# DEFINING A FABRIC ENERGY EFFICIENCY STANDARD

## FOR ZERO CARBON HOMES

**Executive Summary of**
**Task Group Recommendations**
**November 2009**

## Zero Carbon Hub

The full report 'Defining a Fabric Energy Efficiency Standard for Zero Carbon Homes' is available as a PDF download from **www.zerocarbonhub.org**

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All costs based on 2nd quarter 2009 information and do not take account of:

- Renewable Heat Incentive (RHI)
- Feed-in Tariffs (FITs)
- Part L 2010
- SAP 2009

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Vent Axia
WWF

Observers

Department for Communities and Local Government
Department of Energy and Climate Change
Scottish Government
Welsh Assembly

# Defining a Fabric Energy Efficiency Standard for Zero Carbon Homes

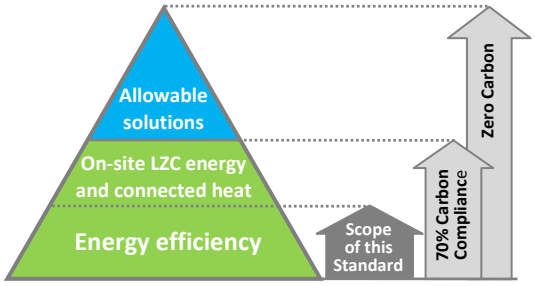


**Figure i: Zero carbon hierarchy**

**The Task Group was asked to:**

***'Examine the energy efficiency metrics and standards which will realise our ambition of the highest practical energy efficiency level realisable in all dwelling types'*** [a]

## The context

In December 2008 Government consulted on the definition of zero carbon homes[b] to provide industry with a clearer concept of what this would mean from 2016 onwards. The definition is based around a hierarchical approach to achieving 'zero carbon' (Figure i):

1. Ensuring an energy efficient approach to building design
2. Reducing $CO_2$ emissions on-site via low and zero carbon technologies and connected heat networks
3. Mitigating the remaining carbon emissions with a selection of Allowable Solutions

In order to provide further clarity and confidence for industry, the Housing Minister announced in July 2009 that the Carbon Compliance level would be set at a 70% reduction in regulated $CO_2$ emissions[c]. In addition, a specialist Task Group was set up to advise on the definition of 'minimum energy efficiency for zero carbon dwellings' so that an announcement on the standard could be made before the end of 2009.

Embedding a high level of energy efficiency within the 2016 zero carbon homes policy is an important step. Minimising energy demand will ensure that dwellings utilise Low and Zero Carbon (LZC) energy sources in the most efficient way. This supports the Government's parallel agendas of carbon reduction, long term energy security and reducing fuel poverty.

Focusing efforts on the comparatively long-lived building fabric helps to 'future proof' the homes. Increased fabric energy efficiency means homes will be less likely to require difficult and expensive refurbishment upgrades at a later date.

[a] Ministerial Statement by the Rt Hon John Healey, *EcoTowns and zero carbon homes*, 16th July 2009

[b] CLG, *Definition of Zero Carbon Homes and Non-domestic Buildings: Consultation*, 17th December 2008. The consultation document applied to England and Wales only.

[c] According to the assumptions contained within the Zero Carbon consultation document.

## The Task Group's recommendations

The Task Group's investigations and discussions provided answers to four key questions:

- **What is the metric?**

  The preferred metric is **kWh/m²/yr** covering space heating and space cooling energy demand (modelled utilising a notional dwelling assuming natural ventilation and excluding any internal gains from the domestic hot water system)

- **Should all dwelling types be treated the same?**

  The Task Group felt that as far as possible all dwelling types should be able to be built to a similar construction specification. To achieve this, **two performance levels** are recommended**:** blocks of flats and mid terrace houses have one level; semi detached, end of terrace and detached houses have another level

- **What are the recommended levels?**

  **Apartment blocks** and **mid terrace houses** have a maximum energy demand of **39 kWh/m²/yr**[d]

  **Semi detached, end of terrace** and **detached houses** have a maximum energy demand of **46 kWh/m²/yr**[e]

  What this means in terms of build specification is illustrated in Figure ii.

