Keystone GROUP

FABRIC FIRST APPROACH TO SUSTAINABLE CONSTRUCTION

A review of the benefits of an improved fabric build specification as a preference to low carbon or renewable energy technologies

Incorporating a review of the
Keystone Hi-therm Lintel

AES Sustainability Consultants

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1. PREFACE

1.1 This statement provides an overview of current policy and research relating to the conservation of energy and the reduction in carbon dioxide (CO_2) emissions from new developments, and seeks to demonstrate that sustainable development can be achieved most effectively and efficiently through following a 'fabric first' approach.

1.2 The statement will establish that the fabric first approach detailed is technically, environmentally and economically more viable than the installation of low carbon and renewable energy technologies, including decentralised energy supply systems, cogeneration, district heating, and heat pumps.

1.3 A review of the Keystone Hi-therm lintel and Keylite roof window has been undertaken to assess their potential energy demand reductions in comparison to standard equivalent products. A range of calculations demonstrates that these products can contribute significantly to the fabric first approach to sustainable construction.

2. INTRODUCTION – SUSTAINABLE DEVELOPMENT

2.1 Published in March 2012, the Department for Communities and Local Government (DCLG) National Planning Policy Framework (NPFF) includes the following policy statement relating to environmentally sustainable development:

NATIONAL PLANNING POLICY FRAMEWORK 2012

95. To support the move to a low carbon future, local planning authorities should:

- plan for new development in locations and ways which reduce greenhouse gas emissions;
- actively support energy efficiency improvements to existing buildings; and
- when setting any local requirement for a building's sustainability, do so in a way consistent with the Government's zero carbon buildings policy and adopt nationally described standards

96 In determining planning applications, local planning authorities should expect new development to:

- comply with adopted Local Plan policies on local requirements for decentralised energy supply unless it can be demonstrated by the applicant, having regard to the type of development involved and its design, that this is not feasible or viable; and
- take account of landform, layout, building orientation, massing and landscaping to minimize energy consumption.

2.2 The NPPF therefore seeks to drive an overall reduction in energy demand and consequent CO_2 emissions from new developments. Specific policies to achieve additional energy demand and greenhouse gas emission reductions above the level of the Building Regulations are expressly left for local authorities to develop.

2.3 Energy policies within Local Plans are primarily guided by national legislation contained within the Planning and Energy Act 2008:

PLANNING AND ENERGY ACT 2008

1. Energy Policies

(1) A local planning authority in England may in their development plan documents, and a local planning authority in Wales may in their local development plan, include policies imposing reasonable requirements for–

(a) A proportion of energy used in the development in their area to be energy from renewable sources in the locality of the development

(b) A proportion of energy used in the development in their area to be low carbon energy from sources in the locality of the development

(c) Development in their area to comply with energy efficiency standards that exceed the energy requirements of building regulations.

2.4 Supported by these provisions, a common approach to achieving the aims of CO_2 emission reductions is for Local Plans to require new-build developments to generate a proportion of the site-wide energy demand through the installation of low carbon or renewable energy sources.

2.5 The main aims of these low carbon and renewable energy policies, as apparent from the wording in the Planning and Energy Act and the NPPF, are twofold:

- Reduce carbon emissions from housing development; and
- Reduce reliance on centralised, non-renewable energy sources.

2.6 These aims form the key considerations when developing strategies for sustainable energy use in buildings, and are acknowledged at a National and International level.

3. ENERGY EFFICIENCY AND LOW CARBON POLICY

NATIONAL POLICY & BUILDING REGULATIONS - PART L

3.1 National policy has primarily driven a reduction in CO_2 emissions from new development through changes to Part L of the Building Regulations in England and Wales. Updates in 2010 and 2013 mandated CO_2 reductions from residential development cumulatively equating to approximately **30% less than Part L 2006**, when minimum standards for CO_2 emissions were first introduced.

3.2 The energy demand reduction objective was further supported by the introduction of a minimum fabric standard into Part L 2013, based on energy use for **heating and cooling a dwelling - the 'Target Fabric Energy Efficiency' (TFEE).** This performance metric was previously used as part of the Code for Sustainable Homes assessment methodology, and has now been incorporated into the Building Regulations to set a minimum compliant standard expressed in kWh/m2/year.

