Defining a Fabric Energy Efficiency Standard for zero carbon homes

Appendix B

Work Group 2 Services

The views and recommendations within this report are those of the Task Group and do not necessarily reflect the views of Government

Services

Introduction

This appendix should be read in conjunction with the main report entitled 'Defining a Fabric Energy Efficiency Standard for zero carbon homes'.

It provides further information regarding the role of building services in future zero carbon homes and summarises the Work Group's discussions regarding how the key elements of such systems may develop between now and 2016.

Work Group 2	Services
Scope of group discussions	The group discussed the appropriate boundary for defining the energy efficient provision of the comfort, health and safety of the occupants of the 2016 home. A minimum efficiency for the building services (boilers, etc) was considered as this is the approach adopted for Part L compliance and laid out in the Domestic Building Service Compliance Guide. This was rejected and it was agreed that the boundary exclude the energy conversion devices – such as boilers – and concentrated on the specification of the 'energy demand profile' for the dwelling. The energy efficiency standard would be that which provided the energy demand required by the minimum practical use of energy. Initially, this allowed the consideration of demand reduction by controls and heat recovery from ventilation air. However following the Task Group review of the Fabric Energy Efficiency Standard's potential scope it was decided that only passive measures would be included. The intention being to ensure that the most enduring aspects of the dwelling would provide the energy efficiency required rather than installed services that would have life expectancy less than that of the building fabric. Also the Task Group was mindful of not defining a minimum standard that unintentionally reduced the range of solutions available to designers and industry. Consequently, the impact of heat recovery by whole house ventilation systems was excluded from the energy efficiency standard for the dwelling fabric. The Carbon Compliance requirement would take account of the actual specified performance of the services. The backstop performance of the services would be captured by the forthcoming Energy Using Products Directive (EUP).

Area of building services included within the recommendations for modelling activities		
	Reasoning	**Possible unintended consequences?**
Heating demand based on a minimum control level of zone time and temperature.	This is the minimum space heating energy demand for the proposed level of fabric performance.	A lesser level of control would not comply with Part L
Ventilation is based on the Part F compliant intermittent extract systems with a fabric air permeability of $3m^3/hrm^{-2}$.	This is the basis of compliance under Part F for a naturally ventilated dwelling to provide adequate indoor air quality. The heat recovery from ventilation air is not included in the fabric standard as it is not a passive measure. A sensitivity analysis showed an air permeability of $5m^3/hrm^{-2}$ compared to one of $3\ m^3/hrm^{-2}$ had little impact on the overall energy modelling results. The fan performance of mechanical ventilation systems will come under the remit of the Energy Using Products Directive (EUP). Plus the wider Carbon Compliance calculations	Dwellings achieving air permeability significantly less than $3m^3/hrm^{-2}$ without a specifically designed ventilation strategy may not provide adequate indoor air quality. Further research is required

Area of building services included within the recommendations for modelling activities		
	Reasoning	**Possible unintended consequences?**
Domestic Hot Water demand was considered for inclusion in the energy standard. In the final analysis it was not included.	Domestic hot water will tend towards being the largest consumer of energy in many future dwellings. However, this energy use would be captured by the Carbon Compliance requirement. At present Part G appears to have a greater influence on overall demand levels than issues such as storage vessel insulation and temperature control which fall within Part L and SAP	The future demand profiles for Domestic Hot Water (DHW) are not clearly known and further investigations of this are required. Additionally, the detailed design of integrated space heating, DHW and solar thermal systems is an area requiring further consideration.
Domestic Hot Water storage losses	Assuming the heat gains from DHW storage systems can displace a considerable amount of space heating energy demand within a dwelling with energy efficient fabric. A subsequent sensitivity analysis indicated the extent of the influence. Therefore, DHW storage cannot be assumed to be the case in all dwellings as it does not account for options such as direct point-of-use or heat network systems where there may be no gains from storage vessels.	Including gains from DHW storage and distribution within the calculation could lead people to intentionally specify lower levels of insulation to maximise their effect. Poorly insulated DHW storage systems within a dwelling may give rise to high internal heat gains that lead to overheating outside the heating season in a dwelling constructed to meet the heating energy standards.
Controls	Controls that reduce demand, such as optimum start or weather compensation, are considered to be energy efficient technologies but are susceptible to commissioning errors and mal-operation.	Including more active control systems in the development of the standard is not in line with the requirement for passive components. Additionally, these systems may not be applicable for all methods of heating.