- **When will it be implemented?**

  The Task Group is recommending full implementation in 2016, with an interim step in 2013.

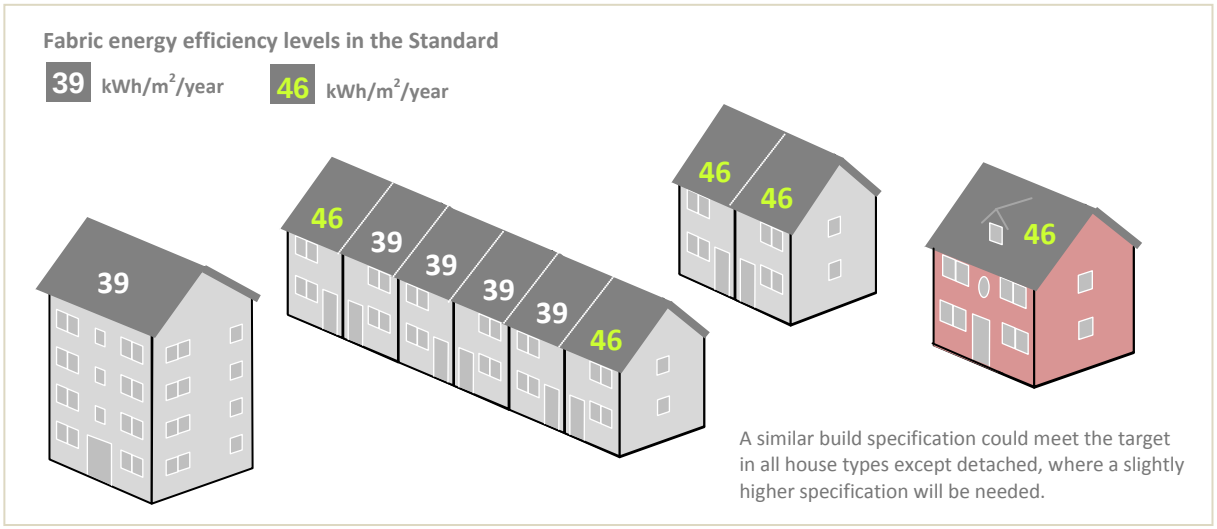


**Figure ii: Target energy demand levels for the main dwelling types**

The UK is leading internationally by having both a minimum fabric energy efficiency and carbon reduction policy approach with implementation in 2016. By recommending a challenging level for the Fabric Energy Efficiency Standard using a performance-based metric, the Task Group aims to: allow for flexibility in design; encourage innovations in both products and processes; and enable the delivery of a consistently high level of dwelling performance.

[d] Based on cSAP modelling. This may require re-basing when the final version of SAP2009 is available.

[e] As above

## Further details of recommendations

### The scope of 'energy efficiency'

The Task Group wanted to be sure that the scope of 'energy efficiency' was complementary to that of Carbon Compliance and Allowable Solutions, and the reach of other legislative drivers.

A number of options were considered:

- Dwelling level energy demand only
- Dwelling level energy demand plus building services appliance efficiency
- Dwelling level energy demand, building services appliance efficiency plus energy conversion and distribution efficiencies

The Task Group concluded that the minimum energy efficiency standard should focus on limiting the energy demands of heating and cooling the dwelling and cover passive measures only. The aspects that are included and how this approach complements other parts of the zero carbon hierarchy is illustrated in Figure iii below.

