SWANSEA CENTRAL

PLANNING ENERGY ASSESSMENT

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PREPARED BY

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FOR

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draft

1. Planning Energy Statement

1.1 INTRODUCTION

This energy assessment is written in support of an outline planning application for the re-development of the Swansea Central and in response to Planning Policy Wales (PPW) 'good design' objectives and the Swansea Local Development Plan (LDP) with particular reference to:

- Policy ER1: Climate change
- Policy EU2: Renewable and low carbon energy technology in new developments
- Policy EU3: District heating and cooling

All the buildings will as a minimum be designed and constructed to meet the requirements of the Building Regulations Part L, 2013. This energy assessment describes the various energy efficiency measures that may be applied to improve upon the building regulations baseline energy efficiency standard.

1.1.1 Development Description

Outline planning application (with all matters reserved) for the refurbishment, alteration and / or demolition of all existing buildings / structures on the site (except St Mary's Church and St David's Church) and redevelopment of site with indicative access / layout and scale parameters on the north site of a maximum of 1 to 7 storeys and maximum new floorspace of 84,050 sqm comprising retail / commercial / office use (Classes A1/A2/A3/B1) residential (Class C3), non-residential institution (Class D1) and leisure (Class D2), multi storey car park and redevelopment of south site of a maximum of 40,700 sqm of floorspace comprising a new arena (Class D2), up to 13 storey hotel / residential building (Class C1/ C3), food and drink (Class A3), undercroft car park, potential energy centre. Across both sites, the provision of associated new public open space / public realm and landscaping, new pedestrian and vehicular access and servicing arrangements (including a pedestrian bridge link across Oystermouth Road), provision of new bus stops on Oystermouth Road, new pedestrian access through existing arches along Victoria Quay, relocation of Sir H Hussey Vivian statue, earthworks, and plant.

1.2 MINIMISING ENERGY USE

1.2.1 General

The project will look to adopt good sustainable building services solutions, which provide reduced energy input while maintaining appropriate conditions for the occupants of the various buildings. The buildings will be designed to achieve the following 'good practice' objectives:

- The adoption of passive measures, including the use of thermal mass and external shading shall be considered in the architectural design of the buildings.

- Provide where practical mechanical and electrical engineering systems that will assist in achieving the lowest possible annual energy input thereby reducing the level of CO_2 emissions.

1.2.2 Good Practice Measures

A key focus of the building designs will be to minimise energy usage first, and then to find the most efficient and economical systems to serve the required purpose. Spaces shall be evaluated to anticipate seasonal internal temperatures based on the load profile of the room prior to making decisions on conditioning level.

In addition, the environmental services proposals will be designed using the latest techniques for 'active and passive' energy recovery and conservation, to achieve the most advantageous and cost effective 'energy targets' possible.

The following sections describe the good practice elements to be reviewed and incorporated where suitable with the renewable elements identified and covered in detail in a later section of this report.

1.2.3 Passive Energy Solutions

The proposed development features the following 'passive' energy saving measures:

As part of the design development, the individual buildings shall be modelled to test various architectural conceptual layouts and orientations to assess the impact on the energy requirements. This modelling exercise assists in developing the most energy efficient design from the outset.

- U-values - thermal performance of the building envelope elements shall be improved beyond the minimum requirement of the current Building Regulations Part L – 2013.

- Air tightness – A reasonable limit for the design air permeability in accordance with current Building Regulations is, 10m3/hr/m2 at 50 Pa, however, for this development, improved air tightness shall be sought wherever practical.

- Solar Shading – Where the façade design allows, solar shading will be provided across the balance of the development via a variety of architectural features including balconies.

- Solar Glazing – Where practical and as part of the passive solar protection measures, solar protection glazing systems shall be installed to limit the solar gains to the building.

1.2.4 Commissioning Standards

To ensure that the operational efficiency is maximised, it is essential that all pre-commission checks and commissioning trials are conducted to the highest standards. The minimum standard of commissioning acceptable will be in accordance with the CIBSE Current Commissioning Codes.

All electrical testing and commissioning shall be in accordance with the latest IEE Regulations (BS 7671).

The above must be undertaken in conjunction with British Standards guidance. The systems will be tested and commissioned in order to demonstrate compliance with the energy and monitoring targets.

