Modern Methods of Retrofitting

Safety, Health and Environmental Conference
Newcastle University, 21st June 2011

Dr Michael Crilly
Director, Studio UrbanArea LLP

e: michael@urbanarea.co.uk
w: urbanarea.co.uk

Studio UrbanArea LLP
2 King Street, Quayside, Newcastle upon Tyne NE1 3UQ
studio@urbanarea.co.uk www.urbanarea.co.uk

HEAT

GEORGE MONBIOT

'At last the global movement has found a vision' *Independent on Sunday*

A little background

European Commission 6th Framework
Egan Review
60K Homes - *Designed for Manufacture* Competition Audit
Code for Sustainable Homes
Homes and Communities Agency *Carbon Challenge* - pPod
Peterbrough Carbon Challenge Consortium
Technology Strategy Board - *Retrofit for the Future*

"… we are learning a lot, which is the whole purpose of the Challenge. The best work is being taken by developers who are taking an open approach, sharing mistakes and successes."

Lomas, Jane [September 2008] Carbon Challenge: Testing Level 6. *Carbon Challenge Bulletin*, English Partnerships.

THE Carbon CHALLENGE

The challenge to build quality sustainable homes

The Carbon Challenge has been launched by Government to accelerate the housebuilding industry's response to climate change by fast-tracking the creation of a number of zero and near zero carbon communities. The key objective is to raise the environmental performance of new communities while still delivering quality and high standards of design.

The Challenge aims to equip the development industry with the skills and technology needed to meet the 10-year environmental goals being set by Government for new housing development. In particular, it will act as a testing ground for the Government's Code for Sustainable Homes and the new Planning Policy Statement on climate change.

Run by national regeneration agency English Partnerships on behalf of Communities and Local Government, the Challenge will be a successor to the Design for Manufacture Competition, which successfully demonstrated how to build sustainable well-designed, affordable, quality homes.

What is a zero and near zero carbon development?

Zero carbon means no net carbon emissions from all energy uses in the home – so the amount of energy taken from the national grid is less than or equal to the amount put back through renewable technologies. This equates to Level 6 of the Code for Sustainable Homes and will qualify for Stamp Duty relief.

Near zero carbon means no net carbon emissions in relation to core Building Regulations energy performance specifications relating to heating, hot water, ventilation and lighting. This equates to Level 5 of the Code for Sustainable Homes.

The choice of a zero or near zero carbon target for any development depends on location, site characteristics and size of the community.

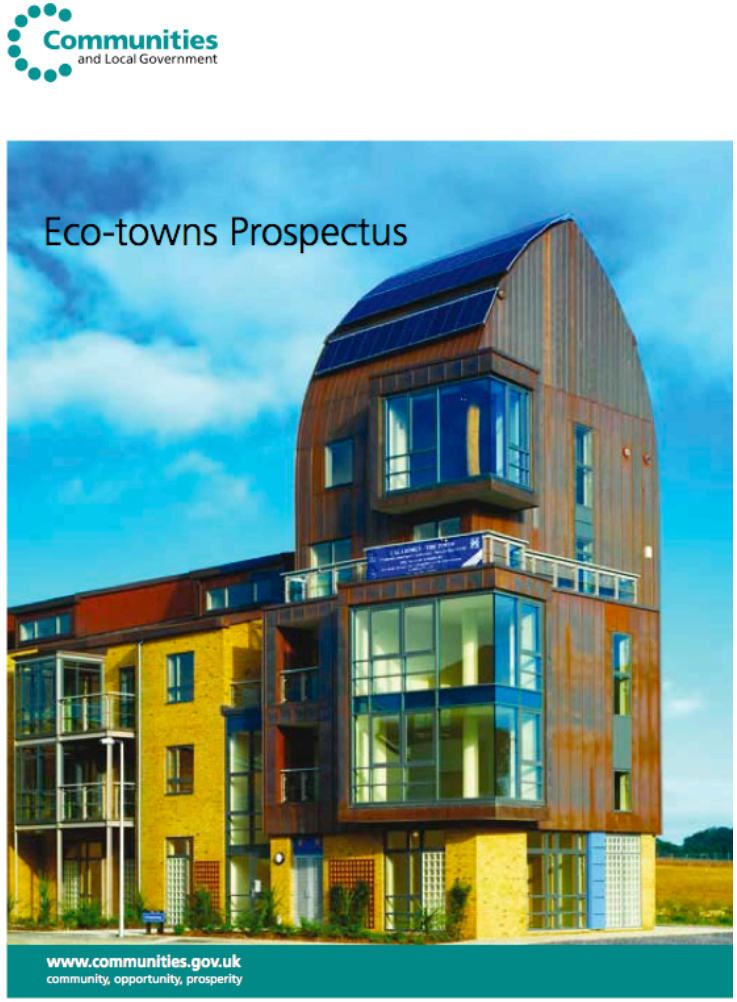
How many homes are being created and where?

The Carbon Challenge will be an on-going initiative with development sites coming on stream throughout the programme. In addition to sites that English Partnerships will make available directly to developers, the Challenge will also call for local authorities, Regional Development Agencies (RDAs), other public-sector land owners and private-sector developers to identify sites that could contribute to the initiative. Those taking part in the Challenge will be right at the forefront of implementing and shaping the way that homes of the future are built.

In the first year of the Challenge, it is expected that a total of around five major public and private-sector sites will be identified. Each must be capable of supporting at least 200 homes to ensure a critical mass, allowing the installation of shared energy systems and other features that will contribute to a zero or near zero carbon footprint to each new settlement.

1. Greenwich Millennium Village, London and Thames Gateway
2. William Verry / Weberhaus and Make Architects' design for the Aylesbury Design for Manufacture site
3. Start on site at Oxley Park Design for Manufacture site, Milton Keynes by George Wimpey

