National Paediatric Hospital Project

Planning Application
National Paediatric Hospital Project
Connolly Hospital
Energy Strategy Report

14_D110 Satellite Centres

**CURRENT ISSUE**

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Appendix 1: Sustainable Options
1. Executive Summary

This report demonstrates that a variety of technologies are viable and could be utilised to reduce the primary energy and carbon emissions of the proposed extension of the Integrated National Children’s Hospital, Connolly Satellite Centre to 214 kWh/m²/year and 222 tonnes of CO₂ per annum from the Part L 2008 compliant base case of 404 kWh/m²/year and 435 tonnes of CO₂.

This is a significant achievement and represents current best practice. The key technologies proposed for the site are:

- Building fabric and energy efficiency measures including natural daylighting, high efficiency mechanical ventilation with heat recovery and intelligent, efficient lighting.
- Natural gas fired CHP (Combined Heat and Power)
- It is also recommended that the potential for solar PV be further investigated during the detailed design stage.

2. Introduction

The following is from the MCA NCH Satellite Centre Site Assessment draft report February 2014

The Integrated National Children’s Hospital (NCH) is to be located on the campus of St. James’s Hospital in Dublin 8. Two satellite centres of the NCH will be developed, one at Tallaght Hospital on the south side and one at Connolly Hospital on the north side of Dublin. The satellite centres are being developed in order to enhance access to emergency / urgent care facilities for children in the greater Dublin area. As well as emergency care, each centre will also provide access to diagnostics and secondary acute outpatient services, including rapid access general paediatric clinics. It is anticipated that the Centres will open from 07:30 – 22:00 hours. The majority of patients attending the centres will be treated and discharged. Critically ill and injured children will be stabilised by appropriately trained staff and transferred to the NCH.

2.1. Role of the NCH Satellite Centres

The following is an extract from National Paediatric Hospital Development Board (NPHDB) document titled "Design Brief for new children’s hospital Satellite Centre 1" Version B September 2014

The new children’s hospital will provide national tertiary paediatric services for all of Ireland and secondary paediatric services for the greater Dublin area. The satellite centres will:

- Provide safe, high-quality paediatric healthcare to children and young people that is child-centred and family focused
- Provide ambulatory outpatient services primarily in general paediatrics supported by rapid access clinics
- Provide chronic disease clinics, such as diabetic review clinics, at the satellites to support children with the provision of care locally
- Provide orthopaedic fracture clinics in support of the urgent care units
- Provision for the management of minor illness and injuries at the urgent care centre
- Support best clinical practice, research and education, thus improving clinical outcomes for children and young people
- Optimise the efficient use of resources, including staff, equipment, ICT and facilities
- Ensure future flexibility to respond to changes in service range and volume, and advances in medical technology
- Provide strong linkages and support to primary and secondary healthcare services
• Provide leadership and influence the development and implementation of policy relating to paediatric care, health promotion and advocacy for children and young people’s health
• Continually develop the expertise of the clinical workforce, through consultation and supervision, and set standards for clinical services and
• Implement value-for-money practices that demonstrate optimal resource utilisation linked with better clinical outcomes.

2.2. Proposed Accommodation for Connolly Satellite Centre

Table 1:

<table>
<thead>
<tr>
<th>Schedule of accommodation at Connolly</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Out Patient Consulting Rooms</td>
<td>6</td>
</tr>
<tr>
<td>Urgent Care Assessment cubicles</td>
<td>10</td>
</tr>
<tr>
<td>Urgent Care short stay observation beds</td>
<td>6</td>
</tr>
<tr>
<td>CSAU (Child Sexual Abuse Unit Examination, Observation and Therapy rooms)</td>
<td>1 + 3 + 7</td>
</tr>
<tr>
<td>HSE paediatric Primary Care Dental Service – Operating Theatres</td>
<td>2</td>
</tr>
</tbody>
</table>

Core Clinical Accommodation

• Shared main reception with Therapies and Diagnostics
• Waiting /Sub waiting+/-(Isolation wait)
• Play area
• Standard and Assisted WC facilities for patients/public and Staff
• Infant Feeding room
• Baby Change facilities
• Patient Changing room with Hoist
• WC Facilities
• Staff Base
• Clinical Assessment room for weigh/height measurement
• Larger Consult/ Examination rooms for children with disabilities
• Standard consult/examination rooms
• Larger Consulting Examination and Therapy rooms for children with disabilities
• Standard Interview Rooms
• Nurse Drop in rooms and other relevant Treatment /Therapy rooms

Clinical Support

• Multidisciplinary Room
• Clean Utilities
• Dirty Utilities
• Equipment Storage /Consumables

Therapy Facilities

• Physiotherapy/OT Assessment/treatment
• Physiotherapy Gym
• Casting/Moulding splinting room
• Orthotics/.Prosthetics Fitting Room

Staff Workstations and bays for

• Consultants
• NCHD’s
• Nursing
• HSCPs
• Administration

Staff Supports
• Staff pantry – Shared with UC
• Education Room/ Case Conferencing
• WC Facilities

The design team recognises the need for buildings to be designed and operated in a manner that reduces the environmental impact of the building, but achieving it in an economical manner and maintaining an internal environment that is comfortable and enjoyable to occupy.

2.3. Methodology Adopted in this Strategy

The aspirations of the developer can be summed up as follows:

• Achieve (as a minimum) Building Regulations Part L compliance
• Further reduce, as far as is feasible and reasonable, the primary energy consumption and CO₂ emissions of the proposed development through design measures; and
• Consider the potential to make use of renewable energy resources

In order to achieve these objectives, the following energy hierarchy was used to identify and prioritise the most effective means of reducing carbon emissions:

Sometimes referred to as "Be Lean, Be Clean & Be Green"

Be Lean – energy efficiency through design and use;
Be Clean – optimise energy supply infrastructure for efficiency through ‘Low Carbon’ strategies;
Be Green – utilise renewable energy resources where appropriate.

Ethos Engineering considers this hierarchy – proposed by a body representing Local Government in the UK and now endorsed by many local authorities – to be well considered and an appropriate set of principles to adhere to in tackling climate change. In adopting the hierarchy, the CO₂ savings at each stage are maximised before strategies at the next stage are considered.

Ethos Engineering will also ensure that the development will attain the highest Energy standard desired by the client. The new building will achieve an A3 Building Energy Rating as this is a requirement for all public sector buildings under S.I.426 2014 Energy Efficiency.
2.4. Fingal County Council Area Development Plan

2.4.1. Energy Efficiency

The National Climate Change Strategy 2007-2012 states that one way of meeting our international commitments on climate change is through the integration of climate change considerations into all policy areas. Fingal recognises the role that energy saving and renewable energy technologies play in reducing emissions of greenhouse gases and Ireland’s dependence upon fossil fuels.

There is now a requirement for all new buildings to become more energy efficient in line with the EU Energy Performance of Buildings Directive 2002/91/EC and through the development of energy related programmes and awareness campaigns targeted at all building users, both new and existing. If such emissions are to be reduced progressively to meet rising target levels, it is crucial that new buildings meet more stringent energy standards as soon as possible. The new Building Regulations (Part L Amendment) Regulations and the European Communities (Energy Performance of Buildings) (Amendment) Regulations 2008 will aid this requirement. Fingal has been to the forefront on this issue and has incorporated energy saving measures into all its recently adopted Local Area Plans.

