Programme Area: Smart Systems and Heat

Project: Value Management

Title: Overcoming barriers to smarter heat solutions in UK homes - Annexe 3b: Payback period drivers

Abstract:

This document was prepared at the time to contribute to ETI internal thinking and planning only.

Context:

This project studied how value can be delivered across a smart energy value chain - in the context of the UK. It built a clear understanding of how smart energy systems can deliver combined consumer value alongside commercial value for market participants - producers, suppliers, distributors. The analysis will help to make the commercial deployment of smart energy systems more likely. This £600,000 project was delivered by Frontier Economics, a leading economic consultancy.

Overcoming barriers to smarter heat solutions in UK homes

Annexe 3b: Payback period drivers

PREPARED FOR THE ETI

March 2015

1 Introduction

The *payback period* of an intervention refers to the time taken for the ongoing stream of cost-savings to outweigh the initial investment. For long-run optimising models of intervention take-up (like ESME and BMET), the payback period is only of tangential relevance: interventions with a high net present value over their lifetime will be taken up, regardless of whether there is a significant delay before these benefits are realised.

However, both customers and business model providers face limits on the length of payback period they are likely to accept. Since many low-carbon interventions are associated with high initial investments and long payback periods, this leads to a barrier to uptake.

This annexe is set out as follows.

- First, we set out why customers are more likely to take up interventions with relatively short payback periods (potentially in the order of five years or less).
- We then discuss whether business model providers can help overcome these constraints. We conclude that, while business models may help overcome payback period issues (as well as credit constraints), they face difficulties in doing this for interventions with long payback periods where the investment costs are sunk.
- This analysis is primarily focussed on household-level interventions (HEMS,[1] cavity, internal and external wall insulation, and heat pumps). District heat also has long payback periods, and we briefly consider the issues for this technology. While the nature of district heat means that individual consumer contracts might prove less of a barrier, systematic uncertainties are likely to require risk-sharing with government.
- We then draw on quantitative modelling from BMET to examine the likely payback periods of different types of low-carbon interventions for different customer groups, and look at what might be required to bring these to within a 5-10 year window.

Overall, we find that HEMS and cavity wall insulation are the only interventions which are likely to have payback periods within such a window given BMET default assumptions.

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1 "HEMS" is used to refer to a home energy management system with advanced features such as the ability to schedule heating in accordance with a time-of-use tariff ("HEMS+").

2 Required payback periods for consumers

In this section, we explain why consumers favour interventions that pay back within a relatively short timeframe, and what this may imply for future take-up of different types of low-carbon intervention.

2.1.1 Preference for benefits in the present

A large body of economic literature, both theoretical and applied, argues that consumers place a higher value on benefits in the present than benefits in the future. The *Green Book*, the standard UK Government text for policy appraisal, uses a discount rate of 3.5% to reflect societal preferences.[2] This is composed of two components:

- The rate at which individuals discount future consumption over present consumption, on the assumption that no change in per capita consumption is expected. This takes into account two reasons for discounting future benefits:
  - "catastrophe risk", the possibility that a devastating event may reduce or eliminate future benefits; and
  - "pure time preference", the fact that, all else equal, individuals tend to prefer to receive benefits earlier.
- A term reflecting the way in which future income is expected to be higher than income today, which means that a pound is worth more today (when income is relatively scarce).

This figure relates to the preferences of society as a whole. Empirical evidence suggests that the discount rates used by individual customers can be far higher (i.e. placing a much lower rate on future consumption). A study of US consumer decisions around choice of air conditioner found that consumers used a discount rate of around 20%[3], and such high discount rates are seen in more recent empirical research.[4] [5] [6]

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2 This is the discount rate that BMET uses for both consumer decision-making and overall social welfare.

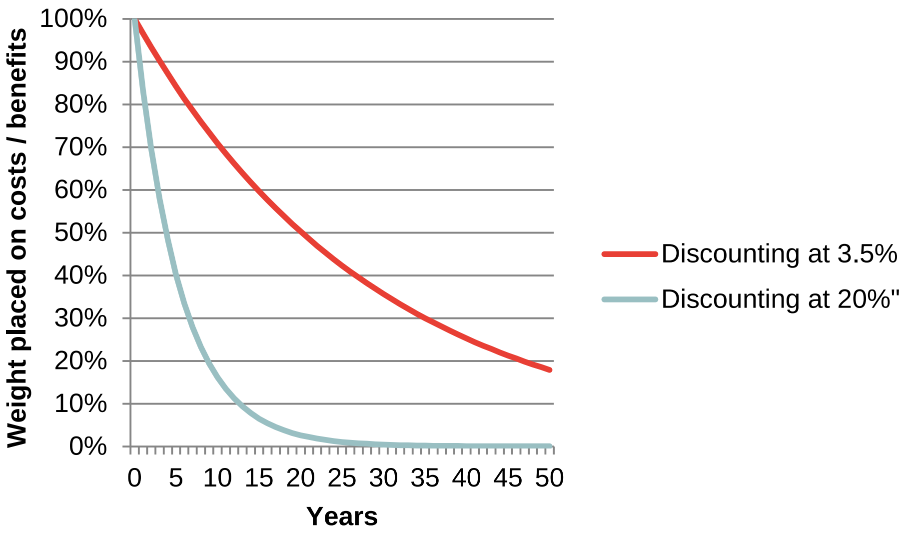
3 Hausman, J.(1979): Individual Discount Rates and the Purchase and Utilization of Energy-Using Durables, The Bell Journal of Economics, Vol 10, No 1

4 For example, Andersen, S., Harrison G.W., Lau, M.I. and Rutström, E.E. (2008), Eliciting Risk and Time Preferences, Econometrica, Vol. 76, No. 3

5 Very high discount rates are implicitly used in the decision making. Pollitt, Shaorshadze (2011): *The Role of Behavioural Economics in Energy and Climate Policy*

Figure 1 shows the weight that consumers with discount rates of 3.5% and 20% would place on costs and benefits arising in a given year (year zero refers to the year in which the decision to invest is made). Costs or benefits accruing more than five years after the decision are only given a 40% weight by consumers with a 20% discount rate (while those accruing ten years after the decision have a weight of 16%). As a result, investments that do not pay back within a relatively short period of time are unlikely to be seen as desirable by consumers.

Figure 1. Effect of discounting



Source: Frontier Economics

Other factors specific to low-carbon interventions may also lead to customers demanding short payback periods. For example, if owner-occupiers believe there is a risk that the full benefits of a measure such as insulation will not be priced into their home when they sell it, they may be unwilling to consider benefits that are likely to accrue to future owners.

2.1.2 Implications for take-up of interventions

This focus on near-term costs and benefits can be seen in a number of markets, such as the pensions market where many people under-save for retirement and regret it later.[7] The relative success of upfront grants such as the Green Deal Home Improvement Fund (GDHIF) compared to ongoing incentives such as

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6 Laibson, D., 1997, Golden eggs and hyperbolic discounting, The Quarterly Journal of Economics, May 1997

7 Financial Conduct Authority, 2013, Occasional Paper No. 1, Applying behavioural economics at the Financial Conduct Authority

the Renewable Heat Incentive (RHI) provides further evidence of the importance of this barrier.

Even where consumers able to spread payments in such a way that they are never "out of pocket", long payback periods can be a significant disincentive to uptake. For example, the original research into the Green Deal proposition undertaken for DECC by Ipsos MORI in November 2011[8] found that a payback period of over ten years was considered a "…*major barrier to wider interest in the scheme.*"

This may appear to contradict with the way in which 79% of households have previously invested in double-glazing,[9] an intervention which can be associated with much longer payback periods. However, in addition to providing a monetary saving, double-glazing provides a number of other ongoing benefits (notably improved aesthetics).

While HEMS offers a variety of novel features (for example ensuring the house is warm when returning from work, a general increase in comfort, and the general appreciation that some consumers may have for gadgets), a number of the other low carbon technologies may not bring such additional benefits. Without additional benefits, it makes it less likely that customers will accept long payback periods.

We therefore consider it unlikely that a consumer would wish to invest in an intervention with a payback period of above five years – and highly unlikely that they would invest in one with a payback period of over ten years – unless it provides additional non-monetary benefits.

