https://www.lowenergybuildings.org.uk/

Project name Peterborough EnviroCluster Retrofit Project

Project summary The comprehensive upgrade of the fabic and services of a 1970s, masonry construction, two storey, three bedroom, semi-detached house to effect an 87% reduction in its overall energy consumption. Including: fully insulating the building and installing super-high performance windows and doors, making the fabric air and wind-tight; installing a sun-space and wind lobby, Installing solar thermal water heating; installing pv micro generation (incorporating battery storage and export to grid facilities); installing heat exchange technology into the fresh air input, together with pre-heated air from the sun-space and roof labyrinth.

Project Description

Projected build start date	03 May 2010
Projected date of occupation	30 Oct 2010
Project stage	Under construction
Project location	Peterborough, Cambridgeshire, England
Energy target	Retrofit for the Future
Build type	Refurbishment
Building sector	Public Residential
Property type	Semi-Detached
Existing external wall construction	Masonry Cavity
Existing external wall additional information	280mm o/a brick, uninsulated cavity, blockwork, plaster
Existing party wall construction	220mm (approx) block, uninsulated cavity, blockwork, plaster
Floor area	76.25 m²
Floor area calculation method	PHPP

Project team

Organisation	UK Centre for Economic and Environmental Development
Project lead	UK Centre for Economc and Environmental Development (UKCEED)
Client	Axiom Housing Association
Architect	Waterland Associates
Mechanical & electrical consultant(s)	Cunnington Clarke
Energy consultant(s)	Cambridge Centre for Energy Studies (Cambrdge University)
Structural engineer	Stanza Consulting
Quantity surveyor	Davis Langdon (Peterborough)
Other consultant	Moixa Energy
Contractor	Larkfleet Homes

Design strategies

Planned occupancy	The property is a family home, with the principal tenants being a late middle aged couple, with adult children and grand children. Some of the adult children reside sporadically with the principal residents and the grand children regularly spend the night at the premises.
Space heating strategy	Heating from existing (SEDBUK 'A' Rated) gas fired combination boiler, through existing radiators. Solar thermal system feeds into the boiler.
Water heating strategy	Existing gas fired combination boiler with feed-in water from solar panels and thermal store. No electric back-up.
Fuel strategy	Mains Gas, Mains Electricity
Renewable energy generation strategy	1kWp photovoltaic panel array on the roof.
Passive solar strategy	Solar collection provision in new roof structure (thermal labyrinth) and in exterior thermal cladding (glazed, solar capture elements). Solar heated (tempered) air feeds into Whole House Heat Recovery Ventilation System.
Space cooling strategy	Natural ventilation and shading incorporated into exterior cladding. Summer bypass and night purging using Whole House Ventilation system.
Daylighting strategy	Daylighting provision remains as is, with glazing interventions maintaining average 2% daylight factor in kitchen and 1.5% in living spaces.
Ventilation strategy	Whole House Heat Recovery Ventilation with summer bypass.
Airtightness strategy	It is proposed to fully insulate the building externally (on the exterior of the existing fabric), effectively wrapping the entire building envelope in, between 200mm & 400mm of, insulation. Into this insulation zone it is proposed to install a wind and air tightness membrane so that the entire house is fully wind and air-tight. Special measures will be incorporated at the existing openings (windows, doors, service penetrations etc) to ensure the minimum air infiltration at these points. The existing air tighness is 10.82 m3/hr.m sq The proposed air tightness will be 0.6 m3/hr.m sq