Area of building services included within the recommendations for modelling activities		
	Reasoning	**Possible unintended consequences?**
Circulation pumps	The assumptions for pump energy use are embedded within the SAP calculation. Following its introduction Lot 11 of the EUP performance standards will govern the use of glandless circulators in heating systems.	Including pumps in the development of the standard is not in line with the requirement for passive components. Energy efficiency developments in this area are being driven by EUP. The SAP assumptions will need to be addressed following the adoption of these standards. .
Cooling	The requirement for cooling and the consequential energy use is triggered by the cSAP estimation of overheating risk. This estimates the cooling energy requirement taking account of the dwelling thermal mass.	Not including cooling energy demand could lead people to specify mechanical cooling rather than explore passive measures. The cSAP tool used to assess the cooling energy gives estimates that are not entirely confirmed by dynamic simulation methods. Further research is required

Metrics discussed		
Type	**Pros**	**Cons**
Energy Efficiency performance levels for each service	Provides clear limits on performance for each service. Current practice for Part L. Easily understood by the supply chain.	Possible conflict with and soon to be superseded by forthcoming EUP standards. Not possible to predict efficiencies of services at the 2016 specification – a particular problem with low output heating systems.
Total kWh/year	A simple and easy to understand number for the householder and developer. It is calculated by cSAP and readily reportable. kWh is familiar unit on utility bills.	It would need to be set at different levels for each building type and size of property
$kWh/m^2/year$	This is a widely used parameter and normalises the energy performance across dwelling sizes. It is calculated by cSAP and readily reportable. It can be determined in practice more easily than the HLP	It depends on the built form and the exposed surface area to volume ratio of the dwelling. Small apartments and terraced houses would achieve a single standard more easily than detached houses
Heat loss parameter (HLP)	This deals explicitly with heat loss from the dwelling.	It is mainly of relevance to fabric specification and does not take account of internal and solar gains that displace space heating. It does not deal with domestic hot water production.

Work Group preferred metrics	
	Reason
kWh/m^2/year	A well recognised and widely understood number that is readily determined at the design stage and potentially in use.
Work group minimum performance level for any backstops	
	Reason
The EUP standards that will come into force in the near future, and will mandate minimum performance standards for the building services	Individual standards for each service may give the impression of being proscriptive elemental standards. The current approach to minimum performance efficiencies, as in the Part L Building Services Compliance Guide, may differ from the methods for determining the performance of services under these regulations that will have been agreed across the EU.

Future Thinking

The industry participants prepared views as to how the specification of the 2106 house would influence the services provided. These notes provide a summary of their views.

The major impact of the proposed reduction of heat losses of the house of 2016 is the very low level of heating requirement. The anticipated design heat loss is thought to be between 1kW and 3kW. This will not be met by the installation of a conventional central heating system which is currently the norm.

The requirement for domestic hot water will most likely not decrease and may be even more than presently assumed within the SAP assumptions. Hot water storage will be required to satisfy the draw-off requirements of the occupants.

With the proposed standards of air permeability for these future homes the ventilation for indoor air quality will most likely tend towards some form of whole house ventilation system of; natural, hybrid or mechanical nature.

The 2016 dwelling’s energy performance will have become more sensitive to the integration of the fabric and services. Careful consideration will be needed to integrate the various energy streams for heating, ventilation, domestic hot water, and potentially cooling. These energy end uses may well come from a variety of primary sources including low and zero carbon technologies such as heat pumps, solar thermal and solar photovoltaic, and include heat recovery from ventilation air and warm grey water. There is increasing concern about dwellings experiencing overheating as a consequence of the increased insulation levels.