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8 DECC (2011), *Consumer Needs and Wants for the Green Deal*

9 English housing survey 2012: energy efficiency of English housing report - https://www.gov.uk/government/statistics/english-housing-survey-2012-energy-efficiency-of-english-housing-report

3 Business models to overcome long payback periods

As described above, consumers' focus on near-term costs and benefits can act as a barrier to the take-up of technologies with long payback periods. In this section we:

- explain how long-term contracts can, in theory overcome barriers to uptake associated with both long payback periods and consumer credit constraints; and
- set out the barriers to such long-run contracts in the energy sector, and how they might be overcome.

This analysis suggests that long-term contracts may be suitable for overcoming barriers to uptake for interventions which have – at most – a payback period of between five and ten years.

3.1.1 The benefits of long-run contracts

Business model providers may[10] not have the same focus on short-run costs and benefits as consumers. For example, firms may discount the future based on their cost of capital, which may be lower than the high discount rates discussed above for consumers.

If business models place a greater weight on future costs and benefits, they may be able to profitably provide a way for consumers to overcome issues associated with long payback periods. Consider, for example, an intervention that initially costs £5,000, and then delivers a bill saving of £1,000 for each of the following ten years. This would have a negative net present value (NPV) of -£810 for a consumer with a discount rate of 20%, but a positive NPV of £1,140 for a business with a discount rate of 10%.

If the business installed the intervention and kept the resulting bill savings, they would be able to profitably pay the consumer £10 in each year. This would yield a positive net present value for both the business (£71) and the consumer (£52). This example demonstrates how, if businesses do not have such a focus on short-run costs and benefits as consumers, they may be able to profitably overcome such barriers.

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10 However, it cannot be taken as given that businesses will place some weight on all costs and benefits, however far in the future. For example, recent research for DECC notes that, when deciding whether to invest in energy efficiency measures for their own businesses, SMEs may demand a payback period of between two and five years – DECC (2014), *Research to Assess the Barriers and Drivers to Energy Efficiency in Small and Medium Sized Enterprises.*

In this situation, both business and consumers can be better off if the business model provider actually reverses the ordering of costs and benefits, front-loading benefits. This business model can, for example, be seen in both the mobile phone market (where mobile companies offer subsidised or free handsets to consumers) and the mortgage market (where customers purchasing a mortgage are often drawn in at teaser rates without looking at the long term rates).[11]

Note that, in addition to potentially overcoming issues around payback periods, longer-term contracts such as these are also effective at overcoming consumer credit constraints.

In order for such contracts to be viable, consumers must accept contracts that are as long as the payback period for the intervention,[12] which may be over ten years. Below, we set out the barriers to such contracts.

3.1.2 Barriers to long-term contracts

Two forms of barriers may exist to long-term contracts: Demand-side constraints (consumers do not wish to take up such contracts) and supply-side constraints (business model providers do not wish to offer them).

Demand-side constraints

Above we described how consumers with a focus on short-run costs and benefits may find a long-run contract to smooth an initial investment preferable to making an up-front payment. Nevertheless, there are behavioural barriers to the take-up of such long contracts.

- **Risk/loss aversion.** Consumers typically consider lock-in clauses to be risky. If they are uncertain whether the long-term contract will offer better or worse value than their default option, loss aversion will reduce sign up.[13]

- **Status quo bias.** [14] This is when consumers are reluctant to change the way things currently work. In the energy sector, long term contracts are not the 'status quo' and therefore, customers may not enter into them.

Indeed, the Ipsos MORI Green deal research[15] found a number of additional concerns associated with the long payback periods. These included the amount

11 FPC, the Bank of England (June 2014) 35: Financial Stability Report

12 If the business model provider is to make profits the contract must be longer than the payback period *after the costs and benefits are discounted at the business model provider's discount rate.*

13 This can be mitigated by allowing consumers to terminate the contract early by paying a "fair" termination charge. In the mobile market this is regulated by Ofcom.

14 Hartman et al., 1991 found evidence of this on choice of contracts for electricity supply.

15 DECC (2011), *Consumer Needs and Wants for the Green Deal*

of interest likely to be accrued over the loan period, whether the intervention would last that long and, even if it did, whether evolving technology and updated standards would mean it was obsolete before it had been paid for.

Supply-side constraints

A business model provider will only be able to profitably offer what is effectively a long-term loan if either:

- there is a low risk of consumer default; or
- it can recover at least a high portion of its investment in the event default occurs.

The second condition can be satisfied if the business model provider can retrieve the asset in the event of default. This is the case for loans secured against a movable asset (such as a car), or against an entire property (which can be repossessed).

However, many types of low-carbon intervention are impossible to retrieve – for example different types of insulation. Even in cases where the appliance might be movable (for example a heat pump), a substantial proportion of costs are likely to be sunk during the installation process, and more will be incurred in disconnecting and removing the appliance. Secured loans are therefore unlikely to be a solution in this sector.

As a result, it is necessary to ensure that there is a low risk of consumer default. Means for doing this include credit checks prior to the contract being signed and the high likelihood of reduced access to future credit if the consumer reneges on the contract. Both of these are common to forms of unsecured lending such as household loans and mobile phone contracts. However, such contracts are typically[16] shorter than the long periods (potentially ten years or more) required for low-carbon interventions to pay back.

The Green Deal itself is a rare example of a long-term (10 to 25 years) unsecured loan. This functions by being tied to an existing essential payment (utility bills) on which consumers are less likely to default. However, this mechanism has itself been blamed for the poor take-up of the Green Deal. For example, Nick Chase, Director of Policy and Research at Action with Communities in Rural England has stated:

The evidence that we have had coming back from Green Deal has identified there is confusion about what benefit it delivers. The fact that there is a loan attached to it, and the loan being

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16 For example, unsecured bank loans are generally not available for longer than seven years (many providers do not offer loans in excess of five years). However, *Hassle Free Boilers* (http://hasslefreeboilers.com/) has recently offered a 12-year finance contract.

attached to the property and the fuel costs in the future is a concept I think people find very difficult to grasp.[17]

Payback periods for district heat

District heat systems also involve high levels of sunk costs and long payback periods. However, unlike the household-level interventions considered in the rest of this document (insulation, heat pumps and HEMS), most components of a district heat system are installed centrally.[18] This can help the provider ensure sufficient demand for its services in the future without having to tie consumers in to long-term contracts.

- District heat schemes can use a large anchor tenant (for example, a public building) to guarantee demand. It may be easier to obtain a long-term contract with such an organisation than with individual consumers.
- If an individual household stopped using the district heat system, a relatively high proportion of the investment could be recouped. Even if it were not economic to recover the heat exchanger, capacity on the central heat plant and piping could be used to supply other customers. This is in contrast to the household-level interventions (particularly insulation) where the entire investment for a particular house may be fixed to that property.
- If a consumer stopped paying a district heat provider, it is relatively straightforward to disconnect them from the network (although there may be issues doing so for vulnerable customers). It may be more difficult for a business model provider to prevent a consumer using a heat pump installed in their home – and impossible to prevent them benefitting from insulation that had been installed. Consumers are less likely to default if they are unable to keep the benefits of the installed asset.

Although these factors will lessen the risks faced by a district heat provider for an individual consumer, they will still be subject to more systematic uncertainties. For example, a future change in government policy that made connection to the district heat system less attractive could severely reduce profitability. Since it is unlikely to be possible to tie individual households into very long-term contracts, risk-sharing with government may be required to ensure district heat take-up. This is discussed further in the main report.

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17 Energy and Climate Change Committee (2014), *The Green Deal: Watching Brief (part 2)*

18 Heat exchangers would need to be installed within each dwelling, however the central heat plant and much of the piping would be common across multiple consumers.

4 Payback periods for household-level low-carbon interventions

As described above, it is unlikely that interventions will be attractive to either consumers or business model providers unless they pay back any sunk costs in a relatively short period. Although there is no absolute rule governing what this payback period must be, something below ten years and, ideally below five years, would be a reasonable assumption.

Using BMET, we have estimated payback periods for HEMS, insulation, and electric heating systems (air-source heat pumps and storage heaters). We have then looked at what factors would need to change (for example, fuel costs or capital costs) to bring payback periods to within this window.