Strategy for minimising thermal bridges	It is proposed to fully insulate the building externally (on the exterior of the existing fabric), effectively wrapping the entire building envelope in, between 200mm & 400mm of, insulation. As a result of this strategy for the insulation, the existing fabric of the building is isolated from the external environment, thus eliminating almost all potential themal bridges. It will be necessary as part of the construction works to investigate the situation at the current points of cavity closure (around windows doors etc) and if necessary take remedial action; allowance has been made for this.
Modelling strategy	SAP (2005) with Extension for Whole House v1.6.
Insulation strategy	It is proposed to fully insulate the building externally (on the exterior of the existing fabric), effectively wrapping the entire building envelope in, between 200mm(walls) & 400mm(roof) of, insulation. In addition to this it is proposed to insulate above the existing floor using 20mm of vacuum insulated panels and the doors and windows are all to be replaced with super-high performance alternatives. U-Values W/(mK) Existing Roof 2.0; First Floor Ceiling n/a; Walls 1.80; Ground Floor 0.52; Windows 2.80; Doors 3.00. Proposed Roof 0.10; First Floor Ceiling 0.22; Walls 0.16; Ground Floor 0.31; Windows 0.80; Doors 0.65.
Other relevant retrofit strategies	We are planning to carry out our package of retrofit measures with tenants remaining, as far as possible, in the dwelling during the proposed works. We intend to demonstrate our approach can be undertaken with minimal disruption to the tenants and with no associated temporary re-housing costs

Other information (constraints or opportunities influencing project design or outcomes)	Peterborough is flat and low lying on the edge of the Fens and subject to S-W prevailing winds. Bretton was built on a II World War airfield and is flat and exposed. Extensive, mature (25-30 yrs.) tree planting offers protection. Mid-density 3 and 2 storey housing provides a dense housing area with intermittent open space and access corridors. The site is surrounded with similar 1970s buildings, which the Local Authority Development Control Department do not consider to be of architectural significance. Advice has been sought from the Senior Development Control Officer and he has confirmed that the proposed development would be welcomed as an improvement on the existing local architectural style.

Energy use

Fuel use by type (kWh/yr)

Fuel	previous	forecast	measured
Electric	547	1097	2253
Gas	23490	2569	2665
Oil			
LPG			
Wood			

Primary energy requirement & CO2 emissions

	previous	forecast	measured
Annual CO2 emissions (kg CO2/m².yr)	68	15	25
Primary energy requirement (kWh/m².yr)	372	75	114

Renewable energy (kWh/yr)

Renewables technology	forecast	measured
Roof mounted Photovoltaic panels	798	
-		
Energy consumed by generation		

Airtightness (m³/m².hr @ 50 Pascals)

	Date of test	**Test result**
Pre-development airtightness	-	10.05
Final airtightness	-	3.33

Annual space heat demand (kWh/m².yr)

	Pre-development	forecast	measured
Space heat demand	-	28	-

Whole house energy calculation method	SAP Extension for Whole House
Other energy calculation method	
Predicted heating load	16.5 W/m² (demand)
Other energy target(s)	

Building services

Occupancy	NULL
Space heating	NULL
Hot water	NULL
Ventilation	NULL
Controls	NULL
Cooking	NULL
Lighting	NULL
Appliances	NULL
Renewables	NULL
Strategy for minimising thermal bridges	NULL

Building construction

Storeys	
Volume	
Thermal fabric area	
Roof description	NULL
Roof U-value	0.00W/m² K
Walls description	NULL
Walls U-value	0.00W/m² K
Party walls description	NULL
Party walls U-value	0.00W/m² K
Floor description	NULL
Floor U-value	0.00W/m² K
Glazed doors description	NULL
Glazed doors U-value	0.00W/m² K
Opaque doors description	NULL
Opaque doors U-value	0.00W/m² K
Windows description	NULL
Windows U-value	0.00W/m² K

Windows energy transmittance (G-value)	
Windows light transmittance	
Rooflights description	NULL
Rooflights light transmittance	
Rooflights U-value	0.00W/m² K