**Objective EN01**

Require the use of energy saving measures in all new developments and in retrofit developments.

2.4.2. Renewable Energy

Fingal seeks to ensure that all new developments contribute positively towards a reduced energy consumption and the associated carbon footprint. New development proposals will be required to demonstrate reduced energy consumption in their design and construction and should incorporate where possible alternative energy technologies such as bio-energy, solar energy, heat pumps, heat recovery and wind energy.

New building design will reflect the need to ensure that development occurs in a sustainable and sensitive manner giving due recognition to the necessity to produce a design which accords with national sustainability and energy conservation policies, and contributes to the creation of appropriate urban form.

**Objective EN02**

Improve the efficiency of existing building stock and require energy efficiency and conservation in the design and development of all new buildings in the County.

**Objective EN03**

Promote energy efficiency and conservation above the Building Regulations standards in the design and development of all new buildings and in residential schemes in particular and require designers to demonstrate that they have taken maximising energy efficiency and the use of renewable energy into account in their planning application.

**Objective EN04**

Require details of the requirements for alternative renewable energy systems, for buildings greater than 1000sq m or residential schemes above 30 units, under SI 666 of 2006 European Communities (Energy Performance and Buildings) to be submitted at pre planning stage for consideration. These should take the form of an Energy Statement or Feasibility Study carried out by qualified and accredited experts.

**Objective EN05**
Permit renewable energy developments where the development and any ancillary facilities or buildings, considered both individually and with regard to their incremental effect, would not create a hazard or nuisance, and would take cognisance of the following:

(i) residential amenity and human health  
(ii) the character or appearance of the surrounding area  
(iii) the openness and visual amenity of the countryside  
(iv) public access to the countryside and, in particular, public rights of way and walking routes  
(v) sites and landscapes designated for their nature conservation or amenity value  
(vi) the biodiversity of the County  
(vii) sites or buildings of architectural, historical, cultural, or archaeological interest, and  
(viii) ground and surface water quality and air quality

Objective EN06, EN08, EN09, EN06, EN10 & EN11

Support Ireland’s renewable energy commitments outlined in national policy by facilitating the exploitation of Wind power, Solar power, Geothermal power, Hydro power & Biomass technology energy where such development does not have a negative impact on the surrounding environment, landscape or local amenities.

2.5. EU Legislative Initiatives

The Energy Services Directive (ESD) is the main legislative mechanism through which energy efficiency policy at EU level is delivered. The directive seeks to promote end-use energy efficiency in EU member states through support measures and the removal of institutional, financial and legal barriers. The ESD was largely repealed by the Energy Efficiency Directive (EED) adopted by the Council and Parliament in October 2012.

The EED will translate certain ambitions elements of the European Energy Efficiency Plan into binding measures. The proposed legislative provisions set binding measures on member states, including an annual rate of renovation for central government buildings of 3%; an obligation on public bodies to procure products, services and buildings with high energy-efficiency performance; obligations on industry relating to energy audits and energy management systems, and a common framework for national energy savings obligations schemes equivalent to 1.5% of energy sales. The new directive entered into force on 4th December 2012 and must be transposed into law by each member state by 5th June 2014.

Ireland transposed the ESD through the Energy End Use Efficiency and Energy Services Regulations 2009 (S.I. 542 of 2009) which provided for national energy efficiency savings targets; energy services including the availability of energy audits to final customers; the exemplary role of the public sector, and the promotion of energy efficiency by energy suppliers.

A primary focus of both the ESD and the EED is on domestic and commercial buildings, as these sectors account for 40% of total energy consumption in the EU. The Directive on Energy Performance in Buildings (EPBD), adopted in 2002, primarily affects energy use and efficiency in the building sector in the EU. Ireland transposed the EPBD through the Energy Performance of Buildings Regulations 2003 (S.I. 666 of 2006) which provided for the Building Energy Rating (BER) system to be administered and enforced by the Sustainable Energy Authority of Ireland (SEAI).
The Recast EPBD, adopted in May 2010, states that reduction of energy consumption and the use of energy from renewable sources in the buildings sector constitute important measures needed to reduce the Union’s energy dependency and greenhouse-gas emissions. The directive aims to have the energy performance of buildings calculated on the basis of a cost-optimal methodology. Member states may set minimum requirements for the energy performance of buildings.

The **recast Energy Performance of Buildings Directive** requires Ireland to ensure, among other obligations, that building energy ratings are included in all advertisements for the sale or lease of buildings; that Display Energy Certificates (DECs) are displayed in public and privately owned buildings frequently visited by the public; that heating and air-conditioning systems are inspected; that consumers are advised on the optimal use of appliances, their operation and replacement, if necessary; that energy performance certificates and inspection reports are of a good quality, prepared by suitable qualified persons acting in an independent manner, and are underpinned by a robust regime of verification; and that a national plan is developed to increase the number of low- or nearly zero-energy buildings, with the public sector leading by example. The directive was transposed by the European Union (Energy Performance of Buildings) Regulations 2012 (S.I. 243 2012).

The **Ecodesign Directive** (2009/125/EC) was transposed by the EU Regulations 2011 (S.I. No 203 of 2011) which extends the scope of an earlier directive to a wider variety of products that can contribute to energy saving.

The **Energy Labelling Directive** (2010/30/EU) was transposed by the EU (Energy Labelling) Regulations 2011 (S.I. No 366 of 2011), which extend the application of the directive to an increasing range of products which have a direct or indirect impact on energy consumption during use. The regulations oblige suppliers of energy-using products covered by an EU measure to supply an energy label and fiche with product.

Part 2 of S.I. 243 (Recast EPBD) deals with Alternative Energy Systems and applies to the design of any large new building, where a planning application is made, or a planning notice is published, on or after 1st January 2007. This calls for a report into the economic feasibility of installing alternative energy systems to be carried out during the design of the building.

- Systems considered as alternative energy systems are as follows:
  - Decentralised energy supply systems based on energy from renewables
  - Cogeneration i.e. Combined heat and power systems
  - District or block heating or cooling, if available, particularly where it is based entirely or partially on energy from renewable sources
  - Heat pumps


There are two key obligations on public bodies with regard to reporting energy performance on an organisational basis:

- Requirement to report the organisation’s energy performance directly to SEAI each year – to track progress towards the 2020 target.
- Requirement to include a statement on the organisation’s energy performance in the organisation’s own annual report. See Your Organisation’s Annual Report

The Government are also committed as part of the EPBD that all new public sector buildings will reach the NZEB benchmark from December 31st, 2018 and this corresponds to a 60% saving in primary energy over the 2008 Building Regulations. NZEB stands for Near Zero Energy Building and is a requirement of the EPBD.
This report investigates the feasibility of various energy efficiency, low carbon and renewable energy technologies for the proposed development. Each solution is described in relation to the site along with any associated issues which need to be taken into consideration. The anticipated carbon emissions reductions for each technology are presented, based on assumptions about the site conditions and information provided by suppliers and manufacturers.


