ENERGY – HOW TO USE LESS
Meeting of the Parliamentary and Scientific Committee on Tuesday 6th November

ENERGY EFFICIENCY SOLUTIONS FOR BUILDINGS

BASF is the world’s leading chemical company. Its chemical products are used in almost all industries, from electronics and agriculture to consumer goods and construction.

By 2050 it is estimated that the world population will grow to about nine billion and 75 per cent of those will be urban dwellers. This is a challenge that demands new concepts for housing and construction.

As a leading provider of raw materials, systems and solutions to the construction industry, BASF is working with industry to increase the energy efficiency and lifespan of buildings, developing solutions that reduce the amount of resources needed for construction and contribute to greater living comfort. Our insulation materials, concrete admixtures and many other products help significantly to reduce carbon emissions generated by buildings over the course of their lifecycles. According to the Intergovernmental Panel on Climate Change, by 2030 around 6.5 billion metric tones of CO2 emissions could be saved globally in the area of housing and construction. As a result, BASF construction experts are actively engaged in Green Building Councils and work closely with architects, planners and urban developers to create housing for all types of climates and diverse architectural traditions. In the UK we have partnered a number of organisations to provide data and evidence for industry to demonstrate the savings which can be achieved from adopting energy efficiency measures.

UNIVERSITY OF NOTTINGHAM CREATIVE ENERGY HOMES PROJECT: AFFORDABLE, LOW CARBON HOUSING

The objective for the BASF House, Nottingham, was to design an affordable, practical, low Carbon home. At the outset the target was for the house to have an energy consumption of 15kWh/m² (meeting Passivhaus standards). The highly insulated fabric of the building (specified U-value for walls of 0.15W/m²K) is considerably in advance of current Building Regulations and the structure was designed to demonstrate a cost-effective approach to meeting Level 4 of the Code For Sustainable Homes.

The first principle was to design the fabric of the house to be well insulated to minimise energy loss. A combination of insulation materials demonstrated the range that exist in today’s market.

Since its completion in 2008 the house has been occupied by both University staff and students and has been carefully monitored as part of the University’s research into building with low carbon solutions and the impact of occupier behaviour. Data from the building’s sophisticated monitoring equipment have evaluated energy consumption, and a range of climatic conditions in the house from the temperature and relative humidity to the lighting, solar radiation and ventilation. The occupants were electronically tagged to create a record of their living patterns. An important aspect of the house’s evaluation was to test the general comfort and practicalities of the house and how it affects the occupants.

Initial monitoring data indicate that the house is beating the target of 15kWh/m² and achieving as little as 10kWh/m².

... savings from adopting energy efficiency measures ...
SUMMARY OF MATERIALS USED

The lower floor and foundations were built using the BASF Neopor® insulated concrete formwork (ICF) system to provide high thermal mass. Neopor, a lightweight, expandable polystyrene (EPS) contains graphite, which considerably enhances the insulation capacity. Blocks of Neopor were assembled to create the shape of the building, including window and door openings. The core was then filled with a pumpable concrete.

For the first floor a prefabricated timber insulated sandwich panel system (SIPS) was used, containing BASF rigid polyurethane insulation.

SIPS was chosen because of the high insulation factor, outstanding air tightness, light weight and the ability to prefabricate off-site non-rectangular shapes – ie for the gable walls. The roof was also constructed of SIPS to demonstrate the versatility of BASF heat management solutions used within the steel coatings.

The result is that the walls and roof structures have a U-value of 0.15W/m²K combined with high air tightness. The South facing aspect of the house consists largely of glazing in order to capitalise on passive solar gain.

The structure also considers the important issue of heat management. As new buildings have to be highly insulated to meet the Code for Sustainable Homes, the energy required to cool these houses down is a concern.

To overcome this issue a modified plasterboard incorporating Micronal® Phase Change Material (PCM) has been used internally within the house. Micronal PCM is made of polymer capsules containing a special wax mixture which stores latent heat. When the temperature rises above 23°C, the wax melts and the phase change material absorbs heat. When the temperature drops, the wax solidifies and heat is emitted.