www.englishpartnerships.co.uk/carbonchallenge



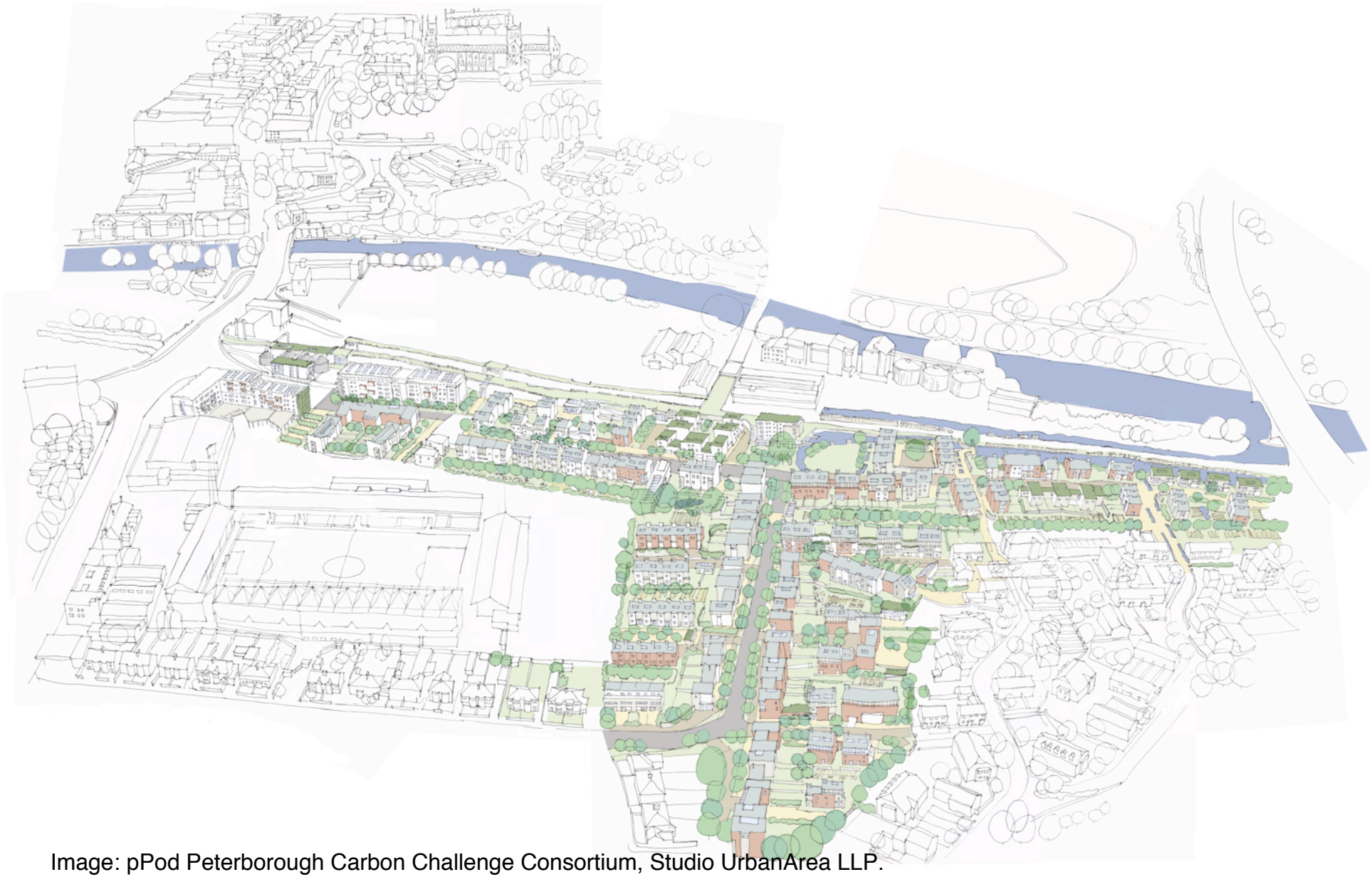


Image: pPod Peterborough Carbon Challenge Consortium, Studio UrbanArea LLP.

Prototype Demonstration unit - Hamptons

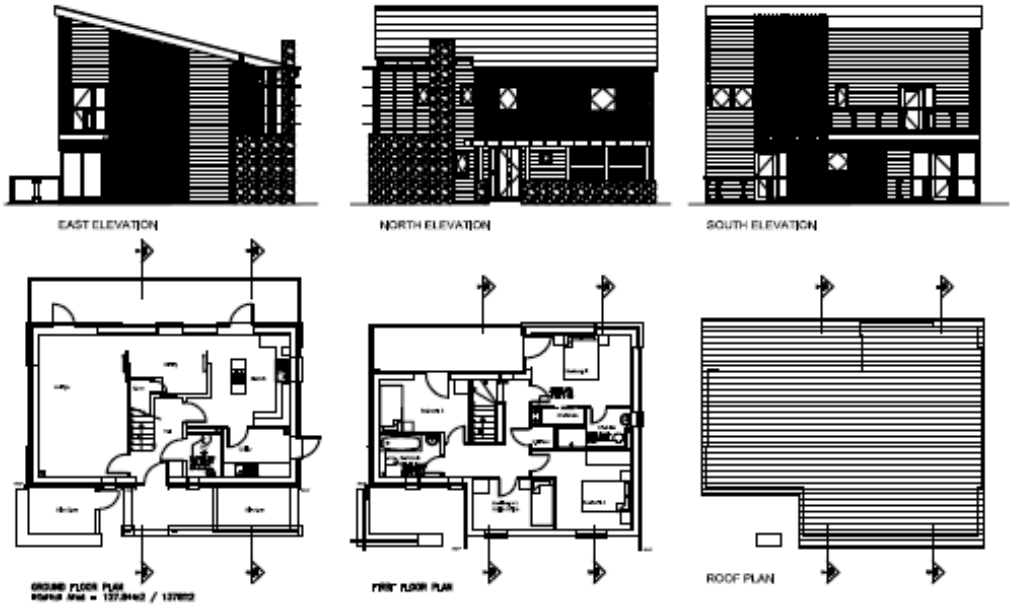
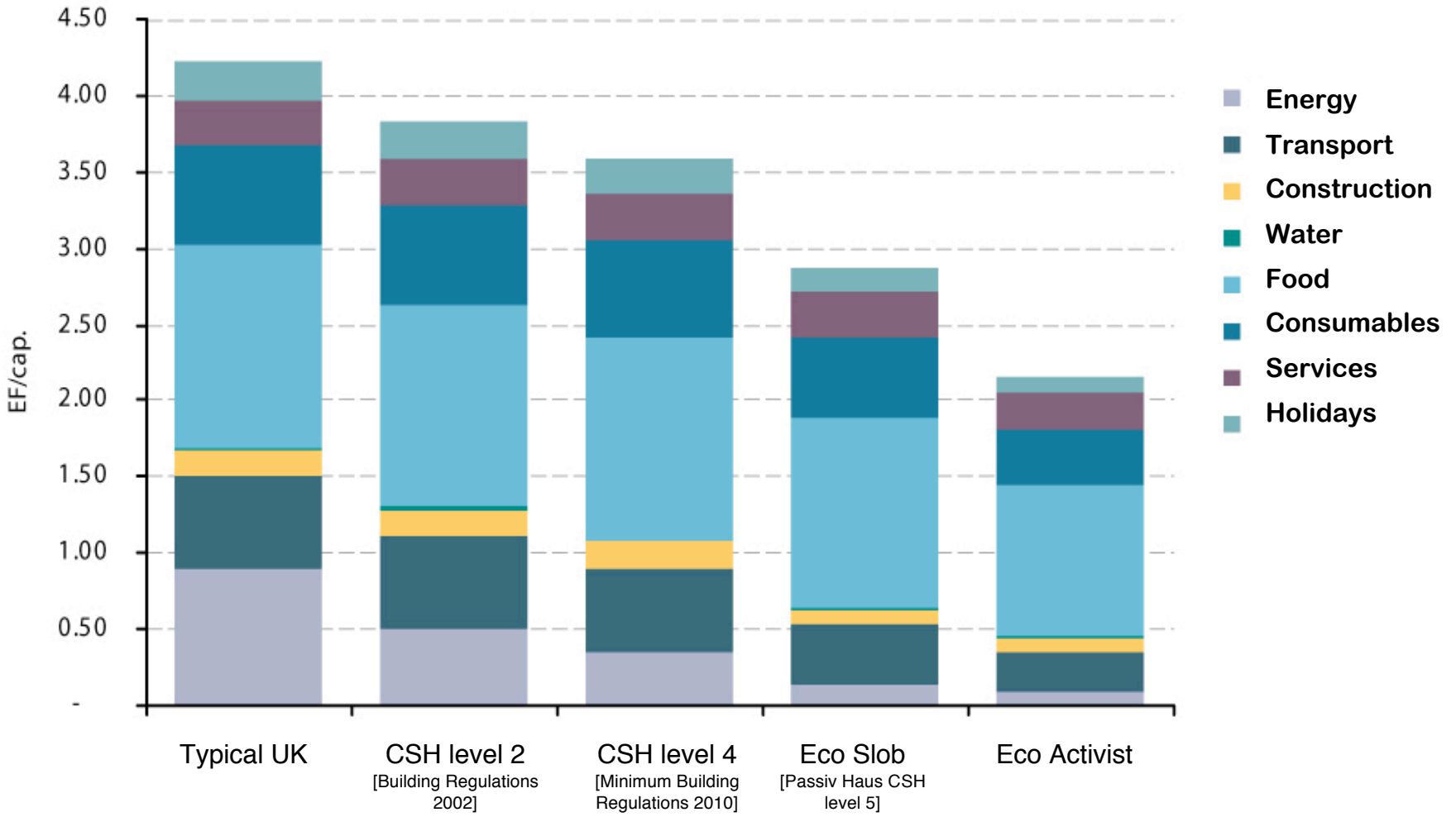


Image: pPod Peterborough Carbon Challenge Consortium, Browne Smith Baker Architects.

