London *Energiesprong* Transferability Assessment

A REPORT PREPARED FOR THE GREATER LONDON AUTHORITY

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Executive Summary

Energiesprong is a model developed in the Netherlands to provide state-of-the-art whole-house retrofits, initially in the social housing sector. These combine industrialised retrofit techniques, designed to obtain net zero energy consumption,[1] with novel contractual structures for delivery and cost recovery.

This model has been successfully implemented across 800[2] homes within the Netherlands but has not yet been undertaken at mass scale. The approach has not yet been tested within the UK, where the market environment may pose different challenges. The GLA therefore commissioned Frontier Economics, Savills and UCL to identify the main components of the *Energiesprong* model, and then consider whether it could be transferred to London.

Our review finds that while there are a number of barriers that could reduce the effectiveness of the model in London, solutions are available in many cases. Indeed, the *Energiesprong* approach shows great potential to solve issues associated with extensive retrofits such as upfront costs and hassle. Further, it is clear from our stakeholder engagement that a wide variety of organisations are keen to develop a model that could work in London.

However, even if these barriers can be overcome, bringing net-zero retrofits to a cost-effective price point could present a significant challenge for industry. Energy modelling conducted for this report (as well as previous studies) indicates that net zero energy consumption is not currently obtainable at a reasonable cost for the vast majority of existing housing stock. The organisations promoting *Energiesprong* believe that this can be overcome through cost reductions driven by a mass market for retrofits. It is important, therefore, that first phase trials can show an affordable pathway to net zero in London.

Even if such a large fall in costs is not possible, the *Energiesprong* business model could still be valuable when applied to retrofits that do not lead to net zero energy usage but reduce usage very significantly. This report sets out our suggestions for some practical next steps to explore the model further.

Description of the Energiesprong business model

The *Energiesprong* organisation[3] is working to develop a mass market for net zero energy retrofits (which would then be produced by a variety of solution

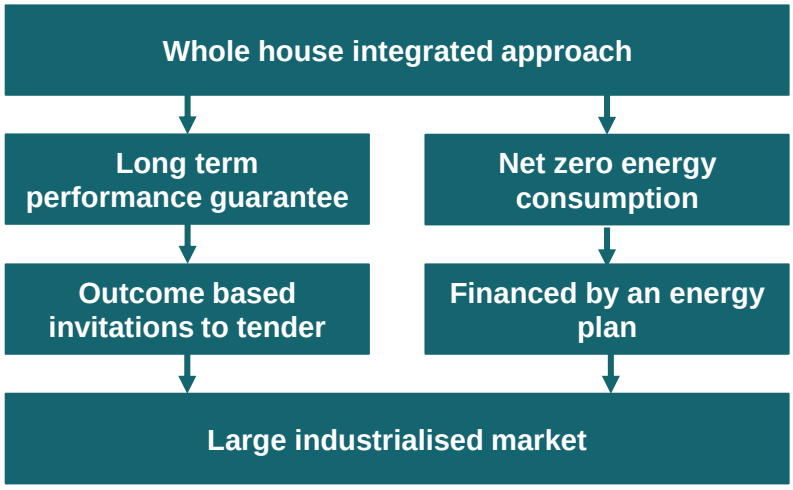
1 Net zero energy consumption is where energy generation within the property equals consumption over the course of the year.

2 Figure provided by Energiesprong in the Netherlands to the GLA in April 2016.

3 There are separate market development teams in the different countries where this approach is proposed, with Energiesprong UK being the UK-based team.

providers). **Figure 1** illustrates the logic that lies behind the resulting business model – how the use of whole-house integrated retrofits can lead to a large industrialised market that can sustain high-volume deals.[4] The business model is currently being targeted at the social housing sector, although a variant could be targeted at the private housing market in the future.

Figure 1. Key components of the *Energiesprong* business model



An *Energiesprong* retrofit takes a "**whole house integrated approach.**" This means that rather than installing one energy saving component at a time, a solution is considered for the property as a whole. Energiesprong UK has indicated that this has two important implications.

- First, because the solution provider delivers a solution for the property as a whole, it is able to give a **long-term performance guarantee** (a warranty) that applies to the net energy consumption of the property. Given the security of such a guarantee, housing providers can set out **outcome-based invitations to tender**, which state a required level of performance rather than the specifics of a retrofit. This gives solution providers the freedom to innovate.

- Second, once a whole house approach is adopted, Energiesprong UK considers there will be relatively low incremental costs involved in obtaining **net zero energy consumption**. Net zero energy consumption makes it simpler for the housing provider to capture their tenants' reduction in energy bills in the form of a fixed "**Energy Plan**" charge which replaces the

[4] The product provided through this business model has a variety of other unique characteristics – e.g. rapid installation of an attractive retrofit.

payments that would previously have been made to an energy supplier. Further, by retrofitting the entire house, maintenance payments are also reduced. Borrowing against both of these additional revenue streams provides housing providers with some, all, or in excess of the capital required to fund the retrofit.

The use of outcome-based tenders, together with the finance available through an Energy Plan and lower maintenance costs over time, is intended to create a **large market for retrofits that leads to industrialisation of the process** (further market development activity by *Energiesprong* and its partners may also be required to facilitate volume deals, once this structure is in place). The aggregation of many net zero retrofits is intended to drive innovations that will reduce the costs of retrofits, improve their quality and prompt regulatory changes required to widen the appeal of the business model.

In this report, we have considered how this business model could be transferred to London.

The requirement for net-zero

Modelling carried out for this project, as well as previous studies, suggests that net zero retrofits are not currently a cost effective solution for the vast majority of properties. However, Energiesprong UK believes that this can be overcome through cost reductions driven by a mass market for retrofits.[5] Within the scope of this project, we have not seen evidence to corroborate this, although any evidence that can be brought forward to substantiate this view would obviously be of great interest.

However, even if net zero energy consumption within the dwelling proves not to be cost-effective, we believe that the *Energiesprong* business model could be adapted to work alongside retrofits which significantly reduce energy consumption without reaching net-zero.[6] The energy modelling described in this report demonstrates how extensive retrofits that reduce energy consumption by 80% or more are likely to be feasible for significant numbers of socially rented properties in London.

Barriers to the business model and potential solutions

This model will need to overcome a number of barriers to work in London including:

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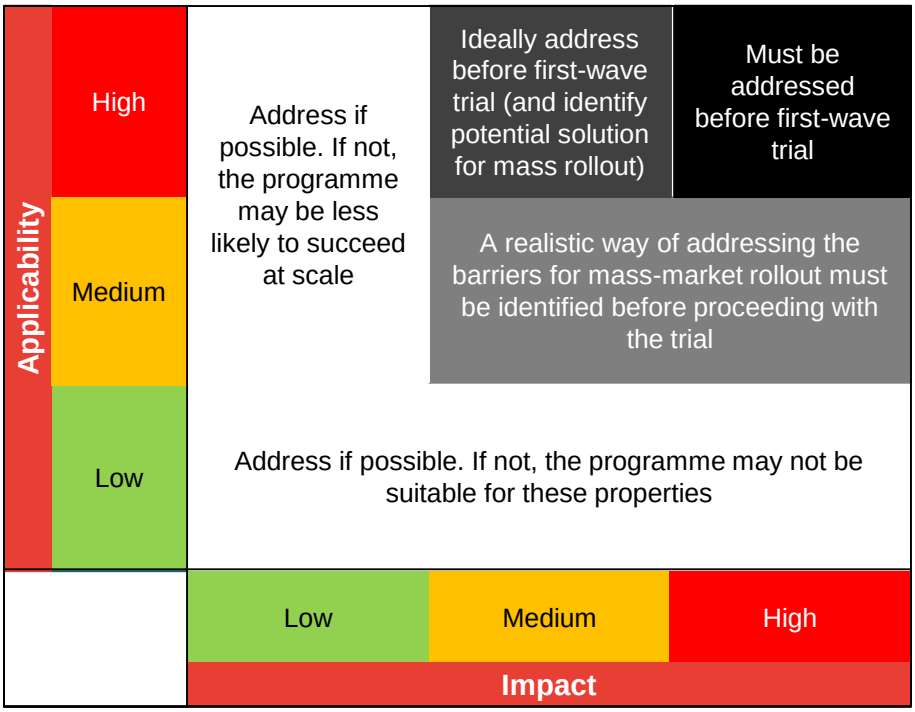
5 **Figure 27** on page 104 shows the cost reductions that have been reported so far for *Energiesprong* in the Netherlands, and forecasted reductions for wider roll-outs.

6 One contractor described this in terms of still having net zero energy consumption, but as part of a wider system including both the dwelling and renewable generation located elsewhere.

- housing regulation, for example, the Right to Buy;
- energy market policies (both individual policies and their interactions);
- planning and building regulations, which restrict the measures that can be applied as part of retrofits;
- limitations in the supply chain required to carry out the work; and
- the attitudes of housing providers and their tenants.

We have identified the severity of each barrier, both in terms of the proportion of properties affected and how seriously the business model might be impacted. This has enabled us to categorise the barriers as shown in **Figure 2**.

Figure 2. Priority of addressing barriers



A small number of barriers will need to be addressed in advance or as part of the first-phase trial.[7] In particular, in addition to the issues around obtaining cost effective net zero energy usage, there will need to be further work to determine how the costs can be recouped from tenants.

Recouping the cost through a service charge is an attractive option (since this can apply both to tenants and leaseholders). However, before implementing this,

7 See Section 10 for a full list of the barriers.

specialist legal advice would need to be sought on whether such an increase would be permissible.

If it is not possible to recoup costs via a service charge, retrofit costs would need to be recouped through some combination of rent and/or a separate contract (potentially using the mechanism for long term cost-recovery associated with the Green Deal). The main body of this report provides more information on the general form that these contracts could take.

Addressing other barriers could help improve the attractiveness of the first-wave trial to housing providers, and will be required for the mass rollout.

- The need to recoup costs from tenants who purchase their property is one such potential barrier. For the trial, it may be sufficient to make use of the "portable discount" which enables housing providers to offer an alternative property to tenants (this will need the approval of tenants). In addition, dwellings could be selected that are less likely to be bought. For the mass rollout, an alternative is likely to be needed, whether recouping costs via the sales price or a service charge (as described above).

- The lack of net metering in the UK means that net zero energy consumption, even if achievable, will not lead to zero bills. Tenant engagement will therefore be required to help develop an acceptable Energy Plan that does not guarantee zero energy costs. If it is possible for energy suppliers to offer long-term fixed price contracts, this may help to provide certainty and overcome this barrier.

- Some potential barriers relate to the planning and building regulations system. For example, to avoid costly and time-consuming planning processes, the RE:NEW Support Team could provide statements to accompany planning applications, or to request waivers to the development caveats. Local development orders could be used as a way of reducing uncertainty in the planning permission process, as could extensions to the existing permitted development rights.

- The UK construction sector will need to adopt new techniques to drive down the costs of retrofits. *Energiesprong* itself is intended to overcome many of the barriers to greater innovation in whole-house retrofits, and the supply chain will need to engage fully with this goal. In the longer term, it will be important for DECC policies to provide a stable platform for such innovation. Contractors should themselves look to provide evidence (whether from trials or detailed modelling) to show a pathway to net zero in London, at affordable prices. Contractors should also:

- look at how they can develop standardised documentation for *Energiesprong* projects (to facilitate long-term maintenance);
- reduce barriers to collaboration (for example through sharing Building Information Management data, codifying designs for different dwelling archetypes, and engaging more with suppliers of equipment); and
- ensure that retrofit packages are developed so tenants do not object on grounds of appearance or hassle (*Energiesprong* does appear to have succeeded in doing so in the Netherlands).

- Performance guarantees, although more common in other sectors, may not yet be seen as credible by housing providers.[8] For the trial, it may be sufficient for large contractors to underwrite the performance guarantee. However, it seems likely that a mass rollout would require insurers to underwrite the guarantee. Given the importance of this issue, Energiesprong UK should therefore start to determine what evidence insurers would need to do this.

- There is a risk that tenants will use retrofitted properties inefficiently, driving up energy costs. While the structure of *Energiesprong* means that such costs would fall on the tenant, it is still crucial for the success of the scheme that retrofits are perceived as performing well for tenants. The first-wave trial should be structured in a way which helps identify the extent of this barrier. In addition, landlords will need to identify how much tenants are currently spending on energy.

There are then a range of barriers that will not affect the success of the trial, but will need to be overcome for mass rollout. It is important that a solution is in mind for these barriers before funds are committed to the first-wave trial.

- Existing "pepper-potted" leaseholders will need to approve and pay for retrofits. For the first-phase trial, it may be possible to select estates where this is not an issue. However, prior to mass rollout, housing providers and legal experts will need to develop an Energy Plan contract that works with leaseholders, and then determine how attractive this would be.

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8 Issues around the credibility of guarantees were brought up by several housing associations we spoke to as part of this research, although such guarantees are more common in the world of commercial property (for example the contracts produced under the Mayor of London's RE:FIT programme).

- Potential future time-of-use tariffs may lead to uncertainty in bill payments. If adopted widely, they will result in energy bills increasing for those with *Energiesprong* retrofits. Providers should start to include plausible time-of-use tariffs in their modelling to determine what the impact will be on customers.

- Housing associations indicated to us that many are reluctant to borrow to finance retrofits. Advice from the Housing and Communities Agency that *Energiesprong* retrofits are a suitable use of borrowed money may help encourage some associations to fund retrofits in this way. However, it may still be necessary for Energiesprong UK and housing providers to explore alternative options, such as the use of project finance funded by large construction companies.

- Existing mortgage lenders may not accept *Energiesprong* works. Housing providers hoping to implement *Energiesprong* should commence discussions with mortgage lenders to determine whether this may be the case, and to define "template" projects that would be acceptable. If this is not possible, government intervention may be required.

- Some property types may lack space for additional plant such as heat pumps, or face issues with congestion and a lack of space for access. The first-phase trials will help contractors develop solutions (some of which are being deployed in the Netherlands).

- Tenants may be unwilling to accept a high degree of monitoring. While we have not seen evidence that this is an issue in the Netherlands, housing providers and Energiesprong UK should engage with groups of tenants to confirm this. If it is, better communication with tenants or lower levels of baseline monitoring may mitigate it. More generally, any rollout of the *Energiesprong* concept needs to ensure that tenants are involved and behind the idea from an early stage.

Other barriers, if overcome, would increase the longer-term prospects for *Energiesprong*.

- Even though *Energiesprong* is intended to be independent of specific government support schemes, it is important that policy is set in a way that does not disadvantage whole-house retrofits over "piecemeal" solutions. We have identified certain aspects of the current RHI and ECO policies that might be improved in this respect.

- Additionally, the scope for widespread *Energiesprong* retrofits within London would be increased if the model could be adapted to work alongside:

- district heating (where heat generation is not carried out at the level of the individual dwelling); and
- conservation areas (which may restrict the ability of solution providers to use the external retrofits that have been applied in the Netherlands.

Applying Energiesprong to other sectors

Finally, we have considered the extent to which an *Energiesprong*-type model may be applicable to the private rented or owner-occupied sectors. There is a significant potential market in these sectors giving impending legislation regarding energy efficiency in the private rented sector. However, the barriers to an *Energiesprong*-type model vary depending on the nature of the property and its owner.

- Where properties are adjacent to those with different owners (i.e. particularly for flats and terraces), retrofits may need to be carried out simultaneously.
- Larger private landlords (as well as freeholders responsible for the upkeep of blocks of flats) may be better placed to implement *Energiesprong* than housing associations, due in part to lower regulatory barriers. However any *Energiesprong* model for small landlords and owner-occupiers is likely to face some of the same issues as the Green Deal (as both schemes require a high capital outlay that is recouped over a long period of time

Given this, *Energiesprong*-type models may be most viable in the following cases.

- Where a landlord (or a freeholder responsible for maintenance of flats) owns a block of properties.
- For smaller landlords and owner-occupiers that own detached houses, and have sufficient funds to pay for the retrofit up-front.

1 Introduction

The Mayor's target of a reduction in CO_2 emissions to 60% of 1990 levels by 2025 will require a large improvement in the efficiency of the London housing stock, which accounts for around 36% of emissions.[9] The GLA has helped to meet this challenge, and raise the overall quality of the housing stock through schemes such as RE:NEW (which, coupled with wider market delivery, has delivered over 500,000 retrofits in London),[10]and the Decent Homes backlog fund.

Energiesprong is a recent approach to retrofit, pioneered in the Netherlands, which aims to "*drive product and process innovation for attractive, affordable, financeable net zero energy refurbishments in the UK*".[11] These combine industrialised retrofit techniques with novel contractual structures for delivery, aimed initially at the social housing market. According to the *Energiesprong* market development team, this could offer a step-change in what is possible, providing a state-of-the-art retrofit without many of the barriers (such as supply chain limitations, occupier hassle, and up-front cost) associated with existing solutions, and reliance on ever-changing government subsidies.

However, the *Energiesprong* approach has yet to be demonstrated at mass scale over the long term within the Netherlands[12] and is entirely unproven within the London market, which differs from the Netherlands in many ways. The GLA commissioned this report to understand the extent to which *Energiesprong* is transferable to London, whether and how any barriers might be overcome, and what the practical next steps for delivery are.

Throughout this report, we have drawn on the following sources of information to answer these questions.

- Detailed interviews with representatives from organisations including social landlords, business within the UK supply chain, and specialists in areas such as technical design, planning and regulation.[13]

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9 Mayor of London (2011), *Delivering London's Energy Future* p113

10 https://www.london.gov.uk/press-releases/mayoral/retrofitting-scheme-to-lower-londons-energy-bills

11 *Energiesprong* website, http://www.*Energiesprong*.eu/index.php/our-approach/

12 800 Dutch houses have currently been retrofitted, as the first part of a 111,000 volume deal – Figure provided by *Energiesprong* in the Netherlands to the GLA in April 2016.

13 For the interviews and roundtables, we selected participants from as wide a range of bodies as practical (some of which are already involved with *Energiesprong*, while others are less familiar with it). Engagement with these organisations has helped us to identify the types of issues that *Energiesprong* may face in London, and the possible solutions. However, this has not been a quantitative survey:

- Two roundtables with 15 organisations (including representatives from housing associations, contractors, technical consultancies and law firms) to discuss issues in more depth.

- Energy modelling carried out by UCL IEDE to determine the effect of different retrofit packages on the London housing stock, which types of property may be most amenable to *Energiesprong* retrofits, and where these are located within London.

- Internal expertise held within the consortium (Frontier Economics, Savills and UCL).

- Information and data provided by Energiesprong UK, including a preliminary version of the finance model being developed for London.

This report is structured as follows:[14]

- Section 2 provides an explanation of how the original Dutch *Energiesprong* business model functions (Annexe 1 sets out the structure of the business model in greater detail) using the "Business Model Canvas" framework.

- Sections 3 through to 8 set out how different aspects of the environment within London (for example, the applicable planning regulations, and the design and state of the London housing stock) may act as a barrier to aspects of this business model. We summarise the next steps that could be carried out to avert these barriers. We consider all aspects of the environment, not just those that differ between the Netherlands and London. Where there are particular insights that can be drawn from a comparison between the Netherlands and London, these are presented in boxes within the text.

- Section 10 summarise the key barriers to *Energiesprong* in London, and what actions may be required (and by whom) to overcome these.

- Section 11 provides a high-level overview of how the *Energiesprong* business model might be adapted for use in the private rented and owner-occupied sectors.[15]

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we have not reported the number of organisations bearing any particular viewpoint, since we have no indication of the extent to which these views are held across all organisations of a given type.

14 We note that many other cities have shown an interest in *Energiesprong*, and we have therefore endeavoured to provide a structure that can be easily applied to other locations.

15 We have not interviewed the actors involved in these sectors, and so the conclusions here should be seen as tentative.

2 Description of the basic *Energiesprong* business model

Energiesprong is a model developed in the Netherlands to provide state-of-the-art whole-house retrofits. Energiesprong UK will not carry out these retrofits itself (third-party suppliers will do this), but instead is intended to act as a catalyst to develop such a market.

In the Netherlands, the organisation promoting *Energiesprong* has brokered a deal between housing associations and builders to retrofit 111,000 properties. These retrofits are believed to be:

- energy neutral (annually a house must not consume more energy for heating, hot water, lights and appliances than it produces);
- financed using the energy cost savings;
- executed within a maximum of 10 days to minimise disruption to the tenant; and
- will come with a 30-year energy performance warranty from the builder.

Additionally, the retrofits are designed to significantly improve the look and comfort of houses (**Figure 3** shows an example of such a retrofit). To date, 800 properties have been retrofitted in this manner through the programme.[16]

16 Figure provided by *Energiesprong* in the Netherlands to the GLA in April 2016.

Figure 3. Example of *Energiesprong* retrofit

Source: http://www.energiesprong.eu/

This report is intended to determine whether and how this business model could be adapted for the London market. To do this, we must first understand how the existing (Dutch) *Energiesprong* business model is intended to work.

It is important to distinguish between *Energiesprong* the retrofitting model (an entire market), and *Energiesprong* the organisation (the team working to develop that market). The analysis here is focussed on the structure of the business model as a whole., not just the organisation which is seeking to develop it. Unless otherwise stated, the term "*Energiesprong*" is used to refer to the retrofitting model, rather than the organisation.

In this section, we have applied a systematic framework[17] (the "Business Model Canvas") to the *Energiesprong* model, to help explore its business logic. This is a recognised framework and "common language" used for examining and comparing business models.

17 Barquet, Ana Paula B., et al. (2011) *Business model elements for product-service system*, Functional Thinking for Value Creation. 2011. 332-337. A version of the canvas is shown at http://www.businessmodelgeneration.com/canvas. The Business Model Canvas is licensed under the Creative Commons Attribution-Share Alike 3.0 Un-ported License.

Description of the basic Energiesprong business model

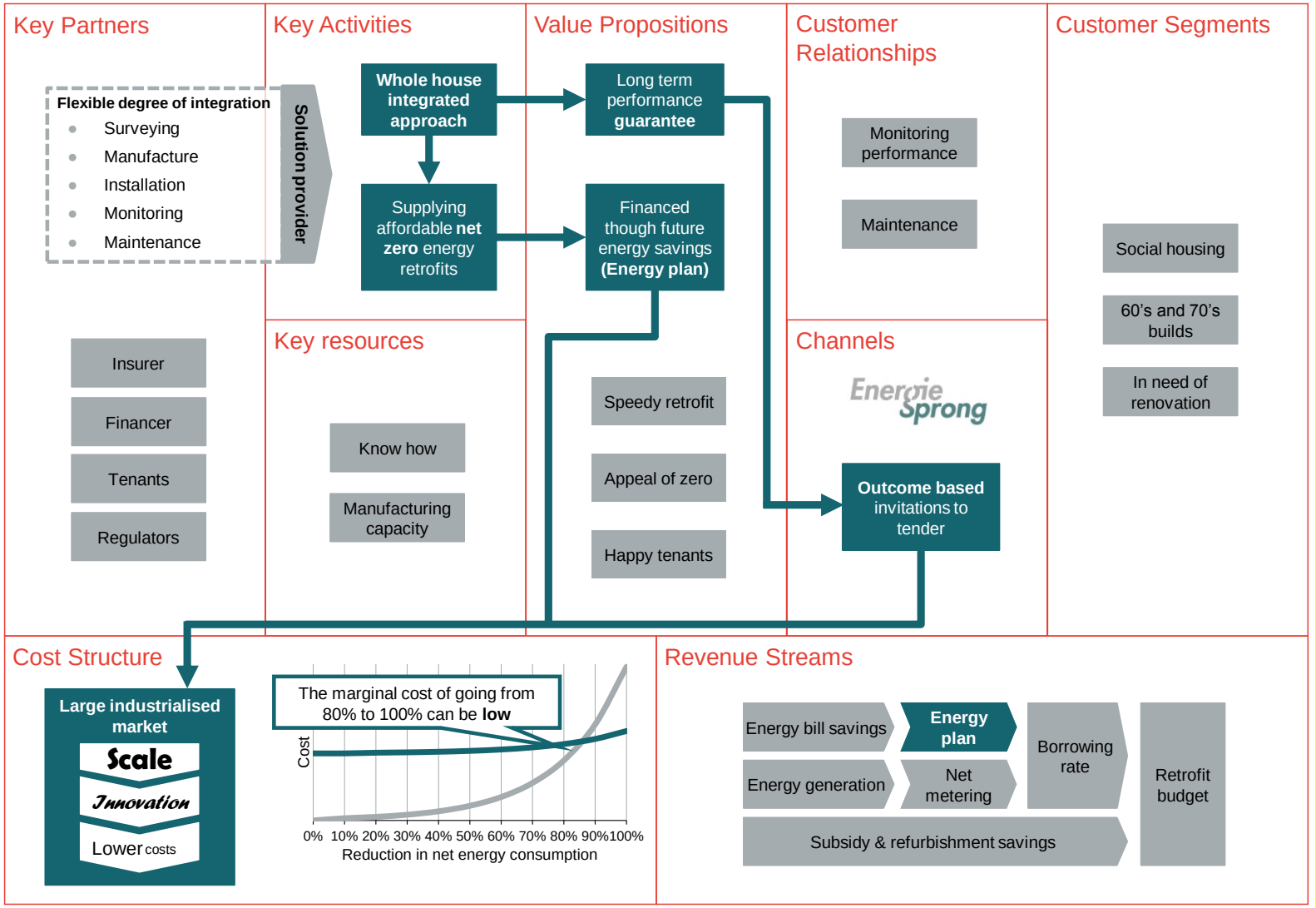
The section below provides a summary of the results of this work. A full description of how the *Energiesprong* business model fits into this framework is presented in Annexe 1.

2.1 Key components of the *Energiesprong* business model

The Business Model Canvas framework is summarised in visual form in **Figure 4**. The diagram is structured as follows:

- At the far right are **customer segments**, the group or groups which the business model serves. This section can be used to explore which areas of the market *Energiesprong* targets, and which are outside its scope.
- In the centre is the **value proposition**, the goods or services that the business model provides to give value to customers, and make them choose it rather than the next-best alternative.
- The canvas illustrates the **channels** used by the business model to reach its customers, and the type of **customer relationships** required (for example, whether it is necessary to maintain a long-term relationship with customers, or whether the relationship is a transactional one).
- Through selling its product to customers the business generates **Revenue streams**. We have explored the structure of these revenue streams within *Energiesprong*.
- **Key activities** are the activities required to provide the value proposition – in this case, primarily the installation of zero-energy retrofits.
- In order to provide their value proposition, businesses require **key resources**, such as physical, financial or intellectual assets.
- Not all activities need to be carried out within the business model, and the **key partnerships** box highlights the other organisations the business model is reliant upon, and the relationship it has with them.
- Finally, the **costs** box highlights the costs incurred in undertaking activities, holding resources, or maintaining partnerships. Issues that can be explored here include the extent to which costs depend on economies of scale.

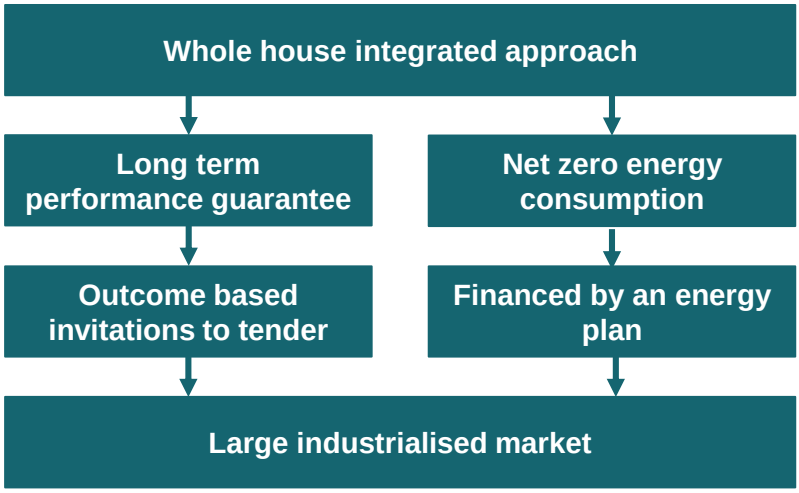
Figure 4. The Business Model Canvas for *Energiesprong*



Description of the basic Energiesprong business model

We simplify this down further in **Figure 5**. This is a high-level overview which focusses particularly on the most important drivers of value,[18] and areas where there may be barriers associated with transfer to London. It shows the chain of logic through which taking a whole house integrated approach to retrofits may lead to a large industrialised market with the volumes needed to bring down costs.

Figure 5. Key components of the *Energiesprong* business model



An *Energiesprong* retrofit takes a "**whole house integrated approach.**" This means that rather than installing one energy saving component at a time, a solution is considered for the property as a whole. Based on discussions with Energiesprong UK, we understand that this has two important implications.

- First, because the solution provider delivers a solution for the property as a whole, it is able to give a **long-term performance guarantee** (a warranty) that applies to the net energy consumption of the property. Given the security of such a guarantee, housing providers can set out **outcome-based invitations to tender**, which state a required level of performance rather than the specifics of a retrofit. This gives solution providers the freedom to innovate.

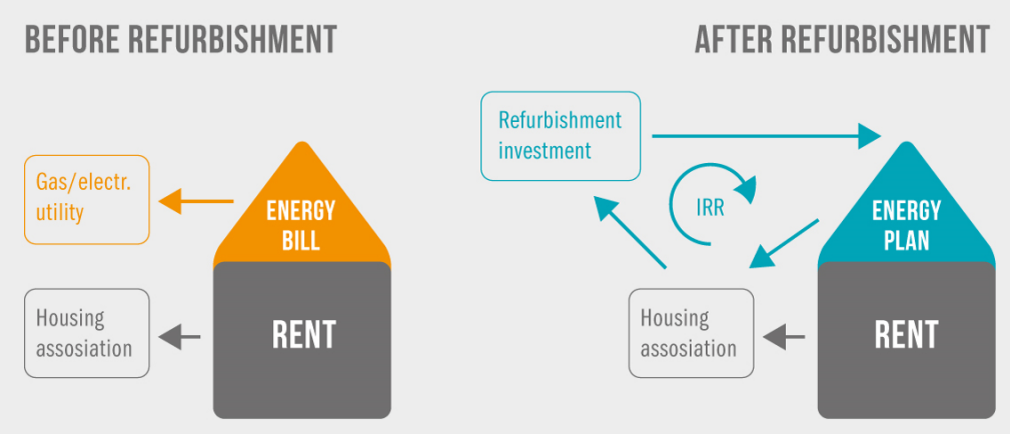
- Second, once a whole house approach is adopted, Energiesprong UK considers that there will be relatively low incremental costs involved in

[18] For example, although the attractiveness of retrofits has been used to help increase uptake of the business model in the Netherlands, we understand from *Energiesprong* that they do not consider this to be a fundamental component of the business model, which could in principle work alongside forms of retrofit with less visual impact. Rapid, hassle-free retrofit is also important to make the programme attractive for landlords and tenants.

obtaining **net zero energy consumption**. Net zero energy consumption makes it simpler for the housing provider to capture their tenants' reduction in energy bills in the form of a fixed "**Energy Plan**" charge which replaces the payments that would previously have been made to an energy supplier. Further, by retrofitting the entire house, maintenance payments are also reduced. Borrowing against both of these additional revenue streams provides housing providers with some, or, or in excess of the capital required to fund the retrofit.

Figure 6 illustrates how the Energy Plan uses money that would have been spent on bills to pay for the retrofit.[19]

Figure 6. Illustration of the Energy Plan



Source: Energiesprong UK (http://www.energiesprong.eu/index.php/our-approach/)

Note that, after refurbishment, the contract with the energy supplier remains. However, bills (except standing charges) over the year are expected to be zero unless occupant behaviour led to more energy being used than allowable in the Energy Plan.

The use of outcome-based tenders, together with the finance available through an Energy Plan, , is intended to create a **large market for retrofits that leads to industrialisation of the process** (further market development activity by *Energiesprong* and its partners may also be required to facilitate volume deals, once this structure is in place). The aggregation of many net-zero retrofits is intended to drive innovations that will reduce the costs of retrofits, improve their quality and prompt regulatory changes required to widen the appeal of the business model.

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3 Implementation of Energy Plans and the interaction with housing regulations

In this section, we explore ways in which the Energy Plan payments can be recouped, given statutory and regulatory requirements affecting the social housing in London (and the rest of England). Any Energy Plan mechanism will need to take account of the following issues, which we describe in the first part of this chapter:

- regulations around how social landlords can set rent and service charges;
- the effect of the Right to Buy schemes on recouping the costs of the retrofit in cases where properties are sold to their occupants;
- the rights and expectations of leaseholders whose homes are pepper-potted among social housing stock; and
- regulations affecting what charges can be covered by welfare and benefit payments.

Annexe 2 outlines in detail the housing regulations that are applicable in London.

In the second part of this chapter, we review three different options for how the Energy Plans can be implemented, and how they interact with the issues described above. These options are to recoup costs though:

- rent;
- a service charge; and
- a separate charge.

There are strengths and weaknesses of each approach. Overall, putting the Energy Plan through as a service charge may be the optimal arrangement, since this could apply to both tenants and leaseholders and does not transfer the costs of works to the government's welfare budget. However, it may not be possible to apply it in all cases without regulatory change to leasehold and affordable rent. Section 3.3 sets out the key legal issues but further specialised legal advice will be required in this area because of the complexity and volume of case law which defines how service charges are handled.[20] It may be possible to recover some charges from tenanted property (not leasehold) through increased rent, although there may not be sufficient flexibility or government will to do this. This leaves

[20] The box at the end of this section summarises all the key legal questions that have arisen as part of our research.

the option of a separate charge – but there are questions whether there is the legal power to maintain this for long enough to repay the cost of works.

Table 1 and **Figure 7** summarise how legal and regulatory requirements could affect the introduction of an Energy Plan, and the next steps that could be taken to create a contractual structure that works within London.

Implementation of Energy Plans and the interaction with housing regulations

Table 1. Summary of the impact of housing regulations/statute on the *Energiesprong* model for implementing the Energy Plan

Impact of statute/regulation	Actions to progress Energiesprong development	Priority[21]	Actors involved
a) Restrictions on rent and service charges will limit housing providers' ability to charge for an Energy Plan through these channels	Obtain specialist legal advice on the extent to which the Energy Plan could be recouped via **a service charge**. The relevant legislation is summarised below and may rule out recouping retrofit costs via a service charge (if the retrofit is not a "facility made available for use"). However, there is a precedent for heating payment being made in this way. If this is not possible, engage with the HCA to determine whether these regulations can be adjusted.	High applicability High impact **Must address for trial**	Energiesprong UK Housing providers Legal experts Homes and Communities Agency
	If it is not possible to recover costs through a service charge, investigate the feasibility of increasing **rents**. This would include using trials to determine whether the retrofit leads to an increase in the value of the property; potentially engaging with the HCA to determine if rent caps on formula rent can be increased; and calculating to what extent housing providers could still ensure their overall rent falls by 1% a year by decreasing rent for non-*Energiesprong* properties.		Energiesprong UK Housing providers Legal experts Homes and Communities Agency

21 Based on the analysis carried out in section 10.

	If it is not feasible to recover costs through a service charge, draw up a **separate contract**. Investigate whether the Green Deal funding mechanism could be used to recoup this Energy Plan. Test this proposition with tenants. See section 4.3 for a description of this possibility. If this model is not feasible, then there may be a higher risk of default for landlords: mitigate this by exploring the feasibility of having PV generation under the landlords' control (so occupiers can be cut off from locally generated electricity if they do not pay).		Energiesprong UK Legal experts Housing providers Tenants
b) Additional approaches to the Energy Plan will be needed to recoup the retrofit costs where residents subsequently exercise the Right to Buy	Consider restricting number of sales of retrofitted properties by exploring whether recent retrofitting could be an allowable reason for housing associations to offer an alternative property when the Right to Buy is requested. This may involve engagement with tenants, and the selection of housing associations with a stock of similar houses nearby (this is not an option for council stock). However, this would not be desirable for a large-scale rollout of *Energiesprong* since it would exclude the Right to Buy from certain archetypes.	High applicability Medium impact **Should ideally address for trial**	Housing providers Tenants
	Following the first-phase trial, obtain the opinion of valuation experts as to whether the value of the properties has increased. If not, a service charge or separate charge will need to be implemented).		Housing providers Valuation experts
	For the first-phase trial, select dwellings that are less likely to be bought e.g. those with mortgageability problems		Housing providers

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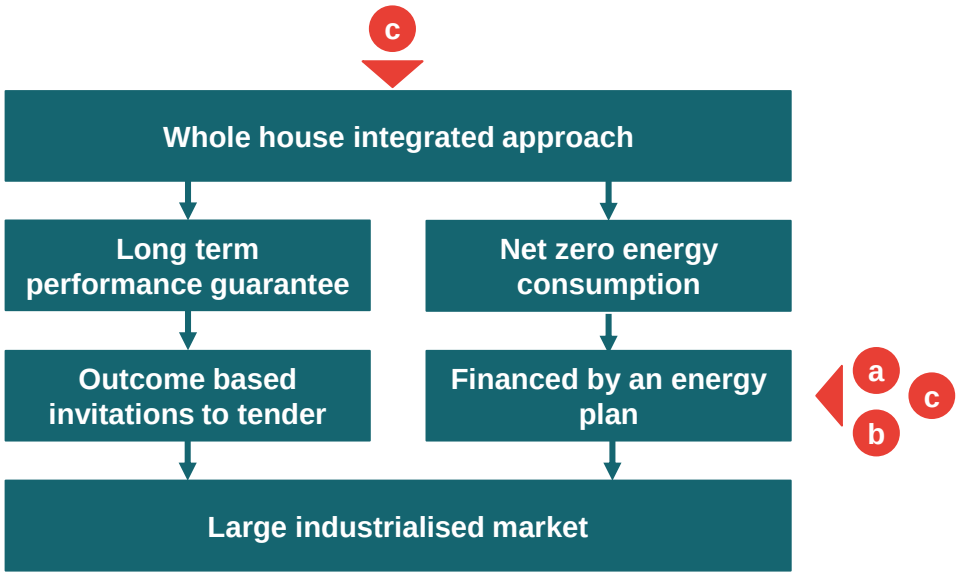
c) "Pepper-potted" leaseholders will need to approve and pay for retrofits (in many instances it may not be possible to avoid retrofitting such properties as this may lead to leakage of heat through party walls).	Test the likely effectiveness of making the Energy Plan a condition of a lease by determining the appetite of leaseholders to pay for an *Energiesprong* retrofit – e.g. with surveys.	Medium applicability High impact **Need to identify solution before mass rollout**	Social landlords Tenants
	Ensure that the Energy Plan contract is designed in such a way that could be applied to leaseholders (if it is collected through rent from tenants, then either a service charge or separate contract will also need to be in place for leaseholders). For the first-phase trial, select dwellings for which this is not an issue i.e. single tenure blocks/buildings		Housing providers Legal experts

Figure 7. Impact of housing regulation and statute on the business model



a Restrictions on rent and service charges

b Recouping costs from Right to Buy scheme

c Pepper-potted lease holders

3.1 Issues that Energy Plans will need to overcome

From our discussions with stakeholders we have identified four key issues in the environment in London that need to be addressed by the approach taken to the *Energiesprong* Energy Plan. The issues are as follows:

- regulations and legislation that restrict the ability of social housing providers to set rent and service charges;
- how the Right to Buy scheme affects the landlords' ability to recoup expenditure at the point of sale or through an ongoing Energy Plan;
- the statutory rights of leaseholders, whose homes are pepper-potted among social stock, to refuse works;
- how an Energy Plan could work with, or alongside, a lease and
- the interaction of the Energy Plan with welfare benefit payments.

