BUILD UP Skills –IRELAND

Analysis of the national status quo

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BEH – Better Energy Homes

BER – Building Energy Rating

BEWH – Better Energy Warmer Homes

CEDEFOP - European Centre for the Development of Vocational Training

CENELEC – European Committee for Electro-technical Standardisation

CER - Commission for Energy Regulation

CHP - Combined Heat and Power

CSO – Central Statistics Office

DCENR - Department of Communications, Energy and Natural Resources

DEAP - Dwelling Energy Assessment Procedure

DECLG - Department of the Environment, Community and Local Government

DEJI - Department of Enterprise, Jobs and Innovation

DIT – Dublin institute of Technology

DKIT – Dundalk Institute of Technology

DKM – DKM Economic Consultants

DoES – Department of Educations and Skills

EC – European Commission

ECFIN - Economic and Financial Affairs

ECTS - European Credit Transfer and Accumulation System

EE – Energy Efficiency

EEA - The European Environment Agency

EGFSN - Expert Group on Future Skills Needs

EHEA - The European Higher Education Area

EPBD - Energy Performance of Buildings Directive

EPC - European Policy Centre

EQF - European Qualifications Framework

ESB – Electricity Supply Board

ESCO - Energy service company

ESD - Energy Services Directive

ESTAT – Eurostat

ETCI – Electro-Technical Council of Ireland

FETAC - Further Education and Training Awards Council

GHS – Greener Homes Scheme

GWh - Gigawatt Hour

HES – Home Energy Saving scheme

HETAC - Higher Education and Training Awards Council

ICT - Information and Communications Technology

IoTs – Institutes of Technology

ISCO - The International Standard Classification of Occupations

ITB – Institute of Technology Blanchardstown

kWh - Kilowatt Hour

LIT – Limerick Institute of Technology

Mtoe - Mega tonnes of oil equivalent

MVHR - Mechanical Ventilation with Heat Recovery

NACE - Statistical classification of economic activities in the European Community

NEEAP - National Energy Efficiency Action Plan

NERP - National Energy Retrofit Programme

NFQ - National Framework of Qualifications

NREAP - The National Renewable Energy Action Plan

NSAI - National Standards Authority of Ireland

OFTEC - Oil Firing Technical Association

OPW – Office of Public Works

PV - Photovoltaic

QQAI - Qualifications and Quality Assurance Ireland

REFIT - Renewable Energy Feed in Tariff scheme

REIA - Renewable Energy Installer Academy

RES – Renewable Energy Systems

RM&I - Repair, maintenance and improvement

SCS - Society of Chartered Surveyors

SEAI – Sustainable Energy Authority Ireland

SLMRU - Skills and Labour Market Research Unit

SME - Small and Medium Enterprise

SSC – Sector Skills Councils

TGD - Technical Guidance Documents

VEC - Vocational Education Committee

VET - Vocational education and training

WHS – Warmer Homes Scheme

0. Executive Summary

Energy use in buildings accounts for over 40% of total final energy consumption in Ireland (Figure 0.1). At a national policy level, Ireland has committed to reducing its total energy consumption by 20% by the year 2020. As a pathway to meeting this target, building regulations and standards have been amended significantly over the past 10 years, establishing a new approach to construction and renovation to prescribed energy performance standards. These standards will continue to evolve toward a near zero carbon framework for buildings by 2020, necessitating the integration of renewable energy systems to achieve the set energy and carbon performance levels.

However, the pace of change in building construction and renovation standard has not been matched by availability of compatible training provision for the construction workforce. Consequently, there is gap in the requisite skills and knowledge that is required for onsite implementation of energy efficiency measures and the integration of renewable energy systems.

The objectives of this report are, to: establish the capacity of the construction workforce to meet the new building construction and renovation standards; identify the skills gaps that exist, and; establish a strategy for planned up-skilling of workers through a formal system of qualification.

