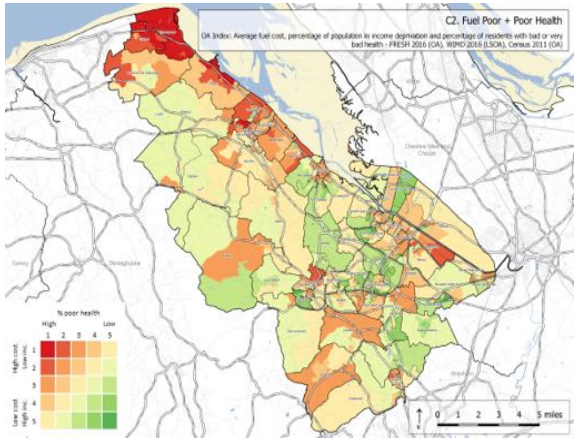
Housing
Developments in New Build and Retrofit

Phil Jones



ERDF
Ewrop & Chymru Buddsoddi yn eich Dyfodol
Europe & Wales: Investing in your Future
European Regional Development Fund

CYMRU GYNNES CWMNI BUDDIANT CYMUNEDOL
warm WALES

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

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21 February 2019

New homes should deliver ultra-high levels of energy efficiency as soon as possible and by 2025

Make all new homes suitable for low-carbon heating

By 2025 at the latest, no new homes should connect to the gas grid. Instead they should have low-carbon heating systems such as heat pumps and low-carbon heat networks.

Statutory requirements should be in place to reduce overheating risk

Improve focus on reducing the whole-life carbon impact of new homes, including embodied and sequestered carbon – Wood

Retrofitting homes to be low carbon and resilient to climate change

EUROPE: *Nearly Zero Energy Buildings (NZEBs)*

- The **Energy Performance of Building Directive (EPBD)** states that Member States shall ensure that new buildings occupied and owned by public authorities are NZEBs after December 31, 2018 and that all new buildings are NZEBs by December 31, 2020.

- A NZEB is a building that ***"has a very high energy performance with the nearly zero or very low amount of energy required covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby***".

- Implemented through **Building Regulations.**

(D'Agostino et al., Synthesis Report on the National Plans for NZEBs; EUR 27804 EN; doi 10.2790/659611)|

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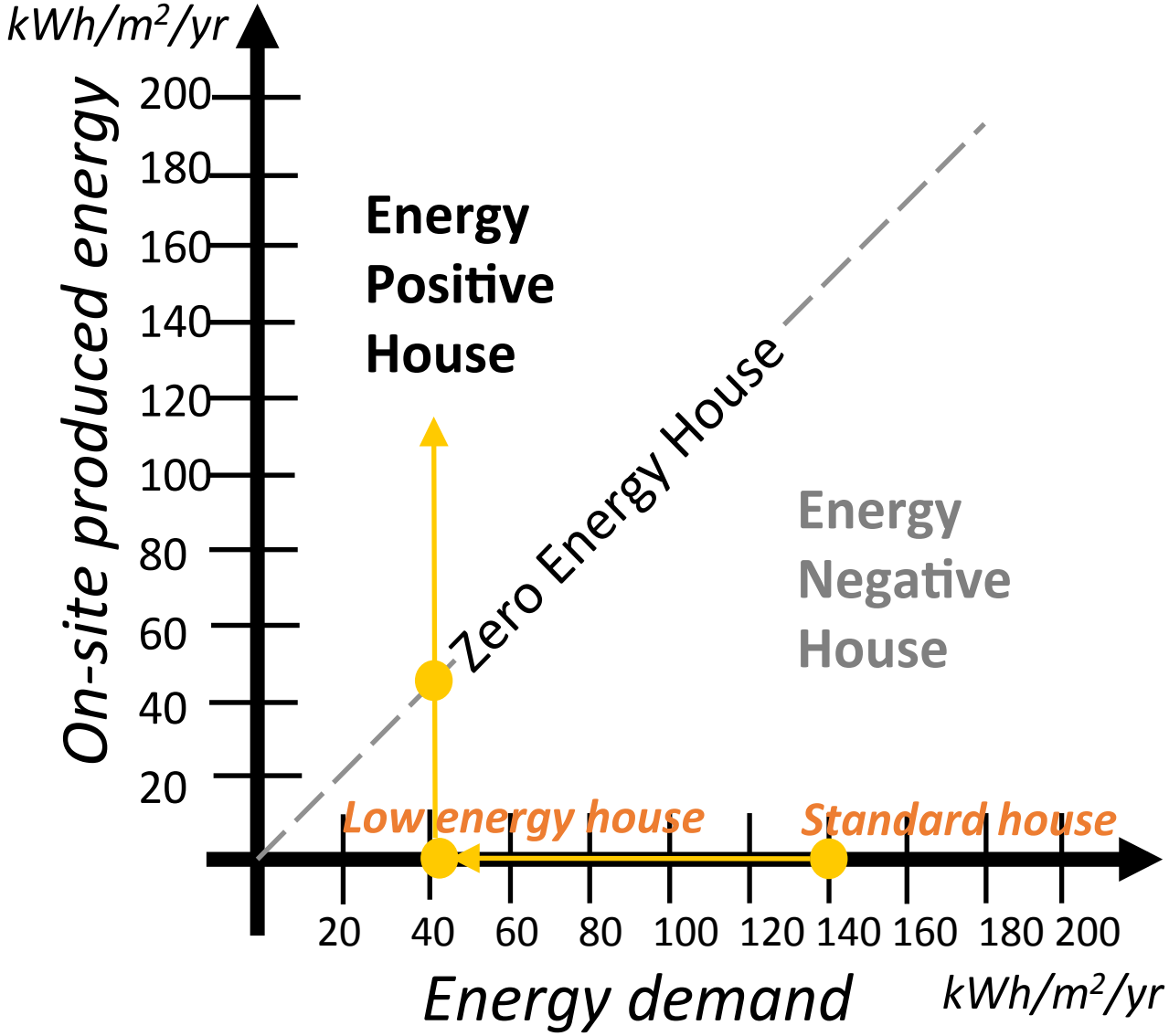
Part L Review

(D'Agostino et al., Synthesis Report on the National Plans for NZEBs; EUR 27804 EN; doi 10.2790/659611)|

NEW BUILD - Performance



USE

- LOW COST

SYSTEMS A

REDU

REN

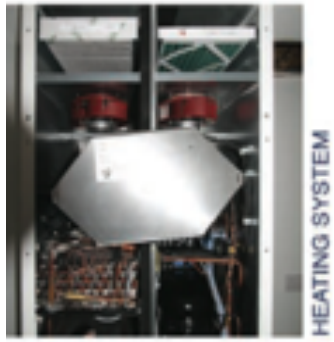
GE

PERFORMANCE
REPLICABILITY
AFFORDABILITY

4.3 KWP PV ROOF

AIR COLLECTOR

6.9 KWh BATTERY



HEATING SYSTEM

hefcw

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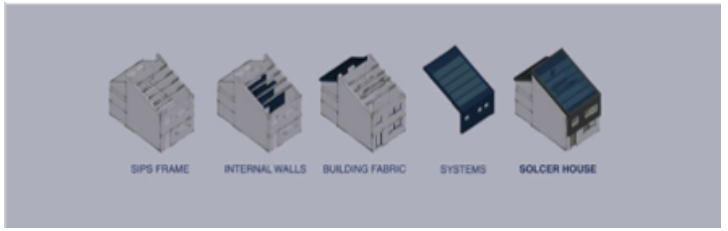
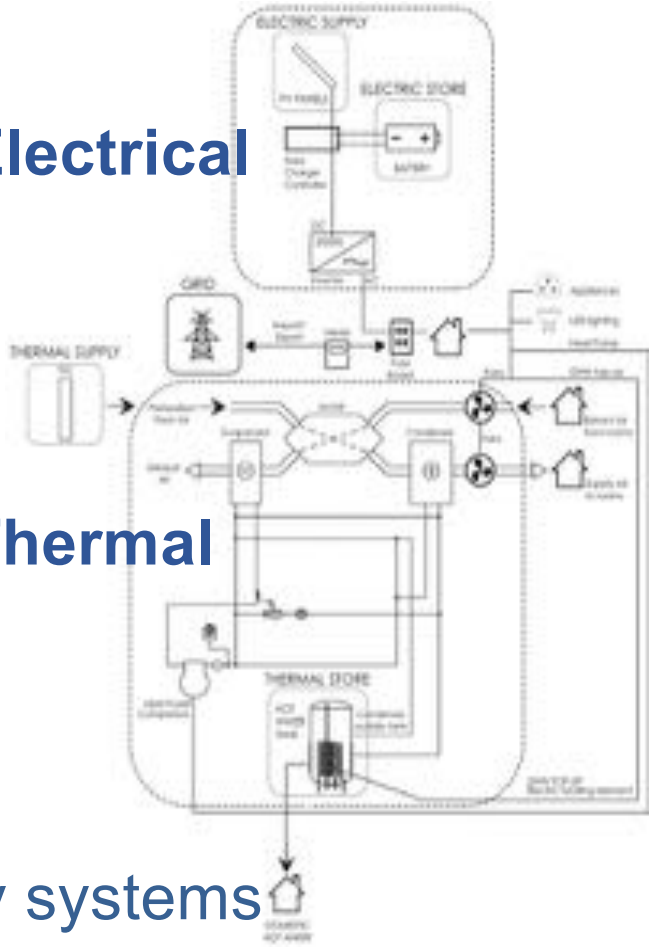
LCRI LOW CARBON RESEARCH INSTITUTE