This innovative material enables a 1.5cm thick plasterboard to contribute a
stable block into three energy
transform a disused Victorian
materials were used to
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THE BRE VICTORIAN
TERRACE  PROJECT

The UK Government has a
legally binding commitment to
reduce CO₂ emissions by 80%
by 2050. To meet this target it
has to ensure that existing
buildings are made more energy
efficient. The UK's housing stock
releases 150 million tonnes of
carbon dioxide per year, with
older buildings contributing
disproportionately. The
Government has therefore put
in place a country-wide energy
efficiency programme,
recognising that refurbishment
of the oldest housing stock is
essential.

In collaboration with BRE
(Building Research
Establishment) at its
headquarters in Watford, BASF
materials were used to
transform a disused Victorian
stable block into three energy
efficient terraced homes fit for
21st century living. The target
was to improve the energy
performance rating of the
building from band F to band
A/B.

INTERNAL AND
EXTERNAL INSULATION
SOLUTIONS

Over a third of the energy
heating a property escapes
through the external walls. Old
solid wall, hard-to-treat buildings
such as the BRE Victorian
Terrace are most affected.
Through participation in this
project, BASF has demonstrated
innovative products and
solutions that tackle a number
of the issues facing the
refurbishment market.

The finished development
now houses an Information
Centre where Visitors are able to
learn about best practice
refurbishment, including the
latest processes, materials and
technological advances to treat
existing homes.

One of the walls of the
presentation room was internally
lined with rigid polyurethane
insulation. Magnesium oxide
boards were adhered to an
80mm Polyisocyanurate (PIR)
insulation board consisting of a
foam core with two low
emissivity facers. This achieved a
U-value of 0.22W/m²K.

The South wall of the
presentation room presented
additional challenges. The wall
was very unstable so a number
of structural repairs had to take
place before all the existing
plaster was removed.
WALLTITE® spray foam
insulation was then sprayed
directly onto the rough, bare
brick substrate to a thickness of
100mm without the need for
primer or levelling coat. The
strength of WALLTITE helped to
consolidate this very unsound
surface. WALLTITE is a closed
cell foam. Its structure helps to
control the movement of vapour
and moisture throughout the
building, reducing the risk of
mould and condensation. At a
thickness of 100mm, WALLTITE
achieved a U-value of
0.25W/m²K.

An added performance
property of WALLTITE is the air
tightness of the system. Air
leakage accounts for 25-50% of
heat loss. WALLTITE has no
joints and has a measured air
leakage value of 0.0033 @ 50
pascals m3/h·m-2 per BSRIA.
Further performance was
achieved by eliminating thermal
bridging via studwork or framing.
The whole surface area of the
wall was sprayed seamlessly and
then finished with gypframe
studs before applying
plasterboard.

Three of the walls were
insulated with an External
Thermal Insulation Composite
System (ETICS) consisting of
150mm thick insulation boards
made of BASF's Neopor
expandable polystyrene (EPS)
and the Heck® external render
system. Neopor insulation
boards were fixed to the outside
of the building and covered with
an alkali resistant reinforcing
mesh, scrim adhesive and a final
decorative finish. This layered
method reduces heat loss and
prevents water ingress.

It is not only the walls that
need consideration. Uninsulated
floors can produce as much as
15% of heat loss from a
building, while effective
waterproofing is essential for a
building of this age.

The floor was therefore
made fully waterproof using
BASF’s Thorojoseal® Super which
was lapped up the walls to
form a damp proof course.
Styrodur® C, an insulation
board, was chosen to meet the
thermal insulation requirements,
with the substrate then being
finished with PCI Novament®
Z3, a fast track screeding
solution with rapid cure
capabilities. The result is an
overall floor U-value considerably
less than the target of 0.22W/m²K in the Building
Regulations.

BASF's Micronal phase
change material (PCM) was
incorporated into the ground
floor presentation room to
contribute to the temperature
management of the space. In
this installation, the PCM was
incorporated into a suspended
ceiling tile system.

These projects are designed to
demonstrate how energy
efficiency can be built into the
structure of homes – whether
at the construction stage or as
part of refurbishment projects.
Visitors are welcome to both
sites. These are two projects in
which BASF has collaborated
and research continues to
provide evidence of how
chemical solutions can
contribute to sustainable
buildings – whether they are for
commercial, industrial or
domestic use.