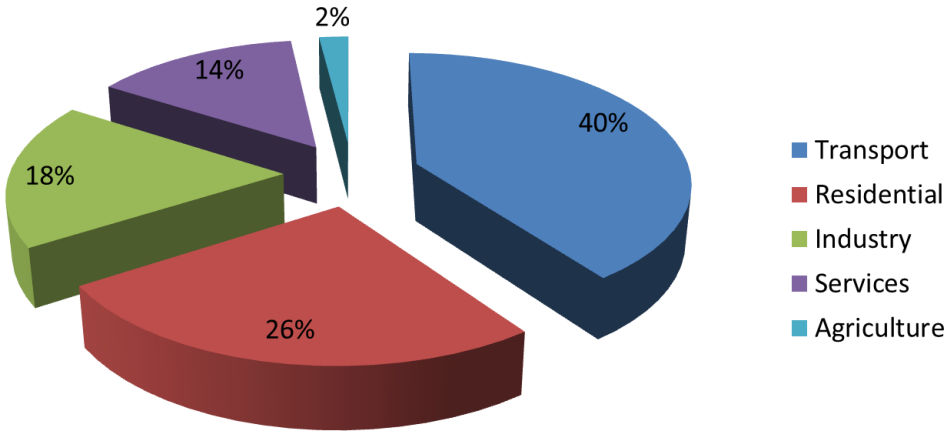


Figure 0.1: Total final energy consumption in Ireland by sector (in % of total Mtoe)
Source: EC (ESTAT, ECFIN), EEA – June2011

Policy Drivers for Building Energy Efficiency and Renewable Energy Deployment

The 2020 energy saving targets for Ireland are outlined in Table 0.1. The European Performance of Buildings Directive (EPBD) 2002 and Irish Government were the catalyst for changes to Irish building regulations for energy performance, resulting in a number of amendments since 2002. Further changes are imminent as a nearly zero energy framework for buildings is developed. Low energy buildings are now the standard, rather than a niche market within the construction industry.

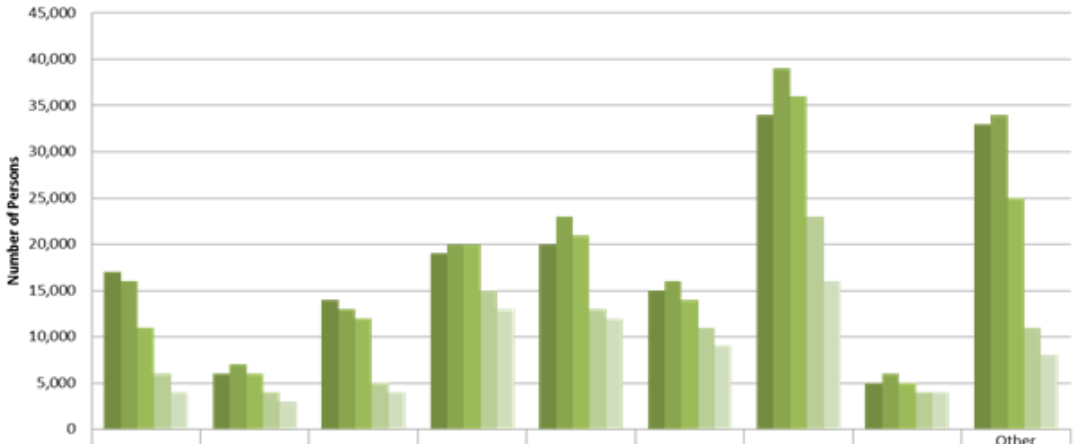
Table 0.1: 2020 energy saving targets

	2020 targets
Energy Efficiency	20% saving
Renewable Energy (overall)	16% of total final energy consumption
Renewable energy in electricity, RES – E	40%
Renewable energy in transport, RES – T	10%
Renewable energy for heat & cooling, RES - H	12%

A National Energy Retrofit Programme (NERP) was introduced in 2011, setting out a target of 1 million buildings to be retrofitted by 2020. Currently, the initiative is exchequer supported through grant-aided programmes for incremental retrofit measures administered by the Sustainable Energy Authority of Ireland (SEAI). The NERP will need to be escalated significantly to meet the 2020 targets, based on currently available data, in the rate and levels of retrofit activity both in terms of the percentage of buildings renovated and the depth of measures applied.

Overview of the Building Sector in Ireland

The prevailing economic condition in Ireland has resulted in an unprecedented fall in commercial and residential construction projects and, consequently, the employment opportunities in the sector. However, there are still approximately 70,000 workers in the sector (Figure 0.2). The residential sector accounted for 68% of the value of building construction output in 2011 with approximately 80% of this activity in Repair, maintenance and Improvement (RM&I). Specifically relevant to the construction sector are the potential of the energy retrofit market and the impact of quantity forcing policies, i.e., setting a minimum renewable energy contributions in the current building regulations.