The impacts of these issues are different depending on whether the costs are recouped through rent, service charge or a stand-alone contract. To be a credible financial model, the Energy Plan will need to overcome their impacts (considered in 4.2).

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Key differences from the Netherlands: The Right to Buy

The Right to Buy is an important differentiator between the Netherlands and England. There is no equivalent in the Netherlands, although housing associations do often offer tenants the opportunity to purchase their property at a 15-25% discount on the market value. This is not a mandated offer so is less important than in England where it will be essential to adapt the *Energiesprong* business model to work with it.

However, many of the other issues that *Energiesprong* will need to overcome in London will have parallels in the Netherlands. For example, in the Netherlands there are often different types of tenure within an estate.

Regulations around the setting of rent and service charges

The rules governing rent setting and rent increases for social housing are just about to change. Currently the rules on rent setting for housing associations and councils mirror each other, but adherence to them is a regulatory requirement for housing associations and voluntary for councils (including ALMOs).[22] However, in practice, almost all councils follow the same practices as housing associations. From April 2016 to March 2020 legislation will direct rent setting for all social landlords, and there will be no discretion about compliance for any landlord. The system to be used beyond April 2020 is not currently known.

The rules governing administration of service charges are separate from those governing rent setting. They have a legal basis and apply to all social landlords.

The regulations and legislation that govern rents and service charges are:

- **For housing associations:** The Homes and Communities Agency's Rent Standard,[23] and associated Rent Standard Guidance[24] (until April 2016).
- **For councils:** Guidance on Rents for Social Housing,[25] published by DCLG (until April 2016).

22 Arms-length management organisations

23 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/419203/Rent_Standard_2015.pdf

24 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/313992/ccrfa3_fullc.pdf

25 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/313355/14-05-07_Guidance_on_Rents_for_Social_Housing__Final_.pdf

- **For all providers:** The Welfare Reform and Work Act 2016, in particular Schedule 2, and associated secondary legislation (currently unpublished) (from April 2016-March 2020).

The legislation that governs service charges is:

- the Landlord and Tenant Act 1985, as amended by the Commonhold and Leasehold Reform Act 2002;
- the Housing Act 1996; and
- the Service Charges (Consultation Requirements) (England) Regulations 2003.

In summary the legislation says that:

- social rents are set by a formula that takes account of local prices and incomes;
- Affordable Rents are set by reference to local market rents, and together rent and service charges must not be more than 80% of local market rent;
- rents for general needs properties must decrease by 1% each year from April 2016-March 2020 (i.e. rents may not be increased);
- landlords of supported housing properties have some flexibility to increase rents above the formula rent at re-let;
- landlords can only charge for services listed in the lease;
- leaseholders can challenge unreasonable service charges.

Right to Buy

Most local authority tenants have a legal Right to Buy their home. Where housing associations have purchased council homes, tenants who were previously council tenants retain their Right to Buy. All housing associations will offer the right to most tenants on a non-statutory basis from later in 2016.

The London variant of *Energiesprong* will therefore need to accommodate the possibility that a tenant may wish to purchase their property. In such circumstances, provision will have to be made to enable the Energy Plan to continue with the new owner (i.e. the tenant who purchases) and any subsequent owners so that or the cost of works can be repaid.

Pepper-potted leaseholders

Throughout local authority stock, and where housing associations own stock formerly owned by local authorities, tenants in flats may have exercised their Right to Buy. This will have created a mix of leaseholders and social tenants in

individual blocks. Stakeholders we spoke to were not able to quantify the number of mixed tenure blocks,[26] but anticipated that there will be a rapid increase in the number of pepper-potted leaseholders once the Right to Buy is introduced for all housing association tenants in 2016.

Stakeholders we spoke to felt that having owners living alongside tenants in adjacent dwellings (particularly flats) could be a potential barrier to both funding and delivering *Energiesprong* works.

While leaseholders are expected to contribute to the maintenance of communal areas and the fabric of the building owned by the freeholder, there are very clear legal rights giving them control over what expenditure they become liable for and what happens to the building they live in. There are different types of leases so not all leaseholders will be in the same position, but broadly individual leaseholders have to:

- be consulted on major works that would be re-charged to them and if the landlord plans to enter a long term contract with a company;
- agree to pay for additional works beyond what is in the sinking fund; and
- give consent to the works being done regardless of who is paying for them.

Leaseholders can also challenge proposed charges on the grounds they are not 'reasonable', regardless of the option for recouping costs (as discussed later in this section).

Interaction with welfare and benefit payments

A high proportion of social tenants claim housing benefit or the housing element of Universal Credit to help pay their rent. There will be a shift from housing benefit to Universal Credit over the next five years. Regulations governing the operation of housing benefit and universal credit state both:

- the maximum rent that can be claimed; and
- what which service charges can be paid for.

It is important to understand how the welfare safety net would extend to tenants in properties that have an Energy Plan to fund works, and how different approaches to applying the plan may have a bearing. The following three factors are relevant.

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26 It may be useful to undertake additional research to establish numbers.

- **The Benefit Cap** – A limit on the total amount a household can receive through certain benefits. The government intends that a working-age tenant in London may not receive more than £23,000 in benefits income per year (£15,400 for single people), and their housing benefit will be restricted to bring them within that cap (forthcoming regulations to implement the Welfare Reform and Work Act 2016).

- **The Local Housing Allowance Cap** – the government intends that from April 2018 a social tenant whose tenancy started after April 2016 may not claim more than the relevant Local Housing Allowance towards their rent (forthcoming regulations).

- **Utility costs may not be included in a claim for housing benefit.** Service charges (other than for things relating to personal care and support) are eligible. (Housing Benefit Regulations 2006). Universal credit is slightly different. Utility costs are not an eligible service charge for Universal Credit. Charges for internal and external repairs are specifically excluded. (Universal Credit Regulations 2013).

Below we look at the feasibility of different ways of implementing the Energy Plan. For each of the three options for implementing a service plan, we consider the effect of rent-setting regulations, the Right to Buy, pepper-potting and welfare payments on landlords' legal ability and potential appetite for the scheme.

3.2 Option 1: recouping costs through rent

Recouping the Energy Plan through rent (as in the Netherlands) would see the tenant paying a higher level of rent, but no energy bill to a provider unless the Energy Plan sum is exceeded. The tenant would continue to pay any service charges unchanged.

Capacity to recoup the cost of retrofit on social rented properties through rents does exist, although is limited. In the Netherlands the limiting factor on using this model was rent caps, and legislation was amended to relax these to enable use of *Energiesprong*. In England the limiting factor is the regulatory/statutory requirements for setting and increasing rents, which includes, but also goes beyond, rent caps. The government has recently announced its intention to pay no more in Housing Benefit for a social rented property than would be payable in Local Housing Allowance for an equivalent private rented property. Because many social tenants claim housing benefit, it is likely that this will become an additional de facto rent cap – social landlords usually wish to avoid charging more rent than benefit dependent households can pay.

Landlords could in theory increase the rent for a property to take account of *Energiesprong*-related improvements. This would be through a higher formula rent

for social rent and higher market valuation for affordable rent. Affordable rent can be re-based every five years or when property is re-let. Social rent can be recalculated at re-let if improvements are undertaken that could affect the value of the property. However, landlords will still need to reduce this amount by 1% each year for four years, and rents must still remain below rent caps set for formula rent. Local Housing Allowance levels are also a de facto brake on affordable rents Lessons from the RE:VALUE project could help to calculate likely amounts here, and will help to identify whether rent caps for formula rents and/or the Local Housing Allowance rates for properties with high energy performance need to be lifted to allow the value uplift to be captured.

Alternatively, in discussions with stakeholders (November 2015) it was suggested that it may be possible to get government to amend rent guidance to allow rents to be set in different ways for properties where *Energiesprong* has been used. One suggestion from stakeholders was that if they could guarantee that their overall rent envelope would fall by 1% per year, they could perhaps have flexibility to increase some rents to pay for *Energiesprong*. Primary legislation may be too tightly drafted to permit this now, although the power to give exemptions via secondary legislation may offer opportunities. Adding a £1,000pa *Energy Plan* to an average social rent would be around a 20% rent increase – if *Energiesprong* were rolled out on a mass scale, this may be more than could be offset by cutting other rents and still sustaining sufficient rental income across the portfolio of properties.

3.2.1 Dealing with tenants who exercise the Right to Buy

Once a property is sold, the rental income stream to cover the cost of previous works is lost. Tenants who purchase will cease paying rent, and it will therefore be necessary for landlords to recoup the remaining costs of the retrofit in another way. This is particularly the case given the need of housing providers to use Right to Buy receipts to replace sold properties (this is discussed in more detail in section 6).

Recouping retrofit costs from leaseholders

If the property is bought within 10 years of the retrofit then the operating parameters for the Right to Buy ought to mean the full value of the retrofit can be recouped at the point of sale. For local authority housing, a mechanism called the "cost floor" means that the discounted sale price for the property cannot be lower than the total expenditure on the property in ten years prior to sale. There is an expectation that the voluntary housing association Right to Buy will include a similar rule. This does not mean the total expenditure will always be recovered, for example if the market value is lower than the total cost of works.

If the property was eventually sold more than 10 years after the retrofit, there will still be financial costs for the landlord to cover, but at that point the cost floor would not apply. The presence of Energeisprong retrofits is likely to increase the

sale value of the property, although it is currently untested whether this would cover the remaining value of the Energy Plan.[27] If not, costs would need to be recouped on an ongoing basis. This could be through a service charge for leaseholders (see section 3.3) or as a stand-alone contract (section 3.4).

Use of the portable discount as an alternative

In principle, housing associations (but not councils) can offer to sell a tenant an alternative home under the Right to Buy. This "portable discount" can be offered where they have good reason not to sell the property currently occupied by the tenant. This could possibly be used for *Energiesprong* properties to overcome any challenges recouping the cost of the works. It could also ensure that retrofitted properties would continue to be available to lower income households who would benefit from them the most.

Subject to tenant approval, this may therefore be a suitable option if any tenants in the first-wave trial exercise the right-to-buy. It may be helpful for associations to carry out retrofits on homes where they have a stock of similar properties in the same location that could be offered.

However, if *Energiesprong* were to be rolled out as a mass market scheme, the use of portable discounts on such a scale could be seen by politicians as depriving tenants of the benefits envisaged under the Right to Buy. The options described below may therefore need to be investigated further.

3.2.2 Dealing with existing leaseholders

A landlord cannot collect an Energy Plan through rent from leaseholders (because they own and do not pay rent). There are alternative mechanisms for collecting property-related costs from leaseholds which we explore here. This will affect both occupants that become leaseholders after the retrofit takes place but also those who are already leaseholders.

Payments for major works to the building would usually be dealt with via a one-off charge. There is much case law and legal challenge in this area from the last 15 years because of high cost decency works.

Stakeholders that we spoke to anticipated that leaseholders could veto retrofit plans for blocks of flats by refusing to pay and/or refusing to allow the works even if the housing association paid. They anticipated that *Energiesprong* would not be considered essential maintenance, and therefore that leaseholders could

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[27] We note that there is some evidence that only a small proportion of tenants seem to take EPCs into account when choosing a property, although even the best rated property is unlikely to be zero carbon (see Consumer Focus, Liz Lainé, 2011, Room for improvement The impact of EPCs on consumer decision-making, available at: http://www.consumerfocus.org.uk/files/2011/02/Room-for-improvement.pdf).

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challenge charges for these works on the grounds of reasonableness. This was based on experience with ECO schemes.

Changes to leaseholder consents may therefore be required to facilitate block based interventions. However stakeholders were sceptical that a rule change could be secured, especially one that was retrospectively binding on existing leaseholders.

Even if all leaseholders did consent to pay for the works, they can only be charged their share of the cost – it cannot be averaged out over a work programme or residential block. Potentially complex calculations based on individual property and individual current energy bills may be required to take *Energiesprong* forward with leasehold properties.

3.2.3 Interaction with welfare and benefit payments

If the Energy Plan is implemented by increasing the rent because the value of the home is higher, then the extra cost would be met by housing benefit/Universal Credit for those eligible to claim. A high percentage of social tenants do claim help with housing costs and so costs of works would be passed to the welfare budget.

In this case the political appetite for giving flexibility to increase rents of *Energiesprong* properties may be low given current focus on reducing welfare expenditure and targeting public resources at new housing supply. An additional objection could be made because effectively the welfare budget for housing costs would pick up tenants' energy bills which they previously paid themselves.

3.3 Option 2: recouping costs through a service charge

Recouping the costs of the Energy Plan through the service charge would see the tenant/leaseholder paying a higher level of service charge, but no energy bill to a provider unless they exceed the Energy Plan allowance. The rental payments would not change.

Feasibility, given regulations on service charge setting

It may be possible to recoup the cost of *Energiesprong* works through service charges. Because social rent, Affordable Rent, and leasehold properties are subject to different rules and regulations as regards service charges there is an added level of complexity. This is particularly an issue for tenants.

Legal ability to increase service charges

Stakeholders with experience of working with service charges did not agree on whether it is permissible to add maintenance costs into service charges. It is our

belief that it is not – maintenance is a core part of rent and is not a "facility made available for use". However, if the Energy Plan is explicitly about providing fixed, lower cost energy to a resident, then there is certainly precedent for charging for heating through service charges and it may be possible to proceed. Legal advice should be sought to clarify, because a) there are recent cases of such charges being challenged through the courts which may add subtleties of interpretation to this matter and b) landlords' financial arrangements would be vulnerable if there is any chance that the description of the Energy Plan as an energy charge could be challenged on the grounds that it is a maintenance charge.

Tenant appetite

When the works are initially undertaken, the current resident would need to agree to a change in their lease or tenancy so that the Energy Plan could be added as a service charge. Legislation governing service charges requires that the person who incurs the cost must be party to the document. A tenant or leaseholder would therefore have to consent to the changed terms. As treatment of high-specification retrofit within service charges is something of a grey area, its inclusion could be challenged, not least because there is no explicit 'need' to retrofit properties or provide energy to residents, so tenants could challenge this on the grounds of "reasonableness".[28]

Consumer appetite for retrofit work will be one determinant of whether a challenge is made. Some associations had undertaken detailed consultation with tenants in advance of Green Deal projects. They had found that tenants did accept that landlords would not normally equip homes to such a high standard, and therefore that they would be prepared to pay more to help fund the works. Due to the guarantee provided with *Energiesprong*, the tenant would not pay more overall, and this may work in favour of getting agreement. On the other hand, lack of clarity about what the charge is for (stock investment or energy provision) could make it difficult and risky for associations to seek to recover costs of *Energiesprong* works in this way. Again, it would be beneficial to get detailed legal advice.

Once a charge is in place, the charge would be a standard part of the lease so we anticipate that there would be no option other than for a potential future occupant to agree to it if they wanted to live there. Given demand for homes in London we do not anticipate this would become a barrier to sale.

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[28] This could be overcome if the retrofits were targeted at dwellings which are already due for renovations to upgrade the current living standard.

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Service charges for Affordable Rent properties

Housing associations pointed out that adding service charges to Affordable Rent properties is not attractive to them because it reduces the net rent they can collect for the property. Total rent and service charge must be no more than 80% of local market rental values. If this cap is already binding, any increase in service charges must be accompanied by a decrease in rents (although if the market rental value went up due to *Energiesprong* works then the financial arrangement may be viable as the landlord would get an increase in overall income that may offset the addition of the service charge).

In practice, there may be more scope to increase service charges within London. Government figures[29] show that average Affordable Rents in London in 2014-15 were 48% of market rents, compared to 70% in the rest of England. This suggests that there may be some room to increase service charges or rent without hitting the 80% cap.[30] However this figure will mask variation across property sizes, and some properties may be closer to the binding cap of 80%.

It may therefore be worth a landlord involved in the Energiesprong pilot illustrating their approach to, and constraints around, setting Affordable Rents to enable scope for rent increases to be explored. Looking solely at Local Housing Allowance as a brake on rents chargeable, it is likely that there is more room for increase in inner and north London than there is in outer south London.

3.3.2 Dealing with tenants who become leaseholders

If the service charge was a feature of the lease when the Right to Buy was exercised, it could be retained at the point of sale. However the landlord may find themselves in negotiation with conveyancers over the lease terms. Conveyancers are often wary of non-standard terms and so explanation and education may be required.

Landlords may find that properties that would otherwise have been sold freehold need to be sold leasehold in order to keep the service charge in place. The legal and administrative framework around leasehold may make this less attractive to landlords. Flats are a high proportion of total stock in London (49%) and are a higher proportion of social rented stock in England (approx. 50%) compared to

[29] Social Housing Lettings April 2014-March 2015 England; DCLG; October 2015

[30] Rents will have been set at their current levels (below the cap) with an eye to affordability for the intended client group and to ensure they are no higher than the relevant Local Housing Allowance (this is common practice, not mandatory). However, the decrease in energy bills from *Energiesprong* should relax these constraints.

other tenures.[31] Leasehold will therefore be most common, but freeholds will be present.

As described above, the portable discount could avert these issues entirely, although this would be politically unattractive for any mass rollout.

3.3.3 Dealing with existing leaseholders

If a landlord wanted to add a new service charge to a lease, existing leaseholders would have grounds to refuse based on whether the retrofit is reasonable.

Energy Plan changes to leaseholder consents may therefore be required to facilitate block based interventions, as with collecting the Energy Plan through rents.

3.3.4 Interaction with welfare and benefit payments

Many tenants receive housing benefit to help cover their housing costs. Personal utility charges are specifically ineligible for housing benefit (and the universal credit housing element). Although an Energy Plan is not a utility charge, it is so closely linked to one that benefit administrators may consider it to be so. It is therefore unlikely that the Energy Plan would be picked up by welfare payments.

3.4 Option 3: recouping costs through a separate Energy Plan charge

Recouping the Energy Plan through a separate charge would see the tenant paying no energy bill to a provider but instead paying the plan to their landlord. The tenant would continue to pay the rent and the service charge unchanged.

3.4.1 Feasibility of a separate contract

A landlord could enter into an additional contract with tenants to pay an Energy Plan for the works. This would need to be negotiated and administered separately from the tenancy agreement, and could potentially be done by a separate energy services company (ESCO).

Landlords would need to adhere to the requirements of the Consumer Contracts Regulations 2013 and Consumer Rights Act 2015. Key points of relevance to charging for the Energy Plan in this way would include:

- the right to a cooling off period;

[31] English Housing Survey 2013

- the requirement for services to be of satisfactory quality and fit for purpose; and
- the requirement not to impose unfair terms such as curtailing cancellation rights.

Landlords would also need to be subject to credit regulation.

As it would be impractical for housing providers to remove and sell the retrofits applied for *Energiepsrong* (such as extensive insulation), residents would need to be "locked in" to these contracts. There are few equivalent models to this. For example, while residents may have no choice to sign up to district heating schemes, these are structured service charges rather than separate contracts. A mandatory separate contract may be unpopular with residents, and subject to legal challenges (for example under competition law) – detailed legal advice should be sought if such a contract is drawn up for *Energiesprong* trials.

Landlords' legal powers to recover the payments would be much less than their powers to recover the rent, and this did raise some concerns for associations. This is a greater concern than it was under the Green Deal (discussed in section 4). Unlike in the Green Deal, the Energy Plan contract is not with the energy supplier, and so housing associations would not have the ability to install pre-pay meters[32] for tenants who did not pay. It might be a possibility that the electricity generated from solar PV installations could be turned off in response to lack of payment by the tenant (this would require the system to be designed appropriately). This would stop the tenant receiving some of the benefits from the retrofit – although they would still obtain the majority of benefits which accrue from enhanced insulation.

The existence of the Energy Plan (and requirement to pay it) could perhaps be specified in the tenancy agreement in the same way as service charges are. In our discussions, associations' appetite to evict or threaten eviction for arrears on an Energy Plan was very low, however.

3.4.2 Dealing with tenants who exercise the Right to Buy

If a tenant has signed a service contract it could remain valid as long as they remain in the property where the service is provided. There may be financial consequences of the contract for someone exercising the Right to Buy, however, and conveyancing lawyers may advise clients to be cautious.

- It may impact on the onward sale price, because it is a binding obligation on the occupier.

32 Although a supplier could theoretically disconnected debtors, there are stringent rules limiting this.

- It may impact on the potential owner's ability to raise finance against the property, if it means that another company has a claim on the property as security for payment of the Energy Plan.

The installing landlord would also need to take steps to protect themselves financially. The contractual arrangements for the Energy Plan will need to be drafted to take account of changes in ownership, in a way that protects the landlord from having on-going liabilities for the maintenance of the retrofit without the on-going income stream to fund it.

There is a lack of clarity from stakeholders on whether a purchaser could be bound by the Energy Plan.

- While it was presumed that a tenant who had agreed to *Energiesprong* works and then wished to buy the property would be bound by the agreement they had signed, it may not be so easy to bind subsequent tenants (i.e. a tenant who moves in after the works are carried out and then wishes to purchase), who may have grounds to insist that the plan is removed at the point of sale. Where Green Deal Plans were to be used to fund solar panels, provisions had to be made to remove the equipment if a subsequent purchaser refused to accept the plan. Clearly this is not possible with *Energiesprong*

- However it was also noted that where district heating systems or ESCOs are in place for mixed tenure flats, they have no ability to opt out and the leaseholders must pay into the scheme or have no energy supply. Stakeholders had no knowledge that such systems had caused issues with ability to mortgage or with leases.

Specialist legal advice would need to be sought to provide greater certainty in this area. This advice could cover:

- Terms used in Green Deal Plans, any experience of the removal clauses being either used by purchasers or tested in court, and any issues raised in practice by mortgage lenders.

- Other legal frameworks that enable or prohibit purchasers to be bound by conditions agreed to by former occupants, and any examples of legal challenges made, for supply of services (energy supply may be one example).

- Treatment of district heating in Right to Buy (and subsequent) sales, any legal challenges, and any issues raised in practice by mortgage lenders.

3.4.3 Dealing with existing leaseholders

It must always be voluntary to enter a contract to pay for services, so leaseholders have a stronger position here than they do if they were to withhold

payments for their lease. In effect the landlord offers the Energy Plan and the leaseholder decides if they want the service or not – there are no statutory procedures around consultation. However, a leaseholder may choose to sign up if they are attracted by *Energiesprong* because paying for works over time may be more attractive than paying up front. It does require the landlord to secure all the finance upfront, rather than charging leaseholders up front.

3.4.4 Interaction with welfare and benefit payments

As discussed in 4.3, an Energy Plan that does not form part of rent would not be covered by housing benefit or Universal Credit.

Housing associations would have to collect the Energy Plan from all residents. The associations that we spoke to had mixed views on whether this would be feasible. Many are used to collecting small sums from tenants, for example where there are district heating systems, and based on this experience some felt they would be equipped to recoup charges. Others considered that it would be undesirable to expose themselves to more collection of small charges.

It should be noted that the move to Universal Credit will make landlords responsible for collecting rent directly from many more tenants than they currently do, and this may change attitudes and capacity in this regard.

Areas for legal advice

This research has highlighted a number of areas where *Energiesprong* UK or its partners may wish to seek specialist legal advice (while legal experts were consulted as part of this work, a detailed knowledge of case law will be required in many cases, as the interpretation of the regulations can be ambiguous). Below, we set out the main questions that may need to be resolved. This list covers both the legal issues raised in this section, as well as those flagged elsewhere in this report.

- Is it permissible to collect payments to fund *Energiesprong* retrofits and their maintenance through the service charge? This will depend on whether a retrofit can be considered a "facility made available for use".
- If collecting payments through a service charge or rent is not feasible, what would a separate contract look like that could be used for tenants?
- If collecting payments through a service charge is not feasible, what would a separate contract look like that could be used for leaseholders?
- How could such contracts be drafted so they can bind future tenants or leaseholders, including after the exercise of the Right to Buy?
- How does an Energy Plan contract need to be drafted and presented to consumers so they are clear about its limitations (e.g. that changes in energy prices or usage might mean they do not have zero energy bills)? What contractual terms will need to be included to cover scenarios such as damage of *Energiesprong* equipment?
- If project finance is used, how would the contracts between the funding parties be drafted?
- What safeguards will need to be in place to gather and store information from in-home monitoring? For example, what would happen if a tenant with *Energiesprong* later withdrew consent for their data to be processed?

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4 Energy market policies

In this section, we set out how the *Energiesprong* business model may be affected by energy market policies applicable within London. We consider the following issues.

- The way in which future time-of-use tariffs (as well as the lack of net metering in the UK) may act as a barrier to *Energiesprong*.
- How the design of some specific current energy policies may help (or potentially hinder) the business case for whole-house retrofits.
- The ways in which the outcomes of the Green Deal policy can provide insights for *Energiesprong*.

Table 2 summarises each barrier created by the energy market policies in London, and what next steps could be undertaken to mitigate their impact. **Figure 8** illustrates where these barriers affect the business model.

The most significant of these is the way that lack of net metering in the UK means a net zero energy guarantee does not imply zero energy bills (if time-of-use tariffs become more prevalent, this will add to this effect). Any trial of *Energiesprong* should assess whether tenants are content with such a guarantee and, if not, whether long-term energy contracts may be a way to mitigate this.

Table 2. Summary of energy market policies and their interactions with the *Energiesprong* model

Barrier	Actions	Priority[33]	Actors involved
a) The lack of net metering means that a guarantee of net zero energy usage may not equate to zero variable energy charges.	Tenant engagement should be undertaken to ensure that tenants understand the implications of a guarantee that is on energy usage rather than bills, and are willing to accept this. This should be in conjunction with legal advice to ensure that contracts are not presented in a misleading manner.	High applicability Medium impact **Should ideally address for trial**	Energiesprong UK Housing providers Tenants Legal experts
	Solution providers should engage with energy suppliers to determine whether it may be possible to provide a longer-term fixed energy contract which would enable a guarantee of zero variable bills to be made for a period.		Energiesprong UK Solution providers Energy suppliers

33 Based on the analysis carried out in section 10.

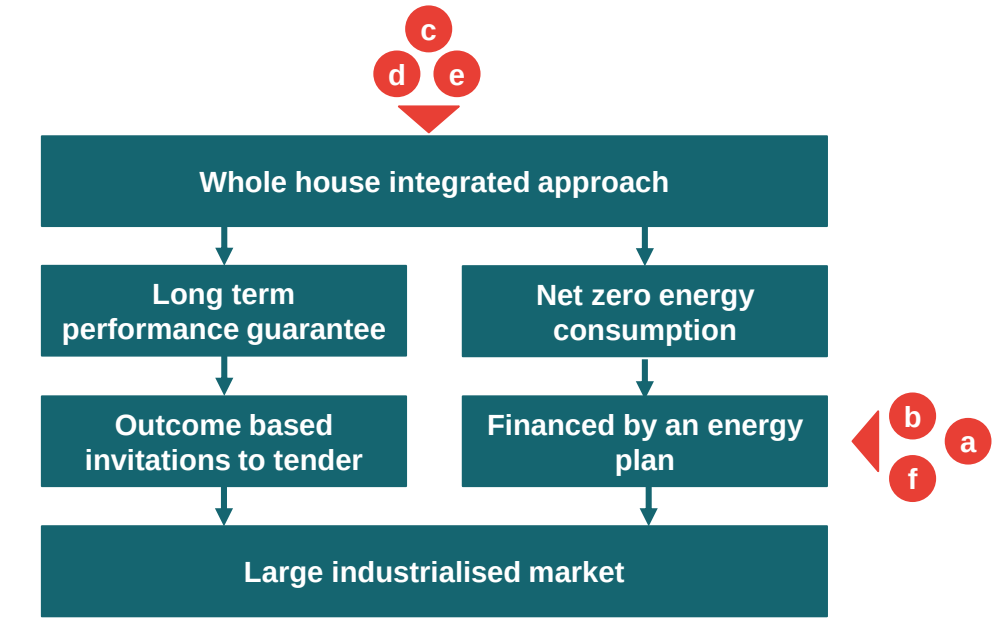
b) Potential future time-of-use tariffs may lead to further uncertainty in energy bill payments.	When modelling the impact of their solutions, providers should determine whether it is possible to provide a standard of retrofit that is likely to lead to zero variable energy bills, even in the presence of time of use tariffs.	Medium applicability Medium impact **Need to identify solution before mass rollout**	Solution providers Energy modelling experts
c) Since RHI income depends on heat usage, this may disincentivise very extensive retrofits	If trials of *Energiesprong* can demonstrate the fundamental cost-effectiveness of whole-house integrated schemes, DECC should examine whether policies can be adapted to work better alongside these types of retrofit.	Medium applicability Low impact **Address if possible**	DECC
d) RHI funding is not currently available for combined solar PV/thermal systems, which may act as a barrier to this type of integrated measure.	Avoid using such measures, unless the resulting bill savings will outweigh the loss of RHI payments.	Medium applicability Low impact **Address if possible**	Solution providers
	Ensure that the RHI (and any similar future policies) do not disadvantage integrated measures if these are cost-effective.		Energiesprong UK DECC Ofgem

e) Funding from ECO is potentially available to piecemeal retrofits, but may be less suited to integrated whole-house measures.	Investigate availability of ECO funding (or any similar future policies) for first-wave trial.	Medium applicability Low impact **Address if possible**	Housing providers ECO funding providers
	Where possible, design innovative retrofit measures in a way which can attract such funding.		Solution providers Ofgem (as ECO administrator)
	Work with providers of ECO scoring software to ensure these applications work effectively with whole-house solutions such as *Energiesprong*.		Energiesprong UK Software developers
	Work to streamline the way that ECO is applied when multiple measures are installed together.		Energiesprong UK DECC Ofgem
f) District heat (DH) systems may complicate the current business model, since it is difficult to guarantee net zero energy when heat generation is elsewhere.	Avoid this barrier for the first-wave trial by ensuring that selected dwellings are unlikely to be connected to a district heat system in the medium term.	Low applicability High impact **Address if possible**	Housing providers London boroughs (as holders of DH masterplans)
	Carry out energy modelling of combined retrofit/DH systems to determine cost-effectiveness, then test customer acceptance of Energy Plan contracts that work alongside a DH contract.		Energiesprong UK Energy modelling experts Housing providers Tenants

Source: Frontier

Energy market policies

Figure 8. Impact of energy market regulations on the business model



a Lack of net metering

b Potential future time-of-use tariffs

c RHI income dependent on heat usage

d RHI funding is not available in conjunction with solar PV

e Funding from ECO

f District heat systems

Source: Frontier

4.1 Time-of-use tariffs and the absence of net metering

An *Energiesprong* retrofit should result in a property that is energy neutral over the year (i.e. electricity exports are equal to imports). Under a "flat" electricity tariff that stays the same throughout the year (and net metering, used in the Netherlands and discussed in the box below), this would result in an electricity bill consisting only of the standing charge. This is not the case within the UK: Unless it is possible to obtain long-term fixed contracts from energy suppliers, *Energiesprong's* net zero energy guarantee will not translate to zero energy bills.

4.1.1 The absence of net metering

The box below describes the net metering arrangements within the Netherlands, and how this form of support for microgeneration compares with the UK's Feed-In Tariffs.

Under Dutch net metering, an increase in electricity retail prices results in both the income from solar panels and the expenditure on grid electricity increasing at the same rate. A home which is consuming net zero energy will therefore continue to face no energy bill (other than standing charges).

Within the UK, changes in energy retail prices will not be reflected in changes in FIT payments (which are fixed at the time the solar panels are installed). Even if it were possible for a house to generate sufficient electricity that it faces no net bills over the course of the year, any increase in electricity prices would result in additional payments being made. The *Energiesprong* guarantee of net zero energy usage will therefore not imply zero bill payments. Moreover, since tariffs are set by energy suppliers and outside the control of *Energiesprong* providers, this adds uncertainty to the customer proposition.

Key differences from the Netherlands: Net metering

Both the Netherlands and the UK provide financial support for domestic solar installations (a key component of the net zero retrofits envisaged for *Energiesprong*). However, this support is delivered in very different ways: The Dutch system of net metering may be more suitable for *Energiesprong* than the Feed-In Tariffs seen here.

With net metering, customers' electricity meters run backwards when their generation exceeds their demand, offsetting electricity bills. This system makes the effects of *Energiesprong* more transparent: A home with net zero energy usage over the year would pay no variable energy bills (only any standing charge) over that year.

By contrast, the UK does not have net metering, and instead supports domestic solar installations with Feed-In tariffs (with a tariff paid for each unit of electricity generated on-site, and a further tariff paid for each unit of electricity deemed to have been exported). As a result, net zero energy consumption within the UK will not necessarily imply zero variable energy bills.

4.1.2 Time-of-use tariffs

Time-of-use tariffs (where electricity prices reflect wholesale demand and supply) may increase this uncertainty. PV generation is likely to be greatest when demand is lowest in the middle of the day and during the summer, when wholesale

electricity prices will be lower. By contrast, PV generation will be lowest (and demand potentially highest)[34] during winter evenings where electricity prices may be considerably higher. This pattern will reduce the cost-effectiveness of the interventions and will mean that tenants may still need to pay a variable energy bill depending on their consumption patterns.

It is outside the scope of this report to suggest how widespread time-of-use tariffs may become. However, several factors point towards an increased adoption, including:

- the rollout of smart meters by the end of 2020;
- increased inflexible and intermittent generation, which may require more flexibility on the demand side; and
- a greater expected rollout in the future of electric technologies such as heat pumps and electric vehicles, which would increase the gains from such tariffs.

Contractors wishing to implement *Energiesprong* may wish to carry out energy modelling to determine what standard of retrofit would be required to lead to an expectation of zero variable energy bills under time-of-use tariffs.

Before rolling out *Energiesprong* at scale, it will also be important to assess whether tenants properly understand, and are willing to accept, an Energy Plan that does not guarantee zero energy bills.

4.1.3 The potential for long-term fixed price energy contracts

As described above, a guarantee of net zero energy usage may still lead to an uncertain energy bill (whether the bill-payer is the occupier, as in the Dutch model, or if the *Energiesprong* solution provider takes on this risk themselves). This could be alleviated by having an energy supplier fix bills at a level equal to FIT payments. There are two barriers that energy suppliers may need to overcome to offer such contracts:

- First, the availability of products that can be used to hedge fuel price risk over the longer term. At present, electricity suppliers are able to purchase products on the wholesale trading market for up to three years ahead,[35] which would not be sufficient to hedge over the periods required to pay off an *Energiesprong* retrofit.

34 This effect will be more significant if electrical space heating is required on cold days, and does not include a storage system that can be charged overnight.

35 CMA (2015), *Energy Market Investigation – Provisional Findings Report* p101

- In addition, to avoid the possibility of consumers leaving the contract if wholesale energy prices fell (making it uncompetitive), suppliers may need to impose significant exit fees. However, it is unlikely that very high exit fees would be viewed favourably by customers or regulators (in the period 2012 – 2014, half the fixed-term contracts available did not include any exit fees, while the remainder only had fees of around £10 to £30 per fuel).[36]

4.2 Effects of specific aspects of the energy market

The measures that can be installed by *Energiesprong* (such as insulation, renewable heat technologies, and microgeneration) benefit society through carbon abatement. While in principle it could be possible to for Government to incentivise such measures through a general carbon price,[37] DECC has instead provided a range of additional policies, such as the Renewable Heat Incentive (RHI) and Feed in Tariffs (FITS) subsidies.

Although *Energiesprong* is designed to be implemented without government subsidies, it may be able to take advantage of them to improve the business case for retrofits for an initial demonstrator project. However, it is also possible that such policies may reduce the attractiveness of *Energiesprong* if they can be more effectively used with alternatives (such as more limited piecemeal retrofits).

With earlier demonstration projects in mind, we have considered the interaction between *Energiesprong* and:

- the Domestic Renewable Heat Incentive (RHI), a tariff received for the production of heat via renewable means;
- Feed in Tariffs (FITs), which provide ongoing support for microgeneration;
- the Energy Company Obligation (ECO), an obligation on suppliers to fund energy efficiency measures; and
- district heat masterplans being considered in London.

We have concentrated on drawing out how these types of policy may act as an incentive or barrier to *Energiesprong*, rather than the specific way the policies work. We also recognise that policy change by itself may act as a barrier. Housing

36 CMA (2015), *Energy Market Investigation – Provisional Findings Report* p306

37 DECC has published a carbon price used for policy appraisal, which represents the estimated marginal cost over time of meeting carbon targets – see DECC (2014), *Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal*. However there is currently no carbon price applied to gas usage, and a very low and unstable price (through EU ETS) on electricity use.

providers and contractors we interviewed frequently believed that changes to policies such as ECO and FITs had generated uncertainty and caused a significant drop in demand for interventions where these revenue streams were an important part of the business case.

4.2.1 Domestic Renewable Heat Incentive (RHI)

Since heat pumps and/or solar thermal panels are commonly installed with *Energiesprong* retrofits, RHI payments could be helpful for the business case.[38] While the RHI would also be available for a more limited retrofit containing a renewable heat technology, in many instances, a heat pump may only be feasible when installed alongside the sorts of extensive insulation measures that *Energiesprong* could provide.[39] However, the RHI could act as a disincentive to installing the extremely high levels of insulation required for a net zero energy property. This is since greater levels of insulation will reduce the deemed heat usage used to calculate RHI payments.

