Reinventing retrofit

How to scale up home energy efficiency in the UK

green alliance...

European Union
European Regional Development Fund

This report is funded by the Zero Energy Buildings Catalyst (ZEBCat) project, supported by the European Regional Development Fund and being led by Devon County Council from 2017 to 2020. It is demonstrating the Dutch Energiesprong approach to retrofitting 15 homes and one office building in Devon and supporting supply chain businesses.

The project aims to build a growing market for net zero energy retrofit and new build, driving innovation and investment leading to cost reduction. This report examines how the Energiesprong approach could be scaled up to help meet the UK's legally binding carbon emission reductions.

ZEBCat project partners:

European Union
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Devon County Council

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Introduction

The UK has the least energy efficient housing stock in Europe. This means high energy bills and, for the poorest, a stark choice between heating or eating. It is estimated that more than 3,000 people die every year due to the cold, unable to afford warm homes. Heating our homes is also a major source of carbon emissions.

To meet its climate targets, the UK has an ambition to retrofit all homes to EPC band C standard by 2035. But only 29 per cent of homes today meet this standard, and the UK's current policy approach is nowhere near ambitious enough to tackle the remaining 71 per cent. In fact, energy efficiency improvements have stalled, measures are expensive, industry is underinvesting and householders still find retrofits a major hassle.

In the power sector, where the UK has rapidly decarbonised, new technology, supported by policy, has made carbon reductions cheap and technically straightforward. Wind power, for example, is now the cheapest form of electricity generation, and provides one sixth of UK power, up from two per cent in less than a decade.

Now, a similar transformation is needed in the domestic buildings sector.

A new approach to retrofit known as Energiesprong (energy leap), which is already successful in the Netherlands, could provide this transformation. This 'whole house' model of retrofit creates a net zero energy home in one step using new technology. It has the potential to almost eliminate the carbon emissions of 41 per cent of UK housing stock, at the same time as providing warm, comfortable homes for many more people.

The Energiesprong approach could contribute to solving one of the UK's major energy challenges by:

- using new technology to permanently lower the cost of retrofits, removing the need for subsidies;
- providing a low hassle option for householders: retrofits by this method can be installed in as little as a day;
- offering a large scale heat solution for the UK;
- stimulating innovation in the construction sector to raise productivity.

We think the potential of this approach to decarbonise the UK buildings sector cost effectively is so significant that it is worth trialling at scale in the UK.

Why the UK needs a new approach to home energy efficiency

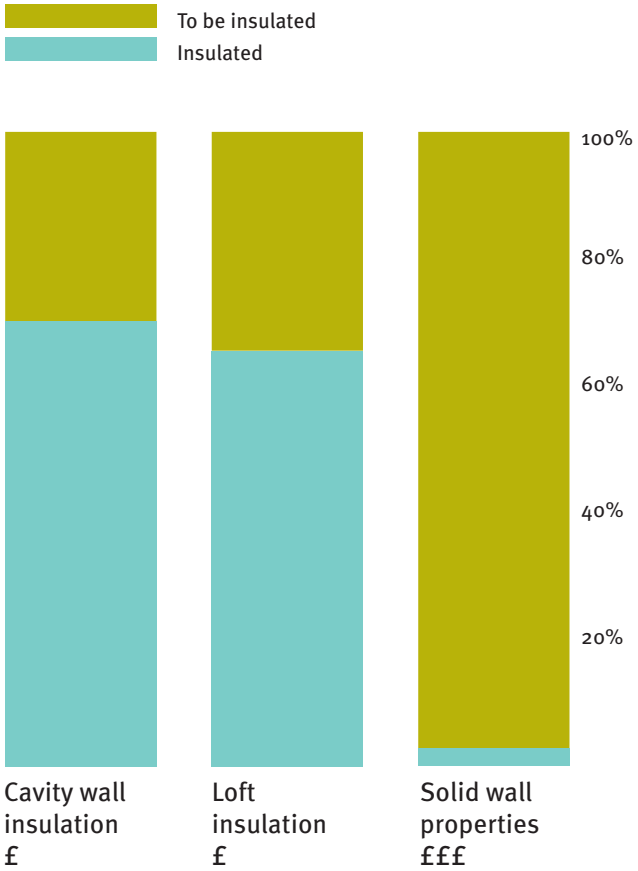
Cheap energy efficiency measures are running out

The UK's main efficiency scheme, the Energy Company Obligation (ECO), and its predecessor schemes CERT and CESP, have targeted low cost measures, such as cavity wall and loft insulation.

As these measures have been installed and the number of households able to benefit from them shrinks, harder to treat homes needing more expensive improvements are now the majority. Already, the rate of efficiency installations has fallen during ECO compared to its predecessor schemes, as easy to treat homes have been dealt with and costs have risen. The National Audit Office has estimated that, from 2013 to 2015, the carbon savings from ECO cost £94 per tonne to deliver, compared to £34 per tonne for CERT and CESP (which ran from 2008 to 2013).

