Towards Zero Carbon Building

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Key UCD Message

- The Innovation Imperative: Productivity growth in the Irish economy has slowed to close to zero. The only way to rediscover productivity growth and be able to sustain it is by innovation and the embedding of the knowledge society.

- The Energy and Climate Change Imperative: We have hugely demanding energy and emission reduction obligations – the only way to meet them is through the use of markets and innovation.

The Earth Systems Institute response to these imperatives - will be an engine showing how to use research and innovation – smart technology and smart policy - to regain competitiveness and productivity, generate jobs and meet our energy and climate change obligations.
European Climate Change Policy

Buildings account for some 40% of European energy consumption and related CO₂ emissions.

Energy savings, is without doubt, the quickest, most effective, and most cost effective manner for reducing carbon emissions and the greatest proportion of these savings coming from the built environment.

Source: EC Green Paper on Energy Efficiency 2005
European Climate Change Policy

Demand for lighting, heating/cooling, hot water in our homes, workplaces and leisure facilities – consume more energy than either transport or industry
European Climate Change Policy

EU Directive Energy end-use Efficiency and Energy Services (ESD) 2006

• provides a framework to enhance the cost effective improvement of energy use efficiency

• assist in achievement of national targets

Source: SEI
Draft Energy Efficiency Action Plan


Draft sets out path to achieve 20% energy reduction by 2020 and deliver White Paper ‘Delivering a Sustainable Energy Future for Ireland’

Potential savings by sector:

Source: NEEPI
EU Directive 2002  
Energy Performance of Buildings (EPBD)

EPBD Required all Member States to:
• set minimum energy requirements for new build construction
• develop a national methodology to calculate energy performance
• provide energy rating certificate for all buildings when sold or let

Recast of EPBD voted European Parliament April 2009
• actively promote uptake of low or zero carbon emission buildings
zero energy building or net zero energy building is a general term applied to a building with zero net energy consumption that is autonomous from the energy grid supply—energy is produced on-site.

zero carbon building or carbon neutral building generally means the carbon emissions generated from on-site or off-site fossil fuel energy use are balanced by the amount of on-site renewable energy production, or offset, but avoiding carbon emissions first so that only unavoidable emissions are offset.
EPBD Irish implementation

EPBD transposed into Irish legislation Building Control 2005
The National Climate Change Strategy 2007-2012
White Paper ‘Delivering a Sustainable Energy Future for Ireland’

Commitment to:
continue the process of tightening Building Regulation standards
• amendment of 2005 TGD Part L Conservation of Fuel & Energy
to deliver a 40% heat energy demand and CO₂ emissions reduction in
new build construction in 2007 and further reduction of 60% in 2010

Source: DEHLG
EPBD Irish implementation

Current Irish Standards

Provide methodologies to assess energy performance:
• Dwelling Energy Assessment Procedure (DEAP) for residential 2007
• Non Domestic Energy Assessment Procedure (NEAP) for non residential 2008

• demonstrate compliance with specific requirements of TGD Part L
• generate the Building Energy Rating (BER), certificate and advisory report for new and existing buildings
EPBD Irish implementation
Building Energy Rating - BER

**Energy supply**
- Solar gains
- Fuel supply
- Flue losses

**Energy loss**
- Windows
- Walls
- Infiltration
- Ventilation
EPBD Irish Implementation
Building Energy Rating - BER

- DEAP and NEAP calculate the energy consumption and CO₂ emissions associated with a standardised use of a building type – BER

- The energy consumption is expressed in terms (kWh/m²/yr) and the CO₂ emissions expressed in terms of (kg CO₂/m²/yr)

- This data is used to generate a certificate or label for the building which is similar to the energy label for a household electrical appliance like a fridge. The label has a scale of A-G and A-rated buildings are the most energy efficient
EPBD Irish implementation
Building Energy Rating - BER

BER Certificate and Advice

• provided by the owner of new and existing building

• to any person expressing an interest in buying or renting (and available to building authority)

• valid for 10 years from the date of its being issued, unless there is a material change eg. extension to the building in the meantime which could affect its energy performance
EPBD Irish implementation
Building Energy Rating - BER


- BER is generally required for all buildings new and existing in 2009
- Large Public Service Buildings required to Display Energy Certificate
- 1,800 SEI registered assessors
The Challenge in Ireland
Increasing standards for new build

Clients and Local Authorities are increasingly requesting higher energy performance than building regulation standard.