Below, we first set out the methodology that we have used for this analysis, before summarising the results for each type of intervention.

Overall, this analysis shows that:

- In the absence of a carbon price,[19] both HEMS and cavity wall insulation are likely to have payback periods under 10 years (and frequently under 5 years) across the range of customer groups to which they might apply. Business models that are able to reduce the interest rates applied to purchases of HEMS, or increase the effectiveness of the technology beyond the assumptions in BMET,[20] can decrease payback periods further.

- Even with a carbon price, solid wall insulation is only just cost-effective for some groups, and is associated with extremely long payback periods (around 30-50 years). These payback periods are inherent given the nature of solid wall insulation – substantial additional changes would be required to lower them to achieve a 10 year payback period.

- Heat pumps are a cost-effective alternative for some groups over the long run in the presence of a carbon price, but with payback periods above 10 years (and potentially up to 20.years, the assumed lifetime of the technology). It is plausible that, for these groups, a combination of business model improvements and some additional Government policies could move payback periods to an acceptable level.

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19 Within BMET, we use the carbon price as a proxy for any policy which compensates customers for the carbon savings of interventions.

20 BMET assumes that HEMS reduces energy usage by 5%, and additionally can shift 5% of peak usage to off-peak.

4.1.1 Methodology

This analysis is based on numerous runs of BMET.[21] We have created a large number of scenarios, which vary some of the factors that can affect the payback period (these are summarised in **Table 1**). For each scenario, we have varied the time horizon of customers,[22] to determine how far ahead customers need to consider costs and benefits for an intervention to be of positive net present value.[23] Note that credit constraints have been disabled for this analysis (credit constraints represent a separate barrier to uptake that we are not considering here). We have also disabled the "additional hassle factor", which is a proxy for non-monetary barriers (discussed in the main report) that could delay the take-up of interventions.

21 The BMET counterfactual has been used, therefore these results are independent of any particular business model.

22 The time horizon has been varied to a number of pre-set levels (1, 2, 5, 10, 15, 20, 30 and 50 years), which means we are unable to exactly state payback periods. For example, when we refer to an intervention as paying back within 10 years, this means that the payback period is no more than that 10 years, and could be as few as 5.

23 Note that, under the default BMET assumptions, these net present values are calculated with a discount rate of 3.5%.

Table 1. Parameters we will test to understand payback period drivers

Parameter	Description	Who can affect it?
Cost of intervention	This is the upfront cost of the interventions. Percentage figures in the charts below relate to the cost as a proportion of the BMET default.	This could be affected either by Government policy (such as rebates) or business model providers (if it is possible to drive down costs).
Efficiency of technology	This relates to the efficiency of heat pumps or electric resistive systems, the effectiveness of insulation (in terms of percentage reduction in building heat requirements), and the effectiveness of HEMS (in terms of both energy reduction and peak-shifting). Percentage figures in the charts below relate to the efficiency as a proportion of the BMET default.	Businesses involved in technological development may be able to drive this up. Government policy could help incentivise this.
Carbon prices	This is implemented within BMET as a tax applied to both electricity and gas, in line with DECC figures for carbon content and price. However we have carried out some analysis with a zero carbon price. Percentage figures in the charts below relate to the carbon price as a proportion of the BMET default.	This is a policy the Government can set.
Interest rate	This is the real interest rate at which consumers can finance interventions if they are unable to pay as a lump-sum. The BMET default is 4% for owner-occupiers (a re-mortgaged loan) and 7% for renters (a Green Deal loan). Percentage figures in the charts below refer to the level of the interest rate.	Either businesses or the Government can offer finance.
Fuel prices	BMET costs for electricity, gas and oil are taken from DECC projections. Percentage figures in the charts below relate to fuel costs as a proportion of the BMET default.	Government could potentially modify this with subsidies or taxes.

Source: Frontier Economics

We first look at the payback period in 2025 for all customer groups to understand whether payback periods are typically in excess of 10 years. This analysis has been carried without a carbon price (i.e. assuming no government support for low-carbon technologies), and is shown in **Figure 2**, **Figure 10**, and **Figure 16**. It is also summarised in the top halves of **Figure 3**, **Figure 8**, **Figure 11**, and **Figure 17** (which also provide a summary of results when a carbon price *is* included).

Then, to understand the effect of the parameters listed in **Table 1** on payback of interventions, we have looked at a number of representative customer groups (it would not be practical to carry out this detailed analysis for every customer group and intervention) that vary in terms of:

- incumbent heating technology;
- heating requirements; and
- type of intervention they take up under a carbon price and the year they take up the intervention.[24]

We have selected customer groups that vary in terms of incumbent heating technology and heating requirements, which will allow us to potentially understand the interplay between the payback period drivers and these characteristics. Also, we have selected customer groups that take up different interventions, to analyse a wider range of interventions.

Table 2 summarises the customer groups and years we consider.

24 We are interested in whether long payback periods are an obstacle to the take-up of interventions which would otherwise be cost effective. We therefore focus the analysis on the period when the intervention becomes cost effective under default BMET assumptions, which will differ by intervention and customer group.

Table 2. Customer groups for which we are testing the payback period drivers

	Uptake with a carbon price	Year	Incumbent heating technology	Heating requirements	Interventions we will consider payback period for
Young Starters	HEMs	2020	Gas boiler	0.0027	Solid Wall Insulation and HEMs
Busy Comfortable Family	HEMs	2015	Gas boiler	0.0021	HPs and HEMs
Older Established	HPs & HEMs	2045[25]	Gas boiler	0.0028	HPs and HEMs
Unconvinced Dependents	HPs & HEMs	2015	Electric resistive	0.0018	HPs and HEMs
Successful Ruralites (oil)	Solid Wall insulation & HPs &HEMs	2015	Oil boiler	0.0042	Solid Wall insulation and HEMs

Source: Frontier Economics

This analysis is summarised in the bottom halves of **Figure 3**, **Figure 8**, **Figure 11**, and **Figure 17**.

For interventions that already have relatively low payback periods (HEMS and cavity wall insulation), much of this analysis uses a zero carbon price as baseline. These are interventions which are already cost-effective within a reasonable period of time without additional Government policies. The analysis helps us understand to what extent it may be possible to drive payback periods down further, even in the absence of Government subsidies.

For interventions that have long payback periods, the baseline includes the DECC projected carbon price, applied to both gas and electricity. These are interventions which are not expected to be cost-effective without some form of Government tax or subsidy. For these, the analysis helps us understand whether a Government tax or subsidy set at the carbon price is sufficient to obtain low payback periods, or whether further actions may be required.

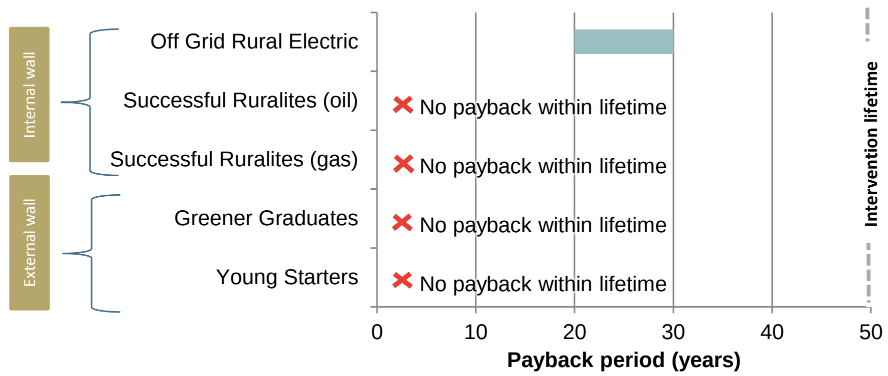
25 HPs & HEMS are taken up by Older Established in 2040. But, in the payback period analysis we will look at the year 2045, because this is the year that HPs are cost-effective without being bundled with HEMS.

4.1.2 Solid wall insulation

Figure 2 summarises the payback period for all BMET customer groups that can take up solid wall insulation in 2025.