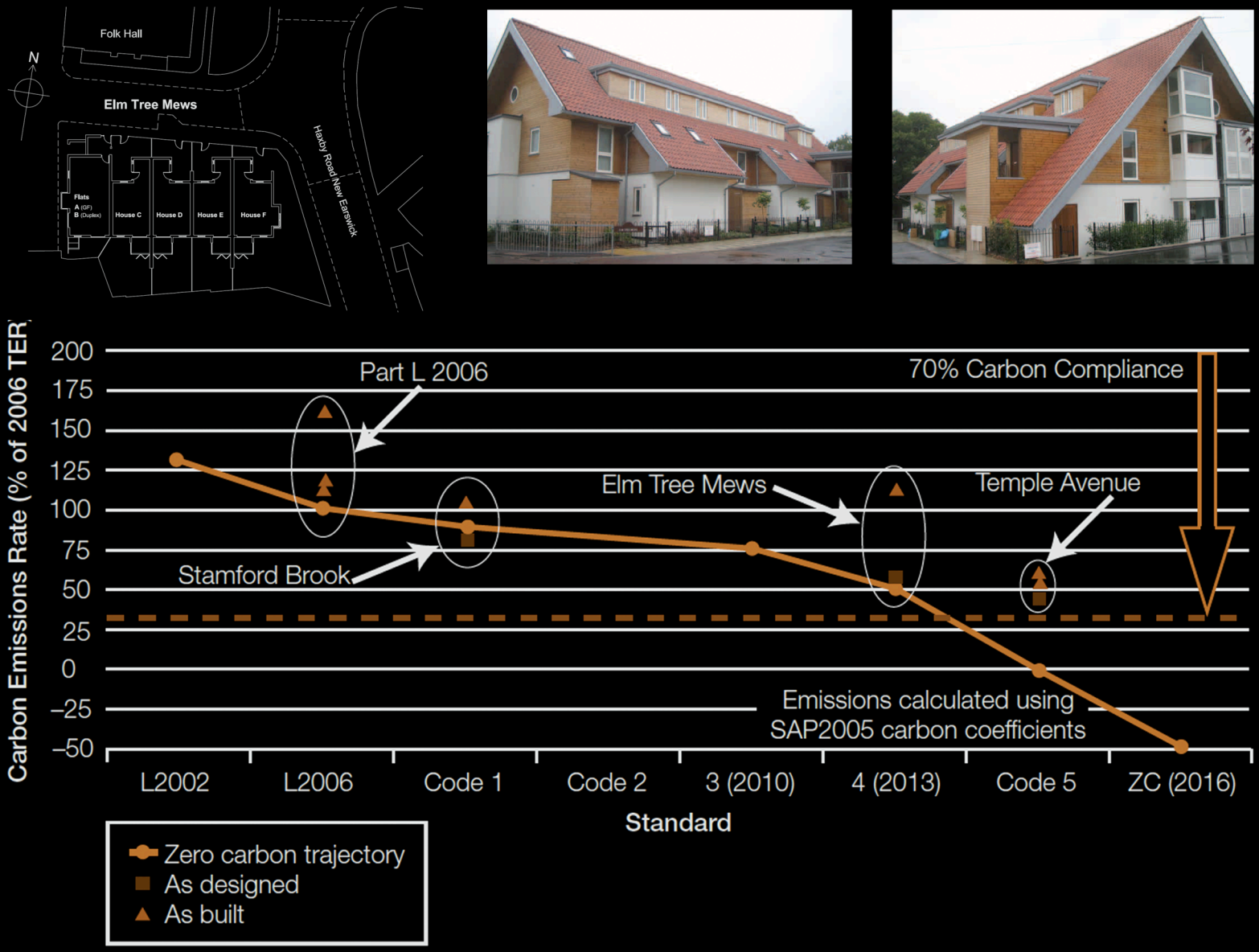


An analysis of four different UK housing types and the associated Ecological Footprint of the residents, combining the indirect impacts of consumption, including the impact of construction – ARUP / SEI 2006.

	kWh per person/ day	Actual kWh per dwelling/ year	Predicted kWh per dwelling/ year (Arup)	kWh per m²/ year
BedZED average 56 monitored homes	**3.4**	**2579**		**34.4**
Owner occupied 26 monitored homes	3.6	2809		30.3
Shared ownership 15 monitored homes	3.3	2074		32.1
Social housing 15 monitored homes	3.2	2687		43.6
1 bed 17 monitored homes	3.7	1896	1700	34.0
1-2 bed 3 monitored homes	2.9	2770		46.6
2 bed 14 monitored homes	2.9	2662	1900	40.2
2 bed (north-facing) 5 monitored homes	5.4	3400		42.9
3 bed 14 monitored homes	2.9	2680	2700	24.6
4 bed 3 monitored homes	3.8	4040	2800	28.6

Heat Consumption 2007	kWh/ person/ day	kWh/ dwelling/ year	kWh/ m²/ year
BedZED average 64 monitored homes	**5.2**	**3,526**	**48.0**
Owner occupied 30 monitored homes	4.9	3,466	37.1
Shared ownership 17 monitored homes	5.3	3,536	54.0
Social housing 17 monitored homes	5.6	3,621	61.2
1 bed 20 monitored homes	6.7	3,047	56.8
1-2 bed 3 monitored homes	6.3	5,974	100.6
2 bed 14 monitored homes	3.2	2,828	42.8
2 bed (north-facing) 6 monitored homes	7.1	4,011	50.7
3 bed 18 monitored homes	4.5	3,813	34.9
4 bed 3 monitored homes	4.5	4,830	34.2

Comparative electricity and heating consumption according to tenure and house type and compared to modeled / predicted consumption. From: BioRegional [July 2009] *BedZED seven years on: The impact of the UK's best known eco-village and its residents* [BioRegional Development Group, Sutton].



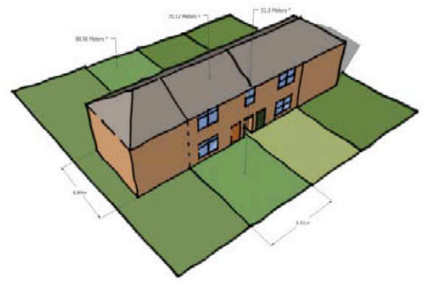
As-designed and as-constructed performance of Elm Tree Mews in the context of other studies and the regulatory trajectory to zero carbon. From: Bell, Malcolm *et al.* [November 2010] *Low Carbon Housing: Lessons from Elm Tree Mews* [Joseph Rowntree Foundation, York].

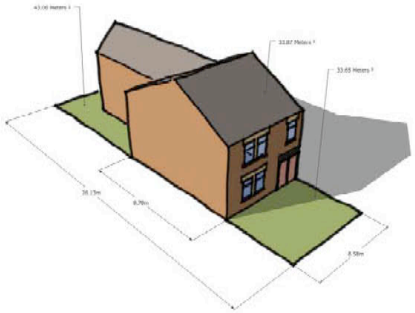
Lessons learnt from *Designed for Manufacture* Competition

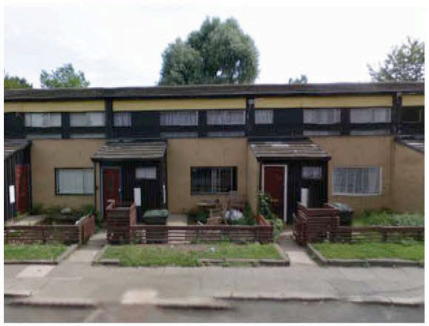
Significant reduced labour on site & during construction
Quality control & improved tolerances / interfaces
Cost efficiency only achieved with the use of a prototype - need to factor in ‘lead-in time’
Positive safety benefits [25% lower rate of site incidents]
Integrated team & project management delivers best results

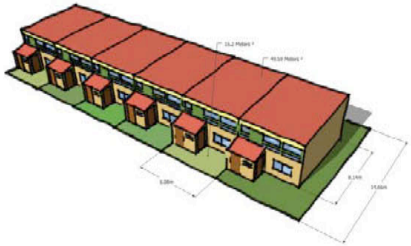
Retrofit for the Future
Technology Strategy Board

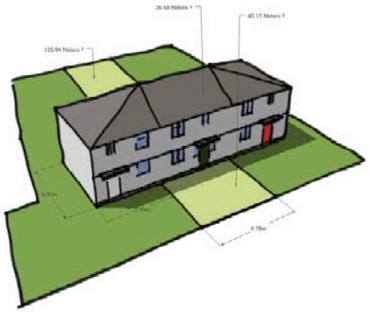
UK Social Housing Sector - 4.5m homes
Over 400 Expressions of interest nationally
197 Stage one – Design
87 Stage two – Implementation Retrofitting