3.1. Low Fabric U Values

The proposed values are in line with the expected fabric U values and efficiencies predicted for the next revision of Part L in 2016 and in 2018. The 2016 and 2018 revision to Part L will demand a 40% and 60% saving in primary energy respectively over the 2005 baseline (current Part L 2008). The 2018 revision will use the same U values but will likely require an MPEPC below 0.4 (60% saving in Primary Energy) and will require the use of mandatory renewables to achieve this. The fabric U values targeted are also consistent with Part L 2011 Dwellings which achieves the 60% saving in primary energy. Table 1: Title always goes before table, use heading 4 as the style

<table>
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<tr>
<th>Element</th>
<th>Proposed</th>
<th>Part L 2008</th>
<th>Part L 2016 (forecast)</th>
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<td>Roof U-value (W/m².K)</td>
<td>0.15</td>
<td>0.22</td>
<td>0.20</td>
</tr>
<tr>
<td>Wall U-value (W/m².K)</td>
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<td>0.27</td>
<td>0.21</td>
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<tr>
<td>Floor U-value (W/m².K)</td>
<td>0.15</td>
<td>0.25</td>
<td>0.21</td>
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<td>Window U-value (W/m².K)</td>
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<td>2.2</td>
<td>1.6</td>
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<tr>
<td>g' value (EN410)</td>
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<td>0.72</td>
<td>0.4</td>
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<tr>
<td>Light Transmittance</td>
<td>71%</td>
<td>76%</td>
<td>71%</td>
</tr>
<tr>
<td>Roof light U-value (W/m².K)</td>
<td>1.6</td>
<td>2.2</td>
<td>1.6</td>
</tr>
<tr>
<td>g' value (EN410)</td>
<td>0.4</td>
<td>0.72</td>
<td>0.4</td>
</tr>
<tr>
<td>Light Transmittance</td>
<td>71%</td>
<td>76%</td>
<td>71%</td>
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<tr>
<td>Thermal Bridging (W/mK)</td>
<td>0.08</td>
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<td>0.15</td>
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<tr>
<td>Air permeability (m³/m²/hr)</td>
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<td>10</td>
<td>7</td>
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<td>Maximum Permissible EPC</td>
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<td>1.0</td>
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</tr>
<tr>
<td>Maximum Permissible CPC</td>
<td>0.56</td>
<td>1.0</td>
<td>0.68</td>
</tr>
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</table>

3.2. Airtight Building Envelope

The design intent will be to achieve an air permeability of 3.0m³/h.m² at 50Pa in the building which represents a reasonable upper limit of air tightness. Should a lower level of air tightness be achieved then care will be taken to ensure that purpose provided ventilation is maintained.

Cold bridging will be designed out of the scheme and a thermo-graphic survey can be carried out on the completed building to identify any thermal weak points in the fabric. Acceptable Construction Details as listed in Part L will be complied with in order to achieve this goal.
3.3. Natural Ventilation

The building design is such that natural ventilation will be feasible in the majority of occupied spaces on the building perimeter. With a suitable window design, most of these spaces will be naturally ventilated. Passive Shading devices will be employed along certain facades in order to help reduce the solar gains due to low angle sunlight. Bedrooms will be designed to have openable window sections which will allow these rooms to be naturally ventilated also. This will be assisted by the extract fan in the ensuite.

3.4. High Efficiency and Condensing Gas Boilers

Use of Condensing Boilers achieves higher efficiencies than standard boilers when condensing temperatures are achieved by utilising latent heat from the combustion gases which is normally wasted. We will be assessing the use of condensing gas boilers for low return temperature loads, 100% resilience load and peak lopping load. We would recommend a cascade arrangement of boilers which will allow for very low modulation ranges. An example of a cascaded boiler system is the Remeha Quinta Pro Plus. This can achieve up to 48% lower carbon emissions and fuel savings than typical ‘best practice’ systems, delivering an overall system efficiency of 98.1% GCV at 50/30°C.

By incorporating Passive Flue Gas Heat Recovery technology, the Quinta Eco Plus recovers normally wasted energy equivalent to around 15% of the gross input energy. The full time condensing environment is irrespective of primary circuit temperatures, making it the perfect solution for a wide range of commercial heating requirements.

3.5. 70°C-40°C Low Carbon System Design

The main characteristic of a “70/40” system is a large Delta T and a low system return temperature.

CIBSE AM12:2013 (9.16, p 49) states:

“It is recommended that, for new systems, radiator circuit temperatures of 70°C (flow) and 40°C (return) are used with a maximum return temperature of 25°C from instantaneous domestic hot water heat exchangers.”

To achieve 70°C flow and 40°C return temperatures calls for a ‘whole system approach’ by the specifier.

Properly designed and commissioned CHP Heating schemes have the potential to significantly reduce energy consumption and carbon emissions. However, traditional design practices are often based on flow/return temperatures of 80/60°C. A return temperature of 60°C is sufficiently high to prevent the Combined Heating and Power system from delivering maximum cost savings, as this temperature only allows limited cooling of the generator and can result in the CHP shutting down.

If system circulating temperatures of 80/60 are used instead of 70/40, heat losses from the distribution system can only increase.

The most effective way to reduce return water temperatures is to reduce water flow rates.

The latest version of CIBSE AM12 ‘Combined Heat and Power for Buildings’ is designed to address these issues and provides new best practice guidance for communal heating systems.

A project that does not achieve recommended return water temperature, therefore, does not follow best practice. This can have serious implications for the system designer.

CIBSE have recommended the following operating temperatures in the Draft document “Heat Networks: Code of Practice UK 2014”.
Table 2: Preferred Operating Temperatures for new building services systems

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Flow Temperature °C</th>
<th>Return Temperature °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiators</td>
<td>Max 70</td>
<td>Max 40</td>
</tr>
<tr>
<td>Fan-coil units</td>
<td>Max 60</td>
<td>Max 40</td>
</tr>
<tr>
<td>Air Handling Unit</td>
<td>Max 70</td>
<td>Max 40</td>
</tr>
<tr>
<td>Underfloor heating</td>
<td>See Note</td>
<td>See Note</td>
</tr>
<tr>
<td>Domestic DHWS instantaneous heat exchanger on load</td>
<td>Min 65</td>
<td>Max 25</td>
</tr>
<tr>
<td>Domestic DHWS cylinder with coil heat up from cold</td>
<td>Min 70</td>
<td>Max 45</td>
</tr>
<tr>
<td>DHWS calorifier with external plate heat exchanger</td>
<td>Min 70</td>
<td>Max 25</td>
</tr>
</tbody>
</table>

Note: Underfloor heating systems will typically operate with floor temperatures below 35°C and typically flow temperatures of 45°C which is advantageous for heat networks as this will result in low return temperatures.

3.6. High Efficiency Chillers

New generation chillers are available that modulate to the required cooling load increasing efficiency to an approximate Seasonal Energy Efficiency Ratios (SEERs) of >6 (water cooled) >4 (air cooled). The current design proposal incorporates the air cooled Climaveneta NX /LN-K /0914P which has a SEER of 4.41.

3.7. Energy Efficient Mechanical Ventilation Solutions

Full Mechanical Ventilation Plant and Systems will be utilised in designated treatment areas due to the high degree of temperature control required which means that a natural ventilation strategy is not feasible.

