BUILDINGS OTHER THAN DWELLINGS

Building Regulations for the Conservation of Fuel and Power

Kingspan®
Insulation

Introduction

The latest amendments to Approved Documents L for the conservation of fuel and power (England) came into effect on 6 April 2014, and represent the next in a series of stages leading to the ultimate target of net zero carbon for all new buildings by 2019.

The journey began in 2002 with the introduction of more stringent requirements for the thermal performance of the individual elements of a building, i.e. roof, walls and floor, together with a new method for calculating compliance.

Subsequent changes in 2006 and 2010 steadily improved standards further, and changed the whole approach to constructing energy efficient buildings by looking at the carbon emissions of the building as a whole, rather than simply setting standards for the thermal elements. This brought in factors such as lighting systems, air tightness, thermal bridging, occupancy and use, and solar gain. It also recognised the complexities of the different types of non-domestic buildings and started to differentiate between the capacity of each type to make energy savings.

Interestingly, the latest changes still allow compliance to be achieved through a fabric first approach, without the need to rely on renewable technologies in most instances. Although the gap between the current standards and the 2019 net zero carbon targets is still significant, having a fresh focus on the building envelope will provide a solid platform from which to work towards this final goal.

This E-brochure takes a look at the requirements of Approved Documents L2A and L2B 2013 for buildings other than dwellings.

2002

- Simple but prescriptive methods of compliance using either elemental or target thermal performance values (U-values) or carbon index.
- New Combined Method of calculating compliance using SBEM (Simplified Building Energy Model).

2006

- Introduction of a whole building carbon emissions approach, with minimum Target CO_2 Emissions Rate (TER) showing an improvement of between 23-28% in energy performance against a 2002 notional building of the same type.
- All buildings must be designed and built such that their Building CO_2 Emissions Rate (BER) is no worse than the TER. Compliance claculated using updated SBEM or equivalent.
- Approved Documents split into new build (ADL2A) and refurbishment (ADL2B)

2010

- Average 25% carbon reduction from 2006 standards for new build.
- New Notional Building targets set for a variety of non-domestic building types.
- SBEM updated; new focus on heating, lighting, air leakage and solar gain.
- The emission rate calculation has to be completed at design stage and submitted to Building Control with the planning application.
- New rules for shell and fit out buildings.

2014

- 9% aggregate improvement over 2010 standards
- New Notional Building Specification can be used as a route to compliance.
- Design stage submissions are needed 1 day before work starts and evidence of as built compliance is needed within 5 days of the work ending.

2016

- Further changes due.

2019

- All new buildings to achieve net zero carbon emission target.

Approved Document L2A (ADL2A): Buildings other than Dwellings

The 2013 edition of ADL2A came into effect on 6th April 2014, and is applicable to all new buildings other than dwellings, including those that exclusively contain rooms for residential purposes such as nursing homes and student accommodation. The regulations cover:

- The construction of new buildings.
- Fit-out works, if included as part of the construction of new buildings.
- Extensions to existing buildings with a total useful floor area greater than 100 m^2 and greater than 25% of the total useful floor area.

There are five criteria given in ADL2A to demonstrate compliance; three of these relate directly to the fabric of the building. This piece focuses on those that are related to insulation and the thermal performance of the building envelope.

Demonstrating Compliance

First and foremost, there is a need to show that the designed building carbon dioxide (CO_2) emission rate (BER) does not exceed the target CO_2 emission rate (TER). TER and BER calculations should be carried out in accordance with the National Calculation Methodology (NCM) e.g. using the Simplified Building Energy Model (SBEM).

The individual fabric elements and the fixed building services must achieve reasonable overall standards of energy efficiency. Minimum backstop standards apply, which limit design flexibility.

It is a requirement to provide evidence that the energy performance of the building 'as built' matches or exceeds the designed performance.

Evidence of Compliance

The calculations carried out using compliance software such as iSBEM or other approved software can be used to supply much of the evidence that demonstrates compliance.