3.3 This standard enables the decoupling of energy use from CO_2 **"emissions and serves as an acknowledgement of the importance of reducing demand, rather than simply offsetting CO2 emissions through low carbon or renewable energy technologies".**

3.4 Prior to Part L 2013 being introduced, an Impact Assessment (IA)[1] was carried out, with the findings supporting the increase of mandatory standards across the build mix. The IA also stated that **"The changes for 2013 should…stimulate fabric focused learning and innovation as the basis for more demanding future policies".**

3.5 The IA recognised that a number of 'market failures' exist when considering sustainable building policy, including an acknowledgement that "a failure to set standards at point of build can lock a building into higher energy consumption, giving those consumers who do want to act limited scope to make savings".

3.6 This lock-in effect was one of the key reasons for a focus for improving building fabric standards, with the IA recognising that driving improvements through Part L means that "The need for energy efficiency measures to be retrofitted at a higher cost later can be avoided" and acknowledging that "Occupants have limited incentive to refurbish their buildings to higher energy standards, as the payback periods through lower fuel bills alone can be unattractive" due to these high retrofit costs.

"The changes for 2013 should… stimulate fabric focused learning and innovation as the basis for more demanding future policies".

"This standard serves as an acknowledgement of the importance of reducing demand, rather than simply offsetting CO2 emissions through low carbon or renewable energy technologies".

"The need for energy efficiency measures to be retrofitted at a higher cost later can be avoided".

1 DCLG, Changes to Part L of the Building Regulations 2013, Impact Assessment, August 2013

FUTURE POLICY DIRECTION

3.7 The anticipated future changes to government planning policy were introduced in early 2015 through a planning written ministerial statement of 27th March[2]. This statement accompanied the passing of the Deregulation Act 2015 and the conclusion of the Housing Standards Review, and indicated that from the date of the anticipated introduction of ‘zero carbon homes’ policy - the timescale for which is still to be confirmed - all energy efficiency standards for new buildings will be incorporated in the Building Regulations.

3.8 Future changes to introduce ‘zero carbon homes’ will require further CO_2 reductions being mandated through an update to Part L, and it is expected that this **improvement** will be primarily delivered through improvements to building fabric energy efficiency.

EU POLICY

3.9 The EU’s main legislative mechanism to drive improvements in building sustainability is the Energy Performance of Buildings Directive[3]. Article 9 requires that “Member States shall ensure that by 31 December 2020 all new buildings are nearly **zero-energy buildings…”** A nearly zero-energy building is defined in Article 2 as “a building that has a very high energy performance. **The nearly zero or very low amount of energy required** should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby”.

3.10 The EPBD therefore acknowledges that the first crucial step in delivering more sustainable buildings is the reduction of energy use to the minimum level practicably achievable, with the aim that the residual energy demand can be largely provided by low and zero carbon energy technologies, either on or off-site.

CO^2 REDUCTIONS TIMELINE

Part L 2006
(Benchmark)

Part L 2010
25% Less than 2006

Part L 2013
6% Less than 2010

2020
Nearly Zero-Energy Buildings?

4. THE FABRIC FIRST APPROACH

'as we approach 2016 and the concept of zero carbon homes, making new dwellings as energy efficient as possible is the crucial first step.'[5]

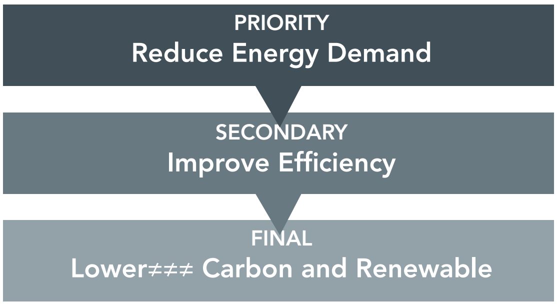


Figure 1. The Energy Hierarchy approach to sustainable construction

4.2 Applied to new-build housing, this approach is referred to as 'Fabric First' and concentrates finance and efforts on improving fabric U-values, reducing thermal bridging, improving airtightness, and installing energy efficient ventilation and heating services. The Energy Saving Trust endorses this approach stating that *'as we approach 2016 and the concept of zero carbon homes, making new dwellings as energy efficient as possible is the crucial first step.'*[5]