1.2.5 HVAC System Zoning

It is anticipated that the engineering services installation will be suitably zoned, both at a macro level for the whole site and micro level for the buildings within the development.

Design solutions will be chosen, with energy recovery and conservation given paramount consideration.

Heating, ventilation, water services and electrical zoning shall be configured to promote maximum flexibility in order to enable the possible remodelling and re-planning to be undertaken at a future date.

To control and monitor energy consumption it is envisaged that provision for sub-metering of all major services to each zone will be required and that this shall be interfaced with the site building management systems.

1.2.6 Variable Speed Drives

The use of frequency inverter, variable speed drives is proposed for all major pump sets and ventilation fans. For primary heating and chilled water distribution systems the variable speed circulation pumps are to be used in association with two-port control valves.

The use of variable speed drives will also remove the use of inefficient belt drive pumps.

1.2.7 Natural Ventilation

The use of natural ventilation would normally be promoted in all areas where specific year round temperature control is not essential or there are no specific needs.

Where no constraints are applicable, and natural ventilation is a viable and effective option, this will be provided through openable windows. It is envisaged that where the provision of openable windows is made, these will be user operated.

1.2.8 Plant Sizing

All the central plant including air handling units, boilers and chiller units will be selected so that they correctly reflect the required loadings for the building. Over sizing of fans will be avoided.

1.2.9 Heating Systems

The heating for the development is to be provided by a mixture of gas central heating boilers and VRF air source heat pumps.

For buildings with a significant year round demand for heat and/or hot water, a local Combined Heat and Power (CHP) system may be considered, at this stage the hotel or residential buildings are expected to be the most appropriate for this technology.

The heating system will incorporate zonal pumping arrangements with run and standby facilities as appropriate, with compensated variable temperature heating circuits to supply the terminal heaters.

The central heating systems shall be provided with a facility to connect to a future district heating system should it become available, refer to district heating section of this report. Note that should a district heating system become available then the provision of local CHP to suitable buildings would not be adopted for the reason that the district heating would be the more efficient means of supporting the buildings heat load.

1.2.10 Day lighting

Through the consideration of external shading and solar control glass, the design of the buildings will maximised the use of daylighting whilst avoiding solar overheating.

1.2.11 Lighting Installation

The lighting installation throughout both buildings shall maximise the use of low energy lamps and high efficiency electronic ballast technology wherever possible.

Where practical, lighting will be linked to light sensors to automatically dim fittings when natural daylighting is available.

In addition, long life lamps will be incorporated into all aspects of the installation, utilising fluorescent and LED technology whenever the task permits.

Automatic PLC based lighting control systems shall be utilised wherever practical.

The lighting will be designed to be in excess of minimum efficiency standards set in Part L of the Building Regulations.

The lighting throughout the development will form a mixture of functional and decorative luminaires.

1.2.12 Ventilation Systems

The mechanical ventilation systems will include either a recirculation system with a free cooling capacity, or where 100% outside air is required, heat recovery components such as plate exchangers, thermal wheels or run around coils.

These facilities will be designed to recover both heating and cooling energy in the winter and summer seasons. The choice of clean or dirty extract systems shall be made to achieve the most efficient energy recovery option, back into their respective supply air systems.

The use of variable speed drives will be considered on ventilation plant where there are likely to be variations in occupancy levels and the air volume can be controlled by the use of CO_2 or occupancy sensors.

1.2.13 Building Management

The individual buildings shall, where practical be provided with a Building Energy Management System (BEMS) to fully control, monitor and record the various Mechanical, Electrical and Public Health systems.

The BEMS shall control the Mechanical, Electrical and Public Health systems and extensively monitor the energy usage via locally installed energy monitors. The BEMS software will allow the building manager to record energy usage and identify where improvement to energy consumption can be made.

1.2.14 Tenant Fit Outs

For areas of tenant fit out where the space is leased as a cold shell, it will be a statutory requirement for the installation by the tenant to meet the minimum requirements of the Building Regulations, Part L 2013. Further to this the fit out guidelines issued to each tenant will encourage and set out measures which should be employed to improve upon the Building Regulations minimum requirement.

1.3 DISTRICT HEATING AND COMBINED HEAT AND POWER

1.3.1 District Heating

Currently there is no local district heating system which can be utilised by the proposed development, however the City and County of Swansea have confirmed that they are investigating the feasibility of a system which may serve the Swansea Central re-development site and the wider area.