ADL2A recommends that two versions of the evidence are presented to Building Control; the first should be submitted at the design stage, not less than one day before building work starts, and the second 'as built', not more than five days after work has completed.

Both the 'designed' and 'as built' submissions should include the TER/BER calculation as well as a list of specifications, and evidence of how these have been met. The 'as built' submission must also include the assessed air-permeability of the building and any changes to the designed specifications. A clear connection should be made between the data input into the compliance software and the product specifications, for example the type of wall construction that delivers the claimed U-value.

The calculations for the 'as built' submission may also be used to provide information for the Energy

Performance Certificate (EPC) for the completed building.

Determining the TER

A notional building of the same size and shape as the actual building is used to determine the TER. The new ADL2A 2013 notional building is categorised into three building types.

- Side lit or unlit, HVAC services heating only
- Side lit or unlit, HVAC services heating and cooling
- Top lit.

Although some elements vary across these three categories, such as the levels of air permeability, the notional U-values remain consistent at 0.18W/m^2.K for the roof, 0.26W/m^2.K for the walls and 0.22 W/m^2.K for the floor. Buildings constructed entirely to the 2013 notional building specification may be deemed to comply. However, it should be noted that in some cases achieving the notional levels of air permeability may be an issue, in which case a more robust and reliable route to making sure that the BER meets or exceeds the TER would be to build to the backstop air permeability rate and to enhance the U-values.

The ADL2A 2013 notional building specification for each building type is summarised in Section 5 of ADL2A and detailed in the 2013 edition of the NCM Modelling Guide (NCM Modelling Guide 2013).

Limiting Fabric Standards

ADL2A sets out area weighted limiting U-value standards for the different fabric elements of the building to ensure a minimum building envelope performance. These do not provide a compliant specification and are simply provided to ensure that the building envelope design is relatively robust, and that performance does not rely on more short lived elements. For instance, the installation of a renewable energy system, which may not necessarily be replaced upon failure, affecting the overall performance of the building in the long term.

A limiting value of 10m^3/hr/m^2 at 50 Pa is set for air permeability. In addition, limits are also set for the energy performance of the fixed building services installed in the building.

Linear Thermal Bridging

The building fabric should be constructed so that there are no reasonably avoidable thermal bridges in the insulation layers caused by gaps within the various elements, at the joints between elements, and at the edges of elements such as those around window and door openings.

There is currently no book of accredited details for the 2013 standards, so either each joint detail will need to be calculated separately, or the generic linear thermal bridge values given in BRE IP 1/06 (Assessing the effects of thermal bridging at junctions and around openings), increased by the greater of either 0.04W/m·K or 50%, will need to be used.

Achieving Acceptable Air-Permeability

The achieved air-permeability, measured by pressure testing at construction stage, is used in the post-construction BER calculation. If the limiting value of 10m^3/hr/m^2 at 50 Pa is not achieved then remedial measures will need to be carried out until that requirement is met. If the measured air permeability is less than the limiting value of 10m^3/hr/m^2 at 50 Pa, but greater than the design air-permeability, other improvements may still be required to achieve the TER.

There are a number of exemptions from pressure testing, including buildings with a total useful floor area less than 500m^2, large extensions covered by ADL2A where sealing off the extension from the existing building is impractical, compartmentalised buildings, and buildings that are too large or complex to test effectively.

	Design Static Pressure			
Duct Pressure Class	**Maximum Positive (Pa)**	**Maximum Negative (Pa)**	**Maximum Air Velocity (m/s)**	**Air-leakage Limit (l/s/m²)**
Low – Class A	500	500	10	$0.027 \times p^{0.065}$
Medium – Class B	1000	750	20	$0.009 \times p^{0.065}$
High – Class C	2000	750	40	$0.003 \times p^{0.065}$
High – Class D	2000	750	40	$0.001 \times p^{0.065}$
Where p is the differential pressure in Pascals (Pa)				

Table 1

Fixed Building Services

System Efficiencies

Each fixed building service in a building, including air-conditioning and mechanical ventilation systems, should be at least as efficient as the minimum acceptable values set out in the 2013 edition of the 'Non-domestic Building Services Compliance Guide' (NDBSCG), published by DCLG.