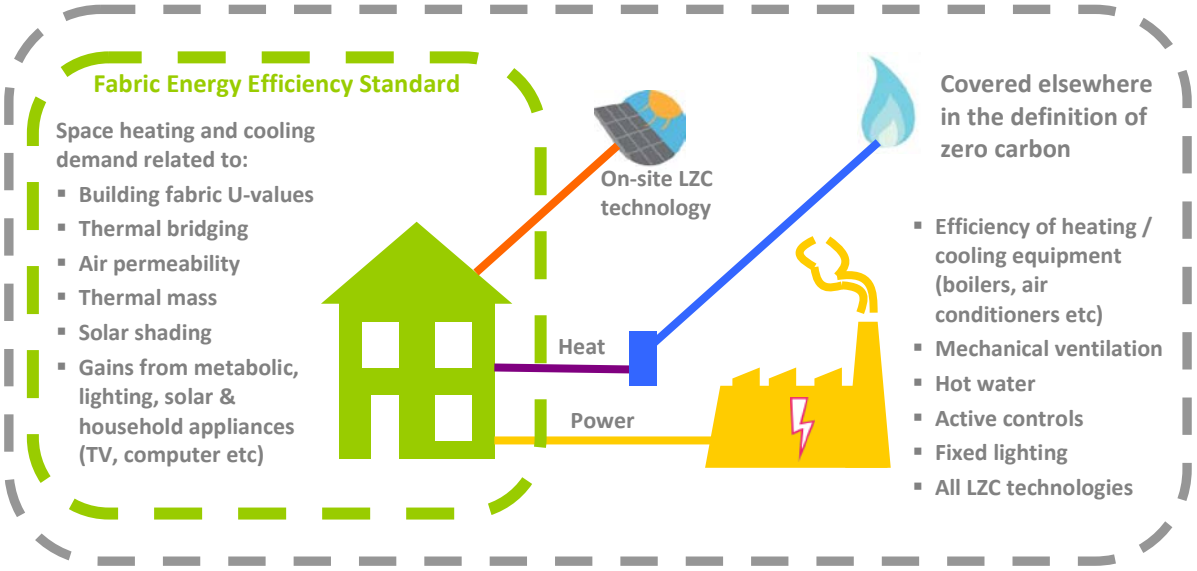


**Figure iii: Task Group definition of the scope of the Fabric Energy Efficiency Standard**

## Metric

The Task Group's recommendation is to use a performance metric of kWh/m$^2$/yr. This is supported by consultation responses as shown in Figure iv.

Although complementary to the overall zero carbon metric of kg/$CO_2$/yr the metric of kWh/m$^2$/yr was deemed to be more appropriate for energy demand and is independent of fuel type.

This approach has the additional benefits of:

- Allowing design flexibility
- Taking into account building form
- Promoting innovation
- Delivering a specific level of dwelling performance
- Being a known 'currency' for energy efficiency internationally

To support industry, design guidance would be created to provide examples of a range of dwellings with a broad combination of solutions that meet the standard.

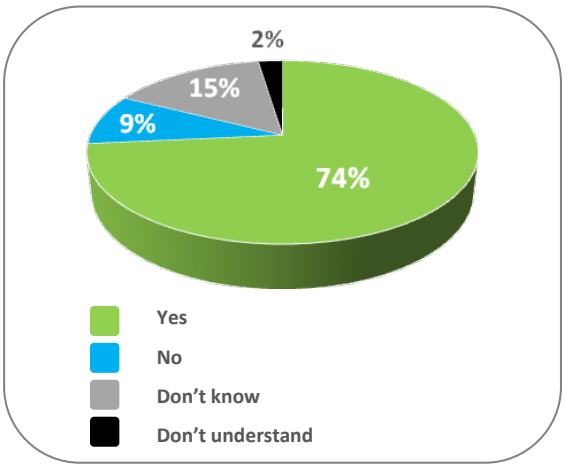


**Figure iv: Metric - should this be kWh/m$^2$/yr? Views from the industry consultation events**

## Levels

### How many levels?

Two performance levels are recommended by the Task Group: one for apartment blocks and mid terrace houses; one for end terrace, semi-detached and detached houses.

By recommending two levels related to dwelling type, the Task Group aimed to set the minimum Fabric Energy Efficiency Standard in a manner that was equally challenging for most construction types.

This is because certain dwelling types, such as mid floor apartments, which have less exposed fabric relative to the floor area, are able to achieve a particular kWh/m$^2$/yr space heating and cooling demand with a less challenging construction specification than other dwelling types. A detached house, for example, has a much higher exposed fabric:floor area ratio so is inherently less energy efficient.

Setting a single level across all dwellings types would result in either detached homes being required to achieve extreme specifications or for little additional effort above current specifications being required by apartments.

On balance the Task Group concluded that it was appropriate to require a realistic but somewhat more challenging construction specification for detached homes. They also wanted to ensure that the construction specifications for mid terraces and end of terraces would be similar.