However, the mechanical ventilation plant strategy is to maximise the efficiency of these systems through the use of heat recovery and the efficient control of both ventilation rates and of heating and/or cooling supply.

Efficient control involves the use of sensors (occupancy or CO₂), actuated dampers and the use of intelligent control strategies based on actual needs and efficient plant with variable speed drives. Demand Control Ventilation is recommended as it can provide significant energy savings during unoccupied or off peak hours in spaces with varying occupancy; however it can substantially increase the initial capital investment of the HVAC installation.

The current HVAC design strategy has not implemented demand control ventilation, however it will be investigated at the detailed design stage.

We would also recommend the installation of outdoor air monitors to accurately measure the outdoor air makeup flow rate. Typical ventilation design (without monitors) tends to encourage increased ventilation that may result in increased energy use and added cost for conditioning increased amounts of outside air. However, the addition of sensors and monitors allows ventilation to be delivered on demand only when required, potentially saving a lot of energy.
3.8. Specific Fan Power Reduction

All ductwork will be generously sized and service routes optimised so as to minimise fan power requirements. All SFPs will be in compliance with the Non Domestic Building Services Compliance Guide 2010.

3.9. Variable Speed Pumps and Ventilation Fans

All pumps and fans will be specified with variable speed drives (VSD’s) and constant pressure control. This means that these items of mechanical plant will run at partial load most of the year rather than at the peak design load delivering energy savings during off peak operation. Pumps will comply with the Energy related Products (ErP) Directive.

3.10. Metering and Sub Metering

Metering is an effective way to raise awareness of energy use and to bring about behavioural change by the building owners and occupiers. It can form part of a site Monitoring & Targeting (M&T) system whereby energy savings targets can be set and the measurement of these savings can be quantified. Sub metering of all major energy uses also allows for the detection of equipment which is not performing adequately and may be in need of maintenance. Sub metering will be in compliance with CIBSE TM39 2009 Building Energy Metering which is a necessary step in the effective calculation of Display Energy Certificates or actual building operational rating. DECs are mandatory for Public Sector buildings with floor areas greater than 500m² and for buildings frequently visited by the public. In order to close the gap between the predicted energy consumption of the new Hospital and the actual energy consumption, we would advise that operational energy is monitored and a DEC type cert is issued on an annual basis. New legislation which will come into effect from 5th June 2014 mandates that large industry will need to carry out regular energy audits and have a robust energy management system in place. Metering and sub-metering are essential for this to take place.

3.11. Low Energy Lamps

"Low energy lamps", (compact fluorescent or linear fluorescent) use about 80% less energy than conventional tungsten lamps for the same light output.

Even greater savings are claimed for the latest LED lamps which are becoming available for luminaries. More efficient fluorescent lights and LED type lights will reduce the amount of energy consumed by the development.

Presence detection can be used to control lighting within internal and perimeter areas throughout the building, with the exception of areas where it would be unsafe to do so, or where operational requirements prevent their use. Daylight dimming will automatically dim lighting in the perimeter zone of the building and will also be incorporated. It will not be feasible to install presence detection controls in Bedrooms due to the nature of the occupancy.

In general, installed lighting loads in treatment, office, bedrooms and staff areas will target a lighting power density of 2.2W/m²/100lux. All other areas will target a luminaire efficacy no less than 70lm/W.

The design will also incorporate a full monitoring (DALI) type system which will allow for metering and warn “out of range” values to enhance the management and maintenance of the lighting installation.

3.12. Insulation of Hot Water Storage Vessels, Pipes and Ducts

All hot water storage vessels, pipes and ducts (where applicable) will be insulated to prevent heat loss. Adequate insulation of hot water storage vessels will be achieved by the use of a storage vessel with factory applied insulation tested to BS 1566, part 1:2002 Appendix B.
Water pipes and storage vessels in unheated areas will be insulated for the purpose of protecting against freezing. Technical Guidance Document G and Risk report BR 262, Thermal insulation avoiding risks, published by the BRE will be followed.

3.13. Power Factor Correction

Power factor correction >0.95 will be installed on the incoming electricity supply. Most electrical equipment creates an inductive load on the supply. This inductive load requires a magnetic field to operate, and when this magnetic field is created, the current will lag the voltage, i.e. the current will not be in phase with the voltage. Power Factor Correction compensates for the lagging current by applying a leading current, reducing the power factor to close to unity.


Thermal wheel technology offers the greatest percentage of heat recovery within an air system, and therefore the greatest reduction in energy use and carbon emissions. A thermal wheel, also known as a ‘rotary’ or ‘regenerative’ heat exchanger, is a system of heat transfer which involves a single rotating wheel with high thermal capacity located within the supply and exhaust air streams of an air handling unit (AHU). Its rotation allows the recovery of thermal energy from air that would otherwise be lost to the atmosphere; the recovered energy then pre-heats (or cools) the incoming fresh air. The use of this technology will reduce the amount of energy needed to heat (or cool) the supply air to the required temperature with a corresponding reduction in carbon emissions.

The AHUs will have thermal wheel heat recovery units within them. The proposed thermal wheel will target a heat recovery efficiency of 80%. This will reduce the overall heat energy consumption, as we are recuperating 80% of the heat within the heated exhaust air.

3.15. Heating / Cooling System Zone Control Strategy

The heating and cooling system will be zoned and sub circuited to allow for areas that are not in use to be turned off. The systems will be zoned to allow defined areas work outside normal hours and will have time scheduling on the intelligent control system.

3.16. Small Power Items and Site Wide Energy Efficiency Drive

All small power items will be reviewed for increased energy efficiency. Feature lighting if installed will be designed for improved energy efficiency or removed completely. Sub metering of electricity will be installed across the site and a site Energy Manager should be tasked with monitoring out-of-range values so that any increased energy consumption due to faults can be investigated and remedied.

3.17. Low Energy White Goods

White goods include fridge/freezers, microwave ovens, and dishwashers. These items are responsible for around half of electrical consumption in dwellings. In hospital buildings they will account for a much lower proportion of energy consumption. White goods are now provided with a certified energy label. These are rate A+, A, B and C with C being the least efficient. Data supplied by the Energy Advice Centre suggests that using A rather than C rated white goods would reduce electrical energy consumption in each dwelling by 800kWh/year. We are not aware of any specific data relating to energy emissions from white goods within hospital buildings, however, it is recommended that all white goods provided will be rated at the highest energy rating available.

3.18. Building User Guide

After the completion of the proposed NCH Hospital building the end user(s) will be provided with sufficient information about the building, its installed services and their maintenance requirements so that the hospital can be operated in such a manner as to use no more fuel and energy than is reasonable. Facilities management evidence shows that many new buildings lose up to 30% of their...
energy efficiency in the first year due mainly to a lack of understanding by the users / occupants on its M&E systems and their operation.

3.19. Energy Efficient Systems

3.19.1. Radiant Heating
Radiant ceiling panels will be employed in all patient areas that do not require active cooling. These systems have been shown to save up to 40% energy when compared to convector systems due to the lower air temperatures required in order for occupants to feel comfortable. Due to the radiation and hence the higher surface temperature of ceiling-mounted heating systems, the indoor air temperature during heating can therefore be kept lower, and still be perceived as pleasant. Energy costs are reduced when heating due to the lower air temperature.