Ductwork Air-leakage

The NDBSCG states that in order to limit air-leakage, ventilation ductwork should be made and assembled so as to be reasonably airtight. Ductwork is classified according to its pressure classification: A, B, C or D. Air-leakage limits are defined for each pressure class, Class D being the most stringent. The lower the air-leakage limit, the greater the contribution towards reducing the overall CO_2 emissions per square metre of useable floor area of the building when setting the TER.

The maximum allowable air-leakage rates, expressed as litres of air per second per surface area of duct ($l/s/m^2$), for each pressure class over a range of design pressures are shown in Table 1.

ADL2A requires ductwork to be tested for air-leakage where required, and states that if a system fails to meet the standard, remedial work should be carried out as necessary to achieve satisfactory performance in accordance with B&ES DW/143.

Achieving Compliance

The 9% aggregate CO_2 savings across the new non-domestic building mix relative to ADL2A 2010 is expected to be achieved primarily through increased air-tightness and improved system efficiencies. However, the overall focus is still firmly on ensuring that the building fabric is intrinsically thermally efficient before other energy reduction/generation measures are considered.

The practicalities of delivering air-permeability rates of 7m³/hr/m² at 50 Pa using traditional building technologies can be challenging, let alone rates of 5 or 3m³/hr/m² at 50 Pa. Reliance upon low air-permeability to meet the energy efficiency requirements could give rise to potentially hefty remedial costs upon failure to pass pressure tests. A far more prudent approach could be to adopt the minimum required value of 10m³/hr/m² at 50 Pa, together with improved U-values.

Analysis is showing that, for buildings that are not heavily air-conditioned, the U-values in Table 2 are at or around the best starting point for specifiers to work from to succeed in getting the design to comply with ADL2A.

Any gap between the performance these U-values provide and the TER can be made up relatively easily by any of the other variables in iSBEM or other approved software.

Element	U-value (W/m²·K)
All Roofs	0.14
Walls	0.22
Floors	0.18

Table 2: Best starting point U-values

Case Study

ESI Building, University of Exeter

The University of Exeter's Environment and Sustainability Institute (ESI) at the Penryn Campus in Cornwall is a new multi-million pound development to lead cutting edge research into environmental change, therefore minimising the building's CO_2 emissions and environmental impact were key design considerations.

To minimise heatloss from the building's ground floor, two 150mm layers of Kingspan's premium performance Kooltherm K3 Floorboard were installed, delivering an outstanding floor U-value of just 0.05W/m^2.K. Kingspan Kooltherm K15 Rainscreen Board was also installed behind the rainscreen elements of the building façade, helping to achieve an external wall U-value of 0.13W/m^2.K. Both products have been assigned a highest possible Green Guide Summary Rating of A+.

A layout was produced for the roof insulation to ensure optimum use, while adhering to the thermal and structural requirements. The ESI roof was covered in Kingspan Thermataper TT47 LPC/FM, with the exception of the stair tower, light well roof and pitched section, where Kingspan Thermaroof TR27 LPC/FM was installed; and the plant room where Kingspan Thermaroof TR26 LPC/FM was fitted. The final roof U-value achieved was 0.09W/m^2.k.

Case Study
Norwich Academy

The multi-million pound City Academy Norwich replaced the outdated Earlham High School with a purpose built facility, incorporating a district heating system linked to the nearby University of East Anglia campus. The academy accommodates 1,100 pupils from ages 11-19 and on completion was assessed as BREEAM 'Excellent' by WSP Group.

To help attain this high level of energy efficiency, 2574 m2 of The Kingspan KoolDuct System was installed to and from air handling units throughout the academy. The System comprises premium performance Kingspan KoolDuct panels which are the most thermally efficient insulation product commonly used for pre-insulated HVAC ductwork. With a thermal conductivity as low as 0.022W/m.K, Kingspan KoolDuct panels can also achieve air leakage rates far lower than traditional sheet metal ductwork.