For further information on
this and other demonstration
projects, go to www.basf.co.uk/
ecp1/Solutions_UK_Ireland/
Construction
ENERGY – HOW TO USE LESS

ENERGY EFFICIENCY: THE ROLE OF SMART METERS

The Meeting also heard from Ashley Pocock, Head of Regulation for Smart Metering at EDF Energy.

Among the points he made were the following:

The target is for the installation of smart meters in all homes and small commercial businesses to be completed between 2015 and 2019.

This will involve 34m properties, over 50m gas and electricity meters, and 50m other technical devices, including displays and communications equipment.

The Government has pledged to deliver a National Communication Network, combining 3 super-regional networks a central data hub.

The meters will allow for a seamless transition between different energy suppliers, and will support different payment modalities. One immediate benefit is that it will no longer be necessary to have estimated bills - a great source of customer dissatisfaction.

For most consumers £ is more intelligible than kWh, and so this is how the information will be displayed. There will not be an output revealing the CO₂ footprint of generation.

When the customer signs up to acquire a meter, there will be three phases - a pre-installation consultation, then the installation itself, and a follow-up later to ensure comprehension and satisfaction.

It is clear that tariffs affect demand, but nonetheless an impact assessment suggests that savings overall will be small - less than 3% anticipated from increased sensitivity by consumers to the energy they use.

In order to achieve more, further changes in behaviour will be needed. Since the largest proportion of domestic energy is used for heating, consumers may have to get used to lowering thermostats, and of course improving insulation.

Even where families are living in identical houses, there can be significant variation in patterns of energy consumption. For example retired people have a comparatively flat pattern throughout the day. A family using, for example, hair dryers will have a noticeable peak early in the day.

Finally, although the benefits should be clear, no one will be compelled to accept such meters if they do not wish.

Additionally, there will be strict regulation to control external access to domestic data and to ensure both privacy and security are maintained by all providers and users of this unique, complex and extensive infrastructure.

ENERGY – HOW TO USE LESS

ENERGY EFFICIENCY

Energy policy in the UK is faced with three conflicting demands: security of supply, affordability and environmental impact; politically, all are important. Failure to keep the lights on or shortages at petrol stations can be toxic to any government. A sudden rise in electricity, gas or road fuel prices creates unwelcome headlines and consumer protests. All recent governments have committed to reducing carbon dioxide emissions, as well as the oxides of sulphur and nitrogen, blamed for the acid rain that had destroyed many North European forests, as well as ground level pollution in cities.

The scale of the challenge faced by policymakers in resolving this trilemma can be . . . shortages at petrol stations can be toxic . . .
seen in Figure 1, which shows the supply and demand of energy in the UK when the Climate Change Act 2008 was passed.

On the left are the four main sources of energy – fossil fuels, nuclear power, renewables and biomass. On the right are the uses made of energy – transport, furnaces and other high temperature uses of heat, electrical appliances and low temperature heating. It can be seen that the major energy flows are from fossil fuels to transport and heating.

The diagram shows average values throughout the year; although many uses of energy are reasonably constant, most of the heating load is taken during the winter months and, predominantly during the early morning and early evening, the peak load can be more than three times the average.

From the point of view of the consumer, it would be convenient to be able to keep the utilisation side of the diagram the same but to change the supply side to more secure low-carbon sources. A glance at the numbers shows the impossibility of this approach. The peak load (heating and electricity) in winter is 250GW which is equivalent to 100 nuclear power stations or 100,000 large wind turbines. As well as changing the source of supply, we have to reduce the amount of energy we use – hence the importance of energy efficiency.

If the UK is to get near the targets in the 2008 Act, we have to tackle the two big sources of CO₂ – transport and heating. Both are hugely challenging but transport is probably the easier of the two. One could envisage widespread adoption of electric vehicles and a major shift to electrically-powered trains and trams, all powered by renewable or nuclear energy. Aircraft and the remaining HGVs, which require more energy than could be stored in batteries, could be fuelled by biofuels derived from agricultural waste and algae or other plant material that do not compete with food crops when food shortages will be increasingly commonplace.