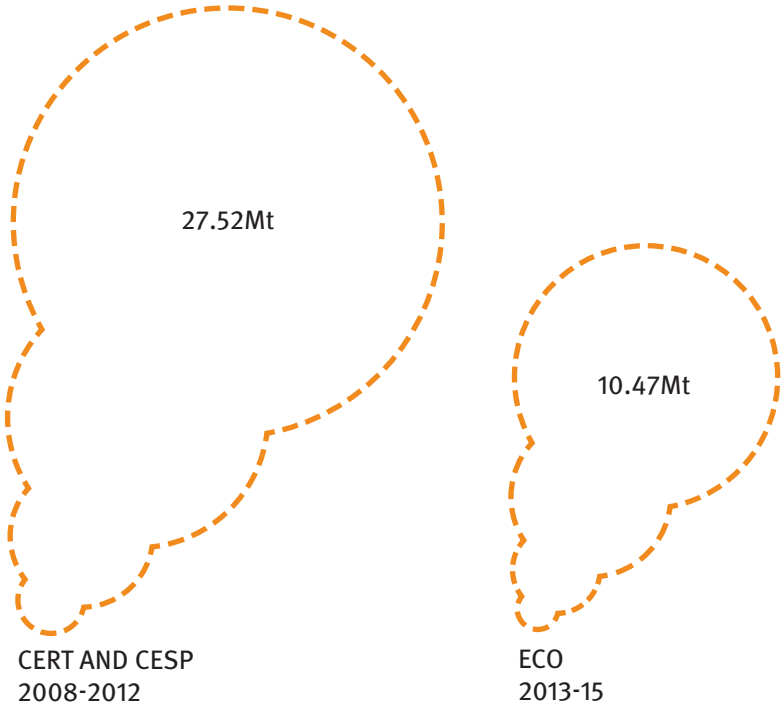
Continuing to only target the least cost measures, instead of innovating to reduce the cost of all the energy efficiency measures needed to achieve the EPC Band C goal by 2035, could raise annual public spending on energy efficiency from £640 million to as much as £2.3 billion.

Most homes left to insulate will need more expensive measures



Cutting emissions is getting more expensive

Carbon savings from £1 billion expenditure for two successive energy efficiency schemes



Current retrofit strategy won't deliver long term climate targets

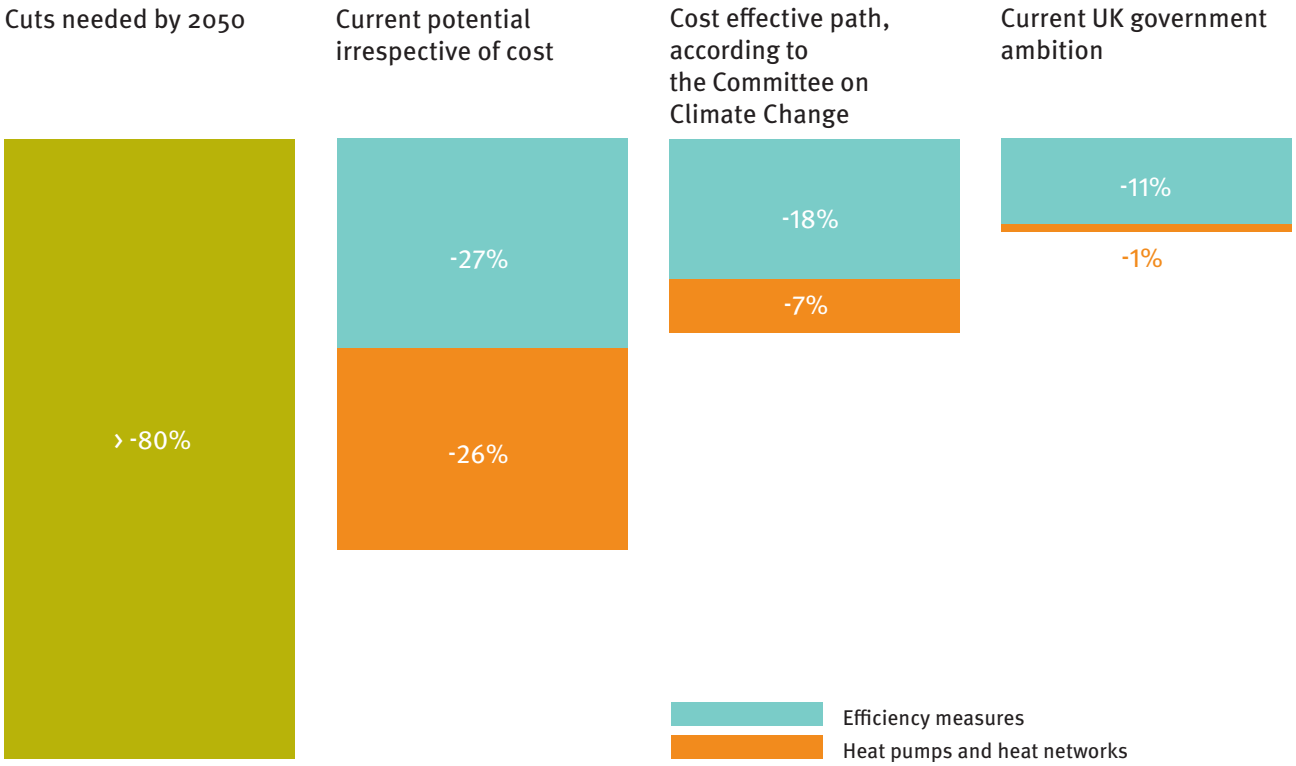
If every UK home had cost effective, conventional energy saving measures installed, energy use would fall by 25 per cent. Current UK ambitions are about half this, so would reduce energy use by about 12 per cent.