The Kingspan KoolDuct System is installed in a single fix and is also the only premium performance pre-insulated ductwork to be UL Listed as a Class 1 Air Duct, to Standard for Safety UL 181 (Underwriters Laboratories: Factory Made Air Ducts & Air Connectors), when fabricated to a specification clearly defined by UL.

Approved Document L2B (ADL2B): Existing buildings other than Dwellings

The requirements for refurbishment under ADL2B remain largely unchanged, apart from some improvements to the requirements for building services, yet even as they stand they represent both an opportunity and a challenge, as large numbers of existing dwellings that will be with us for decades to come currently have little or no insulation.

New & Replacement Thermal Elements

Any new or replacement roofs, walls and floors should have U-values no worse than the following:

Pitched roof (insulation at ceiling level)	– 0.16 W/m^2.K
Pitched roof (insulation at rafter level)	– 0.18 W/m^2.K
Flat roof or roof with integral insulation	– 0.18 W/m^2.K
Wall	– 0.28 W/m^2.K
Floor	– 0.22 W/m^2.K

However, lesser provisions are allowed where meeting these standards would result in a significant impact on the existing structure e.g. a reduction of more than 5% in the internal floor area of the room bounded by the wall, or problems in relation to adjoining floor levels.

The new or replacement building fabric should be constructed so that there are no reasonably avoidable thermal bridges in the insulation layers caused by gaps within the various elements, at the joints between elements e.g. wall and floor junctions, and at the edges of elements such as those around window and door openings. Reasonable provision should also be made to reduce unwanted air leakage through the newly constructed thermal elements.

Renovation of Thermal Elements

Renovation of a thermal element i.e. floor, wall or roof, could include the provision of a new layer, such as cladding or rendering an external wall surface or dry-lining the internal surface. It could also involve the replacement of an existing layer, such as replacing the water proof membrane on a flat roof.

Where 50% or more of the surface of a thermal element, or 25% of the total building envelope is renovated, the performance of the whole element should be improved to achieve or better the recommended target U-values (see Table 3)

If achievement of the target U-value is not technically or functionally feasible or would not achieve a simple payback of 15 years or less, the element should be upgraded to the best standard that falls within those criteria.

Retained Thermal Elements

Where an existing thermal element is part of a building subject to a material change of use, or where an existing element is to become part of the thermal envelope where previously it was not, e.g. as part of a loft or garage conversion where the space is now to be heated, those thermal elements should be upgraded to achieve the target U-values in Table 2, provided this is technically, functionally and economically feasible. A reasonable test of economic feasibility is to achieve a simple payback of 15 years or less.

Where the target U-value in Table 2 is not technically, functionally or economically feasible, then the thermal element should be upgraded to the

Element	Threshold U-value ($W/m^2.K$)	Target U-value ($W/m^2.K$)
Pitched roof – insulation at ceiling level	0.35	0.16
Pitched roof – insulation at rafter level	0.35	0.18
Flat roof or roof with integral insulation	0.35	0.18
Wall – cavity insulation	0.70	0.55
Wall – external or internal insulation	0.70	0.30
Floor	0.70	0.25

Table 3

best standard that is possible with a simple pay-back period of 15 years or less. Examples of where lesser provision than the target U-value might apply are where the thickness of the additional insulation might reduce usable floor area of any room by more than 5%, or where the weight of the additional insulation might not be supported by the existing structural frame.

Beware the cheap option

It's not difficult to see that with both internal and external insulation, there are potential space constraints: floor area reduction for internal and limits created by eaves overhangs for external. There is also an inevitable temptation on cost grounds to use as cheap an insulation material as possible. However, cheap insulation materials also tend to be at the low end of the performance spectrum and, therefore, the thickness needed to achieve the required U-value of $0.30W/m^2.K$ is more likely to transgress the 5% floor area reduction limit or to be too thick to fit under an existing eaves overhang.