Another benefit of radiant systems is that there is less air convection.

3.20. Low Water Use sanitary ware
Potable water usage in buildings constitutes a large portion of freshwater consumption. Strategies to reduce potable water use in buildings entail the selection of efficient plumbing fittings, fixtures, and equipment. Fixtures that use 20-50% less water than code required levels are now widely available. The WaterSense label was developed by the U.S. Environmental Protection Agency (EPA) to identify these efficient fixtures and ensure that higher efficiency does not come at the cost of performance. Only fixtures with an appropriate WaterSense label with be specified for this project.

3.21. Achievable Emissions Reductions

Building energy performance has been evaluated in line with Part L 2008 via SBEM simulation using IES VE 6.1.1.2. To assess the impact of the Lean energy strategy, a base case first assessed. The base case is the exact same as the proposed design except only meeting the minimum requirements for all building fabric and building services under Part L 2008; N.B. this is not the “notional” building.

After the implementation of the “Lean” energy strategies outlined in this section a CO₂ emissions reduction of 169tonne (38.8%) is achieved over the base case. This is equivalent to a reduction in Primary Energy Consumption of 157 kWh/m²/annum; from 404 kWh/m²/annum (Base case) to 247 kWh/m²/annum (Lean).
4. Clean Building Design – Combined Heat & Power (CHP)

4.1. CHP Technology Overview

Combined Heat & Power (CHP) effectively uses waste heat from the electricity generation process to provide useful heat for space and water heating; the advantage of this system is that it leads to higher system efficiencies when compared to a typical supply arrangement of grid-supplied electricity and conventional heat boilers.

A further advantage is that because electricity is generated close to the point of use, the losses incurred in transmission are avoided. CHP is considered a low carbon technology when fired by gas or fuel oil, to generate electricity and provide heating and hot water. At this scale, a gas-fired reciprocating engine CHP is the preferred technology due to efficiency, maintenance and plant space considerations, and is well-proven with many successful installations in Ireland.

4.2. Site Opportunities

There are site opportunities for the implementation of CHP due to presence of the Domestic Hot Water demand and high operating hours of the hospital which will generate a constant year round demand for heating. However, the final design of the CHP will require careful analysis as the ratio of heat to power used by the site is skewed towards heat. It is essential that if the CHP runs based on the heat demand, so the electricity produced can be used on site and not dumped. Carbon Trust guidance indicates that a general hospital would consume 54kWh/m² for its daily heat load; 16kWh/m² for DHW, 38kWh/m² for space heating. Using a predicted occupancy and DHW profile (no hospital profile available), a daily load profile can be calculated. It indicates that the heating demand peaks at approx. 71.5kW on a daily basis. These benchmark figures are purely for preliminary design stage estimations, a full dynamic energy model incorporating CHP will be developed during detailed design.

As a water based heating system will be installed, then there is scope of incorporate a CHP. In this case we would propose a CHP which has a heat capacity of 31kW with an electrical output of 19kW and a Heat to Power ratio of 1.632.

Incorporating a cascade of micro CHPs in tandem with a boiler heating system will make a modest contribution to CO₂ reductions. Our analysis assumes that the CHP will supply 50% of the heat demand and 50% of the DHW demand annually and this could be achieved with careful sizing of a buffer vessel in tandem with the CHP which would store heat from the CHP and smooth out the running of the unit.

The CHP will result in a CO₂ reduction of 34 tonnes over the “Lean” energy strategy; reducing the primary energy consumption by 10.5% to 221kWh/m²/yr.
5. Green Building Design – Renewable Energy

5.1. Outline Technology Appraisal

A wide range of renewable energy and low carbon technologies have been considered for the proposed development.

In each instance, first the local availability of renewable resources – e.g. wind, solar, hydro, ground and air source energy and biomass – is assessed. Where a potential energy resource is identified, its suitability to supply the site energy demand profile (i.e. heating, cooling and electrical load) is examined. Finally, each potential suitable technology is assessed in the following areas in relation to the characteristics and constraints of the site:

- Technology physical size, location and visual impact
- Integration with proposed building energy supply systems
- Impact on local air quality
- Additional future maintenance and access requirements
- Capital cost relative to energy and CO₂ saving potential

The table below presents a summary of the suitability of each of the technologies considered for the site:

- H = High feasibility; no obvious restrictions;
- M = Medium feasibility; very significant issues need to be addressed
- L = Low feasibility; development site unlikely to support technology

<table>
<thead>
<tr>
<th>Technology</th>
<th>Feasibility</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connect to existing community CHP / heating scheme</td>
<td>√</td>
<td>It has been established that there is no existing nearby CHP system to which to connection might be explored</td>
</tr>
</tbody>
</table>
| CHP powered by biofuel            | √           | It is Ethos Engineering’s opinion that a gas fired CHP plant offers a considerably more viable solution than bio-fuel CHP. The following factors work against biodiesel solution:  
- Unavailability of plant of a suitable size
- Plant space, fuel storage and fuel delivery requirements
- Local emissions to air |
<p>| Micro Wind                        | √           | Micro wind turbines can be fitted to the roof of a building and would contribute a negligible amount of energy to the development. Due to the suburban nature of the site, these have not been deemed viable for this site. Vertical axis wind turbines may be more suited to this building, but there would be the obvious aesthetic issues with locating them along the perimeter of the roof. As the building could be extended upwards by another floor in the future, any installed wind turbines would have to be removed and reinstalled which may not be practical. |</p>
<table>
<thead>
<tr>
<th>Technology</th>
<th>Feasibility</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind Power</td>
<td>√</td>
<td>Mast-mounted wind turbines can be located in an open area away from obstructions such as buildings and tall trees. Due to the suburban location of the site, and its location close to a residential area, we do not deem that a large wind turbine is feasible.</td>
</tr>
<tr>
<td>Solar Photovoltaic (roof mounted)</td>
<td>√</td>
<td>Photovoltaic (PV) Cell technology involves the conversion of the sun’s energy into electricity. PV panels can be discrete roof-mounted units or embedded in conventional windows, skylights, atrium glazing, façade cladding etc. A Solar PV array of 100 m² area would contribute approx. 1.7% reduction over the base case primary energy demand. While PV capital costs have reduced significantly in recent years, they do not yet offer payback periods as competitive as other available renewable or low carbon technologies. PV installed on the roof could be designed such that they could be removed and reinstalled should a further floor be added at a later date.</td>
</tr>
<tr>
<td>Solar hot water systems</td>
<td>√</td>
<td>Active solar hot water technology uses the sun’s energy to heat fluid through a collector in an active process. CHP would be a more viable alternative to solar thermal. However, if an air source heat pump solution was adopted, then there is some scope to install a small solar thermal installation in tandem with this. Due to the lack of sufficient roof space and the potential of an additional floor added at a later date it is considered that a solar hot water system is not suitable for the proposed building.</td>
</tr>
<tr>
<td>Biomass Heating</td>
<td>√</td>
<td>Biomass boilers work on the principle that the combustion of wood chip or pellets can create heat for space heating and hot water loads. This technology requires space allowance in a boiler room, access for delivery trucks, a thermal accumulator tank and considerable space for fuel storage of wood chips or pellets. The system also requires regular maintenance to remove ash etc. This use of biomass calls for a continuous local supply of suitable fuel to be truly sustainable. Concerns exist over the level of NOx and particulate emissions from biomass boiler installations, particularly in urban areas; for this reason it is considered not suitable for the proposed building.</td>
</tr>
<tr>
<td>Technology</td>
<td>Feasibility</td>
<td>Comments</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>-------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Ground source heat pump (GSHP)</td>
<td></td>
<td>GSHP technologies exploit seasonal temperature differences between ground and air temperatures to provide heating in the winter and cooling in the summer. GSHP systems use some electricity to run the heat pump, but as most of the energy is taken from the ground, they produce less greenhouse gas than conventional heating systems. Ground source heat systems deliver low temperature heat and high temperature cooling, suitable for underfloor heating or chilled beams. Underfloor heating and cooling could be employed in the main Atrium area and entrance foyer. GSHP technology will need further investigation during detailed design and will depend on a favourable ground Thermal Response Test. Capital costs are high and ideally, there should be a good balance between heating and cooling loads to allow for high COPs and reasonable capital payback.</td>
</tr>
<tr>
<td>Ground source heat pump (GSHP)</td>
<td></td>
<td>As above, this system will require more in-depth analysis during detailed design and depends on suitable aquifers being available.</td>
</tr>
<tr>
<td>Air source heat pump (ASHP)</td>
<td></td>
<td>ASHP technologies exploit seasonal temperature differences between external air and refrigerant temperatures to provide heating in the winter and cooling in the summer. ASHP systems use more electricity to run the heat pump when compared to GSHP, but as most of the energy is taken from the air, they produce less greenhouse gas than conventional heating systems over the heating season. Their COP does reduce to below 2.0 when outside air temperatures are around 0ºC and waste energy on a defrost cycle. These could be combined in a hybrid heating arrangement with gas boilers.</td>
</tr>
</tbody>
</table>
6. Conclusions