4.3 NHBC Foundation research also supports this view, with a 2013 report stating **"The most robust way to minimise energy use is through the building fabric. Getting the fabric right will save energy for the whole life of the dwelling."**[6]

4.4 The fabric first approach has for some time been supported by the housebuilding industry. The benefits are increasingly widely realised and ongoing research continues to re-inforce the significant positive impact this approach can have - economically, environmentally and socially. There is further explicit acknowledgement of the benefits of this approach through the introduction of Fabric Energy Efficiency Standards into Part L of the Building Regulations 2013, intended to **"discourage excessive and inappropriate trade-offs… for example… poor insulation standards being offset by renewable energy systems with uncertain service lives."7**

4.5 Set out below are the reasons why a fabric first approach to development and the adoption of energy demand reduction measures should be considered preferential to the installation of low and zero carbon technologies. These are supported in part by a review completed by the NHBC Foundation[8], which stated:

> The review recommends that the emphasis in policies designed to reduce CO_2 emissions be placed firmly on improving the thermal performance of the building fabric first for future-proofing and for cost-effectiveness.

NHBC

5 Energy Saving Trust (2010), Fabric first: Focus on fabric and services improvements to increase energy performance in new homes.
6 NHBC Foundation (2013), Designing Homes for the 21st century – Lessons for low energy design
7 The Building Regulations 2010, Approved Document L1A, 2013 Edition
8 NHBC Foundation (2009), The Merton Rule: A review of the practical, environmental and economic effects.

4.6 **The reduction in CO_2 emissions achieved through fabric measures is built in for the life of the building** and therefore can ensure that the energy demand and CO_2 emissions of a site remains low. "**Renewable technologies, on the other hand, have a limited lifespan and risk a significant increase in CO_2 emissions from a development once they reach end of life, if not replaced at significant cost to the homeowner".**

4.7 **The reduction in CO_2 emissions achieved through energy demand reduction measures is applied to every dwelling on site** and not just those considered most suitable for renewable technologies. On many developments with a policy requiring renewable contributions, PV panels would only be specified to a select number of dwellings on site with favourable roof space and orientation. On the other hand, fabric measures will generally be applied to every single dwelling on site enabling all homeowners to benefit from reduced energy bills. This is of particular relevance and importance to sites that have affordable housing, where reducing energy bills is key to reducing the likelihood of fuel poverty.

4.8 **Focusing on fabric energy efficiency promotes the concept of using less energy** and may encourage behavioural change of homeowners. In order to reduce carbon dioxide emissions associated with buildings the most important step, and the step that would have the largest impact, is for homeowners and tenants to reduce their energy consumption.

4.9 **Renewable technologies could be fitted by the homeowner after occupation**, whereas it would be difficult to improve the fabric without considerable investment and disruption. The energy efficiency measures proposed include items such as increased insulation in roof, increased thickness of the external wall cavity to provide increased insulation and a reduced air leakage. Whilst occupiers may be able to install insulation in the roof without too much trouble, they would have significant difficulty in increasing the width of the wall cavity and reducing the air permeability of the dwelling. Reducing the U value of the double glazed windows specified would require considerable investment and it would be unlikely that this measure would meet the 'Golden Rule' as set out in the Green Deal, requiring the energy savings over a maximum of 25 years being equal to or more than the cost of implementing the improvements. Installing renewable technologies, on the other hand, would not be so difficult. Furthermore, the installation of renewable technologies is more likely to be considered a suitable recommendation under the Green Deal and through the Government's flagship scheme occupiers could benefit from reduced energy bills with little to no upfront cost, in addition to potential benefits from the current feed-in tariff.

Renewable technologies have a limited lifespan and risk a significant increase in CO_2 emissions from a development once they reach end of life, if not replaced at significant cost to the homeowner.