The temptation would be to argue to building control that the thickness should be reduced to fit the space available. However, LABC has produced a guidance document on the renovation of thermal elements, which sets out the circumstances under which this might be acceptable. The guidance makes it absolutely clear that the U-value cannot be debased, without first considering whether a higher performing insulation material can deliver the required U-value within the space constraints of the building and the 15 year simple payback period.

Specification Matters

Working within the constraints of an existing structure is bound to have its challenges, but this guidance from the LABC makes it clear that the target U-values set out in ADL2B should not be derogated if it is technically and economically feasible to achieve them. Using high and premium performance products such as rigid thermoset insulation make this possible by providing thin, lightweight solutions that offer a payback within 15 years.

Material Change of Use and Change of Energy Status

Where a building is subject to a change of use, or a change to its energy status, which results in a building becoming subject to the energy efficiency requirements of the Building Regulations, where previously it was not, then ADL2B requires that the thermal performance of the walls, floors and roofs achieve a minimum standard of performance, which varies depending on the nature of the works taking place.

Case Study

Lowery Centre, Waltham Forest College

Forming part of the second stage in the multi-million pound 'Heart of the College' development, the 1960's Lowery Centre was externally refurbished, using Structural Insulated Panels (SIPs) to re-clad the existing building.

The original cladding of the centre's upper three floors was stripped back to reveal the concrete floor slabs. Screws were drilled through the four corners of the Kingspan TEK® Cladding Panels and fixed into brackets; these were then fixed to separate slotted brackets which were secured to the floor slabs. This double bracket arrangement allowed the position of the Kingspan TEK® Cladding Panels to be adjusted in order to ensure a smooth exterior surface. The external walls were designed to achieve a U-value of 0.25W/m^2.K.

Window openings in the Kingspan TEK® Cladding Panels were designed to be smaller than those in the original cladding solution, minimising solar gains during summer and heatloss in winter. A breather membrane was stapled to the exterior face of the Kingspan TEK® Cladding Panels and the windows were bracketed within the openings. To allow the application of the external render timber battens were screwed in place outside the breather membrane and particle boards were fixed to these. The grey and white external render system was then applied to the surface of the particle boards.

Introducing Part L 2013

Part L 2013 came into force on 6th April, and Hywel Davies, Technical Director of the Chartered Institution of Building Services considers the 2013 changes...

Over the past 8 months the government has published revised Building Regulations, new editions of the Part L Approved Documents for new buildings (ADL1A and 2A) and the non-domestic and domestic Compliance Guides, together with amendments to the Part L Approved Documents for works to existing buildings (ADL1B and 2B). As we prepared for when these came into force on 6th April, the picture is now pretty much complete.