For the majority of customer groups in 2025, sold wall insulation will never pay back absent a carbon price (or another policy that would internalise the carbon externality, such as an upfront rebate). As shown in below, absent a carbon price internal wall insulation will payback within 20-30 years for only one customer group, Off Grid Rural Electric in 2025, while external wall insulation will not payback within the lifetime of the intervention for any group at that time. In the presence of a carbon price equivalent to DECC's projections on gas and electricity, the solid wall insulation would pay back within 50 years for Successful Ruralites (oil), but would still not payback for the rest of the groups in 2025.

Figure 2. Payback period for solid wall insulation in 2025 across all customer groups



Source: Frontier Economics

Note: As explained in annexe a3e, the ETI defined optimal insulation packages for customer groups in BMET. Some customer groups were assumed to not take up additional insulation because they were already well insulated. In the graph above, we see the payback period of those insulation packages for the groups that had an insulation retrofit option. We assume no policy support through a carbon price or RHI.

Significant changes would need to occur to bring these payback periods down to within 10 years. As a baseline, we will therefore hold the carbon price constant at the DECC levels, and considering what *additional* changes a policy or business model provider can make to bring down the payback period for solid wall insulation to 10 years or less.

Figure 3 summarises the findings of the analysis for solid wall insulation (both internal and external). The top half of this figure shows the overall results across all groups. For these two groups solid wall insulation will never pay back absent a carbon price (or another policy that would internalise the carbon externality, such as an upfront rebate). With a carbon price equivalent to DECC's projections on gas and electricity, then internal solid wall insulation would pay back within 30-50 years for Successful Ruralites (oil) in 2015, but external solid wall insulation would still not payback for Young Starters in 2020.[26]

The bottom half of the figure summarises whether the payback period can be brought down to within 10 years by adjusting various parameters (this analysis is described below). To make the analysis tractable, we have focussed on two groups:

- Young Starters' decision whether to take up external wall insulation in 2020; and
- Successful Ruralites' (oil) decision whether to take up internal wall insulation in 2015.

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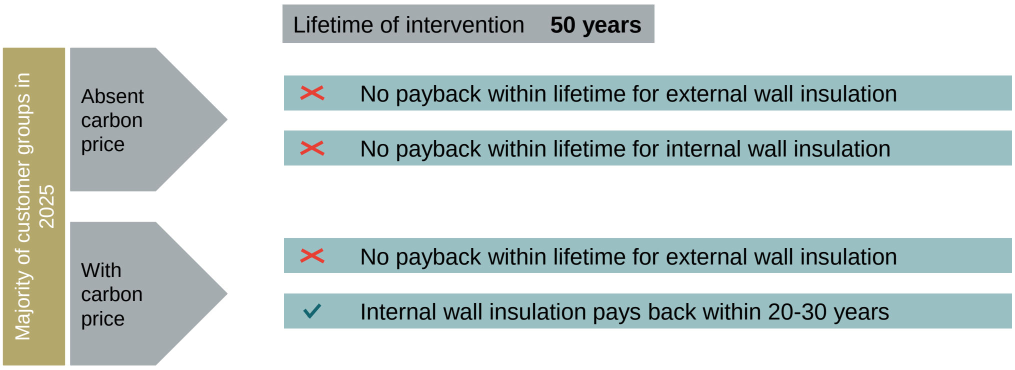
26 The driver of this result is that Successful Ruralite's (oil) have higher baseline heat requirements (18,589 KWh/year) compared to Young Starters (11,847 KWh/year). Therefore, the monetary savings associated with installing solid wall insulation for Successful Ruralites' (oil) are significantly higher than Young Starters' savings.

Figure 3. Key findings for solid wall insulation



Across representative groups

Parameters	What needs to change to reduce payback period to 10 years?
Cost of intervention	**Reduction of 80%** in upfront cost additional to a carbon price
Efficiency of heating technology	Even an increase in effectiveness by a factor of 2, will **not** make solid wall insulation payback within 10 years
Carbon prices	Even an increase in carbon prices by a factor of 10, will **not** make the intervention pay back within 10 years
Interest rate	Even a reduction of 90% in interest rates will not reduce the payback period to 10 years
Fuel prices	Increasing the fuel prices **by a factor of 5**

Source: Frontier Economics

Note: Payback period figures in the top half of this figure are based on averages over customer groups in 2025. A minority of households will fall outside these ranges. For example, internal wall insulation does pay back within 20- 30years for Off-Grid Rural Electric group, even without a carbon price.

Absent a carbon price, the total discount on the cost of interventions required to reduce the payback period to 5-10 years would still be around 80%. This is since the carbon price makes relatively little difference to consumer decisions under such a short time horizon.

Figure 4 shows how Young Starters would require a carbon price at least 50% higher than the DECC level for solid wall insulation to just pay back over the lifetime of the intervention. For Successful Ruralites (oil), the intervention will pay back if the carbon price is 50% of the default or higher.

Figure 4. Impact of carbon prices on payback of solid wall insulation

Carbon prices % of the default	Young Starters in 2020	Successful Ruralites (oil) in 2015
10%	No payback within lifetime	No payback within lifetime
50%	No payback within lifetime	30 - 50 years
70%	No payback within lifetime	30 - 50 years
90%	No payback within lifetime	30 - 50 years
100%	No payback within lifetime	30 - 50 years
120%	No payback within lifetime	30 - 50 years
150%	30 - 50 years	20 - 30 years
180%	30 - 50 years	20 - 30 years
200%	30 - 50 years	20 - 30 years
500%	20 - 30 years	15 - 20 years
1000%	10 - 15 years	10 - 15 years

Source: Frontier Economics

We considered what combination of improvements to effectiveness and reductions in upfront cost would be required to produce lower payback periods. This is shown in **Figure 5**(the gold boxes highlight the default assumptions within BMET). Absent any improvements in insulation effectiveness, upfront costs would need to be reduced by 80% for solid wall insulation to pay back within 10 years for both groups we are considering.

Figure 5. Impact of upfront cost and effectiveness of solid wall insulation on payback period

Successful Ruralites (oil) in 2015

Effectiveness	10%	20%	50%	75%	90%	100%	110%	125%	150%	175%
200%	1 - 2 years	2 - 5 years	5 - 10 years	5 - 10 years	10 - 15 years	10 - 15 years	15 - 20 years	15 - 20 years	20 - 30 years	20 - 30 years
150%	1 - 2 years	2 - 5 years	5 - 10 years	10 - 15 years	15 - 20 years	15 - 20 years	20 - 30 years	20 - 30 years	30 - 50 years	30 - 50 years
125%	1 - 2 years	2 - 5 years	5 - 10 years	15 - 20 years	20 - 30 years	20 - 30 years	20 - 30 years	30 - 50 years	30 - 50 years	No payback within lifetime
100%	2 - 5 years	2 - 5 years	10 - 15 years	20 - 30 years	20 - 30 years	30 - 50 years	30 - 50 years	No payback within lifetime	No payback within lifetime	No payback within lifetime
50%	2 - 5 years	5 - 10 years	30 - 50 years	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime
20%	10 - 15 years	30 - 50 years	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime

£, Cost

Young Starters in 2020

Effectiveness	10%	20%	50%	75%	90%	100%	110%	125%	150%	175%
200%	1 - 2 years	2 - 5 years	5 - 10 years	10 - 15 years	15 - 20 years	20 - 30 years	20 - 30 years	20 - 30 years	30 - 50 years	30 - 50 years
150%	1 - 2 years	2 - 5 years	10 - 15 years	20 - 30 years	20 - 30 years	20 - 30 years	30 - 50 years	30 - 50 years	No payback within lifetime	No payback within lifetime
125%	2 - 5 years	2 - 5 years	15 - 20 years	20 - 30 years	30 - 50 years	30 - 50 years	30 - 50 years	No payback within lifetime	No payback within lifetime	No payback within lifetime
100%	2 - 5 years	5 - 10 years	15 - 20 years	30 - 50 years	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime
50%	5 - 10 years	10 - 15 years	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime
20%	15 - 20 years	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime

£, Cost

Source: Frontier Economics

Fuel prices (changing both electricity and gas prices simultaneously) would need to increase by a factor of 5, for solid wall insulation to pay back within 10 years (and by a factor of 10 to pay back within 5 years). This is shown in **Figure 6**.

