Building and Landscape Conservation

Reducing Energy Use in Traditional Dwellings

Prepared for Historic England by Chris Newman,
Parity Projects Ltd

Discovery, Innovation and Science in the Historic Environment

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Analysis of Four Solid Wall Houses in Reading

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Front cover: A terraced house in Reading, Berkshire.

SUMMARY
This report describes an in-depth ‘whole building’ analysis of energy use carried out in four traditionally built houses in Reading, Berks. The results were used to devise strategies to reduce energy use and carbon emissions for each household. These were then assessed in terms of their effectiveness and cost-efficiency. An important aim of the project was to understand better the costs and benefits of solid wall insulation in relation to other energy and carbon saving measures. The project demonstrates the benefits of a ‘whole building’ approach, and shows how the economics of specific energy and carbon-saving improvements vary from one household to another.

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1 INTRODUCTION

In late 2013/early 2014, Reading Borough Council and English Heritage jointly funded Parity Projects to analyse energy-saving measures in four solid-walled properties in Reading The aim was to investigate the relative merits of different wall insulation options, and how they compare with other measures in terms of effectiveness and cost efficiency. For each property a number of solid wall insulation thicknesses were evaluated for both internal, external and hybrid solutions. (The hybrid solution was for external wall insulation (EWI) on the rear of the properties and internal wall insulation (IWI) on the front).

Parity Projects used its proprietary Home Energy Masterplan tool to evaluate between 62 and 89 measures for each property. These included heating, hot water, fabric, lights and appliances along with the replacement of heating and hot water systems and changes in usage. The analysis was calibrated to the actual energy bills of the owners so that the results could inform them about the costs and benefits of going ahead with energy saving measures. Parity Projects produced the estimated prices based on its pricing database.

1.1 Parity Home Energy Masterplan

The modelling is based on BREDEM, with additional modules and functionality to allow heating, hot water, lighting and appliances to be included as they are actually used. It can therefore have different heating regimes applied, and can also be calibrated to actual bills when they are available. The software allows for the evaluation of a large range of measures, both individually and as packages, and has a large costing database to so that many of the costs can be calculated (e.g. based on units, square meterage and works).

1.2 Packages of Measures

As the net effect of the combination of individual measures is often different to the sum of measures installed in combination, six packages of measures were evaluated for each house. In order to see what levels of improvement could be achieved without upgrading the walls, the first three packages excluded wall insulation.

'Low Cost'

Relatively cheap measures that are easy to install e.g. chimney balloons. This package often has DIY and behavioural measures.

'Medium Cost'

Typically measures that are less than £2,000 each and having paybacks up to 15 years when evaluated individually

'Higher Cost and/or Longer Payback'

Measures that had a payback less that 25 years but cost not considered. This package is essentially the best that could be achieved without wall insulation.

'plus Internal Wall Insulation'

Measures from the 'Higher Cost...' package plus internal wall insulation bringing the walls up to at least current Building Regulations

'plus Internal and External Wall Insulation'

As above but with external on the rear elevation and internal on the front.

'plus External Wall Insulation'

As above but with external on all elevations.

1.3 High Level Conclusions

The table below shows the % CO_2 savings for the maximum cost package without wall insulation, and then the packages with wall insulation. As you can see, the savings without wall insulation, although laudable, appear to be limited to below 40%, whilst the introduction of wall insulation options brings the savings up to around 60% across all the properties.

	House 1	House 2	House 3	House 4
Low cost	25%	10%	16%	6%
Medium cost	34%	36%	28%	22%
Higher cost...package	38%	37%	38%	34%
plus... Wall Insulation packages	57%	66%	58%	61%

1.4 Further Analysis

English Heritage decided to fund some further research into the impact of different heating regimes. The Parity Home Energy Masterplan tool allows for different heating regimes to be evaluated in the energy model built for a dwelling, so we have re-run the analysis for each house. This is the analysis that is covered in detail in the remainder of this paper.

2 HEATING REGIMES

Three different heating regimes have been applied to the houses, outlined below. They have been set to cover the average low to average high typical usage rather than the extremes. The heating profiles have been designed based on our observations of hundreds of households energy use patterns during our Home Energy Masterplan surveys.

2.1 Low Energy Use

This profile is designed to reflect a household that is out most of the day and is also happy to keep their house at a relatively low temperature.

Thermostat setting: 17°C
Weekday Heating Programme Times

00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23

Weekend Heating Programme Times

00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23

2.2 Medium Energy Use

This profile is designed to reflect a household that is out most of the day but keeps their house at a slightly higher temperature.

Thermostat setting: 19°C
Weekday Heating Programme Times

00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23

Weekend Heating Programme Times

00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23

2.3 High Energy Use

This profile is designed to reflect a household that is in most of the day and desires or requires a higher heating temperature.

Thermostat setting: 21°C
Weekday Heating Programme Times

00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23

Weekend Heating Programme Times

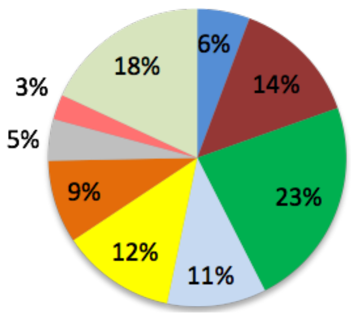
00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23

3 THE HOUSES

The following tables give a high level summary of the four houses. Since these studies relied on the willingness of homeowners to participate in the project, it was not possible to perform analysis on all types of solid wall properties. However, there was some variety. One house is part of a terrace, one is semi-detached, and two are detached. They have between three to six bedrooms. All the houses are in Reading, and have gas-fired central heating and hot water systems. Since central heating with gas is cheaper than most other heating systems, the cost savings achieved by using energy saving measures will not be as high as in houses where more expensive heating systems are used. In all cases, the energy consumption in ‘Low Use’ for annual heating is predicted to be around 50% of the ‘High Use’ scenario. This indicates that significant savings can be made with either behavioral measures or the addition of improved heating controls.

The orange ‘heating inefficiency’ segments in the pie charts on the following pages require some explanation. Most heating systems are not able to convert all the energy in the fuel source into useful heat. Direct electric heating is an exception: i.e., for every 1 kWh you put in, you get 1 kWh of heat out. Gas boilers range in their efficiency from below 65% to over 90%. This means that if a household uses 30,000 kWh of gas, somewhere between 16,000 kWh to 27,000 kWh is actually turned into useful heat, depending on the boiler efficiency. The orange section of the charts reflects the difference between the kWh in the gas coming in and the useful heat produced by the boiler.

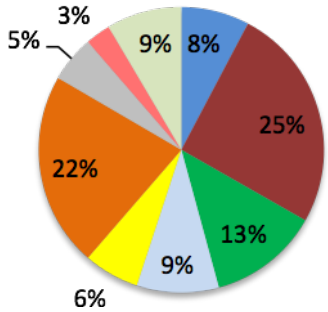
House 1	
Attachment	Mid-Terrace
Bedrooms	3
Floor area	78 m^2
Wall area	57 m^2
Low use heating	8,520 kWh
Medium use heating	11,620 kWh
High use heating	16,780 kWh
Electricity	3,700 kWh
Boiler efficiency	A



Key
(labelled clockwise from top in numbered order)

1 Hot Water
2 Walls
3 Appliances
4 Draughts
5 Windows / Doors
6 Heating Inefficiency
7 Roof
8 Floor
9 Lights

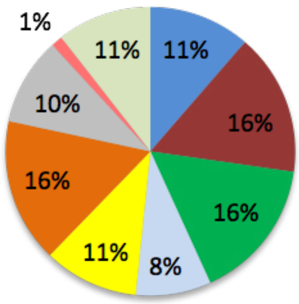
House 2	
Attachment	Detached
Bedrooms	5
Floor area	252 m^2
Wall area	313 m^2
Low use heating	39,170 kWh
Medium use heating	54,800 kWh
High use heating	80,420 kWh
Electricity	4,700 kWh
Boiler efficiency	D



Key
(labelled clockwise from top in numbered order)

1 Hot Water
2 Walls
3 Appliances
4 Draughts
5 Windows / Doors
6 Heating Inefficiency
7 Roof
8 Floor
9 Lights

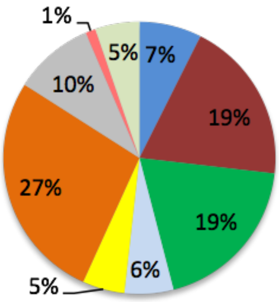
House 3	
Attachment	Detached
Bedrooms	6
Floor area	233 m^2
Wall area	285 m^2
Low use heating	24,040 kWh
Medium use heating	33,550 kWh
High use heating	49,030 kWh
Electricity	5,400 kWh
Boiler efficiency	B



Key
(labelled clockwise from top in numbered order)

1 Hot Water
2 Walls
3 Appliances
4 Draughts
5 Windows / Doors
6 Heating Inefficiency
7 Roof
8 Floor
9 Lights

House 3	
Attachment	Semi-detached
Bedrooms	4
Floor area	100 m^2
Wall area	154 m^2
Low use heating	21,300 kWh
Medium use heating	30,570 kWh
High use heating	46,700 kWh
Electricity	3240 kWh
Boiler efficiency	D



Key
(labelled clockwise from top in numbered order)

1 Hot Water
2 Walls
3 Appliances
4 Draughts
5 Windows / Doors
6 Heating Inefficiency
7 Roof
8 Floor
9 Lights

4 PACKAGES OF MEASURES AND WALL MEASURES

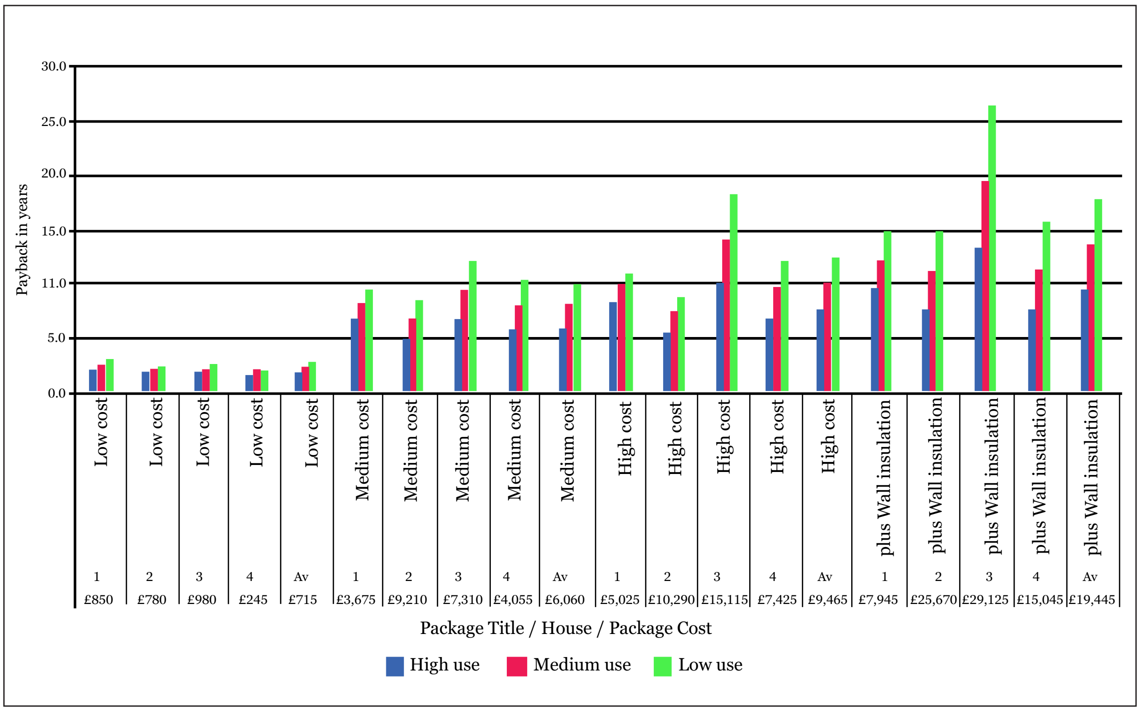
The first graph below shows the economic paybacks for each of the packages for each house. Whilst we have analysed many options, to limit the amount of data overload to the reader we have selected the hybrid solid wall insulation package for this comparison. As might be expected, the payback periods on energy saving measures are longer where the heating use has been more frugal; there is less to be saved for the same capital outlay.

The key things shown in this graph include:

- The payback periods are significantly longer for the higher cost packages. It should be noted that the absolute savings will also be much higher for the higher cost packages, i.e. the occupiers would be expected to save more; the longer payback periods are a consequence of investing more capital to make those higher savings.

- The variance in savings increases markedly for higher cost packages, especially those including wall insulation options. This is shown and discussed further with the next graph.

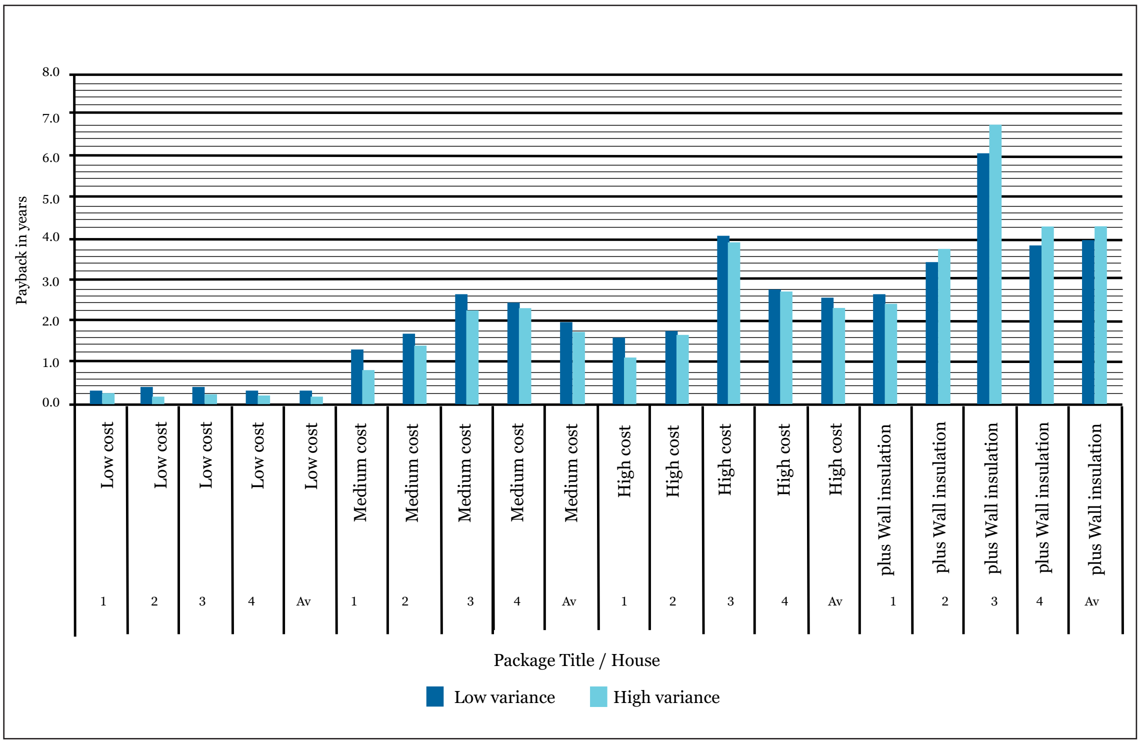
- The key learning point is that it becomes increasingly important to understand the impact of client behaviour and lifestyle when determining the cost effectiveness of higher cost and larger intervention measures.



The next graph shows the variance in expected paybacks away from medium use scenario for the high and low scenarios. The idea is to show how much the occupiers' energy use patterns effect the paybacks.

Example: High Cost Package for house 3. The chart shows that someone living in that house with an energy profile similar to the high use profile should expect the package of measures to take around 4 years less time to pay back the capital invested compared to someone with a medium use energy profile. If they were more like the low use profile then they should expect the payback to be around 4 years longer than someone with a medium use energy profile.

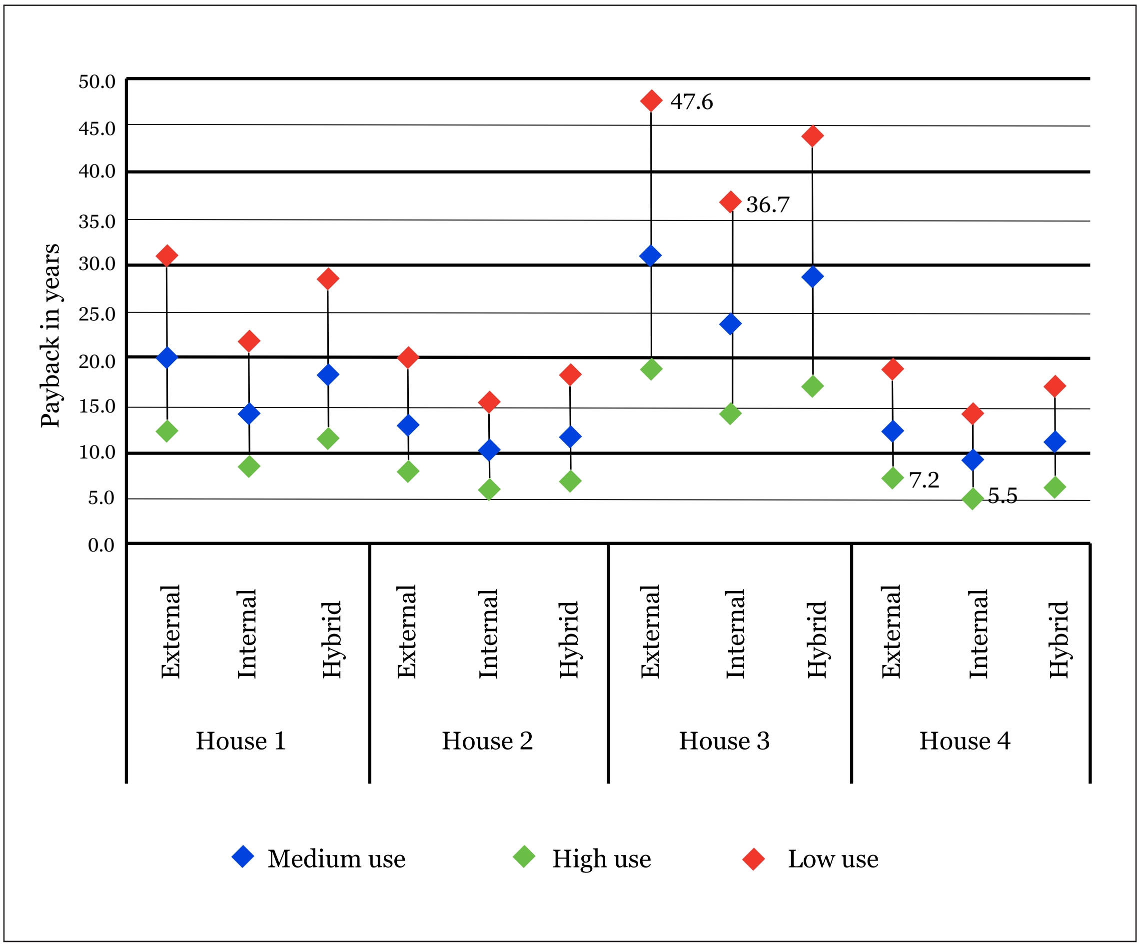
As can be seen, the variance is between 2.2 and 6.6 years across the 4 houses for packages, including wall insulation, with an average around 4 years variance. These will be significantly greater for more extreme high and low scenarios: e.g., people in fuel poverty.