This report demonstrates how a variety of technologies have been incorporated into the proposed design of the new NCH Satellite Centre Connolly to reduce primary energy consumption and CO₂ emissions to 214 kWh/m²/yr and 222 tonnes from 404 kWh/m²/year and 435 tonnes respectively.

The following energy hierarchy has been used to identify and prioritise the most effective means of reducing primary energy and carbon emissions:

- Be Lean – energy efficiency through design and use;
- Be Clean – optimise energy supply infrastructure for efficiency;
- Be Green – include renewable energy systems where appropriate.

The sizing of the technology proposed is summarised here, and the achievable primary energy and carbon emissions reductions are quantified in Table 5-1 and figure 5-1 below.

6.1. Be Lean

The design of the development will incorporate energy efficiency measures (detail of these measures can be found in Section2); it is estimated via SBEM simulation that they will result in approximately 38.8% reduction in primary energy and CO₂ emissions over the 2008 Part L compliant base case. The list below identifies the technologies proposed for the various parts of the development:

- Low Fabric U Values
- Airtight Building Envelope
- Natural Ventilation
- High efficiency cascaded gas condensing boilers with flue gas heat recovery
- High efficiency chiller
- Specific fan power reduction
- Variable Speed Pumps and Ventilation Fans compliant with ErP Directive
- Metering and Sub metering
- Increased efficiency T5 / LED lighting incorporating Dali type controls
- Photovoltaic and occupancy control for lighting where appropriate
- High insulation levels to calorifiers and buffer vessels
- Power factor correction
- Heat recovery thermal wheels in AHUs
- Heating and cooling system zone control
- Small Power Items and site wide Energy Efficiency Drive
- Energy efficient HVAC selection – Radiant panels
- Low Water Use Sanitary ware

6.2. Be Clean

An opportunity has been identified to incorporate gas fired micro Combined Heat & Power (CHP) into the building design, effectively using waste heat from on-site electricity generation to provide heat for space heating and hot water in the hospital development. A gas fired CHP of 19kWe is recommended. A unit of this size would provide around a 38% contribution to site buildings electricity demand and around a 11% contribution to the hospital heat demands. However, the exact sizing of the CHP will need careful consideration during detailed design as the heat load and electrical load are not balanced.
6.3. Be Green

The development benefits from a primary energy and CO₂ savings of 45.3% and 46.6% respectively over the base case from energy efficiency measures and low carbon technology CHP. Whilst a significant reduction in primary energy and CO₂ has been achieved, it has been found viable to provide further energy from renewable sources. There may be the possibility to provide a PV system in the proposals and it is demonstrated that this could provide additional reductions in primary energy and CO₂ emissions of 1.7% and 2.3% respectively over base consumption.

Including all the proposals would result in a 47% reduction in Primary Energy to 214 kWh/m²/yr and a 49% reduction in CO₂ emissions to 46 kgCO₂/m²/year or a reduction of 213 tonnes of CO₂.

We have also explained the constraints preventing a further renewable contribution and demonstrated the rationale behind the proposed approach, which we consider to follow best practice and offer the most appropriate method of primary energy and CO₂ reduction for this development.

Table 5: Steps in primary energy and CO₂ reduction

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Technology</th>
<th>Primary Energy Consumption (kwh/m²/yr)</th>
<th>Primary Energy Reduction (%)</th>
<th>Cumulative CO₂ emissions (tonnes p.a.)</th>
<th>CO₂ savings over base case (tonnes p.a.)</th>
<th>CO₂ savings over base case (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Case proposed Building</td>
<td>N/A</td>
<td>404</td>
<td>-</td>
<td>435</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Be Lean</td>
<td>Energy Efficiency Initiatives</td>
<td>247</td>
<td>38.8%</td>
<td>266</td>
<td>169</td>
<td>38.8%</td>
</tr>
<tr>
<td>Be Clean</td>
<td>CHP</td>
<td>221</td>
<td>45.3%</td>
<td>232</td>
<td>203</td>
<td>46.6%</td>
</tr>
<tr>
<td>Be Green</td>
<td>PV</td>
<td>214</td>
<td>47%</td>
<td>222</td>
<td>213</td>
<td>49.0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>190</strong></td>
<td><strong>47%</strong></td>
<td><strong>222</strong></td>
<td><strong>213</strong></td>
<td><strong>49.0%</strong></td>
</tr>
</tbody>
</table>