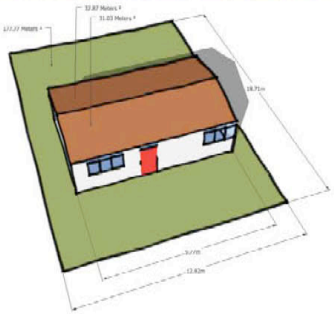






















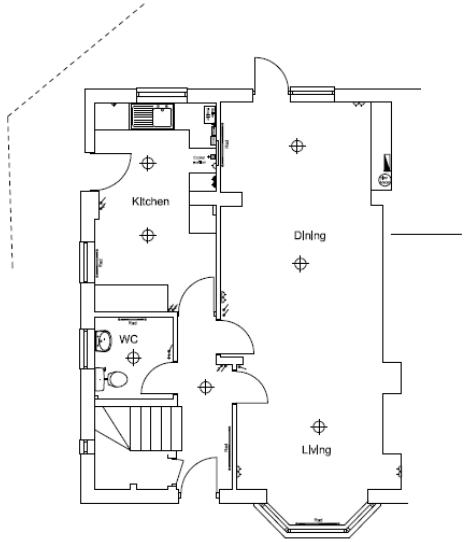

Newcastle City Council

Greenford Road, Pottery Bank

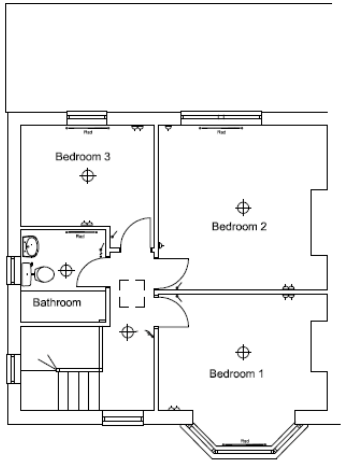
Front (North) Elevation

Gable (East) Elevation

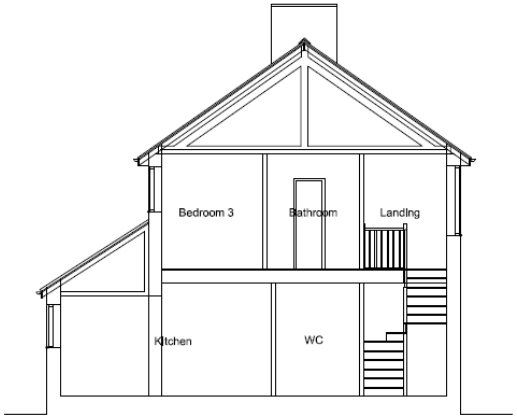
Rear (South) Elevation



Ground Floor



First Floor



Revisions

Newcastle City Council

RetroFit for the Future - 44 Greenford Road, Newcastle NE6

Existing Plans, Elevations & Section

1:50 @ A1 | 12.10.09 | PD/AM

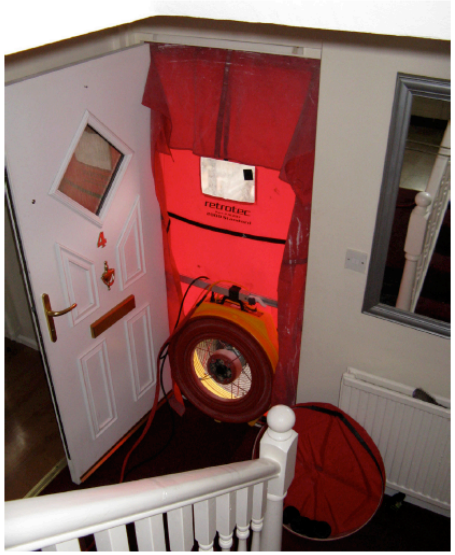
Project No. 09,098

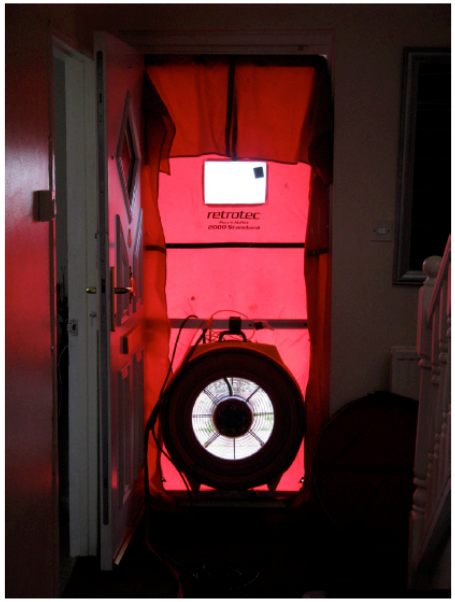
Drawing No. 44GR-P1 | Rev /

The Design Studio Silverbeck Court Stokesley Business Park Stokesley Middlesbrough TS9 5PT
T t:01642 715783 F f:01642 715761 E e:info@dksarchitects.com W w:www.dksarchitects.com

Newcastle City Council

Air Tigntness Testing
Westerdale Place

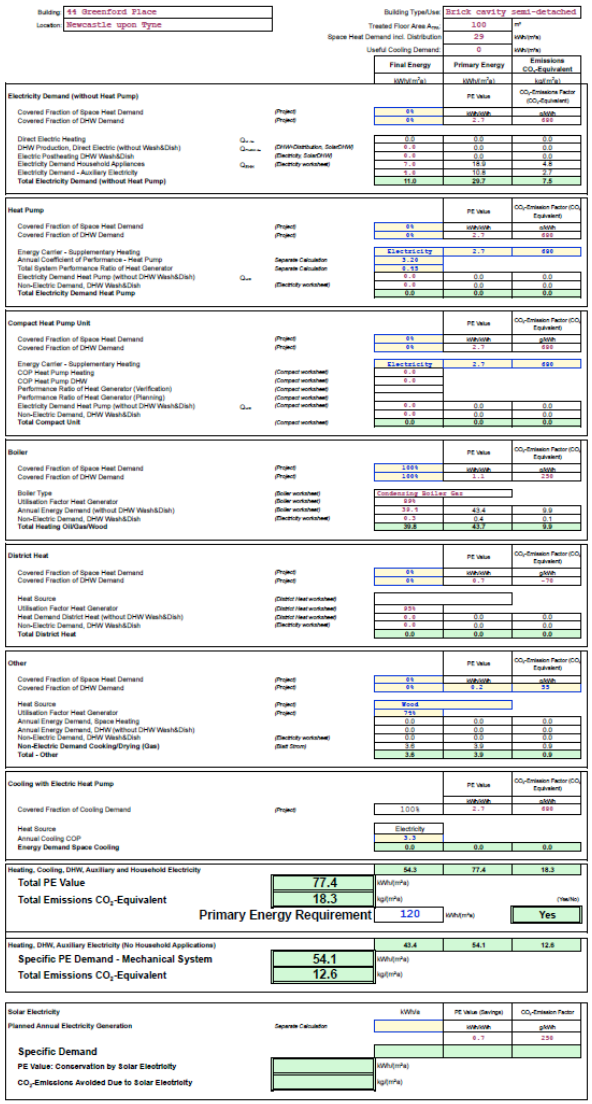




Greenford Road, Pottery Bank
Extracts from PHPP 2007 Summary and SAP Energy Performance Certificate, modelled for the retrofit proposals

Passive House Planning

PRIMARY ENERGY VALUE



Building: 44 Greenford Place
Location: Newcastle upon Tyne
Building Type/Use: Brick cavity semi-detached
Treated Floor Area A_{TFA}: 100 m²
Space Heat Demand Incl. Distribution: 29 kWh/(m²a)
Useful Cooling Demand: 0 kWh/(m²a)