### What are the levels?

The Task Group recommended that the minimum Fabric Energy Efficiency Standard should be set at:

- **39 kWh/m$^2$/yr** for apartment blocks and mid terrace houses
- **46 kWh/m$^2$/yr** for semi detached, end of terrace and detached houses

This sets a challenging but realistic increase in dwelling performance.

Government was considering challenging standards such as PassivHaus and Energy Saving Trust Advanced Practice Energy Efficiency Standard in its December 2008 Zero Carbon consultation. On balance and taking into account a range of important decision criteria the Task Group decided that the above levels would be more appropriate.

Figure v illustrates the two levels and how they relate to current practice and other specifications considered including PassivHaus when modelled in cSAP.

The introduction of a minimum Fabric Energy Efficiency Standard will encourage innovation and development within the UK supply chain. The overall Carbon Compliance requirement will lead to house builders exceeding the minimum performance where it makes sense to do so.

Figure vi shows consultation responses to the level of ambition of the proposed standard and demonstrates broad support.

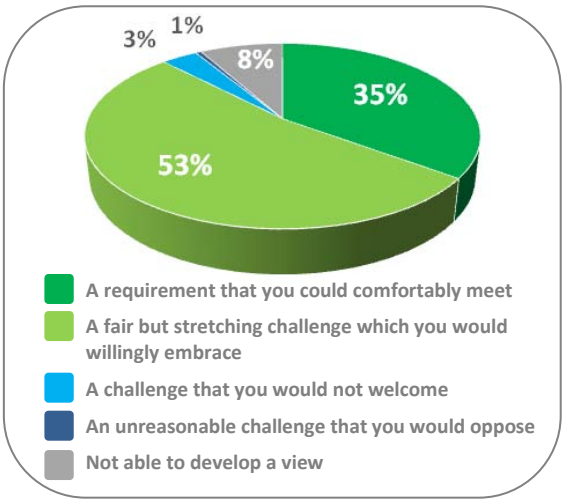


**Figure vi: What is your view about the suggested energy efficiency target set by the Task Group? Views from the industry consultation events**

Those involved in the consultation process will recognise that the energy demand levels adopted have increased. This does not represent a change in ambition but is due to the removal of hot water gains from the calculation (and therefore the minimum level) due to potentially unintended consequences associated with hot water system choice. Further details can be found in the main report.