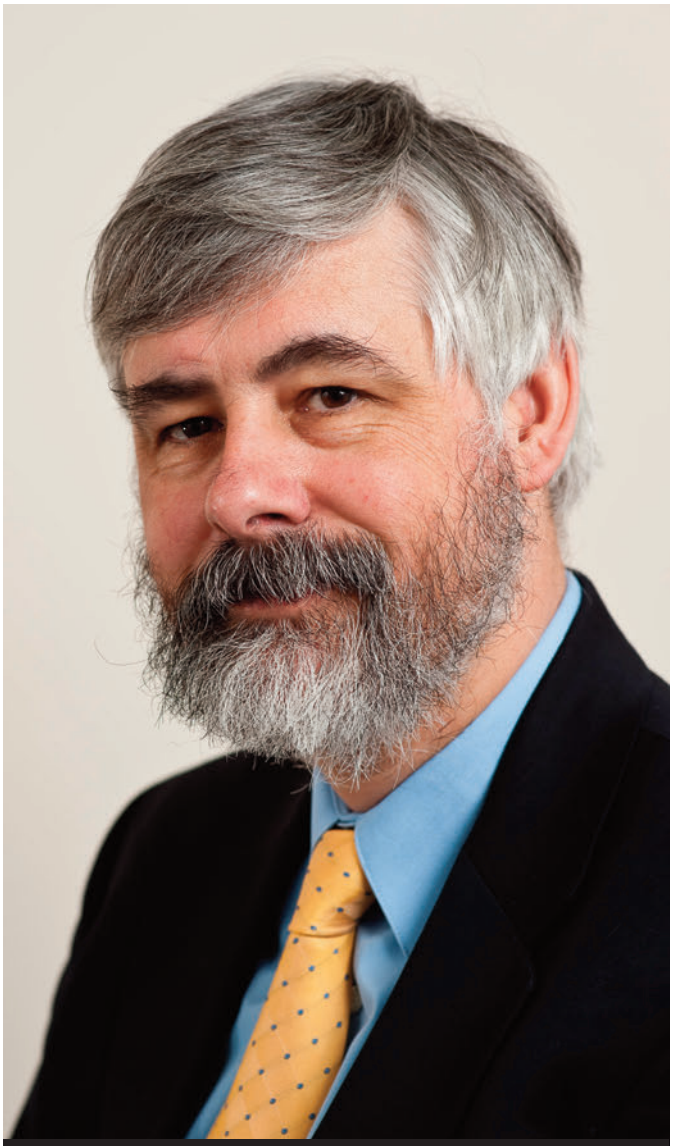
We now know the major changes to the requirements for 2013. Homes must achieve a 6% improvement in carbon emissions relative to 2010, and a new regulation requires a calculation of the fabric energy efficiency both at the design stage and on completion. This calculation must be submitted to building control at each point. Non domestic buildings will, on aggregate, need to achieve a 9% improvement, but the exact figures vary by building type. For offices and hotels the improvement required is 12 or 13 , whilst for warehouses it is between 3% and 8% depending on the layout and size of the warehouse. Table 5 of Approved Document L2A (1) contains a summary of the key characteristics of the notional building.

To support these changes in the non-domestic target, there is a wider range of notional non-domestic buildings, including smaller warehouses, top lit and side lit buildings. The Department of Communities and Local Government (DCLG) and its advisers consider that these requirements are achievable with good fabric and building services design, and construction or installation in most building types. They do not see the installation of renewable energy generating equipment as being necessary to achieve the new targets in most cases.

There are also changes to the detailed standards for building services, contained within the non domestic compliance guide, specifically relating to chillers, fan coil units and lighting. The minimum cooling efficiency of chillers is increased from 2.5 to 2.7, and the specific fan power of fan coil units is reduced from 0.6 to 0.5 W/l/s. It is also worth noting that in calculating the costs of these changes, a service life of 15 years is assumed for the fan coils and chillers, and 20 years for lighting. Other aspects of the building are assumed to have a service life of 60 years, for the purposes of calculating costs for the impact assessment.

"Homes must achieve a 6% improvement in carbon emissions relative to 2010, and a new regulation requires a calculation of the fabric energy efficiency both at the design stage and on completion."

The 2013 edition sees the introduction of the Lighting Energy Numerical Indicator, or 'LENI', as an alternative compliance route for lighting design. Lighting professionals, led by the Society of Light and Lighting, have been seeking this change for



Hywel Davies, Technical Director
Chartered Institution of Building Services

some time, as it helps to align lighting design practice with other aspects of European Standards for lighting. It also gives competent lighting designers additional flexibility and design freedom. However, for smaller lighting installations, that are often installer designed or specified, the existing simple requirements have been strengthened with an increase in initial luminaire efficacy to 60 lamp lumens per circuit watt.

The 2013 edition of the regulations also includes consolidated requirements introduced in 2012 to implement some aspects of the Energy Performance of Buildings Directive (EPBD), which requires "the feasibility of high-efficiency alternative systems to be taken into account before construction commences". It is not entirely clear what this will mean in practice. Whether it will require a specific report to be submitted to building control, or just an affirmation that "something has been done", or indeed whether there will be any meaningful enforcement at all, remains to be seen.

A further welcome change is to the layout of the Approved Documents, which are now in a single column format and so far easier to read on screen on a desktop, laptop or even a tablet. And finally, Part L 2013 only applies to England, and not to Wales, who are producing their own regulations and guidance for the first time since Building Regulations were devolved to the Welsh Assembly.