	Final Energy kWh/(m²a)	Primary Energy kWh/(m²a)	Emissions CO_2-Equivalent kg/(m²a)
Electricity Demand (without Heat Pump)			
Covered Fraction of Space Heat Demand (Project)	0%		
Covered Fraction of DHW Demand (Project)	0%		
PE Value		kWh/kWh	g/kWh
CO_2-Emissions Factor (CO_2-Equivalent)		2.7	600
Direct Electric Heating $Q_{H,...}$	0.0	0.0	0.0
DHW Production, Direct Electric (without Wash&Dish) $Q_{W,...}$ (DHW+Distribution, Solar/DHW)	0.0	0.0	0.0
Electric Postheating DHW Wash&Dish (Electricity, Solar/DHW)	0.0	0.0	0.0
Electricity Demand Household Appliances Q_{HHE} (Electricity worksheet)	7.0	18.9	4.8
Electricity Demand - Auxiliary Electricity	5.0	10.8	2.7
Total Electricity Demand (without Heat Pump)	11.0	29.7	7.5
Heat Pump			
Covered Fraction of Space Heat Demand (Project)	0%		
Covered Fraction of DHW Demand (Project)	0%		
PE Value		kWh/kWh	g/kWh
CO_2-Emission Factor (CO_2-Equivalent)		2.7	600
Energy Carrier - Supplementary Heating	Electricity	2.7	600
Annual Coefficient of Performance – Heat Pump (Separate Calculation)	3.20		
Total System Performance Ratio of Heat Generator (Separate Calculation)	0.53		
Electricity Demand Heat Pump (without DHW Wash&Dish) Q_{HP}	0.0	0.0	0.0
Non-Electric Demand, DHW Wash&Dish (Electricity worksheet)	0.0	0.0	0.0
Total Electricity Demand Heat Pump	0.0	0.0	0.0
Compact Heat Pump Unit			
Covered Fraction of Space Heat Demand (Project)	0%		
Covered Fraction of DHW Demand (Project)	0%		
PE Value		kWh/kWh	g/kWh
CO_2-Emission Factor (CO_2-Equivalent)		2.7	600
Energy Carrier - Supplementary Heating	Electricity	2.7	600
COP Heat Pump Heating (Compact worksheet)	0.0		
COP Heat Pump DHW (Compact worksheet)	0.0		
Performance Ratio of Heat Generator (Verification) (Compact worksheet)			
Performance Ratio of Heat Generator (Planning) (Compact worksheet)			
Electricity Demand Heat Pump (without DHW Wash&Dish) Q_{HP} (Compact worksheet)	0.0	0.0	0.0
Non-Electric Demand, DHW Wash&Dish (Compact worksheet)	0.0	0.0	0.0
Total Compact Unit	0.0	0.0	0.0
Boiler			
Covered Fraction of Space Heat Demand (Project)	100%		
Covered Fraction of DHW Demand (Project)	100%		
PE Value		kWh/kWh	g/kWh
CO_2-Emission Factor (CO_2-Equivalent)		1.2	250
Boiler Type (Solar worksheet)	Condensing Boiler Gas		
Utilisation Factor Heat Generator (Solar worksheet)	89%		
Annual Energy Demand (without DHW Wash&Dish) (Solar worksheet)	38.5	43.4	9.9
Non-Electric Demand, DHW Wash&Dish (Electricity worksheet)	0.3	0.4	0.1
Total Heating Oil/Gas/Wood	38.8	43.7	9.9
District Heat			
Covered Fraction of Space Heat Demand (Project)	0%		
Covered Fraction of DHW Demand (Project)	0%		
PE Value		kWh/kWh	g/kWh
CO_2-Emission Factor (CO_2-Equivalent)		0.7	170
Heat Source (District Heat worksheet)			
Utilisation Factor Heat Generator (District Heat worksheet)	95%		
Heat Demand District Heat (without DHW Wash&Dish) (District Heat worksheet)	0.0	0.0	0.0
Non-Electric Demand, DHW Wash&Dish (Electricity worksheet)	0.0	0.0	0.0
Total District Heat	0.0	0.0	0.0
Other			
Covered Fraction of Space Heat Demand (Project)	0%		
Covered Fraction of DHW Demand (Project)	0%		
PE Value		kWh/kWh	g/kWh
CO_2-Emission Factor (CO_2-Equivalent)		6.2	55
Heat Source (Project)	Wood		
Utilisation Factor Heat Generator (Project)	75%		
Annual Energy Demand, Space Heating	0.0	0.0	0.0
Annual Energy Demand, DHW (without DHW Wash&Dish)	0.0	0.0	0.0
Non-Electric Demand, DHW Wash&Dish (Electricity worksheet)	0.0	0.0	0.0
Non-Electric Demand Cooking/Drying (Gas) (Bad Sinus)	3.8	3.9	0.9
Total - Other	3.8	3.9	0.9
Cooling with Electric Heat Pump			
Covered Fraction of Cooling Demand (Project)	100%		
PE Value		kWh/kWh	g/kWh
CO_2-Emission Factor (CO_2-Equivalent)		2.7	600
Heat Source	Electricity		
Annual Cooling COP	3.3		
Energy Demand Space Cooling	0.0	0.0	0.0
Heating, Cooling, DHW, Auxiliary and Household Electricity	54.3	77.4	18.3
Total PE Value	77.4	kWh/(m²a)	
Total Emissions CO_2-Equivalent	18.3	kg/(m²a)	
Primary Energy Requirement	120	kWh/(m²a)	Yes/No: Yes
Heating, DHW, Auxiliary Electricity (No Household Applications)	43.4	54.1	12.8
Specific PE Demand - Mechanical System	54.1	kWh/(m²a)	
Total Emissions CO_2-Equivalent	12.6	kg/(m²a)	

	kWh/a	PE Value (Savings) kWh/kWh	CO_2-Emission Factor g/kWh
Solar Electricity			
Planned Annual Electricity Generation (Separate Calculation)			
PE Value		0.7	250
Specific Demand			
PE Value: Conservation by Solar Electricity		kWh/(m²a)	
CO_2-Emissions Avoided Due to Solar Electricity		kg/(m²a)	

SBRI - End of Phase Report [Project ZA590K - Walker Garden Suburb] Annex

Energy Performance Certificate

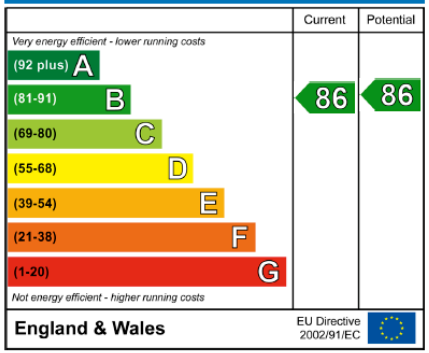
SAP © Crown copyright 2001

Please note that this is a sample Energy Performance Certificate and has not been generated by an Accredited Energy Assessor

Dwelling type:	Semi-detached house
Date of assessment:	22 November 2009
Date of certificate:	23 November 2009
Reference number:	
Type of assessment:	SAP, new dwelling
Total floor area:	99.8 m²

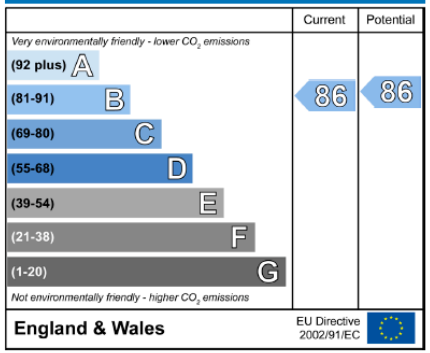
This home's performance is rated in terms of the energy use per square metre of floor area, energy efficiency based on fuel costs and environmental impact based on carbon dioxide (CO_2) emissions.

Energy Efficiency Rating



The energy efficiency rating is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills are likely to be.

Environmental Impact (CO_2) Rating



The environmental impact rating is a measure of a home's impact on the environment in terms of carbon dioxide (CO_2) emissions. The higher the rating the less impact it has on the environment.

Estimated energy use, carbon dioxide (CO_2) emissions and fuel costs of this home

	Current	Potential
Energy use	95 kWh/m² per year	95 kWh/m² per year
Carbon dioxide emissions	1.6 tonnes per year	1.6 tonnes per year
Lighting	£50 per year	£50 per year
Heating	£273 per year	£273 per year
Hot water	£61 per year	£61 per year

Based on standardised assumptions about occupancy, heating patterns and geographical location, the above table provides an indication of how much it will cost to provide lighting, heating and hot water to this home. The fuel costs only take into account the cost of fuel and not any associated service, maintenance or safety inspection. This certificate has been provided for comparative purposes only and enables one home to be compared with another. Always check the date the certificate was issued, because fuel prices can increase over time and energy saving recommendations will evolve.

To see how this home can achieve its potential rating please see the recommended measures.

energy saving recommended
Certification mark

Remember to look for the energy saving recommended logo when buying energy-efficient products. It's a quick and easy way to identify the most energy-efficient products on the market.

For advice on how to take action and to find out about offers available to help make your home more energy efficient, call 0800 512 012 or visit www.energysavingtrust.org.uk/myhome

Newcastle City Council

Greenford Road, Pottery Bank
Extract from SAP Extension worksheet

SAP extension worksheet

name: Greenford

Model the building using any approved version of SAP 9.81
Print out the results to a pdf file and extract the following information into the yellow boxes. The box numbers are shown in the column alongside for easy reference:
Do not model any Low Energy Lighting In SAP, as it is currently limited by regulation; use the extension boxes below.