SAP has been central to the development of the current Fabric Energy Efficiency Standard and is also the main engine in Part L compliance. The current version of cSAP 2009 is a consultation version and this project has shown areas in which developments may be needed. One example in particular, as indicated in the main report, is that the cooling calculation algorithms may need to be addressed to provide more robust results.

Further developments of SAP would be welcome to deal better with the complexities of design that future houses will need in order to meet the carbon targets set by Government initiatives .The energy requirements of the 2016 will need a more holistic design process than that currently adopted. This level of design integration is far beyond that currently employed by the industry and offered by SAP.

Likewise, the determination of actual as built performance will require further research and monitoring to ensure that the designed performance is being achieved.

Information Gaps

The group identified some significant gaps in the knowledge of the energy requirements and performance of dwellings to the proposed 2016 standards. These are summarised below.

Space Heating

Space heating in future low energy houses of 1-3kW heat loss are likely to be quite different from the traditional central wet systems. The exact form of the heating systems is uncertain and further work is required to determine how the small space heating load will be provided. This is particularly so in the context of the continuing domestic hot water demand and the potential use of micro-CHP and heat pumps. The industry recognises that further thought is required as to how to cope with these changes.

Controls

More complex and sophisticated controls will be needed and these will need to act across the various services, for example, controlling the interaction of domestic hot water systems with solar thermal and potentially heat pump systems. To fully satisfy the occupants' need for comfort, future systems may also require some element of learning and predictive action. These areas are poorly understood aspects of controls and occupancy and more information and research is required to bridge this gap in knowledge.

The commissioning of these more complex controls will also require more careful consideration as poorly commissioned advanced controls may result in worse energy performance. The energy benefits of the various control systems are not fully identified and further research is needed to establish these.

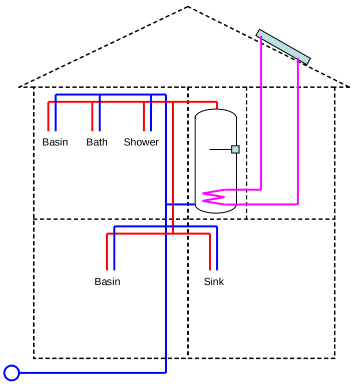
Domestic Hot Water

At present domestic hot water for single family dwellings is generally provided by a single water heater whether it be storage or a combination boiler. This means that all water has to be produced and stored at the maximum temperature required, normally the kitchen tap. However, the patterns of draw-off for domestic hot water are poorly understood, with wide variances being observed between households. Research is needed to increase the knowledge of domestic hot water use and to improve the current assumptions within SAP. It is also anticipated that 'enforced' changes in occupant behaviour to reduce energy use may influence the use of hot water.

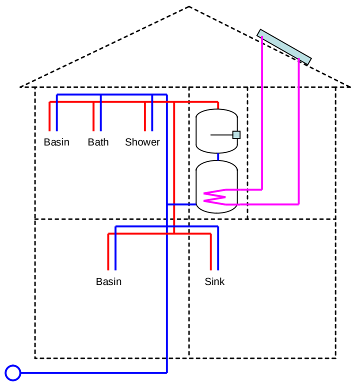
The technology of hot water provision is well understood but how it is employed in future houses is not clear. This is particularly relevant due to the fact it will probably need to be integrated with other systems such as solar thermal. Whilst in the summer a Thermal Solar system can produce high temperatures, the same does not apply throughout the year. An example of the current approach to integration is shown in the following diagram.