The new guidance came into effect on 6th April 2014, and any work started before then is covered by the 2010 edition of the guidance. Any work which is subject to a building notice, full plans application or an initial notice submitted before 6th April 2014 will also be covered by the 2010 guidance provided it is started before 6th April 2015.

http://www.planningportal.gov.uk/uploads/br/BR_PDF_AD_L2A_2013.pdf

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The next step to zero carbon

Paul Wilkins, Chairman of the Association of Consultant Approved Inspectors outlines how Part L 2013 has provided some business certainty for developers and architects...

The Association of Consultant Approved Inspectors (ACAI) welcome the recent initiative of the Department for Communities and Local Government (DCLG) who have now developed a more comprehensive strategy to deliver the zero carbon buildings of our future. The consultations on changes to the Regulations, and the introduction of Allowable Solutions has developed a roadmap to meet the deadlines set between 2016 and 2020. This brings a welcome business certainty (if government policy is unchanging) to developers and architects. We can now plan how we push developments to meet these targets knowing when, and more importantly, being guided as to how this is being delivered.

It is clear the DCLG appreciated the impact of the recession and resultant house-building crisis by setting the 2013 Part L as reasonably achievable improvements. The uplift from the 2010 standards are in the order of improvements of 6% on housing and 9% on non-domestic. This is also averaged over different building types (including housing) to appreciate the different energy profiles. This means that there is a sympathetic approach to targets ranging down to 3% in difficult buildings.

Some key points are:

Fabric and services: The 2010 standards of efficiency is close to the optimum. The 2013 changes to U-values and efficiency of services in the Approved Documents and notional buildings push standards to the best level without, if possible, resorting to renewables. This means that in theory, standards for services and fabric will not change

radically all the way to 2020 as we are reaching limits of efficiency with these components.

Generation: Renewables will, however, need to be specified more often to meet the 2013 standards due to difficult sites, options available and design/cost choices. Certainly for the next push in 2016 to meet higher standards, it will mean that we will have to now consider generation as a standard concept in design (not as a bolt on fix for a shortfall). We trust as happened with PV – over the next few years the market and industry will respond to demand, and renewables will develop by being both more efficient, and cheaper.

"It is clear the DCLG appreciated the impact of the recession and resultant house-building crisis by setting the 2013 Part L as reasonably achievable improvements."

Allowable solutions: The appreciation of a route to meet the toughest zero carbon goal. This "end game" is a route to meeting the toughest targets – even on difficult sites. This will allow offsite options and financial redress if you cannot make a building perform at a figure of zero (BER) on the SAP/SBEM. The option of payment is a careful and balanced thought provoking process to encourage on site solutions but allow alternatives.

Clearly the changes have developed a 2 sided approach to the targets. Firstly (and the title of Part L) Conservation of fuel and power which has a value in energy terms. The reduction of carbon emissions is an independent value within the new SAP and SBEM tool. The software packages now evaluate both these values and report pass/fail values on energy and carbon efficiencies. This also prevents "greenwashing" which was a potential as we push the limits of our building performance. Loading up a poorly designed and inefficient building with PV is not an option. The strategy is to push the design and specification of services to the best values – for instance designing out solar gains (not simply adding cooling).

One area of specialist advice that will no doubt develop further is the interpretation of SBEM and SAP assessments. The complex and hidden data and information which is driven to a single figure answer will need to be analysed, and be subject to expert advice and guidance. Building control staff are trained and used to dealing with hundreds of these documents and build up an expertise and analytical ability to offer proactive guidance. A few examples are:

- Increasing a canopy by 600mm to prevent solar gain following a SBEM failure due to the cooling load. A simple fix with no maintenance and long term benefits;
- Advising on over specification of lighting and identifying that this was an unreasonably high proportion of the building energy profile;
- Choosing which element of energy profile would be most beneficial by considering the supporting data on annual energy use.

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