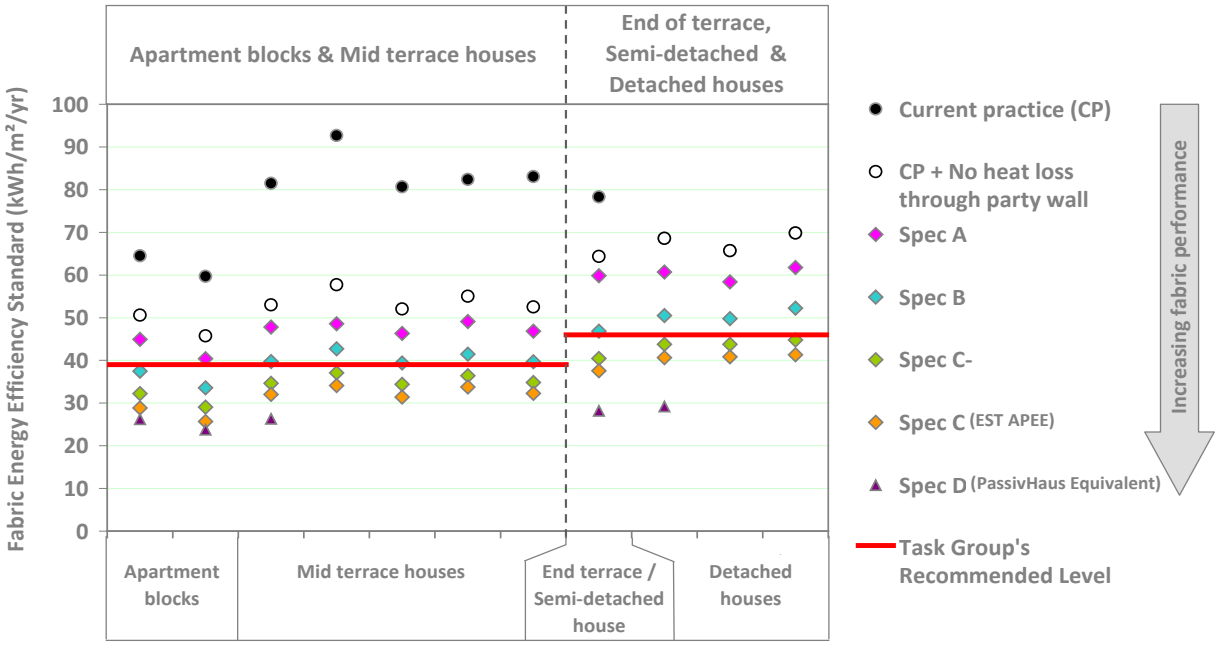


**Figure v: Recommended level of the Standard shown with the range of specifications modelled**

## What this means in practice

### Buildability

The Task Group concluded that the construction specifications required to achieve the minimum Fabric Energy Efficiency Standard are achievable with a sufficiently wide selection of products and techniques.

Figure vii illustrates the type of fabric specifications required to achieve the Fabric Energy Efficiency Standard. However, as it is a performance standard, there is flexibility in the individual element specifications used to comply.

| | Dwelling type | | | |
|---|---|---|---|---|
| | 4-storey apt. block | Mid terrace | End terrace / Semi | Detached |
| **Target Fabric Energy Efficiency Standard** (kWh/m$^2$/yr)[f] | 39 | 39 | 46 | 46 |
| **Wall U-value** (W/m²K) | 0.18 | 0.18 | 0.18 | 0.18 |
| **Floor U-value** (W/m²K) | 0.18 | 0.18 | 0.18 | 0.14 |
| **Roof U-value** (W/m²K) | 0.13 | 0.13 | 0.13 | 0.11 |
| **Window U-value** (W/m²K) | 1.4 | 1.4 | 1.4 | 1.3 |
| **Air permeability** (m³/m²/hr @ 50Pa) | 3 | 3 | 3 | 3 |
| **Thermal bridging y-value** (W/m²K) | 0.05 | 0.05 | 0.05 | 0.04 |

**Figure vii: Examples of construction specifications that meet the Fabric Energy Efficiency Standard**

### Design Performance

The Task Group discussed the question of 'design' versus 'actual' performance as it was recognised that there is currently a gap between the two. It was concluded that only a design standard could be set at this time but further work was urgently required to understand and narrow this gap.

### Health and wellbeing

The Task Group considered householder health and wellbeing within energy efficient dwellings to be of utmost importance.

In particular it was concluded that there is currently insufficient research available to fully understand the relationship between indoor air quality and associated ventilation strategies in homes with low air permeability. The level selected allows for various air permeability and ventilation combinations and the Task Group strongly recommends further research in this area.

[f] Based on cSAP modelling. This may require re-basing when the final version of SAP2009 is available.

## Cost

Financial analysis has understandably been an important factor in the decision making process. The following charts illustrate both the capital costs and whole life costs[g] relating to the range of construction specifications that were defined by the Task Group to explore both technical and financial issues.

The two charts below (Fig viii and Fig ix) illustrate 70% carbon compliance using solar hot water (SHW) & photovoltaic (PV) panels in combination with various fabric improvements. Only Spec C and above would be more costly than current practice.

The Task Group's work indicates a 3-9% increase in capital cost to the build fabric across dwelling types modelled. However, this is incorporated within the cost of achieving overall Carbon Compliance as shown in Figure viii.

Fig ix shows the upfront capital costs, together with the replacement costs and operational savings over 60 years[h].