If the full technical potential of conventional measures was realised, regardless of cost, energy use could be reduced by about 53 per cent by 2035.

But, to achieve the 80-100 per cent cut in carbon emissions that the UK has committed to by 2050, much more ambitious energy savings will be needed.

Even at full potential, current methods won't save enough energy

Potential reduction in total household energy consumption in 2035, compared to 2015



Consumers care about hassle and aesthetics

The Green Deal energy efficiency scheme, which ran from 2013 to 2015, assumed there would be high consumer interest in low cost insulation measures. But just 14,000 households (0.05 per cent of target properties) took advantage of Green Deal loans during the scheme's existence, even though they were well publicised.

By contrast, people buy double glazing regularly: it is estimated that 20 per cent of homeowners are considering it for the future. This is despite the fact that, at £250-390 per tCO_2 saved, it can cost up to four times more than Green Deal measures to achieve the same level of warmth.

But cost is not the sole, or even most important factor for people. Hassle and aesthetics are at least as important. The current policy approach does not take this into account.

For large scale retrofits to be a desirable choice, they have to be seen as simple to do and enhance a home's appearance, as well as being affordable.

One leap to zero carbon homes: the Energiesprong approach

What is Energiesprong?

Energiesprong, which translates as 'energy leap', is an innovative approach to whole house retrofit, first piloted in the Netherlands. It is a set of standards that add up to a net zero energy home, with performance guaranteed for 30 years.

This is typically achieved by:

- A new thermally efficient façade, which creates an airtight and insulated shell around an existing property.
- A solar PV roof, sized to generate as much energy as the property consumes.
- An energy hub, with air or ground source heating and optional batteries, which enable the home to provide energy services to the grid.

Energiesprong retrofits are funded with a whole-life financing model, where the cost is covered by energy savings and reduced home maintenance costs.

1960s terraced homes in Nottingham, retrofitted in 2017 using the Energiesprong approach

Before

Poor quality, draughty homes: with ineffective insulation and invasive to repair.

Fuel bills ranged from £600-£1,800 a year, with lower bills in properties where residents heated only one room to save cost.

After

A low hassle upgrade: ten properties were retrofitted while householders remained at home.

Major aesthetic and comfort improvements, raising property values by 25 per cent.

Tenants have warm homes and energy bills have been cut by up to 60 per cent a year.

Cutting carbon is easier with Energiesprong

The Committee on Climate Change projects that to meet the fifth carbon budget, around 13MtCO_2e of carbon savings will be needed from residential buildings by 2030.

Using the conventional approach to achieve these savings would mean installing 90,000 solid wall and 200,000 cavity wall insulation measures every year. At least 15 million homes would need to be retrofitted by 2030 and, to meet 2050 carbon targets, the same homes would need to have further measures installed again after 2030.