The graph shows two things of significance:

- the expected paybacks of packages of measures cannot be accurately predicted without knowing the energy use profile of the occupiers. This lack of accuracy increases for more extensive packages of works.
- the energy use profile has a significant effect on the expected payback of measures. This would be even more extreme for very high and very low energy users. It is therefore imperative to understand the energy user profile when determining which measures are appropriate for a household.

If we now look more closely at the different wall insulation options, it can be seen thatthe range of economic paybacks is largest for the external wall option, second largest for the hybrid and smallest for the internal. This is a result of the relative decreasing costs for a level of performance that is virtually the same. It does, however, highlight that you can be more confident of the payback that a wall insulation measure will actually achieve if the cost is reduced; e.g. through concurrent working, doing some works as DIY, maturing market offerings and self-financed work.



The paybacks are also lowest for House 2 ,which is detached, and House 4 which is semi-detached, as both have a large area of solid external wall. The lower paybacks will also be partly due to the relatively inefficient boiler in this house. House 3 is also detached, but has a much more efficient boiler. Boiler efficiency is, therefore, a major factor in determining wall insulation paybacks.

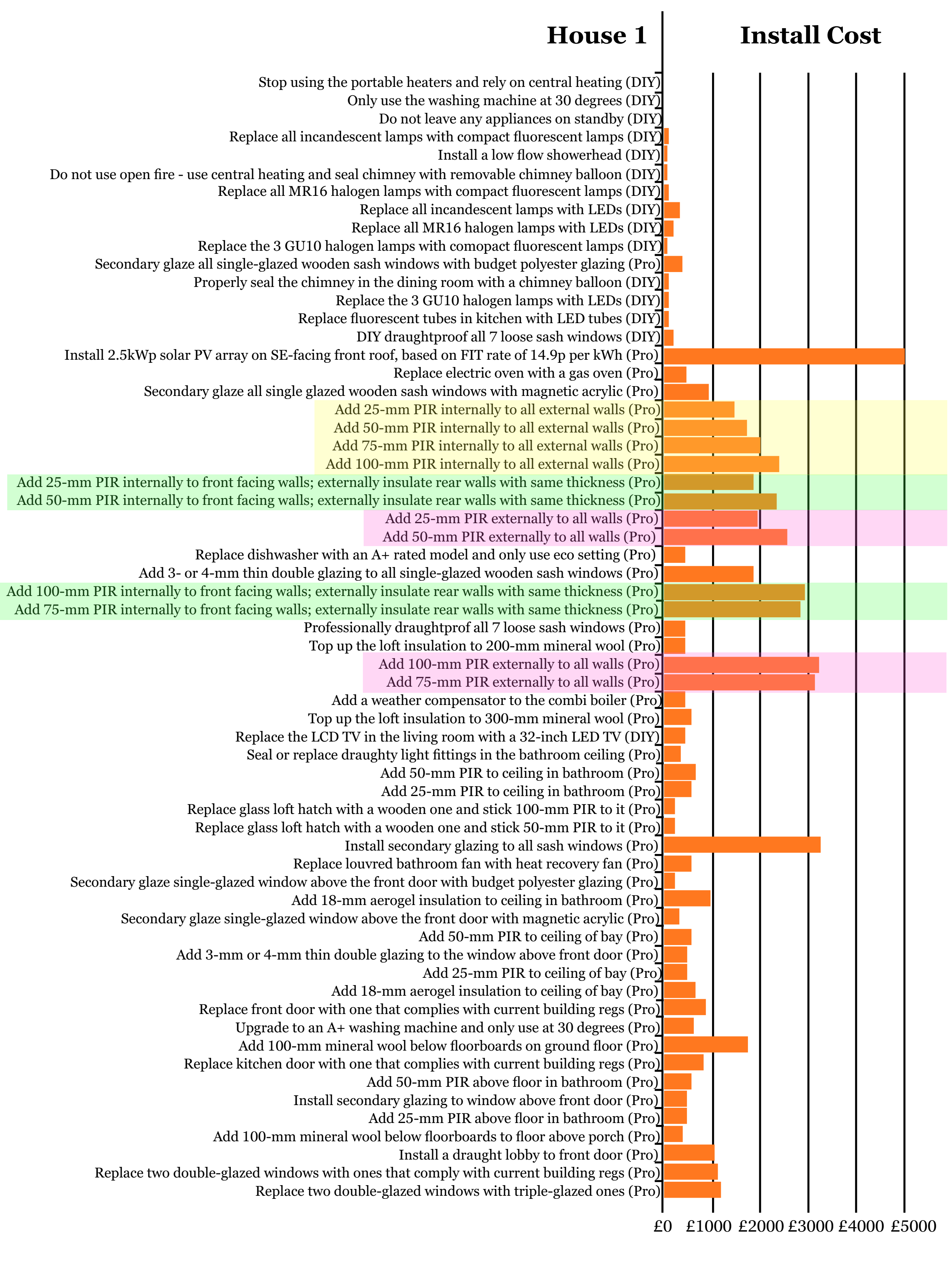
The range for external wall insulation is from around 7 to 45 years, and for internal insulation, from 5 to 37 years.

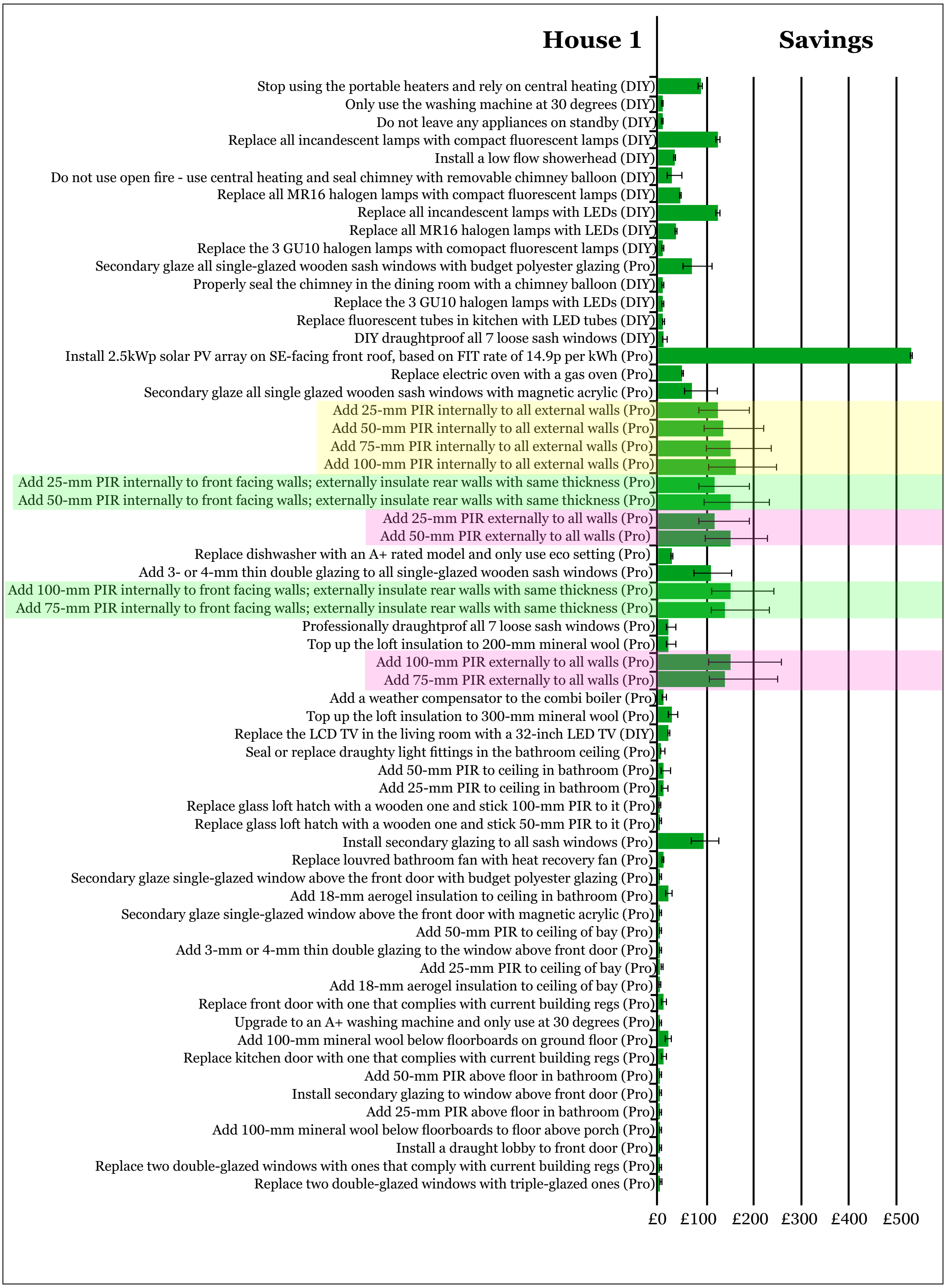
5 COMPARISONS OF ALL APPLICABLE MEASURES

The following pages show the detail for all the measures evaluated in each house. We have highlighted the internal wall insulation measures in yellow, the hybrid wall measures in green, and the external wall measures in pink.

The measures have been ranked by increasing average payback across the three heating scenarios. Both the payback and £ per CO_2 figures are averages across the scenarios. The error bars on the annual savings figures show the range found across the different heating regimes: if you are heating your house more, you can expect to save more by insulating. It is of note that the error bars are greater for wall measures than non-wall measures. This means that the paybacks for wall insulation will be the hardest measures to determine accurately.

All the wall measures rank relatively high in terms of cost effectiveness, especially when DIY measures are excluded. It should be noted that this ranking is for the average and the error bars can be used to indicate where they may rank for low and high energy users. It should be noted that although the wall measures rank relatively high compared to the other measures, they may still not be cost effective in their own right.


House 1
Install Cost
Stop using the portable heaters and rely on central heating (DIY)
Only use the washing machine at 30 degrees (DIY)
Do not leave any appliances on standby (DIY)
Replace all incandescent lamps with compact fluorescent lamps (DIY)
Install a low flow showerhead (DIY)
Do not use open fire - use central heating and seal chimney with removable chimney balloon (DIY)
Replace all MR16 halogen lamps with compact fluorescent lamps (DIY)
Replace all incandescent lamps with LEDs (DIY)
Replace all MR16 halogen lamps with LEDs (DIY)
Replace the 3 GU10 halogen lamps with comopact fluorescent lamps (DIY)
Secondary glaze all single-glazed wooden sash windows with budget polyester glazing (Pro)
Properly seal the chimney in the dining room with a chimney balloon (DIY)
Replace the 3 GU10 halogen lamps with LEDs (DIY)
Replace fluorescent tubes in kitchen with LED tubes (DIY)
DIY draughtproof all 7 loose sash windows (DIY)
Install 2.5kWp solar PV array on SE-facing front roof, based on FIT rate of 14.9p per kWh (Pro)
Replace electric oven with a gas oven (Pro)
Secondary glaze all single glazed wooden sash windows with magnetic acrylic (Pro)
Add 25-mm PIR internally to all external walls (Pro)
Add 50-mm PIR internally to all external walls (Pro)
Add 75-mm PIR internally to all external walls (Pro)
Add 100-mm PIR internally to all external walls (Pro)
Add 25-mm PIR internally to front facing walls; externally insulate rear walls with same thickness (Pro)
Add 50-mm PIR internally to front facing walls; externally insulate rear walls with same thickness (Pro)
Add 25-mm PIR externally to all walls (Pro)
Add 50-mm PIR externally to all walls (Pro)
Replace dishwasher with an A+ rated model and only use eco setting (Pro)
Add 3- or 4-mm thin double glazing to all single-glazed wooden sash windows (Pro)
Add 100-mm PIR internally to front facing walls; externally insulate rear walls with same thickness (Pro)
Add 75-mm PIR internally to front facing walls; externally insulate rear walls with same thickness (Pro)
Professionally draughtprof all 7 loose sash windows (Pro)
Top up the loft insulation to 200-mm mineral wool (Pro)
Add 100-mm PIR externally to all walls (Pro)
Add 75-mm PIR externally to all walls (Pro)
Add a weather compensator to the combi boiler (Pro)
Top up the loft insulation to 300-mm mineral wool (Pro)
Replace the LCD TV in the living room with a 32-inch LED TV (DIY)
Seal or replace draughty light fittings in the bathroom ceiling (Pro)
Add 50-mm PIR to ceiling in bathroom (Pro)
Add 25-mm PIR to ceiling in bathroom (Pro)
Replace glass loft hatch with a wooden one and stick 100-mm PIR to it (Pro)
Replace glass loft hatch with a wooden one and stick 50-mm PIR to it (Pro)
Install secondary glazing to all sash windows (Pro)
Replace louvred bathroom fan with heat recovery fan (Pro)
Secondary glaze single-glazed window above the front door with budget polyester glazing (Pro)
Add 18-mm aerogel insulation to ceiling in bathroom (Pro)
Secondary glaze single-glazed window above the front door with magnetic acrylic (Pro)
Add 50-mm PIR to ceiling of bay (Pro)
Add 3-mm or 4-mm thin double glazing to the window above front door (Pro)
Add 25-mm PIR to ceiling of bay (Pro)
Add 18-mm aerogel insulation to ceiling of bay (Pro)
Replace front door with one that complies with current building regs (Pro)
Upgrade to an A+ washing machine and only use at 30 degrees (Pro)
Add 100-mm mineral wool below floorboards on ground floor (Pro)
Replace kitchen door with one that complies with current building regs (Pro)
Add 50-mm PIR above floor in bathroom (Pro)
Install secondary glazing to window above front door (Pro)
Add 25-mm PIR above floor in bathroom (Pro)
Add 100-mm mineral wool below floorboards to floor above porch (Pro)
Install a draught lobby to front door (Pro)
Replace two double-glazed windows with ones that comply with current building regs (Pro)
Replace two double-glazed windows with triple-glazed ones (Pro)
£0
£1000
£2000
£3000
£4000
£5000


House 1
Savings
Stop using the portable heaters and rely on central heating (DIY)
Only use the washing machine at 30 degrees (DIY)
Do not leave any appliances on standby (DIY)
Replace all incandescent lamps with compact fluorescent lamps (DIY)
Install a low flow showerhead (DIY)
Do not use open fire - use central heating and seal chimney with removable chimney balloon (DIY)
Replace all MR16 halogen lamps with compact fluorescent lamps (DIY)
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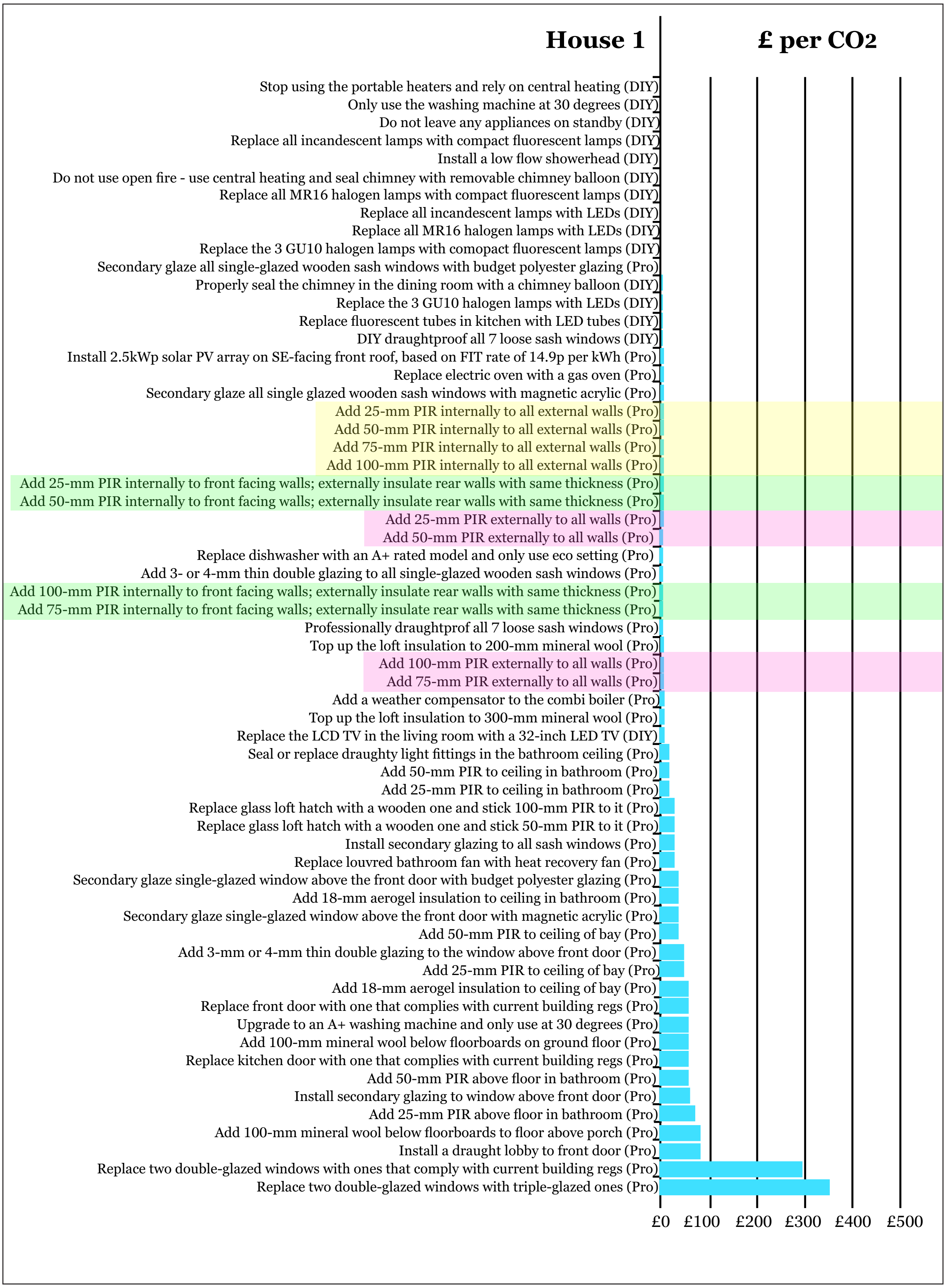
£0
£100
£200
£300
£400
£500