Figure 6. Impact of fuel prices on payback period for solid wall insulation

Fuel price % of the default	Young Starters in 2020	Successful Ruralites (oil) in 2015
10%	No payback within lifetime	No payback within lifetime
50%	No payback within lifetime	No payback within lifetime
70%	No payback within lifetime	No payback within lifetime
90%	No payback within lifetime	30 - 50 years
100%	No payback within lifetime	30 - 50 years
120%	30 - 50 years	20 - 30 years
150%	30 - 50 years	20 - 30 years
180%	20 - 30 years	15 - 20 years
200%	20 - 30 years	15 - 20 years
500%	5 - 10 years	5 - 10 years
1000%	2 - 5 years	2 - 5 years

Source: Frontier Economics

Figure 7 shows that even if interest rates are reduced to 10% of their base level, the payback period remains in excess of 20 years. It is the fundamental cost of the interventions, rather than the way in which they are financed, which lead to the long payback periods.

Figure 7. Impact of changes in the interest rate on payback period for solid wall insulation

Interest rate % of the default	Young Starters in 2020	Successful Ruralites (oil) in 2015
200%	No payback w ithin lifetime	No payback w ithin lifetime
150%	No payback w ithin lifetime	30 - 50 years
100%	No payback w ithin lifetime	30 - 50 years
50%	30 - 50 years	20 - 30 years
30%	20 - 30 years	20 - 30 years
20%	20 - 30 years	20 - 30 years
10%	20 - 30 years	20 - 30 years

Source: Frontier Economics

4.1.3 Cavity wall insulation

BMET only includes one group ("Transitional Retirees") which have uninsulated cavity walls.[27] This is consistent with market evidence that suggests that a very small proportion of households (34%)[28] are not cavity wall insulated – as referred to in Annexe 3e. We looked at the payback period of cavity wall insulation for Transitional Retirees in 2015; the results are summarised in **Figure 8**. Even with a zero carbon price,[29] the intervention pays back within 5 years. **Therefore, we believe that no additional modifications or policy are required to incentivise uptake of cavity wall insulation.**

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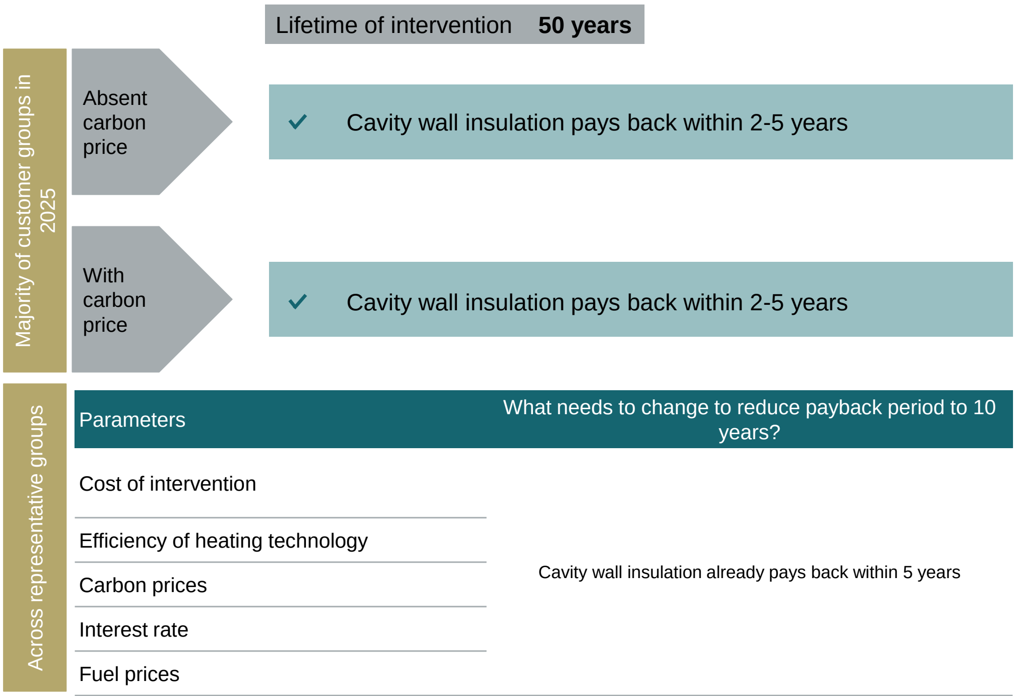
27 This group is assumed to live within 1919-1944 semi-detached houses – see annexe 3e for further details.

28 English housing survey 2012

29 Or other policy support

Figure 8. Key findings for cavity wall insulation



Source: Frontier Economics

Figure 7 shows the effect of varying the carbon price away from the DECC derived default on payback periods associated with cavity wall insulation.

Figure 9. Carbon prices impact on payback of cavity wall insulation

	Transitional Retirees in 2015
10%	2 - 5 years
50%	2 - 5 years
70%	2 - 5 years
90%	2 - 5 years
100%	2 - 5 years
120%	2 - 5 years
150%	2 - 5 years
180%	2 - 5 years
200%	2 - 5 years
500%	1 - 2 years
1000%	1 year

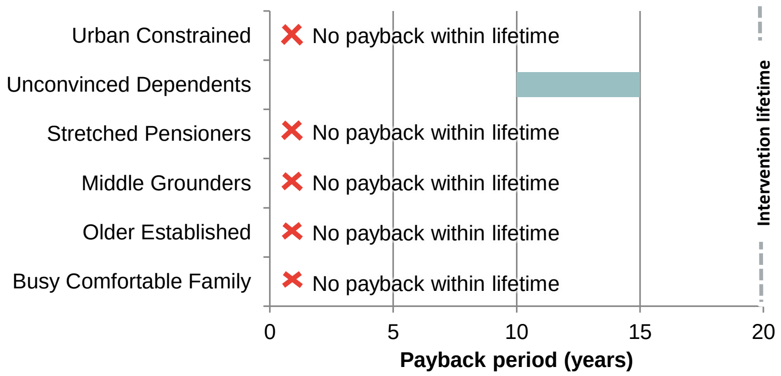
Source: Frontier Economics

4.1.4

4.1.5 Air-source heat pumps

Figure 10 summarises the payback period for all BMET groups that can take up an air-source heat pump in 2025.

Figure 10. Payback period for Heat Pumps in 2025 across all customer groups



Source: Frontier Economics

Note: As set out in annexe a4c, a minimal level of insulation is required for a heat pump to be cost effective. The ETI provided us with assumptions as to which customer groups will be able to take up a heat pump absent taking up additional insulation based on their baseline insulation level. The customer groups shown in this graph are these groups that can take up a heat pump without taking up insulation. We assume no policy support through a carbon price or RHI.

Similar to solid wall insulation, absent a carbon price, most customers will not find it cost effective to install a heat pump. The only exception to this is Unconvinced Dependents who have electric resistive heating as their incumbent technology and can potentially gain from installing a heat pump.[30] This is shown in **Figure 10**. As with solid wall insulation, we have therefore taken a carbon price on both gas and electricity as part of the baseline for this analysis.

For the groups that we are looking at for understanding the payback period drivers (see **Table 2**), we have selected only the customer groups that can take up a heat pump absent insulation.[31] Therefore, we are looking at the payback period drivers for the following groups and respective years:

- Busy Comfortable Family in 2015;

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30 Note that these savings are highly dependent on the nature of time-of-use tariffs. The modelling within BMET somewhat understates the differential between day and night rates and will therefore tend to overstate the gains from installing a heat pump for this group.

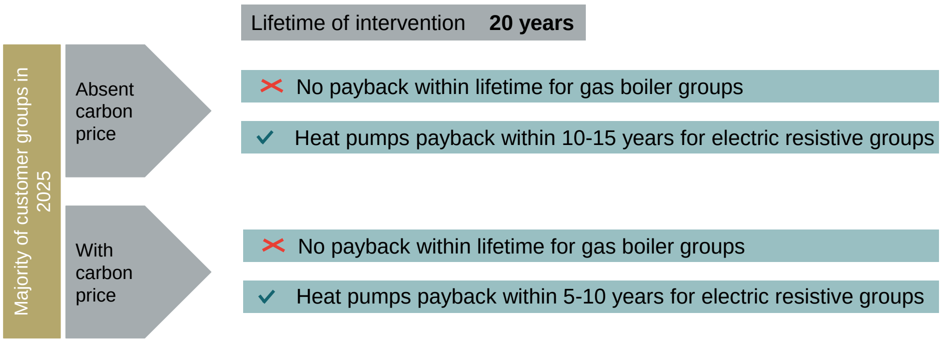
31 The other groups have uninsulated solid walls and, as explained in annexe 4c, we assume that adequate insulation is a prerequisite for installing a heat pump.