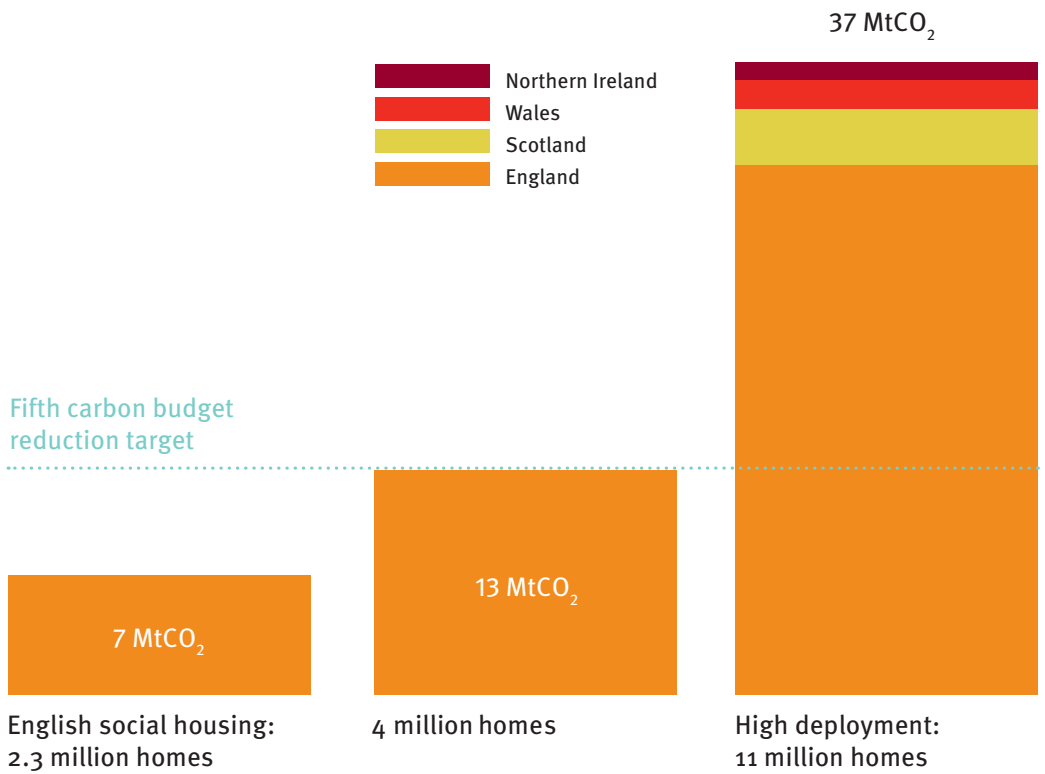
Doing this would more than triple the UK's current rate of energy efficiency installations.

With Energiesprong, carbon reductions would be easier: just four million homes would need to be retrofitted to achieve the same savings.

But the potential is actually much greater: at least 11 million UK homes are suitable for Energiesprong retrofits. This includes 2.3 million social homes, seven million privately owned homes in England and a further 1.8 million homes in Scotland, Wales and Northern Ireland.

Energy upgrades to all these homes could triple carbon reductions to 37MtCO_2e.

Potential UK emissions reductions from Energiesprong retrofits



Adding value to the UK's electricity system

An average Energiesprong retrofit reduces a home's total energy demand by 80 per cent.

Solar panels on the roof generate as much energy as the home consumes over a year. During the summer, the building exports electricity, and, in winter, it draws energy from the grid.

Including batteries allows it to operate flexibly and disconnect from the grid between 4pm and 7pm to avoid daily peak demand.

The low carbon flexibility service that an Energiesprong home can provide to the local electricity grid is worth up to £250 a year. This is largely because it helps to shift energy load away from times of peak electricity demand through the use of battery storage.

Before	
Heating and hot water	18,000 kWh/yr
Appliances	3,500 kWh/yr
Total	21,500 kWh/yr

After	
Heating and hot water	2,000 kWh/yr
Appliances	2,300 kWh/yr
Generation	4,300 kWh/yr
Net total	0 kWh/yr

Energiesprong helps to solve the UK's heat problem

About 85 per cent of UK's domestic heating comes from natural gas. During the coldest winters, demand for heating can be as high as 170 GW, which is over 300 per cent higher than peak electricity demand. Reducing dependence on gas is critical to meeting climate targets and the electrification of heat is emerging as one of the key solutions.

But switching heat to the electricity system without simultaneously lowering energy demand would require huge new investment in grid infrastructure and power stations.

Energiesprong homes can help to avoid this. Their excellent insulation lowers each home's heat demand by at least 90 per cent, and the use of heat pumps, which are four times as efficient as gas boilers, further reduces demand.

