NORTHERN IRELAND ASSEMBLY

Parliament Buildings, Stormont Roof Repair Project

GENERAL & BACKGROUND

Parliament Buildings, Stormont, built in 1921 and officially opened in 1932, is a grade B+ listed building and recognised as one of Northern Ireland's great architectural set pieces.

Sir Arnold Thornley designed the building with perfect symmetry and symbolism, such as the building being 365ft wide, representing one foot for every day of the year; and having six floors and six pillars at the entrance, one for each county in Northern Ireland.

Its prominent hillside location on the East side of the city means it can be seen from high vantage points across most of Belfast.

During the last major refurbishment of the building in 1995, essential mechanical and electrical plant installations were located on the roofs, preventing access for repair of ongoing roof drainage problems.

The starting point for the energy management targets was a Sustainability Report which was completed in 2011. This established the benchmark or 'Base Year' performance for the building, against which the future performance of the building can be measured.

A roof repair and M&E plant rationalisation project was commissioned in 2013 to deliver several of the key objectives as identified in the Sustainability Report:

- Rationalisation and upgrading of M&E Plant
- Reduce environmental impacts and improve energy performance
- Utilise best practice sustainability principles
- Incorporate renewable energy and water conservation technologies

This project is ongoing and scheduled for completion in spring 2015. In parallel, the Assembly Commission has been implementing energy and water conservation works throughout the rest of the building under their Term Maintenance Framework.

COMMUNICATION & DISSEMINATION OF INFORMATION

As expected, the Assembly has an interest in the performance of their building and the expenditure of £400,000 of public money per annum on energy costs. This level of expenditure is considered too high and the Assembly Commission were tasked with its reduction.

The DFP Energy Unit has been involved in scoping the project based work and providing information and advice.

An internal Working Group was set up in advance of the Roof Project and regular communications are sent out to building users, MLAs and the Press.

The Sustainable Development Branch of the NI Assembly have been working with Business in The Community and other organisations to ensure all options have been considered in relation to the roof project and renewables.

The project has been included as a Technical Tour in the 2014-2015 CIBSE NI Region calendar, disseminating the lessons learned from the project into the M&E profession. Similar visits are expected from BIFM and students from the University of Ulster.

Northern Ireland Assembly

COST EFFECTIVENESS

All proposed energy efficiency measures incorporated into the project were examined on a life cycle cost basis by the Assembly Commission and the Roof Project M&E Consultants.

These were presented to the Assembly Environmental Services Team and reviewed on a value for money and financial payback basis before incorporation.

Major items of plant date from 1995 and were at the end of their economic /service life or obsolete. This meant that measures such as replacement boiler plant, DHW plant, replacement of AHUs, associated AC plant and controls, were effectively zero capital cost measures with an instant return.

Measures such as the replacement of pumps in the boilerhouse and provision of renewables were incorporated on their own merits on a life cycle cost basis.

PARTNERSHIPS

The energy conservation measures and the scope for incorporation of renewables has been developed in consultation with the Northern Ireland Environment Agency,

the body responsible for the preservation of historic buildings and environmental sustainability.

Its prominent hillside location means it can be seen from high vantage points across most of Belfast. The building has therefore historically been floodlit from dusk until midnight.

The popular open-top bus city tours all visit the site and the grounds are a popular location for open air concerts and charity events, including:

- Concerts by Pavarotti, Elton John, Sting, The Eagles and Rod Stewart
- Annual International Cross Country
- 2014 Giro D'Italia Team Time Trial

There is close liaison with Tourism NI in respect of these events and the provision of a responsive coloured programmable LED floodlighting will help bring additional events, plus save 50% in running costs.

INNOVATION AND PRODUCT SELECTION/DIVERSITY

Innovation in Engineering Design

The M&E Consultants carried out a thermal image survey of the Roof HVAC plant in operation. This showed extensive energy losses from the roof mounted services.