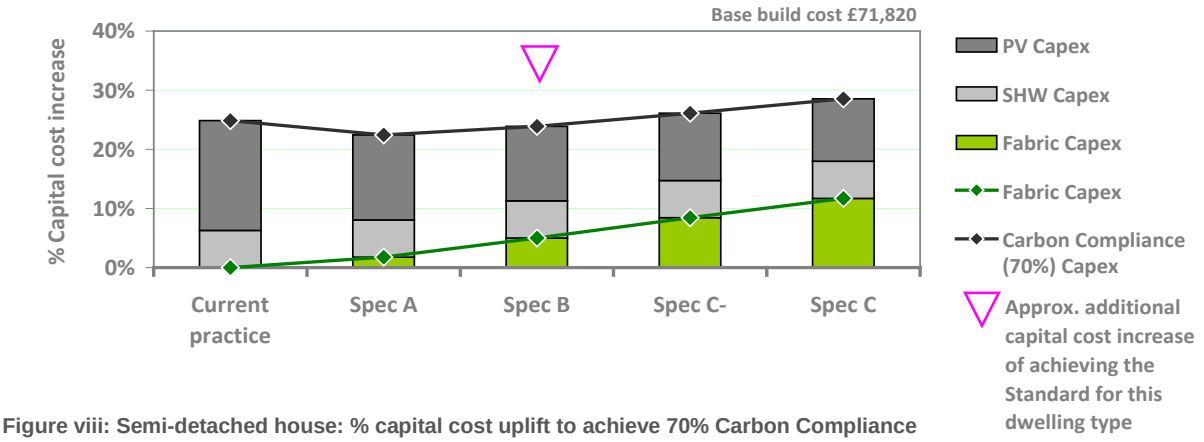


**Figure viii: Semi-detached house: % capital cost uplift to achieve 70% Carbon Compliance**

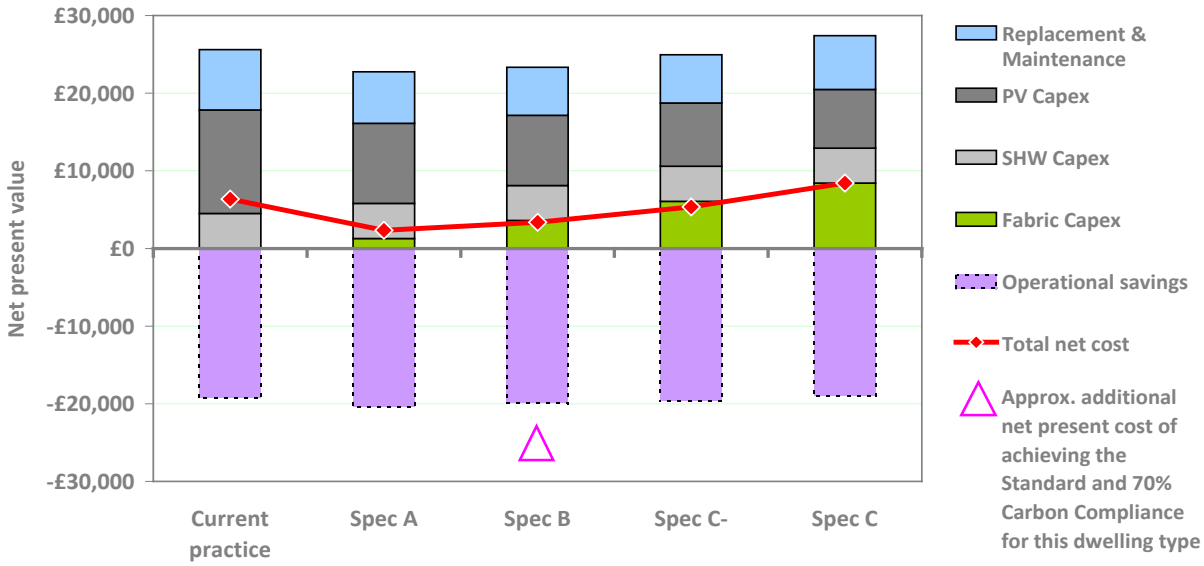


**Figure ix: Semi-detached house: Whole life costings over 60 year period**

[g] These costs are for second quarter 2009 and do not include any adjustment for learning curves, inflation or economies of scale in 2016.

[h] Net present extra over costs. Energy inflation = Retail Price Index (RPI) + 2.5%, 5% discount rate

## Implementation

Early announcement of the final details of the Standard is required to enable industry to fully engage with the proposals, develop appropriate solutions, and commit to delivering energy efficient fabric on a mass scale. The proposed timescales are:

- Full implementation in 2016
- Interim step in 2013
- Formally consulted on within the forthcoming Code for Sustainable Homes consultation
- A very strong policy commitment announced at the earliest possible opportunity

The recommended timescales are confirmed by consultation responses as shown in Figures x and xi.