- Older Established in 2045; and
- Unconvinced Dependents in 2015.

With the default carbon price, a heat pump would also become cost effective for the Older Established group to install in 2045 with a payback period of 20 years.[32] However, they still wouldn't be cost effective for Busy Comfortable Families who have lower heating requirements.

Given the presence of a carbon price (or equivalent policy support), we have considered to what extent various parameters can be adjusted to bring payback periods down to 10 years. This is summarised in **Figure 11**, with analysis presented below.

Figure 11. Key findings for air-source heat pumps



Across representative groups

Parameters	What needs to change to reduce payback period to 10 years?
Cost of intervention	**Reduction of 80%** in upfront cost additional to carbon price for gas boiler groups **Reduction of 25%** in upfront cost additional to carbon price for electric resistive groups
Efficiency of heating technology	**Increase by 50%** for some groups
Carbon prices	**Increase by a factor of 1.8 – 10** for gas boiler groups Increase in carbon prices by a factor of 10 won't drive payback period to 5-10 years for electric resistive groups
Interest rate	**Reduction by 50%** for some groups
Fuel prices	**Increasing the fuel prices by 20%** for electric resistive groups Increasing fuel prices by even a factor of 10 won't reduce the payback period to 10 years for the gas boiler groups

Source: Frontier Economics

Note: Absent a carbon price, the total discount on the cost of interventions required to reduce the payback period to up to 5-10 years would still be 80% for gas boiler groups and 25% for electric resistive groups. Again, this is since with a relatively short time horizon, a carbon price makes relatively little difference to consumer decisions (the bulk of the benefits occur after the time horizon).

It takes a further increase in carbon prices by a factor of 10 to reduce the payback period for Busy Comfortable Family to 10 years, by which stage the

32 This is the maximum payback period for a HP since the lifetime of the intervention is 20 years.

payback period for Older Established reduces to just 2 years. We see that the payback period for Unconvinced Dependents will remain at 15 years in 2015.[33] The reason for this is that this group compares the efficiency of a heat pump to electric resistive heating and therefore changes to the carbon price will be largely offset (both technologies use electricity, not gas) and will not drive the payback period.

Figure 12. Impact of carbon price on payback period for heat pumps

Carbon prices % of the default	Busy Comfortable Family in 2015	Older Established in 2045	Unconvinced Dependents in 2015
10%	No payback within lifetime	No payback within lifetime	10 - 15 years
50%	No payback within lifetime	No payback within lifetime	10 - 15 years
70%	No payback within lifetime	No payback within lifetime	10 - 15 years
90%	No payback within lifetime	No payback within lifetime	10 - 15 years
100%	No payback within lifetime	15 - 20 years	10 - 15 years
120%	No payback within lifetime	10 - 15 years	10 - 15 years
150%	No payback within lifetime	10 - 15 years	10 - 15 years
180%	No payback within lifetime	5 - 10 years	10 - 15 years
200%	No payback within lifetime	5 - 10 years	10 - 15 years
500%	10 - 15 years	2 - 5 years	10 - 15 years
1000%	5 - 10 years	1 - 2 years	10 - 15 years

Source: Frontier Economics

We now explore what policies or business models could do, in conjunction with a carbon price, to lower the payback period to less than 10 years.

For groups such as Busy Comfortable Family, which have low heat requirements and a gas boiler, a reduction of 80% in the upfront cost of a heat pump is

33 We have seen that the payback period for Unconvinced Dependents will fall to 10 years with a carbon price in 2025, because of the higher carbon prices at that time. This is reflected in the top half of **Figure 11**, which considers results for 2025 rather than 2015.

required for heat pumps to payback within 10 years, [34] holding heat pump efficiency constant. For groups with relatively high heat requirements (like Older Established) or with electric resistive heating as their incumbent technology (like Unconvinced Dependents) a reduction of 25% in the upfront cost of heat pumps is sufficient to reduce the payback period to 10 years.

Figure 13. Impact of upfront cost and effectiveness of HPs on payback period

Older Established in 2045

Effectiveness	10%	20%	50%	75%	90%	100%	110%	125%	150%	175%
200%	1 year	1 year	1 - 2 years	2 - 5 years	5 - 10 years	5 - 10 years	5 - 10 years	10 - 15 years	15 - 20 years	No payback within lifetime
150%	1 year	1 year	1 - 2 years	5 - 10 years	5 - 10 years	5 - 10 years	10 - 15 years	15 - 20 years	No payback within lifetime	No payback within lifetime
125%	1 year	1 year	2 - 5 years	5 - 10 years	5 - 10 years	10 - 15 years	10 - 15 years	No payback within lifetime	No payback within lifetime	No payback within lifetime
100%	1 year	1 year	2 - 5 years	5 - 10 years	10 - 15 years	15 - 20 years	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime
50%	1 year	1 year	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime
20%	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime

£, Cost

Unconvinced Dependents in 2015

Effectiveness	10%	20%	50%	75%	90%	100%	110%	125%	150%	175%
200%	1 year	1 year	2 - 5 years	5 - 10 years	5 - 10 years	5 - 10 years	10 - 15 years	10 - 15 years	15 - 20 years	15 - 20 years
150%	1 year	1 year	2 - 5 years	5 - 10 years	5 - 10 years	5 - 10 years	10 - 15 years	10 - 15 years	15 - 20 years	No payback within lifetime
125%	1 year	1 year	2 - 5 years	5 - 10 years	5 - 10 years	10 - 15 years	10 - 15 years	10 - 15 years	15 - 20 years	No payback within lifetime
100%	1 year	1 year	2 - 5 years	5 - 10 years	10 - 15 years	10 - 15 years	10 - 15 years	15 - 20 years	No payback within lifetime	No payback within lifetime
50%	1 year	1 year	5 - 10 years	15 - 20 years	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime
20%	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime

£, Cost

Busy Comfortable Family in 2015

Effectiveness	10%	20%	50%	75%	90%	100%	110%	125%	150%	175%
200%	1 year	1 year	5 - 10 years	10 - 15 years	15 - 20 years	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime
150%	1 year	1 year	5 - 10 years	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime
125%	1 year	1 year	10 - 15 years	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime
100%	1 year	1 year	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime
50%	1 year	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime
20%	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime

£, Cost

Source: Frontier Economics

The effect of fuel bills on the payback period of heat pumps will depend on two opposing drivers.

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34 An 80% reduction in upfront cost will reduce the payback period to 1 year for Busy Comfortable Family. We expect that a reduction between 50%-80% in upfront cost will reduce the payback period to 5-10 years (the modelling is insufficiently granular to pinpoint the point at which the payback period is just below 10 years).

First, an increase in the non-carbon component of gas and electricity bills will tend to lessen the importance of the carbon component. Given the DECC carbon price assumptions within BMET, the carbon price[35] on gas exceeds that on electricity by around 2025. This places gas-fired technologies at a disadvantage. However, if the underlying fuel prices are higher for both gas and electricity, this carbon price becomes a relatively small part of the overall cost of fuel.. This will tend to *reduce* the advantage of a heat pump relative to a gas boiler.

Second, heat pumps (by extracting heat from the environment) have a lower input energy requirement than either gas boilers or electric resistive heating. Higher gas and electricity bills can *increase* this running cost advantage of a heat pump over a gas boiler. This effect will tend to dominate providing the efficiency of the heat pump is high enough.

We see three different scenarios looking at the groups we considered.

- For the Busy Comfortable Family group in 2015, increasing the price of both gas and electricity by a factor of 10 will marginally reduce the benefits of installing a HP for this group, and therefore HPs will still never pay back for this group. The assumed efficiency of heat pumps within BMET in 2015 means that the first effect above dominates.