There are also rules concerning which appliances can receive RHI payments. The only restriction on ground source heat pumps is that there can be no underground common connection for the heat pumps. For air source heat pumps, there is a restriction that the heat pump cannot use heat expelled from an appliance or building. These will not significantly restrict the technology choice available for *Energiesprong* retrofits. However, the restrictions on solar thermal panels may be more binding. To receive RHI, such panels cannot:[40]

- also generate electricity;
- provide space heating (as opposed to hot water); and
- use a refrigerant operating on a vapour compression cycle.

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38 Similarly, the Netherlands recently introduced a support scheme for renewable heat sources, with grants available of between €500 and €2,500 for heat pumps of 10kW or less. Ministry of Economic Affairs, *Investment Grant Renewable Energy* (https://zoek.officielebekendmakingen.nl/stcrt-2015-46527.html); RVO, *Investment Grant Renewable Energy* (http://www.rvo.nl/subsidies-regelingen/investeringssubsidie-duurzame-energie); Rijksoverheid, *New subsidy for renewable energy at home* (https://www.rijksoverheid.nl/onderwerpen/energie-thuis/vraag-en-antwoord/subsidie-zonneboiler-warmtepomp-pelletkachel)

39 It is generally accepted that a minimal level of insulation is required for a heat pump to be cost-effective. This since heat pumps are typically less responsive than gas boilers and are generally left on for long periods of time to maintain an adequate temperature. As a results, they require some form of thermal storage. A cost-effective form of storage is the fabric of the building itself, but with inadequate insulation, this would result in unacceptable thermal losses. For examples of the need for insulation with heat pumps, see http://www.energysavingtrust.org.uk/domestic/air-source-heat-pumps, http://www.thegreenage.co.uk/tech/air-source-heat-pumps/ and https://www.cse.org.uk/advice/renewable-energy/air-source-heat-pumps.

40 Ofgem, Eligibility criteria, available at https://www.ofgem.gov.uk/publications-and-updates/domestic-renewable-heat-incentive-product-eligibility-list-pel

We understand that solar panels that generate both heat and electricity have been used in the Netherlands as part of the *Energiesprong* retrofits. This would not be feasible in London without a change to the RHI regulations. If the regulations remained as they are, then *Energiesprong* solution providers will need to decide whether any cost-savings resulting from the use of combined PV/thermal panels outweigh the loss of RHI payments.

4.2.2 Feed in tariffs (FITs)

Under the existing policy framework, solar panels installed as part of an *Energiesprong* retrofit would be eligible for FITs[41] (providing the installer ensured the technology has the appropriate accreditation and the household is added to the microgeneration register). Although the recent FIT degression has reduced sums available through FITs, they would still make a significant contribution to the business case for *Energiesprong* – potentially a net present value of up to £3,400 for an optimally positioned system.[42]

However, housing providers considering *Energiesprong* may still be to obtain these payments by installing PV panels without *Energiesprong*. This could be done through rent-a-roof schemes or by paying outright for the installation. To be eligible for a solar PV FIT, the dwelling must have an EPC of at least D.[43] However most social housing dwellings have an EPC of C-D already[44] and so could receive FITs without the rest of the *Energiesprong* interventions. As a result, it is not clear that the presence of FITs will always increase the business case for *Energiesprong*.[45] A housing provider weighing up whether to use *Energiesprong* or not would be able to obtain FITs revenue (less PV installation costs) in either case.

It is nonetheless possible that there will be cost savings from installing solar PV panels at the same time as new roofing materials. This would support the

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41 The *Energiesprong* retrofit would, by definition, have an Energy Performance Certificate (EPC) of at least D, which is the minimum required to receive the higher level of FITs. See http://www.energysavingtrust.org.uk/domestic/feed-tariff-scheme.

42 Based on figures from the Energy Savings Trust Solar Energy calculator (http://www.pvfitcalculator.energysavingtrust.org.uk/) for FITs applicable between 15th January and 31st March 2016. A 4kW system on a large south-facing roof sloped at 35 degrees (the optimal angle) would attract FIT payments of £160 a year for generation and £88 a year for export. We have assumed (in line with the calculator) that the output would decline to 80% of the initial value by the 25th year, that FITs are received for 20 years of this, and have applied a discount rate of 3.5%.

43 Energy Savings Trust, Feed-in Tariff scheme, available at

44 Provan, B and Brady A-M, 2015, Energy Plus: Energy Efficiency in Social Housing, available at http://sticerd.lse.ac.uk/dps/case/cr/casereport89.pdf

45 *Energiesprong* UK have a financial model which determines the maximum capital cost with which a net zero retrofit can be carried out and still be financially attractive to housing providers.

Energiesprong business model as these efficiency savings would be unlikely without the whole house retrofit.

4.2.3 Energy Company Obligation (ECO)

ECO funding from suppliers could potentially be used to contribute to the whole-house measures installed under *Energiesprong* (although spending on ECO has been falling as suppliers approach their obligations and the current scheme is due to finish at the end of March 2017). However, the ECO scheme as it stands may not always improve the business case for *Energiesprong* (and could even worsen it).

First, as with FITs, ECO funding is also available for the installation of piecemeal retrofit measures. If housing providers are choosing between *Energiesprong* and a less ambitious retrofit, ECO funds may not increase the relative attractiveness of the *Energiesprong* option.

In addition, ECO may disadvantage whole-house retrofits (relative to piecemeal interventions) through the way it is based around the concept of individual "measures", such as wall insulation, glazing, heat pumps, or PV. When multiple measures are installed together, they must be notified separately, with savings calculated individually in the order in which the measures were installed (unless they were installed on the same day, in which case the order can be chosen by the supplier).[46] This may complicate the use of ECO for whole-house retrofits. Indeed, some of the stakeholders that we talked to believed that the structure of ECO did not incentivise the supply chain to invest in innovative whole-house solutions. Instead, ECO was seen as dictating the use of pre-existing standards for retrofits.

If *Energiesprong* is to take off as a mass market model, it will be advantageous if ECO funding (or its replacement) can be secured easily, however the model should also be able to stand alone. The following developments may help.

- First, businesses developing new forms of retrofit for use with *Energiesprong* should ensure if possible that these conform with the requirements for ECO funding.

- Discussions could also take place with makers of ECO scoring software regarding how *Energiesprong* whole-house retrofits can be easily modelled – and potentially whether such software could be integrated with the calculations currently held on the *Energiesprong* finance model (which indicates the available financial envelope for retrofits).

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46 Ofgem (2015), *Energy Company Obligation guidance* (https://www.ofgem.gov.uk/ofgem-publications/94363/ecoguidance-delivery-pdf)

- Finally, there may be changes to ECO itself which can help incentivise the use of whole-house retrofits, where these are appropriate. Within the current ECO framework, this might be possible by including a "whole house retrofit" measure, which encompasses a number of measures installed in quick succession.

4.2.4 District heating plans

Although the Netherlands has a significant district heat (DH) capacity, the existing *Energiesprong* business model is not seen as being compatible with buildings on these networks.[47] This is since the retrofits provide the households directly with a low carbon heat source (primarily heat pumps), and taking a large number of properties off the district heating network (even if cost-effective) would significantly worsen the economics of the DH provider. *Energiesprong* has therefore been targeted at properties not on DH networks.

Given the low existing use of DH networks within London, we do not believe that this is a barrier to *Energiesprong* at present. However, it may be possible to amend the business model to work alongside these networks as they are built.

For this to happen, it would need to incorporate payments for the DH contract within or alongside the Energy Plan. A potential issue is that such a retrofit would not be net zero energy in the same way that a retrofit with a heat pump is (electricity generated by PV panels will not be directly offsetting fuel used for the DH system). However, if *Energiesprong* can be adapted for properties where net zero energy consumption within the confines of the dwelling is not feasible, doing this in a way that may also facilitate the use of DH would seem sensible.

4.3 Lessons from the Green Deal

Table 3 provides a summary of some of the reasons cited for the lack of take-up of the Green Deal, including those identified by the Energy and Climate Change Committee.[48] We have then considered whether the issues are likely to be relevant for housing providers using the *Energiesprong* model. In most cases they will not.

Some of these issues (the bottom three rows) are likely to have applied more to owner-occupants than housing providers. Of the remaining three, *Energiesprong* will at least partially avert two of them (limits on loan sizes and hassle association with the installation of measures). Access to finance at sufficiently low interest

47 This is according to an interview with *Energiesprong*, available at http://www.energypost.eu/zero-energy-zero-cost-industrialising-building-sector/

48 Energy and Climate Change (2014), *The Green Deal: watching brief (part 2)*

rates may still be a limiting factor for *Energiesprong*, and is discussed in section 6 – although we note that rates of interest available to housing providers are certainly likely to be lower than those used for the Green Deal.

Table 3. Do the reasons for the Green Deal's failure apply to *Energiesprong*?

Reason given for lack of take-up of the Green Deal	Applicable to housing providers taking up the Green Deal?	Applicable to *Energiesprong*?
Interest rates perceived as too high (particularly when compared to short-term or variable loan products)	Yes	As explained in section 6, **access to finance may be a significant constraint on the *Energiesprong* business model**. However, Energiesprong UK does envisage that the interest rates housing providers borrow at will be considerably lower than the 8% or more[49] seen for the Green Deal.
A conservative use of the Golden Rule restricted the size of loans	Yes	Subject to their overall access to finance, housing providers will be able to borrow as much as they require for an individual retrofit project. **This may therefore be less of an issue.**
Hassle associated with installation of measures	Yes	*Energiesprong* is intended to focus on low-hassle retrofits (for example, the use of prefabricated external wall insulation). **This may therefore be less of an issue.**
Complexity and confusion regarding the policy and the application process	Housing providers, which employ specialists to manage maintenance and retrofits, **may find this less of an issue**.	
Concerns that tying the repayment to the house would decrease the value of the house	As explained in section 3, **this may be a concern for tenants planning to exercise the Right to Buy**, and, as set out in section 6, **these issues may affect housing providers' existing mortgages**.	
Consumer aversion to very long-term loans	Uncertain, although it seems plausible that housing providers may find this less of an issue than individuals.	

4.3.1 Energy market policies

[49] http://www.which.co.uk/energy/creating-an-energy-saving-home/guides/the-green-deal-explained/green-deal-finance---paying-for-the-green-deal/ accessed on 22/02/16

4.3.2 Can *Energiesprong* benefit from any aspects of the Green Deal?

In section 3, we set out the concerns of housing providers that it may not be possible to pass the Energy Plan through to tenants and leaseholders as part of rent or service charges (as is done in the Netherlands), and that the alternative (a separate charge) could lead to a higher risk of default and bad debt.

The Green Deal model for repayments, where the repayment is made via the energy supplier, may help to avert this. In the event of default, then the energy supplier would be able to impose a prepayment meter. Housing providers have commented to us that the use of prepayment meters to collect the plan seemed more attractive in terms of encouraging the tenant to pay. Going beyond simply copying this principle of Green Deal funding, some of the stakeholders that we consulted with speculated whether the existing legislative and financial mechanism for recouping Green Deal loans could be re-used for *Energiesprong* (with the housing provider providing funding, rather than the Green Deal Finance Company).

This model may merit further investigation by legal and regulatory experts, particularly if it emerges that it is not possible to charge for the Energy Plan via a service charge.[50] This would not simply be a re-implementation of the Green Deal – as described in the previous section, *Energeisprong* is able to address many of the issues identified as leading to the failure of the Green Deal.

50 While the stakeholder engagement for this report included the opinions of lawyers and funders with experience in this area, more specific legal work would need to be commissioned for definitive answers to this type of question.

Energy market policies

5 The planning and building regulations systems

In this section, we set out how the *Energiesprong* business model may be affected by the planning system within London. We consider the following issues.

- Permitted development rights, which specify the works that can be carried out without applying for planning permission.
- The issues that may arise if external wall insulation results in a building extending beyond its curtilage.
- Conservation areas and Article 4 directions, which set out further restrictions on the external works that can be carried out on dwellings in specific areas.
- The Building Regulations and the Party Wall Act, which specify technical and legal requirements around how certain works, must be approached.

Although the National Planning Policy Framework encourages reduction in carbon emissions, stakeholders generally felt that the planning and building control regimes are significant barriers to "deep retrofits". This is particularly the case for external wall insulation[51] in conservation areas, which are protected by more stringent legislation (although the vast majority of houses targeted by *Energiesprong* would fall outside such areas).[52]

Outside conservation areas, *Energiesprong* interventions may still require costly and time-consuming activities (such as obtaining planning permission for an increase in roof height, notifying Building Control for external wall insulation, and making appropriate arrangements if the works will affect adjacent properties or streets). However, there is much scope for organisations such as local planning authorities and the RE:NEW support team to streamline the process for standardised *Energiesprong* retrofits.

Table 4 explains each of the barriers posed by the planning and buildings regulations in London, and what next steps could be undertaken to mitigate its impact. **Figure 9** illustrates where these barriers affect the business model.

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51 While the outcome-based contracts of *Energiesprong* do not mandate particular solutions, external wall insulation is likely to be a required intervention in many instances.

52 Based on data from DCLG, the GLA estimate that approximately 15% of London is covered by conservation areas.

Table 4. Summary of planning and building regulations and their interactions with the *Energiesprong* model

Barrier	Actions	Priority[53]	Actors involved
a) Extending cladding beyond the curtilage of a property requires permission from the owner of the land.	A blanket approval could be sought for *Energiesprong* encroachments on to pavements so long as specified standards are maintained.	Medium applicability High impact **Should ideally address for trial**	Energiesprong UK Council Highways Departments Transport for London
b) Energiesprong retrofits may require developers to go through a costly and lengthy planning process (for example, if the appearance of the property is changed, or the height of the roof is increased)	Clear guidelines should be developed on how *Energiesprong* retrofits can be developed in a way that works within existing permitted development rights. For example, the RE:NEW Support Team could provide statements to accompany planning applications, or to request waivers to the development caveats.	Medium applicability Medium impact **Should ideally address for trial**	Energiesprong UK Planners RE:NEW support team Solution providers
	Extensions to permitted development rights should be sought. (e.g. allowing raising the height of a roof due to roof insulation cladding)		Energiesprong UK Planners Solution providers

53 Based on the analysis carried out in section 10.

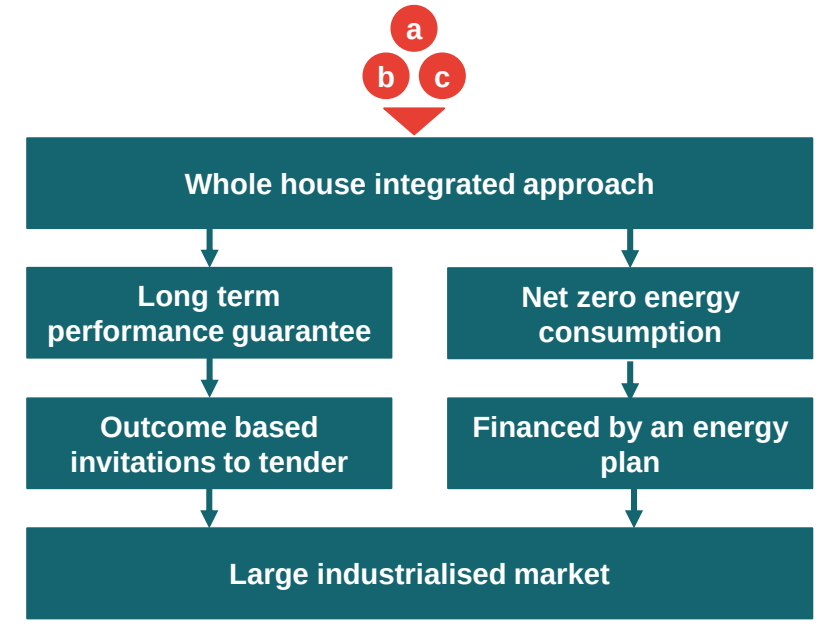
The planning and building regulations systems

	Local development orders could be used to reduce the uncertainty in the planning permission process by providing blanket approval for certain types of retrofit.		Energiesprong UK Local Authorities
	Manufacturers of external wall insulation should continue to develop products which more closely match the types of brickwork seen in existing London properties.		Manufacturers
c) Greater levels of restrictions in conservation areas and for listed buildings may rule out the use of some whole-house retrofit technologies (such as external wall insulation) entirely.	The first-wave trial should attempt to avoid this barrier by targeting properties for which these restrictions do not apply.	Low applicability High impact **Address if possible**	Energiesprong UK Housing providers
	Solution providers could determine whether measures such as internal wall insulation on the front of a property can be used in these areas – although as set out in section 7, this is currently likely to impose higher levels of cost and hassle.		Solution providers
	Energiesprong UK could request General Advice (like a scaled down Pre-Application Discussion) from authorities on how they might consider heritage issues alongside *Energiesprong* retrofits.		Energiesprong UK Planners

Source: Frontier

The planning and building regulations systems

Figure 9. Impact of the planning and building regulations systems on the business model



a Extending cladding beyond the curtilage

b Costly planning process

c Restrictions in conservation areas

Source: Frontier

5.1 Permitted development rights

There are a number of minor developments that can be made to properties without having to apply for planning permission. These are known as 'permitted development rights' and derive from a general planning permission granted by Parliament rather than the local authority. If *Energiesprong* retrofits fall outside the scope of these rights then a time-consuming and costly planning application must be made, which may ultimately result in permission not being granted. We estimate that obtaining planning permission for an *Energiesprong* retrofit would take approximately six months and cost £1000.

5.1.1 Scope of permitted development rights

Permitted development rights apply outside of conservation areas (discussed below) and listed buildings. They cover:

- loft insulation;
- internal wall insulation;

- floor insulation;
- double glazing (with requirements around appearance of materials for houses and appearance of window itself for flats);
- external wall insulation for houses (the restriction does not apply to flats, or if the appearance of the property changes);
- ground source heat pumps;
- solar PV – free standing or on roof (with requirements around siting);
- air source heat pumps (with requirements around siting); and
- wind turbines (with requirements around siting).

Permitted development rights apply within the 'curtilage' of a property (the land around the dwelling).

5.1.2 Barriers to Energiesprong

Some of the specifications linked to permitted development rights would impact on the operation of *Energiesprong*. Some relate simply to design, for example of windows or the appearance of cladding. Others could restrict options for where energy generation could be installed, or indeed the feasibility of using certain technologies on certain properties. This reinforces the need for *Energiesprong* works to be bespoke to each property (through "mass customisation"), which may add costs to the work but is aligned with the philosophy of design and outcome focus.

External wall insulation for houses is covered by permitted development rights unless it changes the appearance of a property, in which case planning permission is required. Planning permission is not required if the appearance of the original materials is maintained.[54] This does not mean that the same type of materials must be used. An *Energiesprong* solution could use a 'mock brick' appearance if a property had a brick facing to start with.

However, this could still create barriers for *Energiesprong*.

- First, if the council requires appearance to be maintained, it restricts the technologies that can be used and potentially increases the costs of materials. For example, external cladding must be brick finished – although such solutions exist, some stakeholders at the roundtables indicated that there

[54] Note this does not apply to conservation areas. Planning permission here must be sought regardless of appearance.

were not yet satisfactory solutions to blend in to some of the different materials used in London streetscapes.

- Second, where *Energiesprong* is being undertaken with the aim of changing the appearance of a property, the works would require the council to be on board with this objective, and it may be easier to gain permission if a whole street was treated rather than pepper-potting properties.

Anecdotally councils are resistant to granting permission for changes in appearance, although perhaps arguments regarding regeneration and the public benefit may be persuasive. If the council does believe that the proposed change will benefit the property, then they are likely to agree. However, councils are generally unlikely to accept what they see as negative changes in appearance to the property unless the change offers a public benefit. This demonstrates the value of *Energiesprong's* focus on visually appealing solutions.

In addition, if *Energiesprong* solutions clad the roof with external insulation rather than replace the roof then they will always require planning permission. This is since, in England, it is not permitted to raise the height of a roof without planning permission. There are also regulations about changes to how far a roof can overhang the walls.

5.1.3 Potential solutions

Where innovations in whole house retrofits identify solutions that are hindered by the planning requirements, it is possible that negotiation could be held with councils to gain exemptions from these requirements on grounds of the overall benefits to society.

It is also possible that the RE:NEW support team could play a role in facilitating *Energiesprong* works on properties covered by permitted development rights. For example the Support Team could provide statements to accompany planning applications, or to request waivers to the development caveats (such as those relating to the streetscape or siting of equipment on a property). Provision of guidance about use/location of energy generation technologies that would comply with permitted development rights could be valuable to contractors.

Another potential solution would be the use of Local Development Orders (LDOs) by local planning authorities, which give a grant of planning permission to specific types of development within a defined area. This can reduce uncertainty, as well as saving time and money for those involved in the planning process.

LDOs can be made by local planning authorities under powers in section 61A of the Town and Country Planning Act 1990. They can cover a wide range of issues ranging from non-physical aspects, such as change of use, through to physical changes to the external appearance of buildings. The scope of LDOs can

range from small scale development (such as changes to signage or to shop fronts) up to allowing the development of new buildings, if supported with the appropriate design guidance. **Figure 10** below demonstrates the process of producing an LDO.

Figure 10. Process of producing an LDO

Source: Savills and Frontier

The Growth and Infrastructure Act 2013 simplified the LDO process. It removed the requirement for the local planning authority to submit the order to the Secretary of State before adoption (for consideration of whether to intervene). This was replaced by a requirement to notify the Secretary of State, via the National Planning Casework Unit as soon as practicable after adoption, as shown above in **Figure 10**

Key differences from the Netherlands: A less centralised approach to planning

The Dutch planning system is centrally focused with few regional disparities across the country. City councils prepare "structure plans", which are used as a framework to transform the national and municipal plans into final, approved plans. The key aspect of the Dutch planning process is the Zoning Plan. This contains the aims, maps, how the building will be used and the building construction. It may also prescribe information on architectural appearance, but this would not be detailed. Once this Zoning Plan has been approved, the urban design is created by the municipal services (or by planning offices on behalf for the municipality).

The approach in the UK is less top-down and prescriptive. The National Planning Policy Framework provides general themes. However, each individual Borough can apply this to their area and their specific requirements so long as it meets these general policies. Therefore the local plans and Neighbourhood plans in the UK provide more flexibility than the system in the Netherlands.

This more flexible system may act as an advantage when implementing *Energiesprong* in the UK. However, in the Netherlands, the promoters of *Energiesprong* have still been able to secure agreements on planning rules to simplify these procedures.[55] As described below, this is a model that would provide benefits in the UK.

5.2 Extending beyond the curtilage of a property

External wall insulation cladding will increase the size of the property. This may mean extending the property beyond its curtilage, in which case permission must be obtained from the owner of the land. While this is not strictly a planning issue, part of the planning application is a form to fill in if the development is going to encroach beyond the properties curtilage. There is also a standard notice that the developer would serve on the owner of the land.

In the case of *Energiesprong*, the most likely issue is with encroachment onto the pavement. The Council's Highways Department (or Transport for London in some instances) could give permission as long as it did not make the pavement so narrow as to be unsafe or impact on amenities.

Energiesprong UK could seek blanket approval from The Council's Highways Department and Transport for London to *Energiesprong* encroachments as long as specified standards are maintained.

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55 http://www.energiesprong.eu/index.php/our-approach/, accessed on 18/02/2016

5.3 Conservation areas and Article 4 directions

There are many conservation areas in London,[56] the aim of which is to preserve the appearance of an area and/or the fabric of buildings. As we describe below, these restrictions may make it difficult to carry out some of the retrofit measures that have been used in the *Netherlands*. However, it should be stressed that the types of property that *Energiesprong* has focussed on in the Netherlands (generally built in the 1960s and 1970s) are unlikely to be affected by conservation areas.

As a general rule, development within conservation areas should protect or enhance the surrounding area and as such there will be greater restrictions on the types of work that can be carried out (and materials that can be used) on buildings. If the proposed change provides enhancement to the building, then it will likely be allowed within a conservation area (subject to planning permission). Permitted development rights (discussed in the preceding section) are also impacted by a property's listing or location within a conservation area, as councils can also issue an Article 4 Direction to remove permitted development rights in areas of acknowledged importance.

When balancing the planning policy imperatives to improve energy efficiency and protect heritage, councils will generally seek to encourage energy improvements whilst ensuring they do not detract from what is special about the conservation area as a whole. In effect this means that conservation will trump high levels of energy efficiency. Not all energy works will be prohibited, and high performing councils will proactively guide owners on what works would be permitted. Despite this **it is likely to be very difficult to carry out the types of retrofit that have been used with *Energiesprong* to date[57] (façade and roof replacement) in older properties in conservation areas**.

Decisions will be made on a case-by-case basis and each council may balance the decision differently. In general, if the historic merit of a building is challenged by energy efficiency additions, the protection of the historic building will likely be of importance and the proposals may be refused. This is particularly evident in Councils such as Kensington and Chelsea, and Westminster.

Particular examples of the restrictions in conservation areas are given below.

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56 Based on data from DCLG, the GLA estimate that approximately 15% of London is covered by conservation areas.

57 Retrofits that do not alter the external fabric of the building – for example internal wall insulation – would not be affected in this way. However, these are currently much more disruptive for householders, since they require the room to be emptied and the repositioning of fittings attached to the wall.

- In conservation areas, planning permission is required for external wall insulation. Most London boroughs are clear that they would not give permission for external cladding to the front of a property in a conservation area because it would either change the uniformity of the façade or eliminate architectural design.[58] This does not totally preclude the use of cladding, but it does mean that the 'wrap' solution pioneered in the Netherlands could not be used, and that perhaps a different design/performance solution would be required for each individual property.

- Further restrictions can apply in Article 4 areas, For example, double glazing[59] may only be permitted where the materials, finish, dimensions and details are the same as the original, while there may be greater restrictions on the siting of solar PV and wind turbines. If the requirements around siting cannot be met, a planning application will be required. Impact on appearance and historic value of a property will be taken into account in determining planning applications, and stakeholders report that councils are very conservative when determining such applications.

- Local authorities may also use Article 4 directions to restrict the removal of particular features of buildings. While some authorities publish constructive guidance to help property owners to improve environmental performance of dwellings in the face of these restrictions, this often promotes a piecemeal approach rather than whole-house solutions.

It is clear that local planning policies increase the costs and restrict options for retrofit works, especially "deep retrofits" like *Energiesprong*. Although there might be potential for more innovative design and technology (e.g. around cladding) to help lower the barriers, appetite among stakeholders to work in conservation areas is very low: it seems likely that these would be a poor choice of location to try to pioneer a new approach to works.

5.4 Building regulations and the Party Wall Act

Building regulations and the Party Wall Act will both impact on *Energiesprong* works as they would on any other internal/external retrofit activity. Designers producing the technical solutions would need to work within the building regulations, and contractors would need to ensure installers had the appropriate

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58 For properties within conservation areas development is not permitted by Class A of the General Permitted Development Order where it would consist of or include the cladding of any part of the exterior of the dwelling with stone, artificial stone, pebble dash, render, timber, plastic or tiles.

59 There are no permitted development rights for flats. Therefore the GPDO does not apply for double glazing on flatted developments.

accreditations (e.g. for window installation) to avoid additional expenditure on council fees. Some features, including external wall installation, are notifiable with Building Control (compliance cannot be certified by an accredited installer), and such notices will add additional time and cost to *Energiesprong* works.

Some contractors we engaged with reported that building control is not a particular issue, whereas others felt that it is. One contractor felt that planning and building control in the same authority do not always behave consistently.

If external cladding is to be a key feature in delivering reductions in energy use, then properties other than detached ones will need a Party Wall Agreement. This will add costs to a retrofit and where the neighbouring property is not owned by the housing provider the neighbour may want to influence the technical solution in relation to the way it joins the property. The person negotiating the agreement will have to ensure good technical performance can be achieved, while meeting the requirements of the neighbours. However, this expertise has already been established due to current installations of external cladding.

In cases with "pepper potted" leaseholders (as opposed to freeholders), this may not be so much of an issue. This is because the Party Wall Act is about the landowner rather than someone with an interest in land. The freeholder will still need to notify the leaseholder, but as the development is not about works to the property the leaseholder lives in then the grounds for refusal are diminished. Party Wall Act applications ought to be simple because *Energiesprong* solutions are unlikely to involve structural changes and so such just require the appointment of a structural surveyor to oversee progress.

6 Financing

In this section we consider how *Energiesprong* could be financed.

- First we look at three possible sources of funding: traditional loans (bank or bond finance), dedicated loans for environmental or health-enhancing works, and project finance.

- We then consider whether the impact of *Energiesprong* on existing secured loans may act as a barrier to adoption.

The availability of funds for housing providers[60] will be an issue of great importance if *Energiesprong* is to be rolled out on a mass scale. **Table 5** explains each of the barriers posed financial issues, and what next steps could be undertaken to mitigate its impact. **Figure 11** illustrates where these barriers affect the business model.

60 Many of the issues described here would apply to homes owned by local authorities through ALMOs as well as housing associations, although the rates of interest available to such organisations might be lower.

Table 5. Summary of financing issues and their interactions with the *Energiesprong* model

Barrier	Actions	Priority[61]	Actors involved
a) The "golden rule"[62] and perceived pressure from the HCA may prevent housing providers from borrowing to finance retrofits.	Work with the Housing and Communities Agency to develop "safe harbour" guidelines that outline when borrowing to fund an *Energiesprong* retrofit will not incur additional attention from the regulator. Intervention from DECC may be helpful.	Medium applicability High impact **Need to identify solution before mass rollout**	Energiesprong UK Housing providers HCA DECC
	Investigate whether additional finance may be available that is tied to specific environmental or health goals (for example, whether a case could ever be made for the NHS contributing to retrofits).		Energiesprong UK Housing providers Potential financiers

61 Based on the analysis carried out in section 10.

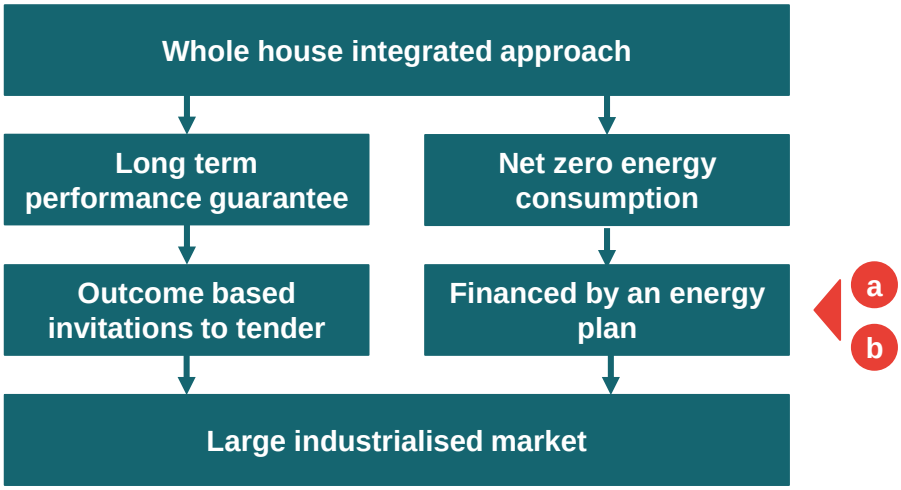
62 This refers to housing associations avoiding borrowing to invest in existing properties, and is distinct from the golden rule of the Green Deal, discussed in section 4.

	Investigate the feasibility of project finance – particularly with large contractors providing the finance.		Energiesprong UK Housing providers Potential financiers Supply chain Legal experts
b) Existing mortgage lenders may not accept *Energiesprong* works, which have novel technologies especially those that are permanently attached to the fabric of the building or permanently affect the provision of heating, and (particularly if paid for by project finance) may attach a claim for future funds to the property.[63]	Commence discussions to determine whether this is an issue for mortgage lenders. Work with lenders to develop guidelines for "template" projects that would be acceptable.	Medium applicability High impact **Need to identify solution before mass rollout**	Energiesprong UK Housing providers Mortgage providers
	If this is not possible, government intervention may be required to help lenders accept these works.		Energiesprong UK Housing providers Mortgage providers DECC and HCA

Source: Frontier

63 This barrier arises from discussions with THFC (a body which arranges finance for Housing associations) and Addleshaw Goddard (the principle lawyers for funding contracts for Housing associations).

Figure 11. Impact of financing issues on the business model



a The Golden Rule and perceived pressure from the HCA

b Novel technologies may be difficult to fund

Source: Frontier

6.1 Sources of finance

Energiesprong anticipates that housing associations would contribute their own funds and then borrow money to make up the difference. The precise split would be for individual associations to determine. Upfront funds could come from existing annual maintenance budgets or from associations' surpluses, with the amount based on anticipated levels of expenditure in future years (for instance bringing forward assumed expenditure). Borrowing would be used where expenditure requirements exceed annual budgets, or where it is more financially prudent to borrow than to draw on surpluses.

Rates for housing association bank/bond finance vary, but recent loans have been issued at around 3.75-5% interest.[64] Current 10 year fixed rates for Public Works Loan Board funds (which are available to local authorities) are around 2.75%[65]. This is more comparable to the cost of borrowing used to fund *Energiesprong* works in the Netherlands.

Alternative sources of finance are available, but housing associations have less experience in using them. Bodies that support associations to access finance are

64 *Social Housing* January 2016

65 UK Debt Management Office

also more cautious about these sources, given a perception that funders' administrative requirements are cumbersome. However the housing associations we spoke to recognised that new approaches to delivering energy performance works may also require new approaches to raising finance.

6.1.1 Traditional loan facilities

All of the housing associations we spoke to[66] directly about financing were resistant to the idea of borrowing to fund *Energiesprong* retrofits. The reasons cited included the following.

- The expansion of Right to Buy looks set to reinforce commitment to the golden rule. This is since councils and housing associations are expected to use their Right to Buy receipts to replace the sold properties (and will lose money to central government if they do not). Debt finance will be needed on top of the receipts to fund replacements, and this will reduce their capacity to raise further funds for non-development works such as *Energiesprong*.

- It is common practice for housing association financial policies to place limits on the extent to which they can borrow to fund retrofits. English housing associations do not typically borrow to fund investment in their existing properties unless it relates to "remodelling" obsolete stock or regeneration. This practice is often referred to as the "golden rule" and the premise is that the income from rental properties should fund their upkeep over a 30 year cycle.The Homes and Communities Agency currently makes robust checks on housing association finances in its role as regulator, and increasingly comments on how funds are used as well as how they are managed. Consequently some stakeholders feel their freedom to borrow money for anything other than new supply is curtailed, not because regulation forbids it but because it could lead to unwanted and time consuming attention from the regulator.

Common practice and regulatory opinion can of course be shaped. However, the need to maintain numbers of homes in ownership is fundamental to the business of a housing association, and so the impact of the Right to Buy may be the hardest to avoid. Alternative sources of finance may therefore be needed for *Energiesprong*. If these are not available, the only source of funding would be through existing revenue streams (which will fall with the legislated rent cuts). These would be insufficient to support a mass roll-out.

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66 A2 Dominion, Affinity Sutton, Amicus Horizon, Accord

Key differences from the Netherlands: Funding costs for housing providers

Housing providers must be able to finance the up-front costs of retrofits (which will gradually be paid back over their lifetime). In the Netherlands the funding for housing associations is collectively regulated. Housing associations are organised into a Guarantee Fund. The Dutch government acts as the lender of last resort for this fund and this underwriting gives the fund a AAA rating from credit rating agencies and lowers the cost of borrowing for *Energiesprong* in the Netherlands.[67]

In England, housing associations instead usually raise finance from bank loans or bonds. Lending is secured against the value of properties in ownership, and ability to repay is assessed based on income streams. In addition, local authorities can access funding from the government-backed Public Works Loan Board to fund works to council-owned homes.

Based on input from Energiesprong UK, we understand that a typical UK housing association might be able to obtain bond finance at a 4.2% interest rate (this falls within the range of 3.75% - 5% described above), which is nearly double the interest rate of around 2.8% that a Dutch association might obtain. This will reduce the business case for *Energiesprong* in London among housing associations (although ALMOs retrofitting council-owned stock might be able to obtain lower rates of interest).

6.1.2 Dedicated loans for environmental or health-enhancing works

There are investors that wish to invest in energy efficiency and retrofitting, although upon interview some housing associations felt that this was more of a "fad" with limited capacity for lending.

The "golden rule" discussed above has meant that these loans have generally been used to deliver *new* homes with good environmental performance rather than retrofits. Stakeholders from the financial sector felt that this type of lending can be difficult to manage, because it can be small funds with high performance monitoring requirements. However the real-time monitoring associated with *Energiesprong*[68] may be attractive to lenders operating in this sphere. It would cater

67 Although note that, due to the loan conditions, unless the retrofit changes the lifetime value of the property the Housing association cannot borrow to fund the retrofit. The Housing association would need to borrow against other assets to get access to the state guarantee and the AAA borrowing rate.

68 The monitoring systems deployed in the Netherlands have been quite extensive, involving sensing of factors such as temperature and humidity in multiple rooms.

for their desire to see real impacts of their investment rather than assumed impacts, as have been provided for projects such as on-site generation to date.

Many housing associations are beginning to work more closely with health commissioners, and some stakeholders suggested that perhaps health budgets could be used to finance *Energiesprong* works, however in practice there is a long way to go. This would involve future savings on acute care resulting from the retrofits being capitalised (as has happened with the very small scale practice of giving "boilers on prescription" for example).

Specific sources of finance that might be suitable for *Energiesprong* retrofits include the following.

- The London Energy Efficiency Fund. This provides loans (financed with £100m from the European Regional Development Fund and London Green Fund) of between £1m and £20m for up to 10 years, with interest rates from 1.65% per annum.[69]

- The Green Investment Bank. Created and capitalised by the UK government (although now moving to the private sector), the GIB invests in a variety of projects including energy efficiency schemes. The GIB has backed large projects with a capital expenditure of more than £1bn and small projects of £2m.[70]

- The £140m recently announced by the Government to support estate regeneration.[71]

6.1.3 Project finance

Because the Energy Plan would have an associated income stream it may be possible to raise finance against this. Housing associations do not generally seek project finance for their activities, although this may be more familiar to contractors.

Several contractors confirmed they were prepared to consider this, although their initial comments indicated they would be looking for full repayment over a fairly short timeframe such as five years.