SAP 9.81 results

	Sap 9.81 box no.s		units
Total Floor Area	5	99.8	m2
Heat loss coefficient	37	130.2	W/K
Additional gains from table 5a	53b	10.0	W
Water heating gains	54	149.0	W
Solar gains	65	346.0	W
Space heating requirement	81	3778	kWh/yr
Heating main kWh/yr	85 or 86*	4445	kWh/yr
fuel		mains gas	
Heating secondary	85a or 87*	0	kWh/yr
fuel		none	
Hot water main	86a or [86a x 90] or 87a	2034	kWh/yr
fuel		mains gas	
Hot water secondary	[86a x 90a] or 87b*	0	kWh/yr
fuel		none	
Pumps & fans	87 or 88*	281	kWh/yr
Renewable energy produced or saved	95 or 95*	Electric standard tariff	kWh/yr
fuel			
Renewable parasitic losses	96 or 96*	0	kWh/yr
fuel		Electric standard tariff	
Mean internal temp	77		C
Annual SAP cost	97		£/yr
SAP	100 or 100*		-
Total SAP CO2/yr	112 or 119*		kg/yr

SAP extension

This sheet extends SAP 9.81 to make a whole house energy model.
It also adjusts SAP to a constant whole house temperature of 21 C and accounts for lower gains from appliances when appropriate
Uses SAP 2005 9.81 emission coefficients

low energy lights proportion	100%= all lighting low energy	100%
low energy appliances proportion	100%= all AA++ appliances	100%
low energy cooking: fuel & saving	100%:= Microwave, induction, AA	100%
low energy cooking fuel		mains gas

calculations

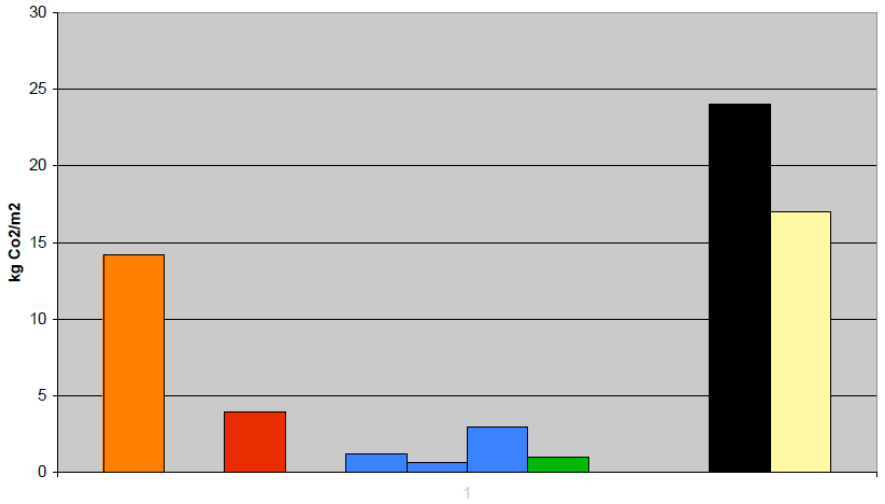
Space heating demand		62	kWh/m2yr
	TOTAL CO2 emissions	2392	kg/yr
CO2/m2/yr			
	Heating 1	14	kg/m2yr
	Heating 2	0	kg/m2yr
	Hot water 1	4	kg/m2yr
	Hot water 2	0	kg/m2yr
	Pumps & fans	1	kg/m2yr
	Lights	1	kg/m2yr
	Appliances	3	kg/m2yr
	Cooking	1	kg/m2yr
	Renewables gains	0	kg/m2yr
	Renewables losses	0	kg/m2yr
	TOTAL Annual CO2 emissions	24	kg/m2yr
	TOTAL Primary Energy	150	kWh/m2yr

savings from a base

base £/yr		£/yr
base CO2 emissions		kg/yr
savings £/yr	-276	£/yr
savings CO2 emissions	-2392	kg/yr