- For Older we see the opposite of what we described for Busy Comfortable Family. Increases in fuel prices will increase the cost effectiveness for this group. The reason is that the HP efficiency has improved significantly by 2045 compared to the year 2015 which we considered for the group Busy Comfortable Family. However the benefits are not sufficient to reduce the payback period materially.

- For Unconvinced Dependents, who have electric resistive heating as their incumbent technology, increasing the fuel bills will increase the monetary savings from installing a heat pump.[36] This can significantly reduce the payback period: A 20% increase in fuel bills for this group will make heat pumps pay back within 10 years.

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35 As noted previously, while BMET uses an explicit carbon price,, this can also be seen as a proxy for any government incentive with the same effect – for example if RHI were set to compensate for the carbon benefits of heat pumps.

36 The first effect does not apply here since both the incumbent technology (electric resistive) and the air-source heat pump use electricity.

Figure 14. Impact of fuel prices on payback period for HPs

Fuel prices % of the default	Busy Comfortable Family in 2015	Older Established in 2045	Unconvinced Dependents in 2015
10%	No payback within lifetime	15 - 20 years	No payback within lifetime
50%	No payback within lifetime	15 - 20 years	No payback within lifetime
70%	No payback within lifetime	15 - 20 years	15 - 20 years
90%	No payback within lifetime	15 - 20 years	10 - 15 years
100%	No payback within lifetime	15 - 20 years	10 - 15 years
120%	No payback within lifetime	15 - 20 years	5 - 10 years
150%	No payback within lifetime	15 - 20 years	5 - 10 years
180%	No payback within lifetime	15 - 20 years	5 - 10 years
200%	No payback within lifetime	15 - 20 years	5 - 10 years
500%	No payback within lifetime	15 - 20 years	2 - 5 years
1000%	No payback within lifetime	15 - 20 years	1 - 2 years

Source: Frontier Economics

A reduction in the interest rate will reduce the payback period for the two groups (Older Established and Unconvinced Dependents) who purchase the heat pump on credit. For the latter group, a 50% reduction in the interest rate is sufficient for the payback period to be reduced to 10 years. As Busy Comfortable Families are modelled as taking up heat pumps using a lump sum payment, changes in interest rates will not affect their payback period.

Figure 15. Impact of interest rate on payback period for HPs

Interest rate % of the default	Busy Comfortable Family in 2015	Older Established in 2045	Unconvinced Dependents in 2015
200%	No payback within lifetime	15 - 20 years	15 - 20 years
150%	No payback within lifetime	15 - 20 years	15 - 20 years
100%	No payback within lifetime	15 - 20 years	10 - 15 years
50%	No payback within lifetime	15 - 20 years	5 - 10 years
30%	No payback within lifetime	10 - 15 years	5 - 10 years
20%	No payback within lifetime	10 - 15 years	5 - 10 years
10%	No payback within lifetime	10 - 15 years	5 - 10 years

Source: Frontier Economics

4.1.6 HEMS

As with the other interventions, we first considered the payback period for HEMS across all BMET customer groups in 2025, without a carbon price (or equivalent policy support). This is shown in **Figure 16**. HEMs will pay back within 5-10 years for the majority of customer groups in 2025, even absent any policy support.[37] The three groups for whom HEMS takes over ten years to pay back have relatively low fuel bills, and therefore a lower scope for bill reductions.

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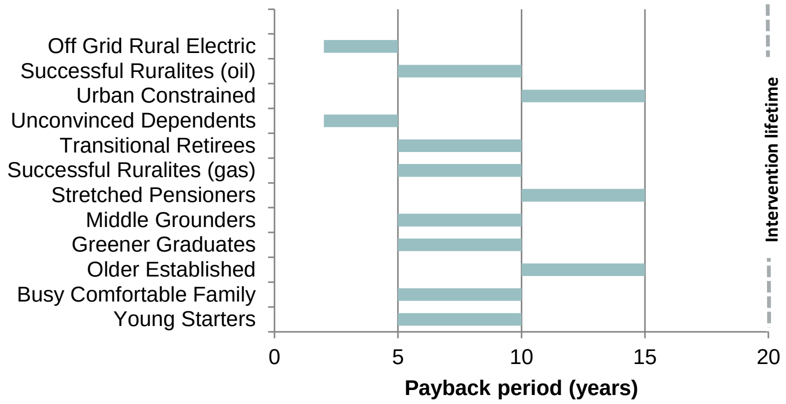
37 Even this is conservative, since the time-of-use prices used within BMET tend to understate the differential between peak and off-peak tariffs, which will understate the gains from HEMS.

Figure 16. Payback period for HEMs in 2025 across all customer groups



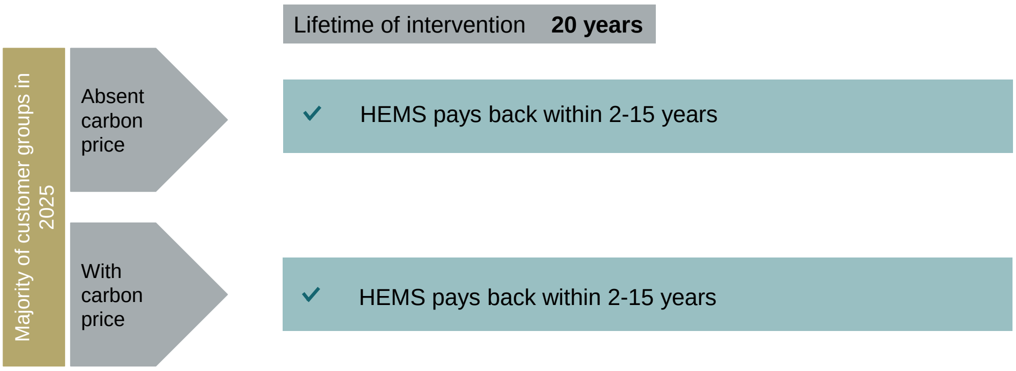
Source: Frontier Economics

Note: HEMs is available for all 12 customer groups in BMET.

For the purpose of understanding the payback period drivers of HEMs we will look at all five groups in **Table 2**. Given the relatively short payback periods without policy support, our baseline for this analysis does not include a carbon price. This will allow us to explore what other policies or business models could be implemented to reduce the payback period to 5 years, absent such a policy.

This analysis is summarised in **Figure 17**.

Figure 17. Key findings for HEMS



Across representative groups

Parameters	What needs to change to reduce payback period to 5 years (already pays back within 10)?
Cost of intervention	**Reduction of 25%-50%** in upfront cost (absent a carbon price)
Efficiency of heating technology	**Increase of 25%-100%** in effectiveness
Carbon prices	**Increase** DECC's projected carbon prices **by a factor of 5** will be sufficient for all customer groups
Interest rate	**Reduction of 20%-50%** in interest rates
Fuel prices	**Increase** fuel prices **by 20%-100%**

Source: Frontier Economics

Figure 18 summarises the impact of varying the carbon price on HEMS uptake.

Figure 18. Impact of carbon price on payback period for HEMs

Carbon prices % of default	Young Starters in 2020	Busy Comfortable Family in 2015	Successful Ruralites (oil) in 2015	Older Established in 2045	Unconvinced Dependents in 2015
10%	5 - 10 years	5 - 10 years	5 - 10 years	10 - 15 years	2 - 5 years
50%	5 - 10 years	5 - 10 years	5 - 10 years	5 - 10 years	2 - 5 years
70%	5 - 10 years	5 - 10 years	5 - 10 years	5 - 10 years	2 - 5 years
90%	5 - 10 years	5 - 10 years	2 - 5 years	5 - 10 years	2 - 5 years
100%	5 - 10 years	5 - 10 years	2 - 5 years	5 - 10 years	2 - 5 years
120%	5 - 10 years	5 - 10 years	2 - 5 years	5 - 10 years	2 - 5 years
150%	5 - 10 years	5 - 10 years	2 - 5 years	5 - 10 years	2 - 5 years
180%	5 - 10 years	5 - 10 years	2 - 5 years	5 - 10 years	2 - 5 years
200%	5 - 10 years	5 - 10 years	2 - 5 years	5 - 10 years	2 - 5 years
500%	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years
1000%	2 - 5 years	2 - 5 years	2 - 5 years	1 - 2 years	2 - 5 years

Source: Frontier Economics

A reduction in the upfront cost of HEMs by 25%-50% will reduce the payback period to 5 years for all groups, as will a 25% increase in its effectiveness. This is shown in **Figure 19**.