An additional feature of project finance is that it could perhaps be "tradable", which could make it more attractive to investors than dedicated loans for environmental works. While the plan could be sold to investors, contractors or

69 www.leef.co.uk

70 www.greeninvestmentbank.com

71 www.gov.uk/government/news/prime-minister-pledges-to-transform-sink-estates

other housing associations as an income stream, housing associations indicated that they would only want to collect plan payments from someone they had an ongoing relationship with. This suggests that a third party administrator would be required if the freehold of properties was sold.

Unlike secured lending, the use of project finance would not reduce capacity for further borrowing to support new supply. However, there could be a conflict between the requirements of the two types of finance provider. For example it appears that providers of secured lending would want the right to remove the Energy Plan if they became a mortgagee in possession, whereas the provider of project finance would want the right to ensure the income generation facility remained in place even if the property was sold. This suggests that Energy Plans may still be better suited to properties that are not already in charge to a lender (as set out in section 6.2 below) even if the *Energiesprong* works themselves are not financed using traditional lending.

Another barrier to project finance (particularly if *not* financed by a contractor) is the likely need for a credible guarantee that the Energy Plan (the only source of funding to repay the debt) will be sufficient to cover capital and maintenance costs. As explained in section 8.3, there are barriers to suppliers being able to offer credible guarantees.

6.2 Interaction with existing secured lending

Housing associations borrow money that is secured against their existing properties. Therefore changes to their existing stock could impact on their existing borrowing arrangements even if the borrowing does not relate to funding *Energiesprong* works.

A key concern for lenders is their ability to enforce their security should the housing association default on its loan. This is not an issue in the Netherlands, as debt finance is not secured against properties

If a lender were to become a mortgagee in possession, it would not want to be bound by liabilities that could hinder its ability to sell the property to release the capital. Therefore lenders would need to know that their rights as a mortgagee in possession are not affected by *Energiesprong* works undertaken, the maintenance contract or the guarantee offered on those works relating to properties that are 'in charge'. These issues were fundamental in the way solar 'rent a roof' schemes were implemented by landlords, and they were one of the main reasons that housing associations did not use Green Deal plans.

There are two potential ways of partially mitigating this issue.

- Housing associations could avoid charging properties that have *Energiesprong* retrofits. However spare security is very limited and associations are likely to be unwilling to restrict the number of properties available to put into charge.

- Ensuring that the housing association owns the works from the outset, and avoiding creation of third party access rights are important to reducing the risk of there being a negative impact on existing lending. However as explained above, this would directly conflict with the use of project finance.

A second concern for lenders is that the open market value of the property is protected (again, in case they need to sell the property as a mortgagee in possession). In theory the asset value should improve following *Energiesprong* works, and this should give lenders comfort. Confirmation that energy performance does/can positively affect value may allay concerns here (this has not yet been verified for the types of whole-house retrofit that *Energiesprong* will facilitate).

Existing secured lenders may need to give consent to *Energiesprong* works being carried out if it changes liabilities (on-going ownership or access rights) or if they are concerned about major works using untested technology that could affect the market valuation of the property or expose them to abnormal risks or costs in future years. If existing borrowing facilities are used to pay for *Energiesprong* works, it may be necessary to check that the technology is not so novel that it falls outside the usual purposes of the loan agreement.

Stakeholders did not feel that lender practices were likely to shift in response to normalisation of models such as *Energiesprong*. If that is the case, this may be a significant barrier to housing associations taking up *Energiesprong* (unless government intervention could change the attitudes of lenders).

7 The housing stock

In this section we summarise the results of modelling of the social housing stock in London.[72]

- First we define archetypes to describe the variety of social housing in London and the distribution of these on a borough-by-borough basis.
- We then examine the results of modelling retrofit packages on these archetypes.
- Finally we note some particular points raised by stakeholders, regarding the feasibility of net-zero retrofits, and potential issues regarding access and congestion within London.

The details of the methodology used and background information on the housing stock can be found in Annexe 3.

Based on UCL's modelling of current leading-edge retrofits used in the UK, this work suggests that a net zero retrofit would not be achievable on any of the broad range of housing archetypes considered. This is consistent with other work in this field, which suggests a reduction in net energy consumption all the way to zero will generally not be achievable or desirable. However, a slightly less extensive retrofit would be feasible – particularly for two of the medium-rise flat archetypes that were modelled: single-facing blocks of flats built between 1914 and 1945, and between 1946 and 1959.

Across London as a whole there are just under 500,000 socially rented flats in purpose-built blocks (with particular concentrations in the boroughs of Southwark, Tower Hamlets and Hackney). Some of these will be high-rise flats presenting greater challenge for the types of retrofits that have been used for *Energiesprong* so far,[73] although around 82% of the purpose built flats within London are low-rise[74] which may be easier to retrofit. There therefore does appear to be a significant volume of properties where an extensive (but potentially not net-zero) retrofit would be viable.

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72 The technical modelling was led by the UCL Institute for Environmental Design & Engineering.

73 High-rise flats will have a far smaller ratio of roof area (usable for electricity generation through PV panels) to energy usage.

74 GLA (2015), *Housing in London 2015* - https://www.london.gov.uk/sites/default/files/housing_in_london_2015.pdf

Table 6 explains each barrier posed by the housing stock in London, and what the next steps could be to mitigate its impact. **Figure 12** illustrates where these barriers affect the business model.

The housing stock

Table 6. Summary of the housing stock and its interactions with the *Energiesprong* model

Barrier	Actions	Priority[75]	Actors involved
a) Net zero is unlikely to be obtainable for the majority of houses	Solution providers which believe net-zero may be feasible for specific types of houses should carry out trials or share results of modelling to demonstrate this to be the case. A variant of the *Energiesprong* business model should be developed which could work alongside retrofits which are not fully net zero energy.	High applicability High impact **Must address for (or as part of) trial**	Energiesprong UK GLA
b) Some property types may lack space for additional plant such as heat pumps	Need to see if it is possible to use technologies which require less space (for example, integrating plan into the façade as has been done in the Netherlands)	Medium applicability High impact **Need to identify solution before mass rollout**	Energiesprong UK Supply chain

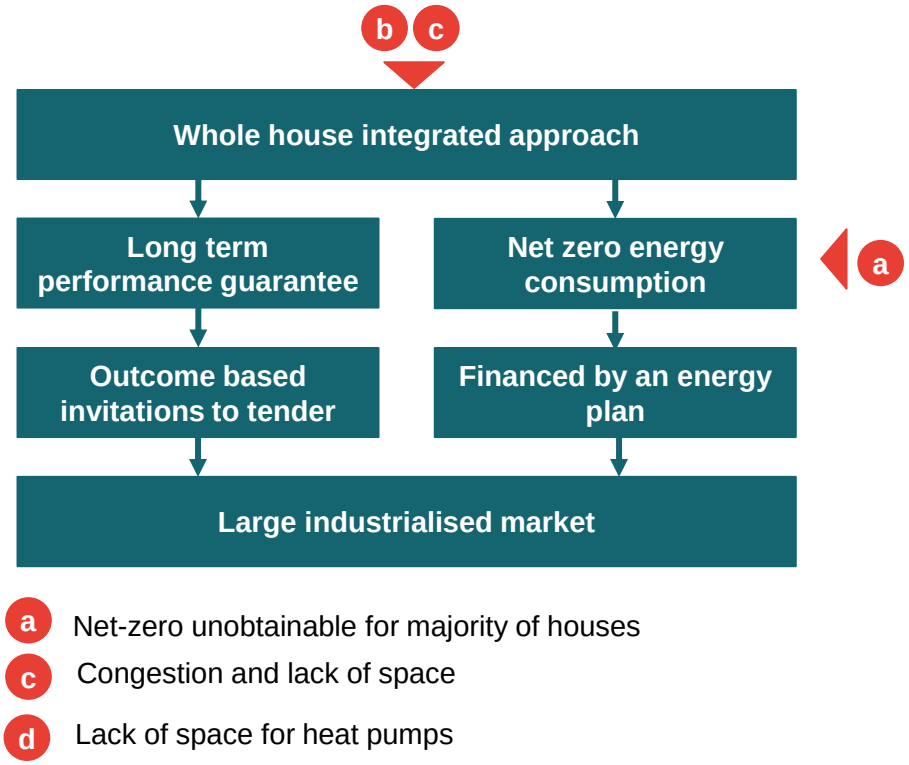
75 Based on the analysis carried out in section 10.

c) Congestion and a lack of space will make delivering whole-house retrofits difficult and costly	Need to work with councils to address access issues	Medium applicability Medium impact **Need to identify solution before mass rollout**	Energiesprong UK Supply chain Councils

Source: Frontier

The housing stock

Figure 12. Impact of the housing stock on the business model



Source: Frontier

7.1 Housing archetypes

The effectiveness of whole-house *Energiesprong* retrofits will largely depend on the specific type of building that is retrofitted. For this analysis, a range of archetypes have been produced to be representative of the variety of dwelling types within the London social rental sector.

7.1.1 Selection of archetypes

UCL has developed models that generate a set of representative housing archetypes for both London and the UK. The methodology for the generation of these statistically representative dwelling archetypes was based on the statistical analysis of a number of databases including:

- national housing surveys, such as the DCLG English Housing Survey (EHS) and the Energy Saving Trust (EST) Homes Energy Efficiency Database (HEED);

- geographic Information System (GIS) databases, such as the ones provided by the Ordnance Survey and The Geo-Information Group; and
- other sources of information on housing stock characteristics (e.g. Reduced Standard Assessment Procedure (RdSAP) for the Energy Rating of Dwellings).

For the London dwelling archetypes used in this study, 27 London dwelling archetypes were constructed.[76] Data on building form and construction age for the London housing stock were derived from two Geographic Information System (GIS) databases: Ordnance Survey MasterMap Topography Layer, and Cities Revealed.

Built form and construction data at the individual building level were available for only 29% of the Greater London Area household spaces. Among the 92 different built form and dwelling age combinations identified, the 15 most common were selected for simulation. This excluded house types with occurrence of less than 1.5%. The set of 15 represents approximately 76% of the housing stock in the area under examination, and many of the excluded dwelling types were similar in built form and age to these 15.

As one of the principles of the *Energiesprong* approach requires "a volume with a homogenous typology",[77] a further analysis of ONS data was carried out to determine prevalence various house types within the London housing stock and map these onto the UCL archetypes. As a result of this, a subset of 13 were selected for analysis. Further, as described in **Table 7**, multi-unit archetypes within this subset were sub-divided into ground floor, mid-floor and top-floor flats (denoted by G,M,T suffix) to provide a more holistic analysis. This approach helped the modelling focus on the archetypes ideal for the implementation of *Energiesprong* in London.

76 Oikonou et al (2012), *Modelling the relative importance of the urban heat island and the thermal quality of dwellings for overheating in London*, Building and Environment vol 57 pp223-238

77 http://www.energiesprong.eu/index.php/our-approach/

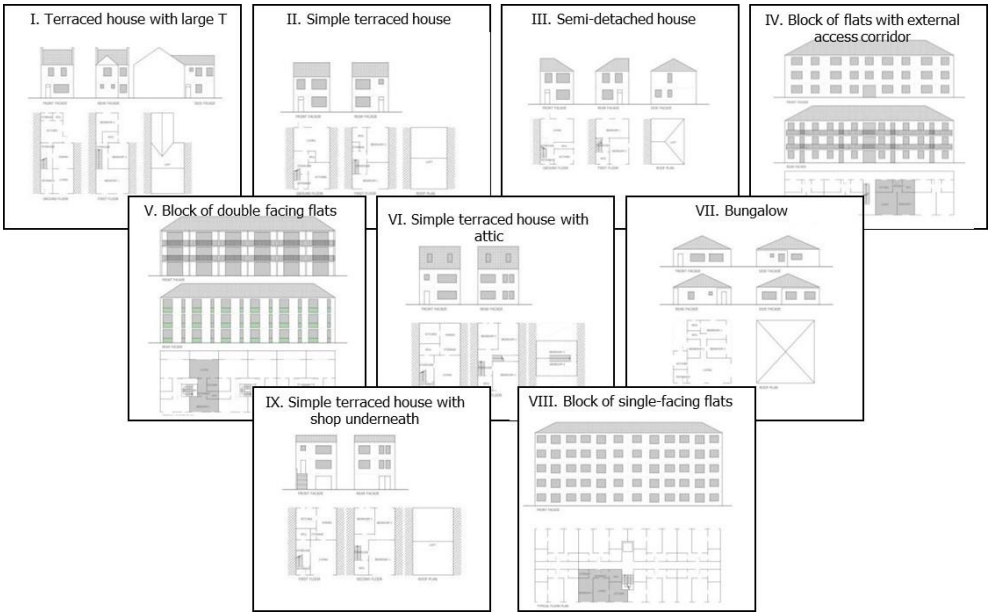
Table 7. Analysed archetypes

Code	Building type	Geometry	Single- or multi-unit archetype?
H01	Terraced House with Large T	(i)	Single
H02	Simple Terraced	(ii)	Single
H04-G	Block of Flats- External Corridor	(iv)	Multi
H04-M	Block of Flats- External Corridor	(iv)	Multi
H04-T	Block of Flats- External Corridor	(iv)	Multi
H05	Simple Terraced	(ii)	Single
H06-G	Block of Flats - Double Facing	(v)	Multi
H06-M	Block of Flats - Double Facing	(v)	Multi
H06-T	Block of Flats - Double Facing	(v)	Multi
H07-G	Block of Flats- External Corridor	(iv)	Multi
H07-M	Block of Flats- External Corridor	(iv)	Multi
H07-T	Block of Flats- External Corridor	(iv)	Multi
H10	Simple Terraced	(ii)	Single
H11-G	Block of Flats - Single Facing	(viii)	Multi
H11-M	Block of Flats - Single Facing	(viii)	Multi
H11-T	Block of Flats - Single Facing	(viii)	Multi
H12-G	Block of Flats - Single Facing	(viii)	Multi
H12-M	Block of Flats - Single Facing	(viii)	Multi
H12-T	Block of Flats - Single Facing	(viii)	Multi
H13	Simple Terraced House With Shop	(ix)	Single
H14	Simple Terraced	(ii)	Single
H15-G	Block of Flats - Single Facing	(viii)	Multi
H15-M	Block of Flats - Single Facing	(viii)	Multi
H15-T	Block of Flats - Single Facing	(viii)	Multi

Source: UCL Institute for Environmental Design & Engineering

The "geometry" column refers to the types of building illustrated in **Figure 13**.

Figure 13. Building geometries used for archetypes



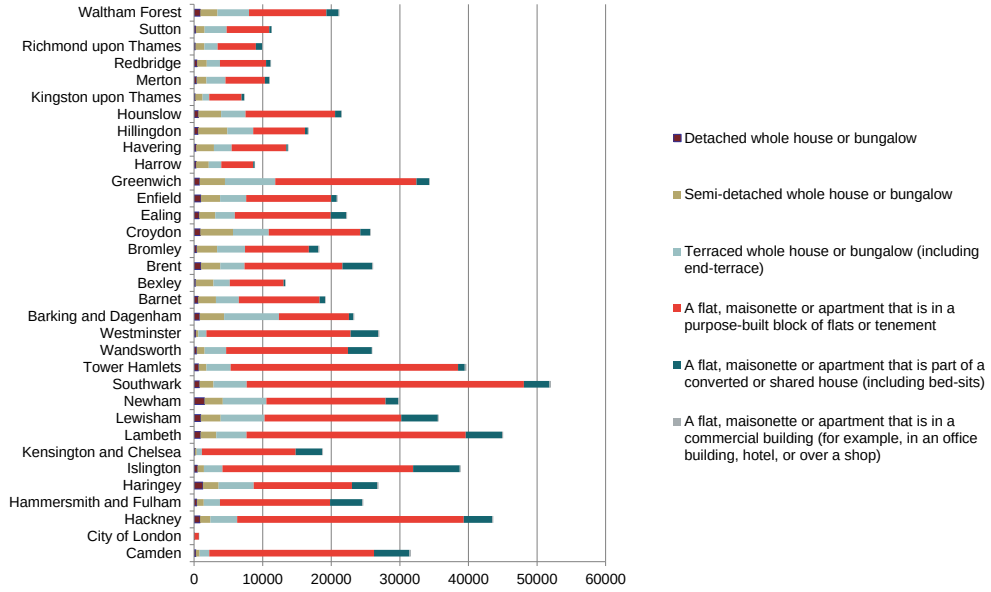
Source: UCL Institute for Environmental Design & Engineering

7.1.2 Distribution of archetypes across London

An analysis of the ONS 2011 Census data (ONS, 2011) was undertaken to highlight the distribution of specific dwelling types in the social rented sector.[78] The distribution of over 3.3 million social housing properties in London by number in each borough is illustrated in **Figure 14** and percentage occurrence in each borough is highlighted in **Figure 15**.

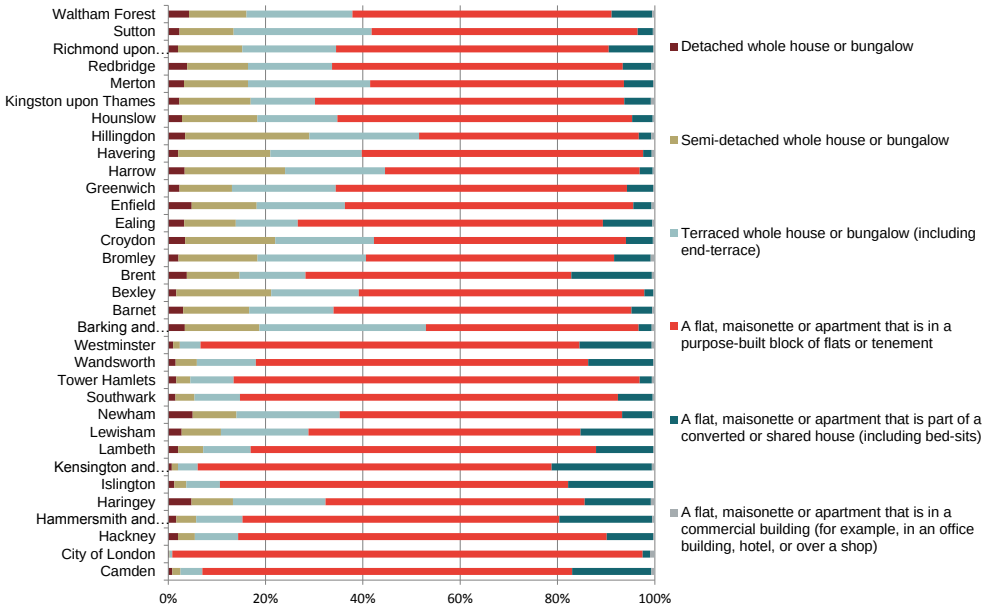
78 It should be noted that in this case census data may be regarded as being potentially more statistically representative than EHS data and was thus selected for analysis.

Figure 14. Absolute numbers of London social housing by dwelling type for each borough



Source: UCL Institute for Environmental Design & Engineering

Figure 15. Proportion of London social housing by dwelling type for each borough



Source: UCL Institute for Environmental Design & Engineering

The UCL archetypes described above were mapped onto these broader categorisations, enabling the prevalence of the key social housing dwelling types to be mapped by London borough.

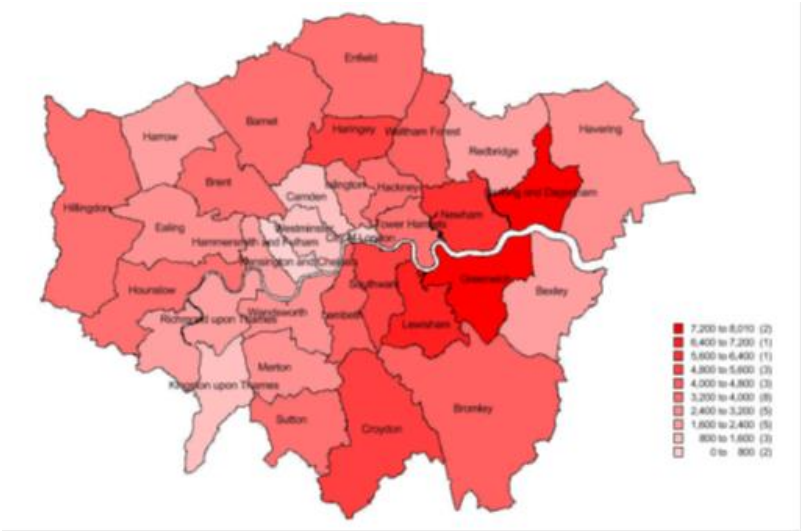
As described below, specific terraced and multi-unit flat archetypes were identified as having the greatest potential for retrofits, and **Figure 16** and **Figure 17** map the prevalence of these archetypes. This shows how the boroughs of Southwark, Tower Hamlets and Hackney have a particular concentration of flats.[79] The data does not indicate what proportion of these are high-rise flats (which are not currently suitable for *Energiesprong*-style retrofits, due to the relatively small roof area for solar panels). However, around 82% of the purpose built flats within London as a whole are low-rise.[80]

It should be noted that a more exact mapping of the locations of individual archetypes would require more detailed GIS data than that which was made available to the project team. However, the detailed archetypes that have been developed for this project could be used in conjunction with any future analysis carried out by the GLA or *Energiesprong* partners at a more granular level.

79 Of the 498,420 purpose-built flats in Greater London, these boroughs account for 106,612.

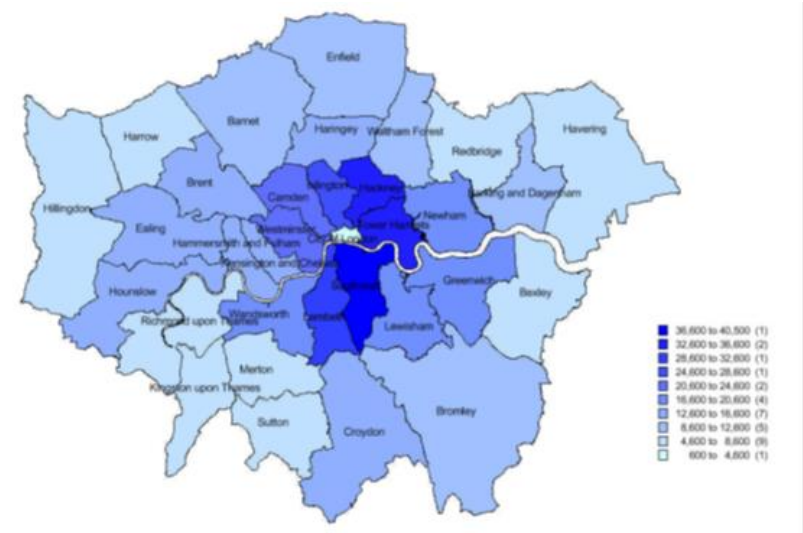
80 GLA (2015), *Housing in London 2015* - https://www.london.gov.uk/sites/default/files/housing_in_london_2015.pdf

Figure 16. Definition of retrofit hotspots - the distribution of terraced archetypes



Source: UCL Institute for Environmental Design & Engineering

Figure 17. Definition of retrofit hotspots - the distribution of flat archetypes



Source: UCL Institute for Environmental Design & Engineering

Key differences from the Netherlands: Age of the housing stock

The organisation promoting *Energiesprong* in the Netherlands considers that the systematic construction methods employed during the 1960s and 1970s are ideal rapid whole-house retrofits[81] (although, as demonstrated in the modelling below, some types of older houses may benefit more from retrofits if they are feasible).

The overall mix of the London housing stock differs from that in the Netherlands. Approximately a third of the housing stock in the Netherlands consists of houses from the 1960s and 1970s. Within London, only 13% of dwellings were built between 1955 and 1972. Ages of dwelling also vary significantly across London: for instance 37% of Inner London homes are pre-1900, compared with only 12% in Outer London.[82] Therefore, while there are still very significant numbers of properties of the age used for *Energiesprong* in the Netherlands, they form a lower proportion of the overall housing stock.

7.2 Results of modelling retrofit packages

In this section, we set out the different retrofit packages that were modelled, and the results (in terms of energy savings) for each of the housing archetypes outlined above.

7.2.1 Modelling Assumptions: Definition of Retrofit Packages

At the time of writing this report, Energiesprong UK and its partners were not able to provide detailed specifications (suitable for the modelling carried out here) of proposed retrofit solutions for London property types. As a result, we have developed three levels of retrofit, reflecting UK best practice in the field of mass-roll-out of retrofit. These differ in terms of both cost and potential disruption to householders. The formulation of these packages was informed by previous research conducted in this area by UCL.[83] This aimed to identify how the retrofitting of the existing housing stock can be accelerated by industrialising the processes of design, supply and implementation, while stimulating demand

81 Energiesprong (2011), *Energeiesprong long-term plan,* http://*Energiesprong*.nl/wp-content/uploads/downloads/2013/02/*Energiesprong*-longtermplan-def1.pdf

82 Valuation Office Agency (2015), *Council Tax: Stock of Properties 2015* table 4.1, available at https://www.gov.uk/government/statistics/council-tax-stock-of-properties-2015

83 For example, Das et al (2015), *Designing uncertain optimization schemes for the economic assessment of stock energy-efficiency measures* Journal of Building Performance Simulation; and EBC Annex 55 *Reliability of Energy Efficient Building Retrofitting - Probability Assessment of Performance & Cost (RAP-RETRO):* http://www.iea-ebc.org/projects/completed-projects/ebc-annex-55/

from householders by exploiting the additional opportunities that come with extensive building refurbishment.

- The ***Basic*** packages are designed to be sufficient to improve the thermal efficiency to a level which will make a significant step towards the 2050 Climate Change commitments (20-50% savings) without excessive cost. Previous work suggests that based on an optimised UK supply chain, for this package the break-even investment (target cost) is in the range of £3,750 to £26,000.

- The ***Enhanced*** packages are based on the highest level of performance we can envisage with products and processes widely available in the next 5 years irrespective of current cost. These typically reflect a desired reduction of 60%-80% in savings. Previous work suggests that based on an optimised UK supply chain, for this package the break-even investment (target cost) is in the range of £7,000 to £36,000.

- The ***Enhanced Plus*** package was developed to assess the possibility of achieving net zero energy for the H15 archetype (Block of Flats - Single Facing), which provides the largest savings potential and closely reflects some of the types of buildings used for the Dutch Energiesprong trials. This package aims to mimic a near Passivhaus[84] level of fabric performance to attempt to reach net zero energy consumption. Although an analysis of cost-effectiveness has been outside the scope of this report, we expect that this package would currently cost close to £150,000.[85]

7.2.2 Key findings

The key findings and insights of the modelling are highlighted below. These should be read in conjunction with annexe 3, which provides information on the modelling methodology and its limitations.

- **Both the "Basic" and "Enhanced" packages provide considerable energy and CO_2 emissions savings across analysed archetypes,** often exceeding the 20%-50% and 60%-85% reduction targets (respectively) defined for each.

84 See http://www.passivhaus.org.uk/ for details of the Passivhaus standard

85 The Retrofit for the Future project (Technology Strategy Board (2014), *Retrofit for the Future: Analysis of Cost Data)* provided 100 properties with a maximum grant of £150,000 each. Most projects used nearly all of that budget (which excludes labour costs), and in any event did not obtain net zero energy usage.

- Despite defining the specification of the "Enhanced Plus" package to near Passivhaus levels, the "best-case scenario" (a single-facing block of flats built between 1946 and 1959) for its implementation does not achieve net zero performance. Further, a retrofit of this nature would (on the basis of previously research carried out within the UK) be highly cost-ineffective. It can be concluded that **for the vast majority of London social housing stock types, it is not feasible to achieve a net zero retrofit**.

- While on average single unit (house) archetypes may achieve considerably higher savings than multi-unit (flat) archetypes, **significant economies of scale could potentially be achieved in implementing mass retrofit programmes in the case of flats**. There are over 1.5 million of these properties in the London social housing market (65% of the total).

- Therefore if the Energiesprong business model can be adapted to work without net zero, **the most promising house types are represented by the two Block of Flats - Single Facing archetypes H12 (1914-1945) and H15 (1946-1959)**. As described above, the boroughs of Southwark, Tower Hamlets and Hackney have the greatest prevalence of these multi-unit archetypes.

- In regards to these archetypes, **top floor flats almost consistently achieve higher savings when retrofit packages are applied**. In the wider context, these archetypes are also associated with increased overheating risks. The "GLA Enhanced" level of retrofit is highlighted by the modelling as being worthwhile in these properties. Per dwelling, these are associated with a yearly energy saving and carbon saving of 85% (compared to 65% and 75% for ground and mid-floor flats within the same archetype).

These findings are in line with the existing body of knowledge that has been produced through rigorous evidence-based research in this field.

- An analysis of the outcomes of the Retrofit for the Future programme,[86] which has results from across over 100 properties refurbished under the grant, shows that a 60% reduction costs approximately half of what it costs to retrofit to an 80% reduction. The report recommends that a 60% reduction is therefore considered to be a more realistic target for a UK wide national programme, unless there is significant technological advancement or costs fall considerably.

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86 TSB (2014).

- The Energy Technologies Institute states that: "*Much of the relatively straightforward, cost-effective improvement to the thermal efficiency of buildings has already been carried out, so achieving further improvements of the existing building stock is likely to be costly and demanding. We believe that the most cost-effective way to deliver energy is to optimise the balance between demand side measures such as energy efficiency, with supply side measures such as district heat using waste heat from a local power station.*"[87]

- The Zero Carbon Hub definition of a (net) zero carbon home states that: *"It is unlikely that a combination of energy efficiency and carbon compliance, alone, will be sufficient to achieve zero carbon. A range of 'allowable solutions' is therefore proposed to deal with the remaining ('residual') emissions"* and *"Experience has shown that improvements in energy efficiency may reduce the CO_2 emissions by up to 44% compared to a house presently built according to the requirements of AD L1A."*[88] That research relates to the possibility of obtaining zero carbon usage for a *new* home – the costs and difficulties will be higher for properties that were not designed with these levels of performance in mind.

- A Portuguese study into the viability of net zero retrofits concluded "…*under the reference economic conditions considered, it is best to upgrade the energy efficiency up to the medium level, and then offset the demand with off-site large-scale wind turbine equipment. These suggest that reaching net zero balance through on-site generation is less efficient than doing it through large-scale facilities.*"[89]

7.2.3 Overview of Results: Single Unit (House) Archetypes

The following results compare the energy use and CO_2 emissions of the base case performance to the Basic and Enhanced retrofit packages for each of the "house" archetypes. It is important to note that the results only indicate the reduction in annual space heating energy consumption directly attributable to the retrofit measures. Total energy consumption figures would include as additional energy usage from household appliance use.

Figure 18 below compares the base level average space heating for each archetype. It shows that flats use less heating than houses, and that mid floor flats use less energy than top floor or ground floor flats.

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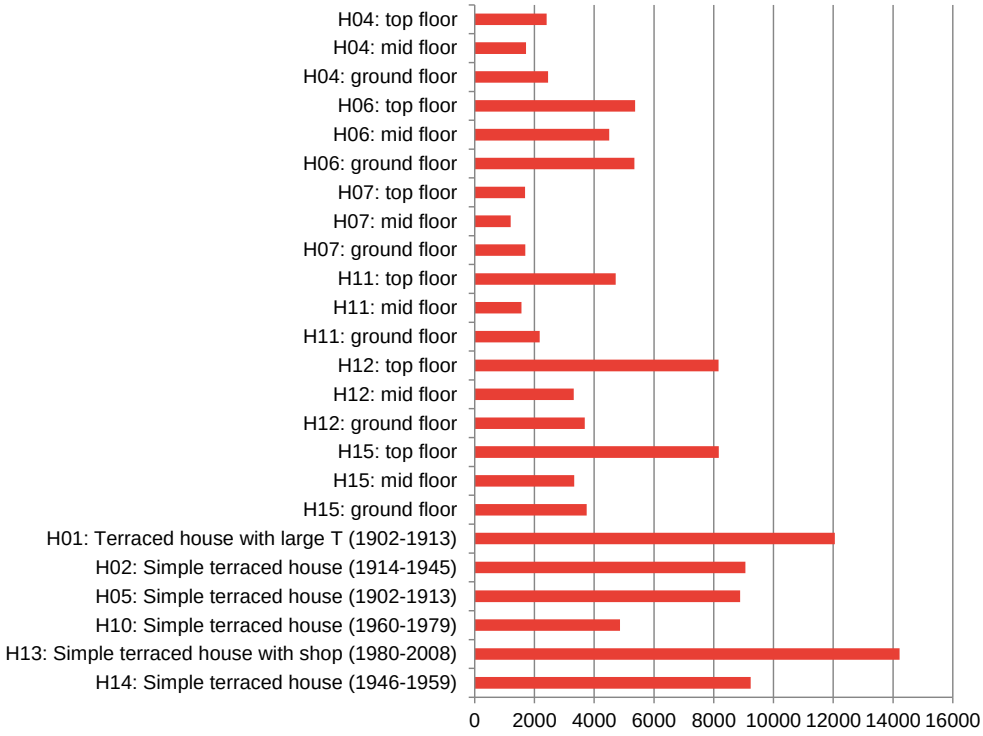
87 ETI (2014), *ETI Response to Energy and Climate Change Committee Inquiry: Home Energy Efficiency and Demand Reduction*

88 Zero Carbon Hub (2009).

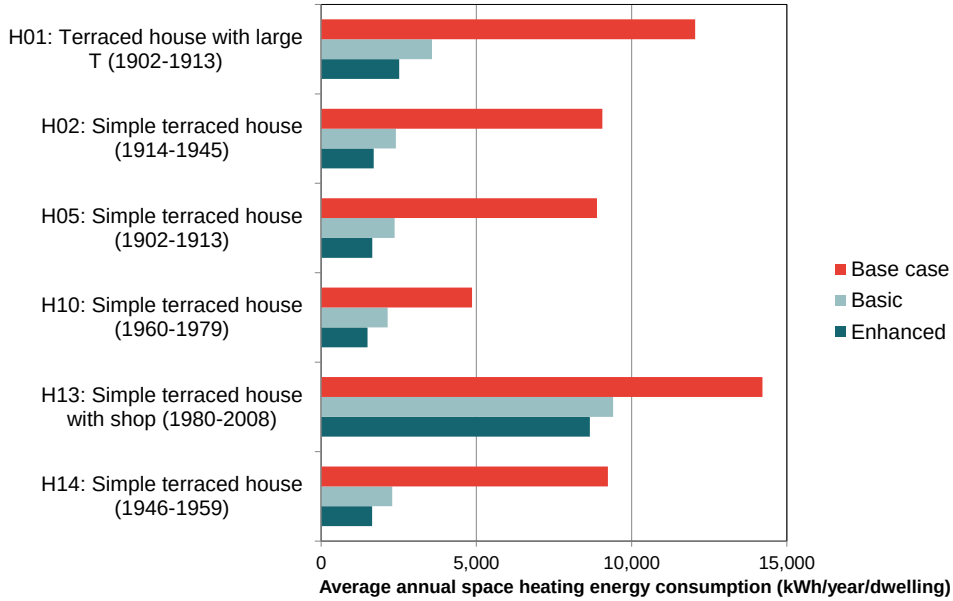
89 Leal et al (2014), *Energy and economic analysis of building retrofit and energy offset scenarios for Net Zero Energy Buildings*, Advances in Building Energy Research Vol. 9, No. 1, pp120-139

Figure 18. Base case average annual space heating energy consumption for house dwelling archetypes



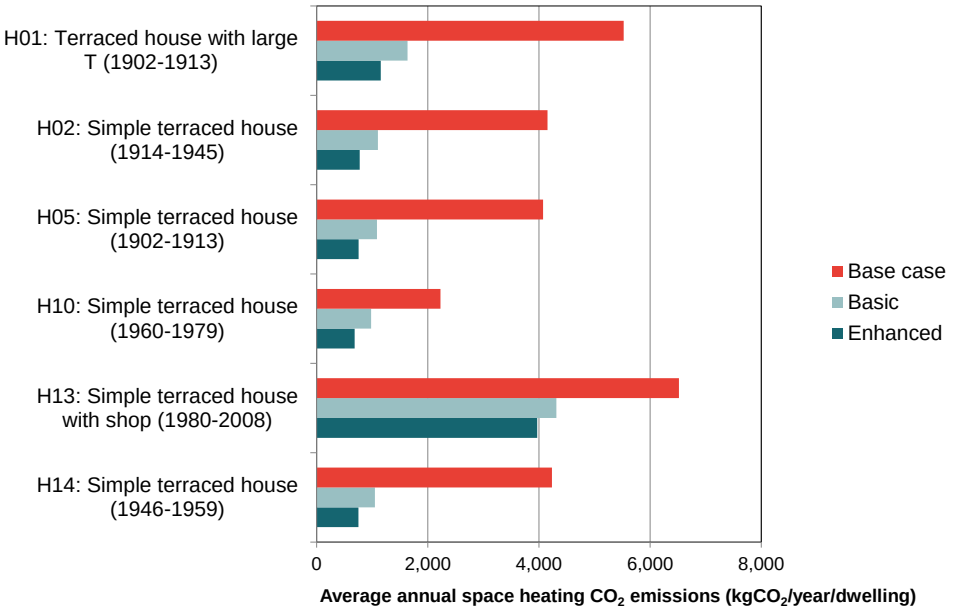
Source: UCL Institute for Environmental Design & Engineering

Figure 19. Average annual space heating energy consumption for house dwelling archetypes



Source: UCL Institute for Environmental Design & Engineering

Figure 20. Average annual space heating CO2 emissions for house dwelling archetypes

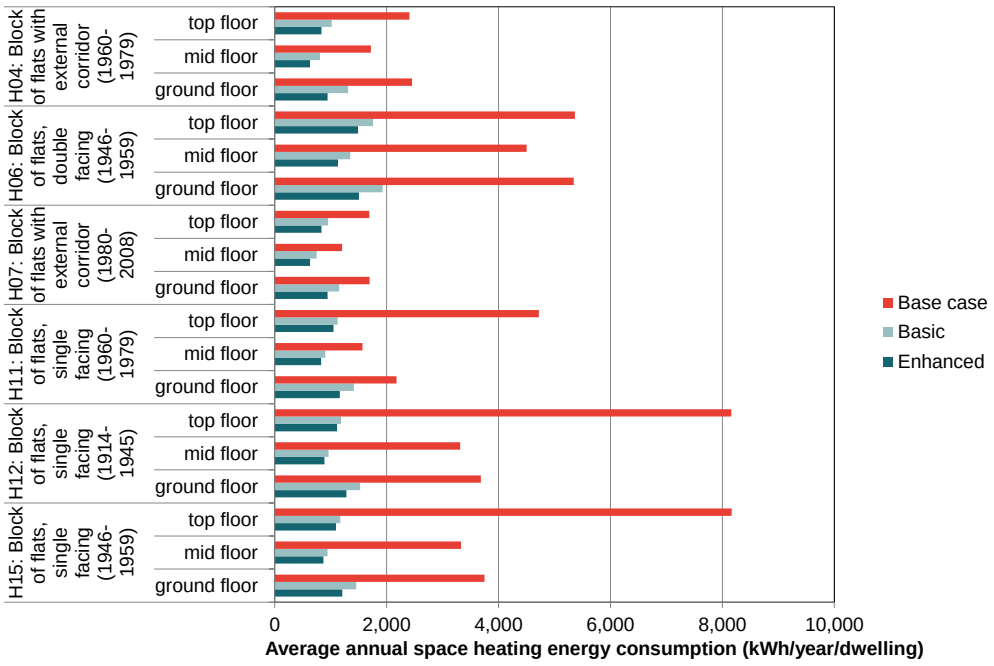


Source: UCL Institute for Environmental Design & Engineering

7.2.4 Overview of Results: Multi Unit (Flat) Archetypes

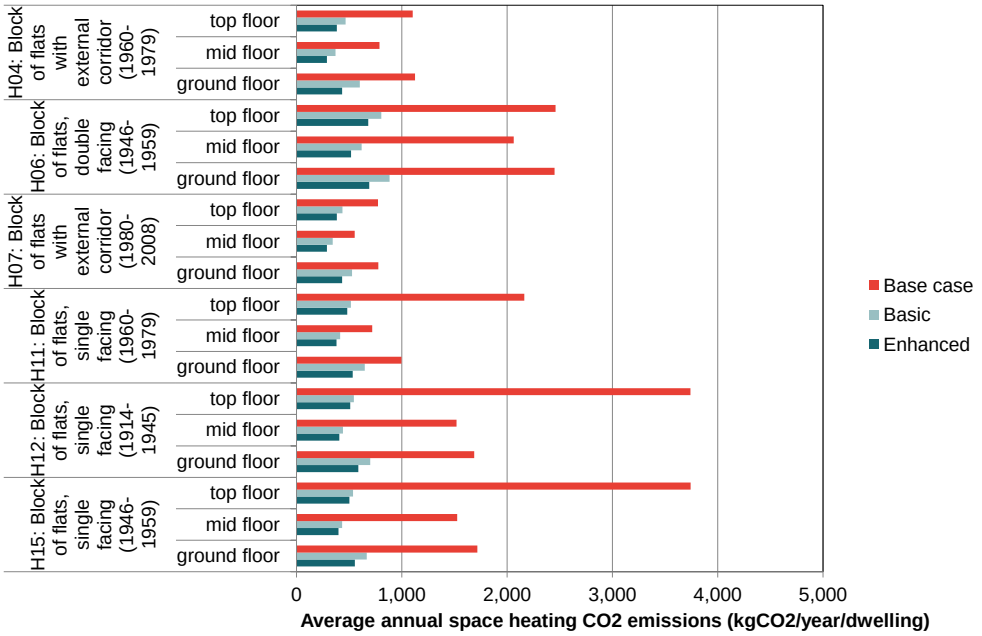
The following results compare the energy use and CO_2 emissions of the base case performance to the Basic and Enhanced retrofit packages for each of the "flat" archetypes, i.e. buildings that contain several dwelling units. The same point about this not including energy consumption from appliance use holds as before.