Project images

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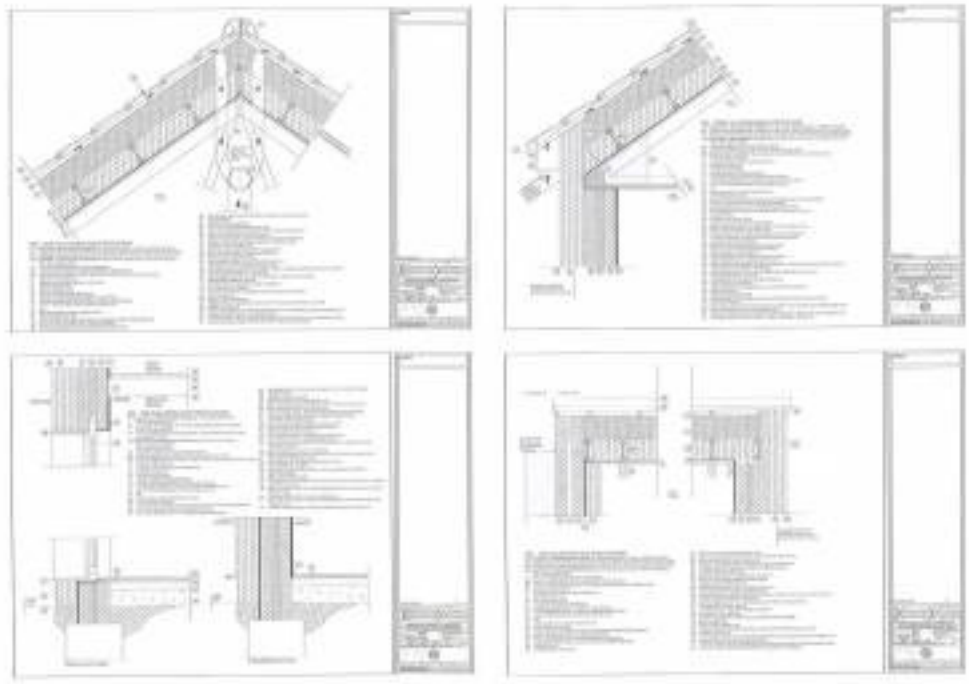
RETROFIT FOR THE FUTURE - CARBON CHALLENGE

ELEMENTAL COST PLAN   REVISION A

ELEMENT	WORK SECTION	COST £	COMMENTS
SUBSTRUCTURE	WORKS TO EXISTING FLOORS	3,415.00	
ROOF	FORM ATTIC PLATFORM	984.00	
	FORM CLOTHES AREA	1,081.00	
	INSULATION	11,799.00	
	AIR AND WIND TIGHNESS MEMBRANES	488.00	
	WORK TO ROOF STRUCTURE	3,902.00	
	BUILDERS WORK INCL. RWG	2,059.00	
EXTERNAL WALLS	RAISE GABLE END	915.00	
	INSULATION	8,197.00	
	RENDER	2,342.00	
	AIRTIGHTNESS MEMBRANES	861.00	
	BUILDERS WORK	1,788.00	
WINDOWS AND EXTERNAL DOORS	NEW WINDOWS	8,410.00	
	BUILDERS WORK	247.00	
SUNSPACE, PORCH & SOLAR COLLECTOR	SUNSPACE CONSTRUCTION	13,759.00	
	PORCH COMPLETE	7,145.00	
	SOLAR COLLECTOR WALL	11,675.00	
INTERNAL WALLS	INSULATION AND AIRTIGHT MEMBRANE	575.00	
	BUILDERS WORK	1,760.00	
FIXTURES & FITTINGS	LIGHT TUBE	602.00	
	SUNDRIES	454.00	
DECORATIONS		1,350.00	
SERVICES	PHOTOVOLTAIC PANELS: 10m2 MONOCRYSTALINE	4,250.00	Including £4250 grant contribution
	WHOLE HOUSE MV SYSTEM	2,580.00	
	SOLAR HOT WATER: 6m2 EVACUATED TUBE	5,085.00	Including £3800 grant contribution
	LED LIGHTING AND DC CABLE NETWORK	1,000.00	
DRAINAGE	BELOW GROUND DRAINAGE	794.00	
PRELIMINARIES	SCAFFOLDING	1,368.00	
	GENERAL (including supervision/welfare/H & S/skips etc)	11,850.00	
METERING	SMART METERING AND DISPLAY EQUIPMENT	5,590.00	
	SUB TOTAL	111,801.00	131066.05
CONSULTANTS FEES @ 10%		10,975.39	15421.88
Tenant Education and Incentivisation		1,500.00	1762.55
	Total	121,276.39	148832.1
	VAT @ 17.5%	32,273.12	
	PROJECT TOTAL COSTS	148,551.09	

