the cheapest option based simply on installation costs, we would have concerns at the higher running costs. We feel that it is likely that the cost of heating oil will continue to increase at a rate greater than inflation, with current predictions that Middle East crude oil could reach and not drop below $120/barrel.

Although the high cost of Wood Pellet Boiler plant and the additional space required for fuel storage tends to disadvantage this technology, there is a considerable advantage when current and future running costs are considered against the other fuel sources.

Based on current fuel costs, and considering Capital Cost together with Running Costs over a ten year period, the simplified" Life Cycle Cost for each Option is as follows:-

System	Estimated Cost of Plant	Estimated Running Cost (pa)	Maintenance Cost (pa)	Total Cost (Per Annum)	Total Estimated Cost (Over 10 Years)
Oil-fired Plant	£8,000.00	£15,077.00	£500.00	£15,577.00	£163,770.00
Wood Pellet Plant	£64,000.00	£7,415.00	£500.00	£7,915.00	£143,150.00
Ground Source Heat Pump	£92,000.00	£11,554.00	£1,000.00	£12,554.00	£217,540.00
LPG-fired Boiler Plant	£8,200.00	£15,128.00	£500.00	£15,628.00	£164,480.00

3.5 Ground Water for "Free Cooling"

It is possible to use ground water from bore-holes, in conjunction with cooling coils on air handling plant, to provide "free-cooling" of mechanical ventilated supply air to the first floor conference room and other meeting rooms.

However, as occupancy profiles for the conference room are of a transient nature and as it is possible to permit temporary increases in internal temperatures in this area, Outline Design proposals do not include for any form of cooling.

Proper design of the Building form, incorporating fabric and shading provisions, to accommodate a natural ventilation solution should negate the requirement for cooling during moderate external ambient temperatures.

As the requirement to cool incoming air would therefore be minimal, we would recommend that the option for ground water cooling is omitted from the Scheme.

4.0 RENEWABLE TECHNOLOGIES

Initial investigations on implementation of the following Renewable Technologies are as follows:-

All of the Technologies listed are Grant-aided under LCBP2, although Aid is dependent on use of registered Manufacturers and Model Ranges. However, under the LCBP2 Initiative applications are considered up to a maximum of three Technologies for each Development, unless prior agreement has been reached with BRE. The Grants are available for a period of twelve months from date of formal notification, as BRE expect the relevant Technology to be installed within this period.

As for the Heat Source Technologies, BRE require that all Systems are installed using BERR approved "Framework Suppliers".

4.1 Photo-voltaics

This technology comprises the use of crystalline panels which use light to generate small amounts of electricity. Each standard sized panels usually generate approximately 250W of electricity, although this is dependent on the strength of the sun, the direction the panel is facing (a South-facing aspect is preferred) and the angle of the panel to the horizontal.

We have generally found that the Payback period for Photo-voltaic (PV) technology is very long, up to 140 years, and often exceeds the Economic Life of the panels installed.

This technology is Grant-aided under LCBP2, although Aid is dependent on use of registered Manufacturers and Model Ranges. Should funding be made available, we feel that a small array of PV panels could be considered. Depending on space availability, this could include up to six number PV arrays, each measuring approximately 2000 x 1400mm. Indicative costs for this array would be approximately £9,500.00 excluding VAT.

4.2 Wind Turbine

This technology comprises the use of a rotating impellor, connected to a DC generator, having an output of between 1 – 3 kW. The electricity generated is fed to a local electrical Distribution Board in the Building.

We have generally found that the Payback period for Wind Turbine technology is reasonable, being in the range of 10 – 15 years.

However, the turbine requires a minimum continuous wind speed to operate. This requirement would be difficult to maintain within an Urban environment such as Donegall Pass, Belfast. It would also be necessary to provide structural reinforcement to the Building in order to support the turbine assembly. It is likely that Planning Permission would be required for the installation of a Wind Turbine.

This technology is Grant-aided under LCBP2, although Aid is dependent on use of registered Manufacturers and Model Ranges.

4.3 Solar Water Heating

This technology comprises the use of a number of evacuated tubes used as solar collectors to heat a primary liquid. Heat is then transferred through a secondary coil fitted to a Hot Water Cylinder to heat Domestic Hot Water (DHW) services.

We have generally found that the Payback period for Solar Water technology is reasonable, being in the range of 10 – 15 years.

This technology is Grant-aided under LCBP2, although Aid is dependent on use of registered Manufacturers and Model Ranges.