House 1
£ per CO2
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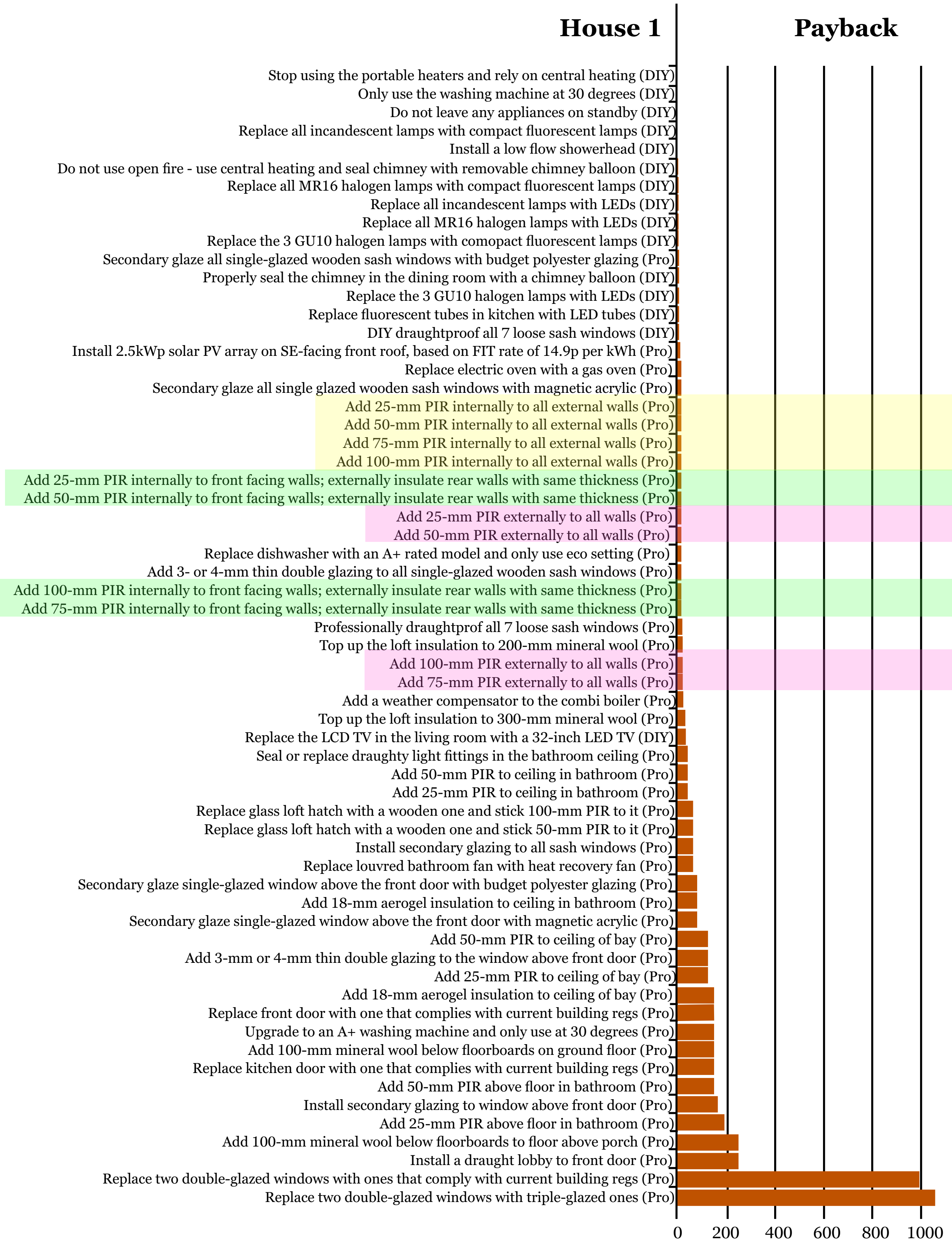
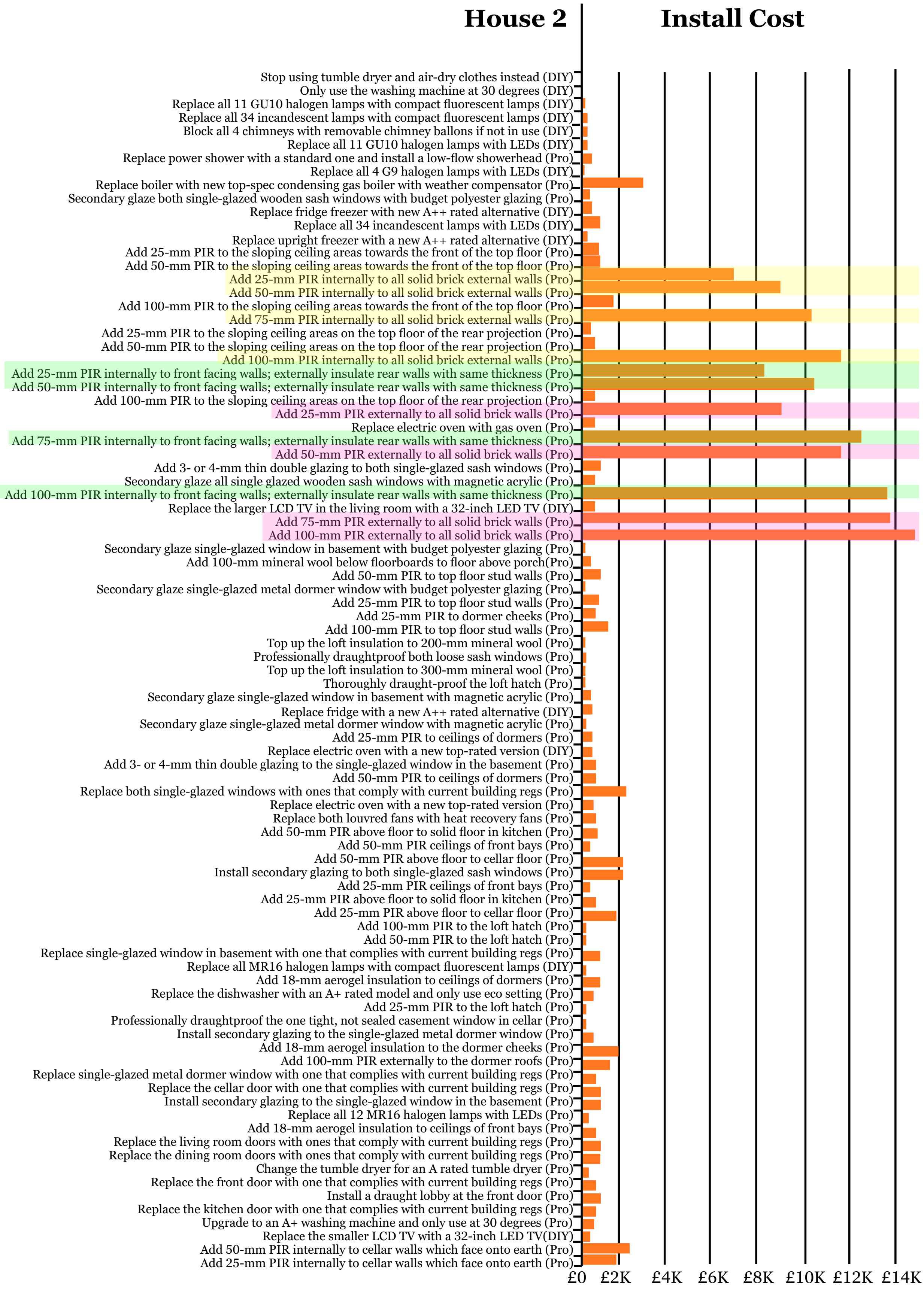
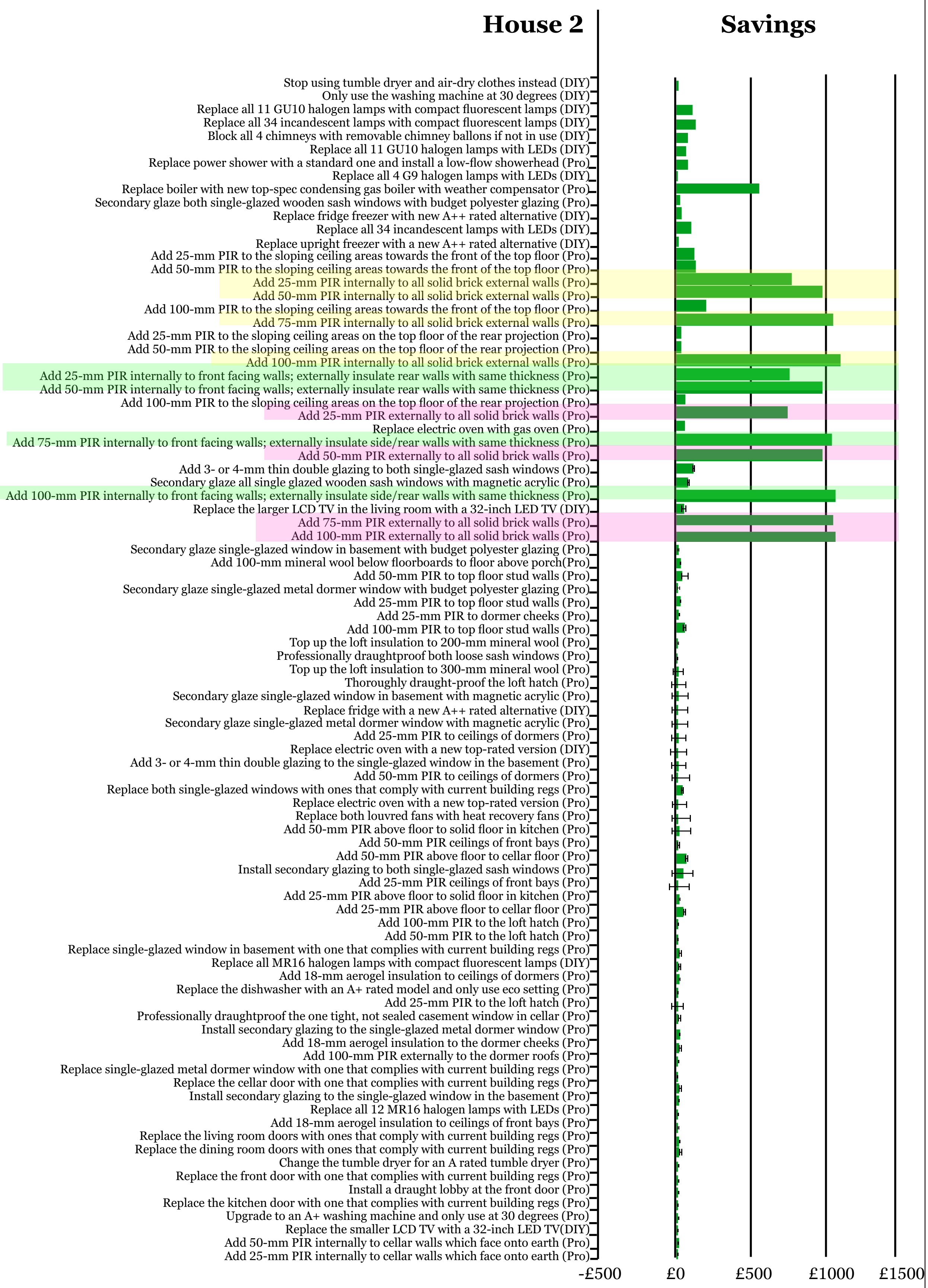
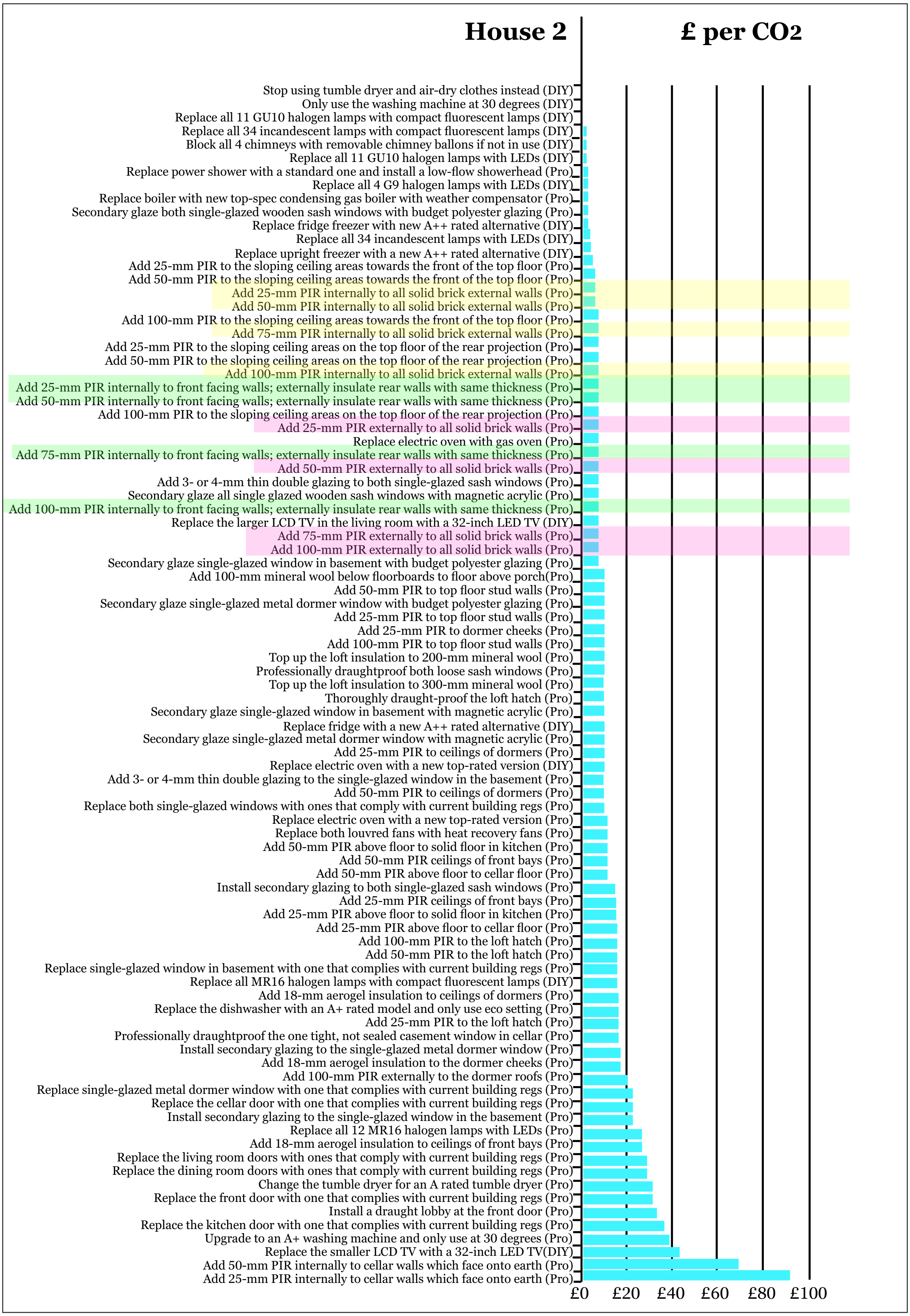
Replace front door with one that complies with current building regs (Pro)
Upgrade to an A+ washing machine and only use at 30 degrees (Pro)
Add 100-mm mineral wool below floorboards on ground floor (Pro)
Replace kitchen door with one that complies with current building regs (Pro)
Add 50-mm PIR above floor in bathroom (Pro)
Install secondary glazing to window above front door (Pro)
Add 25-mm PIR above floor in bathroom (Pro)
Add 100-mm mineral wool below floorboards to floor above porch (Pro)
Install a draught lobby to front door (Pro)
Replace two double-glazed windows with ones that comply with current building regs (Pro)
Replace two double-glazed windows with triple-glazed ones (Pro)
£0
£100
£200
£300
£400
£500

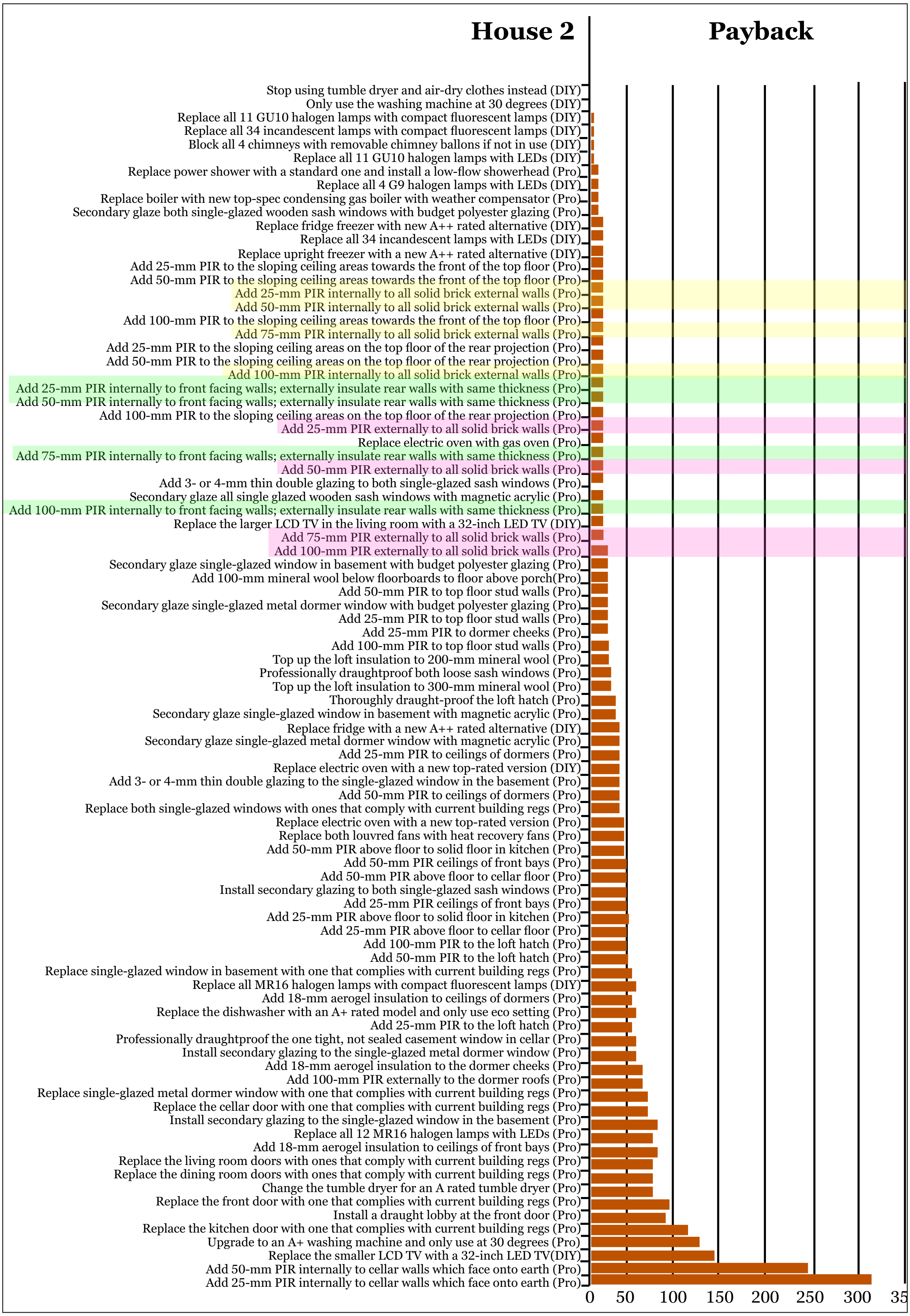

House 1
Payback
Stop using the portable heaters and rely on central heating (DIY)
Only use the washing machine at 30 degrees (DIY)
Do not leave any appliances on standby (DIY)
Replace all incandescent lamps with compact fluorescent lamps (DIY)
Install a low flow showerhead (DIY)
Do not use open fire - use central heating and seal chimney with removable chimney balloon (DIY)
Replace all MR16 halogen lamps with compact fluorescent lamps (DIY)
Replace all incandescent lamps with LEDs (DIY)
Replace all MR16 halogen lamps with LEDs (DIY)
Replace the 3 GU10 halogen lamps with comopact fluorescent lamps (DIY)
Secondary glaze all single-glazed wooden sash windows with budget polyester glazing (Pro)
Properly seal the chimney in the dining room with a chimney balloon (DIY)
Replace the 3 GU10 halogen lamps with LEDs (DIY)
Replace fluorescent tubes in kitchen with LED tubes (DIY)
DIY draughtproof all 7 loose sash windows (DIY)
Install 2.5kWp solar PV array on SE-facing front roof, based on FIT rate of 14.9p per kWh (Pro)
Replace electric oven with a gas oven (Pro)
Secondary glaze all single glazed wooden sash windows with magnetic acrylic (Pro)
Add 25-mm PIR internally to all external walls (Pro)
Add 50-mm PIR internally to all external walls (Pro)
Add 75-mm PIR internally to all external walls (Pro)
Add 100-mm PIR internally to all external walls (Pro)
Add 25-mm PIR internally to front facing walls; externally insulate rear walls with same thickness (Pro)
Add 50-mm PIR internally to front facing walls; externally insulate rear walls with same thickness (Pro)
Add 25-mm PIR externally to all walls (Pro)
Add 50-mm PIR externally to all walls (Pro)
Replace dishwasher with an A+ rated model and only use eco setting (Pro)
Add 3- or 4-mm thin double glazing to all single-glazed wooden sash windows (Pro)
Add 100-mm PIR internally to front facing walls; externally insulate rear walls with same thickness (Pro)
Add 75-mm PIR internally to front facing walls; externally insulate rear walls with same thickness (Pro)
Professionally draughtprof all 7 loose sash windows (Pro)
Top up the loft insulation to 200-mm mineral wool (Pro)
Add 100-mm PIR externally to all walls (Pro)
Add 75-mm PIR externally to all walls (Pro)
Add a weather compensator to the combi boiler (Pro)
Top up the loft insulation to 300-mm mineral wool (Pro)
Replace the LCD TV in the living room with a 32-inch LED TV (DIY)
Seal or replace draughty light fittings in the bathroom ceiling (Pro)
Add 50-mm PIR to ceiling in bathroom (Pro)
Add 25-mm PIR to ceiling in bathroom (Pro)
Replace glass loft hatch with a wooden one and stick 100-mm PIR to it (Pro)
Replace glass loft hatch with a wooden one and stick 50-mm PIR to it (Pro)
Install secondary glazing to all sash windows (Pro)
Replace louvred bathroom fan with heat recovery fan (Pro)
Secondary glaze single-glazed window above the front door with budget polyester glazing (Pro)
Add 18-mm aerogel insulation to ceiling in bathroom (Pro)
Secondary glaze single-glazed window above the front door with magnetic acrylic (Pro)
Add 50-mm PIR to ceiling of bay (Pro)
Add 3-mm or 4-mm thin double glazing to the window above front door (Pro)
Add 25-mm PIR to ceiling of bay (Pro)
Add 18-mm aerogel insulation to ceiling of bay (Pro)
Replace front door with one that complies with current building regs (Pro)
Upgrade to an A+ washing machine and only use at 30 degrees (Pro)
Add 100-mm mineral wool below floorboards on ground floor (Pro)
Replace kitchen door with one that complies with current building regs (Pro)
Add 50-mm PIR above floor in bathroom (Pro)
Install secondary glazing to window above front door (Pro)
Add 25-mm PIR above floor in bathroom (Pro)
Add 100-mm mineral wool below floorboards to floor above porch (Pro)
Install a draught lobby to front door (Pro)
Replace two double-glazed windows with ones that comply with current building regs (Pro)
Replace two double-glazed windows with triple-glazed ones (Pro)
0
200
400
600
800
1000