The development area is unlikely to be able to accommodate an Energy Centre for the city district heating network. Each building's Low Pressure Hot Water (LPHW) central heating systems shall however, be provided with future connection points to facilitate connection to the proposed district heating system should it become available.

Any agreement to connect to a district heating network will be subject to the heat being provided at commercially advantageous rates and that any future pricing fluctuations should be suitably index linked to the gas supply market rate in the usual way.

1.3.2 Combined Heat and Power

Should a district heat network not be available at or near the completion of the development construction, the alternative consideration would be the application local Combined Heat and Power (CHP) systems.

CHP is the use of a local generator to provide electrical power whilst also recovering the waste heat for use in space heating and hot water generation. This process removes the losses associated with electricity generated for the grid.

For CHP to be viable it requires a consistent year round heating load, this is usually found in buildings with a high, daily domestic hot water usage. For the Swansea Central re-development this applies to the Hotel and the residential buildings.

Should the district heating network proposals not be taken forward then the design will consider the feasibility of local CHP systems for these building types.

1.4 RENEWABLE ENERGY

1.4.1 General

This section analyses potential onsite renewable energy generation systems and considers their technical feasibility as applicable to the Swansea Central re-development.

1.4.2 Renewable Energy Systems

The following technologies are considered as possible renewable energy sources.

- Solar electricity (Photovoltaic).
- Solar water heating.
- Biomass Boilers
- Ground source and air source heat pumps.
- Wind
- Hydrogen fuel cells

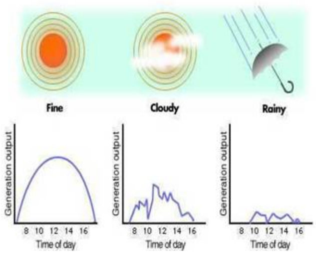
1.4.3 Solar energy, photovoltaic

Photovoltaic (PV) modules convert solar radiation into Direct Current (DC) electricity. The PV modules are made up of several PV cells consisting of a thin layer of semiconductor material such as silicon. A semiconductor consists of two layers referred to as p-type and n-type. A flow of electrons is created between these two layers through the absorption of solar radiation, this flow of electrons produces a DC charge.

The majority of PV panels are made from silicon based materials and are categorised as crystalline silicon cells.

Crystalline cells are available as monocrystalline or polycrystalline; monocrystalline cells have a solar energy to electricity conversion efficiency of 15-18% whilst polycrystalline cells are typically 13-16% efficient.

Photovoltaic panels are optimally mounted facing between southeast and southwest at an ideal angle of between 30° and 40° in the UK. Architectural and planning constraints will limit the amount of area available for a PV panel array.



The area of photovoltaic cells required is dependent on the efficiency of the type of cells used. At present there are a number of varying operating efficiencies available, which directly affects the area coverage required to give the same output (1kWp).

Types of PV modules and associated energy yield:

Photovoltaic Technologies	Approximate m^2 Required to Generate 1kWp.
Amorphous Silicon PV Modules	15
Polycrystalline PV Modules	8
Monocrystalline PV Modules	6

Technology	Conclusion	Comments	Suitable Building Types
Photovoltaics	Potentially viable subject to available roof area of developed building designs	Large areas are required to make significant contribution to renewable energy requirement. The use of PV is a possible option and their inclusion will be assessed at the next stage as the development design progresses.	All where an accessible, unshaded roof space is available.

1.4.4 Solar Heating for Domestic Hot Water

The use of solar heating for hot water generation would require the installation of solar panels at roof level. Ideally the panels should be mounted facing between southeast and southwest at an ideal angle of between 30° and 40°. Architectural and planning constraints may limit the amount of area available for a solar heating array.



The viability of using solar water heating for this development is dependent on the availability of the proposed district heating systems. A district heating system would provide hot water heating throughout the year and the installation of solar panels will mean that both systems shall be competing for the same load.

Technology	Conclusion	Comments	Suitable Building Types
Solar Water Heating	Potentially viable. Dependant on availability of district heating.	Requires domestic hot water load which is also major part of the base load required for the viability of a possible district heating system connection.	Residential buildings and the hotel where a significant year round hot water load is present and accessible, unshaded roof space is present.