	Bricklayers, Masons	Roofers, Slaters, Tilers, Sheeters, Cladders	Plasterers	Builders, Building Contractors	Electricians, Electrical Maintenance Fitters	Plumbers, Heating and related Trades	Carpenters and Joiners	Construction and Related Workers	Other Building and Civil Engineering Labourers
2006	17,000	6,000	14,000	19,000	20,000	15,000	34,000	5,000	33,000
2007	16,000	7,000	13,000	20,000	23,000	16,000	39,000	6,000	34,000
2008	11,000	6,000	12,000	20,000	21,000	14,000	36,000	5,000	25,000
2009	6,000	4,000	5,000	15,000	13,000	11,000	23,000	4,000	11,000
2010	4,000	3,000	4,000	13,000	12,000	9,000	16,000	4,000	8,000

Figure 0.2: Total Numbers Employed in Construction Related Occupations 2006 -2010
Source: FÁS SLMRU

Strategies for Bridging the Skills Gap

As a strategy for bridging the skills gap, this report considers a three occupational-tier training regime; at operative, craft, and supervisory levels (Table 0.2). Such tiered approach will ensure that each worker holds the appropriate level of competency required to carry out the tasks associated with their role.

Table 0.2: Occupational Tiers

Level	Description
Operative level	Defines the skill level outside of the formal apprenticeship training structure, i.e. skills acquired through on site experiential learning, e.g. concrete workers, steel workers, glaziers, roofers.
Craft level	Defines the occupation level where a formal craft apprenticeship or equivalent training has been successfully completed.
Supervisory level	Defines the specialist, supervisory or project manager level where a craft worker has progressed to autonomous roles such as a system installation specialist, site supervisor, small/medium sized building contractor or similar roles.

Generally in the building sector, the gap that exists is one of knowledge rather than skills.

However, this knowledge is fundamental for the successful implementation of low energy buildings. It is important to understand the mind set of workers who, based on their years of experience, believe that they already ***know*** the 'right way' to do their job. The science that underpins energy efficient building should be presented and demonstrated in a format that is familiar to construction workers, in order to foster a change in attitude and enable acceptance of the necessity for a new approach to their work.

The tiered model of up-skilling is designed to provide the foundation skills and knowledge with clearly defined progression pathways to more advanced specialist training where appropriate to workers' roles (Figure 0.3).

This report has identified the importance of a homogeneous approach to on-site implementation of low energy construction/renovation. Maintaining insulation and airtight fabric envelopes, while integrating mechanical and electrical installations will require a common knowledge base and understanding of individual responsibilities among all those involved in the process. At operative and craft level, ***all*** workers involved in building construction and renovation will require training.

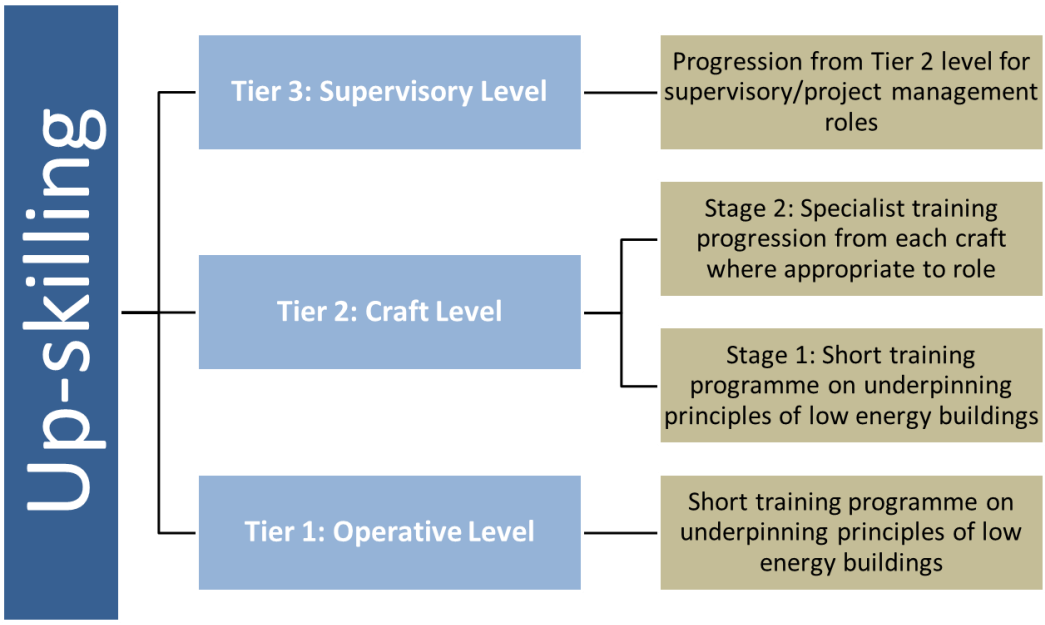


Figure 0.3: Tiered up-skilling training structure

Training at the third tier supervisory level provides for a progression of learning from craft level dependent on the nature of the role to be supported. This will be similar to the traditional progression route from a craft worker to supervisory role. Requisite project management and ICT skills alongside the prescribed specialised technical training reflect the additional responsibility of those engaged at supervisory level. Comprehensive training on domestic retrofit project management is included at this level.