4.10 **When compared to renewable technologies, fabric measures achieve equivalent CO_2 savings at less cost.** Table 1 is taken directly from the NHBC Foundation's review. It demonstrates that, having taken into account the embodied energy and maintenance associated with renewable technologies, the cost per tonne of CO_2 saved is over 4 times less where fabric improvements are installed instead of renewable technologies i.e. **equivalent CO_2 savings are achieved at over a quarter of the cost.** The costs saved by a developer may increase the viability of a scheme and may allow other S106 requirements to remain undiminished.

4.11 **Fabric measures will increase thermal comfort within the dwelling.** Achieving a reduction in carbon dioxide emissions is not the only consideration when designing an energy efficient house. Two important factors that should also be taken into consideration are condensation risk and thermal comfort. Improving thermal detailing and the quality of build reduces the risk of cold spots and, in turn, condensation. Mould growth is most commonly found in the corners of properties as this is where one element of a building meets another and it is highly likely that the insulating layer which has been wrapped around the building will be pierced. This problem can be avoided with good thermal detailing, as good design can ensure that the cold bridge is reduced or even eliminated.

NHBC Foundation Review - Main Findings – Costs and CO_2 Savings

Scenario	Initial 20-year CO_2 saving (tonnes)	60-year CO_2 saving (tonnes)	Immediate cost (£)	60-year cost (£)	Cost per tonne of CO_2 saved (£)
Built-fabric improvements only	163 (10.9%)	488 (10.9%)	47,787	60,546	124
Renewables only	180 (12%)	540 (12%)	101,198	283,593	525
Built-fabric improvements and renewables combined	343 (22.9%)	1028 (22.9%)	148,984	344,138	335

Table 1

When compared to renewable technologies, fabric measures achieve equivalent CO_2 savings at less cost

Renewable technologies have a limited lifespan and risk a significant increase in CO_2 emissions

4.12 Thermal comfort is not taken into account by Standard Assessment Procedure (SAP). In a room that has a poor fabric it has been shown that occupants often will feel colder than in the same room with a good fabric even when the temperature is the same.
This is mainly due to increased draughts. There is a risk that homeowners will turn up the thermostat to counteract the effect of the draughts and in turn increase the energy consumption of the property. Renewable energy technologies are not able to improve thermal comfort in these ways.

4.13 **The market appeal of a development is maintained** through the use of built in fabric measures rather than bolt on renewable technologies. The aesthetics of any development is important to ensure that people live in a pleasant environment. Some buyers view renewable technologies as ugly bolt-ons and this potentially makes it more difficult for the developer to sell houses.

4.14 **Renewable technologies require maintenance.** All low or zero carbon technologies require some level of maintenance, whereas increased energy efficiency measures are built into the fabric and require no maintenance beyond that associated with a standard new-build dwelling. For example if photovoltaic panels (PV) were to be installed, it is likely that the inverters forming part of the PV system would need to be replaced between 2-3 times over the 25-40 year lifespan of the panels. In addition to the replacement part costs, the panels would need to be periodically cleaned to remove any dirt build-up and maintain the potential maximum efficiency. This long term maintenance is an unattractive proposition for tenants and homeowners looking to move to a new development.

4.15 The benefits to prospective homeowners of following the Fabric First approach are summarised in Table 2.

Benefits of the Fabric First approach

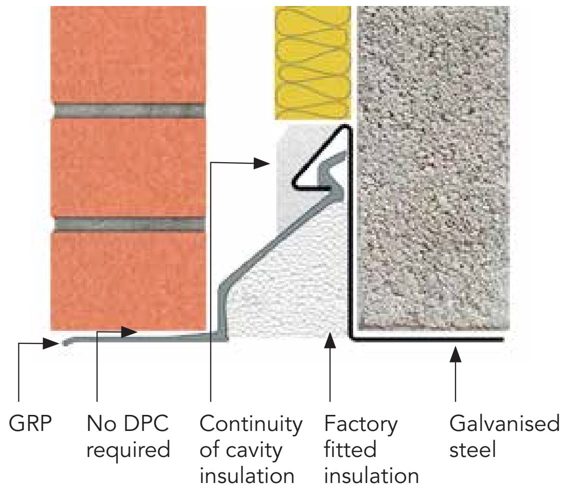
	Fabric energy efficiency measures	Bolt-on renewable energy technologies
Energy/CO_2/fuel bill savings applied to all dwellings	✓	×
Savings built-in for life of dwelling	✓	×
Highly cost-effective	✓	×
Increases thermal comfort	✓	×
Potential to promote energy conservation	✓	✓
Minimal ongoing maintenance / replacement costs	✓	×
Minimal disruption to retrofit post occupation	✓	×