1.4.5 Biomass Heating

Biomass technology could be installed as part of the central heating provision. The most economical option, and the best for reducing CO_2 emission levels would normally be to install Biomass boilers to act as the lead boiler and cater for the base hot water heating load with the remaining gas fuelled boilers sized to meet the total heating load and to form a standby facility.

The Biomass boiler system will require the installation of additional components for the storage of the wood chips or pellets used as fuel, along with the necessary transportation components to link between the storage hoppers and the boiler.

Wood chips or pellets would need to be stored in external or internal hoppers. The amount of wood chips or pellets stored will affect the choice of the silo or bunker storage types. Storage systems require sufficient space for large delivery vehicle to 'shoot' the wood fuel directly into the storage facility.

The wood chips or pellets are transferred from the storage facility by screw or similar transportation system linking between the wood hoppers and the boiler house.

The waste combustion products from the boilers (in the form of ash) can either be removed manually or automatically by the use of screw feed units direct to a collection skip. This plant ash is an inert ash and can be used as fertiliser, assuming that the wood is obtained from clean sources (i.e. non-industrial and not contaminated with plastics). The use of automatic removal of the plant ash will reduce maintenance costs but increase the initial capital installation costs.

Biomass boilers have comparable combustion efficiencies as basic gas fired systems. The flueing requirements for modern wood fired boilers are comparable with those of gas fired systems and the emissions are similar to that of gas fired units with the exception of particulate emissions, where there are concerns when installed in smoke control zones. Where the heat output to water is above 300kW (400kW input) there is a requirement under the clean air regulations, when using waste wood, to install continuous flue monitoring. These systems are relatively expensive to install and maintain.

Biomass Boilers can also operate on a modulating basis to vary the heat output as low as 30% of their maximum load. However these boilers require additional plantroom area over the standard models.

The installation of a Biomass Boiler with pellet storage as the main heating boiler is not usually a viable option when a district heating connection is available, as the majority of the base heating would be provided by the district heating system. The viability of a biomass heating system is therefore dependant on the availability of the proposed district heating system.

Technology	Conclusion	Comments	Suitable Building Types
Biomass Heating and Hot Water	Not suitable	Requires domestic hot water load which is major constituent of base load required for the viability of a possible district heating system. Concerns over future fuel supplies, fuel delivery access and particulate emissions. Requires additional plant area and has the burden of a high maintenance cost. The proximity of the site to Swansea's Air Quality Management Area would also present challenges to the use of Biomass fuel.	None on development site

1.4.6 Ground, Water and Air Source Heating and Cooling

Ground, water and air source heat pump systems provide the opportunity to obtain both heating and cooling via water to water or water to refrigerant heat pumps. A heat pump uses a refrigeration process to raise the temperature of a heat source to a useful level that may be used for space heating and the generation of domestic hot water. During the summer, the same system may be reversed to reject heat and provide cooling to the building.

Ground, water and air source heat pumps utilise the same refrigerant technology but recover heat from the different sources.

A ground source system utilises an open or closed water loop penetrating into the ground strata via bore holes or trenches. At a depth of around 6 m and below the temperature of the earth is relatively stable and maintained at around 10 deg.C throughout the year. This relatively warm temperature makes these the most efficient heat pump systems.

A water source system is a similarly efficient but less expensive option which utilises a nearby body of water for heat extraction/rejection rather than the more expensive bore holes.

Air source heat pumps are not generally as efficient as a water/ground source system due to the higher temperature gradient between heat source (winter outside air temperature) and the conditioned internal space. They do, however, have the benefit of greater flexibility and reduced capital costs.

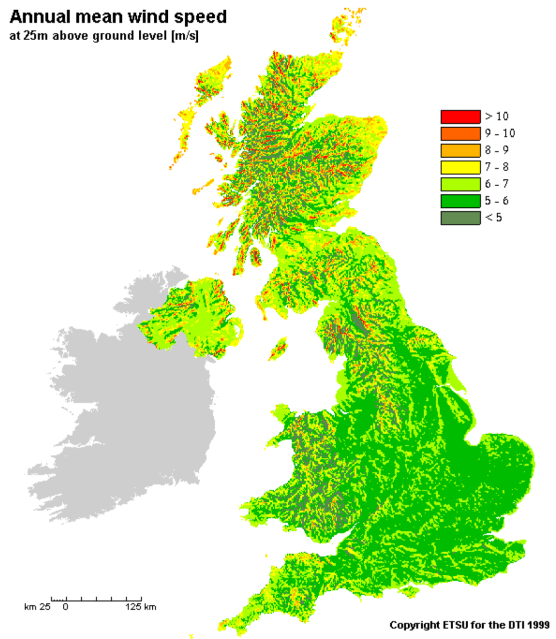
All of these technologies can reduce the demand for conventional energy consumption and thus reduce overall CO_2 emissions.