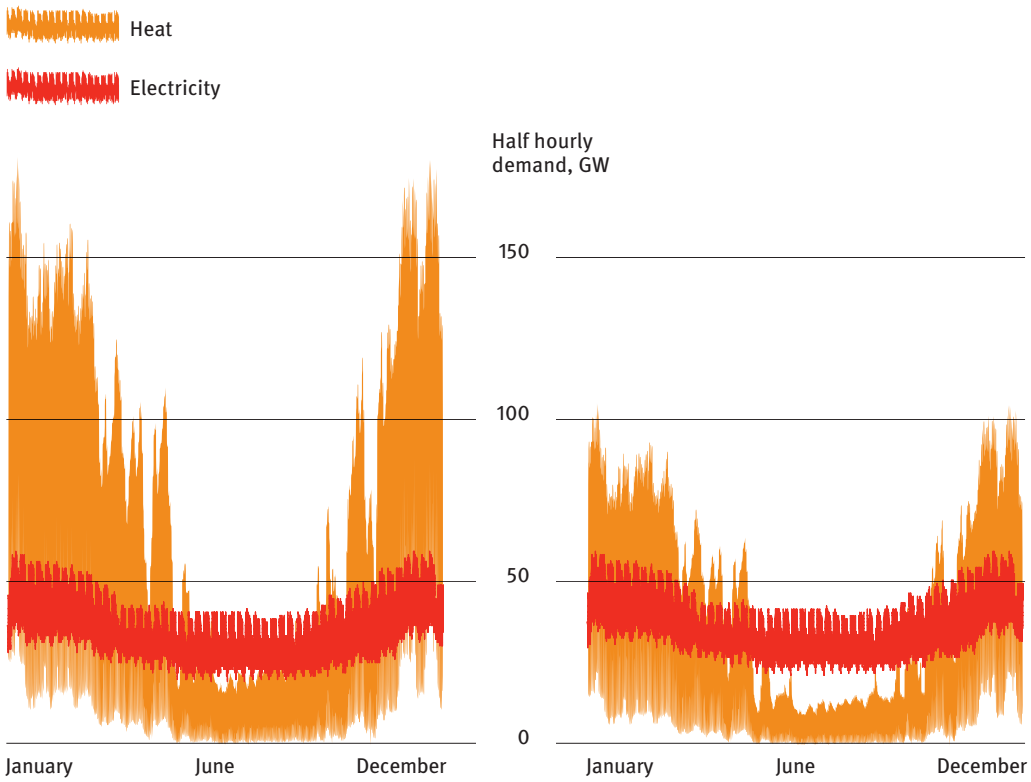
Because they have high thermal inertia, Energiesprong homes retain heat for up to 48 hours, allowing them to stay warm without heating on the coldest days.

It is estimated that retrofitting 11 million homes by this method would cut peak domestic heat demand by 41 per cent. This would significantly reduce the cost of decarbonising the UK's heat supply, which the National Infrastructure Commission say could cost anywhere between £120-£300 billion.

These savings would be made relatively quickly. For example, this scenario would avoid the need to spend between £4 billion and £10 billion on new peaking gas plants, a power source which would also need to be decarbonised before 2050 at further cost.

UK domestic energy demand in an exceptionally cold year (2010)

Energiesprong could lower peak demand by 41%, while decarbonising heat



Installation at scale could be cheaper

As Energiesprong is a novel approach to 'whole house' retrofit, its cost is currently higher than the more usual incremental insulation upgrades.

However, it creates a net zero energy home in one step, which avoids later spending on a decarbonised heat system and also avoids potential spending on further efficiency measures in the future.

Because the Energiesprong approach harnesses technology and construction innovation, its upfront cost is more likely to fall rapidly through mass deployment and economies of scale than conventional retrofits, in which case it will become the cheapest deep-house retrofit option available.

Energiesprong is more immediately compatible with social housing. Rolling it out across 2.3 million social homes could save construction costs of between £10.5-£31.5 billion.

Potential cost reductions, Energiesprong vs conventional retrofits, by 2025

Energiesprong retrofit: >90% CO_2 reduction

Conventional retrofits: 67% CO_2 reduction

How Energiesprong can deliver these benefits

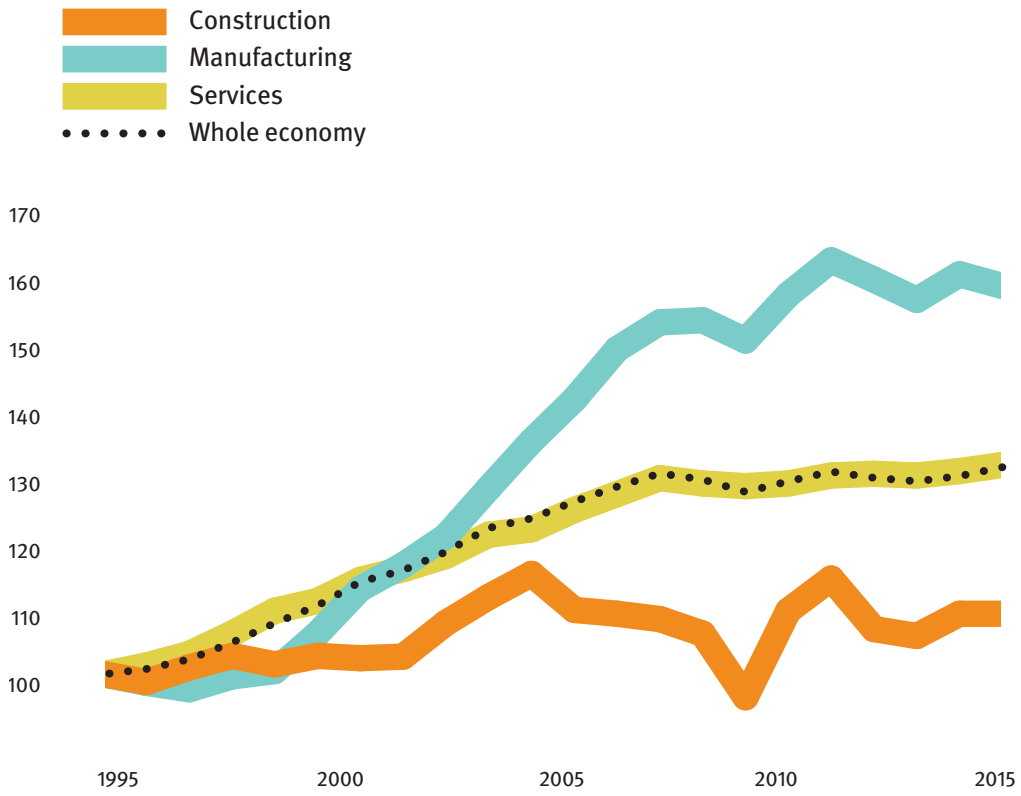
Innovation lowers cost and raises productivity