5.0 ENERGY EFFICIENCY MEASURES

5.1 Rainwater Harvesting

A rainwater harvesting system for WC facilities should be considered. The system would comprise a ground collection tank, to collect rainwater from the roof drainage system and a filter fitted to the intake of the collection tank to remove debris from rainwater. Approximately 85% of rainwater would pass into the tank with the remaining 15% being discharged to waste. Water from the collection tank would then be pumped on demand to a roof breakwater tank. Water supplies to WC's would be fed from a separate cold water down service. The water supply to the breakwater tank would be backed up from the building mains water service, fitted with a solenoid valve, and with a type AA air gap to comply with current Water Byelaws.

However, the anticipated demand for water consumption at the new facility may be low, mainly due to the low Staff occupancy and the transient nature of visits by members of the Public.

The approximate payback in this system is within the region of 20 years.

5.2 Water Consumption Saving Measures

The following measures could be incorporated into the Detailed Design, to reduce water consumption

- WC cisterns with 6 litre flush volume
- Where showers are provided, water flow to be limited to maximum of 9.0 litres / second
- Urinal cisterns to be fitted with PIR occupancy sensing devices
- Tap outlets at sinks and wash basins to be fitted with automatic activation and control
- The cold-water booster set to have a maximum flow setting.
- Incoming water supply to the building to have a pulsed water meter monitored by BEMS.

5.3 Natural Ventilation Strategy

By widening the design criteria for the circulation areas and utilising a natural ventilation strategy, it would be possible to omit the requirement for comfort cooling and mechanical ventilation within Public areas. The internal design temperature for Public circulation areas would be increased for summer conditions up to 26 degrees C.

During summer months the ventilation strategy for the Public areas would incorporate the use of natural ventilation via roof ventilators and inlet louvers. To limit peak daytime internal gains a night-time cooling strategy would be employed to maximise cooling of the building fabric over night. CIBSE guide AM13: 2000 and BSRIA Guidance Note GN 7/2000 will be used as a basis for the design.

It should be noted that it would be necessary to provide mechanical fresh air ventilation to the first floor conference room, to ensure minimum fresh air conditions are maintained during periods of high occupancy. Ventilation plant would incorporate heat recovery utilising a plate heat exchanger matrix, to recover heat from vitiated air and transfer it to incoming fresh air.

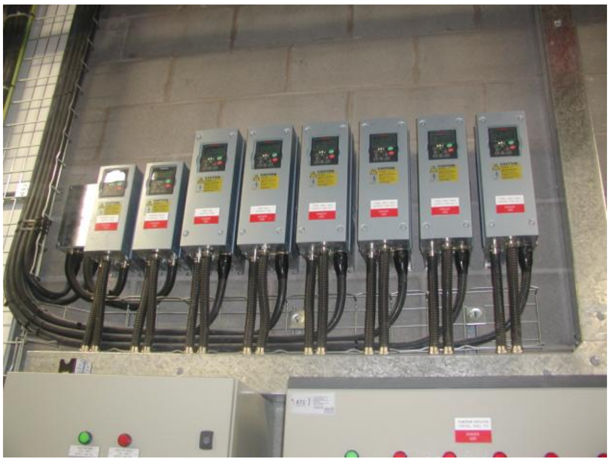

Detail of Air Handling Unit with Heat Recovery

5.4 High Efficiency Motors

We understand that the first floor conference area is to be used for a number of different activities, each with differing occupancy profiles, in line with the varying User-Group requirements.

The Detailed Design of the ventilation strategy for this area should therefore include for the provision of high efficiency motors on ventilation fans, combined with the use of electronic speed controller devices. These would be used to adjust fresh air volumes entering the conference room, to match air loads to specific occupancy ranges. Carbon Dioxide sensors would be incorporated into the design strategy for the ventilation plant serving the conference room, to monitor air quality and adjust plant volumes to minimise load and energy usage.

The use of these high efficiency motors and variable speed drives on fans and pumps would greatly reduce medium to long-term electrical costs.


Typical Detail of Motor Speed Controllers

5.5 Upgrading of Thermal Insulation on Mechanical Services

We would investigate the merits of increasing the thickness of thermal insulation materials to be fitted to heating pipework and ventilation ductwork services.
However, as we have proposed for the Building to be heated by means of underfloor heating, and with the limited requirement for Domestic Hot Water (DHW) to be met from point-of-use type electric water heaters, the extent of services requiring additional insulation is minimal.

5.6 Additional Lighting Controls.

We would investigate the provision of energy efficient lighting to all areas of the Building. Where possible, we would supplement this lighting with automatic control of individual areas by means of PIR detectors and daylight sensing.

5.7 Upgrading Thermal Insulation of Building.

We would investigate the merits of increasing the specification and thickness of thermal insulation materials to be provided on external walls of the Building, to improve the heat loss characteristics. Although the proposed revisions to the Building Regulations indicate improvements to current standards, proposals to further enhance U-values to below 0.2 or 0.12 W/m²/°C ("super-insulation") would be investigated.