Figure 5: Graphical representation of primary energy and CO₂ reduction
Appendix 1: Sustainable Options
<table>
<thead>
<tr>
<th>Options</th>
<th>Description of System</th>
<th>Remarks</th>
<th>Included as part of brief</th>
<th>Order of cost (Excl Builders Work)</th>
<th>Recommended for consideration</th>
<th>Potential Order of savings per annum</th>
<th>Payback in years</th>
<th>Note</th>
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<tbody>
<tr>
<td><strong>Active</strong></td>
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<tr>
<td><strong>Passive</strong></td>
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</tr>
<tr>
<td>1 Micro Combined Heat and Power (CHP)</td>
<td>On-site electrical generation with waste heat produced from the electrical generation process being utilised to provide hot water, space heating. Possibility to export excess electrical and thermal production</td>
<td>Requires sufficient thermal base load to be economical. Significant annual maintenance costs and major overhaul required every 40,000 hours of operation which impacts on life cycle cost of unit. This is not reflected in the simple payback calculation to the right. CHP could make a significant contribution as there will be a year round demand for DHW and relatively constant base heat load.</td>
<td>No</td>
<td>€52,855</td>
<td>Yes</td>
<td>€3,782</td>
<td>14</td>
<td>Small 19kWe unit required in order to achieve A3 BER</td>
</tr>
<tr>
<td>2 Trigeneration</td>
<td>On-site electrical generation with waste heat produced from the electrical generation process being utilised to provide hot water, space heating. Waste heat can also be used to provide cooling by passing it through an absorption chiller. Possibility to export excess electrical and thermal production</td>
<td>Similar to CHP in that it requires sufficient thermal base load to be economical. Added advantage of being able to utilise waste heat to generate chilled water via absorption chiller. Plant also requires major overhaul approx every 40,000 hours of operation. Important that plant is sized correctly to operate for the maximum number of hours per annum continuously with stop/start sequences kept to a minimum. Cooling load of development is likely to not be significant enough to warrant trigeneration. VRF is proposed which is refrigerant based and not water based.</td>
<td>No</td>
<td>-</td>
<td>No</td>
<td>-</td>
<td>-</td>
<td>Scale is too small to warrant an absorption chiller</td>
</tr>
<tr>
<td>3 Photovoltaic (PV)</td>
<td>Conversion of the Sun’s radiance to electrical energy.</td>
<td>Can be installed on available roof space or integrated into building structure or as part of the façade, possibly as part of solar shading measures. Average output for monocrystalline PV cells (South-facing, inclined at 30°) 143kWh/m²/year. 250m² of PV could generate approx. 9% of the required primary electricity demand. Can make significant contribution to reducing Primary Energy Consumption and improving BER rating as the energy is free and not imported, unlike other renewables such as Heat Pumps, Biomass and CHP. An advantage PV has over other renewable technologies is adaptability and reusability. Due to the simplicity of the installation (wiring between panels and grid interface equipment) where any future expansion works to take place, the PV can simply be removed and reused following completion of works.</td>
<td>No</td>
<td>€97,559</td>
<td>Yes</td>
<td>€4,571</td>
<td>21</td>
<td>Installation of (300m²) may be required in order to achieve A3 BER without other technologies</td>
</tr>
<tr>
<td>4 Condensing Boilers</td>
<td>Use of Condensing Boilers achieves higher efficiencies than standard boilers by utilising latent heat from the combustion gases which is normally wasted. Higher efficiencies from boilers will reduce the running cost of heating and hot water provision. Maximum efficiencies when used with low return water temperature systems. Ideal for servicing daily peaks over base heat load, as well as back-up and maintenance resilience to Biomass or ASHP/GSHP systems.</td>
<td>Yes</td>
<td>Included in Basis of Design (BOD)</td>
<td>Yes</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>5 System Design Temperatures 70°C - 40°C Low Carbon Central Plant</td>
<td>70/40 is well suited to new radiator systems at maximum load conditions. In part load conditions, flow temperatures should be reduced using weather compensation. The main characteristic of a “70/40” (60/30 or other) system is a large ΔT and low return temperature to best suit the lead (low carbon) heat source.</td>
<td>Yes</td>
<td>Included in Basis of Design (BOD)</td>
<td>Yes</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
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<tr>
<td>Options</td>
<td>Description of System</td>
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<td>Active</td>
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<tr>
<td>6</td>
<td>Variable speed pumps</td>
<td>The variable speed drive allows the pump to ramp up and down depending on the load requirements of the system, therefore reducing energy usage.</td>
<td>Pumps require slightly greater capital output but this is generally offset by the very short payback period on running costs. Careful design required to maximise pump ramp down on low loads. Pumps will be selected to comply with ErP Directive (IE3 required since 1/1/2015) IE4 pumps can be examined also although not required until 2020</td>
<td>Yes</td>
<td>Included in BOD</td>
<td>Yes</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>Solar Thermal</td>
<td>Conversion of the Sun's irradiation to thermal energy for heating applications.</td>
<td>Installed to assist in the partial fulfillment of domestic hot water (DHW) demand. Efficiency and effectiveness is determined by the demand quantities and profile. Needs to be integrated into overall DHW solution holistically, particularly to ensure it is not competing with other LZC technologies such as CHP, Biomass or ASHP/GSHP systems. Solar thermal is well suited where there is a large and constant DHW demand; hence hospitals are typically considered a good candidate for the technology. 250m³ of solar thermal could generate 111,000kWh of DHW or 23% of the DHW demand. This size of installation would require approx. 17,500 litres of storage. Payback is poor due to the availability of natural gas. A better payback would be attained where gas is not available.</td>
<td>No</td>
<td>€187,952</td>
<td>Not Recommended</td>
<td>€5,686</td>
<td>33</td>
</tr>
<tr>
<td>8</td>
<td>Ground Source Heat Pump (GSHP)</td>
<td>Extracting or rejecting heat using the refrigeration cycle to the thermal mass of the ground to provide heating in the winter and cooling in the summer months.</td>
<td>Requires large areas for horizontal installations or suitable geology for vertical installations. Ground investigation required to determine suitability. A Geological survey and Thermal Response Test would need to be carried out to establish if the ground is suitable for boreholes.  In this case, the GSHP can be designed to supply heat to areas with underfloor heating such as Foyers, Atriums and public circulation areas. The system would also work well with active chilled beams or oversized FCUs. The savings calculated are for a GSHP system providing heating and cooling. High COPs can be achieved if simultaneous heating and cooling is required.  In this case, the GSHP can be designed to supply heat to areas with underfloor heating such as Foyers, Atriums and public circulation areas. The system would also work well with active chilled beams or oversized FCUs. The savings calculated are for a GSHP system providing heating and cooling. High COPs can be achieved if simultaneous heating and cooling is required.</td>
<td>No</td>
<td>€383,385</td>
<td>Not Recommended</td>
<td>€30,879</td>
<td>12</td>
</tr>
<tr>
<td>9</td>
<td>Air Source Heat Pump (ASHP)</td>
<td>Extracting or rejecting heat using the refrigeration cycle to the outdoor air to provide heating in the winter and cooling in the summer months.</td>
<td>VRF Heat Pump Boilers are available from mainstream manufacturers and can be used to raise water to 70ºC for wet systems. Ideally, these should be coupled to low temperature low water content radiators with a flow temp of 45ºC and a return of 35ºC. The units can achieve high seasonal COP of up to 4.  The advantage of the system is that it will meet the future renewable energy requirements where fossil fuel boilers will not. Low temperature heat could be supplied by the units to Active Chilled beams or oversized FCUs. It is feasible in this building but chillers would also be required for cooling.</td>