Although we can envisage a technical solution to decarbonising transport, the politics and economics would not be straightforward. We are accustomed to owning a car that is used daily for a 20 mile commute but that can also be used for a 200 mile weekend trip to a remote farmhouse or a 2000 mile family holiday. Asking people to reorganise their lives to use short-range EVs for the daily commute and public transport for longer trips might not be a vote-winner. Expanding the rail system to cope with greatly increased peaks of Christmas and holiday travel, while maintaining subsidies at an acceptable level and providing a financial incentive for people to use the low-carbon alternative to a car, would be more challenging.

If the political challenge of decarbonising the transport sector at an acceptable cost is “difficult”, the problems with domestic heating are even greater. In the last 50 years we have moved from homes in which we switched on heaters only in occupied rooms and it was normal to wear a sweater indoors to the expectation that buildings are centrally heated and our choice of indoor clothes is dictated by fashion, not the weather.

When constructing new buildings it is possible to build in high-performance insulation and heat exchangers to warm incoming fresh air from the air being extracted. With good design it is possible to build homes that require almost no external sources of heat. However, there are no readily-available technical solutions for installing low-carbon heating in existing buildings and most of the houses that will be in use in 2050 have already been built.

Attempting to balance the trilemma of security of supply, affordability and environmental impact has resulted in more than a decade of policy paralysis, punctuated by occasional bursts of political hyperactivity in pursuit of one of the three, while conveniently ignoring the others. In 2008, the Climate Change Act prioritised reductions in CO₂ emissions – Coalition promises to be “the greenest government ever” followed this line. Five years ago, new nuclear power stations were seen as crucial to keeping the lights on; legal challenges,
the repercussions of the tsunami deluging Fukushima, together with private sector reticence to carry financial risk ensured none has been started. Recent campaigns to cut prices by opening up the energy market and encouraging consumers to switch suppliers seem to have forgotten last year’s plan, which encouraged suppliers to form long-term relationships with customers, investing in insulation and energy saving measures, recouped by lower energy use over the following years.

Since the Energy white paper 2003: Our energy future: creating a low-carbon economy there have been half a dozen major restatements of energy policy but little to show on the ground; we still burn large amounts of coal and run our cars on petrol and diesel, much as in 2003. Energy infrastructure is a long-term business; power stations cost many millions, take several years to build and have a life of 40 years. Companies considering whether to invest would be without those improvements. The corollary of this is that, to use the market mechanism to reduce CO$_2$ emissions, inflation-adjusted energy prices (including taxation) have to rise faster than efficiency improves.

If governments oppose energy price rises, what alternatives are there to reduce overall energy use? One mechanism, which has been successful in reducing car emissions, is regulation. Under EU rules, supported by UK taxation policy, car manufacturers have been forced to improve the fuel efficiency of cars so there is now a range of vehicles with emissions below 100gCO$_2$/km. Engineers in the industry reckon that further improvements to 80 or even 60gCO$_2$/km might be possible but, if this is not to lead to long term increased car use, this has to be accompanied by a comparable fuel price increase.

If holding down gas use by imposing maximum thermostat settings is acceptable, the alternative could include more intrusive regulation, perhaps by individual carbon allowances or the imposition of maximum thermostat settings, or more draconian and retrospective building standards. If neither regulation nor price increases is acceptable, we are running out of options to limit energy use and CO$_2$ emissions. For the last decade politicians have talked about taking “tough decisions”: in energy policy they have studiously avoided taking any decisions. Partly this policy vacuum is based on a misguided belief that “the market” will make sound strategic decisions in the absence of government policy. What should an energy policy include and what should be the dividing line between the public and private sectors? Of critical importance, government needs to have a coherent vision of what it wants to achieve in terms of security of supply, affordability and emissions and a long-term strategy to implement this vision: how many days demand of gas storage, how many power stations of what types, what proportion of electric vehicles, what penetration of district heating, etc, etc. This is a national strategy, requiring agreement between ministries, which cannot be left for the markets to decide. Once the strategy is determined, the private sector can deliver what is needed and would be expected to bear the risk if they fail to deliver. However, what the private sector cannot be asked to do is to carry the risk of the government’s strategic vision.

Creating coherent energy policies requires an understanding of how the different components of energy systems interact and how these relate to other policies, including those on land use, transport and taxation. In the absence of coherent policies, we risk missing all three of the objectives of security of supply, affordability and environmental impact and simply increasing energy efficiency will not deliver the policy objectives we seek.