‘Energy Efficiency Regulations for New Dwellings and Options for Improvement’ study, UCD ERG for the DEHLG 2007, found that 40% performance improvement in energy use and CO\textsubscript{2} emissions was possible in the majority of representative new build dwelling types through improved building design and construction.

Proposed target of a 60% performance improvement signalled for 2010 will require a combination of energy efficient materials, innovative components and technologies and increasing renewable supply systems to be integrated for its’ achievement.
The Challenge in Ireland
Increasing standards for new build

Designers and contractors required to deliver buildings which will require design innovation and guaranteed construction performance greater than regulation standard—turning to European standards for guidance.
The Challenge in Ireland

‘new homes built from 2013 onwards will be carbon neutral’ - John Gormley, Minister DEHLG

Aim to achieve carbon neutral all new buildings by 2019

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<td><strong>Timeline</strong></td>
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<tr>
<td><strong>Part L</strong></td>
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<td>% Improvement</td>
<td>Baseline</td>
<td>40%</td>
<td>60%</td>
<td>Low Carbon</td>
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<td><strong>Energy (Avg Dwelling)</strong> kWh/m²/annum</td>
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<tr>
<td><strong>CO₂ (Avg Dwelling)</strong> kg/m²/annum</td>
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<td>12</td>
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<tr>
<td><strong>EPBD</strong></td>
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<tr>
<td>BER (Avg Dwelling)</td>
<td>B3</td>
<td>B1</td>
<td>A3</td>
<td></td>
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<td><strong>Voluntary Schemes</strong></td>
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<tr>
<td>SEI – Low Carbon Homes</td>
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<td>70% +</td>
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<tr>
<td><strong>DOHLG – Towards Carbon Neutral</strong></td>
<td></td>
<td></td>
<td>A2+</td>
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Source: DEHLG
The Challenge in Ireland

‘But targets alone are not enough. Without concerted action, without real change in the ways in which we live and work, we won’t achieve our goals. In particular, we need a revolution in the ways that we plan, design and construct our buildings’

Source: Margaret Beckett, Minister for Housing and Planning UK
The Challenge in Ireland

New build construction

The Construction Industry Federation (CIF) suggest that significant work would have to be done before zero carbon dwellings become a reality.

Concerns about

- availability of innovative components and materials
- necessity for training of architects, planners, quantity surveyors and construction workers in the new standards
- guarantee for buyers that installed technologies would work in the long term
- increased costs - the cost of achieving the 40% more efficient standard currently required has added about €8,500 to the capital cost of a typical dwelling (Source: UCD ERG, 2007). A carbon neutral house is likely to cost significantly more.
The Challenge in Ireland

Downturn in the construction industry

2008 - output across all sectors of the industry: residential, commercial and public continued to fall

2009 - expected that output could be less than 30,000 dwellings having reached 93,000 in 2006
The Challenge in Ireland

Existing building stock

Reduction in new build construction is a stark reminder that we cannot depend on new build alone to achieve carbon commitment.

50% of Irish housing stock was built before building regulation.

SEI Evaluation of Energy Efficiency Opportunities identified key measures that had the greatest potential to deliver benefits -
• improving existing buildings, and in particular homes
• changing user behaviour

Economic Efficiency Savings Potential by Sector (GWh) and Technology
Meeting the Challenge

In the pursuance of a zero carbon building stock

It is evident that many stake holders in the building delivery chain will find it a significant challenge to:

• deliver the performance required for new build construction
• provide cost effective retrofitting solutions for existing buildings

Issues wide ranging
• policy and regulation
• design and construction practice
• innovative technologies
• energy usage
The Challenge in Ireland

Downturn in the construction industry compromise the proposed target?