The projections for the volume of training required are based on construction industry employment figures in 2010 and forecasts to 2015 with consideration also given to the demands associated with the implementation of energy policy actions. Also a supervisor to worker ratio of 1:10 is assumed for Tier 3 numbers, a general ratio used in the construction industry to forecast skills need for projects. Table 0.3 outlines the volume of training required by craft and skill for each occupational tier.

Trainers in this sector are usually employed on the basis of trade related qualifications and onsite experience and will, therefore, require up-skilling to support training needs on the scale proposed. It is envisaged that at least 100 trainers would be required to complete Operative and Craft level training alone within a calendar year.

Table 0.3: Numbers of workers to be trained by Occupational Tier

Occupational Tier	Qualification Need	NFQ Level	Numbers
Operative Level	Foundation energy training (all construction operatives including concrete workers, steel workers, roofers and glaziers)	5	10,000
Craft Level	Stage 1: Foundation energy training (for all construction crafts)	6	49,000
	Stage 2: Craft specific energy training (for all)		
	• Carpentry & Joinery		16,000
	• Brick & Stone Laying		4,000
	• Plastering		4,000
	• Plumbing		9,000
	• Electrical		6,000
	Total		49,000
Supervisory Level	Domestic Heating Technician	7	1,350
	Ventilation Installation Technician	6	500
	Combined Heat & Power (CHP) Technician	7	180
	Site Supervisors/Foremen	7	3,000
	Domestic Energy Retrofit Project Management	7	2,200
	Total		7,230
	*Note: completion of craft level training assumed		

Key Conclusions & Recommendations

The building sector has the potential to make a significant contribution to the reduction in energy consumption in Ireland while achieving many secondary benefits. Beside the advantage to society of greater energy security, tackling fuel poverty and environmental protection, the construction industry which has been so adversely affected by the recent economic downturn has the opportunity to consolidate and ensure a more sustainable future through the development of a highly skilled workforce.

The rapid evolution of the building standards for energy performance has resulted in a skills gap across the current workforce. The efforts by individual training providers to develop and offer programmes that seek to address this gap have not been efficiently coordinated nationally, which has limited their impacts. It is noteworthy that all those currently employed in the construction and renovation of buildings require some level of up-skilling and those entering the sector should have similar training incorporated into their formal apprentice education.

Improving the energy performance of the existing building stock offers the most practicable intervention towards meeting Ireland's 2020 energy saving targets. With the high contribution to energy savings expected from the retrofitting of existing dwellings, there is a need for competent contractors/supervisors to oversee works and technicians with an in depth knowledge of heating system design, integration and control. The demand for such skills will be intrinsically linked to the level of energy policy implementation.

The establishment and maintenance of a framework of mandatory qualifications for professional practice would serve a dual purpose of improving work standards while establishing a real motivation for participation on training programmes. This participation should be promoted and funded for those in employment to support the sustainability of the construction industry tasked with implementation of building standards.

The introduction of a nearly zero energy framework for buildings presents a challenge to the construction industry that will require a highly skilled workforce to implement. The Build Up Skills Ireland project is a timely opportunity for the main actors in the building and energy sectors to reach agreement on a framework for the up-skilling that will be required.

1. Introduction

Build Up Skills is part of a three year (2011-2013) funding initiative under the Intelligent Energy Europe (IEE) programme. The project focuses on the continuing education and training of craftsmen and other onsite construction workers and system installers in the fields of energy efficiency and renewable energy sources in buildings. The main objectives are to:

- **Initiate national discussion processes** that bring together all relevant stakeholders
- **Identify and quantify the need** for a workforce qualified in energy efficiency and renewable energy in each member state by 2020 (and beyond)
- **Set up and agree national qualification roadmaps** to achieve the sustainable energy policy objectives for 2020
- **Support concrete qualification schemes** on the basis of roadmaps to 2020 with identified needs and priorities

Pillar 1 of the project commenced in November 2011, initially with consortiums representing 21 EU member states, and focuses on the development of national qualifications platforms and roadmaps (Figure 1.1). A broad spectrum of relevant stakeholders are to be engaged in the process including public authorities, national energy and qualifications bodies, training providers, trade representative organisations, industry representatives, social partners, building design experts and potential financing bodies. This report represents the first stage of the project, providing an analysis of the national status quo which identifies and quantifies the need for qualified building workers. The report has been completed in the first six months of the project to provide a basis for discussion with all relevant stakeholders toward the set up and endorsement of qualification roadmaps.