The thermal imaging study confirmed extensive heat losses from the external insulated pipework, as evidenced by the drop in flow temperature in the pipework from 82°C to as low as 67°C. Overall efficiency of the system was severely compromised as a result.

The M&E Consultants therefore implemented the following efficiency measures:

- Reduce external pipework length
- Install AHU plant within insulated Pods so that pipework was internal and protected
- Increase the thickness and efficiency of insulation
- Change heating control at the AHUs from a 3-port (always hot) to a 2 –port arrangement
- Redesign the constant temperature circuit to operate on 60°C/50°C flow/return rather than 82°C/71°C, reducing standing and distribution losses by 30.5% and allowing CT boilers to operate in condensing mode.
- Reconfigure the controls for the main VT boilers to allow the boiler temperature to be reduced.

'Refurbish not Replace'

Budget pressures / value for money and disruption issues has laid to the comprehensive refurbishment of 4 existing air handling units rather than replacement. The refurbishment retains the cabinet and existing ductwork with replacement of the following components:

- Fan and motor assembly
- Heating and cooling coils
- Cooling condensers
- Controls / BEMS

This gives the same life as a new AHU system, but with works completed in 2-3 weeks rather than several months (an unacceptable level of disruption), minimal material wastage and a saving of circa £120,000 in project costs.

Incorporation of Renewables

The potential for incorporation of renewables is limited by the:

- historic building fabric and building prominence – no externally visible services permitted
- lack of structural information regarding the roof – wind loads for inclined PV and solar thermal may exceed the structural capability
- need to maintain maintenance access to the roof membrane

The Roof Project M&E designers have therefore specified a flexible thin-film adhesive PV system (Nordtex Rubbersun) to overcome the combined restrictions imposed by visibility and roof wind loading. This acts as a roofing membrane itself and does not compromise roof performance.

The Kingspan Environmental solar thermal EVT system was selected on quality and its ability to deliver the best solar performance from a horizontal array. This is achieved by optimum angling of the individual tubes to maximise solar collection.

The system is used to pre-heat the DHW before the gas fired DHW heaters – thus a solar contribution can be made even in winter.

CARBON REDUCTION COMMITMENT

The carbon targets for the project are managed and monitored through the Assembly Commission's ISO 14001 Environmental Management System. A target of 30% savings in fossil fuels and 10% for electricity was set for the project.

These targets have been exceeded.

Fuel Savings (Gas)

Projected gas energy reduction is circa 56% or 329 tonnes of CO2 per annum, achieved by:

- Upgrading the roof insulation to 0.13 W/m2K
- Replacing existing boilers with condensing models
- Replacing DHW calorifiers with direct gas fired units
- Installing gas and hot water metering, monitored by the BEMS
- Replacing the 'always on' fan convectors in the Long Gallery with controllable units
- Replacing AHUs and associated AC equipment with more efficient units
- Measures to reduce distribution losses (as previously outlined)

Refer to Appendix B for the detailed energy and cost savings of the works.

Electrical Savings

Electrical savings are circa 17% and 229 tonnes of CO2 per annum, achieved by:

- Replacing internal uplighting with low energy CFL lamps (term maintenance)
- Replacing lighting in the Great Hall chandeliers (term maintenance)
- Replacing pumps in the boilerhouse with ErP compliant models
- More efficient lighting to existing open

plan offices

- Replacing the AHUs with more efficient units
- Replacing inefficient AC equipment with AA rated units
- Replacing external flood lighting with programmable LED based system
- Recovery on PV generation
- Comprehensive electrical sub-metering
- Free cooling to new Comms Room and higher room temperatures in existing Comms Rooms

Water Conservation

The Roof Project includes a proportion of rainwater harvesting. The anticipated water saving is 255m3 per annum, equivalent to 56,000 'free' toilet flushes.

Further water savings have been made by installing 'Hippos' within the existing toilet cisterns.

A 5% overall water saving is anticipated as a result of these measures.

Electric vehicles

Two EV charging points are being provided within the car park of to encourage staff and MLAs to embrace this technology.