SYSTEM INTEGRATION

Electrical

Thermal



Technologies:

Thermal and electrical energy systems

Technologies and building design:

Renewable energy systems as construction elements

PV ROOF SYSTEM

Monocrystalline solar cells – Efficiency: cell 22%; Panel 15%

TRANSPIRED SOLAR AIR COLLECTOR

17m^2, temperature uplift up to 30^{o}C

VENTILATION HEATING SYSTEM

GENVEX COMBI

Heat pump

MVHR

Thermal water storage (185l)

BATTERY STORAGE

Lithium-iron phosphate LFP; capacity 6.9kWh

Energy Strategy: Priority to use in the house

- PV electricity used directly
- Charge batteries
- (Heat DHW)
- Export to grid (mainly summer)

SIPS ECO PANEL CONSTRUCTION

High insulation (0.14), airtight, recycled timber, fast construction

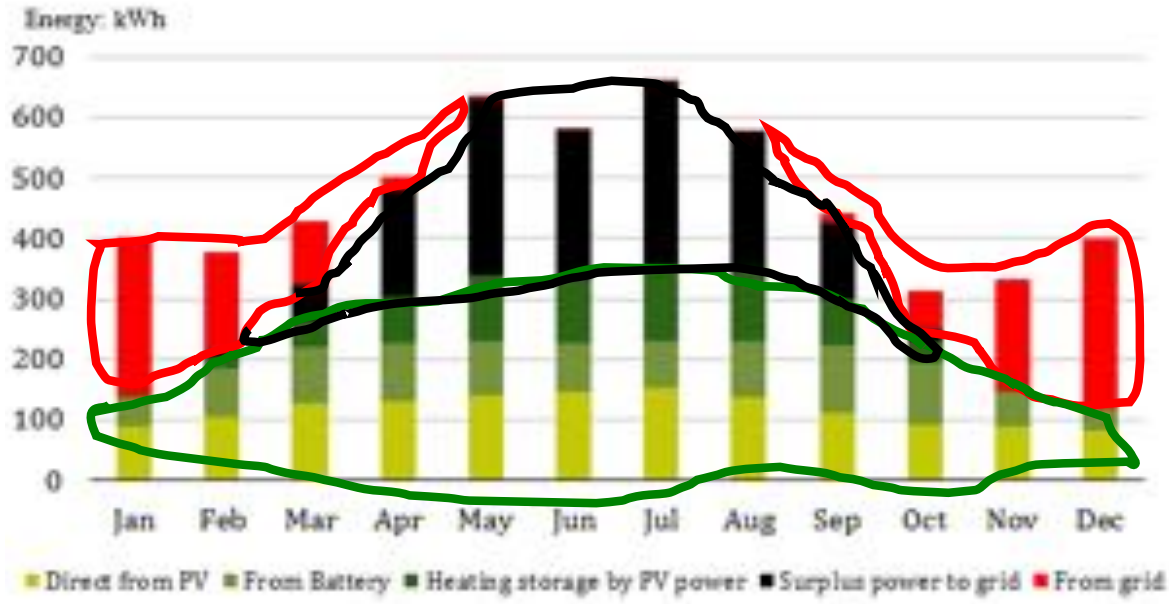
16 weeks construction programme

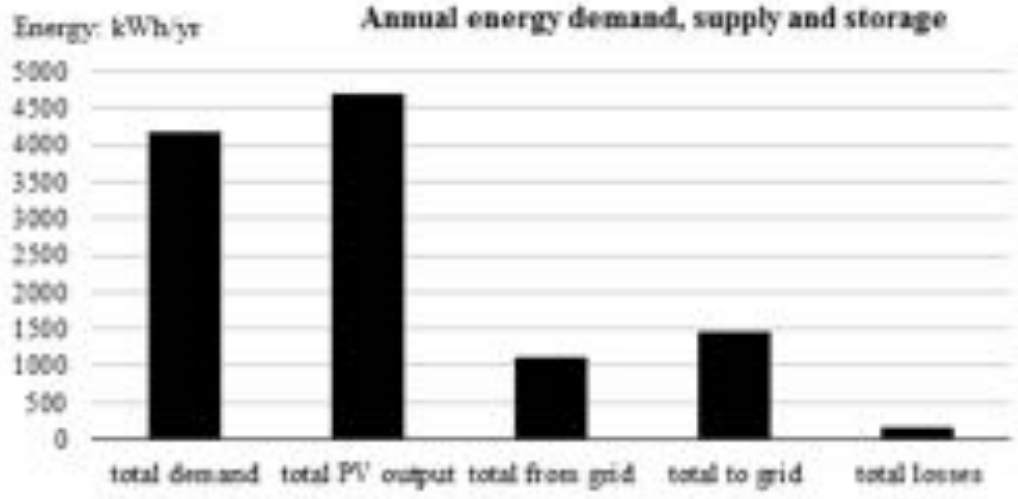
SOLCER: the energy positive house

COSTS £1,300/m²

Typical new house energy costs	£780/year
SOLCER earns	£166/year
Benefit	£946/year

ENERGY POSITIVE PERFORMANCE



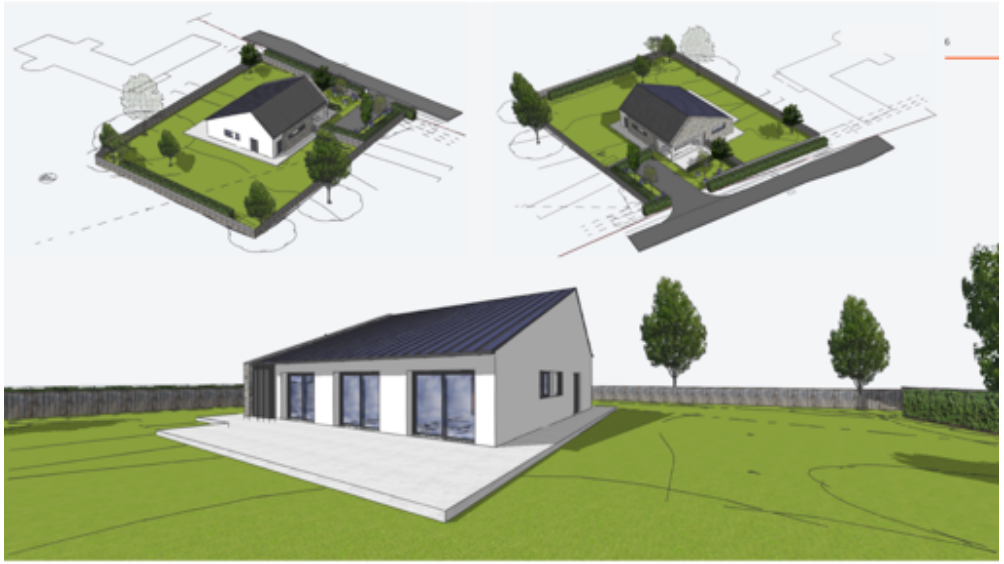


Energy Positive Housing Projects

zenergy design

Bryn Bragl, Bridgend

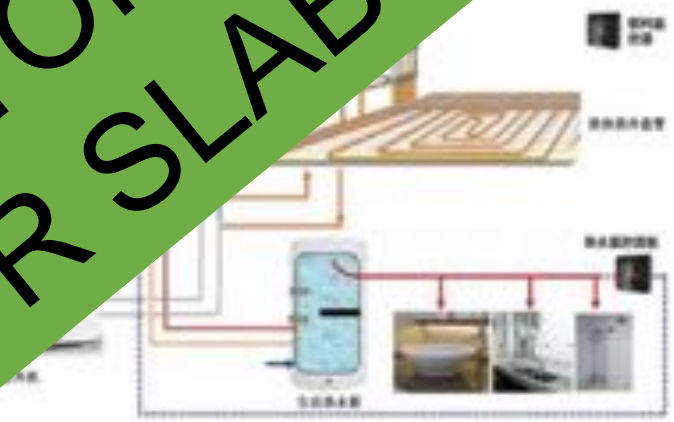
Stone house, The Vale



Gaoling Town, (Xi'an) – 2 houses based on SOLCER

Each house has **4.8kWp PV**; one house has a **1.5kWp** … the roof. The houses use an Air-to-Water **heat pump radiant heatin**… **m**; there is a 200l hot water tank, which recovers heat from the… Zhang PhD project at Cardiff University).