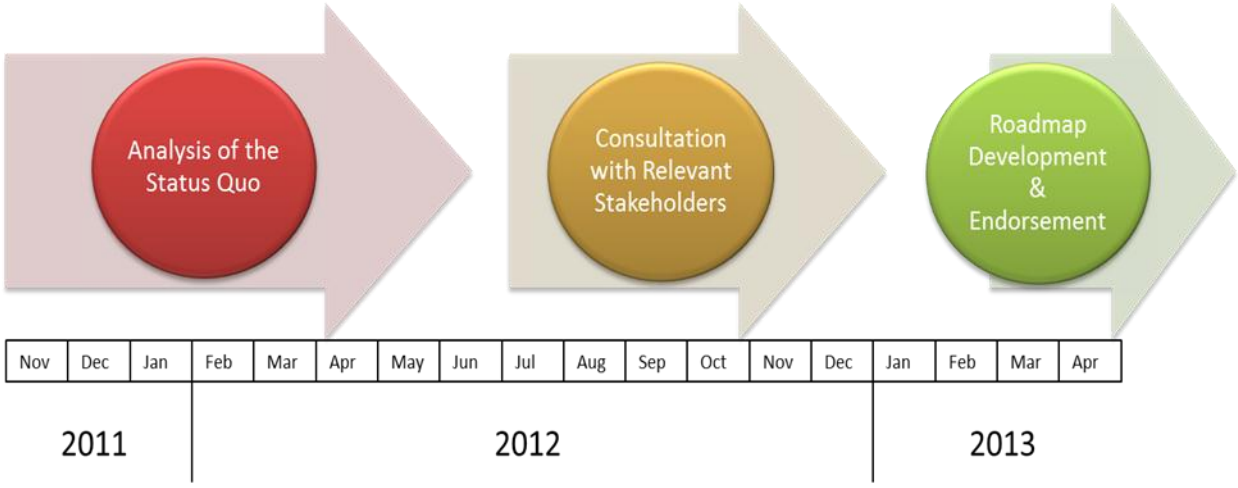


Figure 1.1: BUSI Project Timeline

The Irish consortium, Build Up Skills Ireland (BUSI), comprises five organisations; Limerick Institute of Technology (LIT) – as co-ordinators, Institute of Technology Blanchardstown (ITB) – leading the status quo report, Dublin Institute of Technology (DIT) – leading the

consultation and roadmap development, Irish Congress of Trade Unions (ICTU) – for employee input, and Construction Industry Federation (CIF) – for industry input. A steering committee, comprised of the key national stakeholders in the training and energy sectors, was set up early in the project to guide the work of the consortium (see Figure 1.2). National and regional workshops, interviews and surveys engaging relevant market actors will be undertaken in the consultation phase.