CONCLUSIONS

This Energy Management Initiative is a positive step towards making Parliament Buildings an exemplar in respect of sustainable development of a historic building and ensuring that the environmental impact of the Assembly is reduced.

The Project is expected to deliver the following annual savings:

To realise energy savings and carbon

Gas:	1,698,230 kWh	(56%)
Electricity:	425,742 kWh	(17%)
Overall Energy:	2,123,972 kWh	(38.3%)
CO2 emissions:	559.4 tonnes	(28.9%)
Water:	568 m^3	(5%)

reductions of this order in a historic listed building which already has a creditable 'D' rating on its DEC will be a remarkable achievement.

APPENDIX A – ROOF PROJECT TEAM

Client:
The Northern Ireland Assembly Commission

Project Manager:
Hamilton Architects LLP, Belfast

Architect:
Hamilton Architects LLP, Belfast

M&E Consultants:
Bennett Robertson Design, Belfast

Quantity Surveyor:
Edmond Shipway, Belfast

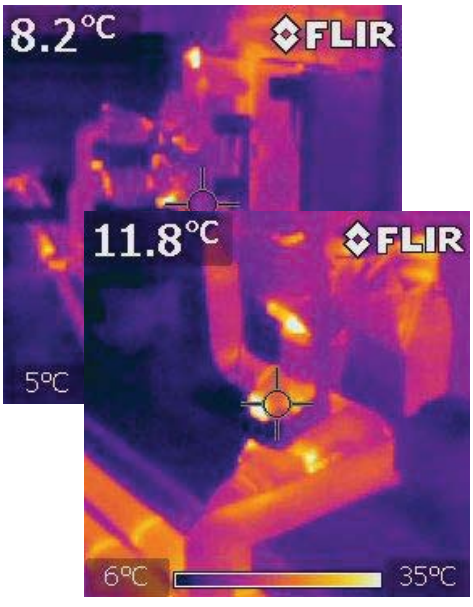
Structural Engineers:
WYG Group Ltd, Belfast

CDMC:
FCM Partnership, Belfast

Main Contractor:
Tracey Brothers Ltd, Enniskillen

M&E Contractor:
AEM Ltd, Belfast

BEMS Specialists:
Schneider Electric , Belfast



Appendix B - NI Assembly Parliament Buildings
Energy Efficiency Measures

			Cost
Base Year (to Nov 2010) Gas:	**3,048,017**	**kWh Pa**	**£156,000**
Base Year (to Nov 2010) Electricity:	**2,494,235**	**kWh Pa**	**£273,000**
Base Year Total Energy:	**5,542,252**	**kWh Pa**	**£429,000**
Base Year (to Nov 2010) Water:	**10,728**	**m3**	**£28,536**

Heat Energy - Gas	Ave. Energy Saving kW	Operating Hrs per annum	Saving Energy kWh	Cost per kWh	Cost Saving pa	CO2 saving kg pa
Roof insulation upgrading 100mm XPS (U=0.25) to 190 PUR (U=0.12) over 4,552 m2	13.7	6570	53848	£0.0480	£2,584.69	10446
Replace existing 19 year old oversized boilers (70% eff.) with condensing (90.5% eff.)	143.8	4800	690435	£0.0480	£33,140.88	133944
Install gas & hot water sub-metering throughout the building	n/a	n/a	137279	£0.0480	£6,589.39	26632
Replace calorifiers (65% seasonal efficiency) with direct gas fired units.	8.0	4800	38209	£0.0480	£1,834.03	7413
Omit DHW primary pump circuit & standing losses - direct gas fired units used.	2.3	4800	10992	£0.0480	£527.62	2132
Install solar thermal EVTs to pre-heat DHW	10.5	3600	37800	£0.0480	£1,814.40	7333
Reduce CT temperatures from 82/71 deg C to 60/50 deg C (31% reduction)	64.2	3600	231012	£0.0480	£11,088.58	44816
Change AHU CT heating circuits from 3 pipe to 2 pipe & use demand control	35.0	3600	126000	£0.0480	£6,048.00	24444
Reduce external LTHW pipe length & improve insulation of remainder (Kooltherm)	71.1	3600	255960	£0.0480	£12,286.08	49656
Omit DHW primary pump - direct gas fired units used. Saving 4 kW	4.0	4380	17520	£0.0480	£840.96	3399
Replace airside control fan convectors in Long Gallery with new waterside control units	n/a	n/a	25015	£0.0480	£1,200.72	4853
Replace AHUs with more efficient units c/w VFDs & demand control (less Fresh Air)	20.6	3600	74160	£0.0480	£3,559.68	14387
TOTAL GAS SAVING	373		1698230		£81,515.03	329457
% Saving			56%			