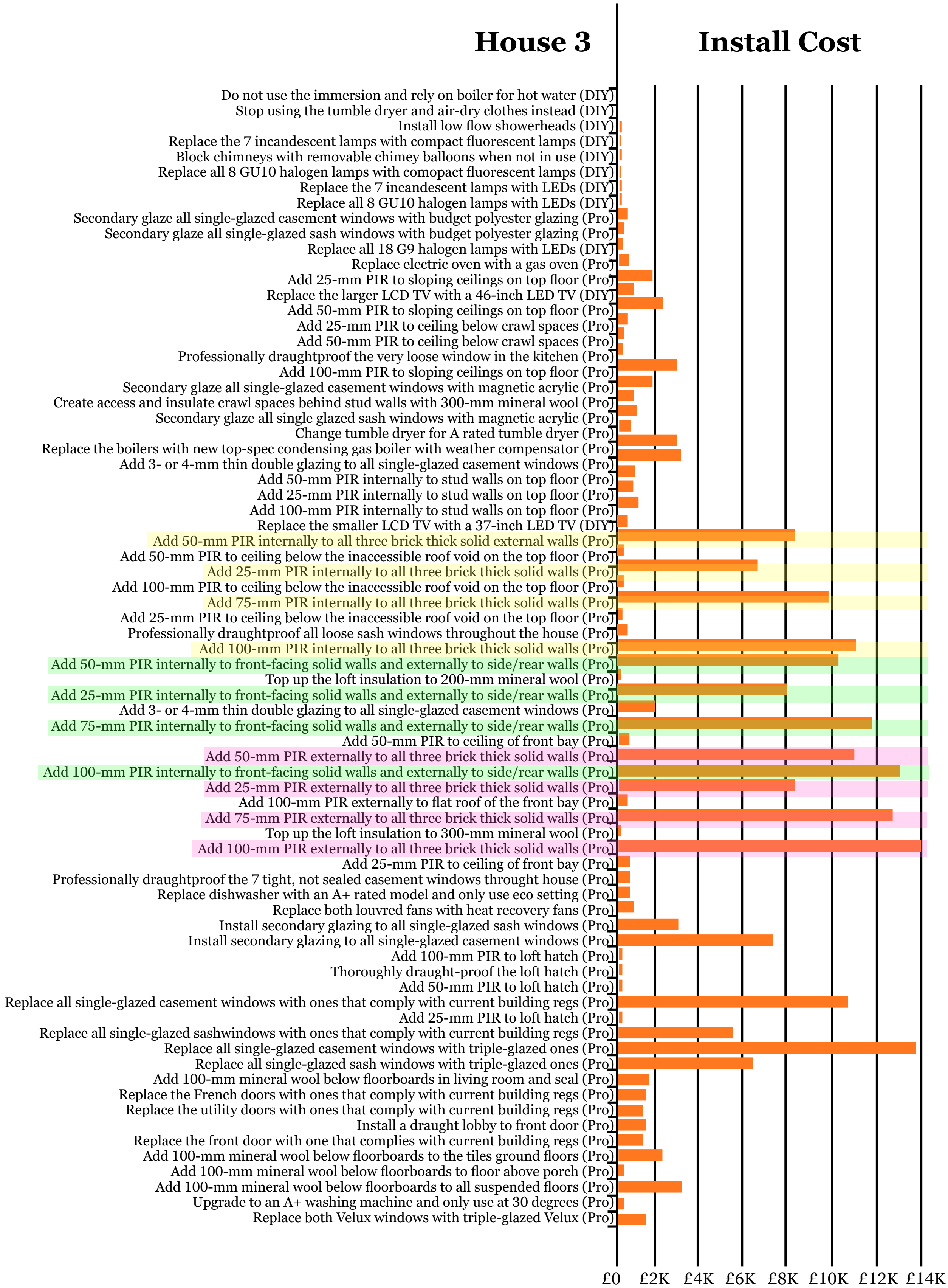

House 2
Install Cost
Stop using tumble dryer and air-dry clothes instead (DIY)
Only use the washing machine at 30 degrees (DIY)
Replace all 11 GU10 halogen lamps with compact fluorescent lamps (DIY)
Replace all 34 incandescent lamps with compact fluorescent lamps (DIY)
Block all 4 chimneys with removable chimney ballons if not in use (DIY)
Replace all 11 GU10 halogen lamps with LEDs (DIY)
Replace power shower with a standard one and install a low-flow showerhead (Pro)
Replace all 4 G9 halogen lamps with LEDs (DIY)
Replace boiler with new top-spec condensing gas boiler with weather compensator (Pro)
Secondary glaze both single-glazed wooden sash windows with budget polyester glazing (Pro)
Replace fridge freezer with new A++ rated alternative (DIY)
Replace all 34 incandescent lamps with LEDs (DIY)
Replace upright freezer with a new A++ rated alternative (DIY)
Add 25-mm PIR to the sloping ceiling areas towards the front of the top floor (Pro)
Add 50-mm PIR to the sloping ceiling areas towards the front of the top floor (Pro)
Add 25-mm PIR internally to all solid brick external walls (Pro)
Add 50-mm PIR internally to all solid brick external walls (Pro)
Add 100-mm PIR to the sloping ceiling areas towards the front of the top floor (Pro)
Add 75-mm PIR internally to all solid brick external walls (Pro)
Add 25-mm PIR to the sloping ceiling areas on the top floor of the rear projection (Pro)
Add 50-mm PIR to the sloping ceiling areas on the top floor of the rear projection (Pro)
Add 100-mm PIR internally to all solid brick external walls (Pro)
Add 25-mm PIR internally to front facing walls; externally insulate rear walls with same thickness (Pro)
Add 50-mm PIR internally to front facing walls; externally insulate rear walls with same thickness (Pro)
Add 100-mm PIR to the sloping ceiling areas on the top floor of the rear projection (Pro)
Add 25-mm PIR externally to all solid brick walls (Pro)
Replace electric oven with gas oven (Pro)
Add 75-mm PIR internally to front facing walls; externally insulate rear walls with same thickness (Pro)
Add 50-mm PIR externally to all solid brick walls (Pro)
Add 3- or 4-mm thin double glazing to both single-glazed sash windows (Pro)
Secondary glaze all single glazed wooden sash windows with magnetic acrylic (Pro)
Add 100-mm PIR internally to front facing walls; externally insulate rear walls with same thickness (Pro)
Replace the larger LCD TV in the living room with a 32-inch LED TV (DIY)
Add 75-mm PIR externally to all solid brick walls (Pro)
Add 100-mm PIR externally to all solid brick walls (Pro)
Secondary glaze single-glazed window in basement with budget polyester glazing (Pro)
Add 100-mm mineral wool below floorboards to floor above porch(Pro)
Add 50-mm PIR to top floor stud walls (Pro)
Secondary glaze single-glazed metal dormer window with budget polyester glazing (Pro)
Add 25-mm PIR to top floor stud walls (Pro)
Add 25-mm PIR to dormer cheeks (Pro)
Add 100-mm PIR to top floor stud walls (Pro)
Top up the loft insulation to 200-mm mineral wool (Pro)
Professionally draughtproof both loose sash windows (Pro)
Top up the loft insulation to 300-mm mineral wool (Pro)
Thoroughly draught-proof the loft hatch (Pro)
Secondary glaze single-glazed window in basement with magnetic acrylic (Pro)
Replace fridge with a new A++ rated alternative (DIY)
Secondary glaze single-glazed metal dormer window with magnetic acrylic (Pro)
Add 25-mm PIR to ceilings of dormers (Pro)
Replace electric oven with a new top-rated version (DIY)
Add 3- or 4-mm thin double glazing to the single-glazed window in the basement (Pro)
Add 50-mm PIR to ceilings of dormers (Pro)
Replace both single-glazed windows with ones that comply with current building regs (Pro)
Replace electric oven with a new top-rated version (Pro)
Replace both louvred fans with heat recovery fans (Pro)
Add 50-mm PIR above floor to solid floor in kitchen (Pro)
Add 50-mm PIR ceilings of front bays (Pro)
Add 50-mm PIR above floor to cellar floor (Pro)
Install secondary glazing to both single-glazed sash windows (Pro)
Add 25-mm PIR ceilings of front bays (Pro)
Add 25-mm PIR above floor to solid floor in kitchen (Pro)
Add 25-mm PIR above floor to cellar floor (Pro)
Add 100-mm PIR to the loft hatch (Pro)
Add 50-mm PIR to the loft hatch (Pro)
Replace single-glazed window in basement with one that complies with current building regs (Pro)
Replace all MR16 halogen lamps with compact fluorescent lamps (DIY)
Add 18-mm aerogel insulation to ceilings of dormers (Pro)
Replace the dishwasher with an A+ rated model and only use eco setting (Pro)
Add 25-mm PIR to the loft hatch (Pro)
Professionally draughtproof the one tight, not sealed casement window in cellar (Pro)
Install secondary glazing to the single-glazed metal dormer window (Pro)
Add 18-mm aerogel insulation to the dormer cheeks (Pro)
Add 100-mm PIR externally to the dormer roofs (Pro)
Replace single-glazed metal dormer window with one that complies with current building regs (Pro)
Replace the cellar door with one that complies with current building regs (Pro)
Install secondary glazing to the single-glazed window in the basement (Pro)
Replace all 12 MR16 halogen lamps with LEDs (Pro)
Add 18-mm aerogel insulation to ceilings of front bays (Pro)
Replace the living room doors with ones that comply with current building regs (Pro)
Replace the dining room doors with ones that comply with current building regs (Pro)
Change the tumble dryer for an A rated tumble dryer (Pro)
Replace the front door with one that complies with current building regs (Pro)
Install a draught lobby at the front door (Pro)
Replace the kitchen door with one that complies with current building regs (Pro)
Upgrade to an A+ washing machine and only use at 30 degrees (Pro)
Replace the smaller LCD TV with a 32-inch LED TV(DIY)
Add 50-mm PIR internally to cellar walls which face onto earth (Pro)
Add 25-mm PIR internally to cellar walls which face onto earth (Pro)
£0
£2K
£4K
£6K
£8K
£10K
£12K
£14K



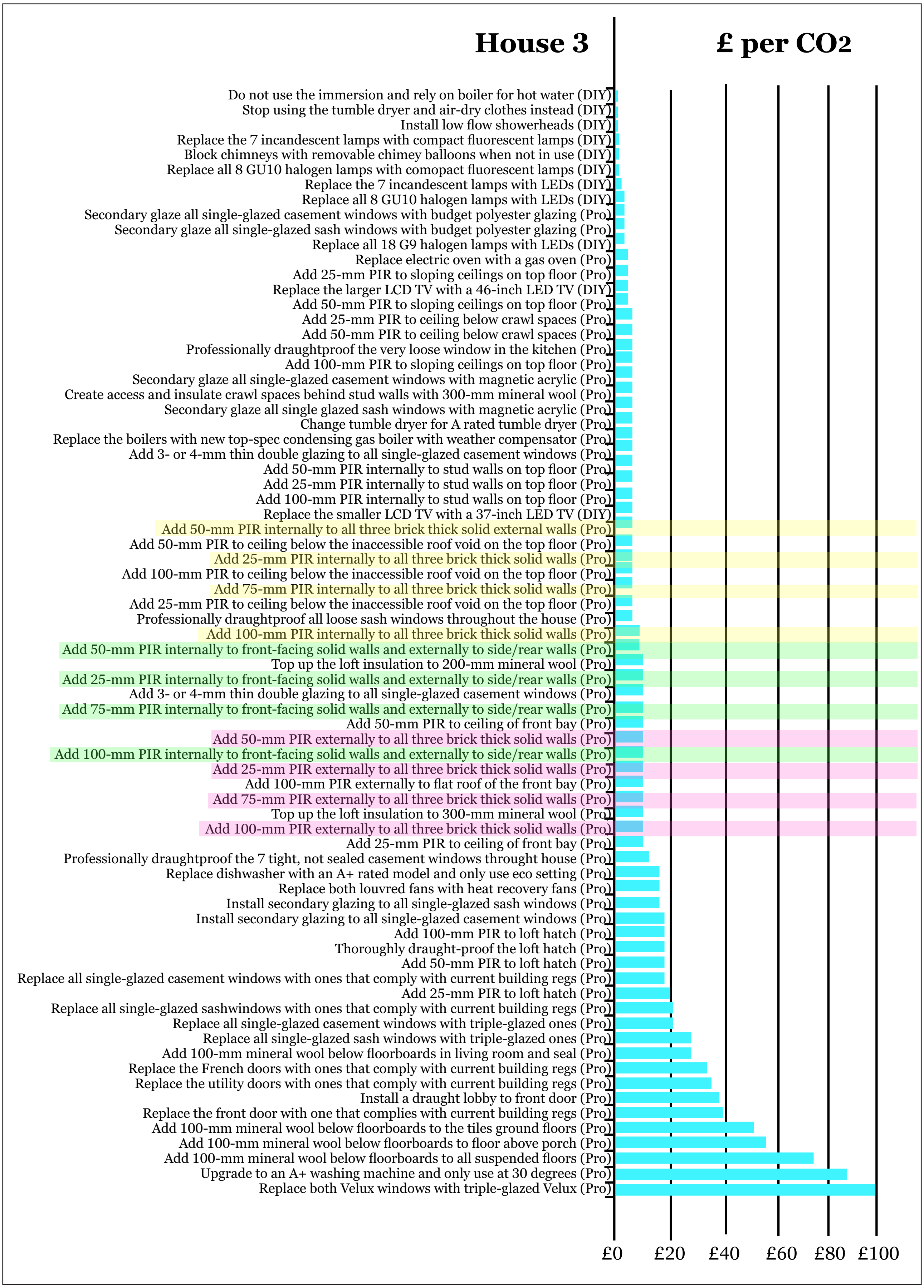
House 2
Savings
Stop using tumble dryer and air-dry clothes instead (DIY)
Only use the washing machine at 30 degrees (DIY)
Replace all 11 GU10 halogen lamps with compact fluorescent lamps (DIY)
Replace all 34 incandescent lamps with compact fluorescent lamps (DIY)
Block all 4 chimneys with removable chimney ballons if not in use (DIY)
Replace all 11 GU10 halogen lamps with LEDs (DIY)
Replace power shower with a standard one and install a low-flow showerhead (Pro)
Replace all 4 G9 halogen lamps with LEDs (DIY)
Replace boiler with new top-spec condensing gas boiler with weather compensator (Pro)
Secondary glaze both single-glazed wooden sash windows with budget polyester glazing (Pro)
Replace fridge freezer with new A++ rated alternative (DIY)
Replace all 34 incandescent lamps with LEDs (DIY)
Replace upright freezer with a new A++ rated alternative (DIY)
Add 25-mm PIR to the sloping ceiling areas towards the front of the top floor (Pro)
Add 50-mm PIR to the sloping ceiling areas towards the front of the top floor (Pro)
Add 25-mm PIR internally to all solid brick external walls (Pro)
Add 50-mm PIR internally to all solid brick external walls (Pro)
Add 100-mm PIR to the sloping ceiling areas towards the front of the top floor (Pro)
Add 75-mm PIR internally to all solid brick external walls (Pro)
Add 25-mm PIR to the sloping ceiling areas on the top floor of the rear projection (Pro)
Add 50-mm PIR to the sloping ceiling areas on the top floor of the rear projection (Pro)
Add 100-mm PIR internally to all solid brick external walls (Pro)
Add 25-mm PIR internally to front facing walls; externally insulate rear walls with same thickness (Pro)
Add 50-mm PIR internally to front facing walls; externally insulate rear walls with same thickness (Pro)
Add 100-mm PIR to the sloping ceiling areas on the top floor of the rear projection (Pro)
Add 25-mm PIR externally to all solid brick walls (Pro)
Replace electric oven with gas oven (Pro)
Add 75-mm PIR internally to front facing walls; externally insulate side/rear walls with same thickness (Pro)
Add 50-mm PIR externally to all solid brick walls (Pro)
Add 3- or 4-mm thin double glazing to both single-glazed sash windows (Pro)
Secondary glaze all single glazed wooden sash windows with magnetic acrylic (Pro)
Add 100-mm PIR internally to front facing walls; externally insulate side/rear walls with same thickness (Pro)
Replace the larger LCD TV in the living room with a 32-inch LED TV (DIY)
Add 75-mm PIR externally to all solid brick walls (Pro)
Add 100-mm PIR externally to all solid brick walls (Pro)
Secondary glaze single-glazed window in basement with budget polyester glazing (Pro)
Add 100-mm mineral wool below floorboards to floor above porch(Pro)
Add 50-mm PIR to top floor stud walls (Pro)
Secondary glaze single-glazed metal dormer window with budget polyester glazing (Pro)
Add 25-mm PIR to top floor stud walls (Pro)
Add 25-mm PIR to dormer cheeks (Pro)
Add 100-mm PIR to top floor stud walls (Pro)
Top up the loft insulation to 200-mm mineral wool (Pro)
Professionally draughtproof both loose sash windows (Pro)
Top up the loft insulation to 300-mm mineral wool (Pro)
Thoroughly draught-proof the loft hatch (Pro)
Secondary glaze single-glazed window in basement with magnetic acrylic (Pro)
Replace fridge with a new A++ rated alternative (DIY)
Secondary glaze single-glazed metal dormer window with magnetic acrylic (Pro)
Add 25-mm PIR to ceilings of dormers (Pro)
Replace electric oven with a new top-rated version (DIY)
Add 3- or 4-mm thin double glazing to the single-glazed window in the basement (Pro)
Add 50-mm PIR to ceilings of dormers (Pro)
Replace both single-glazed windows with ones that comply with current building regs (Pro)
Replace electric oven with a new top-rated version (Pro)
Replace both louvred fans with heat recovery fans (Pro)
Add 50-mm PIR above floor to solid floor in kitchen (Pro)
Add 50-mm PIR ceilings of front bays (Pro)
Add 50-mm PIR above floor to cellar floor (Pro)
Install secondary glazing to both single-glazed sash windows (Pro)
Add 25-mm PIR ceilings of front bays (Pro)
Add 25-mm PIR above floor to solid floor in kitchen (Pro)
Add 25-mm PIR above floor to cellar floor (Pro)
Add 100-mm PIR to the loft hatch (Pro)
Add 50-mm PIR to the loft hatch (Pro)
Replace single-glazed window in basement with one that complies with current building regs (Pro)
Replace all MR16 halogen lamps with compact fluorescent lamps (DIY)
Add 18-mm aerogel insulation to ceilings of dormers (Pro)
Replace the dishwasher with an A+ rated model and only use eco setting (Pro)
Add 25-mm PIR to the loft hatch (Pro)
Professionally draughtproof the one tight, not sealed casement window in cellar (Pro)
Install secondary glazing to the single-glazed metal dormer window (Pro)
Add 18-mm aerogel insulation to the dormer cheeks (Pro)
Add 100-mm PIR externally to the dormer roofs (Pro)
Replace single-glazed metal dormer window with one that complies with current building regs (Pro)
Replace the cellar door with one that complies with current building regs (Pro)
Install secondary glazing to the single-glazed window in the basement (Pro)
Replace all 12 MR16 halogen lamps with LEDs (Pro)
Add 18-mm aerogel insulation to ceilings of front bays (Pro)
Replace the living room doors with ones that comply with current building regs (Pro)
Replace the dining room doors with ones that comply with current building regs (Pro)
Change the tumble dryer for an A rated tumble dryer (Pro)
Replace the front door with one that complies with current building regs (Pro)
Install a draught lobby at the front door (Pro)
Replace the kitchen door with one that complies with current building regs (Pro)
Upgrade to an A+ washing machine and only use at 30 degrees (Pro)
Replace the smaller LCD TV with a 32-inch LED TV(DIY)
Add 50-mm PIR internally to cellar walls which face onto earth (Pro)
Add 25-mm PIR internally to cellar walls which face onto earth (Pro)
-£500
£0
£500
£1000
£1500