THERMAL STORAGE IN FLOOR SLAB



Retrofitting Housing

Up to 12% of households live in fuel poverty.

Substandard housing estimated to cost the National Health Service £2.5 billion a year.

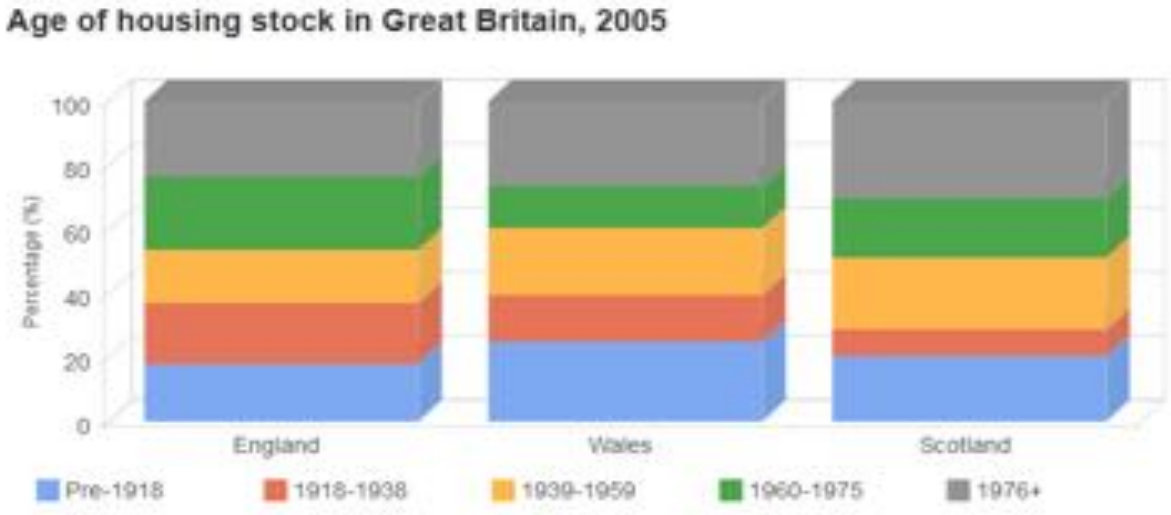
50% of existing buildings have had some energy efficiency measures installed .

Without energy efficiency improvements from 1970 energy consumption would be twice current levels.

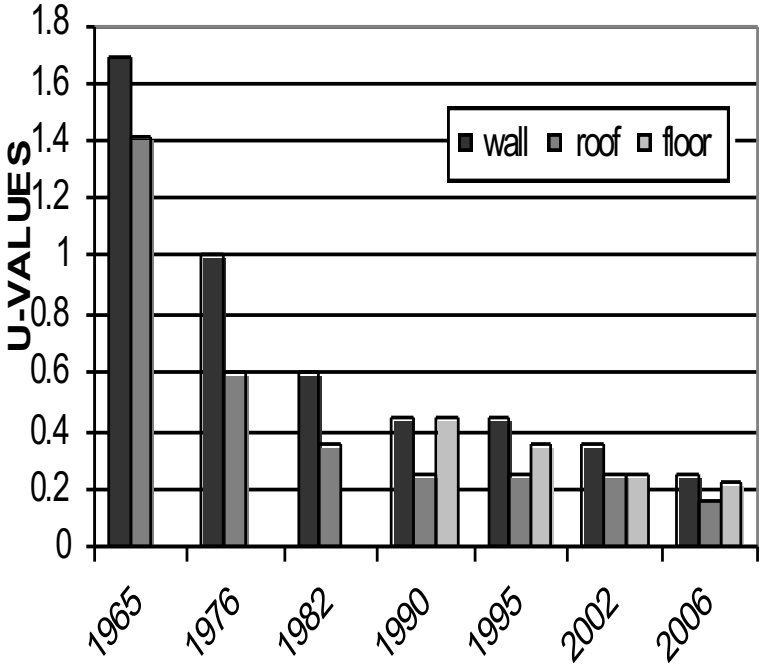
UK housing stock

80% of the homes that will exist in 2050 have already been constructed

New build is less than 0.5% per year.
Demolition less than 0.1% per year.



This graph shows the distribution of housing stock by age in Great Britain in 2005.

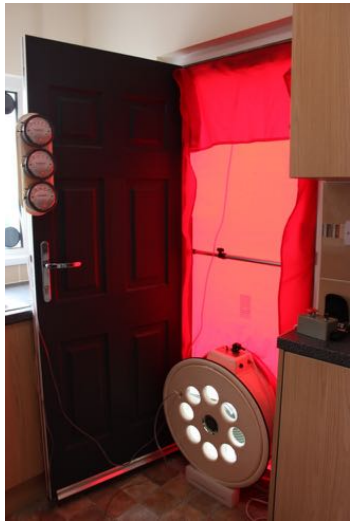


Measures

Wall insulation: External / internal

Reduce air leakage

Mechanical Ventilation Heat Recovery (MVHR)