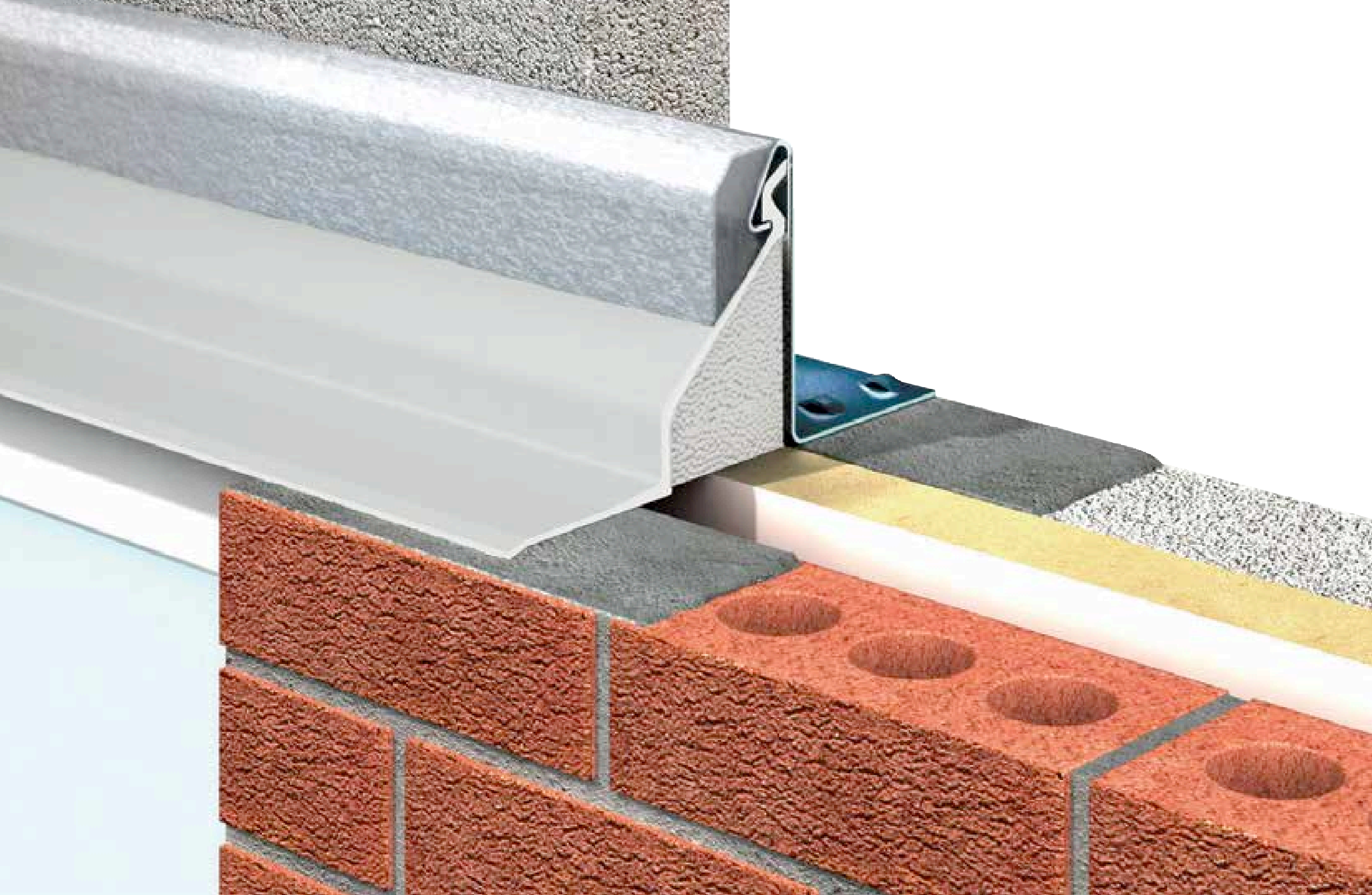
Table 2

Hi-therm™ LINTELS

Keystone Lintels has redefined lintel performance with the introduction of its new, innovative Hi-therm Lintel which offers a thermal performance that is up to five times more efficient than a standard cavity wall steel lintel.