Figure 21. Average annual space heating energy consumption for flat dwelling archetypes



Source: UCL Institute for Environmental Design & Engineering

Figure 22. Average annual space heating CO2 emissions for flat dwelling archetypes



Source: UCL Institute for Environmental Design & Engineering

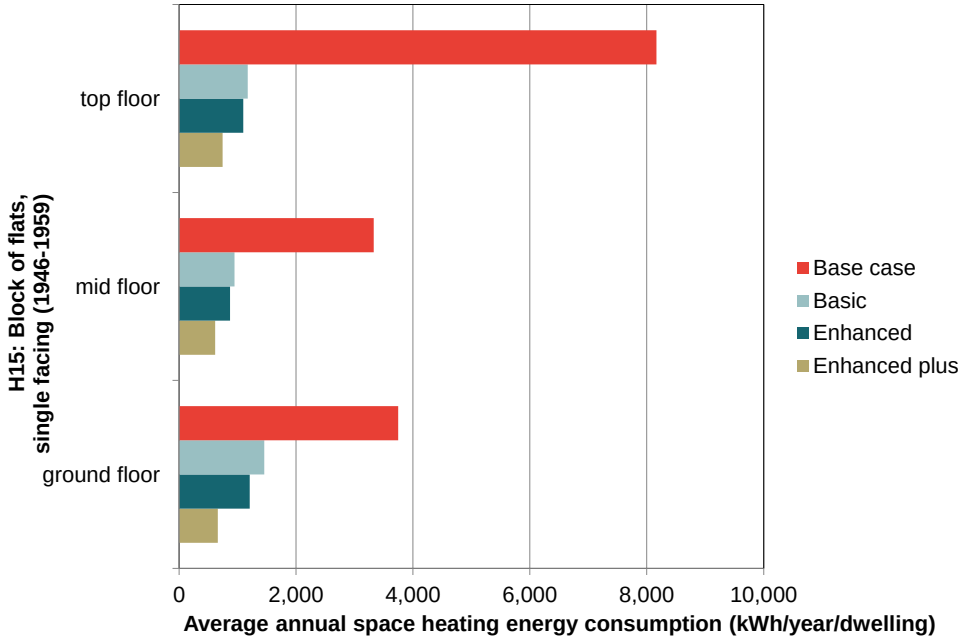
7.2.5 Detailed Enhanced-Plus Analysis

The following results compare the energy use and CO_2 emissions of the base case performance to the Enhanced Plus retrofit package, which aims to represent "the ultimate target" scenario for the H15 archetype (Block of Flats - Single Facing) with both the Basic and Enhanced packages included for reference. Following an analysis of the Basic and Enhanced packages for the 13 selected archetypes, H15 was selected to demonstrate a "best-case scenario" for the Enhanced Plus package due to:

- potential for achieving high savings through retrofit;
- prevalence of the particular archetype in the London social housing stock (multi-unit purpose built flats account for nearly 65%); and
- potential for further economies of scale that could be delivered due to the multi-unit configuration.

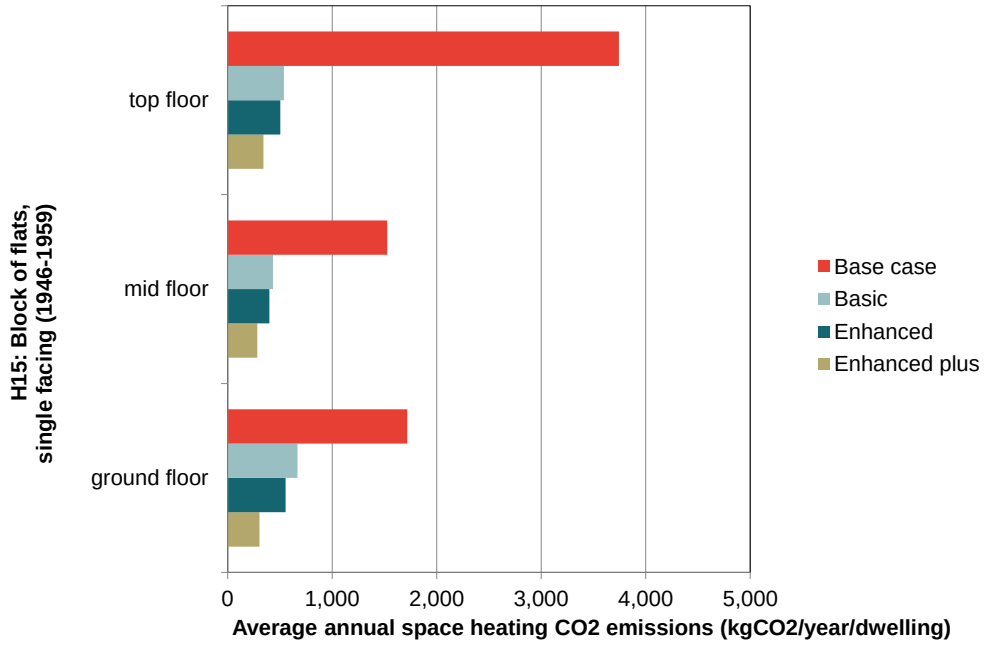
Again, this does not include energy consumption for appliance use.

Figure 23. Average annual space heating energy consumption for H15 flat archetype



Source: UCL Institute for Environmental Design & Engineering

Figure 24. Average annual space heating CO_2 emissions for H15 flat archetype



Source: UCL Institute for Environmental Design & Engineering

7.3 Additional comments from stakeholders

Some of the contractors we approached as part of research (some of whom are currently working with Energiesprong UK) felt that cost-effective net zero retrofits would be possible (if extremely challenging) on some specific types of London dwelling. As described above, the available evidence, as well as the modelling commissioned as part of this report, would suggest that may be an optimistic view. However, any evidence that can be brought forward to substantiate this view would obviously be of great interest.

One contractor felt that net zero energy usage would be feasible not within the dwelling itself, but could be when considering the dwelling as part of a wider system (for example, through "bundling" low-carbon generation located elsewhere). This is consistent with our modelling, which demonstrated that a substantial reduction in within-dwelling energy usage of 80% or more may be possible for some archetypes. **This highlights the much greater market that *Energiesprong* might be suitable for if it could be adapted for retrofits that do not necessarily lead to net zero energy consumption within individual houses.**

Two further issues were raised by participants at the roundtable sessions.

- Some participants were concerned that congestion and a lack of space within central London would make whole-house retrofits more difficult and costly to undertake. UK solution providers hoping to implement *Energiesprong* in such areas will need to plan accordingly – and may need to work alongside councils to ensure that sufficient space is available to carry out multiple retrofits in one location.

- It was noted that some property types (for example some flats, or terraces abutting the pavement) might lack space for additional plant required for whole-house retrofits (for example, heat pumps). The contractors carrying out retrofits within the Netherlands have developed innovative space-saving solutions (for example, placing equipment within the façade), and UK solution providers will need to produce designs that work within the constraints of the targeted dwelling types.

8 The supply chain

In this section, we consider the extent to which the development of the supply chain may act as a barrier to the roll-out of *Energiesprong* within GB.

- First, we consider the extent to which UK-based component suppliers and installation specialists may be able to develop innovative retrofit solutions which can reduce costs.
- We then set out stakeholder opinions on the readiness of the UK supply chain to provide ongoing monitoring and maintenance.
- Finally, we consider whether the different parts of the UK supply chain will be able to co-ordinate to provide the integrated package required by *Energiesprong*.

Table 8. Summary of the supply chain and its interactions with the *Energiesprong* model

Barrier	Actions	Priority[90]	Actors involved
a) The UK construction sector will need to adopt new techniques to drive down the cost of retrofits – and even then, there is no clear evidence that such extensive retrofits could be carried out cost-effectively	*Energiesprong* itself is intended to overcome some of the reasons for this, through outcome-based contracts and creating a mass demand for retrofits. However, it will still be crucial to engage with DECC to ensure government support provides a stable platform for innovation in the supply chain.	High applicability Medium impact **Should ideally address for trial**	Energiesprong UK Supply chain DECC
	Contractors should look to provide evidence (such trials or detailed modelling) to show a pathway to net zero in London, at affordable prices.		Energiesprong UK Supply chain
b) A lack of clear documentation of *Energiesprong* systems could prevent maintenance being carried out over the long term, affecting the viability of the performance guarantee.	Manufacturers and installers should work together to develop a minimum standard of documentation to be provided for *Energiesprong* retrofits.	High applicability Medium impact **Should ideally address for trial**	Energiesprong UK Supply chain

90 Based on the analysis carried out in section 10.

The supply chain

c) Performance guarantees from solution providers (particularly when they relate to novel technologies) may not be seen as credible by housing providers. Associations have no experience of such long term arrangements.	Draw up contracts for energy performance guarantees which cover scenarios such as malicious damage of *Energiesprong* equipment.	High applicability Medium impact **Should ideally address for trial**	Energiesprong UK Housing providers Solution providers Legal experts
	Determine which contractors may have sufficient credibility and appetite to guarantee performance (for first phase trial – and, if insurance is not feasible, for mass rollout).		Energiesprong UK Housing providers Solution providers Credit rating agencies
	Engage with insurers to determine whether it would be feasible for them to underwrite *Energiesprong* performance guarantees (potentially after the basic operation of the programme has been verified as part of the first wave trial).		Energiesprong UK Supply chain Insurers
	Extensive monitoring over several years during a trial will help allay some fears of performance degradation (although it will not indicate what may happen further into the life of a retrofit).		Energiesprong UK Supply chain

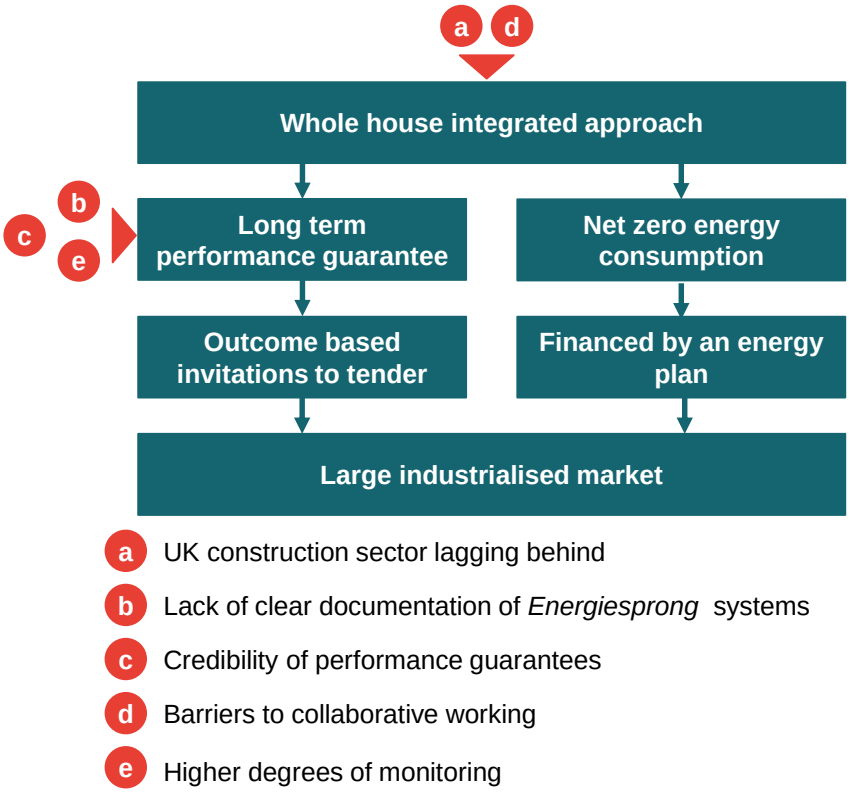
d) Barriers to collaborative working between suppliers may affect the ability to provide a whole-house retrofit at a low cost.	Develop standards for sharing Building Information Management (BIM) data between different organisations involved in an *Energiesprong* retrofit.	High applicability Medium impact **Should ideally address for trial**	Energiesprong UK Supply chain
	Start to create a library of coded designs for different building archetypes. A first stage may be to agree a definition of archetypes, perhaps building on the work carried out for this report.		Energiesprong UK Solution providers
	Installers should engage with suppliers of equipment such as solar PV panels and heat pumps to determine whether there can be more flexibility for installers to optimise their performance.		Energiesprong UK Installers Component manufacturers

The supply chain

e) Tenants may be unwilling to accept the high degree of monitoring which is required to support the performance guarantee.	Engage with tenants and legal professionals to identify whether this is a barrier (there is no evidence that it has been one in the Netherlands) and if so whether it can be overcome with sufficient communication.	Medium applicability High impact **Need to identify solution before mass rollout**	Energiesprong UK Housing providers Tenants Consumer rights bodies Legal experts
	Examine the feasibility of installing a baseline level of monitoring in each house, and upgrading this only in the event of disputes (NB enhanced monitoring will probably need to be installed in all trial properties to confirm the techniques work).		Energiesprong UK Housing providers Tenants Supply chain

Source: Frontier

Figure 25. Impact of supply chain constraints on the business model

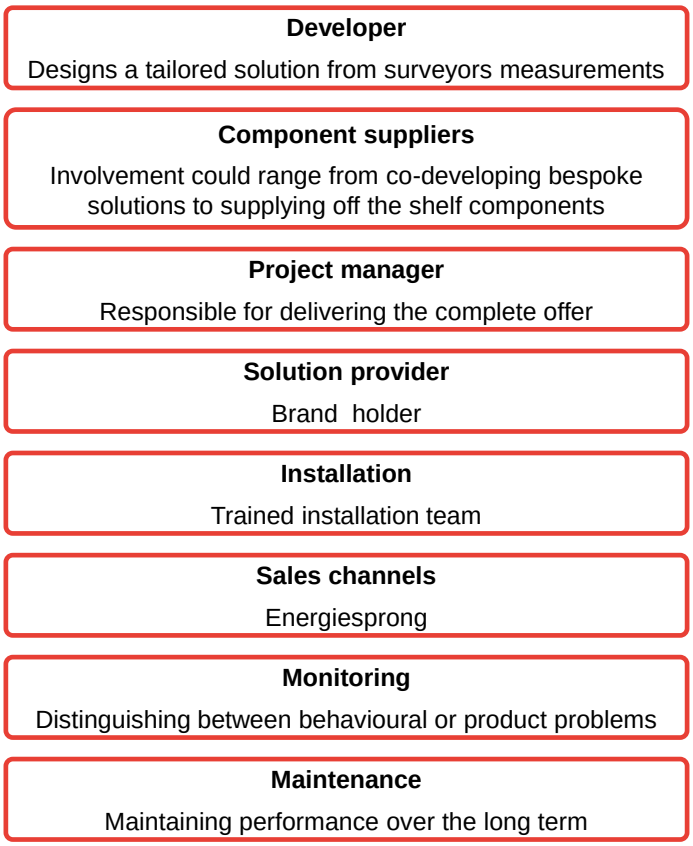


Source: Frontier

8.1 Ability of suppliers to develop innovative solutions

The *Energiesprong* supply chain consists of a variety of service providers, described in **Figure 26** below. The business model could involve a number of separate providers working together in a consortium to provide each product or service, or some degree of vertical integration between providers.

Figure 26. The *Energiesprong* supply chain



Source: Frontier, adapted from a supply chain slide provided by *Energiesprong*

The *Energiesprong* approach does not mandate any particular technical solution. However, low-cost net zero retrofits with minimal hassle will certainly require significant innovations (even for the most promising archetypes discussed in section 7).

8.1.1 Potential for new techniques in the UK

Suppliers we contacted typically believed that the UK supply chain lagged behind other Northern European countries in terms of the available techniques for carrying out highly energy-efficient retrofits at minimal cost and hassle. For example, techniques such as laser systems and pre-cut insulation were noted as being standard in other markets, but still too expensive in the UK to deploy widely. There is very little offsite construction[91] in existence within the UK, despite occasional spikes of interest in the method. However stakeholders did

[91] Some suppliers felt that offsite construction would be crucial to delivering *Energiesprong*, although one had no confidence in this approach.

note the existence of some products, such as one firm offering pre-fabricated internal wall insulation. They also noted a housing association that runs its own factory for offsite manufacturing of insulated walls for new homes. This shows the potential to develop the supply chain if appropriate demand could be created, and some organisations did believe they were in a position to start offering whole house retrofits in the UK market.

The following reasons were given for the relative lack of development of the UK market. We note that *Energiesprong* is targeted at targeted at overcoming some of these.

- It was believed that the UK market has been driven by the "opportunistic" use of grants and schemes such as ECO (discussed in section 4), which do not incentivise "whole house" integrated solutions or innovative products.

- It was also felt by some that customers had yet to fully embrace innovative products (although another supplier felt that customers would appreciate these developments if they could be delivered).

- Suppliers believed that developing techniques such as off-site manufacture would require significant R&D investment. Installer training (a lack of which has previously been identified as a major barrier to the supply of low carbon heat components[92]) would also require investment.[93] Suppliers were unwilling to commit funds unless they were able to obtain a firm commitment for orders from customers, and could be assured that government policy would not change adversely.

92 http://www.delta-ee.com/images/downloads/pdfs/2014/MIS_Installer_Whitepaper_Spring_2014_2.pdf

93 One supplier noted a reliance on overseas contractors due to a shortage of skills.

Key differences from the Netherlands – building costs and techniques

In general, residential building costs in the UK tend to be 10-15% higher than in the Netherlands.[94] This is not an issue specific to *Energiesprong*, but will increase the size of the cost reductions needed to make net zero energy retrofits cost-effective.

UK contractors are also believed to lag behind their northern European counterparts in the knowledge and skills required to assemble highly energy-efficient housing (e.g. those meeting the Passivhaus standard).[95] There are over 100,000 passive homes in northern Europe while the number is far lower in the UK. There is also perceived to be lower acceptance of these types of innovative product among customers and mortgage lenders in the UK. However, this does not preclude the sort of market development that the team behind *Energiesprong* is attempting to facilitate.

8.2.1 Reductions in the cost of retrofits

Contractors we spoke to were broadly confident that, if these developments occurred, the UK market would be able to develop innovative solutions in line with some of the developments seen in the rest of Northern Europe. However, contractors did not believe that these developments would enable them to lower the costs of net zero retrofits down to the levels that the current *Energiesprong* finance model indicates might be required (potentially as low as £30,000[96] per dwelling).

Energiesprong itself is designed to promote innovation, by moving away from the use of ad-hoc grants, using outcome-based contracts to give suppliers greater flexibility, and providing a large pipeline of retrofits, all of which can enable investment. **Figure 34** shows the average cost in the Netherlands of providing a

94 ICC International Construction Costs survey 2013

95 To be considered a passive house several criteria must be met. One of these criteria is that the total energy to be used for all domestic applications (heating, hot water and domestic electricity) must not exceed 120 kWh per square meter of treated floor area per year. http://www.passiv.de/en/02_informations/02_passive-house-requirements/02_passive-house-requirements.htm

96 Based on provisional finance modelling carried out by *Energiesprong UK*. This finance model considers the different streams of income that could be used to finance an *Energiesprong* retrofit, including the Energy Plan, reduced maintenance costs, and government subsidies such as FITs and RHI. The available budget for a retrofit could be higher if (for example) interest rates were lower than the assumed 4.2% (this might be the case for an ALMO) or if *Energiesprong* was assumed to increase the building lifetime.

single *Energiesprong* retrofit broken down by component.[97] The first two columns show how actual costs have changed so far, the final three columns are *Energiesprong's* predictions showing what costs are expected to be once providers have installed a certain number of retrofits. The main drivers for expected cost reductions include the use of 3D scanning and prefabricated parts to reduce time requirements and spreading fixed investment costs over a larger number of houses.

These reductions are significant: they forecast a reduction in costs of around 30% compared to current levels (and of almost 50% compared to costs seen prior to *Energiesprong*). However, it should be noted that the €63,000[98] cost for 11,000 or more installations is still (at around £50,000 given the exchange rate at the time of writing) materially above the level that might make the business model viable in London.[99]

A full assessment of the cost-effectiveness of *Energiesprong* (including the potential future trajectory of costs) was outside the scope of this report. Our discussions with suppliers, together with the Dutch cost forecasts, suggest that reaching net-zero at a cost-effective price point will present a major challenge to industry (if indeed it is possible at all – see section 7 for a description of the difficulties in achieving these levels of energy reduction). Nevertheless, any evidence (such trials or detailed modelling) that contractors can produce to show a pathway to net zero in London, at affordable prices, would be extremely valuable.

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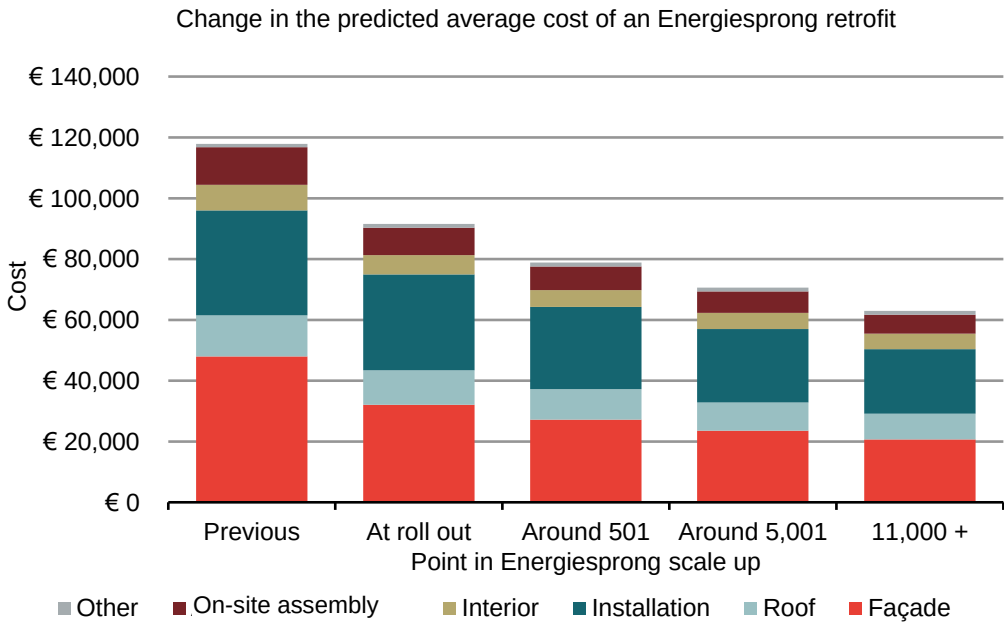
97 This cost is the average of four solution providers in the Netherlands. The breakdown of archetypes is not known.

98 This cost will refer to retroffiting a Dutch building and is therefore not directly comparable, although we have seen no evidence to suggest that Dutch retrofits would be more expensive than those in the UK.

99 Potentially as low as £30,000 although this is based on a provisional version of the *Energiesprong* financial model, and could be different if input assumptions varied. See footnote 96 on page 108.

Figure 27. Change in the predicted average cost of an *Energiesprong* retrofit



Source: Energiesprong UK

Energiesprong UK have indicated that these figures do not assume that the process is industrialised, or that the supply chain is significantly reorganised (they are based on putting retrofit packages together in a manual way in a streamlined workshop). The interior works include a new kitchen and bathroom

8.3 Readiness to provide long-term monitoring and maintenance

As explained in section 2, performance guarantees are a key part of the *Energiesprong* business model. The housing associations that we spoke to agreed that such guarantees were an essential pre-requisite for them to procure at scale and on an outcomes basis. While many suppliers believed that it would be difficult to guarantee a new technology (such as thinner materials and offsite manufactured whole-house cladding),[100] given potential issues with design and manufacture, appropriate installation and quality assurance, and uncertainties in how tenants will use the building.

[100] Guarantees are available for some individual products, such as 25-year guarantees on the performance of solar PV panels. However, housing associations were more familiar with this in the guise of "rent-a-roof" schemes (where the asset is owned by the installer) rather than retrofits owned by the association themselves.

The supply chain

This will be a difficult area to test – several years' monitoring will be required to confirm whether trial houses can meet performance guarantees over a range of weather conditions, and it is by nature impossible to test the viability of a decades-long guarantee as part of a time-limited trial.

Suppliers felt that effective **maintenance** and **monitoring** would be pre-requisites for such a guarantee, and these are discussed below. Housing associations also highlighted the importance of a **credible** guarantee, preferably backed up by insurance. Suppliers also believed that **greater integration** between suppliers may also be helpful when providing guarantees, which is discussed in section 8.4.

8.3.1 Maintenance

In interviews and roundtable discussions we did not find stakeholder consensus on whether a market could be created for on-going maintenance services. Contractors believed the installer should accept an on-going relationship (i.e. the installation and maintenance services would be carried out by the same entity), and considered this a normal arrangement. This would remove the need for unfamiliar third parties to understand the equipment, and provide an incentive to installers to do the upfront work as well as possible.

However, it was felt by some that clear operating and maintenance manuals would need to be provided by installers, so they can be passed to other companies if required. Given the decades-long life of *Energiesprong* retrofits, it seems likely that in many cases a different firm may ultimately end up with maintenance responsibility for the building. A supplier also noted that, with recently improved technical due diligence checks being carried out by clients, housing providers would be less likely to pay for works before they are assured that they have sufficient information about equipment.

One contractor said that they would want access rights to maintain the system if they gave a 30 year guarantee. They did see a difference between *Energiesprong* and a usual warranty for something like a boiler where the landlords' access rights are sufficient.

8.3.2 Monitoring systems

To fulfil the terms of the performance guarantee, the solution provider needs to be able to monitor performance so it can distinguish performance problems from issues associated with tenant behaviour. The monitoring systems deployed in the Netherlands have been quite extensive, involving sensing of factors such as temperature and humidity in multiple rooms.

According to stakeholders, monitoring the performance of systems is normal for some retrofit technologies. However, the following barriers were identified.

- First, tenants may have concerns regarding the privacy of the data associated with their house. One supplier we talked to believed that this would not be a significant issue, although a prescriptive approach to monitoring may put off tenants. However, there have been privacy concerns raised regarding smart meters which provide far less information. Engagement with tenants and consumer rights groups would be advisable at an early stage, to confirm whether this will be an issue.

- One contractor also believed that room-to-room monitoring would incur a high cost. They suggested the possibility of installing a basic level of monitoring, and only installing additional instrumentation in the event that the tenant raises a dispute regarding retrofit performance.

- One housing association felt that it would face an additional burden of explaining the monitoring (and other aspects of the Energy Plan) to tenants moving in to a retrofitted property. Further, it believed that tenants with retrofit performance issues would approach it in the first instance (even if alternatives such as a dedicated call centre were available), resulting in additional costs.

8.3.3 Credibility of guarantees

Guarantees mean nothing if the company offering them folds. The long chain of small suppliers that could be involved in major works means an upfront investment in a potentially new technology would be a particular risk for a procuring association.

Some housing associations would only be willing to invest in *Energiesprong* if the guarantee was backed up by a reputable insurer with experience of such guarantees. However, there are significant barriers to this (and it is notable that none of the Dutch *Energiesprong* trials are currently backed by insurance). It will be extremely difficult for insurance companies to price insurance on unproven "deep retrofit" technologies, which may require considerable costs to remove or repair if they fail.

At the very least, if insurance is not feasible, the guarantor needs to be a strong company which is unlikely to become insolvent over the lifetime of the contract. Suppliers we discussed these issues with indicated that it may be necessary for smaller companies developing innovative technologies to team up with larger players who could offer more credible guarantees. Housing associations also required that the guarantee was given directly by the company, and not by a special purpose vehicle which may have no assets.

The interviews with stakeholders yielded further questions around the guarantees provided by the *Energiesprong* method. For example, whether the guarantee would still be valid if the tenant maliciously damages the *Energiesprong* equipment?

The supply chain

Liabilities here need to be clear in the wording of the guarantee and maintenance contract.

It appears that further detailed legal work on a potential guarantee is needed before *Energiesprong* could proceed beyond demonstration stage.

8.4 Collaborative working

Providing an integrated whole-house solution will require collaboration between the different parts of the supply chain (for example, the heating system installer may need to know what the properties of insulation will be). Such collaboration can also help increase the viability of long-term guarantees.

The housing associations that were interviewed were used to joint procurement through various consortia, so although there is recognition that *Energiesprong* is likely to require a consortium approach there was no particular concern about it. However, no association reported having done energy works in partnership before and the level of involvement and interdependency required to deliver *Energiesprong* could be rather more than for a standard procurement consortium.

Contractors we spoke to also believed that it is currently difficult to join up the different aspects of providing a whole-house solution. Potential solutions to this barrier include the following.

- **Building Information Modelling (BIM) systems which can be used to share data between contractors.** Suppliers (particularly smaller ones) focussed on the need to share BIM data, rather than the systems themselves. BIM was felt to be expensive to introduce but worth it for a sufficiently large programme. However, BIM is not a perfect solution for retrofit. According to the interviewees, construction form and service locations need to be factored in and landlords rarely have proper plans for the type of properties *Energiesprong* would be used for.

- **The development of codified designs for different building archetypes.** Stakeholders believed that standardised designs and processes could drive quality assurance and supply chain strength. This would also increase the attractiveness of area-based schemes (covering a large number of houses of a single type).

- **Greater collaboration with suppliers of equipment such as solar PV panels and heat pumps.** In the past these have tended to supply a "one box fits all" product, which may limit the extent to which installers can optimise their performance as part of an integrated package being installed on properties.

The supply chain

9 Landlords and tenants

In this section, we set out how the *Energiesprong* business model may be affected by the actions of landlords and tenants within London.

- We start from the point of view of tenants, setting out the extent to which housing providers believe *Energiesprong* will appeal to their tenants.
- We then turn to the possible incentive effects that *Energiesprong* might have on tenants once it is carried out.
- Finally, we turn to the perspective of landlords, and provide a summary of the attractiveness of outcomes-based procurement and *Energiesprong* as a whole.

Table 9 explains each of the barriers posed by the landlord and tenant environment in London, and what next steps could be undertaken to mitigate its impact. **Figure 28** illustrates where these barriers affect the business model.

Table 9. Summary of landlord and tenant issues and their interactions with the *Energiesprong* model

Barrier	Actions	Priority[101]	Actors involved
a) Housing provider procurement systems are focussed on the specification of products rather than outcomes.	Housing provider procurement teams should work with Energy Performance System vendors and solution providers to develop systems that are based around outcomes.	High applicability High impact **Must address for trial**	Energiesprong UK Housing providers Solution providers Energy Performance System vendors
	Different procurement teams within housing providers may need to adopt a more integrated approach.		Housing providers

101 Based on the analysis carried out in section 10.

b) Tenants may object to retrofits on the grounds of appearance or hassle, preventing the use of some measures.	The supply chain will need to develop products that minimise hassle and are attractive to tenants. UK landlords have found that even quite short-term works are objected to by some tenants if they affect access to, or functionality of, the property. The Netherlands experience has been positive in this regard.	Medium applicability High impact **Should ideally address for trial**	Solution providers Housing providers Tenants
	The first-wave trial could focus on properties viewed as unattractive (and where invasive works such as internal wall insulation are not required), which will minimise the risk of tenant dissatisfaction.		Energiesprong UK Housing providers Solution providers
c) Studies[102] show that tenants may use their newly retrofitted properties in a way that wastes energy	The first-wave trial should be used to investigate the extent to which this is an issue. For example, different approaches to communicating the need to use buildings efficiently could be tested using a randomised control trial. Research could also be carried out to determine the type of tenants and properties that are associated with better or worse energy efficiency outcomes.	High applicability Medium impact **Should ideally address for trial**	Energiesprong UK Housing providers Researchers

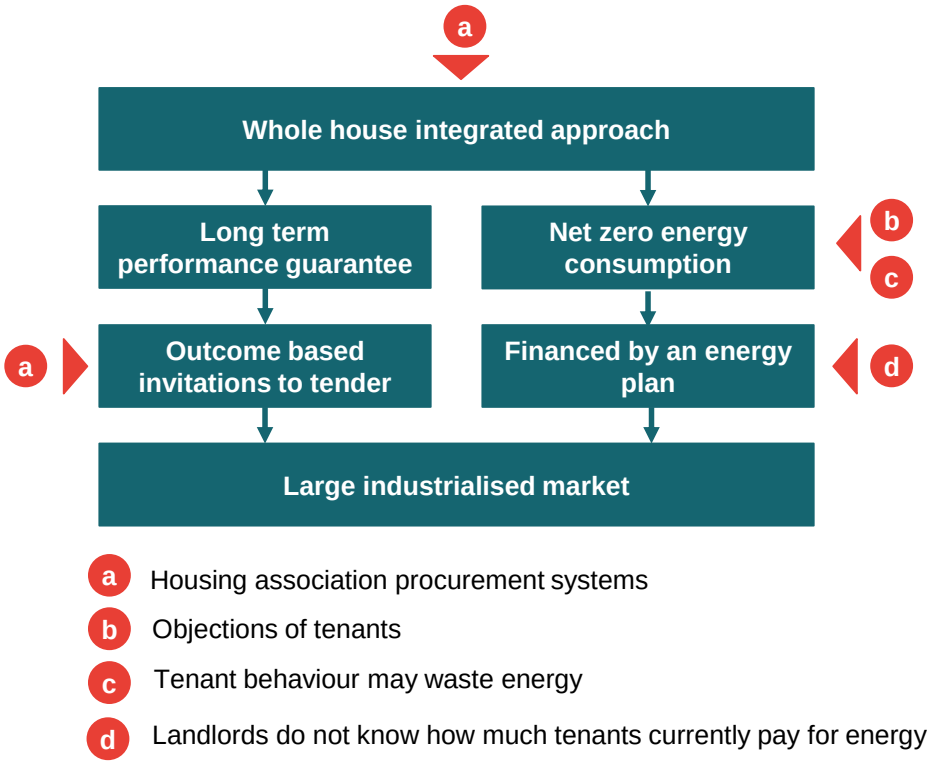
102 The Amicus Horizon IFOR assessment, for example, shows this behaviour.

d) Landlords do not know how much their tenants currently pay for energy, which means they will be unsure how much they can charge through an Energy Plan.	For now, this might involve either a detailed survey as well as the installation of temporary metering equipment. Once the national smart meter rollout has finishes, landlords may be able to ask tenants for permission to access their consumption data.	High applicability Medium impact **Should ideally address for trial**	Housing providers Tenants

Source: Frontier

Landlords and tenants

Figure 28. Impact of landlord and tenant issues on the business model



9.1 Tenant appetite for *Energiesprong*

Housing providers have mixed opinions on the extent to which *Energiesprong* will appeal to their tenants.[103] Careful tenant engagement will certainly be required to overcome any reservations regarding *Energiesprong* (similar reservations, with subsequent vetoes, have prevented the installation of low-carbon technologies such as heat pumps).[104] However, the *Energiesprong* focus on attractive retrofits with minimum hassle will be unfamiliar to UK housing providers and their tenants, and has been able to drive enthusiasm in the Netherlands. London-based trials will help show whether this is also the case here.

103 Here, we discuss whether residents are likely to accept an *Energiesprong* contract. Whether such a contract can be offered (given regulations in the sector) is discussed in section 3.