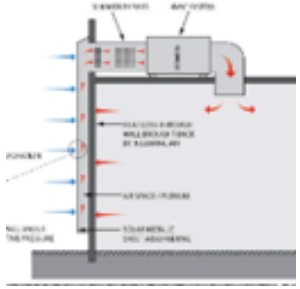


LED lighting

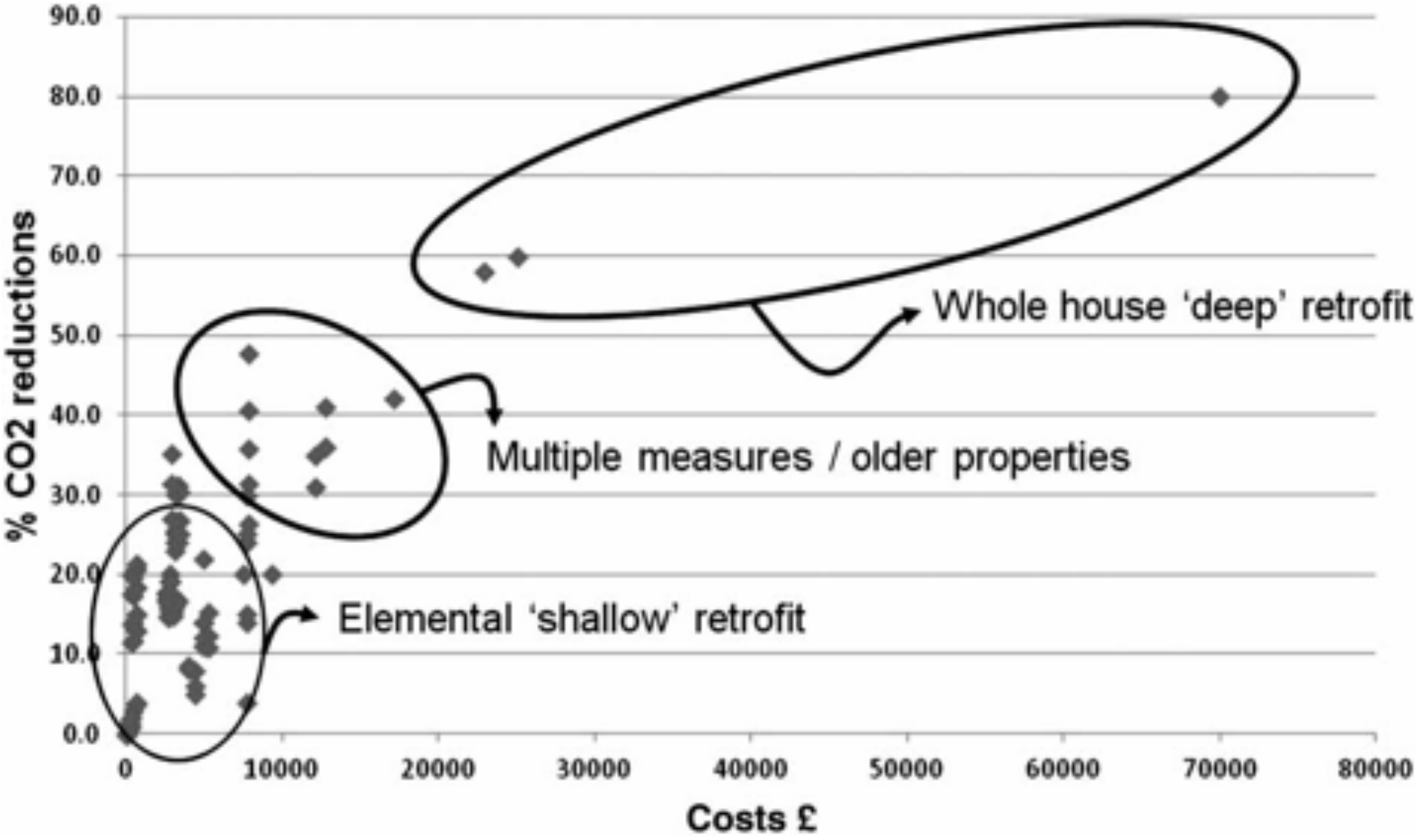
Solar PV: integrated / bolt on

Battery storage

Transpired Solar Collector



Cost versus CO2 emission reductions



Whole House Retrofit (UK Gov. funded)

Retrofit House Newport

Retrofit Measures

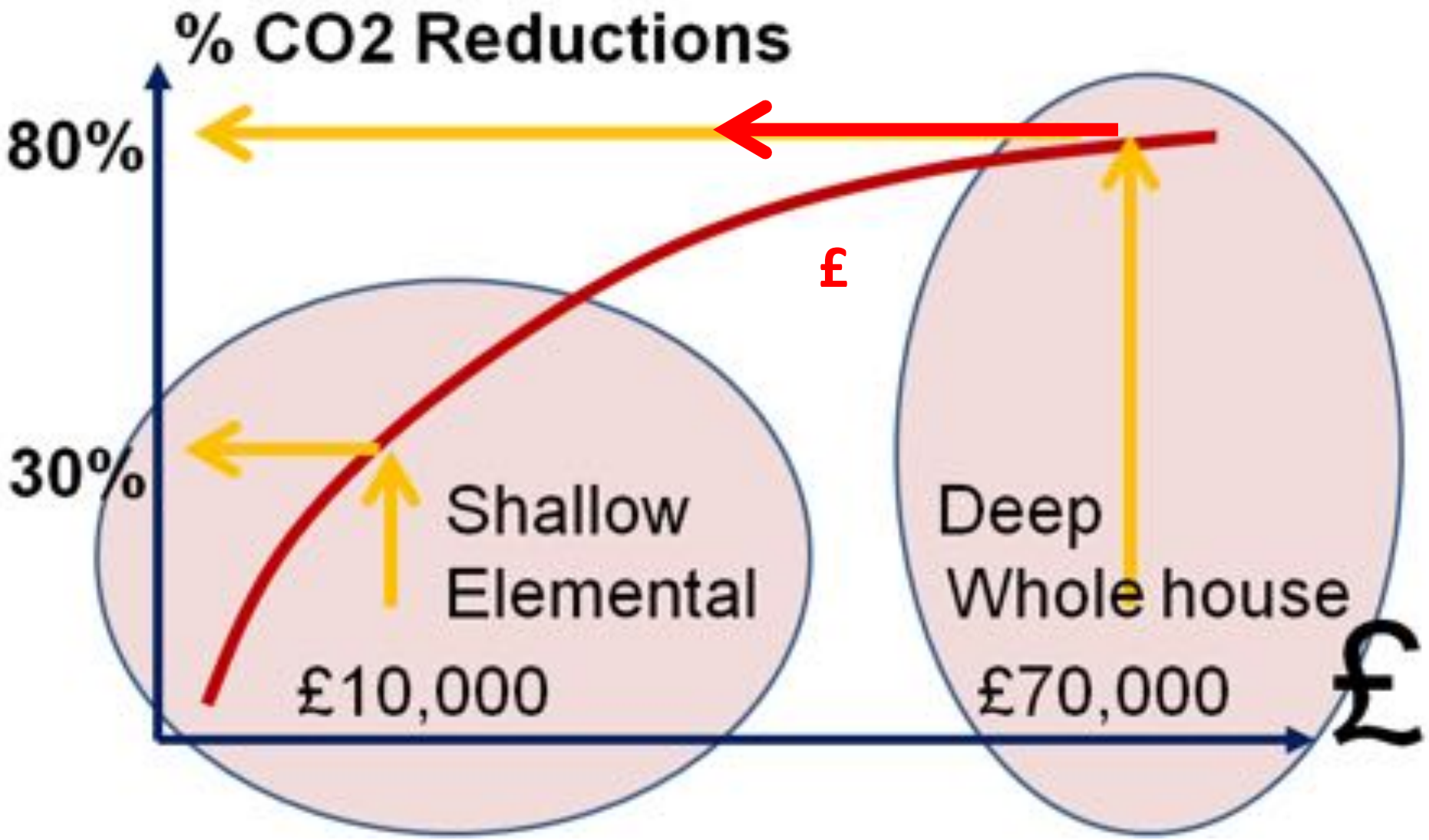
Dry lining insulation on internal walls - U Value 0.19

80% CO2 reductions

£70,000

- Solar thermal evacuated tube collectors (2.88m2)
- MVHR ventilation system.
- 2KWhp Photovoltaic panels.

Elemental versus whole house



SOLCER low carbon Retrofits (2015)

Before retrofit

Whole House Deep Retrofits





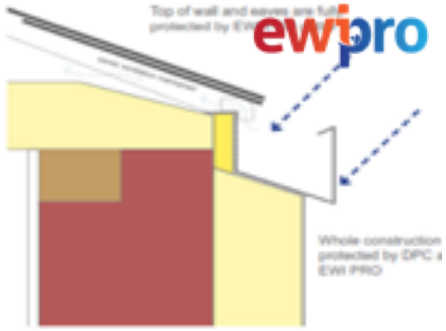
PV roof

Batteries

MVHR

EWI

Details

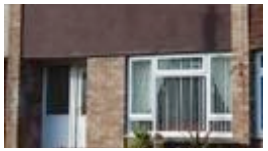


Before retrofit





Energy savings £450/year
(on an average energy bill £1000/year)
Cost of whole house retrofit ~ £25,000


A summary of performance optimisation through domestic retrofit

	Retrofit 1	Retrofit 2	Retrofit 3	Retrofit 4	Retrofit 5
Reduction of electricity imported from the grid	37%	41%	79%	72%	84%
Gas reduction	56%	23%	0	35%	6%
CO_2 reduction	64%	49%	54%	74%	61%
Cost savings	62%	52%	85%	81%	84%