Figure 19. Impact of upfront cost and effectiveness of HEMS on payback period

Young Starters in 2020

Effectiveness	10%	20%	50%	75%	90%	100%	110%	125%	150%	175%
200%	1 year	1 year	1 - 2 years	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years	5 - 10 years	5 - 10 years
150%	1 year	1 year	2 - 5 years	2 - 5 years	2 - 5 years	5 - 10 years	5 - 10 years	5 - 10 years	5 - 10 years	5 - 10 years
125%	1 year	1 - 2 years	2 - 5 years	2 - 5 years	5 - 10 years	5 - 10 years	5 - 10 years	5 - 10 years	10 - 15 years	10 - 15 years
100%	1 year	1 - 2 years	2 - 5 years	5 - 10 years	5 - 10 years	5 - 10 years	5 - 10 years	10 - 15 years	10 - 15 years	15 - 20 years
50%	1 - 2 years	2 - 5 years	5 - 10 years	10 - 15 years	15 - 20 years	15 - 20 years	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime
20%	2 - 5 years	5 - 10 years	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime

£, Cost

Busy Comfortable Family in 2015

Effectiveness	10%	20%	50%	75%	90%	100%	110%	125%	150%	175%
200%	1 year	1 year	1 - 2 years	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years	5 - 10 years	5 - 10 years
150%	1 year	1 year	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years	5 - 10 years	5 - 10 years	5 - 10 years	5 - 10 years
125%	1 year	1 - 2 years	2 - 5 years	2 - 5 years	5 - 10 years	5 - 10 years	5 - 10 years	5 - 10 years	5 - 10 years	10 - 15 years
100%	1 year	1 - 2 years	2 - 5 years	5 - 10 years	5 - 10 years	5 - 10 years	5 - 10 years	5 - 10 years	10 - 15 years	10 - 15 years
50%	1 - 2 years	2 - 5 years	5 - 10 years	10 - 15 years	10 - 15 years	15 - 20 years	15 - 20 years	No payback within lifetime	No payback within lifetime	No payback within lifetime
20%	2 - 5 years	5 - 10 years	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime

£, Cost

Successful Ruralites (oil) in 2015

Effectiveness	10%	20%	50%	75%	90%	100%	110%	125%	150%	175%
200%	1 year	1 year	1 - 2 years	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years	5 - 10 years
150%	1 year	1 year	1 - 2 years	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years	5 - 10 years	5 - 10 years
125%	1 year	1 year	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years	5 - 10 years	5 - 10 years	5 - 10 years	5 - 10 years
100%	1 year	1 - 2 years	2 - 5 years	2 - 5 years	5 - 10 years	5 - 10 years	5 - 10 years	5 - 10 years	5 - 10 years	10 - 15 years
50%	1 - 2 years	2 - 5 years	5 - 10 years	5 - 10 years	10 - 15 years	10 - 15 years	10 - 15 years	15 - 20 years	No payback within lifetime	No payback within lifetime
20%	2 - 5 years	5 - 10 years	15 - 20 years	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime

£, Cost

Older Established in 2045

Effectiveness	10%	20%	50%	75%	90%	100%	110%	125%	150%	175%
200%	1 year	1 year	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years	5 - 10 years	5 - 10 years	5 - 10 years	5 - 10 years
150%	1 year	1 - 2 years	2 - 5 years	2 - 5 years	5 - 10 years	5 - 10 years	5 - 10 years	5 - 10 years	10 - 15 years	10 - 15 years
125%	1 year	1 - 2 years	2 - 5 years	5 - 10 years	5 - 10 years	5 - 10 years	5 - 10 years	10 - 15 years	10 - 15 years	15 - 20 years
100%	1 year	1 - 2 years	2 - 5 years	5 - 10 years	5 - 10 years	10 - 15 years	10 - 15 years	10 - 15 years	15 - 20 years	No payback within lifetime
50%	1 - 2 years	2 - 5 years	10 - 15 years	15 - 20 years	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime
20%	2 - 5 years	10 - 15 years	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime

£, Cost

Unconvinced Depedents in 2015

Effectiveness \ £, Cost	10%	20%	50%	75%	90%	100%	110%	125%	150%	175%
200%	1 year	1 year	1 year	1 - 2 years	1 - 2 years	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years
150%	1 year	1 year	1 - 2 years	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years
125%	1 year	1 year	1 - 2 years	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years	5 - 10 years	5 - 10 years
100%	1 year	1 year	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years	5 - 10 years	5 - 10 years	5 - 10 years
50%	1 year	1 - 2 years	2 - 5 years	5 - 10 years	5 - 10 years	5 - 10 years	5 - 10 years	10 - 15 years	10 - 15 years	15 - 20 years
20%	2 - 5 years	2 - 5 years	10 - 15 years	15 - 20 years	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime

Source: Frontier Economics

Fuel price changes will have a relatively homogenous impact on the payback period of HEMs across customer groups. As seen in **Figure 20**, for most groups a 50% increase in fuel prices is sufficient to reduce the payback period to 5 years.

Figure 20. Impact of fuel prices on payback period for HEMS

Fuel prices % of the default	Young Starters in 2020	Busy Comfortable Family in 2015	Successful Ruralites (oil) in 2015	Older Established in 2045	Unconvinced Dependents in 2015
10%	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime	No payback within lifetime
50%	15 - 20 years	15 - 20 years	10 - 15 years	No payback within lifetime	5 - 10 years
70%	10 - 15 years	10 - 15 years	5 - 10 years	15 - 20 years	5 - 10 years
90%	5 - 10 years	5 - 10 years	5 - 10 years	10 - 15 years	2 - 5 years
100%	5 - 10 years	5 - 10 years	5 - 10 years	10 - 15 years	2 - 5 years
120%	5 - 10 years	5 - 10 years	2 - 5 years	5 - 10 years	2 - 5 years
150%	5 - 10 years	2 - 5 years	2 - 5 years	5 - 10 years	2 - 5 years
180%	2 - 5 years	2 - 5 years	2 - 5 years	5 - 10 years	2 - 5 years
200%	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years	2 - 5 years
500%	1 - 2 years	1 - 2 years	1 - 2 years	1 - 2 years	1 year
1000%	1 year	1 year	1 year	1 year	1 year

Source: Frontier Economics

A reduction in the interest rate can lower the payback period for HEMS. Under the default BMET interest rate, all customer groups would purchase HEMS upfront rather than on credit under the default assumptions. Reductions in the interest rate might make customers better off taking up HEMS on credit (this would be the case if the interest rate is lower than the consumers' discount rate), reducing the payback period for all groups below 5 years.

Increases in the interest rate above the BMET default have no effect, as consumers will continue to purchase HEMS upfront.

This is shown in **Figure 21**.

Figure 21. Impact of interest rate on payback period for HEMS

Interest rate % of the default	Young Starters in 2020	Busy Comfortable Family in 2015	Successful Ruralites (oil) in 2015	Older Established in 2045	Unconvinced Dependents in 2015
200%	5 - 10 years	5 - 10 years	5 - 10 years	10 - 15 years	2 - 5 years
150%	5 - 10 years	5 - 10 years	5 - 10 years	10 - 15 years	2 - 5 years
100%	5 - 10 years	5 - 10 years	5 - 10 years	10 - 15 years	2 - 5 years
50%	5 - 10 years	5 - 10 years	2 - 5 years	5 - 10 years	2 - 5 years
30%	5 - 10 years	2 - 5 years	2 - 5 years	5 - 10 years	2 - 5 years
20%	2 - 5 years	2 - 5 years	1 - 2 years	2 - 5 years	1 - 2 years
10%	1 - 2 years	2 - 5 years	1 year	2 - 5 years	1 - 2 years

Source: Frontier Economics

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