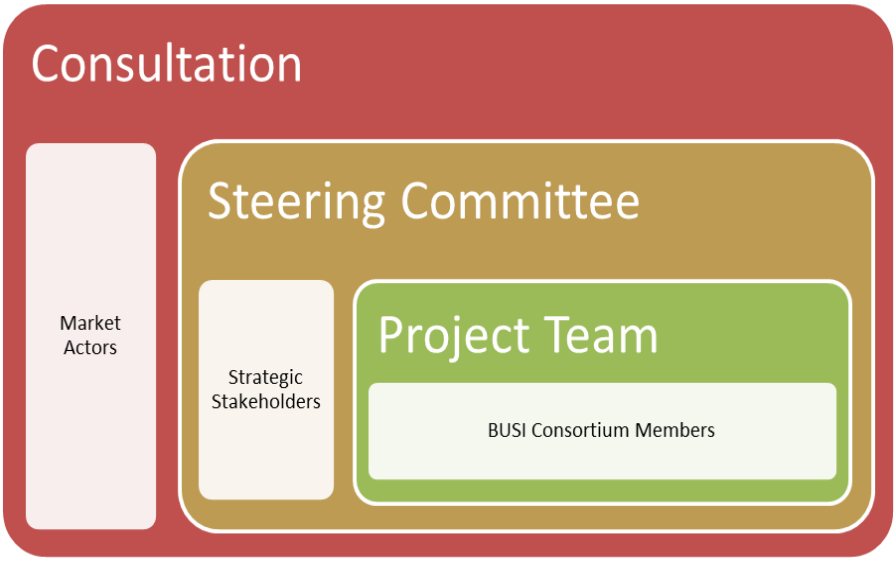


Figure 1.2: BUSI project structure

The BUSI project offers a timely opportunity to address the fundamental changes that are affecting the construction industry in Ireland while supporting the national commitment towards the 2020 energy policy targets. Building Regulations in Ireland have evolved dramatically in the last ten years and are fundamentally changing the approach to the construction of buildings as building designers strive to achieve the increasingly onerous energy performance standards that are being prescribed.

Previously, important considerations for buildings have been largely based on location, aesthetics and accommodation. Now the emphasis is shifting, perhaps returning to the most basic function of a building, to provide shelter from the elements and comfort for occupants. Consumers are now considering the viability of investing in low energy building and in renewable energy resources. Low energy building involves the adoption of the latest technologies to achieve a performance of significant improvement, both in terms of energy consumption and the comfort and wellbeing of occupants. Terms such as air permeability and thermal bridging, while new to most construction workers, are embedded principles underpinning future construction and renovation of buildings.

Until recently in Ireland, there has been ***no coordinated national response*** towards the continuous assessment of the skills needs of the building workforce in respect of energy utility. Separate initiatives, from agencies such as Sustainable Energy Authority of Ireland (SEAI), in response to the Article 14.3 of the RES directive, and FÁS (National Training and Employment Authority) provision of up-skilling courses for construction workers, have attempted to fill the gaps. It is a reasonable conclusion that the skills of practically every

construction worker will need to evolve to realise the new targets for building energy performance, i.e. near zero carbon buildings as outlined in the European Performance of Buildings Directive (EPBD) recast (see 7.2 Identified Skills Needs later). The achievement of increasingly stringent air permeability standard for dwellings, for example, will require collective responsibility onsite from all involved in the construction process.

As a consequence of the boom in the construction industry from the mid-1990s to 2007, Ireland has been left with a surplus building stock. Consequently, it has been forecasted that the rate of new construction in the short to medium-term will be modest (see 5.1.4 Annual Rate of Construction/Renovation). As a result, it is acknowledged that the most significant potential for energy reduction resides with the retrofit of existing buildings (see 5.3.3 Technologies/measures for energy efficiency and renewable energy in buildings

Table 5.4 outlines the measures and technologies currently being deployed for each of the main elements of energy efficient building construction and renovation. This information has been derived from an analysis undertaken in Appendix *A4 Review of existing and emerging technologies and skills in energy efficiency and renewable energy in buildings.*

Table 5.4: Energy efficient and renewable energy technologies/measures in buildings

Building Element	Measure/Technology
Building Fabric	• External insulation • Internal dry-lining • Full fill cavity wall insulation • Cavity walling with 150mm partially insulated cavity • High performance timber frame external walling • Insulation and air tight retrofit measures for raised timber ground floors • Concrete slab on ground floors with under slab and perimeter insulation • Twin layer quilt insulation at ceiling level of pitched roofs • Multi-layer insulation of flat roof construction • Blown loose fill loft insulation • Sprayed foam insulations direct to rafters and underside of roof membranes in lofts • Insulation of pitched ceilings in room in roof • Air tightness membranes and materials • Thermal bridging detailing
Ventilation	• Passive Stack Ventilation • Mechanical Ventilation • Positive Input Ventilation • Mechanical Heat Recovery Ventilation (MVHR), • Hybrid Ventilation Systems
Space Heating/ Cooling, Water Heating and Controls	• High efficiency heating appliances • High performance insulation of primary and distribution pipe work and storage vessels • Underfloor heating (low temperature heating circuits) • Heating controls - automatically regulating operation in zones by temperature • Combined systems – i.e. systems combining different energy sources for primary and secondary heating and hot water • Air-conditioning (industrial/commercial applications)

Lighting	• Lighting controls • Low energy lamps

Renewable Energy Systems	• Renewable heat :
	  ○ Solar Thermal
	  ○ Biomass
	  ○ Heat Pump
	• Renewable electricity:
	  ○ Solar Photo-Voltaic (PV)
	  ○ Small-Scale Wind Generation

Building Energy Management	Building Management Systems (BMS)

5.3.4 Retrofit of Existing Dwellings for Energy Performance Improvement). The construction workforce is the keystone to meeting this challenge, as it will be responsible for implementing the increasingly stringent detailing and specification that new designs and regulations will demand.