104 See, for example, Moore, N., Haines, V. and Lilley, D. (2015), *Improving the installation of renewable heating technology in UK social housing properties through user centred design*, Indoor and Built Environment 0(0) 1-16

One housing association indicated to us that their resident panel had considered the *Energiesprong* model and broadly supported it. They were attracted by reduced energy bills and long term certainty over costs to them. However, other associations raised potential tenant objections.

- Residents can lack the motivation to do retrofits and can refuse works because they do not want the inconvenience. This applies even where works are external and therefore do not affect their ability to live normally in their home.

- Residents in more "traditional" London properties tend to like their appearance, and external cladding therefore might not be appealing to them. However, where stock to be treated has a traditional council house appearance, stakeholders felt that changes in appearance are more welcomed. Similarly where an area needs to be regenerated, changes in appearance are often beneficial.

- One queried whether the promise to get rid of energy price inflation is as attractive as it would have been a few years ago, because energy costs are currently stable or falling.

- One was concerned that tenants may feel that they should not have to pay for what is an investment in the housing stock. As a solution, housing providers stressed the importance of transparency around the use of the Energy Plan (e.g. showing tenants how the money was being spent, and over what time period).

9.2 Tenant behaviour and incentives

It is commonly acknowledged that energy-efficiency measures can lead to a "rebound effect" where households heat their house to a higher temperature following the retrofit, due to the additional temperature costing them less.[105] Housing providers with experience of retrofits have reported observing this effect, as well as tenants who used their extra disposable income from lower energy bills to buy equipment that then increased bills again. Such actions can contribute to a better tenant quality of life, although will lead to higher energy bills than may have been modelled. Tenants may also waste energy by operating

105 See, for example, DECC (2014), *Valuation of energy use and greenhouse gas (GHG) emissions*

newly retrofitted houses in an inappropriate way (for example opening windows during winter).[106]

Many stakeholders believed that the "acceptable use policy" aspect of the Energy Plan, together with extensive monitoring to verify it, could avoid these types of issues. However, as described in section 8.3, there are concerns regarding the acceptability of such intensive monitoring. In addition, tenants may require significant training: in some past retrofit projects, occupants have just been briefed when equipment is handed over and when engineers come to service equipment, but no more than this.

Although such monitoring may help once measures are installed, a further issue raised in the interviews is that landlords do not know what their tenants *currently* spend on energy. One major landlord we spoke to had begun a project to gather this information, but other big providers felt that they would need more information before they could commit to an *Energiesprong* trial. They therefore cannot know what their potential income stream from an Energy Plan would be. Estimates may be far from the reality, because social tenants in particular are believed to under-heat their homes. As a result, tenants may not have high bills even though the cost of heating their homes to a satisfactory level would be high.

9.3 Outcome-based procurement by housing providers

As described in section 2, outcomes-based contracts are a key part of the *Energiesprong* business model.

At present, procurement by housing providers is by product, and by the performance of that product, rather than the resulting energy outcome. Current approaches to procurement are also heavily weighted towards costs: contractors proposing an innovative and high-specification, but higher cost, solution will not get through tender processes.

Various barriers were cited to the use of outcomes-based contracting.

- Systems used by housing providers will sometimes determine themselves what works will deliver their desired SAP rating. For example, one association described that its Energy Performance System works by specifying what measures are needed to get a property to a specific rating, and then it procures that.

106 UKERC (2007), *The Rebound Effect: An Assessment of the Evidence for Economy-Wide Energy Savings from improved Energy Efficiency* discusses this type of behavioural change.

- There is also inconsistency across how different asset management teams work, even within one association. This may be an issue for the types of whole-house retrofits that *Energiesprong* intends to incentivise.

However, there does generally appear to be an appetite among housing providers to move towards an outcomes-based approach like that envisaged for *Energiesprong*. For example, one association reported that it does not currently commission energy works on outcomes (energy performance contracting), but it believed that it could work in this way and would feel comfortable doing so. They are aware that this is normal for commercial property, and so would expect contractors to be able to respond. Indeed, there was appetite expressed by a number of large providers in London. Further, the Mayor of London's RE:FIT programme[107] provides an example of a successful framework for outcomes-based procurement in the commercial property sector.

9.4 Housing provider appetite for *Energiesprong*

A number of large London based housing associations clearly stated that they were interested in *Energiesprong* and that they had appetite to explore its application. There is an appetite to improve the energy performance and appearance of property. The barriers and challenges articulated through this report were almost all provided in the context of constructive consideration. There is also recognition that there is a hard core of properties in London that cannot be improved by current approaches.

Appetite given the Decent Homes Standard

Some associations expressed concern that *Energiesprong* would require them to replace components that are not nearing the end of their life, and that this would be financially inefficient. This is a particular issue due to the improvements to social housing that were carried out early in this century so that all properties would comply with the Decent Homes standard by 2010. Because Decent Homes looks at the age of components (kitchen, bathroom, and roof) as well as thermal comfort, housing providers do have to run cyclical programmes to maintain compliance with the standard.

Due to the Decent Homes standard, there is no 'hard core' of properties in London with very outdated facilities that could be upgraded to make *Energiesprong* works more attractive to the tenants. This is in contrast to the Netherlands, where *Energiesprong* has used new kitchens and bathrooms as an incentive for

107 RE:FIT projects are carried out by Energy Service Companies, which also provide a guarantee on the energy savings to be made of the agreed payback period

tenants.[108] Indeed, tenants were able to have input into the designs and this was a popular aspect of *Energiesprong*.

108 See for example: *The Guardian*, Ikea kitchens help sell insulation to Dutch – and UK could be next, 10/10/2014, available at http://www.theguardian.com/environment/2014/oct/10/uk-looks-to-dutch-model-to-make-100000-homes-carbon-neutral-by-2020

10 Practical next steps for the business model

In this section, we summarise the key barriers to *Energiesprong* in London, and what actions may be required (and by whom) to mitigate these.

- First, we apply a framework to help prioritise the need to address different barriers. This considers both when the barrier needs to be addressed (before the first-wave trial, or in advance of any subsequent mass rollout), and how important it will be to do so.

- We then summarise the next steps required by each actor to address these barriers.

10.1 Key barriers

We have categorised barriers based on their **applicability** (how many potential *Energiesprong* projects in London they may affect)[109] and their **impact** (how serious an impact they may have on those projects). In the absence of detailed quantitative evidence on the extent of barriers (which would require further research such as surveys), we have used the descriptive scale summarised in **Figure 29**.

Figure 29. Overview of scale for assessing barriers

Applicability		Impact	
Low	Will only affect a small proportion of potential projects	Low	Barrier is unlikely to make a significant impact on the feasibility of Energiesprong
Medium	Will affect a large proportion of potential projects, and may prevent a mass -market	Medium	Barrier will significantly reduce attractiveness of Energiesprong, but it could still be feasible
High	Will affect all potential projects, including those that might be used for a first-wave trial	High	Barrier is likely to make Energiesprong infeasible

As illustrated in **Figure 30**, the rating of a barrier will determine the priority to be placed on addressing it.

109 We consider applicability as a proportion of the market *Energiesprong* is currently targeted at (60s and 70s social housing in need of maintenance).

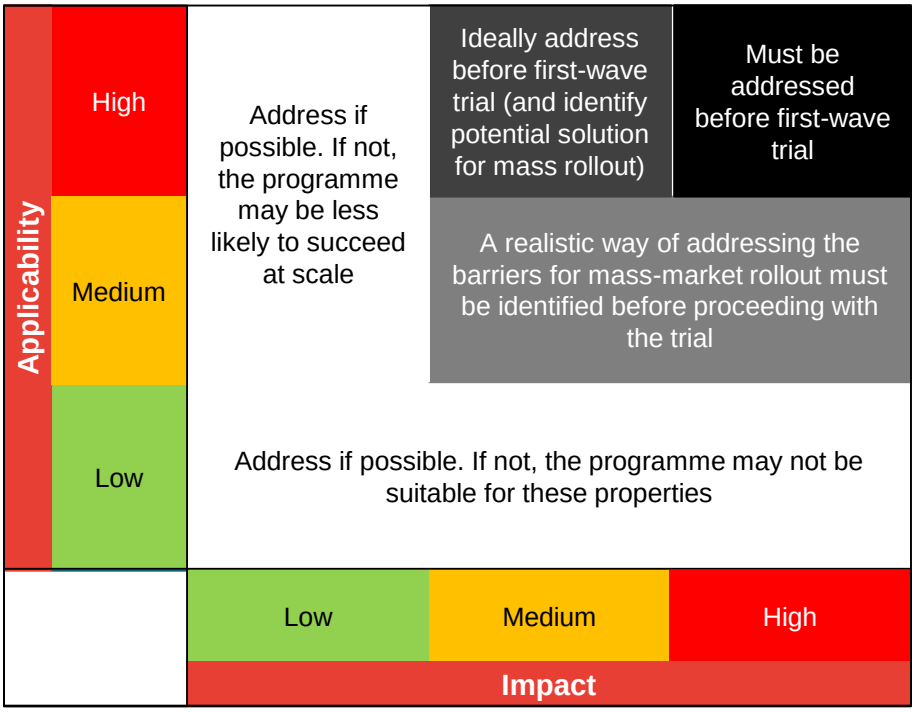
- High-impact barriers which apply to all potential properties will prevent a successful first-wave trial among a few hundred or thousand properties. They must be addressed in advance of a first-wave trial (or, in some cases, as part of that trial).

- Medium-impact barriers which apply to all potential properties should ideally be addressed before the first wave trial, as otherwise they may affect the financial viability of the trial or willingness of housing providers to become involved. However, it may still be possible to run a trial (perhaps at additional cost) if these barriers have not all been mitigated.

- High or medium barriers that affect a significant proportion of the potential market may not need addressing before the trial. However, if the proportion of the market would affect the viability of a mass rollout (a key outcome of *Energiesprong*) it is important that a realistic way of addressing them is identified. If it were not possible to overcome these barriers, then the trial may be of limited use (since the programme will not be widely applicable).

- Barriers of low impact or applicability should ideally be addressed, but may not prove insurmountable for the business model as a whole.

Figure 30. Priority of addressing barriers



Using this framework, table **Table 10** summarises the prioritisation of each barrier (the codes in the first column reflect the chapters of this report).

Practical next steps for the business model

Table 10. Prioritisation of barriers

	Barrier	Aspect of *Energiesprong* affected	Applicability	Impact	Prioritisation
3a	Restrictions on rent and service charge setting	Energy Plan	**High** Will affect all housing providers	**High** If Energy Plan cannot be recouped	Must address for trial
3b	Need to recoup costs from tenants who purchase their property	Energy Plan	**High** All housing providers will soon be affected by RTB	**Medium** Impact depends on % of tenants purchasing properties	Should ideally address for trial
3c	"Pepper-potted" leaseholders will need to approve and pay for retrofits	Energy Plan Whole-house approach	**Medium** Some HA blocks will not have leaseholders	**High** Without approval, retrofits cannot go ahead	Need to identify solution before mass rollout
4a	Lack of net metering means net zero energy usage does not lead to zero bills	Energy Plan	**High** Affects all retrofits	**Medium** May make the Energy Plan less attractive	Should ideally address for trial

4b	Potential future time-of-use tariffs may lead to uncertainty in bill payments	Energy Plan	**Medium** Not all households may take up time-of-use tariffs	**Medium** May make the Energy Plan less attractive	Need to identify solution before mass rollout
5c	Structure of RHI payments may disincentivise very extensive retrofits	Whole-house approach	**Medium** Heat pumps and insulation likely to form a part of most *Energiesprong* retrofits	**Low** RHI funding not a prerequisite for *Energiesprong*	Address if possible
4d	RHI funding is not available for combined solar PV/thermal systems	Whole-house approach	**Medium** Affects retrofits where this would be optimal technology	**Low** Could avoid using solar thermal or forego RHI, which is not seen as a prerequisite in the finance model	Address if possible
4e	ECO funding more suited to piecemeal retrofits	Whole-house approach	**Medium** Potentially affects all retrofits that would otherwise be eligible for ECO	**Low** ECO funding not seen as a prerequisite in the finance model	Address if possible
4f	*Energiesprong* is not compatible with district heat systems	Energy Plan	**Low** Affects retrofits in areas with DH	**High** Existing Energy Plan model would not work	Address if possible

Practical next steps for the business model

6a	Extending cladding beyond the curtilage of a property requires permission from the landowner	Whole-house approach	**Medium** Will affect all properties where external wall insulation would impinge on other land	**High** Unless permission is granted, rules out the use of a measure that has been integral to *Energiesprong* retrofits	Should ideally address before trial
5b	Retrofits may require a costly and time-consuming planning permission (and could be rejected).	Whole-house approach	**Medium** Affects all potential projects where the material of the property cannot be replicated	**Medium** Will reduce attractiveness of business model, may make some houses infeasible	Should ideally address for trial
5c	Greater restrictions in conservation areas	Whole-house approach	**Low** Affects conservation areas only	**High** Unless planning permission is granted, rules out the use of a measure (external wall insulation) that has been integral to *Energiesprong* retrofits	Address if possible
6a	Housing providers are highly reluctant to borrow to finance retrofits	Energy Plan	**Medium** Some providers may be able to carry out limited financing for a trial	**High** A source of finance is required to cover up-front costs	Need to identify solution before mass rollout

Practical next steps for the business model

6b	Existing mortgage lenders may not accept *Energiesprong* works	Energy Plan	**Medium** Some landlords may have homes not charged to a lender	**High** Mortgage lenders could veto the programme	Need to identify solution before mass rollout
8a	Net zero is unlikely to be obtainable for the majority of houses	Net zero energy consumption	**High** Unless very specific housing types can be identified where this is not an issue, this will affect any *Energiesprong* project	**High** Net zero is a crucial part of the current business model	Must address for trial
8b	Some property types may lack space for additional plant such as heat pumps	Whole house approach	**Medium** Some properties will have sufficient space	**High** The use of such equipment is likely to be required for most retrofits	Need to identify solution before mass rollout
8c	Congestion and a lack of space will make delivering whole-house retrofits difficult and costly	Whole house approach	**Medium** May be more of an issue for inner London	**Medium** Will increase costs	Need to identify solution before mass rollout
8a	UK construction sector will need to adopt new approaches to drive down costs – and such extensive retrofits might never be cost-effective	Whole-house approach	**High** Will affect all potential projects	**Medium** Retrofits are still possible, but more expensive	Should ideally address for trial

Practical next steps for the business model

8b	A lack of clear documentation could prevent long-term maintenance	Long-term performance guarantee	**High** Will affect all potential projects	**Medium** Will not stop initial rollout of retrofits, but could be long-term issue	Should ideally address for trial
8c	Performance guarantees may not be seen as credible by housing providers	Long-term performance guarantee	**High** Potentially applies to all projects	**Medium** Could go ahead, but with considerable uncertainty	Should ideally address for trial
8d	Barriers to collaborative working between suppliers	Whole-house approach	**High** Potentially applies to all projects	**Medium** May affect viability of a whole-house retrofit	Should ideally address for trial
8e	Tenants may be unwilling to accept high degree of monitoring	Long-term performance guarantee	**Medium** There may be groups of tenants which are more amenable to monitoring	**High** Tenant acceptance is required	Need to identify solution before mass rollout
9a	Housing provider procurement systems are focussed on specifications, not outcomes	Outcome-based tenders Whole-house approach	**High** Potentially applies to all projects	**High** Outcomes-based procurement fundamental to *Energiesprong*	Must address for trial

Practical next steps for the business model

9b	Tenants may object to retrofits on grounds of appearance or hassle	Net zero energy consumption	**Medium** Many groups of tenants (particularly in less attractive buildings) may not find this an objection	**High** Tenant acceptance required	Should ideally address for trial
9c	Tenants may use retrofitted properties inefficiently	Net zero energy consumption	**High** Housing provider experience indicates this will not apply to all tenants. However at present these tenants cannot be identified, and so would affect all possible projects	**Medium** Will affect viability of the Energy Plan	Should ideally address for trial
9d	Landlords do not know how much tenants currently pay for energy	Energy Plan	**High** Potentially applies to all projects	**Medium** It will be difficult to set the Energy Plan without a knowledge of prior consumption	Should ideally address for trial

Practical next steps for the business model

10.2 Summary of required actions to address barriers

Based on this assessment, we now summarise the actions that could be undertaken to mitigate the barriers identified above. We have grouped these by their priority. In particular, the question we ask is when the barriers need to be addressed by, and whether the requirement is essential or just preferable. This provides us with four categories.

- Barriers that need to be addressed in advance of the trial.
- Barriers that ideally should be addressed in advance of the trial, and will need to be addressed for mass rollout.
- Barriers that need to be addressed for mass rollout.
- Barriers where it would be desirable if they were addressed.

The codes before each barrier description relate to **Table 10**, and include the chapter of this report where the barrier is discussed.

10.2.1 Barriers that need to be addressed in advance of the trial

The following barriers will need to be addressed in advance of the first-wave trial, otherwise the *Energiesprong* business model is unlikely to be feasible even for a limited number of properties.

- **3a) Restrictions on rent and service charges may prevent the Energy Plan being passed through to tenants using these channels.** Recouping the cost through a service charge is an attractive option (since this can apply both to tenants and leaseholders). However, before implementing this, specialist legal advice would need to be sought on whether such an increase in service charges would be permissible. There was no agreement on this topic from stakeholders we approached for this research: although *Energiesprong* retrofits would not appear to meet the necessary criteria of being a "facility made available for use", there is precedent of charging for heating through a service charge.

  For Affordable Rent properties, an increase in the service charge would need to be matched by a decrease in rent, unless it could be shown that the market rental value had increased. Trials of *Energiesprong* will be valuable in showing whether this is the case.

  If these barriers cannot be overcome, retrofit costs would need to be recouped through some combination of rent and/or a separate contract (potentially using the mechanism for long term cost-recovery associated with the Green Deal).

- **8a) Modelling carried out for this project, as well as previous peer-reviewed UK studies, suggests that net-zero retrofits are unlikely to be a feasible solution for the vast majority of properties**. Unless very specific dwellings can be identified where net-zero is obtainable at a reasonable cost, or sufficient evidence can be brought forward to show where such an approach will be cost effective, the trial is likely to involve a reduction of energy usage that falls short of net zero. Our view is that it is worth investigating the option of amending the Energy Plan to work with retrofits that approach, but do not reach, the goal of net zero.

- **9a) Housing provider procurement systems are focussed on specifications, not outcomes**. Housing provider procurement teams will need to adopt an outcomes-based approach. In the longer-run, this may be helped by working with Energy Procurement System developers to develop systems that are based around outcomes.

  We have included this as a high-priority barrier since outcomes-based procurement is such as integral part of *Energiesprong*. However, given the enthusiasm we have seen among some stakeholders, it seems unlikely that this would act as a barrier to a trial.

The trial itself should also be structured in a way which helps understand the magnitude of other barriers. For example, research could be undertaken into how householders can be incentivised to use energy in their homes efficiently; valuation experts could advise on the effect of retrofits on sales value; and different parts of the supply chain could develop systems for more collaborative working.

10.2.2 Barriers that should be addressed in advance of the trial, and will need to be addressed for mass rollout

The following barriers should ideally be addressed before the first-wave trial, as they will reduce the appetite of housing providers to participate in it. At a minimum, a plan to tackle these barriers needs to be in place for the mass rollout.

- **3b) The need to recoup costs from tenants who purchase their property.** For the trial, it may be sufficient to make use of the "portable discount" which enables housing providers to offer an alternative property to tenants (this will need the approval of tenants). In addition, dwellings could be selected that are less likely to be bought (for example, those with mortgageability problems). For the mass rollout, an alternative is likely to be needed: One option may be to recoup the costs via the sales price, and valuation experts should be consulted following the first-phase trial to determine if this is feasible. If not, the Energy Plan might be passed through

Practical next steps for the business model

the service charge, although further specialist legal advice will be needed to design an appropriate mechanism.

- **4a) Lack of net metering means that net zero energy usage, even if achievable, will not lead to zero bills.** Tenant engagement will therefore be required to help develop an acceptable Energy Plan that does not guarantee zero energy costs. If it is possible for energy suppliers to offer long-term fixed price contracts, this may help to provide certainty and overcome this barrier.

- **6a) Extending cladding beyond the curtilage of a property requires permission from the owner of the land.** A common issue may be where external wall insulation encroaches upon the movement. A blanket approval (subject to specified standards) could be sought from council highways departments and Transport for London.

- **5b) Some retrofits will require costly and time-consuming planning permission (and could be rejected**). Suppliers of wall insulation should continue to develop products which will better match the London built environment, or internal products which can be installed with minimal hassle and cost. The RE:NEW Support Team could provide statements to accompany planning applications, or to request waivers to the development caveats. Local development orders could be used as a way of reducing uncertainty in the planning permission process, as (in the longer term) could extensions to the existing permitted development rights.

- **8a) The UK construction sector will need to adopt new techniques to drive down the cost of retrofits – and even then, there is no clear evidence that such extensive retrofits could be carried out cost-effectively.** *Energiesprong* itself is intended to overcome many of the barriers to greater innovation in whole-house retrofits, and the supply chain will need to engage fully with this goal. In the longer term, it will be important for DECC policies to provide a stable platform for such innovation. Contractors should themselves look to provide evidence (whether from trials or detailed modelling) to show a pathway to net zero in London, at affordable prices.

- **8b) A lack of clear documentation could prevent long-term maintenance**. Manufacturers and installers should work together to develop a minimum standard of documentation that is provided with *Energiesprong* retrofits.

- **8c) Performance guarantees, although more common in other sectors, may not yet be seen as credible by housing providers**.[110] For the trial (where the exposure of any one association to the risk of underperforming solutions may be limited), it may be sufficient for large suppliers to underwrite the performance guarantee. We understand that this is the case in the Netherlands, where the guarantee is not currently underwritten by an insurer. However, it seems likely that a mass rollout would require insurers to underwrite the guarantee. Given the importance of this issue, Energiesprong UK should therefore start to determine what evidence insurers would need to underwrite guarantees.

- **8d) Barriers to collaborative working between suppliers.** Solution providers should start to develop standards for sharing Building Information Management data, codifying designs for different dwelling archetypes, and engaging more with suppliers of equipment such as solar PV panels and heat pumps.

- **8e) Tenants may object to retrofits on grounds of appearance or hassle.** The supply chain will need to develop whole-house solutions which are acceptable to tenants. This is a key part of the *Energiesprong* proposition, and based on the experience in the Netherlands these concerns may be unfounded – any trials will verify this.

- **9c) Tenants may use retrofitted properties inefficiently**. While the structure of *Energiesprong* means that such costs would fall on the tenant, it is still crucial for the success of the scheme that retrofits are perceived as performing well for tenants. The first-wave trial should be structured in a way which helps identify the extent of this barrier. For example, different means of communication should be tested, and the trial could be used to determine the characteristics of tenants or properties that are associated with inefficient use of retrofitted properties.

- **9d) Landlords do not know how much tenants currently pay for energy**. Housing providers in trial areas will need to identify this so they can determine the maximum value of the Energy Plan. This could involve surveys, or through the installation of metering devices. In the longer-term,

110 Issues around the credibility of guarantees were brought up by several housing associations we spoke to as part of this research, although such guarantees are more common in the world of commercial property (for example the contracts produced under the Mayor of London's RE:FIT programme).

Practical next steps for the business model

the rollout of smart meters may facilitate this (if tenants give landlords permission to access their consumption data).

10.2.3 Barriers that will need to be addressed for mass rollout

These barriers will not need to be addressed for the first-wave trial. However, if a solution is not viable, then this may call into question the reason for carrying out trials in the first place (since mass rollout may not be possible).

- **3c) "Pepper-potted" leaseholders will need to approve and pay for retrofits.** For the first-phase trial, it may be possible to select estates where this is not an issue. However, prior to mass rollout, Housing providers and legal experts will need to develop an Energy Plan contract that works with leaseholders, and then determine how attractive this would be. This is likely to take the form of either recouping the cost through the service charge, or through a separate contract (perhaps utilising the mechanism of the Green Deal). Section 3 describes the benefits and issues associated with of each approach in more detail.

- **4b) Potential future time-of-use tariffs may lead to uncertainty in bill payments.** Solar PV panels will produce most electricity during the daytime when electricity prices are lower. If there is a wide adoption of time-of-use tariffs, this will result in energy bills increasing for those with *Energiesprong* retrofits. Providers should start to include plausible time-of-use tariffs in their modelling to determine what the impact will be on customers.

- **6a) Housing providers are reluctant to borrow to finance retrofits.** Advice from the HCA that *Energiesprong* retrofits are a suitable use of borrowed money may help encourage some to fund retrofits in this way. However, it may still be necessary for Energiesprong UK and housing providers to explore alternative options, such as the use of project finance funded by large construction companies.

- **6b) Existing mortgage lenders may not accept *Energiesprong* works**. Housing providers hoping to implement Energiesprong should commence discussions with mortgage providers to determine whether this may be the case, and to define "template" projects that would be acceptable. If this is not possible, government intervention may be required to ensure that lenders accept these types of works.

- **8b) Some property types may lack space for additional plant such as heat pumps.** This is less likely to be an issue for the flats that *Energiesprong* will initially target. However, solution providers should start to investigate the feasibility of delivering such retrofits in property types with limited space. There has already been progress made on this front within the

Netherlands (for example, incorporating heat pumps within the façade of buildings).

- **8c) Congestion and a lack of space will make delivering whole-house retrofits difficult and costly**. This has been anecdotally reported as a barrier, and the first-phase trials will help demonstrate to what extent the supply chain may need to innovate to deliver retrofits cost-effectively in central London, or if local councils can help ensure access.

- **8e) Tenants may be unwilling to accept a high degree of monitoring.** Housing providers and Energiesprong UK should engage with groups of tenants to identify whether this may be a barrier, and if so whether better communication with tenants or lower levels of baseline monitoring (increased only if there are reported issues with the retrofit) may mitigate it. More generally, any rollout of the *Energiesprong* concept needs to ensure that tenants are involved and behind the idea from an early stage.

10.2.4 Barriers that it would be desirable to address

The following barriers have been assessed as not being critical for *Energiesprong*, since they only affect a small proportion of properties, or do not significantly worsen the business case. However, it would still benefit the ultimate mass-rollout if they could be addressed.

- **5c) The structure of RHI payments may disincentivise very extensive retrofits.** At present, insulating a house above the minimum required to install a heat pump would results in lower RHI payments. This is unlikely to have a significant impact on *Energiesprong* (which has been designed to work without RHI), but if whole-house integrated retrofits are demonstrated as effective, DECC should examine whether policies can be adapted to work better alongside them.

- **4d) RHI funding is not available for combined solar PV/thermal systems.** Ideally, future DECC policies to incentivise low-carbon retrofits would be neutral regarding the exact technology used.

- **4e) ECO funding is more suited to piecemeal retrofits.** Solution providers could work with providers of ECO scoring software to ensure these applications work effectively with whole-house solutions such as *Energiesprong*. In the longer term, Energiesprong UK may wish to work with DECC to ensure that ECO (or any successor policy) can work well with whole-house solutions. However, in any event, *Energiesprong* has been designed to work without such subsidies.

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- **4f) *Energiesprong* is not currently compatible with district heat systems.** Although this will not be a barrier for the majority of houses, the prevalence of district heat systems may increase. It would therefore be beneficial for Energiesprong UK to carry out modelling of the cost effectiveness of an *Energiesprong* retrofit alongside district heat. If this appears feasible, an Energy Plan contract could be developed and tested with housing providers and tenants.

- **5c) Some retrofits (notably external wall insulation) may not be feasible in conservation areas.** First-wave trials can simply avoid these areas. For the future, solution providers could work to consider whether cost-effective whole-house retrofits can be developed that do not affect the external appearance of such buildings (for example using internal wall insulation on the front), although this is likely to increase the cost and hassle of retrofits significantly. Energiesprong UK could request General Advice (like a scaled down Pre-Application Discussion) from authorities on how they might consider heritage issues alongside *Energiesprong* retrofits.

11 Potential business model for the private rented and owner-occupied sectors

At present, *Energiesprong* is focussed on the social housing sector. However, as explained in section 3, the "pepper-potted" nature of leaseholders within London housing estates means that a variant of the business model may need to be developed for owner-occupiers in tandem.

Even if this were not the case, it would significantly increase the range of properties that *Energiesprong* could be applied to if it could be adapted to these sectors. From April 2018, residential private landlords will be prohibited from granting a new tenancy for dwellings with an energy performance indicator of below "E" (and, after April 2020, will not be able to continue existing tenancies for such properties).[111] In addition, after April 2016, residential private landlords will not be able to "unreasonably" refuse tenants' consent for energy efficiency improvements if the tenant has secured funding. There is therefore likely to be an increased demand for a model that can deliver retrofits to the private sector. However, the private rented and owner-occupied sectors may present additional barriers that will need to be overcome.

In this section, we first consider the barriers that may exist to such a business model. For each of the main aspects of the environment covered in sections 3 to 9, we set out whether the barriers identified the social housing sector would apply to the other sectors, and if there are any additional barriers. We then consider how these barriers might be addressed.

Overall, the barriers to an *Energiesprong*-type model in these sectors vary depending on the nature of the property owner, and the property itself.

- **Property owner:**
  - Larger private landlords (as well as freeholders responsible for the upkeep of blocks of flats) may in some ways be better placed to implement *Energiesprong* than housing associations, due in part to lower regulatory barriers.
  - However any *Energiesprong* model for small landlords and owner-occupiers is likely to face some of the same issues as the Green Deal (as both schemes require a high capital outlay that is recouped over the long-run).
- **Property**

111 Under the Energy Efficiency (Private Rented Property) (England and Wales) Regulations 2015

- Where properties are adjacent to those with different owners, retrofits may need to be carried out simultaneously. This is likely to prove a significant barrier.

Given this, *Energiesprong*-type models may be most viable in the following cases.

- Where a landlord (or a freeholder responsible for maintenance of flats) owns a block of properties. This would include the case of "pepper-potted" leaseholders in housing association flats, providing the issues around service charges discussed in section 3 can be addressed. It may also be possible for institutional landlords to purchase older housing association properties for retrofit, providing associations with capital to invest in new stock.

- For smaller landlords and owner-occupiers that own detached houses, and have sufficient funds to pay for the retrofit up-front (or otherwise are unconcerned with having a long-term loan).

11.1 Barriers to *Energiesprong* outside the social housing sector

Below, we consider the different types of barrier that may affect the private rented and owner-occupied sectors. Many of the barriers are identical to those in the social sector (and some may be less important). However, **Table 11** identifies some additional barriers.

The barriers identified for owner-occupiers relate primarily to freeholders who would themselves be responsible for financing and installing retrofits. For leaseholders, some retrofits affecting the fabric of the property may be procured by the holder of the freehold, and passed through (for example as a service charge). The barriers to such arrangements would be more similar to those for private landlords and tenants.

Potential business model for the private rented and owner-occupied sectors

Table 11. Summary of additional barriers for the private rented and owner-occupied sectors

Barrier	Sectors affected
The complexity of any potential scheme may deter applicants	May be more of an issue for owner-occupiers and smaller landlords
Owners may be averse to long-term loans	
The need to obtain planning permission may be a greater obstacle for some owners than housing associations	May be less of an issue for larger landlords
Access to finance may be limited	
Adjacent houses may need to be retrofitted at the same time	Will affect any properties that are adjacent to properties with a different owner

11.1.1 Housing regulations

The regulations described in section 3 (covering the setting of rent and the Right to Buy) are aimed at the social sector, and would not apply to owner-occupiers or the private rented sector. Although we have not carried out an analysis of whether other regulations may act as a barrier to the business model in these sectors, it seems unlikely that they would be as limiting as in the social housing sector.

11.1.2 Energy market policies

The specific issues that we have identified regarding energy policy, as well as the lack of net metering, will affect owner-occupiers and private renters in a similar way to the social housing sector.

However, as set out in **Table 3** on page 50, the Green Deal's failure may point to further barriers for these sectors. Scheme complexity deterring applicants and consumer aversion to long-term loans were both implicated in the failure of the Green Deal, and may equally apply to a variant of *Energiesprong*. Any potential *Energiesprong* model for these sectors will need to avoid these issues.

11.1.3 The planning and building regulations systems

The restrictions on retrofits that the planning and building regulations systems impose will apply equally to private owners and tenants/landlords as to social landlords. However, it does seem likely that many private tenants or smaller private landlords may find the planning process more of an administrative burden than larger housing providers.

11.1.4 Financing

This is an area where the issues faced by owner-occupiers and private landlords may differ from one another (and from social housing providers).

- Larger private landlords may have greater access to funds than social landlords, since they do not face the same pressures to borrow only to fund new stock. Further, some of these organisations may be willing to engage in the types of project finance discussed in section 6.1.

- Small private landlords and owner-occupiers may be wary of borrowing large sums of money to fund retrofits. It is also likely that, if available, such credit would be at a higher rate of interest. These groups may also be averse to the complications associated with project finance arrangements.

Where properties are mortgaged, both groups may share the concern of social landlords that a business model which attached a liability to the property may decrease its value.

11.1.5 The housing stock

Private renters and owner-occupiers will occupy a different distribution of the housing archetypes modelled in section 7. However, the same fundamental limitations will still apply: Net-zero is likely to be infeasible in most housing types, and will be cost-inefficient even where it is possible.

11.1.6 The supply chain

The supply chain used by owner-occupiers and private landlords will be the same as used by social housing providers (therefore these groups will benefit from supply chain developments that take place as a result of *Energiesprong* in the social housing sector).

Outcomes-based contracts will be unfamiliar to smaller landlords and owner-occupiers. However these require far less specialist knowledge than detailed tenders for particular products. It seems possible that an easy-to-understand standardised contract could appeal to these sectors. However, the credibility of the guarantee will be crucial.

11.1.7 Property owners and occupiers

Private landlords seeking to carry out *Energiesprong* works for their tenants may face many similar issues to those faced by social landlords.

However, an additional complication exists for owners of houses (both landlords and owner-occupiers) adjacent to houses with other owners. As discussed in section 3 in relation to the right-to-buy, an effective whole-house retrofit will

Potential business model for the private rented and owner-occupied sectors

generally require treating adjacent houses. Where these have different owners, all will need to agree simultaneously to finance and carry out the works.

11.2 Potential solutions to these barriers

As described above, the barriers that affect larger landlords (and the freehold owners of flats responsible for maintenance) are likely to be lower than for smaller landlords and owner-occupiers. Below, we set out how *Energiesprong* might work for the former group – and ways in which some (but not all) of the barriers could be addressed for the latter.

11.2.1 Larger private landlords

As described in **Table 11**, many of the additional barriers are unlikely to apply to large institutional private landlords, providing that their properties are not adjacent to properties with another owner that would need to be retrofitted at the same time.

In these cases, a business model very similar to that developed for the social rented sector may be appropriate. Further, some of the barriers that housing associations would face may not apply here (for example, the Energy Plan could be recouped through rents, since the restrictions in the social rented sector would not apply). Given the likely requirement to avoid adjacent houses with different owners, this model would work particularly well for flats. It may even be possible for private landlords to purchase the most dilapidated properties from housing associations, providing a source of finance that housing associations can use to invest in new stock.

11.2.2 Smaller private landlords and owner-occupiers

Like larger landlords, smaller private landlords could carry out works and pass the Energy Plan through as rent or service charge. Owner-occupiers could potentially pay for the plan through a loan attached to the property, as with the Green Deal (discussed in section 4.3). However, the additional barriers discussed above would need to be addressed. **Table 12** indicates some of the ways this could be done – and highlights where we have not been able to identify an action that is likely to remove the barrier.

Table 12. Summary of potential solutions to barriers affecting smaller landlords and owner occupiers

Barrier	Actions	Actors involved
The complexity of any potential scheme may deter applicants	A simple package would need to be developed – potentially including all the aspects of financing and project management. However, home owners would need to be confident enough in the scheme to accept it without necessarily understanding the full details of the retrofit.	Energiesprong UK Solution providers Home owners
Owners may be averse to long-term loans	An *Energiesprong* retrofit fundamentally requires a high capital expenditure with a long payback period. Other than a small proportion of home owners with sufficient funds to pay for this up-front, this will have to involve some sort of long-term loan, unless there is significant government subsidy.	Government departments (e.g. DECC)
The need to obtain planning permission may be a greater obstacle for some owners than housing associations	As explained in section 5, regulatory exceptions for certain measures carried out for *Energiesprong* would help to mitigate this barrier. Energiesprong UK could also work alongside solution providers and the RE:NEW support team to provide clear guidance on what works can be carried out within the existing scope of permitted development rights.	Energiesprong UK Solution providers RE:NEW support team

Potential business model for the private rented and owner-occupied sectors

Access to finance may be limited	Further sources of finance would need to be made available. Given the learnings from the Green Deal, this would ideally need to be at a low interest rate. Ideally, Energiesprong UK could work with finance providers to supply lower-cost loans once the effectiveness of the standard *Energiesprong* package has been demonstrated. However, government subsidised loans may be required.	Energiesprong UK Finance providers Solution providers Government departments (e.g. DECC)
Adjacent houses may need to be retrofitted at the same time	Energiesprong UK could attempt to foster community groups that bring together adjacent owners to encourage retrofits. However, this will require the business model to become attractive to the majority of owner-occupiers, despite the barriers listed above.	Energiesprong UK

Potential business model for the private rented and owner-occupied sectors

Annexe 1: The *Energiesprong* business model

This annexe provides a full description of the Business Model Canvas used to describe *Energiesprong* in section 2. We have used the Business Model Canvas[112] framework to explore the business logic behind *Energiesprong*. The Business Model Canvas is a recognised framework used for "taking apart" and comparing business models.

An example of a blank canvas is shown in **Figure 31**. This is structured as follows.

- At the far right are **customer segments**, the group or groups which the business model serves. This section can be used to explore which areas of the market *Energiesprong* targets, and which are outside its scope.
- In the centre is the **value proposition**, the goods or services that the business model provides to give value to customers, and make them choose it rather than the next-best alternative.
- The canvas illustrates the **channels** used by the business model to reach its customers, and the type of **customer relationships** required (for example, whether it is necessary to maintain a long-term relationship with customers, or whether the relationship is a transactional one).
- Through selling its product to customers the business generates **Revenue streams**. We have explored the structure of these revenue streams within *Energiesprong*.
- **Key activities** are the activities required to provide the value proposition – in this case, primarily the installation of zero-energy retrofits.
- In order to provide their value proposition, businesses require **key resources**, such as physical, financial or intellectual assets.