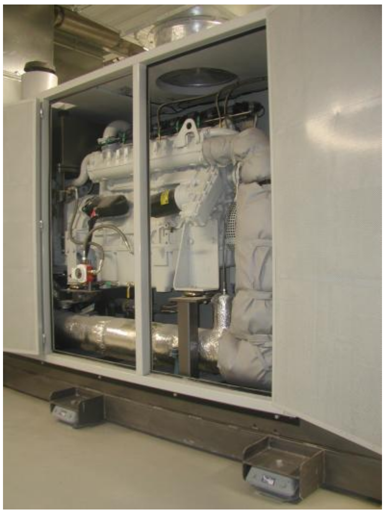
5.8 Upgrading Specification of External Glazing.

This exercise would be carried out in conjunction with the proposal to upgrade thermal insulation, as noted above.

5.9 Combined Heat & Power / District Heating.

Combined Heat and Power comprises the use of an engine driven alternator to provide on-site generation of electricity, with the waste heat generated by the engine also being recovered to provide low grade heat.

However, initial assessments indicate that Base Loads for Electricity and Heat will be too low to justify incorporation of CHP into the Design.



Detail on Combined Heat & Power Plant.

6.0 OPTIONS FOR SPACE HEATING

Options available for Space Heating are therefore as follows:-

(a) Convective type Radiators

(b) Underfloor Heating

(c) Radiant Ceiling Panels

(d) Fan Convectors

6.1 Convective Type Radiators

The Space Heating would comprise a number of radiators located at low level on walls throughout the Building. The main Heating distribution pipework would be routed at high level, within ceiling voids, with branch flow and return pipes dropping or rising to connect to radiators.

The Heating circuit would be controlled from a main modulating type valve in the Boilerhouse, to compensate the water flow temperature for varying outside temperatures. Local control would be provided by means of thermostatic valves fitted to individual radiators.

6.2 Underfloor Heating

The Space Heating would comprise a number of loops of non-metallic pipes embedded within the floor screeds throughout the Building. The main Heating distribution pipework would be routed at high level, within ceiling voids, with branch flow and return pipes dropping or rising to underfloor heating manifolds. The underfloor loops would then be taken from these manifolds to serve individual rooms.

The Heating circuit would be controlled from a main modulating type valve in the Boilerhouse, to compensate the water flow temperature for varying outside temperatures. Local control would be provided by means of “telestat” valves fitted to individual pipe loops.

6.3 Radiant Ceiling Panels

The Space Heating would comprise a number of Steel panels integrated within ceiling finishes throughout the Building. The main Heating distribution pipework would be routed at high level, within ceiling voids, with branch flow and return pipes taken to connect to individual ceiling panels. The ceiling panels would be manufactured in aluminium, and would be complete with pipework acting as the emissive surface

The Heating circuit would be controlled from a main modulating type valve in the Boilerhouse, to compensate the water flow temperature for varying outside temperatures. Local control would be provided by means of thermostatic valves fitted to individual ceiling panels.

6.4 Fan Convectors

The Space Heating would comprise a number of Fan Convectors installed throughout the Building. The main Heating distribution pipework would be routed at high level, within ceiling voids, with branch flow and return pipes dropping or rising to individual Fan Convector Units. Each Fan Convector would be complete with heating element, air filter and air fan.

The Heating circuit would be un-modulated, with no compensation of the water flow temperature. Local control would be provided by means of control thermostats fitted to each Fan Convector.

7.0 OTHER IMPORTANT CONSIDERATIONS

It is important that the new Donegall Pass building deals with passive energy and environmental considerations, and that good building practices are incorporated as the building is developed through its detailed design and technical stages, and it is just as important that best practice construction methods are utilised. The following checklist should be applied:-

Orientation
Maximising solar gain is important. The orientation of the site is not helpful, as the principal elevation faces north. However, the garden areas to the upper floor crèche can be utilised to provide south facing glazing and thereby enhance solar gain.

Footprint
Reduced footrpint area, compact planning and increased insulation levels.

Windows
Reducing the number of thermal breaks in a window will enhance thermal insulative performance. Windows must open inwards in order that the pressure works correctly. Double glazing.

Construction
Airtight envelope, employs airtight connections – robust detailing.
Minimise thermal bridges
Build service penetrations into pre-cast elements to reduce opportunities to air leakage combined with the use of special air tight tapes.

Sustainability Agenda
The sustainability agenda needs to be established with the client body. It is important that the building adopts “green” credentials and that consideration is given to these at an early stage and throughout future development stages.