This report on the status quo endeavours to provide an objective analysis, both in qualitative and quantitative terms, of the training requirement needed to provide a building workforce capable of achieving 2020 targets. It also attempts to identify and estimate the real skills demand, both present and for the future. It draws the relationship between training and actual employment opportunities for the cohort by providing realistic projections based on trends and government supported jobs initiatives. This will be crucial to the engagement of participation on the proposed training schemes. The main objective of the report is to provide a comprehensive basis for discussion with all relevant national stakeholders and, therefore, endeavours to be as accurate and up to date as possible. The relevant government departments, national agencies, training and standards authorities have been engaged to provide access to data and information to this end, including:

(1) The Department of Communications, Energy & Natural Resources (DCENR) have provided updates on revisions to energy policy and actions for implementation.

(2) The Department of Environment, Community & Local Government (DECLG) have clarified the direction of changes to Building Regulations and how they anticipate this will affect the skills needed for onsite implementation.

(3) The Sustainable Energy Authority of Ireland (SEAI) have provided data and information on the penetration of renewable energies in buildings, initiatives and grant supported schemes for the public, commercial and residential sectors, including rates of energy efficient renovations.

(4) FÁS, the national training authority, have given access to the data held by their Skills and Labour Market Research Unit (SLMRU) to quantify employment and apprenticeship training in the construction sector and future projections. They have also provided data for the participation rates on the training programmes they provide relevant to energy efficiency and renewable energy in buildings.

(5) The Further Education and Training Awards Council (FETAC) and the Higher Education and Training Awards Council (HETAC) have supplied participation rates on the relevant programmes that they provide in this sector.

(6) The National Standards Authority of Ireland (NSAI) was consulted for clarification on their role in developing codes of practice in the field and their involvement in standards certification for related products and their installation.

The BUSI project coincides with a time of significant change in government policy in Ireland, national training structures and economic circumstances, all of which are relevant to training in construction. The underpinning themes of efficiency and sustainability, however, could not be more relevant or topical in the evolving national status quo.

2. Objectives and Methodologies

The objective of this report is to identify and quantify the new skills required to support the implementation of energy efficiency (EE) measures and renewable energy sources (RES) in buildings. It is intended that this report will act as guidance to the development of training programmes for the up-skilling of crafts and skills in the construction sector. The scale of the training needs is also considered with indicative numbers of qualifications provided. This will provide a basis for engagement with relevant national stakeholders towards a collective agreement on and endorsement of the way forward for the up-skilling of the construction workforce.

A qualitative and a quantitative gap analysis have been undertaken with a focus on the progression of skills from those currently held in each of the different construction related trades/professions. The technologies to be used for EE and RES in buildings were analysed to determine the specific skills and knowledge that will be required to support their implementation. Skill levels required relative to the role of the worker are also considered, i.e. operative, craft worker/system installer, supervisor/system specialist/inspector. The methods used to achieve this are:

1. **Qualitative Gap Analysis:**

Firstly, the broadly available training provision for the construction workforce was reviewed to determine the general skills availability in the sector and how they are achieved. This included a comprehensive analysis of the training curricula for each of the main construction related trades (Figure 2.1, Task 1). The more recently introduced supplemental training specific to EE and RES in buildings was examined to determine the extent to which they support the implementation of the technologies onsite. This study was qualified through discussions with organisations involved in the administration of retrofit and renewable energy schemes (Figure 2.1, Task 2). The existing and emerging technologies and skills for the implementation of EE and RES are reviewed (see Appendix A4), including each of the main features of an energy efficient building, identifying the specific skill sets required to support each element (Figure 2.1, Task 3).

A comparison is then completed between existing training programmes and the relevant identified skills established through the review of the existing and emerging technologies. From this analysis a reasonable assessment of the actual gap in training has emerged. This process also serves to determine which existing trades/skill sets provide the strongest platform for progression of learning through an up-skilling programme. Also, skill level relative to each workers role and the need for multi-disciplinary skills and knowledge is considered.