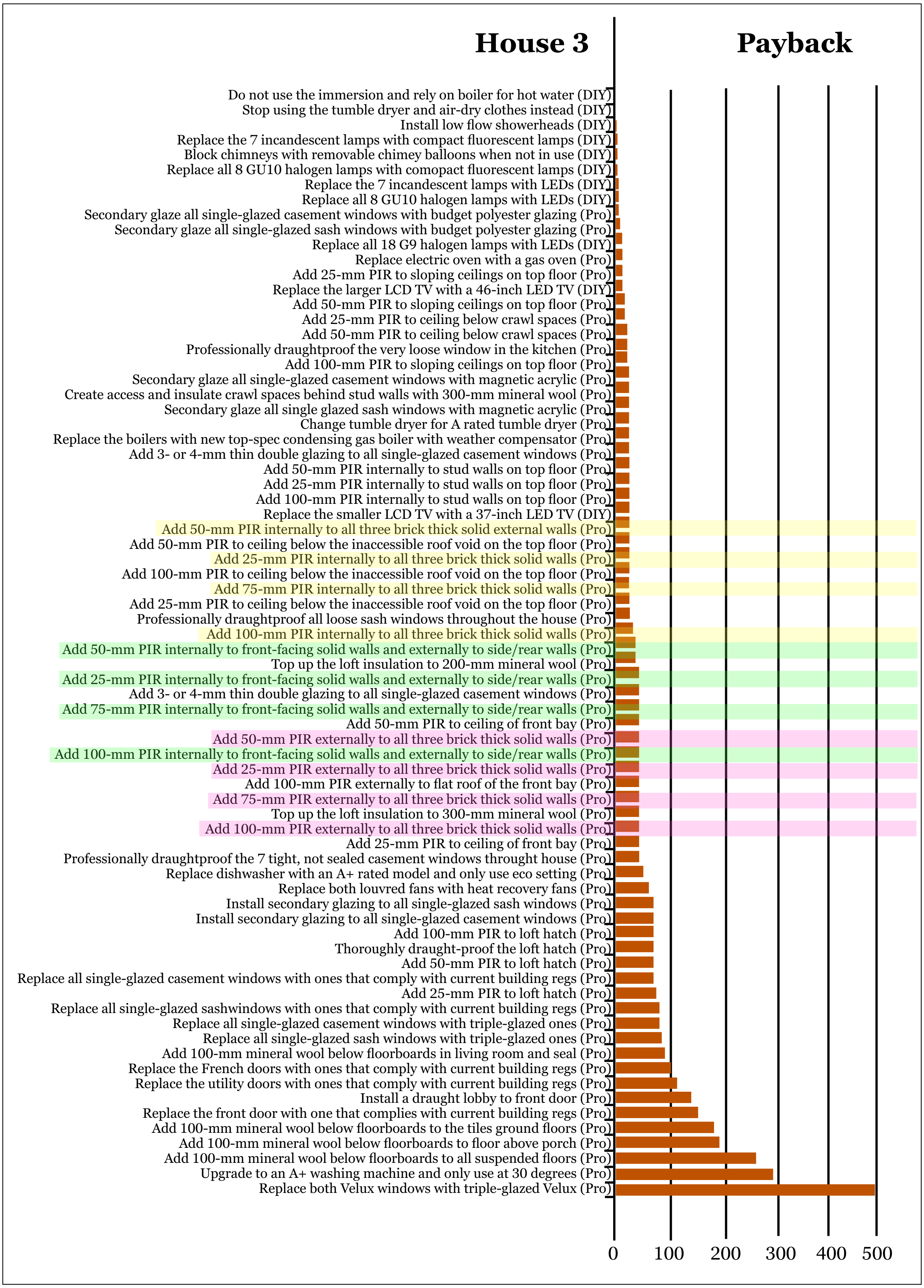

House 2
£ per CO2
Stop using tumble dryer and air-dry clothes instead (DIY)
Only use the washing machine at 30 degrees (DIY)
Replace all 11 GU10 halogen lamps with compact fluorescent lamps (DIY)
Replace all 34 incandescent lamps with compact fluorescent lamps (DIY)
Block all 4 chimneys with removable chimney ballons if not in use (DIY)
Replace all 11 GU10 halogen lamps with LEDs (DIY)
Replace power shower with a standard one and install a low-flow showerhead (Pro)
Replace all 4 G9 halogen lamps with LEDs (DIY)
Replace boiler with new top-spec condensing gas boiler with weather compensator (Pro)
Secondary glaze both single-glazed wooden sash windows with budget polyester glazing (Pro)
Replace fridge freezer with new A++ rated alternative (DIY)
Replace all 34 incandescent lamps with LEDs (DIY)
Replace upright freezer with a new A++ rated alternative (DIY)
Add 25-mm PIR to the sloping ceiling areas towards the front of the top floor (Pro)
Add 50-mm PIR to the sloping ceiling areas towards the front of the top floor (Pro)
Add 25-mm PIR internally to all solid brick external walls (Pro)
Add 50-mm PIR internally to all solid brick external walls (Pro)
Add 100-mm PIR to the sloping ceiling areas towards the front of the top floor (Pro)
Add 75-mm PIR internally to all solid brick external walls (Pro)
Add 25-mm PIR to the sloping ceiling areas on the top floor of the rear projection (Pro)
Add 50-mm PIR to the sloping ceiling areas on the top floor of the rear projection (Pro)
Add 100-mm PIR internally to all solid brick external walls (Pro)
Add 25-mm PIR internally to front facing walls; externally insulate rear walls with same thickness (Pro)
Add 50-mm PIR internally to front facing walls; externally insulate rear walls with same thickness (Pro)
Add 100-mm PIR to the sloping ceiling areas on the top floor of the rear projection (Pro)
Add 25-mm PIR externally to all solid brick walls (Pro)
Replace electric oven with gas oven (Pro)
Add 75-mm PIR internally to front facing walls; externally insulate rear walls with same thickness (Pro)
Add 50-mm PIR externally to all solid brick walls (Pro)
Add 3- or 4-mm thin double glazing to both single-glazed sash windows (Pro)
Secondary glaze all single glazed wooden sash windows with magnetic acrylic (Pro)
Add 100-mm PIR internally to front facing walls; externally insulate rear walls with same thickness (Pro)
Replace the larger LCD TV in the living room with a 32-inch LED TV (DIY)
Add 75-mm PIR externally to all solid brick walls (Pro)
Add 100-mm PIR externally to all solid brick walls (Pro)
Secondary glaze single-glazed window in basement with budget polyester glazing (Pro)
Add 100-mm mineral wool below floorboards to floor above porch(Pro)
Add 50-mm PIR to top floor stud walls (Pro)
Secondary glaze single-glazed metal dormer window with budget polyester glazing (Pro)
Add 25-mm PIR to top floor stud walls (Pro)
Add 25-mm PIR to dormer cheeks (Pro)
Add 100-mm PIR to top floor stud walls (Pro)
Top up the loft insulation to 200-mm mineral wool (Pro)
Professionally draughtproof both loose sash windows (Pro)
Top up the loft insulation to 300-mm mineral wool (Pro)
Thoroughly draught-proof the loft hatch (Pro)
Secondary glaze single-glazed window in basement with magnetic acrylic (Pro)
Replace fridge with a new A++ rated alternative (DIY)
Secondary glaze single-glazed metal dormer window with magnetic acrylic (Pro)
Add 25-mm PIR to ceilings of dormers (Pro)
Replace electric oven with a new top-rated version (DIY)
Add 3- or 4-mm thin double glazing to the single-glazed window in the basement (Pro)
Add 50-mm PIR to ceilings of dormers (Pro)
Replace both single-glazed windows with ones that comply with current building regs (Pro)
Replace electric oven with a new top-rated version (Pro)
Replace both louvred fans with heat recovery fans (Pro)
Add 50-mm PIR above floor to solid floor in kitchen (Pro)
Add 50-mm PIR ceilings of front bays (Pro)
Add 50-mm PIR above floor to cellar floor (Pro)
Install secondary glazing to both single-glazed sash windows (Pro)
Add 25-mm PIR ceilings of front bays (Pro)
Add 25-mm PIR above floor to solid floor in kitchen (Pro)
Add 25-mm PIR above floor to cellar floor (Pro)
Add 100-mm PIR to the loft hatch (Pro)
Add 50-mm PIR to the loft hatch (Pro)
Replace single-glazed window in basement with one that complies with current building regs (Pro)
Replace all MR16 halogen lamps with compact fluorescent lamps (DIY)
Add 18-mm aerogel insulation to ceilings of dormers (Pro)
Replace the dishwasher with an A+ rated model and only use eco setting (Pro)
Add 25-mm PIR to the loft hatch (Pro)
Professionally draughtproof the one tight, not sealed casement window in cellar (Pro)
Install secondary glazing to the single-glazed metal dormer window (Pro)
Add 18-mm aerogel insulation to the dormer cheeks (Pro)
Add 100-mm PIR externally to the dormer roofs (Pro)
Replace single-glazed metal dormer window with one that complies with current building regs (Pro)
Replace the cellar door with one that complies with current building regs (Pro)
Install secondary glazing to the single-glazed window in the basement (Pro)
Replace all 12 MR16 halogen lamps with LEDs (Pro)
Add 18-mm aerogel insulation to ceilings of front bays (Pro)
Replace the living room doors with ones that comply with current building regs (Pro)
Replace the dining room doors with ones that comply with current building regs (Pro)
Change the tumble dryer for an A rated tumble dryer (Pro)
Replace the front door with one that complies with current building regs (Pro)
Install a draught lobby at the front door (Pro)
Replace the kitchen door with one that complies with current building regs (Pro)
Upgrade to an A+ washing machine and only use at 30 degrees (Pro)
Replace the smaller LCD TV with a 32-inch LED TV(DIY)
Add 50-mm PIR internally to cellar walls which face onto earth (Pro)
Add 25-mm PIR internally to cellar walls which face onto earth (Pro)
£0
£20
£40
£60
£80
£100

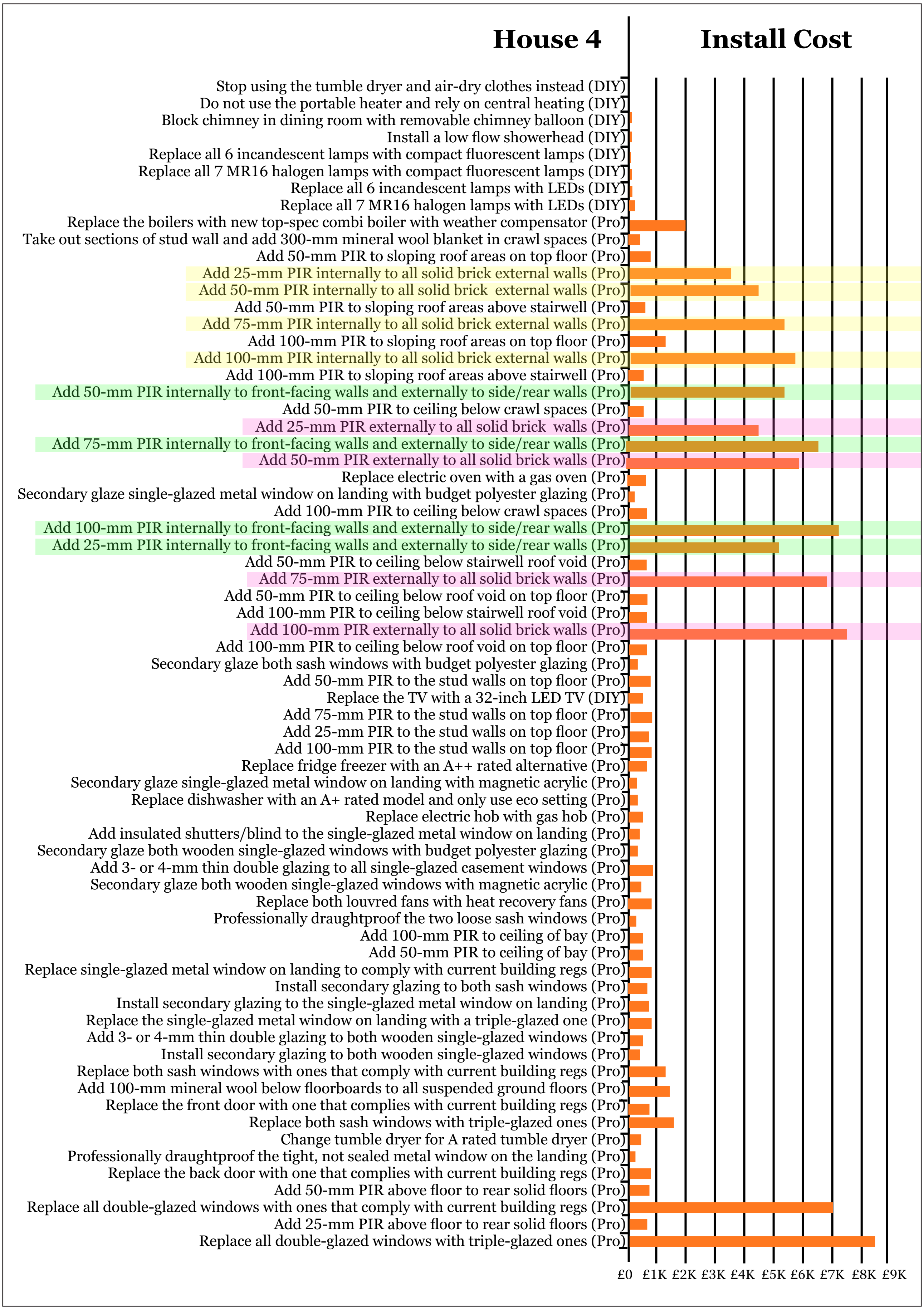

House 2
Payback
Stop using tumble dryer and air-dry clothes instead (DIY)
Only use the washing machine at 30 degrees (DIY)
Replace all 11 GU10 halogen lamps with compact fluorescent lamps (DIY)
Replace all 34 incandescent lamps with compact fluorescent lamps (DIY)
Block all 4 chimneys with removable chimney ballons if not in use (DIY)
Replace all 11 GU10 halogen lamps with LEDs (DIY)
Replace power shower with a standard one and install a low-flow showerhead (Pro)
Replace all 4 G9 halogen lamps with LEDs (DIY)
Replace boiler with new top-spec condensing gas boiler with weather compensator (Pro)
Secondary glaze both single-glazed wooden sash windows with budget polyester glazing (Pro)
Replace fridge freezer with new A++ rated alternative (DIY)
Replace all 34 incandescent lamps with LEDs (DIY)
Replace upright freezer with a new A++ rated alternative (DIY)
Add 25-mm PIR to the sloping ceiling areas towards the front of the top floor (Pro)
Add 50-mm PIR to the sloping ceiling areas towards the front of the top floor (Pro)
Add 25-mm PIR internally to all solid brick external walls (Pro)
Add 50-mm PIR internally to all solid brick external walls (Pro)
Add 100-mm PIR to the sloping ceiling areas towards the front of the top floor (Pro)
Add 75-mm PIR internally to all solid brick external walls (Pro)
Add 25-mm PIR to the sloping ceiling areas on the top floor of the rear projection (Pro)
Add 50-mm PIR to the sloping ceiling areas on the top floor of the rear projection (Pro)
Add 100-mm PIR internally to all solid brick external walls (Pro)
Add 25-mm PIR internally to front facing walls; externally insulate rear walls with same thickness (Pro)
Add 50-mm PIR internally to front facing walls; externally insulate rear walls with same thickness (Pro)
Add 100-mm PIR to the sloping ceiling areas on the top floor of the rear projection (Pro)
Add 25-mm PIR externally to all solid brick walls (Pro)
Replace electric oven with gas oven (Pro)
Add 75-mm PIR internally to front facing walls; externally insulate rear walls with same thickness (Pro)
Add 50-mm PIR externally to all solid brick walls (Pro)
Add 3- or 4-mm thin double glazing to both single-glazed sash windows (Pro)
Secondary glaze all single glazed wooden sash windows with magnetic acrylic (Pro)
Add 100-mm PIR internally to front facing walls; externally insulate rear walls with same thickness (Pro)
Replace the larger LCD TV in the living room with a 32-inch LED TV (DIY)
Add 75-mm PIR externally to all solid brick walls (Pro)
Add 100-mm PIR externally to all solid brick walls (Pro)
Secondary glaze single-glazed window in basement with budget polyester glazing (Pro)
Add 100-mm mineral wool below floorboards to floor above porch(Pro)
Add 50-mm PIR to top floor stud walls (Pro)
Secondary glaze single-glazed metal dormer window with budget polyester glazing (Pro)
Add 25-mm PIR to top floor stud walls (Pro)
Add 25-mm PIR to dormer cheeks (Pro)
Add 100-mm PIR to top floor stud walls (Pro)
Top up the loft insulation to 200-mm mineral wool (Pro)
Professionally draughtproof both loose sash windows (Pro)
Top up the loft insulation to 300-mm mineral wool (Pro)
Thoroughly draught-proof the loft hatch (Pro)
Secondary glaze single-glazed window in basement with magnetic acrylic (Pro)
Replace fridge with a new A++ rated alternative (DIY)
Secondary glaze single-glazed metal dormer window with magnetic acrylic (Pro)
Add 25-mm PIR to ceilings of dormers (Pro)
Replace electric oven with a new top-rated version (DIY)
Add 3- or 4-mm thin double glazing to the single-glazed window in the basement (Pro)
Add 50-mm PIR to ceilings of dormers (Pro)
Replace both single-glazed windows with ones that comply with current building regs (Pro)
Replace electric oven with a new top-rated version (Pro)
Replace both louvred fans with heat recovery fans (Pro)
Add 50-mm PIR above floor to solid floor in kitchen (Pro)
Add 50-mm PIR ceilings of front bays (Pro)
Add 50-mm PIR above floor to cellar floor (Pro)
Install secondary glazing to both single-glazed sash windows (Pro)
Add 25-mm PIR ceilings of front bays (Pro)
Add 25-mm PIR above floor to solid floor in kitchen (Pro)
Add 25-mm PIR above floor to cellar floor (Pro)
Add 100-mm PIR to the loft hatch (Pro)
Add 50-mm PIR to the loft hatch (Pro)
Replace single-glazed window in basement with one that complies with current building regs (Pro)
Replace all MR16 halogen lamps with compact fluorescent lamps (DIY)
Add 18-mm aerogel insulation to ceilings of dormers (Pro)
Replace the dishwasher with an A+ rated model and only use eco setting (Pro)
Add 25-mm PIR to the loft hatch (Pro)
Professionally draughtproof the one tight, not sealed casement window in cellar (Pro)
Install secondary glazing to the single-glazed metal dormer window (Pro)
Add 18-mm aerogel insulation to the dormer cheeks (Pro)
Add 100-mm PIR externally to the dormer roofs (Pro)
Replace single-glazed metal dormer window with one that complies with current building regs (Pro)
Replace the cellar door with one that complies with current building regs (Pro)
Install secondary glazing to the single-glazed window in the basement (Pro)
Replace all 12 MR16 halogen lamps with LEDs (Pro)
Add 18-mm aerogel insulation to ceilings of front bays (Pro)
Replace the living room doors with ones that comply with current building regs (Pro)
Replace the dining room doors with ones that comply with current building regs (Pro)
Change the tumble dryer for an A rated tumble dryer (Pro)
Replace the front door with one that complies with current building regs (Pro)
Install a draught lobby at the front door (Pro)
Replace the kitchen door with one that complies with current building regs (Pro)
Upgrade to an A+ washing machine and only use at 30 degrees (Pro)
Replace the smaller LCD TV with a 32-inch LED TV(DIY)
Add 50-mm PIR internally to cellar walls which face onto earth (Pro)
Add 25-mm PIR internally to cellar walls which face onto earth (Pro)
0
50
100
150
200
250
300
35