More challenging - but provides an opportunity to

- review policy and regulation
- up skill design and construction techniques
- provide business opportunities for manufacturers and suppliers of innovative, low carbon technologies
- undertake research into their impact
- inform building users of their part in optimising it’s achievement in new build construction
Meeting the Challenge

Policy and Building Regulation

- Strengthen relationship between planning/building regulation - to optimise potential for achieving zero energy development
- Importance of building regulations framework - would provide programme of performance requirements and future proof construction methods, remove the need for Local Authorities to move forward of national regulation, support the construction industry to move forward in a unified manner and ensure the capacity of designers, suppliers and contractors to achieve the requirements of the regulation
- Performance based requirements - would allow for more flexible provision, tend to be more achievable, innovative and cost effective
- Expand building regulation to include broader environmental issues - to deliver buildings that are sustainable and provide a healthy indoor environment
Meeting the Challenge

Code of Sustainable Homes

Building Research Establishment (BRE)

- voluntary code for homes
- sets out six levels of achievement
- relate to proposed building regulations
- provides guidance on construction
- not just energy
Meeting the Challenge

Code of Sustainable Homes

Dwellings demonstrating compliance with all six levels of the Code have been constructed in the BRE headquarters in Watford

- Eco-Tech Swedish ‘Organics’ home – level 2
- Osbourne’s demonstration house – level 3
- Hanson Eco-House – level 4 (Passivhaus)
- Stewart Milne Sigma home – level 5
- Kingspan Lighthouse – level 6 (Zero Carbon)
Meeting the Challenge

Design and Construction practices

It has long been understood that a very low level of regulatory compliance has been achieved in Ireland.

- Reform in enforcement and compliance practices are required - designers and contractors required to deliver construction performance but minimal Building Control enforcement - opinion on compliance - must include confirmation from contractors / subcontractors that design and specification and construction in accordance with architects details.

- Necessity to develop quality control procedures, both in design and construction phases, which will deliver construction quality and minimise non compliance - the designation of responsibility within the design and construction team may have to be more clearly defined in order to control risk or liability - may have to be jointly assessed and project insurance products developed rather than individual professional and contractor’s indemnity insurances.
Meeting the Challenge

Design and Construction practices

Past - specification - detail - construction - testing
Meeting the Challenge

Innovative Technology

• Encourage innovative, high performance, cost effective construction methods - *facilitate speedy certification for use in Ireland*

• Encourage demand for innovative components and renewable technologies - *has the potential to reduce costs, drive innovation and create jobs in an increasingly difficult market*

• Facilitate a transfer from the present centralised energy generation to a system that encourages renewable integration - *to achieve significant carbon reduction and reduce dependence on imported fuel*

SEI ‘The Greener Home Scheme’ providing grants for the installation renewable technologies
Meeting the Challenge

Passivhaus Standard

The standard is being applied across Europe as a method of achieving low energy buildings in many countries in the move to low carbon in the short-term and zero carbon in the future, particularly in residential

<table>
<thead>
<tr>
<th>Country</th>
<th>Target in Europe</th>
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<tbody>
<tr>
<td>Austria</td>
<td>PHS level 2020</td>
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<tr>
<td>Denmark</td>
<td>PHS level 2015</td>
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<tr>
<td>Germany</td>
<td>PHS level 2015</td>
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<tr>
<td>Netherlands</td>
<td>PHS level 2015 Non-residential will follow</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>PHS level 2013    ZERO CARBON 2016</td>
</tr>
</tbody>
</table>
Meeting the Challenge

Passivhaus Standard

Low energy standard developed by Passivhaus Institute, Germany

- variety of design strategies, construction methods and technologies
- applicable to any building type or function
- building energy requirement
  - annual space heating requirement of 15kWh/m²a treated floor area
  - total primary energy demand for space and water heating, ventilation, electricity for fans and pumps, household appliances and lighting not exceeding 120kWh/m²a, regardless of energy source
  - air permeability not exceeding 0.6 air changes per hour at 50 Pascal
Meeting the Challenge
Passivhaus Standard