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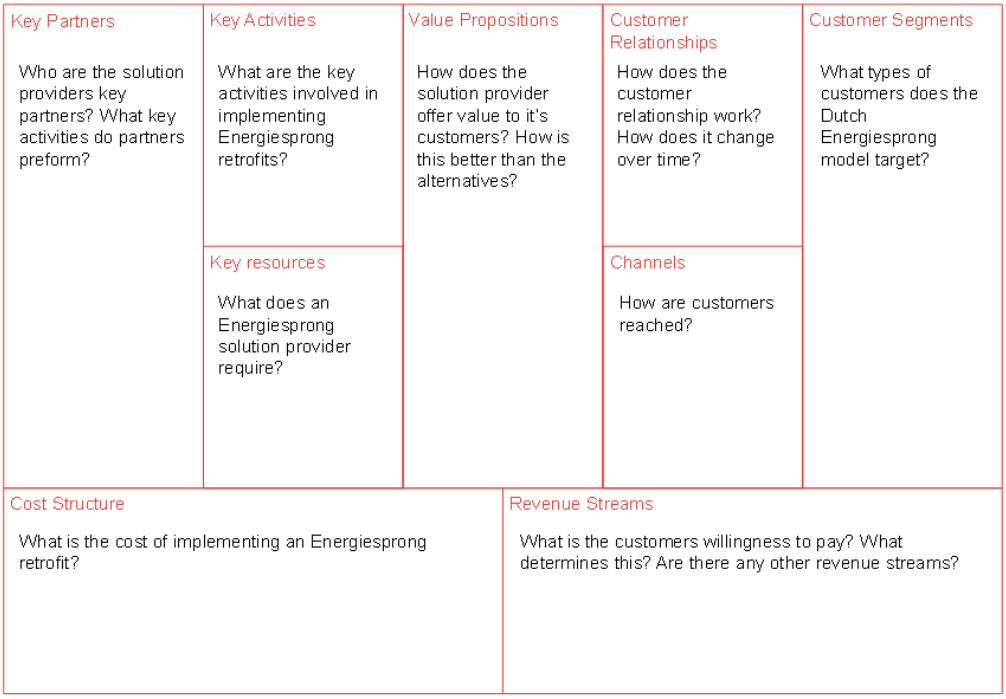
112 Barquet, Ana Paula B., et al. (2011) *Business model elements for product-service system*, Functional Thinking for Value Creation. 2011. 332-337. A version of the canvas is shown at http://www.businessmodelgeneration.com/canvas. The Business Model Canvas is licensed under the Creative Commons Attribution-Share Alike 3.0 Un-ported License.

- Not all activities need to be carried out within the business model, and the **key partnerships** box highlights the other organisations the business model is reliant upon, and the relationship it has with them.

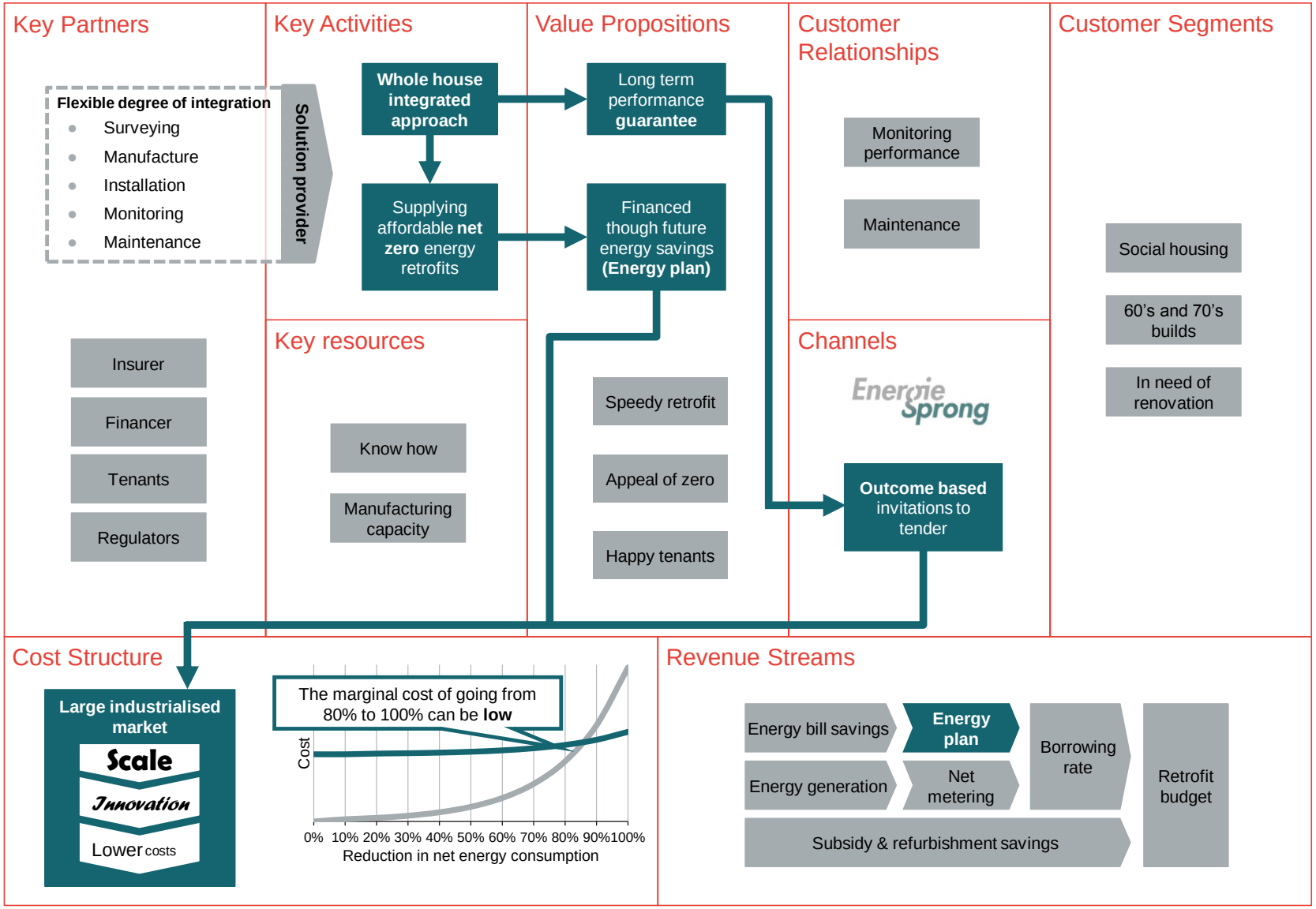
- Finally, the **costs** box highlights the costs incurred in undertaking activities, holding resources, or maintaining partnerships. Issues that can be explored here include the extent to which costs depend on economies of scale.

Figure 31. The Business Model Canvas



The following page illustrates the existing *Energiesprong* business model using this framework. The sections below go through each part of the Business Model Canvas in greater detail.

Annexe 1: The Energiesprong business model



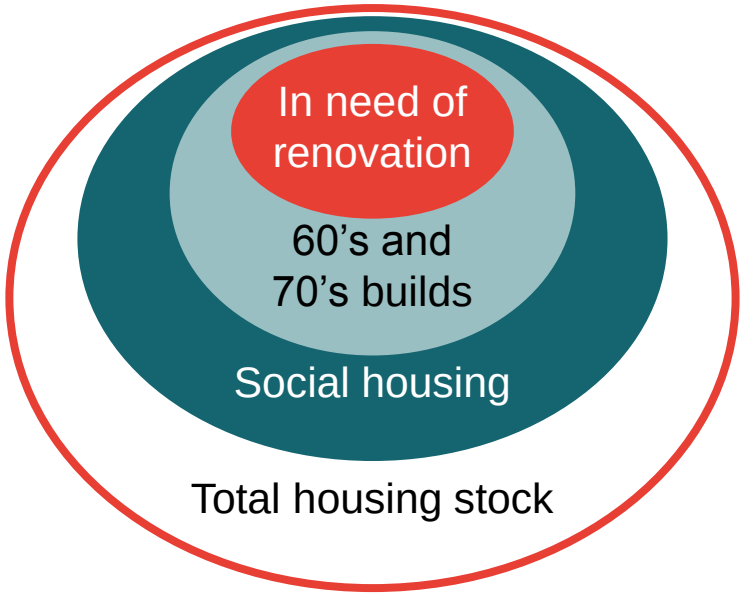
Annexe 1: The Energiesprong business model

11.2.3 Customer segments

Energiesprong's aim is a mature mass market where private landlords select from a range of established solution providers to implement an *Energiesprong* retrofit.

However, to start with *Energiesprong* has identified social housing providers which own houses built in the 1960s and 1970s as its key customer segment. The customers are not the tenants of these properties but the landlords.

Figure 32. The ideal customer segment



Source: Frontier

Energiesprong have identified the ideal customer segment as having the following characteristics:

- **Capable of creating high demand.** Approximately a third of the housing stock in the Netherlands consists of houses from the 1960s and 1970s. A large proportion of these homes (38%) are owned by housing associations.[113]

[113] http://*Energiesprong*.nl/wp-content/uploads/downloads/2013/02/*Energiesprong*-longtermplan-def1.pdf

- **Largely homogeneous.** The systematic construction methods used in the construction of 1960s and 1970s properties is ideal for a conceptual, system-oriented approach to renovation.

- **In need of a substantial retrofit anyway.** Costs can be combined by focusing on the many properties of associations that are up for a significant retrofit anyway.[114]

- **Limited issues with planning rules.** Planning regulation, particularly regulation relating to the façade, makes the renovation more difficult for homes of greater architectural interest.

Bringing large numbers (400 to 500) of homes of a similar type to the market at one time provides an incentive to create affordable renovations. That these homes require substantial renovation anyway strengthens the business case.

Developing a retrofit proposition for a property is a fixed cost. This fixed innovation investment can spread over many retrofits of the same archetype.

As the providers' experience and knowledge increases the expectation is that solutions will get smarter and the number of appropriate housing types will increase.

11.2.4 Value proposition

The value that an *Energiesprong* retrofit provides a housing association is the value over and above what the housing association would have done otherwise in a counterfactual situation. The counterfactual for a housing association is likely to be a less ambitious "piecemeal" retrofit of their existing housing stock.[115] This would result in greater ongoing payments for maintenance and energy (with the latter paid for by tenants), but at a lower up-front cost.

Value to housing associations

There are a number of features of an *Energiesprong* retrofit that provide value to housing associations.

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114 http://*Energiesprong*.nl/wp-content/uploads/2014/06/Transition_zero.pdf

115 *Energiesprong* have told us that in the absence of an *Energiesprong* retrofit housing associations in the Netherlands are implementing 'Label B' retrofits. 'Label B' means that the property consumes 1.25 times the energy of the average 1990 new build. This comes from an agreement signed by the association of social housing providers in the Netherlands that commits them to improving the average energy efficiency of their total rental housing stock. This corresponds to a saving in the building-related energy consumption of existing housing association homes of 33% in the period 2008 to 2020.

Annexe 1: The Energiesprong business model

- **The retrofit is at least in part financed using the energy cost savings.**

The energy savings the tenant receives can be captured by the housing association by charging the tenant an "Energy Plan" charge. This additional revenue stream can be borrowed against to provide capital to fund the retrofit.[116]

If energy savings realised under the counterfactual cannot be captured and borrowed against (which could be the case for a "piecemeal" retrofit), any retrofit will only result in an additional cost (with no counter-veiling revenue stream) to the housing association.[117]

- **The retrofit comes with a 30-year performance warranty.**

A credible performance warranty creates certainty for the housing association. This should make it easier for the housing association to borrow against these future energy savings.

Ideally, for the credibility of the long term energy performance warranty, solution providers would be insured against insolvency by a third party in such a way to protect the warranty.[118]

Warranties are thought to be possible with an *Energiesprong* retrofit but not with a Label B retrofit. This is because the integrated whole house approach of the *Energiesprong* model means that the solution provider is responsible for the energy performance of the whole property rather than a specific component.

- **Cost savings**

We understand from *Energiesprong* that housing associations consider the total cost of ownership when making retrofit decisions, rather than simply the up-front capital cost.

The total cost of ownership can broadly be split into the three categories of:

- management;
- planned and routine maintenance; and
- major repairs.

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116 Social housing providers often face significant restrictions on how they can change their rent. In the Netherlands regulation has been changed so that housing associations are able to charge an additional '*Energy Plan*' which reflects the decrease in energy bills a tenant can expect as a result of the retrofit. This is an example of the type of engagement with regulators that is required.

117 This is likely to be the case because the energy savings cannot be guaranteed and so an *Energy Plan* is likely to be a harder sell to both regulators and tenants.

118 This has not been common practise in the Netherlands. *Energiesprong* point out that long term warrantees are not common with new builds either .

Energiesprong has told us that they expect **management costs** will fall once an association scales up its *Energiesprong* solutions.[119] It expects that there will be fewer staff required in asset management and also potentially in customer response units. They argue that with improved housing quality, and particular new building envelope,[120] the number of call-outs for responsive repairs (for example: draughts, boiler breakage, mould / moisture issues) will fall significantly. While there may be an initial increase in tenants calling housing associations in relation to a newly installed solution, *Energiesprong* say that in its experience this increase is marginal. For example, *Energiesprong* states that tenants do not require any specific training or behaviour change.

Energiesprong say it expects planned and routine **maintenance costs** to fall substantially.[121] This reduction is due to new components being installed as part of the retrofit where the supplier will have an incentive to ensure quality as they are also liable for maintenance.

The highest cost savings are anticipated in **major repairs**.[122] *Energiesprong* say that this is due to the many solutions providing entirely new envelopes and a long term warranty on the performance of that solution.

To the extent that these costs are due to the integrated approach and the warranty they would not be realised under the counterfactual "piecemeal" retrofit.

A further important one off cost that housing associations face is rehousing tenants while work is carried out. An *Energiesprong* retrofit should be executed within 10 days. A short retrofit time reduces the cost to the housing association of housing its tenants in alternative accommodation. It's not clear that installation times could not be similarly short under a Label B retrofit. However, an 'all in one' retrofit is likely to result in shorter cumulative times as various features can be installed at once.

- **The appeal of zero**

Energiesprong says that it has found that the concept of an energy neutral housing stock has an inspiring, attention grabbing quality, which appeals to housing

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119 In the UK version of an *Energiesprong* finance model this decrease in management costs is estimated to be 10%.

120 The building envelope is the physical separator between the interior and exterior of a building. Components of the envelope are typically: walls, floors, roofs, windows and doors.

121 In the UK version of an *Energiesprong* finance model this decrease in planned and routine maintenance costs is estimated to be 25%.

122 In the UK version of an *Energiesprong* finance model this decrease in major repairs costs is estimated to be 50%.

Annexe 1: The Energiesprong business model

associations, and far exceeds that which would derive from a lower reduction in net energy consumption.

Value to tenants

There are a number of aspects of the proposition that can provide value to tenants.

- **Increasing comfort**

A better insulated home with a state of the art heating system would increase the comfort of the property for the tenant. It is likely that to some extent this could be achieved under a Label B retrofit. There is a possibility however, that tenants will not enjoy the change in heating style from radiator system to a heat pump.

- **Financially no worse off**

As discussed above the retrofit can be partly funded though the introduction of an Energy Plan that charges the tenants the value of their decrease in energy bills. This should leave the tenant no worse off, at least on average.

- **Other additional benefits**
  - The look of the building is updated.
  - The retrofit can include new kitchens and bathrooms. Most Dutch *Energiesprong* retrofits have included this.
  - The retrofit should be executed within 10 days. This reduces the inconvenience to the tenant of having to live in temporary accommodation.

11.2.5 Channels

Energiesprong (the market development organisation) is intended to generate momentum in the scheme, which will subsequently be rolled out via outcome-based invitations to tender.

Generating momentum

Energiesprong as an organisation plays an important role in facilitating the relationship between housing associations and solution providers. Working with "frontrunner" housing associations *Energiesprong* helped to organise trials that led to not only new concepts, practices and processes but relationships between solution providers and these housing associations.

With these trials in place, *Energiesprong* generates momentum by getting housing associations and solution providers to sign up to larger scale retrofits.

Annexe 1: The Energiesprong business model

Energiesprong has shared with us a draft hypothetical agreement between a number of housing associations and a number of solution providers, referred to as a 'concept deal'. The agreement is designed to give providers the confidence to invest in developing the ability to provide *Energiesprong* retrofits.

The agreement states that housing associations will commit to purchasing retrofits for at least 5,000 properties between them as long as certain criteria are met. These criteria amount to solution providers being able to supply an *Energiesprong* retrofit. More details on these criteria are provided below.

Though such 'concept deals' *Energiesprong* hopes to foster the market for *Energiesprong* retrofits. The template 'concept deal' suggests that this will take place in in three phases. These are illustrated here:

- Phase 1: Prototyping: Q2 2016 t/m Q1 2017 (50 homes)
- Phase 2: Scaling up: Q1 2017 – Q4 2018 (5,000 homes)
- Phase 3: Full Industrialisation [under the condition phase 2 is successful and additional demand (>25,000) is secured] > Q3 2017

Outcome based invitations to tender

An important change to the customer channel is a move to outcome based invitations to tender. Housing associations are encouraged by *Energiesprong* to submit an invitation to tender that focuses on quality performance outcomes rather than predefining the details of the design, thereby giving solution providers flexibility to come up with innovative solutions. For example, in the template 'concept deal' housing associations commit to purchasing retrofits for at least 5,000 properties between them as long as certain criteria are met.

Such an agreement could take the form of:

"Social housing organisation [name] agrees to purchase [X] net zero energy retrofits for their housing stock as specified in Annex [A] according to the schedule specified in Annex [B], when the offer from [Solution provider], hereafter called supplier, meets the following criteria:

- *After the retrofit, a whole house/housing unit is brought to net zero energy standards as well as indoor climate standards for [Y] years within the parameters as specified in* […]
- *The supplier guarantees this performance standard for the full period of [Y] years. This guarantee is subject to adherence of the tenant to an agreement setting out the behavioural parameters as specified in Annex [C] beyond which the performance warranty would not apply.*
- *The supplier provides an arrangement for the performance warranty to remain intact in the case of insolvency.*

Annexe 1: The Energiesprong business model

- *The supplier delivers the refurbishment within 10 working days on site;*
- *The supplier is responsible for convincing the tenants to agree to the refurbishment works. The housing association commits to support this to the best of their ability.*
- *There is a positive business case for the social housing organisation based on a total cost of ownership approach.*
- *[Other requirements, such a new kitchen and bathrooms or façade specifications.]*

Annexe 1: The Energiesprong business model

Figure 33. Illustrative criteria

Energy		
Total available for own use	[X]	kWh/yr
Of which is needed for space heating	[Y]	kWh/yr
Because of which at least available for personal use (utilities, like washing, cooking, TV, etc.)	[Z]	kWh/yr
Comfort		
Minimum available warm water	200	Litre/day
Guaranteed temperature kitchen/ living room	21	°C
Guaranteed temperature bedroom	18	°C
Maximum hours above 26 °C during summer in occupied room	150	Hours
Minimal ventilation	New build standard	
Interior climate		
Minimum percentage of time CO2 concentration below 1200 PPM	95%	
Day light requirements	At least similar to current situation	
Noise levels external walls	< 20	dB
Noise level occupied space of building installations	< 30	dB

Source: Based on *Energiesprong* draft concept contract. All figures are illustrative.

11.2.6 Customer relationships

There are two distinct phases to the relationship between the housing association and the solution provider. The first is the installation phase in which the solution provider tenders for and implements the renovation. If a large number of properties are involved then this phase is likely to last years.

Annexe 1: The Energiesprong business model

The second phase is post-renovation. The renovation includes a warranty for upwards of 30 years. This implies a long term relationship involving monitoring of performance and maintenance.

11.2.7 Revenue streams

The major revenue stream for the solution provider is an upfront lump sum from the housing association to pay for the renovation. The amount available for the renovation would normally be largely determined by the amount that housing associations have put aside for planed renovations plus the net present value of the reduction in future energy bills and provider costs.

However, because refurbishing a property to energy neutral standard dramatically reduces energy bills, the *Energiesprong* model means that housing associations are able to introduce additional tenant fees called "Energy Plans" which are approximately equivalent to the reduction in energy bills, leaving tenants equally well off. The housing association is then able to borrow against the additional revenue streams created by the Energy Plan and any additional revenue from the sale of excess energy. This creates an upfront amount that forms a major part of the housing associations ability to pay.

Energiesprong have told us that most maintenance to the house is included in the retrofit implying that typically budgets for maintenance and retrofits can be combined to add to the ability to pay.

11.2.8 Key activities

This section discusses the key activities involved in implementing *Energiesprong* retrofits. There is a considerable degree of flexibility as to which of the activities are provided 'in house' by the solution provider and which are contracted out. This is discussed further in the "Key partnerships" section. For the purposes of this section we will assume a fully vertically integrated solution provider.

The major activity of the solution provider is to implement an *Energiesprong* renovation. There are several activities to this.

- *Surveying* - Before the renovation can begin the solution provider must first identify what work should be carried out, this includes detecting any structural problems with the property. *Energiesprong* have stated that innovative technologies can be used at this stage, such as 3D laser scanning, to obtain accurate measurements at a lower cost.

- *Manufacturing* – Many of the *Energiesprong* renovations parts, such as external wall insulation cladding can be manufactured off site. In the Netherlands this is done at the same factories that provide materials for new builds. Specialist equipment such as heat pumps and monitoring devices also need to be manufactured or procured.

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- *Installation* - An *Energiesprong* retrofit should take no more than ten days to install in order to reduce the amount of time that the tenant has to spend living elsewhere.

Energiesprong tell us that an important feature of an *Energiesprong* retrofit is that it is conducted on a whole-house basis as an integrated system. This means that the solution provider can have much greater certainty in the product. This enables them to offer a long term energy usage warrantee, as there are no parts of the building that they are unsure of. *Energiesprong* compared this to a car manufacturer giving a performance warrantee on a car that they had only provided parts for, as opposed to a car they had conducted a full service on.

Once the *Energiesprong* retrofit has taken place, performance needs to be monitored required maintenance undertaken. This exact nature and remit of this activity depends on the specifics of the contract agreed with the housing association.

11.2.9 Key resources

The key resources required by the solution provider will depend on how vertically integrated they are.

A major resource is the technological knowhow required to profitably achieve all of the ambitious requirements of an *Energiesprong* retrofit. There are also manufacturing and installation activities that will require the appropriate human and capital resources.

11.2.10 Key partnerships

Almost all of the "Key activities" listed above could be outsourced to partners by the solution provider. In this section we focus on partners that do not directly relate to these key activities.

Insurer

It is possible that the solution provider is a recent start up rather than an established player in the construction industry. It therefore seems important for the long term warranty given by the solution provider to be backed by an insurer in the case of insolvency.

This however, has not been common practise in the Netherlands. *Energiesprong* pointed out that neither is it common practise to receive a long term insurance backed performance warranty on new build properties.

Tenants

Tenants are a key partner in a number of respects.

- Tenant must consent to monitoring of their energy use.

Annexe 1: The Energiesprong business model

- Tenants will be the ultimate users of the solution provider's products. If the solution provider fails to properly consider the tenant then behavioural problems will likely lead to considerably higher costs and potentially undermine energy savings. For example, the solution provider may install a difficult to use heating system which results in the tenant resorting to open windows to regulate temperature.

Regulators

Regulation plays a key role in the feasibility of the *Energiesprong* model.

The ability of social housing organisations to receive additional income from the savings in energy bills is crucial to the financing of the project, but social housing provider's incomes are often highly regulated. In the Netherlands the government has given housing associations explicit permission to charge an "Energy Plan" on net zero energy homes.

11.2.11 Costs

Due to the considerable degree of flexibility regarding the extent of the vertical integration of the solution provider there is ambiguity over the costs directly incurred by the solution provider. We will here assume a fully vertically integrated solution provider for simplicity, however these cost considerations will also apply to less integrated providers in the form of input prices.

Economies of scale

Energiesprong have stated that the cost of an *Energiesprong* retrofit falls considerably with economies of scale. Largely this is because innovation investment can be spread out over many houses: there are fixed costs associated with developing a solution to a building archetype that are not incurred for each additional property refurbished.

Other economies of scale relate to the costs incurred implementing the renovation. This ranges from specialist equipment like 3D laser scanners which can be used for surveying to the training of installation staff. *Energiesprong* has found a major source of cost savings to be the prefabrication of parts such as external wall cladding. Scanning the property means that tailored parts can be manufactured off site, delivered just in time and installed quickly.

Energiesprong have said that they expect further cost savings as providers gain experience. They have provided us with high level cost trajectories based on approximately the first 500 *Energiesprong* retrofits and the providers' further projections.

Figure 34 shows the average cost of providing a single *Energiesprong* retrofit broken down by component.[123] The first two columns show how actual costs have changed so far, the final three columns are predictions showing what costs are expected to be once providers have installed a certain number of retrofits.

Energiesprong have indicated that these figures do not assume that the process is industrialised, or that the supply chain is significantly reorganised. They are based on putting retrofit packages together in a manual way in a streamlined workshop. The interior works include a new kitchen and bathroom.

Figure 34 shows that the average cost of providing an *Energiesprong* retrofit has fallen by over 20% so far and is expects to fall by a similar absolute amount as providers gain experience.

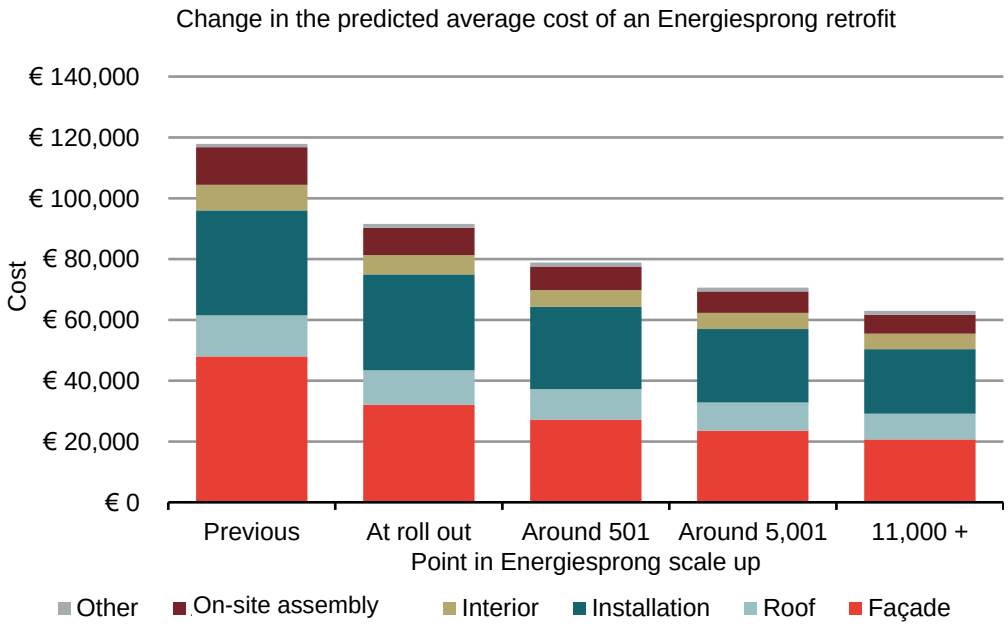
The main cost saving to date has been in the Façade, **Figure 34** shows that this cost has fallen 33% so far, more than all other components combined, and is predicted to fall further.

The main other cost saving predicted to occur is in installation costs. Further training and greater experience should reduce the time it takes to make an installation. This should make it possible to make further retrofits for the same labour costs.

123 This cost is the average of four solution providers in the Netherlands. The breakdown of archetypes is not known.

Annexe 1: The Energiesprong business model

Figure 34. Change in the predicted average cost of an *Energiesprong* retrofit



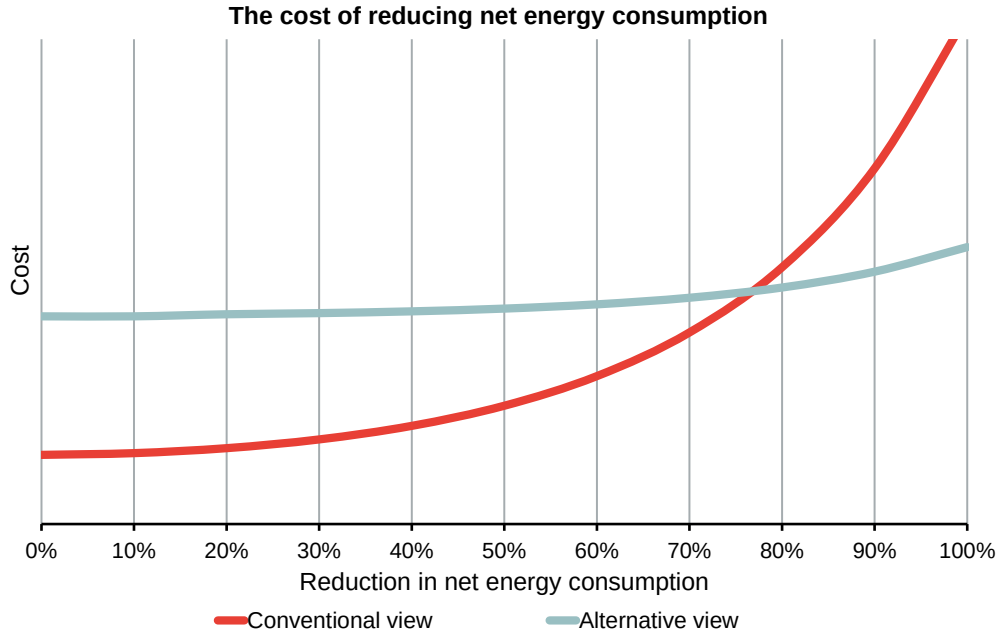
The cost of going from an 80% to an 100% net energy consumption reduction

As described in section 7, existing research in this field suggests that the final measures required to get from an eighty to a one hundred percent reduction in net energy consumption are extremely expensive.

However, *Energiesprong* (the organisation) have said that this is only true for the current model of layering different interventions on top of one another at different times. They argue that if you do a whole-house retrofit as an integrated system, the jump up from 80% to 100% is comparatively cheap. **Figure 35** provides a (purely illustrative) picture of these very different views of retrofit costs.

Annexe 1: The Energiesprong business model

Figure 35. The cost of reducing net energy consumption



Source: Frontier

This illustrates why the "conventional view" would suggest that it is most cost-effective to target reductions of net energy usage of below 100%, while a 100% target could be preferable if the costs of doing so are more in line with the "alternative view" line.

Annexe 1: The Energiesprong business model

Annexe 2: Background on housing regulations

In this annexe, we provide a high-level review of the relevant regulations that apply within London. Regulation of social housing providers within London is undertaken by the Homes and Communities Agency, using a framework that applies to the whole of England.

Social landlords

All social landlords are expected to adhere to "consumer standards". There are four consumer standards, of which the following two are relevant to application of *Energiesprong*:

- Home – physical standards and maintenance services
- Tenant involvement and empowerment – opportunities for tenants to engage with decisions and make complaints

Landlords are required to comply with these standards but the regulator does not actively police them and can only intervene in cases of non-compliance where a serious harm is or may be done to tenants.

Councils that own social housing (and ALMOs that manage council housing) are not bound by these economic standards. Instead they are expected to have regard to the guidance on rents for social housing[124] published by central government. They have discretion not to follow this guidance, but in reality almost all do.

The Welfare Reform and Work Bill currently in Parliament would give a statutory rather than regulatory basis to rent setting for all social landlords. The approach is very different from the current framework.

Housing associations

Housing associations must also adhere to "economic standards". All could pertain to *Energiesprong*, and they cover:

- Governance and viability – effective management of finances and risk, including exposure to liabilities that could call on social housing assets
- Rents – how rents are set and increased

[124] DCLG, Guidance on rents for social housing, available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/313355/14-05-07_Guidance_on_Rents_for_Social_Housing__Final_.pdf

- Value for money – approaches to use of resources to deliver aims, and maximising return on physical assets.

Compliance with these requirements is actively monitored and enforced by the regulator.

It is important to note that many landlords in London, especially those whose tenants currently have the Right to Buy, have a number of leasehold properties mixed in with their social rented stock. Leaseholders are not covered by the social housing regulations. They have separate legal rights enshrined in their individual leases relating to maintenance of the external fabric and communal areas of their buildings. Their liability for the costs of works and their right to be consulted before major works are also covered.

The following sections set out in more detail the restrictions that these regulations impose.

- First, we discuss the **physical standards** part of the consumer standards;
- next, we set out the regulations applying to **tenant involvement and engagement**;
- we then set out the implication of the economic standards on rents and service charges; and
- finally, we describe the **Right to Buy** – this legislation potentially has a significant impact on the *Energiesprong* business model.

Physical standards

All social rented homes are expected to meet the Decent Homes standard. This requires minimum safety standards, a reasonable state of repair, reasonably modern facilities, and appropriate thermal comfort. This is not an "aspirational" standard and does not specify a high level of environmental performance. Many landlords have chosen to exceed the standard, but there is no requirement to do so. As major works programmes to get large numbers of properties up to the standard are now largely complete, all landlords will have a rolling programme of works to maintain compliance as property components age. Some London councils have struggled to undertake the major works required to meet the standard. The Mayor's Decent Homes Backlog fund is supporting these councils in the current financial year.

Tenant involvement and engagement

Landlords are expected to give tenants opportunities to engage with, and influence:

- decisions about management of repairs and maintenance services, including commissioning;
- setting service standards; and
- developing strategic priorities.

Most landlords do have well established tenant groups that participate in specifying and procuring maintenance services. Experience suggests that tenants embrace energy efficiency measures subject to the terms.

Rents and service charges

Rent setting is tightly regulated so landlords' ability to increase rents to recover costs of improvement work is very limited.

Landlords will charge either *Social Rent* or *Affordable Rent* for their social housing – these are described in more detail below.

11.2.12 Current rent setting

The following paragraphs describe the position prior to forthcoming legislative changes to rent setting. It is assumed that the rent setting regime will return to something along the lines set out after 2020.

Social Rent increases are limited to no more than CPI+1% annually. Rent setting is based on a formula, and social landlords may re-calculate the rent after a major improvement. This would allow any identifiable increase in market value to be taken into account to a limited extent. The formula uses 1999 market values as a basis (thus not benefitting from recent London price rises) and would only influence 30% of the rent figure (as the other 70% is based on local earnings). Landlords may set rents above the formula rent by 5%, in consultation with tenants, although again the amount recoverable would be small. There are caps on the maximum rents chargeable, set by size of property. However, most Social Rents are not near these levels.

Affordable Rent is set at up to 80% of the local private rent for a comparable property, and service charges must be included within this figure. Rents can be 'rebased' every five years or sooner if the property is re-let (to a new tenant or the existing one at the end of a fixed term). In-tenancy rent increases are limited to CPI+1% annually. If *Energiesprong* increased the rental valuation of the property then higher rents could be charged. Then additional income (above normal rental inflation) could be gained to cover the cost of the works. This would be subject to the operation of the local market. There is no evidence of correlation between energy performance and willingness to pay higher rent.

Most existing social housing rents are Social rather than Affordable, but there have been quite a large number of conversions from Social to Affordable in the

capital. These will be pepper-potted amongst stock as conversion can only happen when a vacancy occurs. Landlord policies mean Affordable Rents are more likely to be charged on one and two bed properties rather than larger family homes.

11.2.13 Future rent setting

Assuming the Welfare Reform and Work Bill is enacted, Social and Affordable Rents must be cut by 1% each year from April 2016 to March 2020. New rents set in that time should be based on what they would have been if set in the 2015-16 financial year.

11.2.14 Service charges

A service charge is defined in legislation and does allow a charge for maintenance and improvements, though rules are different for leaseholders and tenants. A charge can only be collected if the service is specified in the tenancy agreement or lease.

Landlords can only recover the costs incurred in providing the service and administering the charges. Tenants can challenge what is charged for (charges must be reasonably incurred). Leaseholders must be consulted and have fairly strong rights of challenge.

Leaseholders can be charged a service charge for maintenance to cover works to communal areas, external parts of the building, and to create a sinking fund for major works. Costs must be apportioned to each property, so no occupier pays more than their share. Tenants' service charges would not normally cover maintenance of the fabric of the building. They are more closely focused on additional services such as cleaning and gardening for communal areas, maintenance of lifts and provision of furniture.

It is possible that, under the terms of a standard 'repair, renew, and redecorate' lease (which would affect social tenants as well as leaseholders), high-specification retrofit works may not be deemed 'necessary/reasonably incurred'. These provisions are intended to provide functional boilers, roofs etc.

Where tenants receive housing benefit or Universal Credit housing element to help pay the rent, benefit rules govern what service charges are covered. They specifically exclude maintenance or repairs for the property other than for shared owners.

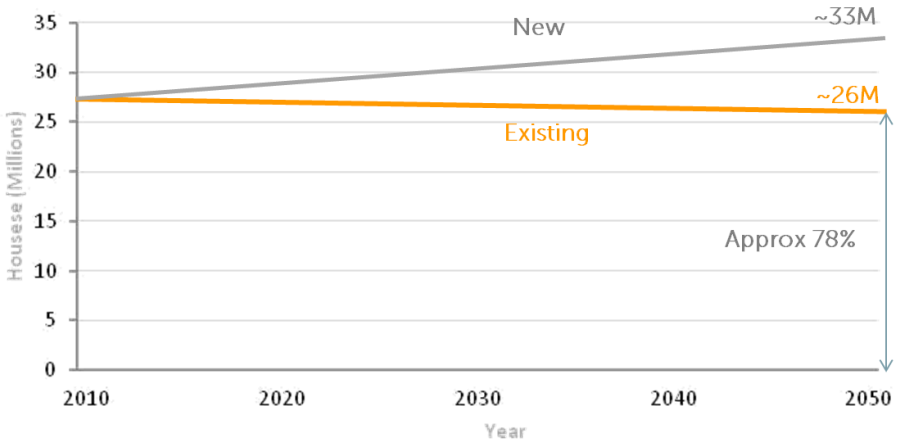
Annexe 2: Background on housing regulations

Annexe 3: The housing stock

This annexe contains the full details of the energy modelling undertaken for this report by UCL Institute for Environmental Design & Engineering. The results of this work are presented in section 7.