The Energiesprong approach combines three technology innovations:

- **Offsite construction:** creating prefabricated façades and roofs offsite at a factory enables simple onsite work.
- **Mass customisation:** using laser measurement and drones to survey homes allows developers to take detailed measurements, increasing the accuracy and production speed of offsite manufacturing.
- **Integrated components:** consolidating solar electronics, a heat pump, battery storage and heat recovery ventilation into a single unit enables the home to provide grid services as well, like demand modulation.

Netherlands-based factories building parts for Energiesprong retrofits have improved the labour productivity of construction by 75 per cent and reduced waste by 90 per cent. In contrast, the UK construction sector's productivity has been flat since 1994. The UK energy efficiency product sector already makes £13.9 billion a year and employs 100,000 people. Raising its productivity by investing in a large scale Energiesprong retrofit programme now could add a further £11 billion a year to the UK market in the 2030s.

Productivity index
Output per hour worked, index (1994 = 100)



Integrating components is cheaper

Integrating energy related components into a single hub for each house, and procuring them at scale, has helped to cut installation costs by more than half in the Netherlands. A proposed future new generation hub would be integrated into a roof, further lowering installation costs and energy efficiency.

Pre-integration

Separate technologies that could include a ventilation (MVHR) unit, a hot water boiler, a heat pump and a distribution board and meters.

Cost £25,000

1st generation hub

Integrates technologies to cut installation cost.

Cost £17,000

2nd generation hub

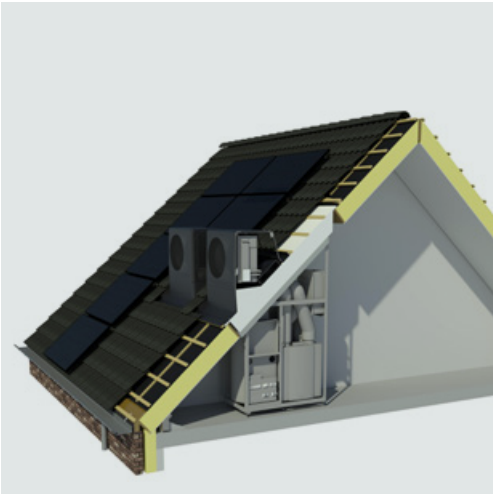
Adds a solar PV inverter, compact design and economies of scale to reduce costs further.

Cost £11,000

3rd generation hub (in development)

Roof integration and building at scale could see prices reduce still further.