Retrofit Example

Retrofit Example

Building Integrated PV

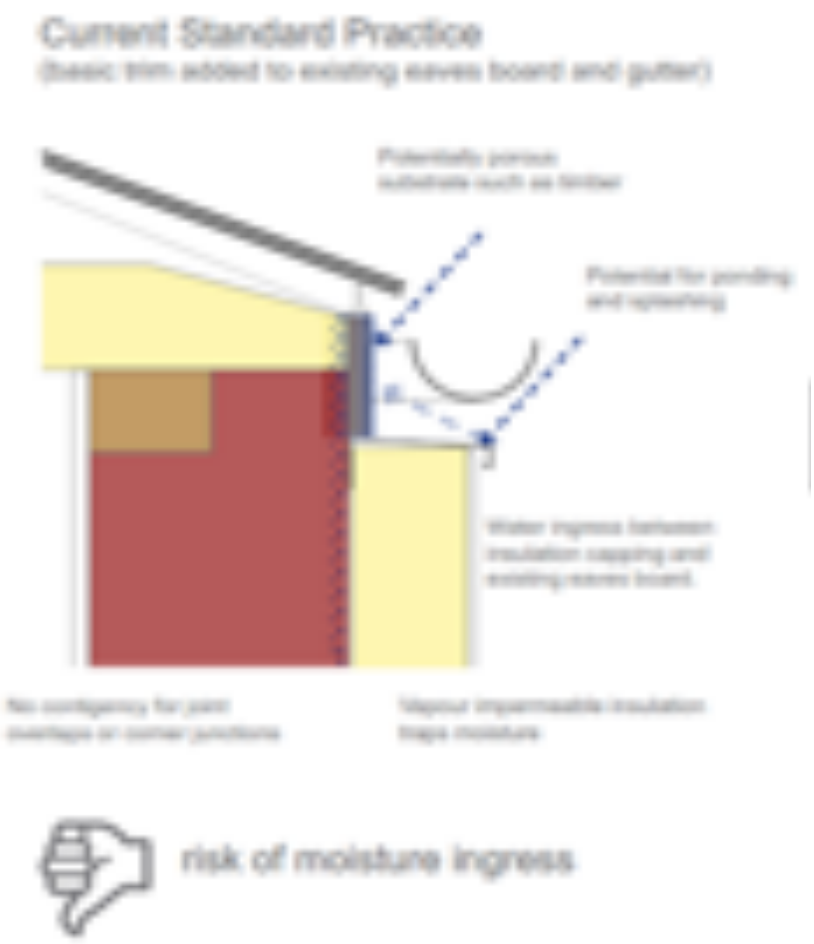
Roof tiles not required

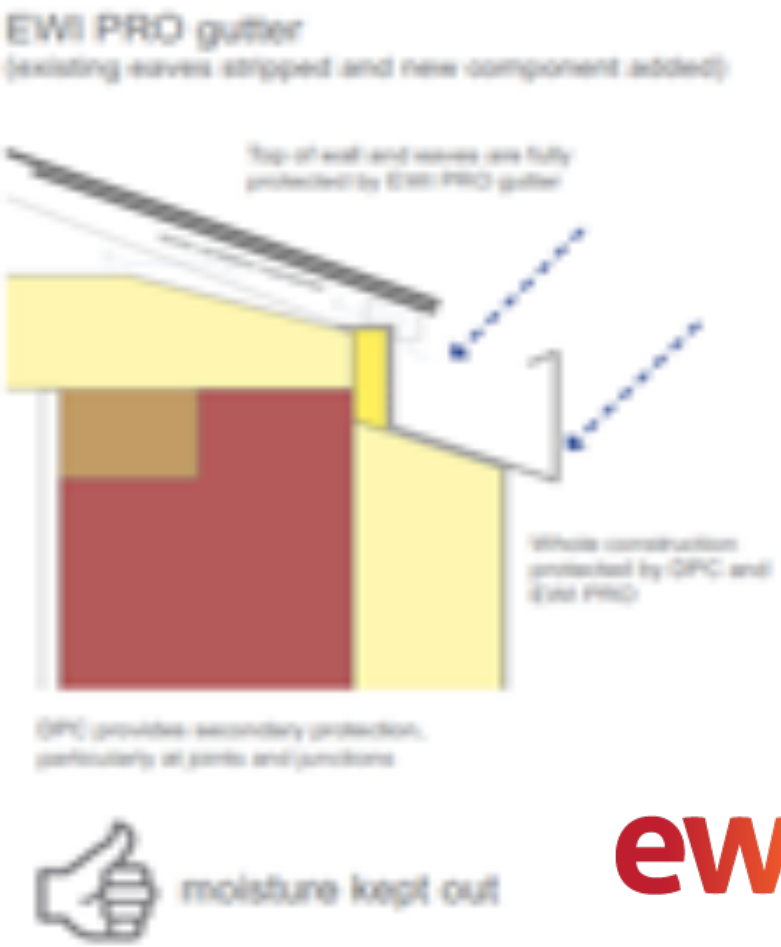
Retrofit Example

Detail – implementation of improved technologies

Aerogel at window reveals – reduces cold bridging around windows

Retrofit Example





Retrofit Example

enviroVent
Because Air Matters

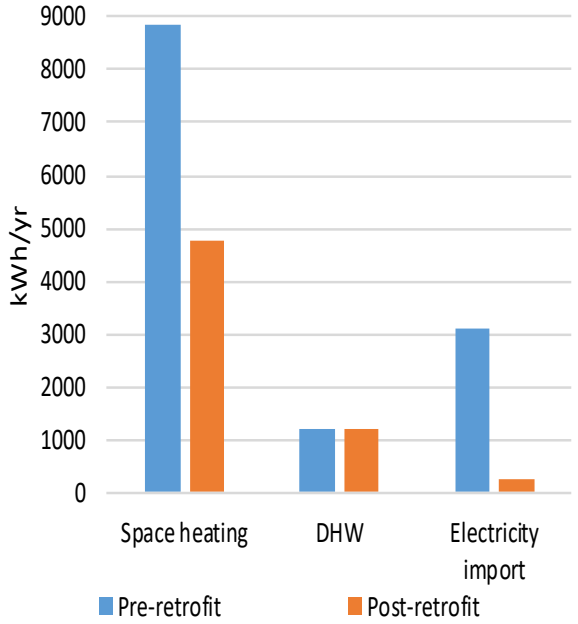
Retrofit Example

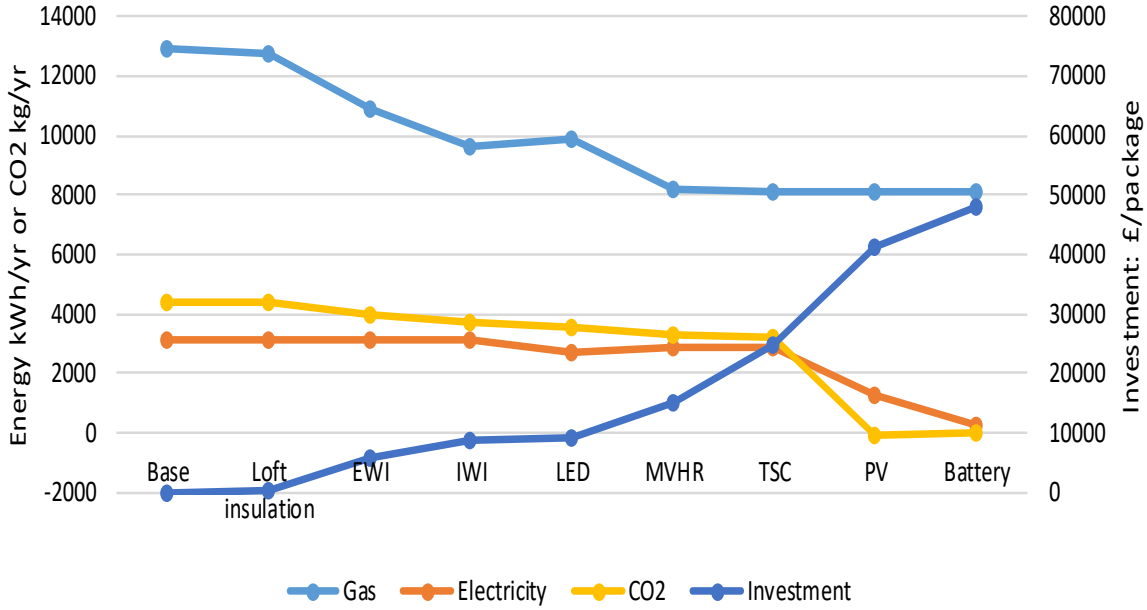
Recovering voids back into the housing stock

Improved housing condition and neighbourhoods

SPECIFIC Whole house ‘deep’ retrofit (2018)