The Hi-therm Lintel bonds the internal and external walls together by spanning the intervening gap and contributes towards the achievement of lowering CO_2 and improving Fabric Energy Efficiency (FEE). It can be manufactured to suit different cavity widths, making it ideal for a wide range of different building types. This impressive new lintel, approved by the British Board of Agreement (BBA), has an extremely low Psi value of 0.04 - 0.06 W/mK.





5 KEYSTONE HI-THERM LINTEL AS PART OF THE FABRIC FIRST APPROACH

5.1 This section of the report will consider the potential contribution of the Hi-therm Lintel as part of the fabric first approach to sustainable construction.

FABRIC ENERGY EFFICIENCY AND THERMAL BRIDGING IN PART L

5.2 The update to Part L in 2013 introduced a minimum standard for the energy required for heating and cooling of the dwelling being assessed. This 'Target Fabric Energy Efficiency' (TFEE) is calculated based on the specific dimensions of the dwelling under consideration, with assumptions for the thermal performance based on the 'Notional Specification' contained within L1A as shown in Table 3.

5.3 Individual building elements are required as a minimum to meet the limiting fabric parameters contained within Part L1A, however as demonstrated in Table 3, the notional specification values used to calculated the TER and TFEE are significantly better than these 'backstop values'.

A reduction in performance in any area of the notional specification would need to be offset by an improvement in another area in order to ensure regulations compliance. **Conversely an improvement to an area would allow the relaxation of the fabric standard in another area, allowing a fully flexible approach and cost-effective solutions to be adopted.**

Part L1A 2013 Limiting Fabric Parameters

Element	Limiting Fabric Parameter	Appendix R Reference Values
External Walls	0.30 W/m²k	0.18 W/m²k
Party Walls	0.20 W/m²k	0.0 W/m²k
Floor	0.25 W/m²k	0.13 W/m²k
Roof	0.20 W/m²k	0.13 W/m²k
Windows	2.00 W/m²k	1.4 W/m²k
Opaque / glazed doors	2.00 W/m²k	1.0 / 1.2 W/m²k
Air tightness	10 m³/hr/m²	5 m³/hr/m²
Thermal bridging	Default Ψ = 0.150	SAP Appendix R-values

Table 3

THERMAL BRIDGING

5.4 **"Junctions between building elements, elements that cross over layers of insulation and elements which cause a significantly higher rate of thermal transfer than the surrounding materials are referred to as thermal bridges."** The heat losses at these junctions are considered independently of the u-values of the elements themselves, with 41 different potential junction types being identified within the SAP 2012 document and requiring assessment under Part L1A 2013.

5.5 The impact of these bridges increases proportionally with the reduction in heat losses elsewhere in the building envelope, and hence thermal bridging is of increasing importance when considered within a dwelling with more highly insulated walls, floors and roof. The improved requirements of Part L1A 2013 have a much greater focus on thermal bridging due to this factor.

REDUCING THERMAL BRIDGING

5.6 SAP calculations must account for either a default overall 'y-value' where calculations of all relevant junctions have not been undertaken, or a calculated value that takes into account the detailed characteristics of each junction and assesses the heat losses.

5.7 Thermal bridges can in many cases be designed out or **significantly** reduced through good detailing. Methods to achieve this are described through various industry standards including the Government published Accredited Construction Details (ACDs), as well calculations from other industry groups or individual manufacturers, following approved detailing.

5.8 In some areas the bridging of an insulation layer may be more difficult to avoid, for example above and around door and window openings or at ground floor junctions. In these areas the specification of products and materials designed to reduce thermal transmittance enable the structural requirements of the element to be met, but with materials designed to reduce the impact of bridging the insulation layer.