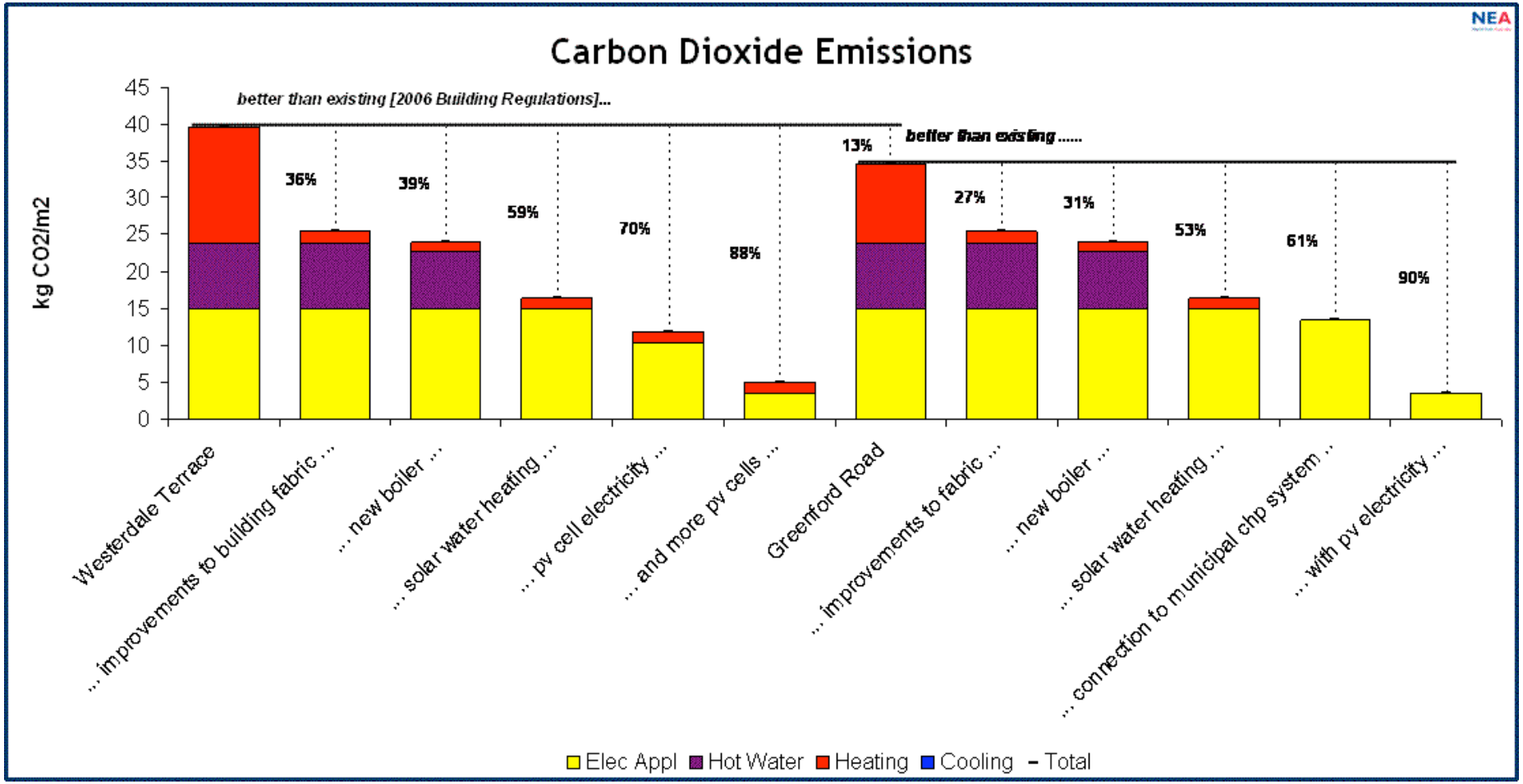
Greenford

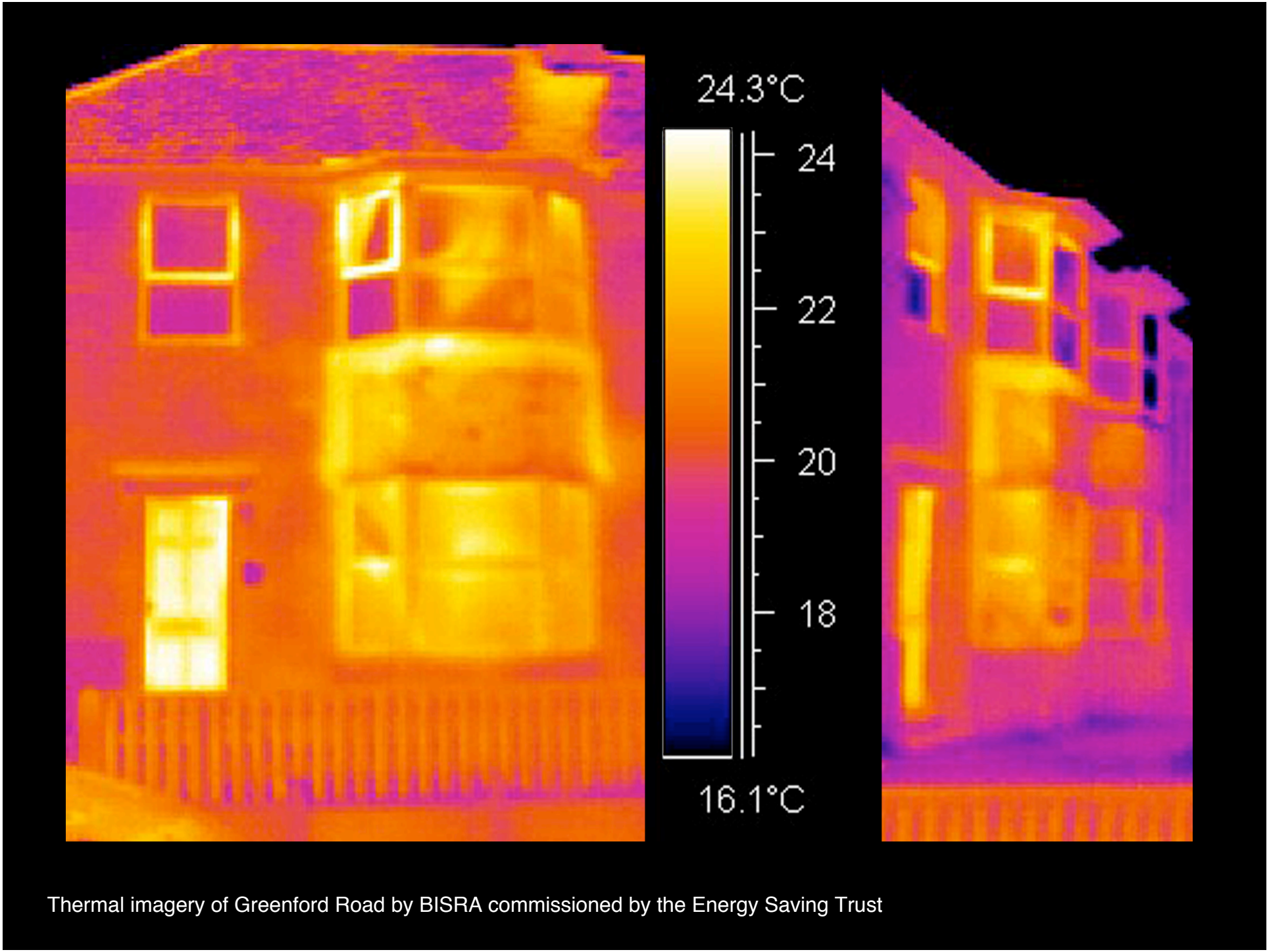
24 kg/m2 TOTAL Annual CO2 emissions



TOTAL Primary Energy 150 kWh/m2yr [cf target 115]

Newcastle City Council


Carbon Dioxide Emissions
NEA
kg CO2/m2
45
40
35
30
25
20
15
10
5
0
better than existing [2006 Building Regulations]...
better than existing .....
36%
39%
59%
70%
88%
13%
27%
31%
53%
61%
90%
Westerdale Terrace
... improvements to building fabric ...
... new boiler ...
... solar water heating ...
... pv cell electricity ...
... and more pv cells ...
Greenford Road
... improvements to fabric ...
... new boiler ...
... solar water heating ...
... connection to municipal chp system ...
... with pv electricity ...
Elec Appl
Hot Water
Heating
Cooling
Total



Thermal imagery of Greenford Road by BISRA commissioned by the Energy Saving Trust


passivebaY


NO SMOKING FOOD OR DRINK

Image: DKS Architects.

Detailed design by DKS Architects & Datum

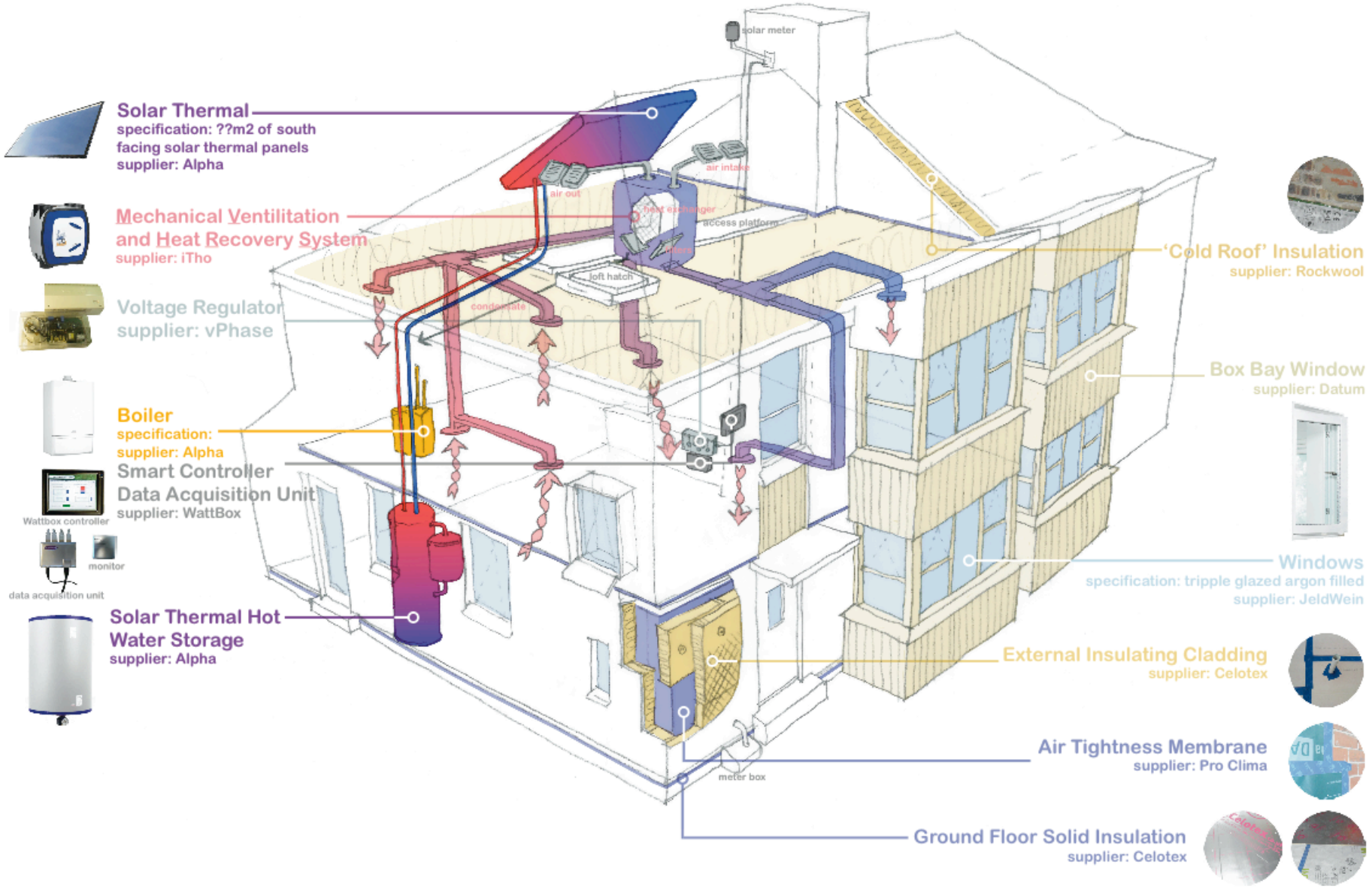
Removal of existing bay window on 44 Greenford Road with external and internal preparation.

Preparation of joints at roof, first floor and ground levels for new bay window.

Window fixing prior to lifting.

The big lift!

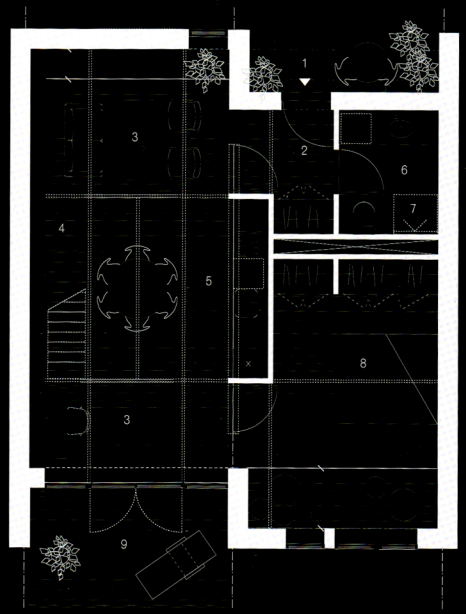
Window fixing prior to lifting.