NOTES

1 VAT ASSUMED AT 17.5%(NOTTRR)
2 ALL COSTS EXCLUDE REPLACEMENT KITCHENS/BATHROOMS AND FLOOR COVERINGS AND ASSOCIATED REDECORATION
3 POTENTIAL 50% GRANT REBATES ON CERTAIN ITEMS HAVE BEEN INCLUDED WITHIN THESE COSTS



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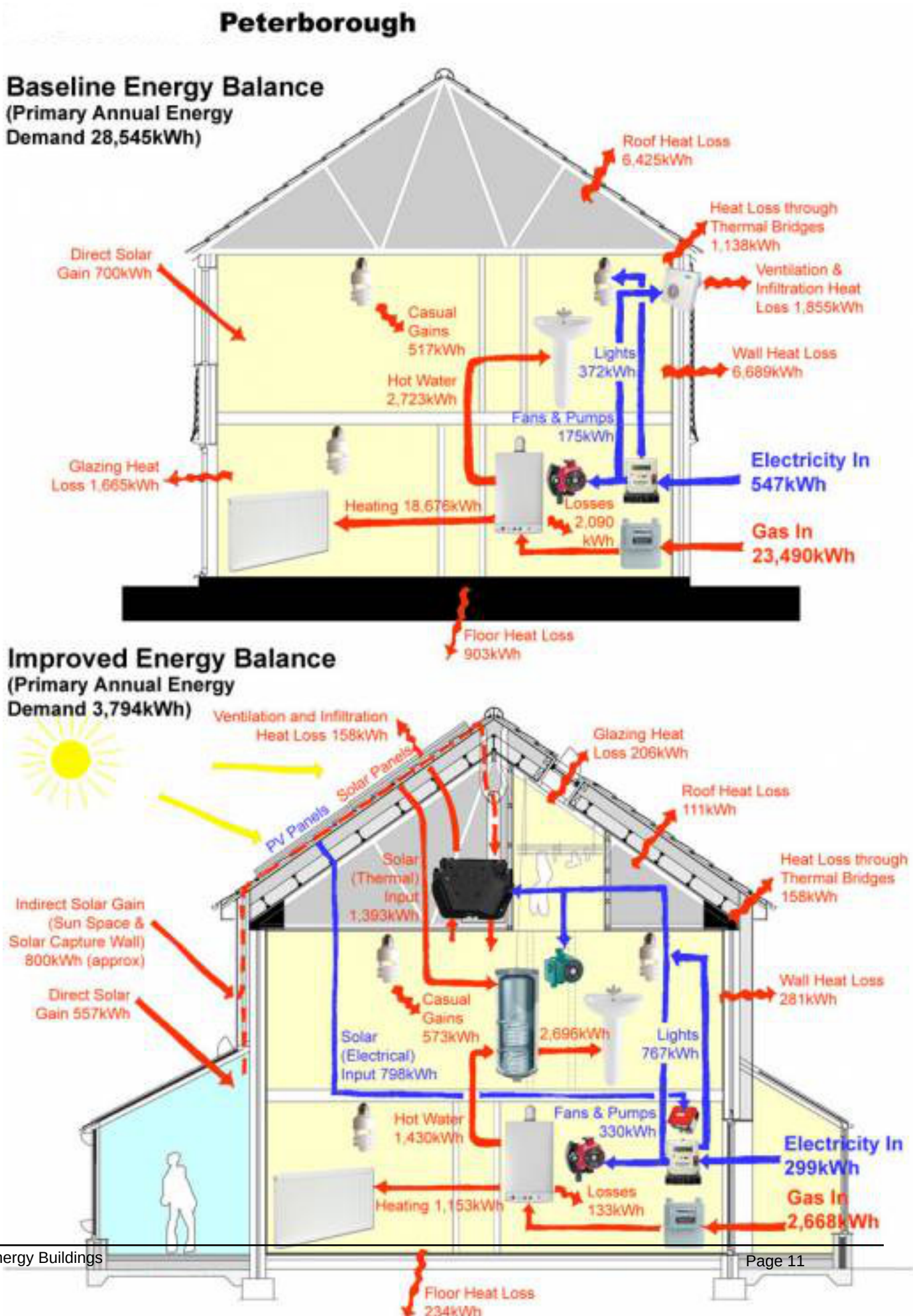
Peterborough
Baseline Energy Balance
(Primary Annual Energy
Demand 28,545kWh)
Roof Heat Loss
6,425kWh
Heat Loss through
Thermal Bridges
1,138kWh
Direct Solar
Gain 700kWh
Ventilation &
Infiltration Heat
Loss 1,855kWh
Casual
Gains
517kWh
Lights
372kWh
Wall Heat Loss
6,689kWh
Hot Water
2,723kWh
Fans & Pumps
175kWh
Electricity In
547kWh
Glazing Heat
Loss 1,665kWh
Heating 18,676kWh
Losses
2,090
kWh
Gas In
23,490kWh
Floor Heat Loss
903kWh
Improved Energy Balance
(Primary Annual Energy
Demand 3,794kWh)
Ventilation and Infiltration
Heat Loss 158kWh
Glazing Heat
Loss 206kWh
Solar Panels
PV Panels
Roof Heat Loss
111kWh
Solar
(Thermal)
Input
1,393kWh
Heat Loss through
Thermal Bridges
158kWh
Indirect Solar Gain
(Sun Space &
Solar Capture Wall)
800kWh (approx)
Wall Heat Loss
281kWh
Direct Solar
Gain 557kWh
Casual
Gains
573kWh
Solar
(Electrical)
Input 798kWh
2,696kWh
Lights
767kWh
Hot Water
1,430kWh
Fans & Pumps
330kWh
Electricity In
299kWh
Losses
133kWh
Heating 1,153kWh
Gas In
2,668kWh
Floor Heat Loss
234kWh