LINTELS

5.9 **Lintels are in most cases the most significant non-repeating thermal bridges,** as traditional style lintels interrupt the line of insulation with a continuous piece of highly conductive steel. The ACDs for a typical steel lintel assume a linear thermal transmittance (Psi value) of 0.30 W/mK, and could account for more than a third of the total heat loss through non-repeating thermal bridges, as demonstrated by the calculations in Table 4, based on two sample .... house types.

Lintel thermal bridging

	Total heat loss through thermal bridging (W/mK)	Heat loss through lintels (ACDs) (W/mK)	% of linear thermal bridging through lintels
House type 1	14.47	5.36	37.04 %
House type 2	15.77	6.58	41.72 %

Table 4

KEYSTONE HI-THERM LINTEL

5.10 The Keystone Hi-therm lintel utilises a two-piece construction, with a galvanized steel inner leaf supporting the inner blockwork connected to a GRP outer leaf supporting the outer brickwork. The GRP component has much lower thermal conductivity than steel – 0.2 W/mK as opposed to around 50 W/mK - reducing total heat loss substantially.

QUANTIFYING THE THERMAL BENEFITS OF HI-THERM LINTEL

5.11 The reduced thermal conductivity of the Hi-therm lintel means that the Psi value applied to the calculations for this key thermal bridge may be reduced to 0.05 W/mK or lower (depending on block conductivities and cavity width), ie. equivalent to around an 80% reduction in thermal transmittance. Table 5 demonstrates this reduction

5.12 As the lintel forms such a significant proportion of the overall heat loss through thermal bridging, improving this element leads to significant reductions in total heat loss, as demonstrated in Table 6.

5.13 Specifying Hi-therm lintels in place of a standard steel lintel following ACDs can lead to a saving of around a third in total heat losses from thermal bridging.

Reduction in thermal bridging through Lintels – Hi-therm vs ACD

	Heat loss – steel lintel, accredited details (W/mK)	Heat loss - Hi-therm	% of linear thermal bridging through lintels
House type 1	5.36	0.89	83.96 %
House type 2	6.58	1.10	83.28 %

Table 5

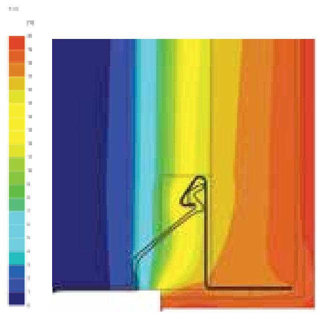
Reduction in thermal bridging using Hi-therm lintels

	Heat loss from all thermal bridging		Heat loss through lintels		Reduction in overall heat loss using Hi-therm Lintel
	With steel lintel (W/mK)	With Hi-therm lintel (W/mK)	Steel lintel (W/mK)	Hi-therm lintel (W/mK)	
House type 1	14.47	10.01	5.36	0.89	30.82 %
House type 2	15.77	10.29	6.58	1.10	34.75 %

Table 6

THERMAL PERFORMANCE TESTING

Testing of the Hi-therm Lintel was carried out by the BRE (Building Research Establishment) using Physibel's thermal analysis software TRISCO which complies with BS EN ISO 10211-1. The modelling follows the requirements of the BRE conventions document BR497.



80%
reduction in thermal transmittance through lintels in comparison to accredited construction detail.

CALCULATION OF DWELLING PERFORMANCE – CO_2 EMISSIONS

5.14 A sample range of dwellings have been assessed for their thermal performance incorporating the specification of Hi-therm Lintels and additionally the Keystone Group's Keylite roof window. A comparison has been undertaken with standard Accredited Construction Details / default values as appropriate.

5.15 The contribution to CO_2 savings from these products is in line with the improvements in thermal performance that they bring. As the savings realised are through a reduction in space heating demand, the precise level of CO_2 savings achieved will depend on the heating strategy for the dwellings under assessment. Table 7 shows the calculated improvement in CO_2 emissions for the sample house types assuming standard gas heating.