A summary of the simulation results





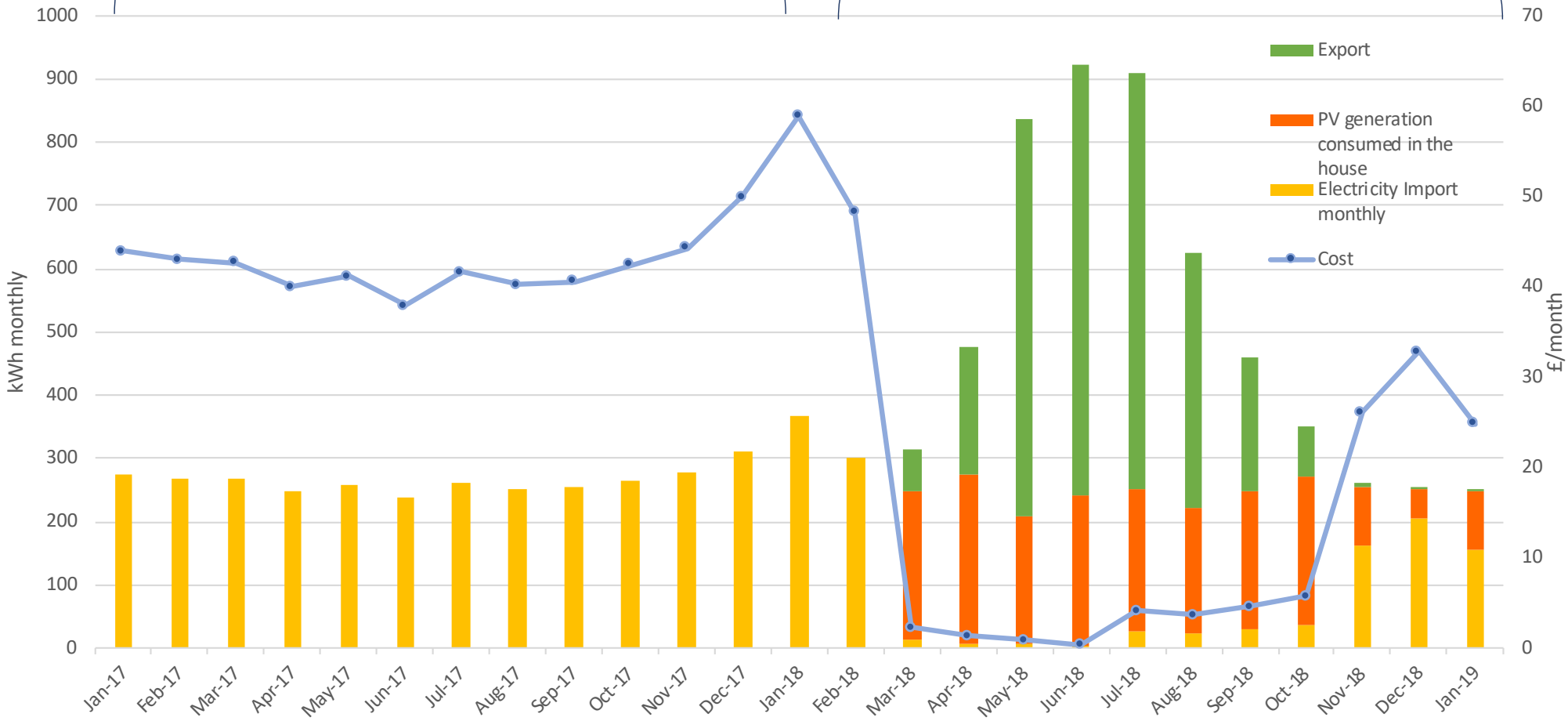
cases	Heating	DHW	Gas consumption	Electricity import	Electricity export	Operating energy cost		Total CO2 emission		electricity self-sufficient ratio	Package cost	Retrofit package payback time	Single component payback time
Base Case	8859	1185	12911	3106	0	913		4401		0	0		
340mm loft insulation	8741	1185	12773	3106	0	908	-0.5%	4371	-0.7%	0	364	75	75
90mm EWI on side and rear walls	7187	1185	10944	3106	0	845	-7.5%	3976	-9.7%	0	5934	87	88
Kooltherm k118 IWI system on the front wall	6081	1185	9643	3106	0	799	-12.5%	3695	-16.0%	0	8798	77	63
with LED lighting	6271	1185	9867	2734	0	758	-17.0%	3550	-19.3%	0	8998	58	5
with MVHR: 90m3/hr flow rate	4826	1185	8167	2865	0	716	-21.6%	3251	-26.1%	0	14971	76	143
With TSC: 4m^2 on the gable	4756	1185	8084	2865	0	713	-21.9%	3233	-26.5%	0	24844	124	3445
with PV on both roofs	4756	1185	8084	1285	4796	505	-44.7%	-76	-101.7%	55.10%	41098	79	36
With Tesla battery (13.5kWh)	4756	1185	8084	276	3694	372	-59.3%	-28	-100.6%	90.40%	48000	73	52