UCD ERG research on application in Irish housing construction:

• significant energy saving potential if adopted for new build housing
• analysis more moderate Irish climate found that the requirements could be relaxed to achieve the thermal energy target
• can be achieved both masonry and timber frame construction methods
• standard would achieve a rating of A3 in comparison with current Irish standard B1
Meeting the Challenge
Passivhaus Standard

First certified house - O’Leary home Wicklow

• construction tested and monitored by UCD ERG
• data collected indicate thermal energy one fifth that of current building regulation standard
• to test and monitor ICF Zero Energy House
Meeting the Challenge

Passivhaus Standard

Focus on dwellings where poor construction hinders occupants to heat home adequately to provide comfort

Homes for the 21st Century, 1999, UCD study found that
• fuel poverty in Ireland was amongst the highest in Europe
• housing standards were among the lowest
• least well off tended to live in the worst of homes
• considerable long-term economic, environmental, health and social benefits from improved thermal efficiency that far outweighed the costs of the retrofitting

Home Energy Saving (HES) Grant Scheme
• aims to improve the energy efficiency of existing housing stock, €70m to provide grants to house owners
• significant funding for social and low income homes grants
Meeting the Challenge
Passivhaus Standard

SEI support implementation
• guidance for application in Ireland
• workshops /conferences
• PPHP tool
• grant support

‘Low Carbon Homes Programme’
grants of up to 40% for dwellings 70%
(BER A2) better 2005
Meeting the Challenge
Design and Construction skills

National framework for training and at all levels and in all sectors of industry - *in energy efficient design and construction and its evaluation with specific training in specialist areas to achieve specific skills*

Interdisciplinary training of designers - *UCD undergraduate, post graduate and mid-career level to achieve integrated design approach for performance achievement*

Provision of robust details and realistic performance data applicable to Ireland – *of innovative components and technologies are essential for client confidence, designer specification, contractor’s successful integration*
Meeting the Challenge
Design and Construction performance evaluation

• Lack of knowledge of the performance of Irish building stock requires robust research to be undertaken - UCD ERG research on the relationship between building performance and indoor air quality in dwellings - UCD Building Environmental Laboratory

• Completed new build demonstration projects should be rigorously tested, commissioned, monitored, post occupancy studies - results disseminated - (even when targets not achieved) to industry, so that industry can learn from achievement and failure
Meeting the Challenge
Design and Construction environmental evaluation

Development environmental evaluation tools appropriate to Ireland for all stages of the design, construction and post-construction alongside adequate training in their application.

Recent UCD ERG developed IBEAM framework for assessment tool applicable to commercial develop further - for homes.
Meeting the Challenge
Building users – you and me!

• provide user information on energy technologies and systems

• face to face training in buildings with passive design features and sophisticated energy systems, particularly in the workplace

• understand the impact which their lifestyle has on energy usage and related carbon emissions

Source: SEI
Achieving the goal

Energy efficiency and comfort at a reasonable cost
UCD Earth Systems Institute
Meeting the Challenge of Climate Change
Seminar Series

In collaboration with
Comhar Sustainable Development Council, Environmental Protection Agency, Forfás, Geological Survey of Ireland, Marine Institute, Met Éireann, Sustainable Energy Ireland & Teagasc

Further details on the seminar series is available at www.ucd.ie/earth
A paper and podcast of this seminar will be available on the ESI website soon, please join the online ESI mailing list for such notifications

ESI email: esi.admin@ucd.ie
UCD Earth Systems Institute
Meeting the Challenge of Climate Change
Seminar Series

Next week...Seminar #12

Friday 13th March 2009
Royal College of Physicians, 12.30pm

Dr. Jon Yearsley
UCD School of Biology & Environmental Science

A *behind-the-science look at predictions of species extinction from climate change*

Further details available at [www.ucd.ie/earth](http://www.ucd.ie/earth)