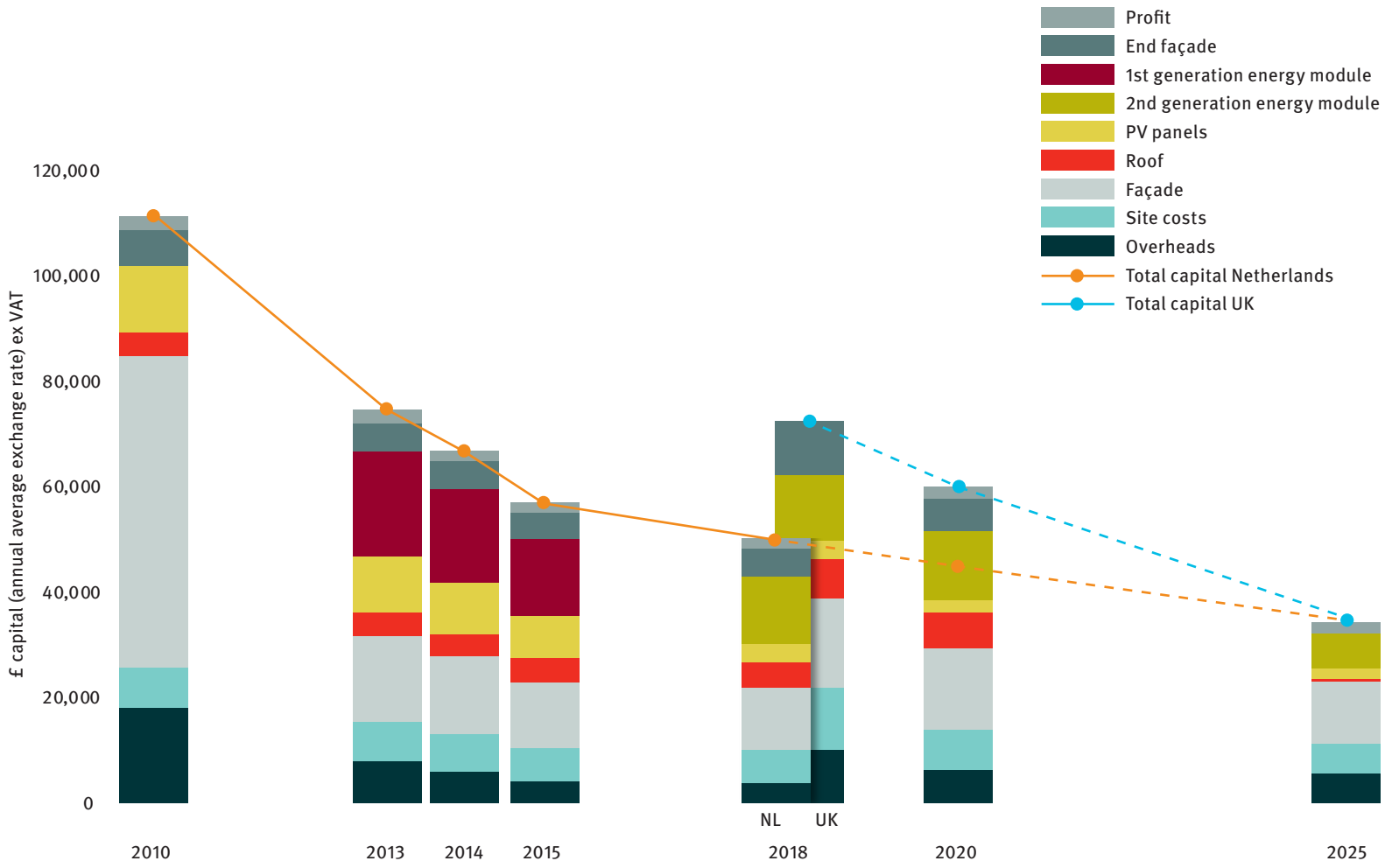
Cost potentially £5,000
(at large scale uptake)



Costs have already come down in the Netherlands

Innovation and economies of scale in the Netherlands have nearly halved the cost of Energiesprong retrofits over seven years. Some of this reduction has already translated to the UK: the first Energiesprong installations in Nottingham cost around £75,000 per home, compared to around £110,000 per home in the Netherlands in 2010.

But there is potential to bring costs down further. A more robust and competitive domestic supply chain, underpinned by a commitment to Energiesprong retrofits in the UK, would continue to cut costs by raising the productivity of UK construction. By 2025, a total retrofit could cost £35,000 per home, on the basis of 5,000 homes being retrofitted every year.



How to make the Energiesprong approach work in the UK

Commit and review

To meet carbon targets, the UK will need to cut emissions by at least 80 per cent by 2050, but in the heat and buildings sectors policy makers have few cost effective options. Simply extending existing programmes like ECO for energy efficiency or the renewable heat incentive (RHI) for low carbon heat will not be enough because these schemes are not stimulating innovation to bring costs down.

Energiesprong uses an innovative approach to both buildings and heat, and has the potential to decarbonise over 40 per cent of UK homes. But it needs to come down in cost, and this can only happen through learning by doing. This is the process that enabled solar power, lithium-ion batteries and offshore wind costs to fall by 77 per cent, 79 per cent and 63 per cent respectively in less than a decade.

Industry believes that a government commitment to supporting 5,000 retrofits would drive economies of scale, enabling market actors to finance further retrofits towards a £35,000 per retrofit cost goal. At this level, Energiesprong retrofits could be subsidy free.