Whole house ‘deep’ retrofit – results

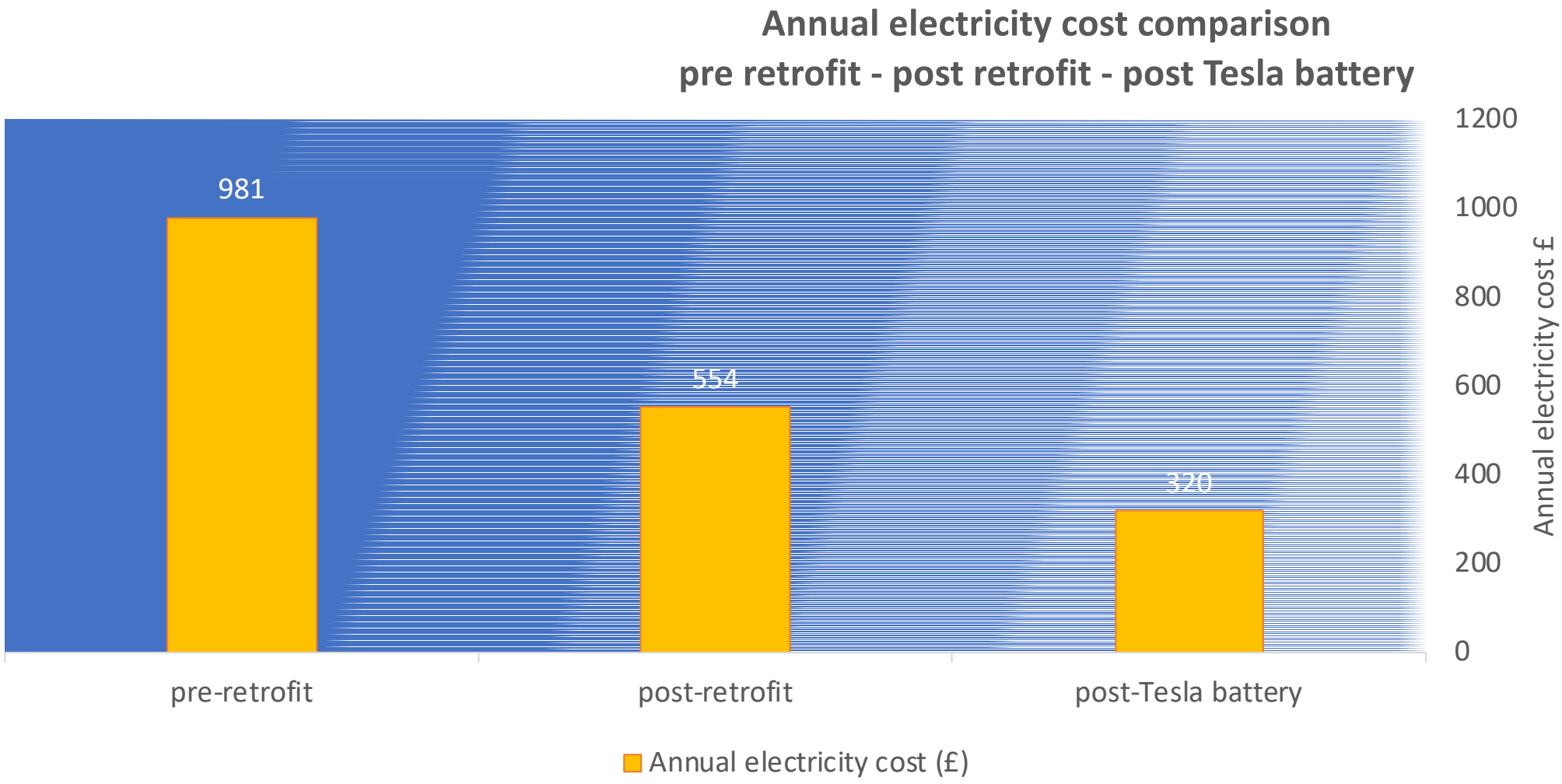
PV generation and electricity import

Annual electricity cost before : £522

Annual electricity cost after : £155

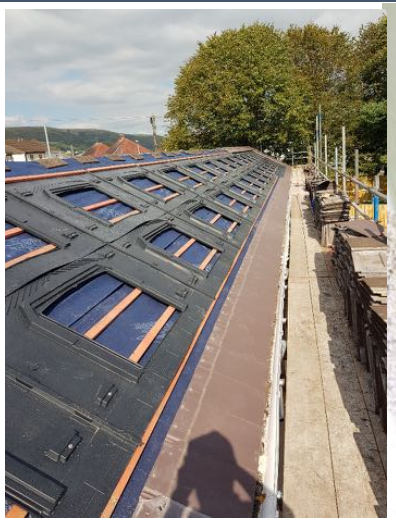


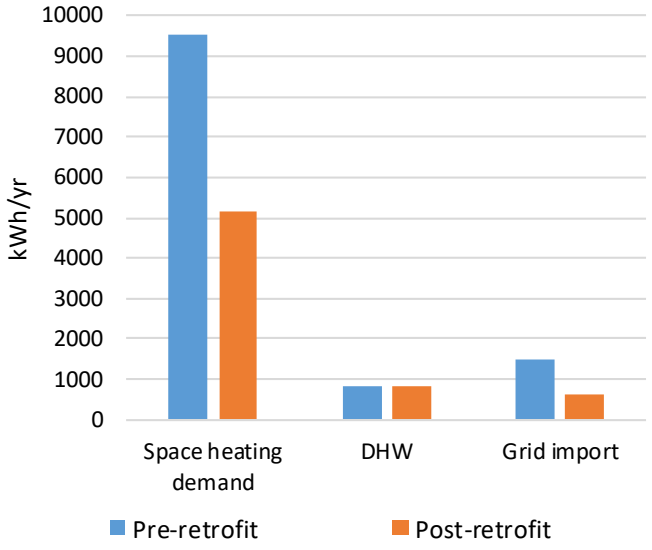
Reduction in energy costs

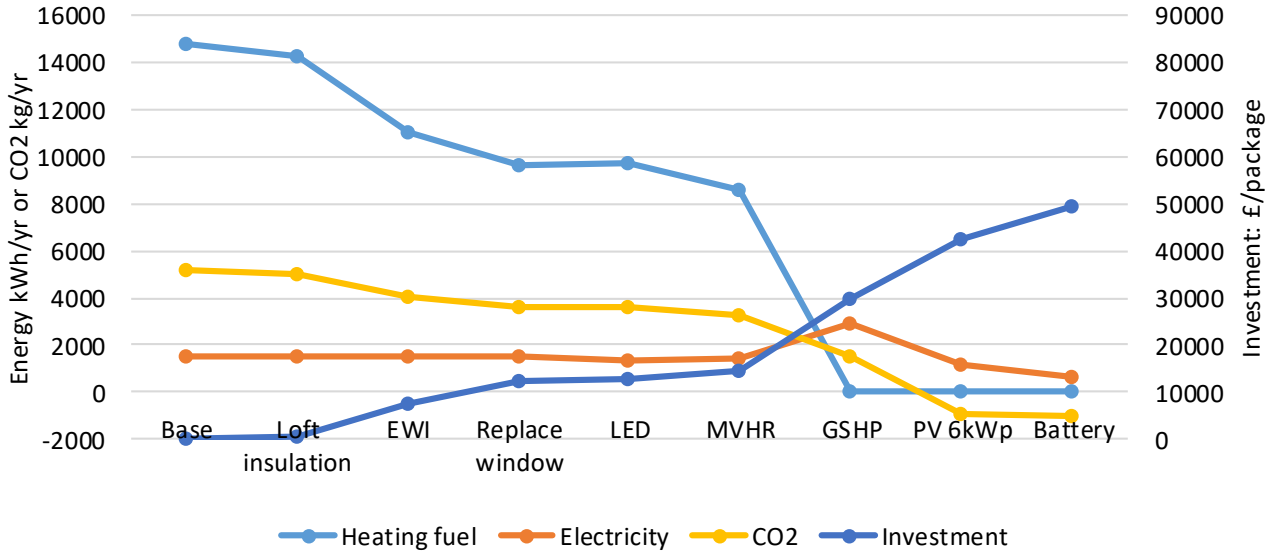


6 off gas bungalows: Swansea







Results from retrofits

- Cost - £23,000 to £50,000
- Electric savings - 30% to 85%
- Gas savings 0% to 60%
- CO_2 reductions 50 -75%

Plan – Design – Construct – Operate – Maintain

Multiple benefits

B[illegible]s

- Health
- Comfort
- Energy savings

Multiple Benefits of Energy Retrofits

Job creation - 22 jobs / £1M spent.

Increased house value.

Reduces fuel pover

Every £ ducing fuel poverty reduces h by 42P.

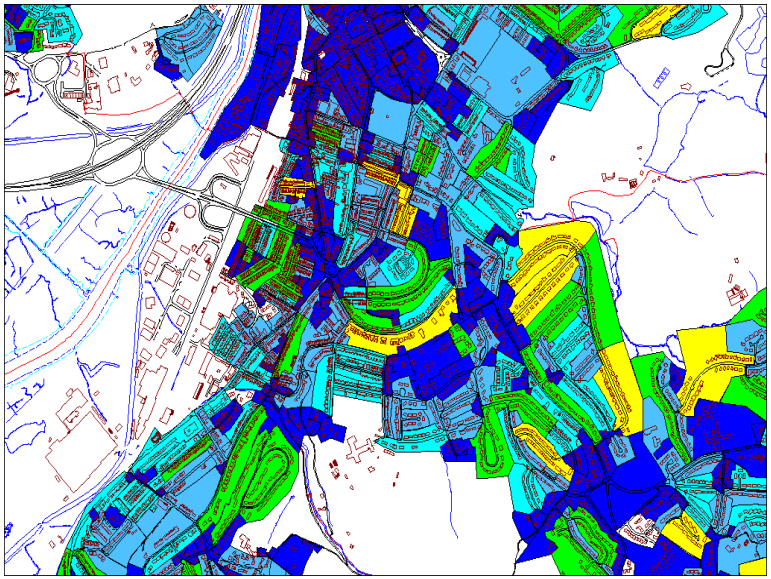
Social value of £1 investment in energy retrofits yields a return of £4.

NEED MORE INCLUSIVE COST MODELS

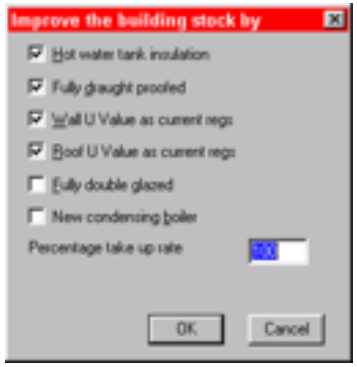
Mapping energy use and potential savings

EEP

Energy and
Environmental
Prediction
Model



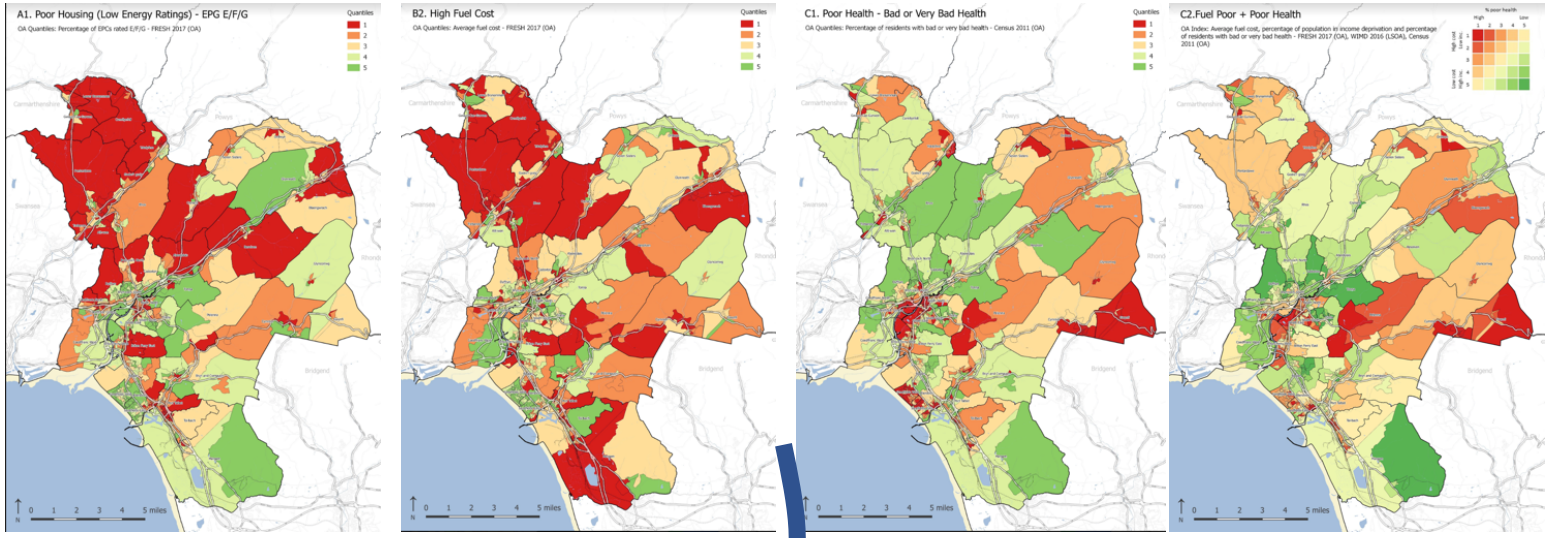
Planning tool for local authorities



FRESH Mapping Housing, Income and Health

Identify vulnerable households

- EPC data and valuation office used to map out SAP rating, energy use and fuel cost.
- Census data (REF), provides information on income, disability, tenure and priority services area.
- Maps can be layered and combined.