The use of a heat pump system is not typically compatible with a district heating connection due to both systems needing the same heating load to be viable. For areas with a low annual heating load, such as the retail shell units, an air source heat pump system may however be a better overall solution.

Technology	Conclusion	Comments	Suitable Building Types
Ground and Air Source Heating and Cooling	Generally not a compatible system that would facilitate the connection to a district heating system. Notwithstanding, an air source heat pump solution may be preferable for the retail shell units.	Not a compatible technology with the possible district heating system. May be viable for heating and cooling source to areas with a low heating load such as the retail shell units.	Retail shell units

1.4.7 Wind Power

To evaluate the suitability for wind power generation, it is necessary to undertake a full survey and analysis of the site to ascertain the likely wind speeds available to support the viability of wind generation.



The British Wind Energy Association (BWEA) wind database suggests that the annual mean wind speed at the site would be around 5-7m/s at 25m above ground level. This could support a small wind turbine, however, annual load generation will be relatively low.

In addition, planning requirements from the local authority regarding potential noise from the wind generators as well as the visual impact would have to be considered. It is likely that during the day sound levels would not be noticeable, however, with lower background levels at night, this could be invasive to the buildings, particularly the residential buildings.

It would therefore be reasonable to conclude that, even without a technical review of the installation costs, the requirements for maintenance and the installation restraints, that the installation of electrical wind generation is not suitable for this development.

Technology	Conclusion	Comments	Suitable Building Types
Wind Power	Not suitable	Not considered suitable due to turbine noise generation and relatively low output.	None on development site

1.4.8 Hydrogen Fuel Cells

Hydrogen fuel cells have been considered but have been discounted due to the current lack of a commercially viable source of hydrogen. Many current installations are known to be running on natural gas until hydrogen becomes available.

Fuel cells are most efficient when they deliver heat and power to the development. The waste heat from this process would reduce the potential for annual demand from a district heating connection. The application of a Combined Heat and Power (CHP) hydrogen fuel cell is therefore not considered a compatible technology to the preferred district heating.

Technology	Conclusion	Comments	Suitable Building Types
Hydrogen Fuel Cells	Not suitable	Concerns over availability of hydrogen fuel. Not compatible with possible district heat network.	None on development site

1.5 CONCLUSION

As the building designs develop, the various measures described in this report to minimise energy usage shall all be considered and applied wherever practical with the goal of improving upon the benchmark minimum energy efficiency standard required by Part L, The building Regulations 2013.

Each buildings heating system shall be developed to facilitate connection to the district heating network currently being investigated by City and County of Swansea. Should the district heating network not become available to the development, the provision of local CHP generators shall be considered as an alternative for buildings with a suitable year round heat load.

Renewable energy technologies have been assessed with regard to their suitability for the developments various building types. From this initial assessment, Photovoltaic panels are considered potentially viable for all buildings with a suitable unshaded roof space. Solar hot water generation and ground, water or air source heat pumps are other renewable technologies that may be suitable, however, their viability is likely to be dependent on the district heating network connection not being available.

Further we are also aware of the Tidal Lagoon Swansea Bay project and have given consideration as to how this renewable energy project may interact with the Swansea Central Re-development. The use of sustainable power from the national grid, to which the tidal lagoon is expected to be connected is an obvious benefit. In addition to this the Swansea Central Re-development design will continue to monitor the carbon intensity factor for grid generated electricity, as it has fallen over recent years and is projected to drop further due in part to the application of renewable energy projects such as Tidal Lagoon Swansea Bay. A significant drop in the carbon intensity of grid generated electricity would result in electrically driven systems for heating becoming the preferred choice over gas for minimising carbon emissions.