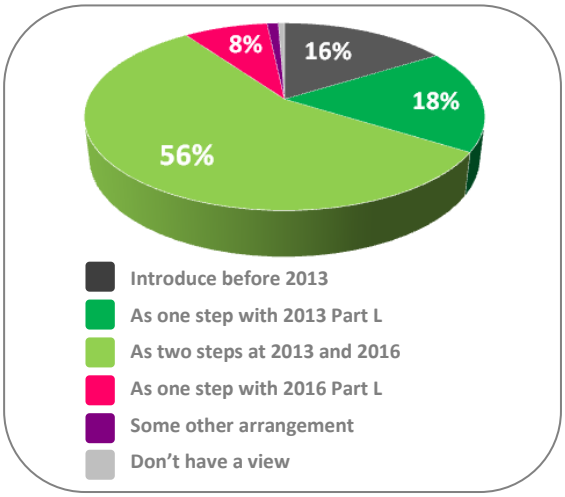


**Figure x: When to introduce the Standard? Views from the industry consultation events**

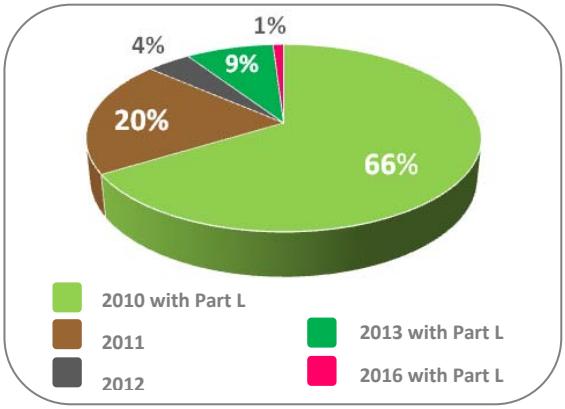


**Figure xi: How soon should the final decision on the Standard be announced? Views from the industry consultation events**

## Contribution to emission reduction

### Relationship: Past

Figure xii shows the energy demand of homes built to different building standards[i] and how these relate to the recommended Fabric Energy Efficiency Standard. This shows the significant reduction in space heating demand and the increasing relative importance of unregulated electricity and hot water demand.

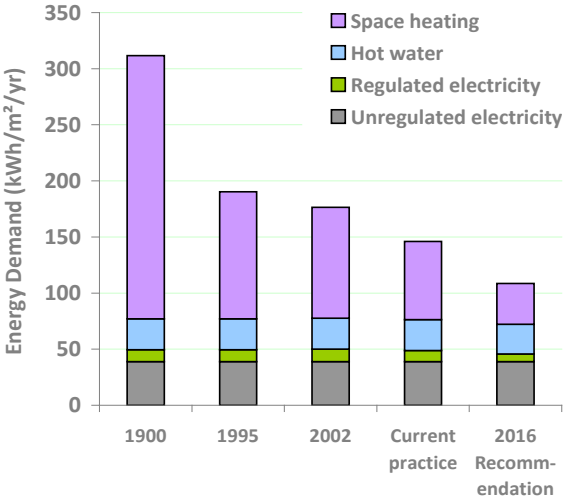


**Figure xii: Energy demand of a semi-detached home built to different building standards, assuming contemporary comfort levels, hot water usage and appliance use**

### Relationship: Present

The proposed Fabric Energy Efficiency Standard equates to around a 20-25% reduction in carbon dioxide emissions[j] compared to current Part L 2006 compliance, assuming gas fuelled heating.

### Relationship: Future

How the Fabric Energy Efficiency Standard relates to achievement of the minimum 70% Carbon Compliance standard is important. The choice of fuel and dwelling type play a significant role in overall carbon performance. However, assuming a gas fuelled heating system, the minimum Fabric Energy Efficiency Standard would produce around a 25-30% reduction in regulated emissions[k].