Introduction

In the UK, housing is considered to be a major contributor to national greenhouse gas (GHG) emissions, where the technical potential for relatively low cost energy efficiency measures in the sector has been estimated to be 40 $MtCO_2$ savings, with 9-18 $MtCO_2$ per annum considered achievable by 2020 from existing buildings (CCC, 2008). Since approximately 75-85% of the UK domestic stock that will exist in 2050 already exists today, the retrofit of exiting housing has consequently become an important focus of government policies to mitigate climate change (Shrubsole et al., 2014).



New and Existing Housing UK housing stock projections

Source: Barratts Developments (2012)

To help guide policy decisions in this area, in recent years a range of physics-based residential stock energy models have been developed to allow the estimation of the baseline energy demand of the existing stock as well as providing insight on its future demand (Kavgic et al., 2010).In general, models provide a useful mechanism by which to structure thoughts and ideas and provide a framework to aid the understanding of complex datasets. Within the built environment modelling specifically enables the study of transient responses of a building and its energy systems to the climate (Thomas, 2002) and allows for the specification of detailed parameters that influence building performance.

This report presents the findings from the modelling study undertaken by UCL Institute for Environmental Design and Engineering (UCL IEDE) to determine

the potential improvements and savings that could be delivered through the retrofit of sections of the London housing stock through the Energiesprong programme.

11.2.15 Modelling Objectives

The modelling exercise aims to quantify the effect of energy efficiency improvements (retrofit packages) as in comparison to the performance of the current "base-case" as applied to a number of defined London housing archetypes. To enable this, the following objectives can be defined:

- to generate a set of typical geometric forms (archetypes) frequently occurring in the London social housing stock;
- to specify a number of plausible fabric efficiency retrofit scenarios and associated construction
- element configurations;
- to simulate the thermal performance of the defined archetypes at hourly resolution using a specifically developed front-end to existing validated dynamic thermal modelling package;
- to assess the potential improvements and savings that could be delivered through the retrofit of sections of the London housing stock; and
- to highlight further areas on investigation required to inform the implementation of a wide-scale retrofit programme in London.

Study Methodology

This analysis has been produced using (EpGen-2), a computer tool developed by UCL. This allows for the simulation of the effect of a variety of energy efficiency improvements on a number of energy metrics – including energy consumption. The process undertaken (discussed in detail below) involved the implementation of the following steps:

1. Analysis of UCL London dwelling archetypes to define those most relevant to the social housing stock - -London Archetypes (Section 2.1).
2. Tailoring of London Archetypes and definition of "base-case" building characteristics (see Section 2.3).
3. Formulation of retrofit packages and specification of "basic" and "enhanced" and "enhanced plus" building characteristics (Section 2.2).
4. Construction of London archetype geometries/characteristics in EPGen-2 environment (Section 2.3)

Annexe 3: The housing stock

5. Implementation of "base-case" modelling runs to calculate the baseline energy metrics
6. Implementation of "Basic" and "Enhanced" runs to evaluate the potential level of improvement and energy savings generated by the application of packages of improvements to the current London social housing stock.
7. In depth analysis of "Enhanced Plus" package for identified archetype H15 (Block of Flats- Single Facing).

11.2.16 Development of GLA-UCL London Archetypes

To assist in the large scale domestic modelling for applications relevant to energy efficiency, thermal comfort and indoor air quality, UCL has developed models that generate a set of representative housing archetypes for both London and the UK. The methodology for the generation of these statistically representative dwelling archetypes was based on the statistical analysis of a number of databases which includes:

- National housing surveys, such as the DCLG English Housing Survey (EHS) and the Energy Saving Trust (EST) Homes Energy Efficiency Database (HEED);
- Geographic Information System (GIS) databases, such as the ones provided by the Ordnance Survey and The Geo-Information Group; and
- Other sources of information on housing stock characteristics (e.g. Reduced Standard Assessment Procedure RdSAP for the Energy Rating of Dwellings).

For the London dwelling archetypes used in this study, the process described above was followed for the construction of 27 London dwelling archetypes (Oikonomou et al., 2012). Data on building form and construction age for the London housing stock were derived from two Geographic Information System (GIS) databases: Ordnance Survey MasterMap Topography Layer, and Cities Revealed.

Built form and construction data at the individual building level were available for only 29% of the Greater London Area household spaces. Amongst 92 different built form and dwelling age combinations identified, the 15 most common were selected for simulation. This excluded house types with occurrence of less than 1.5%. The set of 15 represents approximately 76% of the housing stock in the area under examination, and many of the excluded dwelling types were similar in built form and age to these 15, characteristics of which are described in Appendix 7.1 of this report.

As one of the Principles of the Energiesprong approach requires *"a volume with a homogenous typology"* (Energiesprong, 2015), a further analysis of ONS data was

carried out to determine prevalence various house types within the London stock housing stock (Table 1) and map these onto the UCL archetypes. As a result of this, a subset of 13 were selected for analysis. Furthermore to provide a more holistic analysis, multi-unit archetypes within this subset were sub-divided into ground floor, mid-floor and top-floor flats (denoted by G,M,T suffix). This approach helped the modelling focus on the archetypes ideal for the implementation of Energiesprong in London[125].

Prevalence of house types in London social housing stock

	Social rented		
	Rented from council (local authority)	Other social rented	Total
Detached whole house or bungalow	1.3%	1.2%	2.5%
Semi-detached whole house or bungalow	4.8%	3.9%	8.8%
Terraced whole house or bungalow (including end-terrace)	7.3%	7.3%	14.6%
A flat, maisonette or apartment that is in a purpose-built block of flats or tenement	39.1%	24.9%	64.0%
A flat, maisonette or apartment that is part of a converted or shared house (including bed-sits)	3.1%	6.3%	9.4%
A flat, maisonette or apartment that is in a commercial building (for example, in an office building, hotel, or over a shop)	0.3%	0.2%	0.5%
A caravan or other mobile or temporary structure	0.0%	0.0%	0.1%
Remainder *	0.1%	0.1%	0.1%

Analysed Archetypes

Code	Building Type	Geometry
H01	Terraced House with Large T	(i)
H02	Simple Terraced	(ii)
H04-G	Block of Flats- External Corridor	(iv)
H04-M	Block of Flats- External Corridor	(iv)
H04-T	Block of Flats- External Corridor	(iv)
H05	Simple Terraced	(ii)
H06-G	Block of Flats - Double Facing	(v)
H06-M	Block of Flats - Double Facing	(v)
H06-T	Block of Flats - Double Facing	(v)
H07-G	Block of Flats- External Corridor	(iv)
H07-M	Block of Flats- External Corridor	(iv)
H07-T	Block of Flats- External Corridor	(iv)

[125] As a result of this analysis house types with low prevalence were excluded, even if significant savings might have been achieved through their refurbishment.

Annexe 3: The housing stock

H10	Simple Terraced	(ii)
H11-G	Block of Flats - Single Facing	(viii)
H11-M	Block of Flats - Single Facing	(viii)
H11-T	Block of Flats - Single Facing	(viii)
H12-G	Block of Flats - Single Facing	(viii)
H12-M	Block of Flats - Single Facing	(viii)
H12-T	Block of Flats - Single Facing	(viii)
H13	Simple Terraced House With Shop	(ix)
H14	Simple Terraced	(ii)
H15-G	Block of Flats - Single Facing	(viii)
H15-M	Block of Flats - Single Facing	(viii)
H15-T	Block of Flats - Single Facing	(viii)

Key:

Single Unit Archetypes

Multi Unit Archetypes

A range of retrofit packages were defined for these archetypes, as described in section 7.2.

11.2.17 Modelling Environment: EpGen-2 and EnergyPlus

To facilitate the simulation of such a large number of building archetypes/improvement package combinations in time effective manner, EnergyPlus Generator 2 (EpGen-2) a novel Python-based interface to EnergyPlus for automated batch mode runs was used for data input (Biddulph et al., 2015). The simulation engine used to implement modelling runs -EnergyPlus- is a complex tool based on systems simulation modules integrated with a heat balance-based zone simulation in which analysis is performed at time steps of less than an hour (USDOE, 2010).

As a multi-platform, open source tool, EnergyPlus has been extensively validated through a series of analytical, comparative and release/executable tests. This approach is considered to provide more flexibility and realism than what many standard domestic energy models use (e.g. the 2-zone configuration used in SAP and BREDEM). With regard to the EnergyPlus calculation core, as a multi-platform, open source tool, EnergyPlus has been extensively validated. It is important to note that testing using industry standard methods is a significant part of its ongoing development. The testing regime that has been applied in the validation process of Energyplus is summarised in Appendix 7.2 of this report.

In total, over 300 simulations for the various archetypes (4 orientations per archetype, with top, mid and ground floor variations for blocks of flats) were run. To reduce processing time, the UCL Legion High Performance Computing Facility (Legion@UCL) which provides a large number of cores (> 7500 CPU

cores + 7168 CUDA cores) for high spec computing was used to implement modelling runs.

The results of this modelling are presented in section 7.2.

11.2.18 Limitations of the study

In interpreting the outputs that result from any modelling exercise it is important to identify the associated constraints and limitations and their impact. The main types of uncertainties that can be associated with this exercise can be listed as:

- **Epistemic uncertainty:** These are systematic sources of error that may arise from limitations in the calculation process of a particular modelling engine as well as uncertainties in the data input process due to the quality of the available data, in the data inference process of missing variables and in the validation process due to the lack of data. While, the first aspect is a product of the inherent limitations of any calculation technique, errors produced by limitations falling in the last three categories can be addressed through the collection of better quality data to increase the reliability of the model output.

- **Aleatoric uncertainty:** This mainly arises from variations in results that are attributed to the human factor, for example when occupants behave in a way that significantly deviates from the patterns assumed by the model and data available.

Next Steps

The scope of work defined for this study aimed to focus on assessing the potential impact of the installation of retrofit packages on energy performance. To provide a more holistic analysis of the potential, impact and risks associated with the introduction of a mass-scale retrofit programme such as Energiesprong the following areas of investigation are proposed.

11.2.19 Sensitivity Analysis of Retrofit Measures

Sensitivity analysis is an analytical testing approach that provides an individual/local measure of sensitivity of each output variable to each input variable, which in the context of retrofit packages refer to the impact of the single measures incorporated into these packages. Sensitivity analysis can be used to (Das et al., 2014):

- Understand how well we can constrain an output variable from the measurements of the input variables.

- Define input variables in need of more accurate measurements to reduce output variable uncertainty.

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- Identify which input variables are important for the output variable.

The Monte Carlo analysis can be used to explore the sensitivity of a complex system by varying parameters within statistical constraints and is a viable tool where there is a lot of uncertainty and variability with input parameters (Soratana and Marriott, 2010). The main limitation of sensitivity analysis in general is that such analysis typically involves the perturbation of one or perhaps two parameters at a time in isolation. But in the real world, uncertainty is driven by the interaction of many variables and corresponding parameters (Jaffe and Stavins, 2007). MSCA overcomes this issue but it can lead to misleading results if inappropriate inputs are entered into the model and does not directly provide the precise insights that analytical methods might (e.g. it cannot reveal cause-and-effect relationships).

11.2.20 Optimisation of Retrofit Packages

Optimisation refers to the use of advanced computational search methods to help in finding optimal design solutions more efficiently, i.e. finding the best out of all feasible solutions in a given system through the generation of a large number of design alternatives, examining them and choosing the best ones (Nguyen et al., 2014). As a method, optimisation has been used in various studies for such aspects as load distribution, building systems, construction materials and building form to improve building performance. Further analysis involving parametric simulations can lead to the improvement of the design of retrofit packages and the identification of those that provide the optimal solution under specified constraints (e.g. a cost price point).

11.2.21 Mitigating Unintended Consequences: Overheating Risk, Thermal Bridging & Moisture Modelling

While current policy promotes the application of a variety of energy efficiency measures to a diverse building stock, research suggest that there is a tremendous risk that large-scale, rapid transformation of the stock may fail to take into account the complex interactions between the various physical components of a residential building and will likely lead to a wide range of 'side-effects' to the solution. These side effects are often referred to as *unintended consequences* which can be defined as "outcomes that arise unintentionally as a result of policy, development or implementation" (Shrubsole et al., 2014). As this is likely to be exacerbated in the future due to climate change, further analysis to determine the impact of a wide-scale retrofit programmes should include the assessment of the following aspects:

Assessing Overheating Risk: An assessment of the risk of summer overheating should be undertaken to quantify the proportion of dwellings with a slight, medium and high risk and provide some indication of the potential risks that exist in a number of selected dwelling / household type combinations. Various

approaches (using either simplified or sophisticated modelling techniques) may be implemented to analyse specific house types and circumstances (Mavrogianni, 2012).

Thermal Bridging Analysis: The occurrence of thermal bridges when energy efficiency measurements such as external insulation are applied should be assessed for a number of building details. Low temperatures on the internal surface of thermal bridges usually occur in cold months. Internal surfaces with low temperature may result in surface condensation, interstitial condensation or mould growth. Various calculation methods/tools such as 'TRISCO' (Physibel, 2015) may be used for the prediction of surface temperature. This is a steady-state heat transfer tool based on the finite difference method.

Assessing Mould Growth Risk: The risk of mould growth may also be assessed according to the performance criteria for the control of mould introduced as part of the ventilation regulations for England (HMSO, 2015).The criteria, stated in the Approved Document F 2010 (2010 edition incorporating 2010 and 2013 amendments), have established limiting values of air relative humidity (RH) and water activity to be met if mould growth on external walls is to be avoided.

11.2.22 Understanding the Human Factor: Assessing "Take Back"

Previous research on the impact of improving the energy efficiency of dwellings suggest that they result in increases in indoor temperature as opposed to lower energy consumption in what is referred to as the 'temperature take back factor' (Hamilton et al., 2011). To account for the impact of this, UCL has developed an empirically derived algorithm relating notional energy consumption, actual energy consumption and income which may be applied in further analysis to reflect this and simulate the effect of comfort take and underperformance – a known phenomenon following energy efficiency improvements.

11.2.23 Acknowledgements

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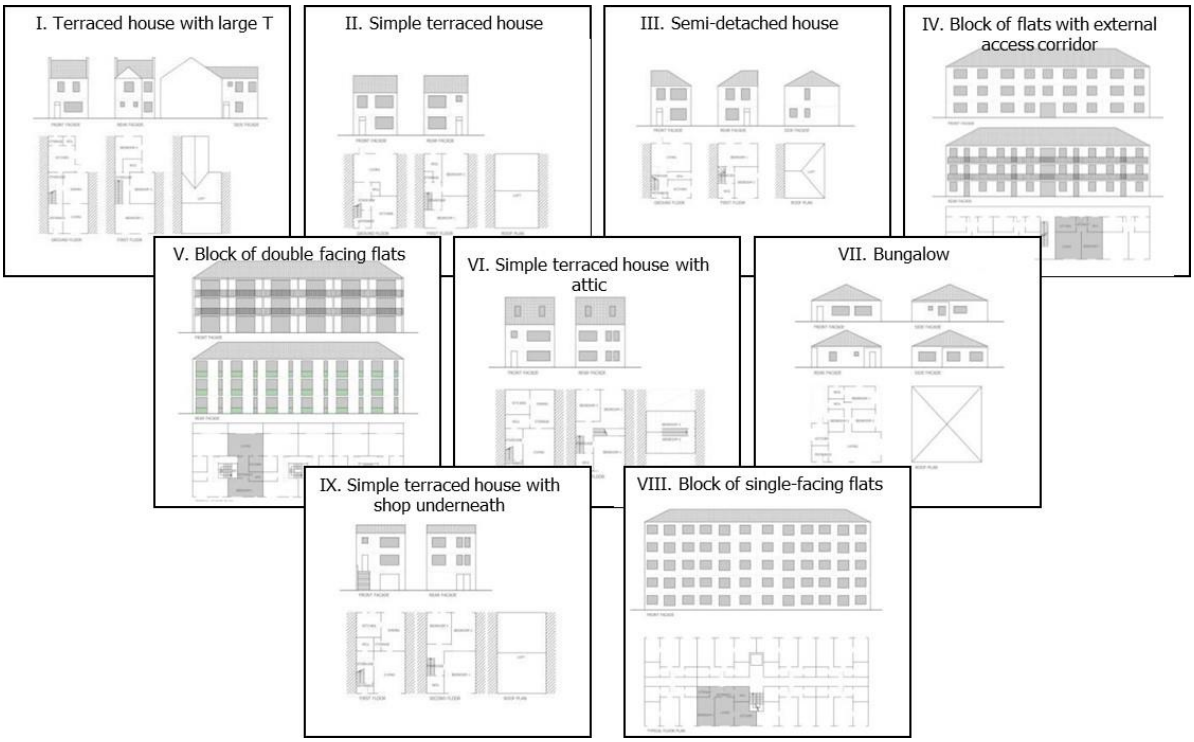
Modelling appendices

11.2.25 Archetype Characteristics



House type	Building type	Building type variation	Approximate age band	Infiltration rate (ac/h@50Pa)	Percentage of occurrence
H01	I	-	1902-1913	10.5	15.4%
H02	II	A	1914-1945	15	14.5%
H03	III	-	1914-1945	16	8.8%
H04	IV	-	1960-1979	14.15	5.7%
H05	II	C	1902-1913	10.5	5.5%
H06	V	-	1946-1959	16.2	4.7%
H07	IV	-	1980-2008	10.05	3.6%
H08	IV	-	1902-1913	10.5	2.9%
H09	VII	-	1914-1945	15	2.5%
H10	II	B	1960-1979	14.15	2.4%
H11	VIII	-	1960-1979	14.15	2.3%
H12	VIII	-	1914-1945	15	2.1%
H13	IX	-	1980-2008	10.05	2.1%
H14	II	A*	1946-1959	16.2	1.9%
H15	VIII	-	1946-1959	16.2	1.8%

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	Building Type	Building Type	Age Band	Walls (as built)	Walls (after retrofit)	Roof (as built)	Roof (after built)	Floor (as built)	Floor (after retrofit)	Windows (as built)	Windows (after retrofit)	Infiltration (ac/h@50P	Heating	Ventillation
H01	Terraced House with Large T	O	1902-1913	Solid brick, Wall thickness: 230mm, Insulation: NO, U-value=2.10, Percentage: 85%	Solid brick, Wall thickness: 230mm, Insulation: YES, U-value=0.60, Percentage: 15%	Pitched, Loft: YES, Loft insulation: YES, Insulation thickness: 100mm, U-value=0.40, Percentage: 90%	Loft: YES, Loft insulation: YES, Insulation thickness: 270mm, U-value=0.15, Percentage: 10%	Insulation thickness: 0mm, U-value: 1.20, Percenage: 95%	Insulation thickness: 25mm, U-value: 0.51, Percenage: 5%	Single-glazed, U-value: 4.8, Percentage: 30%	Double-glazed UPVC, U-value: 2.0, Percentage: 70%	10.5	Gas fired boiler (>12 years old)	Natural ventilation + Heat
H02	Simple Terraced	A	1914-1945	Solid brick, Wall thickness: 230mm, Insulation: NO, U-value=2.10, Percentage: 85%	Solid brick, Wall thickness: 230mm, Insulation: YES, U-value=0.60, Percentage: 15%	Pitched, Loft: YES, Loft insulation: YES, Insulation thickness: 100mm, U-value=0.40, Percentage: 90%	Loft: YES, Loft insulation: YES, Insulation thickness: 270mm, U-value=0.15, Percentage: 10%	Insulation thickness: 0mm, U-value: 1.20, Percenage: 95%	Insulation thickness: 25mm, U-value: 0.51, Percenage: 5%	Single-glazed, U-value: 4.8, Percentage: 30%	Double-glazed UPVC, U-value: 2.0, Percentage: 70%	15	Gas fired boiler (>12 years old)	Natural Ventilation
H03	Semi-Detached	O	1914-1945	Solid brick, Wall thickness: 230mm, Insulation: NO, U-value=2.10, Percentage: 85%	Solid brick, Wall thickness: 230mm, Insulation: YES, U-value=0.60, Percentage: 15%	Loft: YES, Loft insulation: YES, Insulation thickness: 100mm, U-value=0.40, Percentage: 90%	Loft: YES, Loft insulation: YES, Insulation thickness: 270mm, U-value=0.15, Percentage: 10%	Insulation thickness: 0mm, U-value: 1.20, Percenage: 95%	Insulation thickness: 25mm, U-value: 0.51, Percenage: 5%	Single-glazed, U-value: 4.8, Percentage: 30%	Double-glazed UPVC, U-value: 2.0, Percentage: 70%	16	Gas fired boiler (>12 years old)	Natural Ventilation
H04	Block of Flats - External Corridor	O	1960-1979	Cavity wall, Wall thickness: ..., insulation: NO, U-value=1.60, Percentage: 45%	Cavity wall, Wall thickness: ..., insulation: YES, U-value=0.50, Percentage: 55%	Pitched, Loft: YES, Loft insulation: YES, Insulation thickness: 100mm, U-value=0.40, Percentage: 90%	Loft: YES, Loft insulation: YES, Insulation thickness: 270mm, U-value=0.15, Percentage: 10%	Insulation thickness: 0mm, U-value: 1.20, Percenage: 95%	Insulation thickness: 25mm, U-value: 0.51, Percenage: 5%	Double-glazed UPVC, U-value: 3.1, Percentage: 30%	Double-glazed UPVC, U-value: 2, Percentage: 70%	14.5	Gas fired boiler (>12 years old)	Natural Ventilation
H05	Simple Terraced	C	1902-1913	Solid brick, Wall thickness: 230mm, Insulation: NO, U-value=2.10, Percentage: 85%	Solid brick, Wall thickness: 230mm, Insulation: YES, U-value=0.60, Percentage: 15%	Loft: YES, Loft insulation: YES, Insulation thickness: 100mm, U-value=0.40, Percentage: 90%	Loft: YES, Loft insulation: YES, Insulation thickness: 270mm, U-value=0.15, Percentage: 10%	Insulation thickness: 0mm, U-value: 1.20, Percenage: 95%	Insulation thickness: 25mm, U-value: 0.51, Percenage: 5%	Single-glazed, U-value: 4.8, Percentage: 30%	Double-glazed UPVC, U-value: 2.0, Percentage: 70%	10.5	Gas fired boiler (>12 years old)	Natural Ventilation
H06	Block of Flats - Double Facing	O	1946-1959	Solid brick, Wall thickness: 230mm, Insulation: NO, U-value=2.10, Percentage: 85%	Solid brick, Wall thickness: 230mm, Insulation: YES, U-value=0.60, Percentage: 15%	Pitched, Loft: YES, Loft insulation: YES, Insulation thickness: 100mm, U-value=0.40, Percentage: 90%	Loft: YES, Loft insulation: YES, Insulation thickness: 270mm, U-value=0.15, Percentage: 10%	Insulation thickness: 0mm, U-value: 1.20, Percenage: 95%	Insulation thickness: 25mm, U-value: 0.51, Percenage: 5%	Single-glazed, U-value: 4.8, Percentage: 30%	Double-glazed UPVC, U-value: 2.0, Percentage: 70%	16.2	Gas fired boiler (>12 years old)	Natural Ventilation
H07	Block of Flats - External Corridor	O	1980-2008	Cavity wall, Wall thickness: ..., insulation: YES, U-value=0.45/0.35, Percentage:	Cavity wall, Wall thickness: ..., insulation: YES, U-value=0.45/0.35, Percentage:	Pitched, Loft: YES, Loft insulation: YES, Insulation thickness: 150mm, U-value=0.29, Percentage: 90%	Loft: YES, Loft insulation: YES, Insulation thickness: 270mm, U-value=0.15, Percentage: 10%	Insulation thickness: 25mm, U-value: 0.45/0.25, Percenage: 35% / 65%	Insulation thickness: 25mm, U-value: 0.45/0.25, Percenage: 35% / 65%	Double-glazed UPVC, U-value: 3.1, Percentage: 30%	Double-glazed UPVC, U-value: 2, Percentage: 70%	10.05	Gas fired boiler (>12 years old)	Natural Ventilation
H08	Block of Flats - External Corridor	O	1902-1913	Solid brick, Wall thickness: 230mm, Insulation: NO, U-value=2.10, Percentage: 85%	Solid brick, Wall thickness: 230mm, Insulation: YES, U-value=0.60, Percentage: 15%	Pitched, Loft: YES, Loft insulation: YES, Insulation thickness: 100mm, U-value=0.40, Percentage: 90%	Loft: YES, Loft insulation: YES, Insulation thickness: 270mm, U-value=0.15, Percentage: 10%	Insulation thickness: 0mm, U-value: 1.20, Percenage: 95%	Insulation thickness: 25mm, U-value: 0.51, Percenage: 5%	Single-glazed, U-value: 4.8, Percentage: 30%	Double-glazed UPVC, U-value: 2.0, Percentage: 70%	10.05	Gas fired boiler (>12 years old)	Natural Ventilation
H09	Bungalow	O	1914-1945	Solid brick, Wall thickness: 230mm, Insulation: NO, U-value=2.10, Percentage: 85%	Solid brick, Wall thickness: 230mm, Insulation: YES, U-value=0.60, Percentage: 15%	Pitched, Loft: NO, Loft insulation: NO, Insulation thickness: 0mm, U-value=2.30, Percentage: 90%	Loft: NO, Loft insulation: NO, Insulation thickness: 270mm, U-value=0.15, Percentage: 10%	Insulation thickness: 0mm, U-value: 1.20, Percenage: 95%	Insulation thickness: 25mm, U-value: 0.51, Percenage: 5%	Single-glazed, U-value: 4.8, Percentage: 30%	Double-glazed UPVC, U-value: 2.0, Percentage: 70%	15	Gas fired boiler (>12 years old)	Natural Ventilation
H10	Simple Terraced	B	1960-1979	Cavity wall, Wall thickness: ..., insulation: NO, U-value=1.60, Percentage: 45%	Cavity wall, Wall thickness: ..., insulation: YES, U-value=0.50, Percentage: 55%	Pitched, Loft: YES, Loft insulation: YES, Insulation thickness: 100mm, U-value=0.40, Percentage: 90%	Loft: YES, Loft insulation: YES, Insulation thickness: 270mm, U-value=0.15, Percentage: 10%	Insulation thickness: 0mm, U-value: 1.20, Percenage: 95%	Insulation thickness: 25mm, U-value: 0.51, Percenage: 5%	Double-glazed UPVC, U-value: 3.1, Percentage: 30%	Double-glazed UPVC, U-value: 2, Percentage: 70%	14.5	Gas fired boiler (>12 years old)	Natural Ventilation
H11	Block of Flats - Single Facing	O	1960-1979	Cavity wall, Wall thickness: ..., insulation: NO, U-value=1.60, Percentage: 45%	Cavity wall, Wall thickness: ..., insulation: YES, U-value=0.50, Percentage: 55%	Pitched, Loft: NO, Loft insulation: NO, Insulation thickness: 12mm, U-value=1.50, Percentage: 90%	Loft: NO, Loft insulation: NO, Insulation thickness: 270mm, U-value=0.15, Percentage: 10%	Insulation thickness: 0mm, U-value: 1.20, Percenage: 95%	Insulation thickness: 25mm, U-value: 0.51, Percenage: 5%	Double-glazed UPVC, U-value: 3.1, Percentage: 30%	Double-glazed UPVC, U-value: 2, Percentage: 70%	14.5	Gas fired boiler (>12 years old)	Natural Ventilation
H12	Block of Flats - Single Facing	O	1914-1945	Solid brick, Wall thickness: >230mm, Insulation: NO, U-value=2.10, Percentage: 85%	Solid brick, Wall thickness: >230mm, Insulation: YES, U-value=0.60, Percentage: 15%	Pitched, Loft: NO, Loft insulation: NO, Insulation thickness: 0mm, U-value=2.30, Percentage: 90%	Loft: NO, Loft insulation: NO, Insulation thickness: 270mm, U-value=0.15, Percentage: 10%	Insulation thickness: 0mm, U-value: 1.20, Percenage: 95%	Insulation thickness: 25mm, U-value: 0.51, Percenage: 5%	Single-glazed, U-value: 4.8, Percentage: 30%	Double-glazed UPVC, U-value: 2.0, Percentage: 70%	15	Gas fired boiler (>12 years old)	Natural Ventilation
H13	Simple Terraced House With Shop	O	1980-2008	Cavity wall, Wall thickness: ..., insulation: YES, U-value=0.45/0.35, Percentage:	Cavity wall, Wall thickness: ..., insulation: YES, U-value=0.45/0.35, Percentage:	Pitched, Loft: YES, Loft insulation: YES, Insulation thickness: 150mm, U-value=0.29, Percentage: 90%	Loft: YES, Loft insulation: YES, Insulation thickness: 270mm, U-value=0.15, Percentage: 10%	Insulation thickness: 25mm, U-value: 0.45/0.25, Percenage: 35% / 65%	Insulation thickness: 25mm, U-value: 0.45/0.25, Percenage: 35% / 65%	Double-glazed UPVC, U-value: 3.1, Percentage: 30%	Double-glazed UPVC, U-value: 2, Percentage: 70%	10.05	Gas fired boiler (>12 years old)	Natural Ventilation
H14	Simple Terraced	A*	1946-1959	Solid brick, Wall thickness: 230mm, Insulation: NO, U-value=2.10, Percentage: 85%	Solid brick, Wall thickness: 230mm, Insulation: YES, U-value=0.60, Percentage: 15%	Pitched, Loft: YES, Loft insulation: YES, Insulation thickness: 100mm, U-value=0.40, Percentage: 90%	Loft: YES, Loft insulation: YES, Insulation thickness: 270mm, U-value=0.15, Percentage: 10%	Insulation thickness: 0mm, U-value: 1.20, Percenage: 95%	Insulation thickness: 25mm, U-value: 0.51, Percenage: 5%	Single-glazed, U-value: 4.8, Percentage: 30%	Double-glazed UPVC, U-value: 2.0, Percentage: 70%	16.2	Gas fired boiler (>12 years old)	Natural Ventilation
H15	Block of Flats - Single Facing	O	1946-1959	Solid brick, Wall thickness: >230mm, Insulation: NO, U-value=2.10, Percentage: 85%	Solid brick, Wall thickness: >230mm, Insulation: YES, U-value=0.60, Percentage: 15%	Pitched, Loft: NO, Loft insulation: NO, Insulation thickness: 0mm, U-value=2.30, Percentage: 90%	Loft: NO, Loft insulation: NO, Insulation thickness: 270mm, U-value=0.15, Percentage: 10%	Insulation thickness: 0mm, U-value: 1.20, Percenage: 95%	Insulation thickness: 25mm, U-value: 0.51, Percenage: 5%	Single-glazed, U-value: 4.8, Percentage: 30%	Double-glazed UPVC, U-value: 2.0, Percentage: 70%	16.2	Gas fired boiler (>12 years old)	Natural Ventilation

11.2.27 Validation and verification of the EpGen calculation core

With regard to the EpGen calculation core, as a multi-platform, open source tool, EnergyPlus has been extensively validated. It is important to note that testing using industry standard methods is a significant part of the ongoing development EnergyPlus, with the aim of ensuring that it is as bug-free as possible. The testing regime that has been applied to in the validation process of Energyplus in summarised in Appendix xx of this report. Three major tests types have been conducted:

- Analytical tests:
  - HVAC tests, based on ASHRAE Research Project 865
  - Building fabric tests, based on ASHRAE Research Project 1052
- Comparative tests:
  - ANSI/ASHRAE Standard 140-2011
  - International Energy Agency Solar Heating and Cooling Programme (IEA SHC) BESTest (Building Energy Simulation Test) methods not yet in Standard 140
  - EnergyPlus HVAC Component Comparative tests
  - EnergyPlus Global Heat Balance tests
- Release and executable tests

With regards to the specific version of EnergyPlus utilised in the modelling framework (v 8.1) , the full validation reports and detailed relevant results are available on the Department of Energy portal for the tool (http://apps1.eere.energy.gov/buildings/energyplus/energyplus_testing.cfm).

11.2.28 Retrofit improvement packages

i. Basic

	Building Type	Building Type Variation	Age Band	Walls	Roof	Floor	Windows	Doors	Airtightness Improvements	Heating	Ventillation
H01	Terraced House with Large T	O	1902-1913	U-value: 0.2 (EWI 100mm, IWI thin high performance front façade, no insulation to reveals, use easily removable solutions around window and	U-Value: 0.15 Top up loft insulation to 300mm	No Change	G-Value: 2.0 Secondary Glazing & Draughtproofing	Draughtproofing	8	Replace Boiler + 50MM HWTank Insulation	Natural ventilation + Heat Recovery Extract Fansin kitchen/bathrooms
H02	Simple Terraced	A	1914-1945	U-value: 0.2 (EWI 100mm, IWI thin high performance front façade, no insulation to reveals, use easily removable solutions around window and door reveals EWI to	U-Value: 0.15 Top up loft insulation to 300mm	No Change	G-Value: 2.0 Secondary Glazing & Draughtproofing	Draughtproofing	8	Replace Boiler + 50MM HWTank Insulation	Natural ventilation + Heat Recovery Extract Fansin kitchen/bathrooms
H03	Semi-Detached	O	1914-1945	U-value: 0.2 (EWI 100mm, IWI thin high performance front/side façade, no insulation to reveals, use easily removable	U-Value: 0.15 Top up loft insulation to 300mm	No Change	G-Value: 2.0 Secondary Glazing & Draughtproofing	Draughtproofing	8	Replace Boiler + 50MM HWTank Insulation	Natural ventilation + Heat Recovery Extract Fansin kitchen/bathrooms
H04	Block of Flats- External Corridor	O	1960-1979	U-Value: 0.15 (CWI+EWI), 0.2 (EWI only)EWI + CWI where possibleno insulation to reveals, use easily removable	U-Value: 0.15 Top up loft insulation to 300mm	No Change	No Change	Draughtproofing	7	Replace Boiler + 50MM HWTank Insulation	Natural ventilation + Heat Recovery Extract Fansin kitchen/bathrooms
H05	Simple Terraced	C	1902-1913	U-value: 0.2 (EWI 100mm, IWI thin high performance front façade, no insulation to reveals, use easily	U-Value: 0.15 Top up loft insulation to 300mm	No Change	G-Value: 2.0 Secondary Glazing & Draughtproofing	Draughtproofing	8	Replace Boiler + 50MM HWTank Insulation	Natural ventilation + Heat Recovery Extract Fansin kitchen/bathrooms
H06	Block of Flats- Double Facing	O	1946-1959	U-Value: 0.15 (CWI+EWI), 0.2 (EWI only)EWI + CWI where possibleno insulation to reveals,	U-Value: 0.15 Top up loft insulation to 300mm	No Change	No Change	Draughtproofing	7	Replace Boiler + 50MM HWTank Insulation	Natural ventilation + Heat Recovery Extract Fansin kitchen/bathrooms
H07	Block of Flats- External Corridor	O	1980-2008	U-Value: 0.15 (CWI+EWI), 0.2 (EWI only)EWI + CWI where possibleno insulation to reveals,	U-Value: 0.15 Top up loft insulation to 300mm	No Change	No Change	Draughtproofing	7	Replace Boiler + 50MM HWTank Insulation	Natural ventilation + Heat Recovery Extract Fansin kitchen/bathrooms
H08	Block of Flats- External Corridor	O	1902-1913	U-Value: 0.2 IWI thin high performance throughoutno insulation to reveals, use easily removable	U-Value: 0.15 Top up loft insulation to 300mm	No Change	G-Value: 2.0 Secondary Glazing & Draughtproofing	Draughtproofing	8	Replace Boiler + 50MM HWTank Insulation	Natural ventilation + Heat Recovery Extract Fansin kitchen/bathrooms
H09	Bungalow	O	1914-1945	U-Value: 0.15 (CWI+EWI), 0.2 (EWI only)EWI + CWI where possibleno insulation to reveals,	U-Value: 0.15 Top up loft insulation to 300mm	No Change	No Change	Draughtproofing	8	Replace Boiler + 50MM HWTank Insulation	Natural ventilation + Heat Recovery Extract Fansin kitchen/bathrooms
H10	Simple Terraced	B	1960-1979	U-Value: 0.15 (CWI+EWI), 0.2 (EWI only)EWI + CWI where possibleno insulation to reveals,	U-Value: 0.15 Top up loft insulation to 300mm	No Change	No Change	Draughtproofing	7	Replace Boiler + 50MM HWTank Insulation	Natural ventilation + Heat Recovery Extract Fansin kitchen/bathrooms
H11	Block of Flats- Single Facing	O	1960-1979	U-Value: 0.15 (CWI+EWI), 0.2 (EWI only)EWI + CWI where possibleno insulation to reveals,	U-Value: 0.15 Top up loft insulation to 300mm	No Change	No Change	Draughtproofing	7	Replace Boiler + 50MM HWTank Insulation	Natural ventilation + Heat Recovery Extract Fansin kitchen/bathrooms
H12	Block of Flats- Single Facing	O	1914-1945	U-value: 0.2 (EWI 100mm, IWI thin high performance front/side façade, no insulation to reveals, use easily removable	U-Value: 0.15 Top up loft insulation to 300mm	No Change	G-Value: 2.0 Secondary Glazing & Draughtproofing	Draughtproofing	8	Replace Boiler + 50MM HWTank Insulation	Natural ventilation + Heat Recovery Extract Fansin kitchen/bathrooms
H13	Simple Terraced House With Shop	O	1980-2008	U-Value: 0.15 (CWI+EWI), 0.2 (EWI only)EWI + CWI where possibleno insulation to reveals,	U-Value: 0.15 Top up loft insulation to 300mm	No Change	No Change	Draughtproofing	7	Replace Boiler + 50MM HWTank Insulation	Natural ventilation + Heat Recovery Extract Fansin kitchen/bathrooms
H14	Simple Terraced	A*	1946-1959	U-Value: 0.15 (CWI+EWI), 0.2 (EWI only) EWI + CWI where possible no insulation to reveals,	U-Value: 0.15 Top up loft insulation to 300mm	No Change	No Change	Draughtproofing	7	Replace Boiler + 50MM HWTank Insulation	Natural ventilation + Heat Recovery Extract Fansin kitchen/bathrooms
H15	Block of Flats- Single Facing	O	1946-1959	U-Value: 0.15 (CWI+EWI), 0.2 (EWI only)EWI + CWI where possibleno insulation to reveals,	U-Value: 0.15 Top up loft insulation to 300mm	No Change	No Change	Draughtproofing	7	Replace Boiler + 50MM HWTank Insulation	Natural ventilation + Heat Recovery Extract Fansin kitchen/bathrooms

Annexe 3: The housing stock

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