Measure analysis - one by one

	Measure	Savings		Capital cost & Life		60 year Cost			Cost effectiveness analysis		Selection
	Measure	Annual CO_2 emission savings from measure	Annual Fuel savings from measure	Measure Life (years) Fabric measures: 60 Windows: 30 Airtightness (as MVHR): 30 Plant and controls: 15 Appliances: 8	Capital cost (& lifetime maintenance cost if significant)	Fuel cost savings over 60 year life	Capital costs over 60 year life	Net cost of measure over its lifetime (Capital less fuel savings)	CO_2 saved from measure over 60 years	£/tonne CO_2 saved	Measure in package?
		kg/yr	£/yr	years	£	£	£	£	tonne CO_2 saved	£/tonne CO_2 saved	1=yes
1	Roof Insulation	1188	91.72	60	27,820	8,800	27,820	19,420	72	228	1
2	Wall Insulation	1269	105.84	60	13,303	6,930	13,303	6,370	76	88	1
3	Ground Floor Insulation	81	6.82	60	4,007	409	4,007	3,600	5	741	1
4	New windows and doors	181	14.79	30	9,852	887	23,710	22,830	11	2,102	1
5	Solar Thermal	287	24.92	30	3,028	1,495	7,260	5,800	18	371	1
6	Photovoltaic panels	423	81.13	30	4,868	3,880	4,868	8,920	27	330	1
7	Heat Recovery Ventilation + Increased Airtightness	228	13.7	30	5,115	822	15,330	14,510	14	1,061	1
8											
9											
10											
11											
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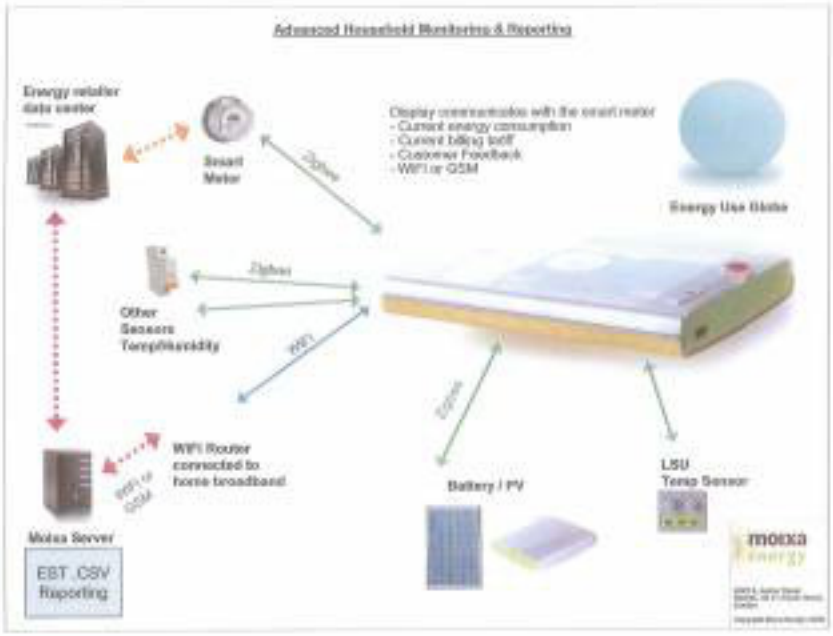
	Package(1)	3050	£ 140		£ 62,646	£ 8,400	£ 95,220	£ 86,820	183	£ 474	



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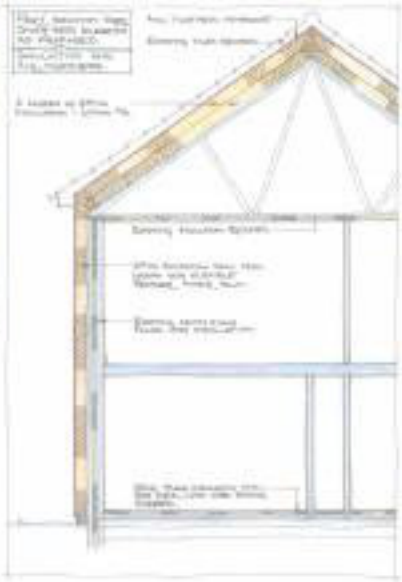
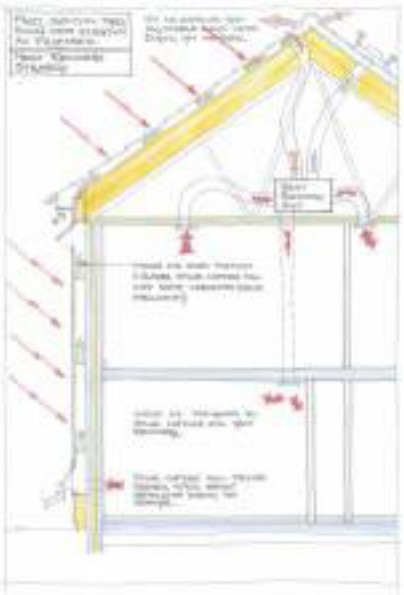
GROUND FLOOR
FIRST FLOOR
FRONT ELEVATION
REAR ELEVATION
SIDE ELEVATION
SECTION A-A
Peterborough – Carbon Retrofit Project
Waterland Associates





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