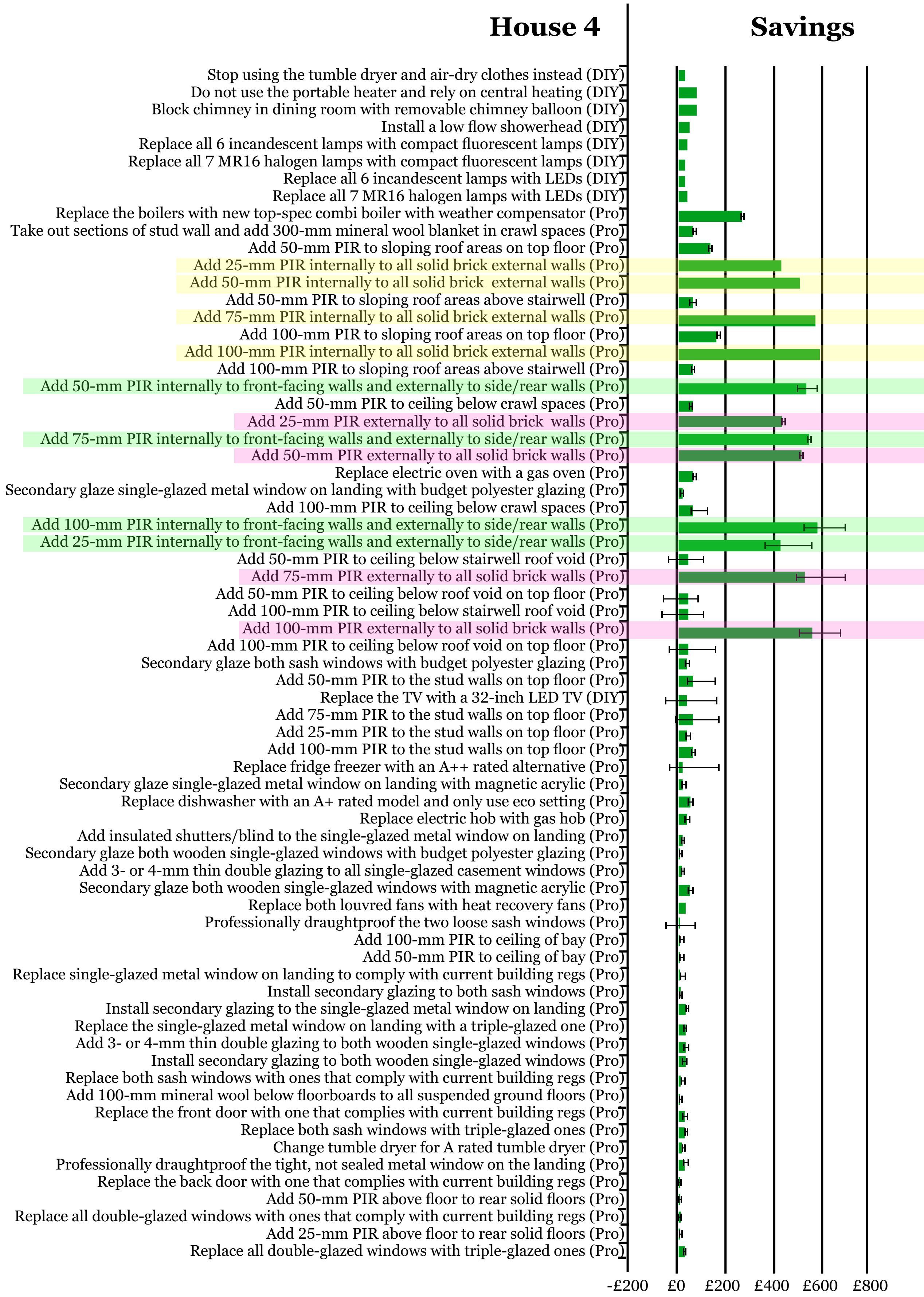

House 3
Install Cost
Do not use the immersion and rely on boiler for hot water (DIY)
Stop using the tumble dryer and air-dry clothes instead (DIY)
Install low flow showerheads (DIY)
Replace the 7 incandescent lamps with compact fluorescent lamps (DIY)
Block chimneys with removable chimey balloons when not in use (DIY)
Replace all 8 GU10 halogen lamps with comopact fluorescent lamps (DIY)
Replace the 7 incandescent lamps with LEDs (DIY)
Replace all 8 GU10 halogen lamps with LEDs (DIY)
Secondary glaze all single-glazed casement windows with budget polyester glazing (Pro)
Secondary glaze all single-glazed sash windows with budget polyester glazing (Pro)
Replace all 18 G9 halogen lamps with LEDs (DIY)
Replace electric oven with a gas oven (Pro)
Add 25-mm PIR to sloping ceilings on top floor (Pro)
Replace the larger LCD TV with a 46-inch LED TV (DIY)
Add 50-mm PIR to sloping ceilings on top floor (Pro)
Add 25-mm PIR to ceiling below crawl spaces (Pro)
Add 50-mm PIR to ceiling below crawl spaces (Pro)
Professionally draughtproof the very loose window in the kitchen (Pro)
Add 100-mm PIR to sloping ceilings on top floor (Pro)
Secondary glaze all single-glazed casement windows with magnetic acrylic (Pro)
Create access and insulate crawl spaces behind stud walls with 300-mm mineral wool (Pro)
Secondary glaze all single glazed sash windows with magnetic acrylic (Pro)
Change tumble dryer for A rated tumble dryer (Pro)
Replace the boilers with new top-spec condensing gas boiler with weather compensator (Pro)
Add 3- or 4-mm thin double glazing to all single-glazed casement windows (Pro)
Add 50-mm PIR internally to stud walls on top floor (Pro)
Add 25-mm PIR internally to stud walls on top floor (Pro)
Add 100-mm PIR internally to stud walls on top floor (Pro)
Replace the smaller LCD TV with a 37-inch LED TV (DIY)
Add 50-mm PIR internally to all three brick thick solid external walls (Pro)
Add 50-mm PIR to ceiling below the inaccessible roof void on the top floor (Pro)
Add 25-mm PIR internally to all three brick thick solid walls (Pro)
Add 100-mm PIR to ceiling below the inaccessible roof void on the top floor (Pro)
Add 75-mm PIR internally to all three brick thick solid walls (Pro)
Add 25-mm PIR to ceiling below the inaccessible roof void on the top floor (Pro)
Professionally draughtproof all loose sash windows throughout the house (Pro)
Add 100-mm PIR internally to all three brick thick solid walls (Pro)
Add 50-mm PIR internally to front-facing solid walls and externally to side/rear walls (Pro)
Top up the loft insulation to 200-mm mineral wool (Pro)
Add 25-mm PIR internally to front-facing solid walls and externally to side/rear walls (Pro)
Add 3- or 4-mm thin double glazing to all single-glazed sash windows (Pro)
Add 75-mm PIR internally to front-facing solid walls and externally to side/rear walls (Pro)
Add 50-mm PIR to ceiling of front bay (Pro)
Add 50-mm PIR externally to all three brick thick solid walls (Pro)
Add 100-mm PIR internally to front-facing solid walls and externally to side/rear walls (Pro)
Add 25-mm PIR externally to all three brick thick solid walls (Pro)
Add 100-mm PIR externally to flat roof of the front bay (Pro)
Add 75-mm PIR externally to all three brick thick solid walls (Pro)
Top up the loft insulation to 300-mm mineral wool (Pro)
Add 100-mm PIR externally to all three brick thick solid walls (Pro)
Add 25-mm PIR to ceiling of front bay (Pro)
Professionally draughtproof the 7 tight, not sealed casement windows throught house (Pro)
Replace dishwasher with an A+ rated model and only use eco setting (Pro)
Replace both louvred fans with heat recovery fans (Pro)
Install secondary glazing to all single-glazed sash windows (Pro)
Install secondary glazing to all single-glazed casement windows (Pro)
Add 100-mm PIR to loft hatch (Pro)
Thoroughly draught-proof the loft hatch (Pro)
Add 50-mm PIR to loft hatch (Pro)
Replace all single-glazed casement windows with ones that comply with current building regs (Pro)
Add 25-mm PIR to loft hatch (Pro)
Replace all single-glazed sashwindows with ones that comply with current building regs (Pro)
Replace all single-glazed casement windows with triple-glazed ones (Pro)
Replace all single-glazed sash windows with triple-glazed ones (Pro)
Add 100-mm mineral wool below floorboards in living room and seal (Pro)
Replace the French doors with ones that comply with current building regs (Pro)
Replace the utility doors with ones that comply with current building regs (Pro)
Install a draught lobby to front door (Pro)
Replace the front door with one that complies with current building regs (Pro)
Add 100-mm mineral wool below floorboards to the tiles ground floors (Pro)
Add 100-mm mineral wool below floorboards to floor above porch (Pro)
Add 100-mm mineral wool below floorboards to all suspended floors (Pro)
Upgrade to an A+ washing machine and only use at 30 degrees (Pro)
Replace both Velux windows with triple-glazed Velux (Pro)
£0
£2K
£4K
£6K
£8K
£10K
£12K
£14K


House 3
Savings
Do not use the immersion and rely on boiler for hot water (DIY)
Stop using the tumble dryer and air-dry clothes instead (DIY)
Install low flow showerheads (DIY)
Replace the 7 incandescent lamps with compact fluorescent lamps (DIY)
Block chimneys with removable chimey balloons when not in use (DIY)
Replace all 8 GU10 halogen lamps with comopact fluorescent lamps (DIY)
Replace the 7 incandescent lamps with LEDs (DIY)
Replace all 8 GU10 halogen lamps with LEDs (DIY)
Secondary glaze all single-glazed casement windows with budget polyester glazing (Pro)
Secondary glaze all single-glazed sash windows with budget polyester glazing (Pro)
Replace all 18 G9 halogen lamps with LEDs (DIY)
Replace electric oven with a gas oven (Pro)
Add 25-mm PIR to sloping ceilings on top floor (Pro)
Replace the larger LCD TV with a 46-inch LED TV (DIY)
Add 50-mm PIR to sloping ceilings on top floor (Pro)
Add 25-mm PIR to ceiling below crawl spaces (Pro)
Add 50-mm PIR to ceiling below crawl spaces (Pro)
Professionally draughtproof the very loose window in the kitchen (Pro)
Add 100-mm PIR to sloping ceilings on top floor (Pro)
Secondary glaze all single-glazed casement windows with magnetic acrylic (Pro)
Create access and insulate crawl spaces behind stud walls with 300-mm mineral wool (Pro)
Secondary glaze all single glazed sash windows with magnetic acrylic (Pro)
Change tumble dryer for A rated tumble dryer (Pro)
Replace the boilers with new top-spec condensing gas boiler with weather compensator (Pro)
Add 3- or 4-mm thin double glazing to all single-glazed casement windows (Pro)
Add 50-mm PIR internally to stud walls on top floor (Pro)
Add 25-mm PIR internally to stud walls on top floor (Pro)
Add 100-mm PIR internally to stud walls on top floor (Pro)
Replace the smaller LCD TV with a 37-inch LED TV (DIY)
Add 50-mm PIR internally to all three brick thick solid external walls (Pro)
Add 50-mm PIR to ceiling below the inaccessible roof void on the top floor (Pro)
Add 25-mm PIR internally to all three brick thick solid walls (Pro)
Add 100-mm PIR to ceiling below the inaccessible roof void on the top floor (Pro)
Add 75-mm PIR internally to all three brick thick solid walls (Pro)
Add 25-mm PIR to ceiling below the inaccessible roof void on the top floor (Pro)
Professionally draughtproof all loose sash windows throughout the house (Pro)
Add 100-mm PIR internally to all three brick thick solid walls (Pro)
Add 50-mm PIR internally to front-facing solid walls and externally to side/rear walls (Pro)
Top up the loft insulation to 200-mm mineral wool (Pro)
Add 25-mm PIR internally to front-facing solid walls and externally to side/rear walls (Pro)
Add 3- or 4-mm thin double glazing to all single-glazed casement windows (Pro)
Add 75-mm PIR internally to front-facing solid walls and externally to side/rear walls (Pro)
Add 50-mm PIR to ceiling of front bay (Pro)
Add 50-mm PIR externally to all three brick thick solid walls (Pro)
Add 100-mm PIR internally to front-facing solid walls and externally to side/rear walls (Pro)
Add 25-mm PIR externally to all three brick thick solid walls (Pro)
Add 100-mm PIR externally to flat roof of the front bay (Pro)
Add 75-mm PIR externally to all three brick thick solid walls (Pro)
Top up the loft insulation to 300-mm mineral wool (Pro)
Add 100-mm PIR externally to all three brick thick solid walls (Pro)
Add 25-mm PIR to ceiling of front bay (Pro)
Professionally draughtproof the 7 tight, not sealed casement windows throught house (Pro)
Replace dishwasher with an A+ rated model and only use eco setting (Pro)
Replace both louvred fans with heat recovery fans (Pro)
Install secondary glazing to all single-glazed sash windows (Pro)
Install secondary glazing to all single-glazed casement windows (Pro)
Add 100-mm PIR to loft hatch (Pro)
Thoroughly draught-proof the loft hatch (Pro)
Add 50-mm PIR to loft hatch (Pro)
Replace all single-glazed casement windows with ones that comply with current building regs (Pro)
Add 25-mm PIR to loft hatch (Pro)
Replace all single-glazed sashwindows with ones that comply with current building regs (Pro)
Replace all single-glazed casement windows with triple-glazed ones (Pro)
Replace all single-glazed sash windows with triple-glazed ones (Pro)
Add 100-mm mineral wool below floorboards in living room and seal (Pro)
Replace the French doors with ones that comply with current building regs (Pro)
Replace the utility doors with ones that comply with current building regs (Pro)
Install a draught lobby to front door (Pro)
Replace the front door with one that complies with current building regs (Pro)
Add 100-mm mineral wool below floorboards to the tiles ground floors (Pro)
Add 100-mm mineral wool below floorboards to floor above porch (Pro)
Add 100-mm mineral wool below floorboards to all suspended floors (Pro)
Upgrade to an A+ washing machine and only use at 30 degrees (Pro)
Replace both Velux windows with triple-glazed Velux (Pro)
-£200
£0
£200
£400
£600