[i] As modelled in cSAP 2009

[j] As modelled in SAP 2005 and according to Building Regulations Part L 2006 methodology

[k] According to the assumptions contained within the Zero Carbon consultation document

## The process followed by the Task Group

Intense work was conducted by the Task Group over a three month period in order to provide recommendations in advance of the forthcoming Code for Sustainable Homes consultation and to enable further details of the Zero Carbon Homes policy to be announced before year end.

A series of Work Groups[I] were established to provide the Task Group members with detailed information and assessments relevant to their deliberations. The approach followed the basic structure outlined below:

- Initial data and information gathering
- Extensive energy and financial modelling, architectural and buildability analysis and assessment of the wider policy implications / benefits
- A review of the findings followed by a series of consultation events and an online survey

The combined consultation approach allowed around 400 industry stakeholders (over 180 attended the events and over 200 responded online) to feed back their opinions to the Task Group prior to the final decision workshops which took place in early November 2009.

### Task Group Considerations

In order to ensure that the wider policy objectives and implications of setting the minimum level for the Fabric Energy Efficiency Standard were addressed, an assessment matrix was developed. This included nine areas for consideration:

- Building practices
- Future proofed construction
- Buildability at mainstream delivery scale
- Health and wellbeing
- Desirable homes
- Upfront build costs
- Long term maintenance and energy costs
- Energy security
- Broader environmental concerns

This matrix provided a structure for the Task Group's initial review of the data generated by the Work Groups. Key areas of interest included:

- **Technical implications**

  A range of construction specifications were modelled in the latest consultation version of SAP 2009 (cSAP).

  This, in conjunction with architectural, structural and buildability reviews, allowed the Task Group to understand the practical implications of delivering the various levels of performance at a mainstream delivery scale from 2016 onwards.

- **Financial implications**

  Each of the construction specifications were modelled to understand the capital cost of the energy efficiency measures, how this might fit within a wider approach to achieve 70% minimum Carbon Compliance, and also whole life costings.

- **Wider policy implications**

  Broader policy implications were also considered, such as: supply chain development, skills and training requirements, consumer acceptance, fuel resource efficiency and health and wellbeing for the eventual occupants of these homes.

[I] The three Work Groups were: Form & Fabric, Services and Lighting. Membership lists and the detailed information developed by these groups can be found in the Appendices

## Supplementary work required

Defining the Energy Efficiency Standard is a critical step in engaging industry in the widest sense and setting the trajectory for delivery. To support this process a range of supplementary actions are also required; again working with established industry groups.

The table below summarises these actions and broadly identifies: Government responsibilities, areas where considerable additional research is required and tasks where the Zero Carbon Hub may provide a coordinating role. Many of the new activities will need to be scoped and budgets / funding sources agreed.

| | Zero Carbon Hub | Government | Research |
|---|---|---|---|
| **Integration into Code for Sustainable Homes consultation** | | **CfSH** | |
| **Health / Air permeability / Ventilation** | **Task Group*** | **Part F** | **Required*** |
| **Overheating** | **Task Group*** | **Part L** | **Required*** |
| **SAP 2009 modelling tool development / rebasing** | **Task Group*** | **SAP / Part L** | |
| **Additional dwelling modelling** | | **Required*** | |
| **Design Guidance** | **Task Group* / industry** | | |
| **Daylight requirements** | | **Required*** | |
| **Land take costs** | **Task group*** | | |
| **Certification, Verification & Audit** | **Task Group*** | **Part L** | **Required*** |
| **Actual dwelling performance** | **Facilitation*** | **TSB / other** | **Required*** |

* New or substantially increased activities

**Figure xiii: Overview of supplementary work required**

## Your Notes

## Zero Carbon Hub

The Zero Carbon Hub was established in the summer of 2008 to support the delivery of zero carbon homes from 2016. We are a public/private partnership drawing support from both government and the industry and reports directly to the 2016 Taskforce.

Zero Carbon Hub has developed five workstreams to provide a focus for industry engagement with key issues and challenges:

- Energy Efficiency
- Energy Supply
- Examples and Scale Up
- Skills and Training
- Consumer Engagement

To find out more about these workstreams, please visit **www.zerocarbonhub.org**.

If you would like to contribute to the work of the Zero Carbon Hub, please contact **info@zerocarbonhub.org**.

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