Improvement in Dwelling Emissions Rate

House type	DER - standard specification (kWh/m2/year)	DER – with Keystone Group products (kWh/m2/year)	Improvement in DER %
1	16.24	15.89	**2.16%**
2	16.70	16.31	**2.34%**
3	16.19	15.86	**2.04%**
4	13.97	13.65	**2.29%**
5	14.79	14.47	**2.16%**
6	14.16	13.83	**2.33%**

Table 7

5.16 **This significant improvement in Dwelling Emission Rate is in many cases sufficient to avoid more costly uplifts such as Waste Water Heat Recovery Systems, and may enable a reduced wall cavity width when considered as part of the overall construction specification, . therefore assisting house builders to achieve a value engineered building fabric.**

CONTRIBUTION TO SITE-WIDE ENERGY DEMAND REDUCTION TARGETS

5.17 Many local planning authorities require that the energy performance of dwellings on developments within their jurisdiction is improved beyond the standards of the Building Regulations. In many cases, this requirement is to reduce overall energy demand by 10%, or install renewable energy technologies to generate 10% of the developments requirements.

5.18 Table 8 calculates the potential contribution from Keystone products as part of a fabric first approach to addressing a 10% energy reduction requirement on a 50-unit site, which would otherwise be met through solar photovoltaic (PV) systems.

Representative contribution of Keystone products to site-wide energy targets

	Site-wide energy demand (kWh)	Additional energy reduction required (kWh)	Estimated Solar PV (kWp)
Standard build spec	276,615	27,662	32.5
With Keystone products	266,792	17,838	21.0
Saving	9,824		11.5

Table 8

5.19 This representative example demonstrates that following the fabric first approach described and installing the **Keystone products discussed could lead to significant savings in renewable energy systems**, in this example equivalent to approximately 11.5kWp solar PV, or 46 standard 250Wp panels.

5.20 In addition to the significant capital saving, the dwelling energy performance for the whole life of the building is improved long after the renewable energy technologies have reached end-of-life, in addition to the numerous other benefits described in the previous sections of this report.

{ Keystone products discussed could lead to significant savings in renewable energy requirements. }

6 CONCLUSIONS

6.1 This report discusses the key drivers and policies surrounding the move towards more energy-efficient homes. National policy is progressively tightening the requirements around energy consumption and the consequent production of carbon dioxide emissions from new development, with an increasing focus and minimum standards relating to the performance of the dwelling fabric being introduced into Part L 2013.

6.2 This report sets out the widely supported 'Fabric First' approach to development and demonstrates that this enables the energy demand & CO_2 reduction objectives contained within Building Regulations to be met, while delivers significant additional benefits over the installation of low and zero carbon technologies. The three key advantages are:

- The reduction in CO_2 emissions achieved through fabric measures is built in for the life of the building.
- The reduction in CO_2 emissions achieved through energy demand reduction measures is applied to every dwelling on site and not just those considered most suitable for renewable technologies.
- When compared to renewable technologies, fabric measures achieve equivalent CO_2 savings at lower cost.

{ Hi-therm lintels can reduce thermal bridging by approximately **34%** }

6.3 The increasing focus on thermal bridging in Part L1A 2013 means that materials specification and junction detailing needs to be carefully considered as part of the overall compliance strategy. Poorly performing products and calculations utilising default values are increasingly penalised and therefore products and materials which enable good detailing or have inherently high thermal performance are beneficial.

6.4 A review of the Keystone Hi-therm lintel has been undertaken to assess its contribution as part of the Fabric First approach, in comparison with the specification of a standard equivalent product. This review demonstrates the Hi-therm lintel performs approximately 80% better than standard steel lintels, with calculations demonstrating that overall heat loss through thermal bridging may be reduced by approximately 34% through the specification of this product.

6.5 A representative site model establishes that if considered as part of an overall 'Fabric First' approach to meeting site-wide energy demand reduction planning requirements, the specification of the Keystone products may lead to a significant reduction in renewable energy systems. On the representative 50 unit site modelled with a 10% energy reduction condition, these products may save the equivalent of a third of the total solar PV requirement, significantly reducing capital outlay on renewable energy systems as well as ensuring the long term benefits of the Fabric First approach discussed within this report.

{ Keystone products may lead to a significant reduction in renewable energy systems. }

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