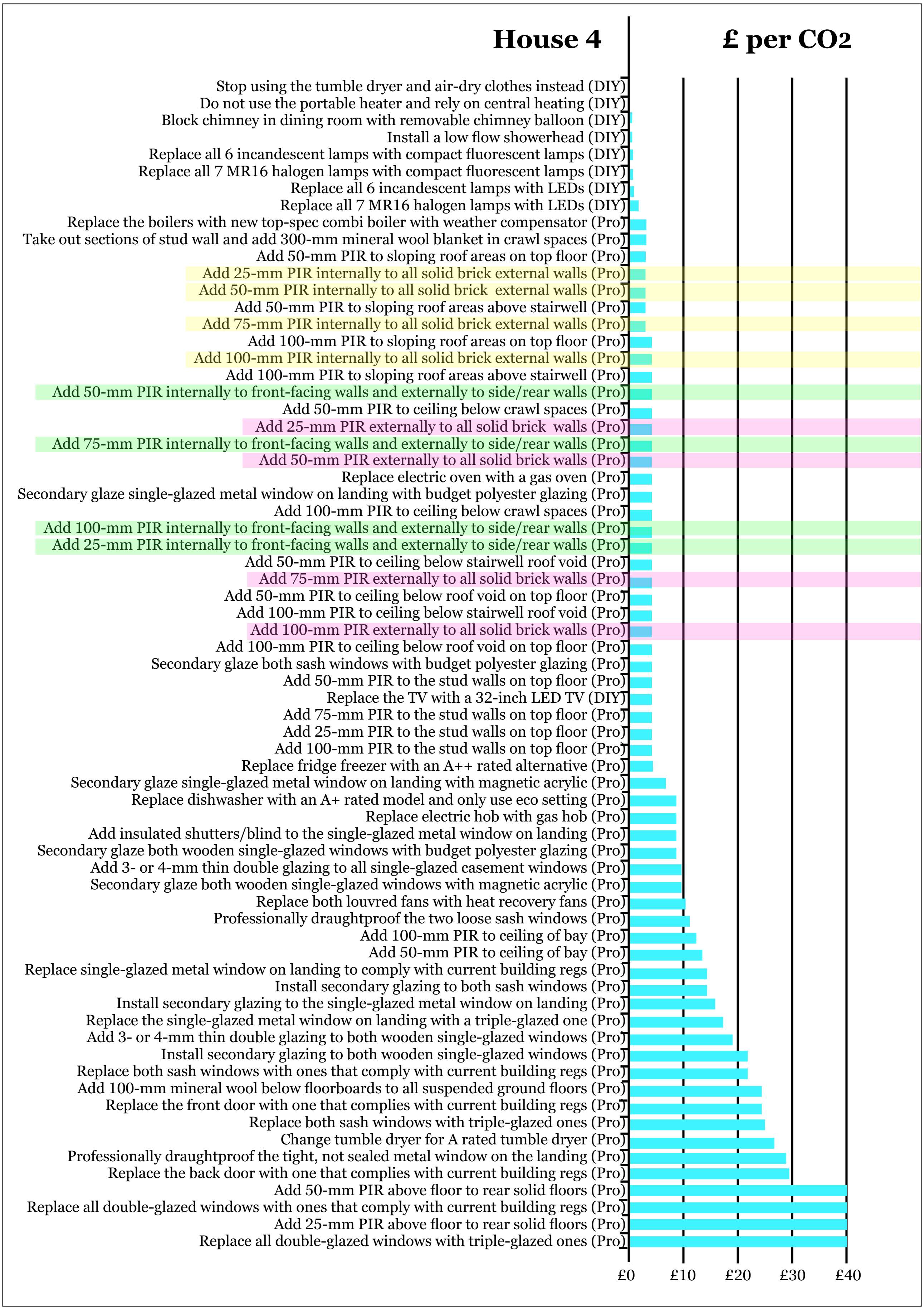

House 3
£ per CO2
Do not use the immersion and rely on boiler for hot water (DIY)
Stop using the tumble dryer and air-dry clothes instead (DIY)
Install low flow showerheads (DIY)
Replace the 7 incandescent lamps with compact fluorescent lamps (DIY)
Block chimneys with removable chimey balloons when not in use (DIY)
Replace all 8 GU10 halogen lamps with comopact fluorescent lamps (DIY)
Replace the 7 incandescent lamps with LEDs (DIY)
Replace all 8 GU10 halogen lamps with LEDs (DIY)
Secondary glaze all single-glazed casement windows with budget polyester glazing (Pro)
Secondary glaze all single-glazed sash windows with budget polyester glazing (Pro)
Replace all 18 G9 halogen lamps with LEDs (DIY)
Replace electric oven with a gas oven (Pro)
Add 25-mm PIR to sloping ceilings on top floor (Pro)
Replace the larger LCD TV with a 46-inch LED TV (DIY)
Add 50-mm PIR to sloping ceilings on top floor (Pro)
Add 25-mm PIR to ceiling below crawl spaces (Pro)
Add 50-mm PIR to ceiling below crawl spaces (Pro)
Professionally draughtproof the very loose window in the kitchen (Pro)
Add 100-mm PIR to sloping ceilings on top floor (Pro)
Secondary glaze all single-glazed casement windows with magnetic acrylic (Pro)
Create access and insulate crawl spaces behind stud walls with 300-mm mineral wool (Pro)
Secondary glaze all single glazed sash windows with magnetic acrylic (Pro)
Change tumble dryer for A rated tumble dryer (Pro)
Replace the boilers with new top-spec condensing gas boiler with weather compensator (Pro)
Add 3- or 4-mm thin double glazing to all single-glazed casement windows (Pro)
Add 50-mm PIR internally to stud walls on top floor (Pro)
Add 25-mm PIR internally to stud walls on top floor (Pro)
Add 100-mm PIR internally to stud walls on top floor (Pro)
Replace the smaller LCD TV with a 37-inch LED TV (DIY)
Add 50-mm PIR internally to all three brick thick solid external walls (Pro)
Add 50-mm PIR to ceiling below the inaccessible roof void on the top floor (Pro)
Add 25-mm PIR internally to all three brick thick solid walls (Pro)
Add 100-mm PIR to ceiling below the inaccessible roof void on the top floor (Pro)
Add 75-mm PIR internally to all three brick thick solid walls (Pro)
Add 25-mm PIR to ceiling below the inaccessible roof void on the top floor (Pro)
Professionally draughtproof all loose sash windows throughout the house (Pro)
Add 100-mm PIR internally to all three brick thick solid walls (Pro)
Add 50-mm PIR internally to front-facing solid walls and externally to side/rear walls (Pro)
Top up the loft insulation to 200-mm mineral wool (Pro)
Add 25-mm PIR internally to front-facing solid walls and externally to side/rear walls (Pro)
Add 3- or 4-mm thin double glazing to all single-glazed casement windows (Pro)
Add 75-mm PIR internally to front-facing solid walls and externally to side/rear walls (Pro)
Add 50-mm PIR to ceiling of front bay (Pro)
Add 50-mm PIR externally to all three brick thick solid walls (Pro)
Add 100-mm PIR internally to front-facing solid walls and externally to side/rear walls (Pro)
Add 25-mm PIR externally to all three brick thick solid walls (Pro)
Add 100-mm PIR externally to flat roof of the front bay (Pro)
Add 75-mm PIR externally to all three brick thick solid walls (Pro)
Top up the loft insulation to 300-mm mineral wool (Pro)
Add 100-mm PIR externally to all three brick thick solid walls (Pro)
Add 25-mm PIR to ceiling of front bay (Pro)
Professionally draughtproof the 7 tight, not sealed casement windows throught house (Pro)
Replace dishwasher with an A+ rated model and only use eco setting (Pro)
Replace both louvred fans with heat recovery fans (Pro)
Install secondary glazing to all single-glazed sash windows (Pro)
Install secondary glazing to all single-glazed casement windows (Pro)
Add 100-mm PIR to loft hatch (Pro)
Thoroughly draught-proof the loft hatch (Pro)
Add 50-mm PIR to loft hatch (Pro)
Replace all single-glazed casement windows with ones that comply with current building regs (Pro)
Add 25-mm PIR to loft hatch (Pro)
Replace all single-glazed sashwindows with ones that comply with current building regs (Pro)
Replace all single-glazed casement windows with triple-glazed ones (Pro)
Replace all single-glazed sash windows with triple-glazed ones (Pro)
Add 100-mm mineral wool below floorboards in living room and seal (Pro)
Replace the French doors with ones that comply with current building regs (Pro)
Replace the utility doors with ones that comply with current building regs (Pro)
Install a draught lobby to front door (Pro)
Replace the front door with one that complies with current building regs (Pro)
Add 100-mm mineral wool below floorboards to the tiles ground floors (Pro)
Add 100-mm mineral wool below floorboards to floor above porch (Pro)
Add 100-mm mineral wool below floorboards to all suspended floors (Pro)
Upgrade to an A+ washing machine and only use at 30 degrees (Pro)
Replace both Velux windows with triple-glazed Velux (Pro)
£0
£20
£40
£60
£80
£100


House 3
Payback
Do not use the immersion and rely on boiler for hot water (DIY)
Stop using the tumble dryer and air-dry clothes instead (DIY)
Install low flow showerheads (DIY)
Replace the 7 incandescent lamps with compact fluorescent lamps (DIY)
Block chimneys with removable chimey balloons when not in use (DIY)
Replace all 8 GU10 halogen lamps with comopact fluorescent lamps (DIY)
Replace the 7 incandescent lamps with LEDs (DIY)
Replace all 8 GU10 halogen lamps with LEDs (DIY)
Secondary glaze all single-glazed casement windows with budget polyester glazing (Pro)
Secondary glaze all single-glazed sash windows with budget polyester glazing (Pro)
Replace all 18 G9 halogen lamps with LEDs (DIY)
Replace electric oven with a gas oven (Pro)
Add 25-mm PIR to sloping ceilings on top floor (Pro)
Replace the larger LCD TV with a 46-inch LED TV (DIY)
Add 50-mm PIR to sloping ceilings on top floor (Pro)
Add 25-mm PIR to ceiling below crawl spaces (Pro)
Add 50-mm PIR to ceiling below crawl spaces (Pro)
Professionally draughtproof the very loose window in the kitchen (Pro)
Add 100-mm PIR to sloping ceilings on top floor (Pro)
Secondary glaze all single-glazed casement windows with magnetic acrylic (Pro)
Create access and insulate crawl spaces behind stud walls with 300-mm mineral wool (Pro)
Secondary glaze all single glazed sash windows with magnetic acrylic (Pro)
Change tumble dryer for A rated tumble dryer (Pro)
Replace the boilers with new top-spec condensing gas boiler with weather compensator (Pro)
Add 3- or 4-mm thin double glazing to all single-glazed casement windows (Pro)
Add 50-mm PIR internally to stud walls on top floor (Pro)
Add 25-mm PIR internally to stud walls on top floor (Pro)
Add 100-mm PIR internally to stud walls on top floor (Pro)
Replace the smaller LCD TV with a 37-inch LED TV (DIY)
Add 50-mm PIR internally to all three brick thick solid external walls (Pro)
Add 50-mm PIR to ceiling below the inaccessible roof void on the top floor (Pro)
Add 25-mm PIR internally to all three brick thick solid walls (Pro)
Add 100-mm PIR to ceiling below the inaccessible roof void on the top floor (Pro)
Add 75-mm PIR internally to all three brick thick solid walls (Pro)
Add 25-mm PIR to ceiling below the inaccessible roof void on the top floor (Pro)
Professionally draughtproof all loose sash windows throughout the house (Pro)
Add 100-mm PIR internally to all three brick thick solid walls (Pro)
Add 50-mm PIR internally to front-facing solid walls and externally to side/rear walls (Pro)
Top up the loft insulation to 200-mm mineral wool (Pro)
Add 25-mm PIR internally to front-facing solid walls and externally to side/rear walls (Pro)
Add 3- or 4-mm thin double glazing to all single-glazed casement windows (Pro)
Add 75-mm PIR internally to front-facing solid walls and externally to side/rear walls (Pro)
Add 50-mm PIR to ceiling of front bay (Pro)
Add 50-mm PIR externally to all three brick thick solid walls (Pro)
Add 100-mm PIR internally to front-facing solid walls and externally to side/rear walls (Pro)
Add 25-mm PIR externally to all three brick thick solid walls (Pro)
Add 100-mm PIR externally to flat roof of the front bay (Pro)
Add 75-mm PIR externally to all three brick thick solid walls (Pro)
Top up the loft insulation to 300-mm mineral wool (Pro)
Add 100-mm PIR externally to all three brick thick solid walls (Pro)
Add 25-mm PIR to ceiling of front bay (Pro)
Professionally draughtproof the 7 tight, not sealed casement windows throught house (Pro)
Replace dishwasher with an A+ rated model and only use eco setting (Pro)
Replace both louvred fans with heat recovery fans (Pro)
Install secondary glazing to all single-glazed sash windows (Pro)
Install secondary glazing to all single-glazed casement windows (Pro)
Add 100-mm PIR to loft hatch (Pro)
Thoroughly draught-proof the loft hatch (Pro)
Add 50-mm PIR to loft hatch (Pro)
Replace all single-glazed casement windows with ones that comply with current building regs (Pro)
Add 25-mm PIR to loft hatch (Pro)
Replace all single-glazed sashwindows with ones that comply with current building regs (Pro)
Replace all single-glazed casement windows with triple-glazed ones (Pro)
Replace all single-glazed sash windows with triple-glazed ones (Pro)
Add 100-mm mineral wool below floorboards in living room and seal (Pro)
Replace the French doors with ones that comply with current building regs (Pro)
Replace the utility doors with ones that comply with current building regs (Pro)
Install a draught lobby to front door (Pro)
Replace the front door with one that complies with current building regs (Pro)
Add 100-mm mineral wool below floorboards to the tiles ground floors (Pro)
Add 100-mm mineral wool below floorboards to floor above porch (Pro)
Add 100-mm mineral wool below floorboards to all suspended floors (Pro)
Upgrade to an A+ washing machine and only use at 30 degrees (Pro)
Replace both Velux windows with triple-glazed Velux (Pro)
0
100
200
300
400
500


House 4
Install Cost
Stop using the tumble dryer and air-dry clothes instead (DIY)
Do not use the portable heater and rely on central heating (DIY)
Block chimney in dining room with removable chimney balloon (DIY)
Install a low flow showerhead (DIY)
Replace all 6 incandescent lamps with compact fluorescent lamps (DIY)
Replace all 7 MR16 halogen lamps with compact fluorescent lamps (DIY)
Replace all 6 incandescent lamps with LEDs (DIY)
Replace all 7 MR16 halogen lamps with LEDs (DIY)
Replace the boilers with new top-spec combi boiler with weather compensator (Pro)
Take out sections of stud wall and add 300-mm mineral wool blanket in crawl spaces (Pro)
Add 50-mm PIR to sloping roof areas on top floor (Pro)
Add 25-mm PIR internally to all solid brick external walls (Pro)
Add 50-mm PIR internally to all solid brick external walls (Pro)
Add 50-mm PIR to sloping roof areas above stairwell (Pro)
Add 75-mm PIR internally to all solid brick external walls (Pro)
Add 100-mm PIR to sloping roof areas on top floor (Pro)
Add 100-mm PIR internally to all solid brick external walls (Pro)
Add 100-mm PIR to sloping roof areas above stairwell (Pro)
Add 50-mm PIR internally to front-facing walls and externally to side/rear walls (Pro)
Add 50-mm PIR to ceiling below crawl spaces (Pro)
Add 25-mm PIR externally to all solid brick walls (Pro)
Add 75-mm PIR internally to front-facing walls and externally to side/rear walls (Pro)
Add 50-mm PIR externally to all solid brick walls (Pro)
Replace electric oven with a gas oven (Pro)
Secondary glaze single-glazed metal window on landing with budget polyester glazing (Pro)
Add 100-mm PIR to ceiling below crawl spaces (Pro)
Add 100-mm PIR internally to front-facing walls and externally to side/rear walls (Pro)
Add 25-mm PIR internally to front-facing walls and externally to side/rear walls (Pro)
Add 50-mm PIR to ceiling below stairwell roof void (Pro)
Add 75-mm PIR externally to all solid brick walls (Pro)
Add 50-mm PIR to ceiling below roof void on top floor (Pro)
Add 100-mm PIR to ceiling below stairwell roof void (Pro)
Add 100-mm PIR externally to all solid brick walls (Pro)
Add 100-mm PIR to ceiling below roof void on top floor (Pro)
Secondary glaze both sash windows with budget polyester glazing (Pro)
Add 50-mm PIR to the stud walls on top floor (Pro)
Replace the TV with a 32-inch LED TV (DIY)
Add 75-mm PIR to the stud walls on top floor (Pro)
Add 25-mm PIR to the stud walls on top floor (Pro)
Add 100-mm PIR to the stud walls on top floor (Pro)
Replace fridge freezer with an A++ rated alternative (Pro)
Secondary glaze single-glazed metal window on landing with magnetic acrylic (Pro)
Replace dishwasher with an A+ rated model and only use eco setting (Pro)
Replace electric hob with gas hob (Pro)
Add insulated shutters/blind to the single-glazed metal window on landing (Pro)
Secondary glaze both wooden single-glazed windows with budget polyester glazing (Pro)
Add 3- or 4-mm thin double glazing to all single-glazed casement windows (Pro)
Secondary glaze both wooden single-glazed windows with magnetic acrylic (Pro)
Replace both louvred fans with heat recovery fans (Pro)
Professionally draughtproof the two loose sash windows (Pro)
Add 100-mm PIR to ceiling of bay (Pro)
Add 50-mm PIR to ceiling of bay (Pro)
Replace single-glazed metal window on landing to comply with current building regs (Pro)
Install secondary glazing to both sash windows (Pro)
Install secondary glazing to the single-glazed metal window on landing (Pro)
Replace the single-glazed metal window on landing with a triple-glazed one (Pro)
Add 3- or 4-mm thin double glazing to both wooden single-glazed windows (Pro)
Install secondary glazing to both wooden single-glazed windows (Pro)
Replace both sash windows with ones that comply with current building regs (Pro)
Add 100-mm mineral wool below floorboards to all suspended ground floors (Pro)
Replace the front door with one that complies with current building regs (Pro)
Replace both sash windows with triple-glazed ones (Pro)
Change tumble dryer for A rated tumble dryer (Pro)
Professionally draughtproof the tight, not sealed metal window on the landing (Pro)
Replace the back door with one that complies with current building regs (Pro)
Add 50-mm PIR above floor to rear solid floors (Pro)
Replace all double-glazed windows with ones that comply with current building regs (Pro)
Add 25-mm PIR above floor to rear solid floors (Pro)
Replace all double-glazed windows with triple-glazed ones (Pro)
£0 £1K £2K £3K £4K £5K £6K £7K £8K £9K



House 4
Savings
Stop using the tumble dryer and air-dry clothes instead (DIY)
Do not use the portable heater and rely on central heating (DIY)
Block chimney in dining room with removable chimney balloon (DIY)
Install a low flow showerhead (DIY)
Replace all 6 incandescent lamps with compact fluorescent lamps (DIY)
Replace all 7 MR16 halogen lamps with compact fluorescent lamps (DIY)
Replace all 6 incandescent lamps with LEDs (DIY)
Replace all 7 MR16 halogen lamps with LEDs (DIY)
Replace the boilers with new top-spec combi boiler with weather compensator (Pro)
Take out sections of stud wall and add 300-mm mineral wool blanket in crawl spaces (Pro)
Add 50-mm PIR to sloping roof areas on top floor (Pro)
Add 25-mm PIR internally to all solid brick external walls (Pro)
Add 50-mm PIR internally to all solid brick external walls (Pro)
Add 50-mm PIR to sloping roof areas above stairwell (Pro)
Add 75-mm PIR internally to all solid brick external walls (Pro)
Add 100-mm PIR to sloping roof areas on top floor (Pro)
Add 100-mm PIR internally to all solid brick external walls (Pro)
Add 100-mm PIR to sloping roof areas above stairwell (Pro)
Add 50-mm PIR internally to front-facing walls and externally to side/rear walls (Pro)
Add 50-mm PIR to ceiling below crawl spaces (Pro)
Add 25-mm PIR externally to all solid brick walls (Pro)
Add 75-mm PIR internally to front-facing walls and externally to side/rear walls (Pro)
Add 50-mm PIR externally to all solid brick walls (Pro)
Replace electric oven with a gas oven (Pro)
Secondary glaze single-glazed metal window on landing with budget polyester glazing (Pro)
Add 100-mm PIR to ceiling below crawl spaces (Pro)
Add 100-mm PIR internally to front-facing walls and externally to side/rear walls (Pro)
Add 25-mm PIR internally to front-facing walls and externally to side/rear walls (Pro)
Add 50-mm PIR to ceiling below stairwell roof void (Pro)
Add 75-mm PIR externally to all solid brick walls (Pro)
Add 50-mm PIR to ceiling below roof void on top floor (Pro)
Add 100-mm PIR to ceiling below stairwell roof void (Pro)
Add 100-mm PIR externally to all solid brick walls (Pro)
Add 100-mm PIR to ceiling below roof void on top floor (Pro)
Secondary glaze both sash windows with budget polyester glazing (Pro)
Add 50-mm PIR to the stud walls on top floor (Pro)
Replace the TV with a 32-inch LED TV (DIY)
Add 75-mm PIR to the stud walls on top floor (Pro)
Add 25-mm PIR to the stud walls on top floor (Pro)
Add 100-mm PIR to the stud walls on top floor (Pro)
Replace fridge freezer with an A++ rated alternative (Pro)
Secondary glaze single-glazed metal window on landing with magnetic acrylic (Pro)
Replace dishwasher with an A+ rated model and only use eco setting (Pro)
Replace electric hob with gas hob (Pro)
Add insulated shutters/blind to the single-glazed metal window on landing (Pro)
Secondary glaze both wooden single-glazed windows with budget polyester glazing (Pro)
Add 3- or 4-mm thin double glazing to all single-glazed casement windows (Pro)
Secondary glaze both wooden single-glazed windows with magnetic acrylic (Pro)
Replace both louvred fans with heat recovery fans (Pro)
Professionally draughtproof the two loose sash windows (Pro)
Add 100-mm PIR to ceiling of bay (Pro)
Add 50-mm PIR to ceiling of bay (Pro)
Replace single-glazed metal window on landing to comply with current building regs (Pro)
Install secondary glazing to both sash windows (Pro)
Install secondary glazing to the single-glazed metal window on landing (Pro)
Replace the single-glazed metal window on landing with a triple-glazed one (Pro)
Add 3- or 4-mm thin double glazing to both wooden single-glazed windows (Pro)
Install secondary glazing to both wooden single-glazed windows (Pro)
Replace both sash windows with ones that comply with current building regs (Pro)
Add 100-mm mineral wool below floorboards to all suspended ground floors (Pro)
Replace the front door with one that complies with current building regs (Pro)
Replace both sash windows with triple-glazed ones (Pro)
Change tumble dryer for A rated tumble dryer (Pro)
Professionally draughtproof the tight, not sealed metal window on the landing (Pro)
Replace the back door with one that complies with current building regs (Pro)
Add 50-mm PIR above floor to rear solid floors (Pro)
Replace all double-glazed windows with ones that comply with current building regs (Pro)
Add 25-mm PIR above floor to rear solid floors (Pro)
Replace all double-glazed windows with triple-glazed ones (Pro)
-£200
£0
£200
£400
£600
£800