WARM WALES
CYMRU GYNNES

Energy Champions (WWU)

FRESH – Community Energy Champions

For Everyone:	
Energy saving advice	Tariff switching advice
Smart meter advice	Carbon Monoxide awareness
Benefit Entitlement Check	Fire safety & smoke alarm advice

Criteria Dependent (Vulnerable, Key Benefits, Age, Poor Health):	
Carbon Monoxide detector	Priority Services Register
Slips, Trips & Falls assessment	Community Alarm, Key safe
Debt Management	Fuel Debt Assistance
Free Gas Connection	Water Tariff discounts/rebates
Cooker locking valve	Nest/Boiler replacement referral
Home Insulation & heating	Home Insulation (LA)

- CECs provide advice and support and make relevant partner organisation referrals
- The referrals are monitored and all outcomes logged for reference/evidence.

Project Savings to end Oct 2019:

Project to date:

Area	Savings £	No. households	Av Sav
South Wales	£644,223	1066	£604.34
North Wales	£535,583	667	£802.97
Cornwall	£314,311	414	£759.21
Severn Wye	£14,384	72	£199.78
Totals:	**£1,508,501**	**2,219**	**£679.81**

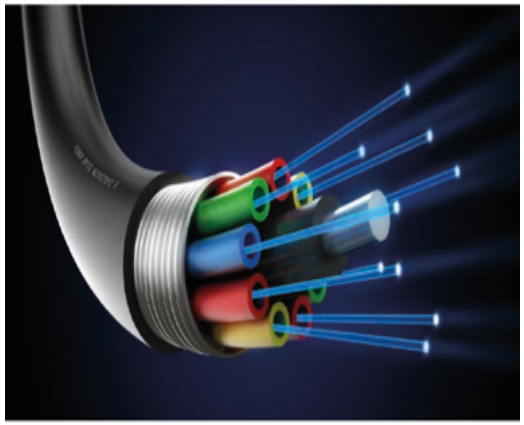
Mrs C is aged 85 has lived alone since being widowed less than a year ago. Mrs C is mostly housebound as she can barely walk, she suffers from osteoporosis and heart problems and feels the cold and was struggling with her bills. Our CEC put her onto the Welsh Water HelpU tariff, saving £484.63 a year and she also received a rebate of £146.63. (Total £631.26 actual savings).

HOUSING: Scale up SOLCER

The City Region has adopted a stepped approach model for delivering SOLCER standards at scale and magnitude.

DINAS-RANBARTH Bae Abertawe Swansea Bay CITY REGION

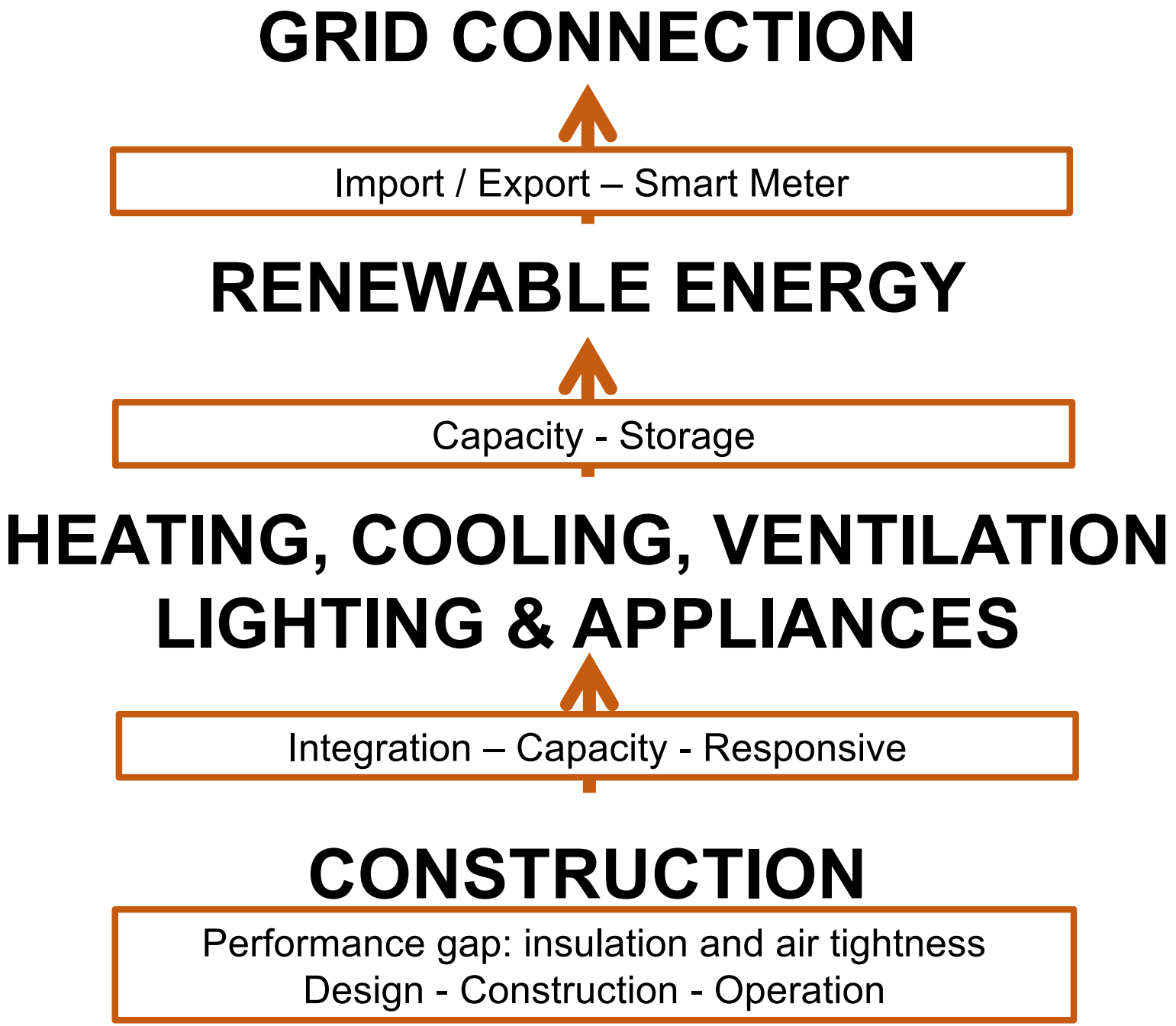
Swansea Bay City Region:
A City Deal 2016-2035



THE INTERNET COAST

- Regional Programme across the four SBCR Local Authorities
- Structured and co-ordinated rollout of smart energy positive healthy homes, assisting to deliver regional and national carbon reduction targets.

SUMMARY


GRID CONNECTION
Import / Export – Smart Meter
RENEWABLE ENERGY
Capacity - Storage
HEATING, COOLING, VENTILATION
LIGHTING & APPLIANCES
Integration – Capacity - Responsive
CONSTRUCTION
Performance gap: insulation and air tightness
Design - Construction - Operation

THE WAY FORWARD

Develop technical solutions

New build and retrofit - combined solution

Cost – New Build / Retrofit

Skills and Quality

Supply chains – industry needs to keep up

MULTIPLE BENEFITS

Process: Commissioning – Operation & Maintenance

Building Regulations – Part L

THANKS

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Dr Jo Patterson
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