<td>No</td>
<td>€108,000</td>
<td>Not recommend as cooling is also required</td>
<td>€27,000</td>
<td>4</td>
</tr>
<tr>
<td>Options</td>
<td>Description of System</td>
<td>Remarks</td>
<td>Included as part of brief</td>
<td>Order of cost (Excl Builders Work)</td>
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<td>Potential Order of savings per annum</td>
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</tr>
<tr>
<td><strong>Active</strong></td>
<td>10 Biomass Boilers</td>
<td>The use of locally produced or imported biomass (wood pellets/chips or agricultural products) in order to fire the boilers. Systems include Boiler, Fuel store, fuel transfer equipment.</td>
<td>Carbon 'neutral' technology, largest benefits come from utilising local fuel suppliers to cut carbon emissions due to transport. Sized to cater for base heat loads which do not require an instant response (LPHW heating circuits). Greatest outputs from processed wood pellets, although availability has to be guaranteed. System will be sized for base load with gas boiler top up. The major benefit to biomass systems is that they will significantly contribute to the future CO2 reduction requirements of the upcoming revision to Part L Non Domestic. One hindrance commonly restricting the application of biomass is the large storage requirement for the dry storage of fuel stock. Biomass can be an economically viable option particularly if gas is not available on site.</td>
<td>No</td>
<td>TBC</td>
<td>Not Recommended as there is no payback versus gas boilers</td>
<td>N/A</td>
<td>N/A</td>
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<td><strong>Passive</strong></td>
<td>11 Improved Insulation</td>
<td>Additional insulation utilised in the construction of the building, exceeding the requirements of Part L of the Building regulations 2008, in order to reduce heat loss through the building fabric.</td>
<td>Additional cost of additional materials normally recouped by short payback periods. Recommended to adhere to TGD Part L 2011 Dwellings as these values will most likely be used in the forthcoming revision to Part L for Buildings other than Dwellings in 2016.</td>
<td>No</td>
<td>QS</td>
<td>Yes</td>
<td>TBA</td>
<td>TBA</td>
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<td><strong>Passive</strong></td>
<td>12 Rainwater Harvesting</td>
<td>Rainwater harvesting for WC flushing</td>
<td>Will reduce overall quantity of water supplied from mains supply as well as reducing the overall volume of surface water run-off to the drains. Based on an estimated available roof collection area of 1,000m² mains water consumption could be reduced by approx. 28%. Such a system would require a 8m³ storage tank below ground. Consideration also needs to be given to associated plant space for filtration and pumping.</td>
<td>No</td>
<td>€8,886</td>
<td>Yes</td>
<td>€264</td>
<td>34</td>
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<td><strong>Passive</strong></td>
<td>13 Natural Ventilation</td>
<td>The use of operable external windows, facades, roof low level openings to allow the fresh air to be supplied to the building and provide natural fresh air to the occupants. the design must mitigate any potential for cold drafts, particularly due to the nature of the building. Motorised dampers and finned heat pipework allow a high level of control and the air to be tempered before entering the space.</td>
<td>Greatest benefits experienced where air flows can circulate through all areas freely, such as in open plan office layouts. Most suited to applications that can be incorporated with exposed thermal mass and &quot;stacks&quot; for increased natural air movement. Effects can be limited in areas of high heat load or high occupancy. Detailed design strategy required in consulting rooms &amp; bedrooms etc to ensure effective air flow and reduce draughts. Many rooms in this development will require full mechanical ventilation as they are located internally with no access to an outer wall. Certain rooms will also need to meet HTM requirements for Mechanical ventilation.</td>
<td>Yes</td>
<td>Included in BOD</td>
<td>Yes - in some perimeter areas</td>
<td>-</td>
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<td>Options</td>
<td>Description of System</td>
<td>Remarks</td>
<td>Included as part of brief</td>
<td>Order of cost (Excl Builders Work)</td>
<td>Recommended for consideration</td>
<td>Potential Order of savings per annum</td>
<td>Payback in years</td>
<td>Note</td>
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<td><strong>Active</strong></td>
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<td>14 Building Air Tightness Testing</td>
<td>Constructing buildings in accordance with CIBSE TM 23 to minimise unnecessary infiltration; loss of internal heated air, entry of cold external air. Such heat losses increase the building heat load for space heating, leading to the requirement for larger HVAC plant and equipment. Also creates a more controlled environment, reduces mechanical ventilation requirements and increases the ability of the building to operate independently of external conditions.</td>
<td>Detailed building design needed to ensure that minimum ventilation rates are achieved whilst maintaining air tightness. The building should be pressure tested following completion to ensure CIBSE TM23 is achieved. Current best practice for healthcare facilities is an air tightness less than or equal to 3m³/hr/m² @ 50Pa.</td>
<td>Yes</td>
<td>Included in BOD</td>
<td>Yes</td>
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<td>15 Building Management System (BMS)</td>
<td>Control of all mechanical and electrical services through a central control system, enabling self regulation and economic energy use throughout the building and monitoring of year round performance.</td>
<td>Full control, scheduling and monitoring of all connected services allowing efficient control to be achieved.</td>
<td>Yes</td>
<td>Included in BOD</td>
<td>Yes</td>
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<td>16 High Efficiency Lighting systems</td>
<td>Utilising high efficiency lighting with long-life fittings, presence detection and controls, such as daylight compensation.</td>
<td>Lighting design will exceed current building regulations and be low energy throughout with a full lighting management system. Presence detection in low use areas, such as corridors and toilets, control lighting to function only when the space is occupied. Daylight compensation reduces artificial lighting when it is not required whilst maintaining correct lighting levels to darker areas.</td>
<td>Yes</td>
<td>Included in BOD</td>
<td>Yes</td>
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<td>17 Maximise on daylight</td>
<td>The floor plate will be arranged to allow the maximum daylight to each workspace. Glass specification and positioning of solids in the walls is important.</td>
<td>Rooms benefit from generous glazing percentage which means that rooms are flooded with natural daylight. The allowance for daylight must be finely balanced with the need to limit solar gains in accordance with the requirements of Part L Solar Overloading (25W/m² in perimeter zones)</td>
<td>Yes</td>
<td>Included in BOD</td>
<td>Yes</td>
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<td>18 Ground Air Heat Exchanger</td>
<td>Ground-air heat exchangers (also known as earth tubes) offer an innovative method of heating and cooling a building and are often used on zero carbon / Passivhaus buildings. Ventilation air is simply drawn through underground pipes at 1.5m deep which pre-heats the air in the winter and pre-cools the air in the summer.</td>
<td>The air supply to the AHUs could be supplied via a GAHE. This would provide energy savings as the air reaching the AHU would be tempered to the temperature of the ground which is a constant 10°C - 12°C all year round. Ground availability will likely rule out this option. Payback is generally poor in Ireland as our climate is temperate. More suited to continental regions where temperatures are more extreme.</td>
<td>No</td>
<td>TBC</td>
<td>Yes</td>
<td>TBC</td>
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<td>19 Water Efficient Appliances</td>
<td>Reduction in consumption through use of automatic taps, low flow/waterless urinal flushing and dual flush WC cisterns.</td>
<td>Will reduce overall quantity of water supplied from mains supply as well as reducing the overall volume of surface water run-off to the drains.</td>
<td>Yes</td>
<td>Included in BOD</td>
<td>Yes</td>
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Notes:
1) Capital cost based on 19kWe CHP unit