House 4
£ per CO2
Stop using the tumble dryer and air-dry clothes instead (DIY)
Do not use the portable heater and rely on central heating (DIY)
Block chimney in dining room with removable chimney balloon (DIY)
Install a low flow showerhead (DIY)
Replace all 6 incandescent lamps with compact fluorescent lamps (DIY)
Replace all 7 MR16 halogen lamps with compact fluorescent lamps (DIY)
Replace all 6 incandescent lamps with LEDs (DIY)
Replace all 7 MR16 halogen lamps with LEDs (DIY)
Replace the boilers with new top-spec combi boiler with weather compensator (Pro)
Take out sections of stud wall and add 300-mm mineral wool blanket in crawl spaces (Pro)
Add 50-mm PIR to sloping roof areas on top floor (Pro)
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Replace the TV with a 32-inch LED TV (DIY)
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Add 100-mm PIR to the stud walls on top floor (Pro)
Replace fridge freezer with an A++ rated alternative (Pro)
Secondary glaze single-glazed metal window on landing with magnetic acrylic (Pro)
Replace dishwasher with an A+ rated model and only use eco setting (Pro)
Replace electric hob with gas hob (Pro)
Add insulated shutters/blind to the single-glazed metal window on landing (Pro)
Secondary glaze both wooden single-glazed windows with budget polyester glazing (Pro)
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Replace both louvred fans with heat recovery fans (Pro)
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Replace the back door with one that complies with current building regs (Pro)
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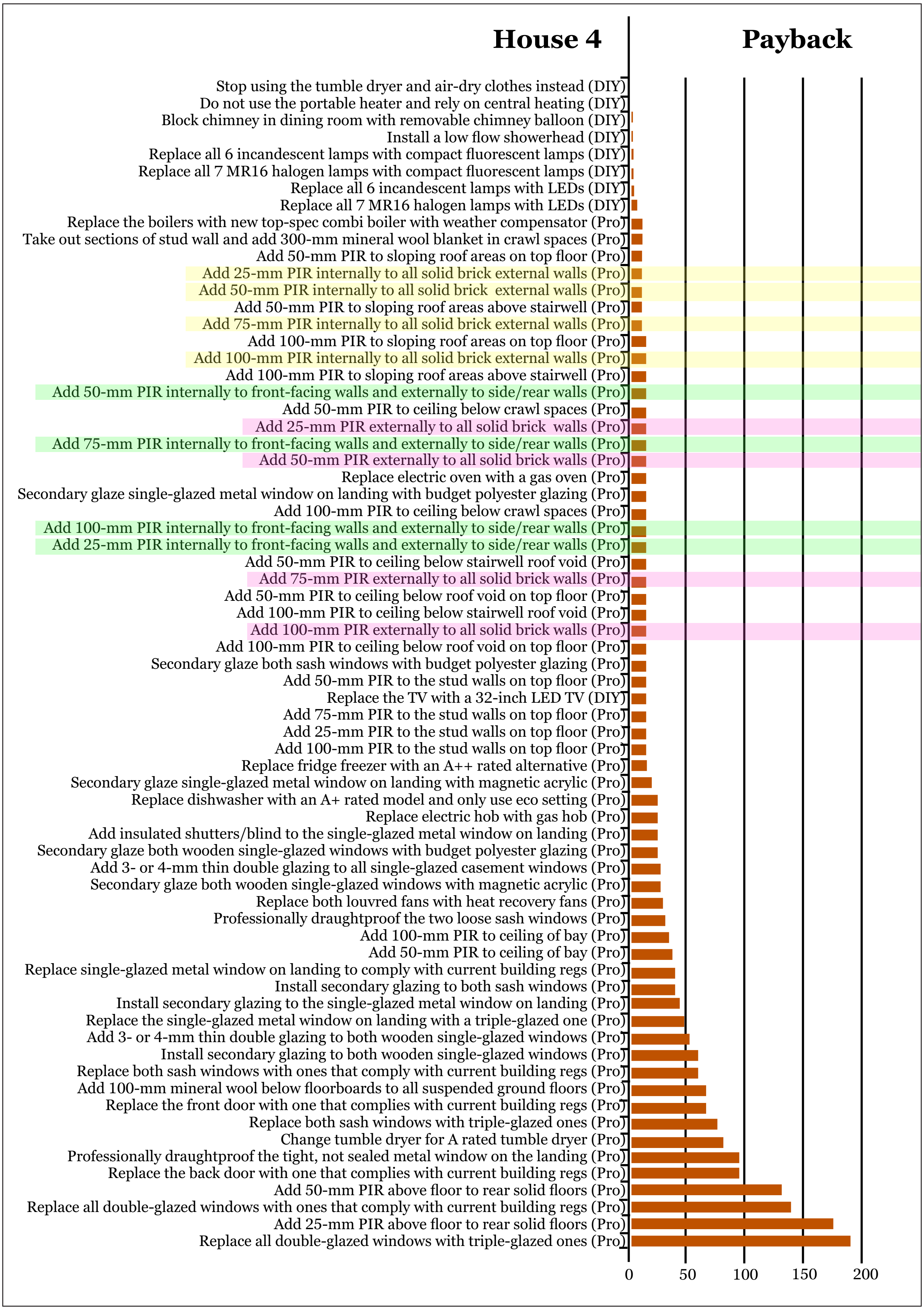
£0
£10
£20
£30
£40


House 4
Payback
Stop using the tumble dryer and air-dry clothes instead (DIY)
Do not use the portable heater and rely on central heating (DIY)
Block chimney in dining room with removable chimney balloon (DIY)
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Replace all 6 incandescent lamps with compact fluorescent lamps (DIY)
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Add 50-mm PIR above floor to rear solid floors (Pro)
Replace all double-glazed windows with ones that comply with current building regs (Pro)
Add 25-mm PIR above floor to rear solid floors (Pro)
Replace all double-glazed windows with triple-glazed ones (Pro)
0
50
100
150
200

6 LIMITATIONS

The additional analysis was designed to give a number of examples that would promote discussion. . While not every variation can be covered, this section reviews the most significant of these.

Costs

There is a heavy reliance on the estimated installation figures used. In reality, there may be significant variance away from the figures, with the following examples for wall insulation used as an illustration:

1. Individual contractor prices will vary significantly.

2. The maturing of internal and external solid wall insulation markets may reduce prices.

3. The degree to which ancillary costs associated with wall insulation are included in the price or excluded: for example, if a wall already needs rendering, then the scaffolding and rendering may be deemed to be excluded. Similarly, if other measures are installed at the same time (for example, a flue for a wood burner or roofing works) then the cost of the scaffolding may be split. For internal insulation, an example would be if a room is due for redecoration, then some costs due to be incurred already may be excluded.

4. How much of the works is carried out by DIY. For wall insulation, a significant proportion of the cost is the labour, and so this element can be discounted if the works are carried out DIY.

5. ECO, Green Deal Cashback or other grants have not been included in the analysis.

Modelling

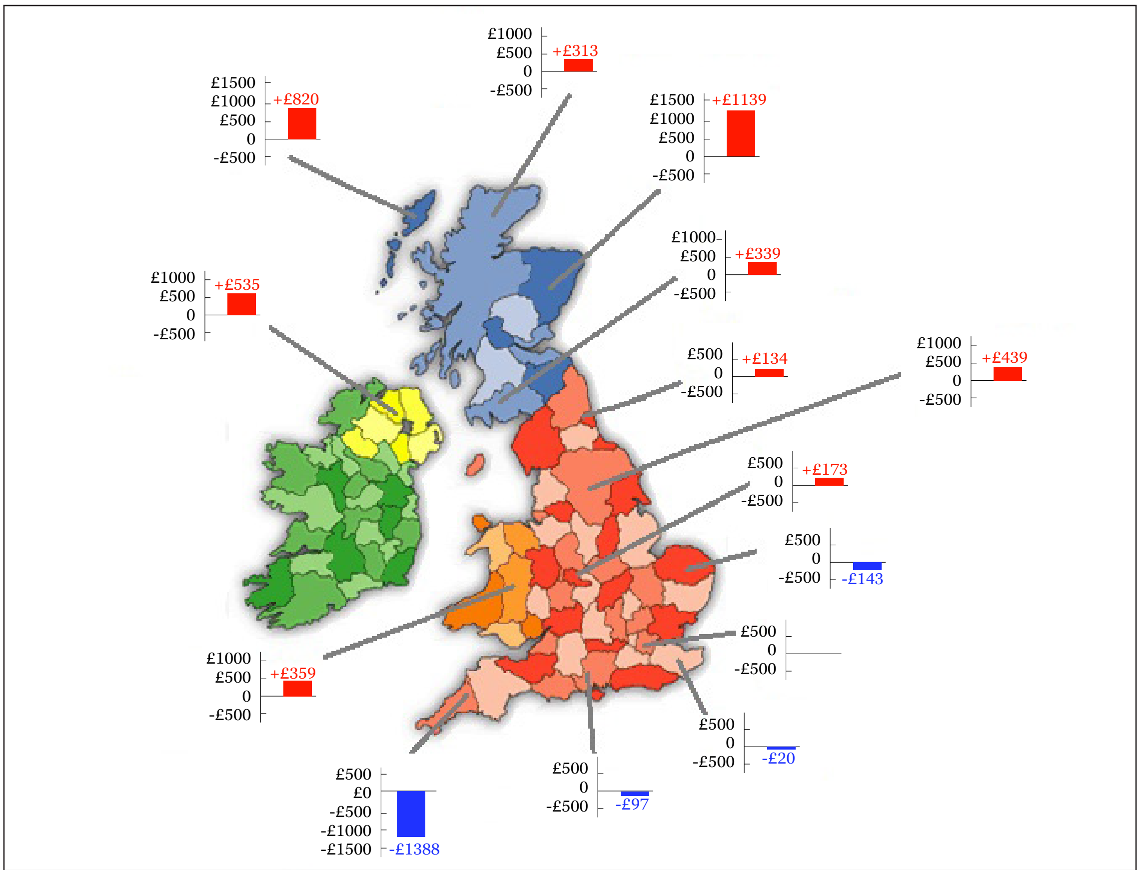
The model used is based on BREDEM, alongside standard assumed u-values for elements such as solid walls. It is therefore only as accurate as both the u-value assumptions and the modelling. Some assurance can be gained from the fact that when the modelled properties were compared to the actual bills of the property owners, there was a high degree of correlation.

Weather

Our modelling uses a standard weather year based on information supplied by ASHRAE. The impact of wall insulation and any other heating measures will be much greater during winters such as 2013 rather than one like 2014.

Location

We have modelled all the properties using location specific data from Reading. Similar properties located in other areas of the country will experience different climates, and so will have longer or shorter paybacks. The diagram on the right shows some previous analysis we carried out on a boiler upgrade to a hypothetical property located in a variety of locations in the country. The bars show the variance in the 20-year savings for the boiler depending on where the property is located.



The Rebound Effect

It is a well-known phenomenon that cost savings from energy efficiency improvements will often be invested in more heating. Whilst many take the view that this should be used to decrease the predicted savings, we do not. If a homeowner wishes to invest their savings in more comfort, then that is their right. This means that the savings may not be reflected by a corresponding reduction in bills, and so the paybacks may appear longer than they would be otherwise.

Specification and Detailing

The analysis did not take any account of detailing, or of the suitability of insulation. The model used conductivity values for polyisocyanurate insulation (PIR) in the analysis, as this is a common insulation material. The selection of PIR for the modelling was to allow for comparisons. It should not be taken as a recommendation that this type of insulation should be used for these specific properties or similar ones.

7 OTHER FACTORS TO CONSIDER

This paper has primarily focused on the cost and CO_2 effect of a range of measures applied to 4 example properties. Whilst these are important factors to consider when choosing a measure, there is also a range of other considerations that is important, and which we have outlined and discussed below:

Appropriateness to the aesthetics and heritage nature of the property and surroundings

This consideration may make external wall insulation inappropriate.

The impact of measures on moisture movements throughout the house and within the building fabric

It is important to determine what the building needs in terms of moisture management, both in terms of ventilation and permeability of building fabric. External factors such as location and exposure to wind, rain and sun, as well as specific building factors such as form, orientation and materials need to be understood.

Space constraints within the building

This may limit the thickness of insulations and type of plant that can be installed.

Security and noise considerations

Although windows are rarely cost effective to replace, there may be other reasons to consider upgrading them, such as increased security and noise reduction.

Comfort and health

Both of these are difficult to quantify, but improving insulation levels and appropriate ventilation can make a marked improvement on both.

Concurrent working

Concurrent working is a good way to save time and money, and minimise disturbance to building occupants. Measures that would not be cost effective if done on their own will be more so if performed while another measure is taking place at the same time. An example might be installing external wall insulation when the house needs re-rendering.

Dependencies

While it is important to carry out the most urgent measures first, sometimes the success and ease of installation of one measure depends on another measure. An example of this is installing suspended floor insulation before the walls are insulated and the floorboards can't be easily raised. While wall insulation would usually take higher priority, installing the suspended floor insulation first would mean that both measures can be undertaken easily.

8 CONCLUSIONS

The following are our key conclusions from both the previous work and this additional work focused on the impact of different heating regimes.

1. Significant CO_2 savings, i.e. above 40%, are probably not normally possible for solid walled houses without addressing the solid walls. If the walls are also addressed, then savings around 60% can be expected.

2. Solid wall insulation compares favourably to other energy measures, especially for high-energy users, and where costs can be minimised.

3. Paybacks on solid wall insulation can vary significantly, depending on the heating profile of the occupiers. The higher the heating use, the shorter the financial paybacks. Therefore, promoting specific paybacks to occupiers without understanding their heating profiles is likely to result in inaccuracies.

4. Paybacks can also vary significantly from one property to another, and will vary primarily based on the area of solid walls, the efficiency of heating systems, and the type of fuel used.

5. CO_2 and financial savings are only two of a range of factors that will determine whether solid wall insulation is worth carrying out.

APPENDIX A: RESULTS AGGREGATED BY MEASURE CATEGORY

Measure Category		Estimated Install Cost	Annual Fuel Cost Saving			Payback in Years			Annual kgCO_2 Saving		
			Low	Medium	High	Low	Medium	High	Low	Medium	High
Property 1	APPLIANCE STANDBY	£ –	£6.0	0	20						
	APPLIANCES	£247	£27.5	27	88						
	LIGHTING	£99	£56.3	3	184						
	HOT WATER	£40	£36.7	1	136						
	DOORS	£800	£4.0	£6.2	£10.7	201	128	75	15	24	41
	DRAUGHTS	£316	£7.6	£11.5	£18.8	101	67	41	31	47	77
	FLOORS	£643	£2.9	£4.4	£7.3	266	172	105	11	17	27
	HEATING	£250	£7.7	£11.7	£18.2	33	21	14	28	43	68
	ROOFS	£ 371	£5.9	£9.2	£15.1	85	55	33	22	34	57
	WALLS	£2,398	£93.6	£145.0	£237.1	25	16	10	352	545	890
	WINDOW DRAUGHTS	£215	£9.2	£14.2	£23.5	22	14	9	35	53	88
	WINDOWS	£914	£20.2	£31.5	£52.1	423	274	163	76	118	195
	RENEWABLES	£5,000	£547.8	£547.8	£547.8	9	9	9	1212	1212	1212
Property 2	APPLIANCE STANDBY	£ -									
	APPLIANCES	£308	£19.3	41	62						
	LIGHTING	£244	£62.2	20	204						
	HOT WATER	£380	£93.6	4	348						
	DOORS	£840	£5.7	£9.3	£16.7	155	94	53	21	35	62
	DRAUGHTS	£453	£19.6	£30.5	£51.8	73	47	28	73	113	192
	FLOORS	£1,386	£14.1	£20.5	£30.8	160	111	76	52	76	114
	HEATING	£3,000	£410.8	£567.6	£823.9	7	5	4	1525	2107	3059
	ROOFS	£524	£21.8	£33.9	£58.1	53	34	20	81	126	216
	WALLS	£8,066	£451.2	£692.7	£1,140.7	25	16	10	1675	2571	4234
	WINDOW DRAUGHTS	£125	£3.0	£4.7	£7.9	63	40	24	11	17	29
	WINDOWS	£704	£16.5	£25.4	£43.0	54	34	20	61	94	159
	RENEWABLES										

APPENDIX A: RESULTS AGGREGATED BY MEASURE CATEGORY

Measure Category		Estimated Install Cost	Annual Fuel Cost Saving			Payback in Years			Annual $kgCO_2$ Saving		
			Low	Medium	High	Low	Medium	High	Low	Medium	High
Property 3	APPLIANCE STANDBY	£ –									
	APPLIANCES	£361	£40.6	54	132						
	LIGHTING	£114	£31.7	4	104						
	HOT WATER	£40	£104.3	0	345						
	DRAUGHTS	£433	£11.7	£17.6	£29.2	95	63	38	46	70	116
	FLOORS	£1,718	£5.9	£9.0	£14.8	297	195	118	23	35	59
	HEATING	£3,000	£135.5	£181.5	£256.3	22	17	12	494	665	942
	ROOFS	£639	£30.2	£47.1	£79.5	43	28	16	113	176	296
	WALLS	£8,525	£200.6	£307.8	£506.5	40	26	16	782	1194	1955
	WINDOW DRAUGHTS	£273	£7.4	£11.3	£18.7	38	25	15	29	44	73
	WINDOWS	£4,408	£65.1	£100.3	£167.0	476	271	143	255	391	652
	RENEWABLES										
Property 4	APPLIANCE STANDBY	£ –									
	APPLIANCES	£295	£30.1	20	97						
	LIGHTING	£61	£26.6	2	87						
	HOT WATER	£40	£37.1	1	138						
	DRAUGHTS	£310	£28.2	£45.1	£79.0	29	18	10	105	167	293
	FLOORS	£900	£5.1	£8.2	£14.4	229	144	82	19	30	53
	HEATING	£2,050	£192.2	£267.4	£400.3	11	8	5	714	993	1486
	ROOFS	£485	£28.8	£44.2	£74.2	25	16	10	107	164	276
	WALLS	£4,378	£260.1	£404.0	£682.1	18	12	7	966	1500	2532
	WINDOW DRAUGHTS	£93	£1.1	£1.7	£2.9	108	71	42	4	6	11
	WINDOWS	£1,312	£9.1	£14.5	£25.3	96	60	34	34	54	94
	RENEWABLES										



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