Electrical Savings	Ave. Energy Saving kW	Operating Hrs per annum	Saving Energy kWh	Cost per kWh	Cost Saving pa	CO2 saving kg pa
Replace internal tungsten lighting with low enegry CFL	14.2	3200	17551	£0.1200	£2,106.12	9478
Replace Great Hall chandelier lighting tungsten 40W to 3W LED	8.1	5840	47538	£0.1200	£5,704.51	25670
Install electricity sub-metering throughout the building	n/a	n/a	112337	£0.1200	£13,480.44	60662
Replace pumps in boilerhouse with Erp compliant models - 36.0 kW to 24.7 kW	11.3	4800	54240	£0.1200	£6,508.80	29290
Change AHU CT heating circuits from 3 pipe to 2 pipe & modulate 8.5 kW pumps	4.9	4800	23664	£0.1200	£2,839.68	12779
Replace pressure jet fired boilers with new shell boilers	3.0	4800	14400	£0.1200	£1,728.00	7776
Omit DHW primary pump - direct gas fired units used. Saving 4 kW	4.0	4380	17520	£0.1200	£2,102.40	9461
New lighting to Room 401 - 368 m2 @ 14.5 W/m2 for CFL to 8.5 W/m2 T5	2.2	3200	7072	£0.1200	£848.64	3819
Replace AHUs with more efficient units c/w VFDs & demand control - 85% speed ave	7.9	1450	27350	£0.1200	£3,282.00	14769
Replace AHU condensing units EER 2.5 to 3.6 inverter driven units	10.4	1450	15056	£0.1200	£1,806.72	8130
Replace inefficient AC equipment with AA rated units EER 2.5 to 3.4. 77.4 kW	8.2	1450	11890	£0.1200	£1,426.80	6421
Raise set temperature in server rooms from 19 deg C to 21.5 deg C (tamperproof)	n/a	n/a	25015	£0.1200	£3,001.80	13508
New server room (1 of 2) with cold aisle/hot aisle configuration and new fresh air / AC equipment	n/a	n/a	17290	£0.1200	£2,074.80	9337
Replace existing floodlighting with LED (colour changing)	4.5	2190	9855	£0.1200	£1,182.60	5322
Replace Kitchen Extract fans (1 x long cased HP axial & 3 belt driven) with cabinet fans	2.0	2600	5200	£0.1200	£624.00	2808
Install PV on roofs - 12.5 kWp mono/polycrystalline and 13.9 kWp of thin film	26.4	n/a	19705	£0.1200	£2,364.60	10641
NI ROCs recovery on PV generation (mono/poly system only)	n/a	n/a	n/a	£0.1200	£1,119.60	n/a
Pump energy from water savings	n/a	n/a	59	£0.1200	£7.08	32
TOTAL SAVING	85		425742		£44,397.96	229900
% Saving			17%			

Water Saving	Ave. Water Saving l/day	Saving m3 pa	Pumping Energy kWh	Cost per m3	Cost Saving pa
Rainwater Recovery	622	255	18	£1.02	£260.10
Hippos in WCs	857	313	22	£2.66	£831.44
TOTAL SAVING	1479	568	39		£1,091.54
% Saving		5%			