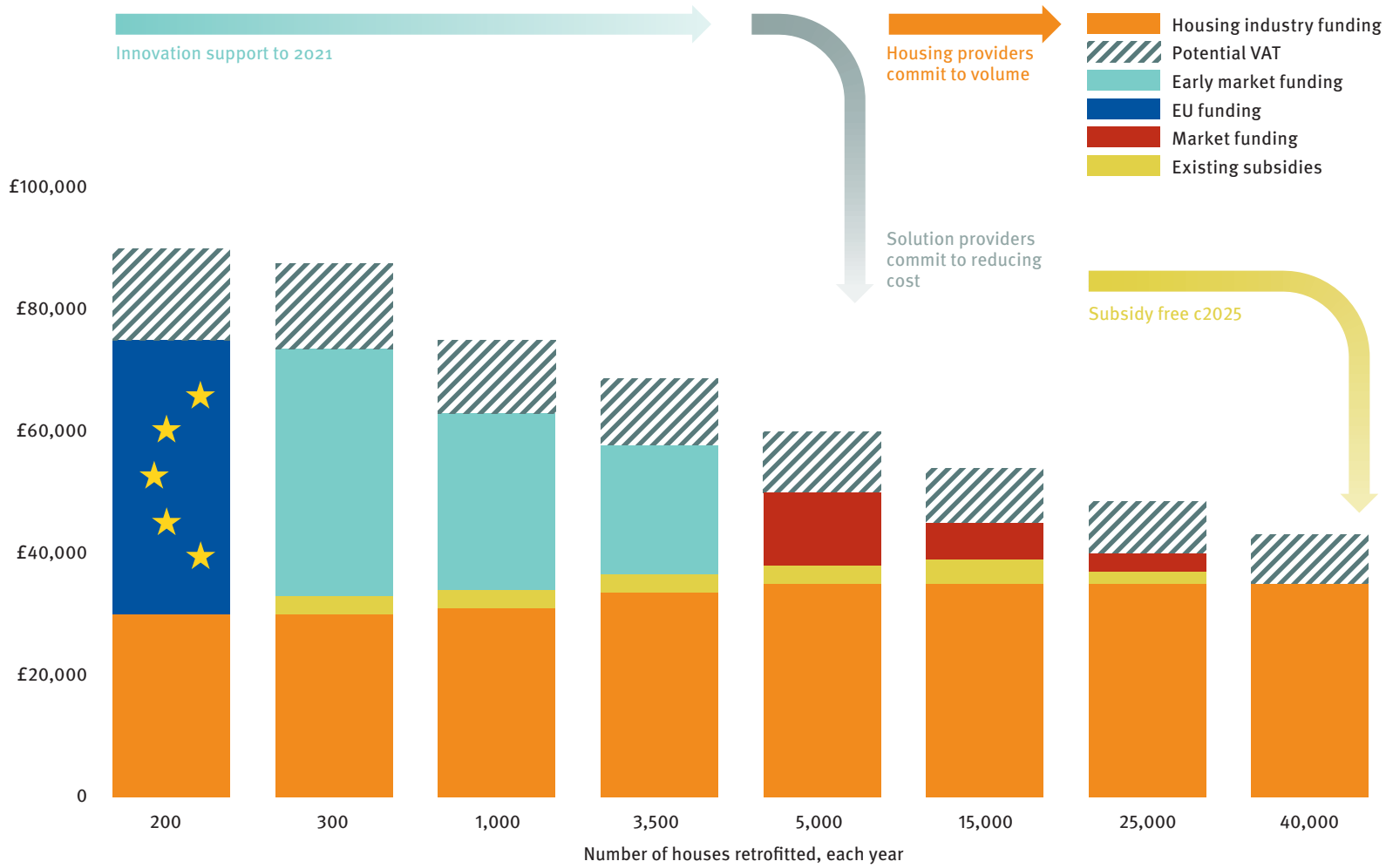
Supporting a 5,000 home Energiesprong retrofit programme would cost approximately £120 million. To put this in context, this is about 20 per cent less than the failed Green Deal Home Improvement Fund cost during its three years of operation, and two thirds less than the UK's £320 million district heat pilot.

Committing to supporting 5,000 retrofits would not mean writing a blank cheque. Instead, a commitment could be conditional on industry progress towards achieving the £35,000 per retrofit target, whilst reducing energy demand and delivering the promised comfort plan. A similar 'commit and review' approach to offshore wind has resulted in near subsidy free wind power in the UK and most parts of Northern Europe, while building a world leading UK industry.

The path to subsidy free, zero carbon retrofits

The Energiesprong approach to retrofitting and finance makes it more readily suitable to scaling up in the social housing sector, because landlords can accrue energy and maintenance savings over thirty years.

A commitment to supporting 5,000 homes would enable the cost of an Energiesprong retrofit to fall to £50,000, the point at which social landlords should be able to self-finance these retrofits. This would then enable the further scaling required to achieve the £35,000 goal for a whole house retrofit that could be sold in the market, not simply as a net zero carbon retrofit, but as a low hassle aesthetic and comfort upgrade which increases the value of a property.



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Heat demand: peak domestic heat demand is assumed to be 170 GW (2010-11). Giving 41 per cent of UK homes an Energiesprong retrofit would bring this domestic heat demand down to 100GW. Energiesprong homes use 90 per cent less heat all year round, using roughly 7GW of electricity, as heat pumps are used. The thermal storage of the buildings allows heat pumps to generate heat at warmer parts of the day and store it for use at colder times when demand is at its peak. This results in a coefficient of performance of 3.9 (3.9kW of heat generated for every 1kW of electricity) creating a 1.7GW of electricity demand which, as it shifts the load from peak times, does not cause a rise in peak electricity demand.

See the technical annex to this report at www.green-alliance.org.uk/reinventing_retrofit_annex.php

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By Chris Friedler and Chaitanya Kumar

Green Alliance
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