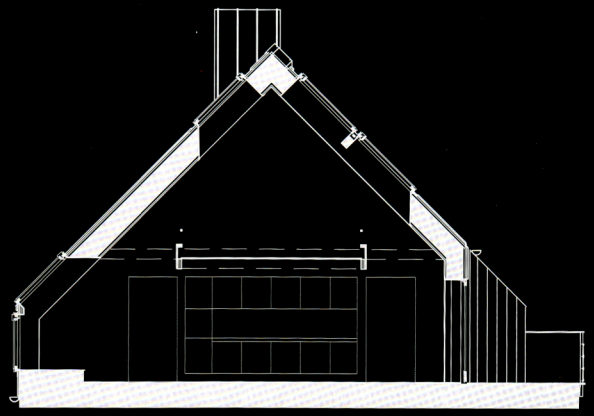
Building user guide summary of ***services*** and ***fabric*** improvements for 44 Greenford Road. Image: Studio UrbanArea LLP

Project Cottesmore, Leicester.

Initial concepts for project Cottesmore, Leicester.



Plan

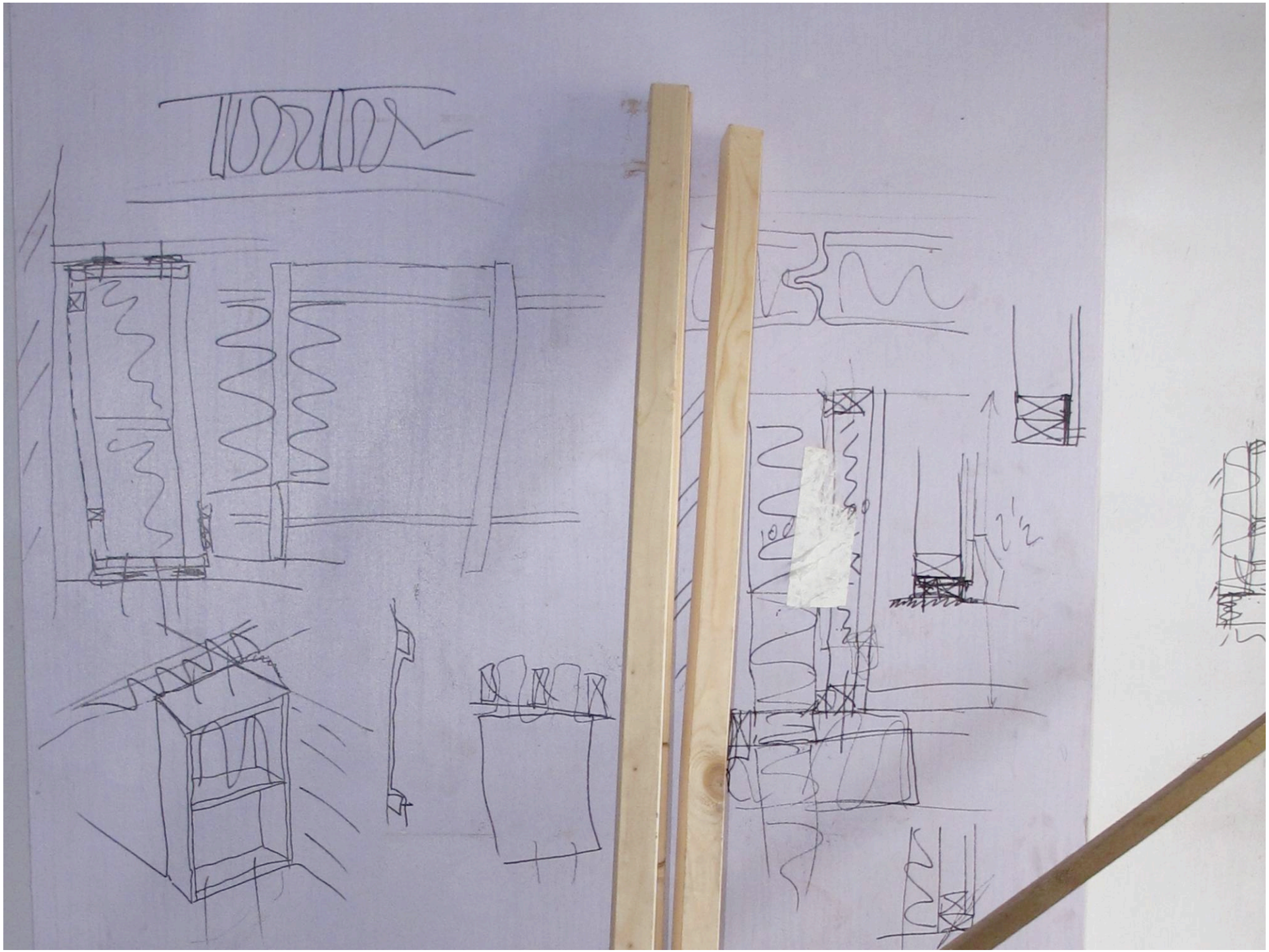


Section looking east

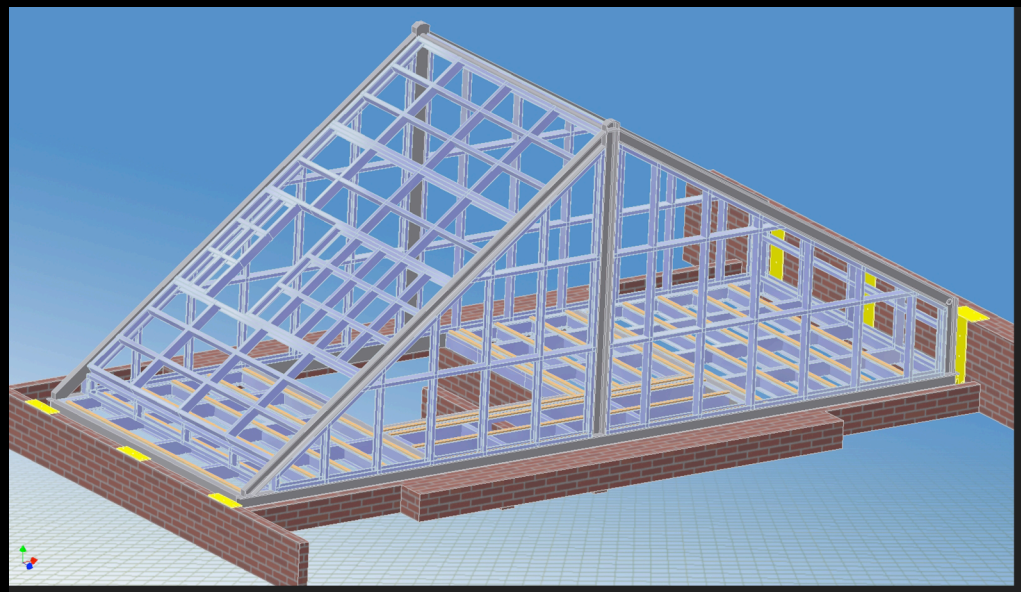
Images of northern European prototype SOLTAG “sun roof”, a prefabricated roof refurbishment solution funded through the European Commission’s 6th Framework in partnership with Velux; from Guzowski, Mary [2010] *Towards Zero Energy Architecture: New Solar Design* [Laurence King, London]. Reported to achieved a primary energy demand of 60 kWh/m2/a that can all be met through solar PV.

59 Cottesmore Road Proposed

Image: East Midlands Housing Association.




RECTICEL
insulation



Roof pod. Images: EnviroHomes & East Midlands Housing Association.


Cleveland Crane Hire
ROLAND HILL LTD
NL57 TKK

Roof pod footing to terrace walls.

Roof pod.

Lessons learnt from *Retrofit for the Future* Competition

Demonstration with prototypes that it can be achieved
Learn by doing
Different internal and external solutions appropriate
Significant economies of scale if approach is rolled out across the estate or the terrace - can be achieved in pepper-potted approach
Change required in industry for new prototypes
On site speed balanced by lead-in time for prototypes - reduced disturbance for occupied properties
Cost benefit has to be considered for design specifications - acceptance of significant cost to meet 80% reduction in carbon emissions
Integrated team & project management delivers best results - but less time on processes and more on detailing
Need to keep monitoring

Thank you

Dr Michael Crilly
Director, Studio UrbanArea LLP

e: michael@urbanarea.co.uk
w: urbanarea.co.uk

Studio UrbanArea LLP
2 King Street, Quayside, Newcastle upon Tyne NE1 3UQ
studio@urbanarea.co.uk www.urbanarea.co.uk