Typical Current Thermal Solar Systems

Primary storage options also available
as are pre-heat systems used with combis



Twin zone 'hot top' cylinder
(UK & European Norm)

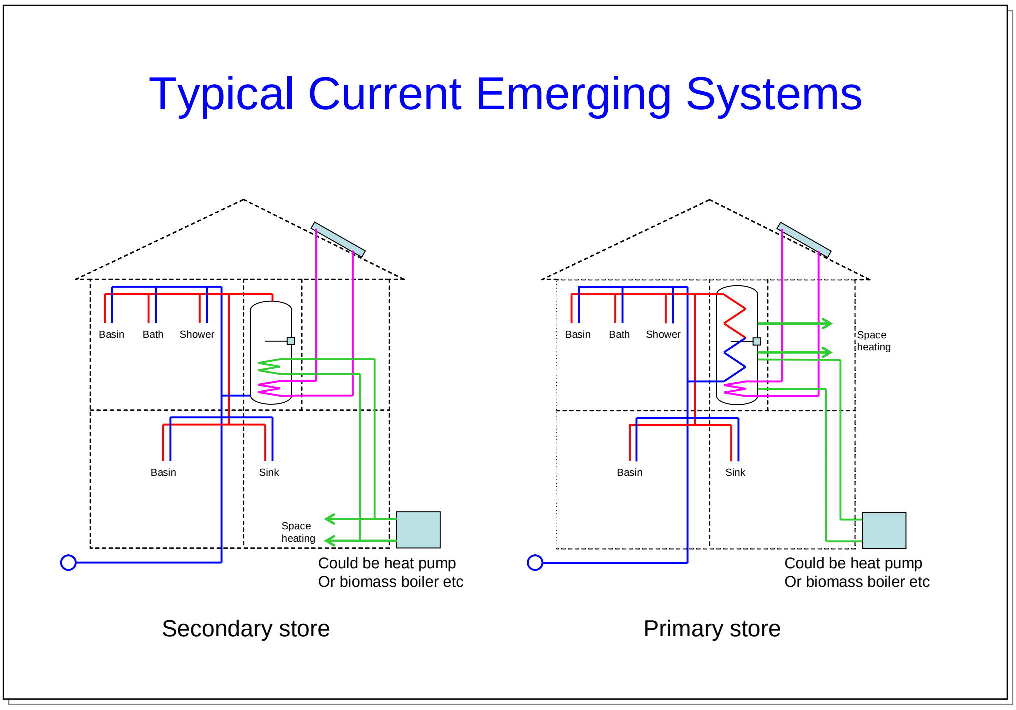


Preheat Cylinder
(less popular option)

Heat pumps generally tend to be most efficient at producing temperatures of up to around 45^{o}C. Whilst some will go higher this is inevitably at the expense of efficiency. In all cases an additional back up heat source is required for periods when Thermal Solar is not sufficient and/or to boost the delivery temperature.

A number of options exist, for example lower temperature storage and point of use re-heat, but the controls required by these are in need of further development. Likewise the integration of domestic hot water and space heating systems needs further investigation. Some examples of how future DHW systems have been provided. The current emerging systems include:

- Storage combination boilers with passive flue gas heat recovery for DHW efficiency
- 'Solar Compatible' combination boilers that will accept preheated water
- Heat recovery systems from grey water, shower trays etc.



Ventilation

The 2016 house may have an air permeability of $3m^3/hrm^2$ or less in order to achieve the levels of energy and carbon efficiency required. As a consequence care will need to be taken to provide adequate ventilation to meet the indoor air quality requirements of the occupants. Current proposed revisions to Part F recognise this situation and present alternative means of complying with the performance standard based on the permeability of the dwelling.

A number of ventilation systems will need to be investigated that take advantage of the trade-offs that exist between the range of alternatives from natural ventilation with intermittent local extract through to whole house ventilation.

Mechanical systems that include heat recovery also offer the opportunity to reduce space heating energy requirements. However, in order for such systems to provide the optimum performance, balancing energy efficiency and indoor air quality, installation and commissioning will need to be carefully monitored and controlled. It is likely that to achieve the full benefits of these systems more and advanced controls will be required that take into account the occupancy levels.

Research is needed to develop both appropriate indoor air quality sensors and the controls and control algorithms that will be required. The energy benefits of demand control are as yet unknown and not fully addressed in the SAP calculation.