2. **Quantitative Gap Analysis:**

Current employment in the construction sector is reviewed by craft/profession to determine the requirement for up-skilling of the existing workforce while taking into account participation on existing training programmes in the energy field (Figure 2.2, Task 1). Employment trends and forecasts are also analysed to give an indication of future skills demand (Figure 2.2, Task 2). Particular attention is paid to existing and proposed actions for the implementation of national energy policy (Figure 2.2, Task 3). Conclusions were qualified through discussions with representatives from the relevant government departments. This

provides an indication of the number of workers required to support policy actions while also determining the type of skills needed, e.g. retrofit initiatives, renewable energy implementation schemes.

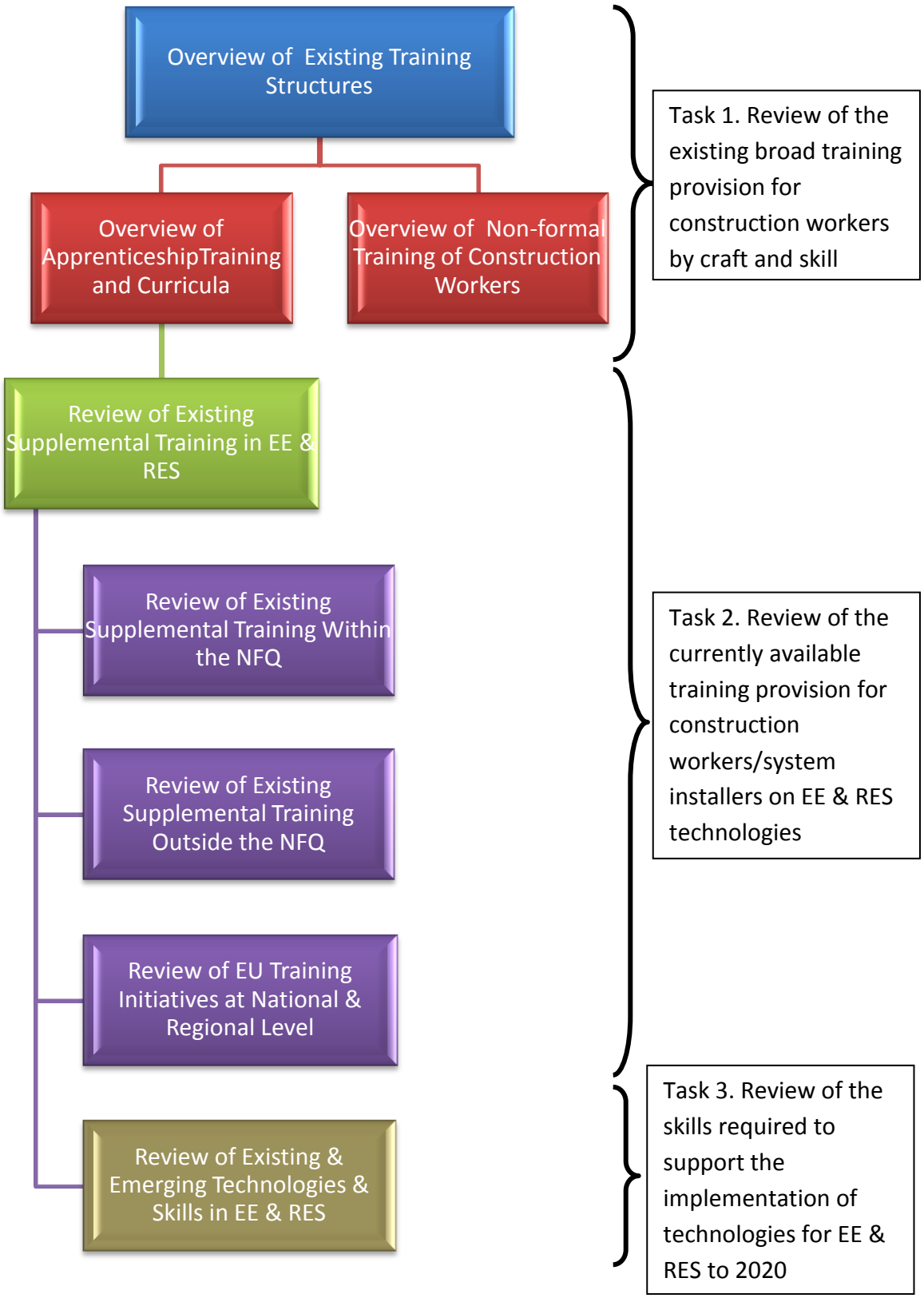


Figure 2.1: Qualitative Gap Analysis for workforce to support 2020 targets

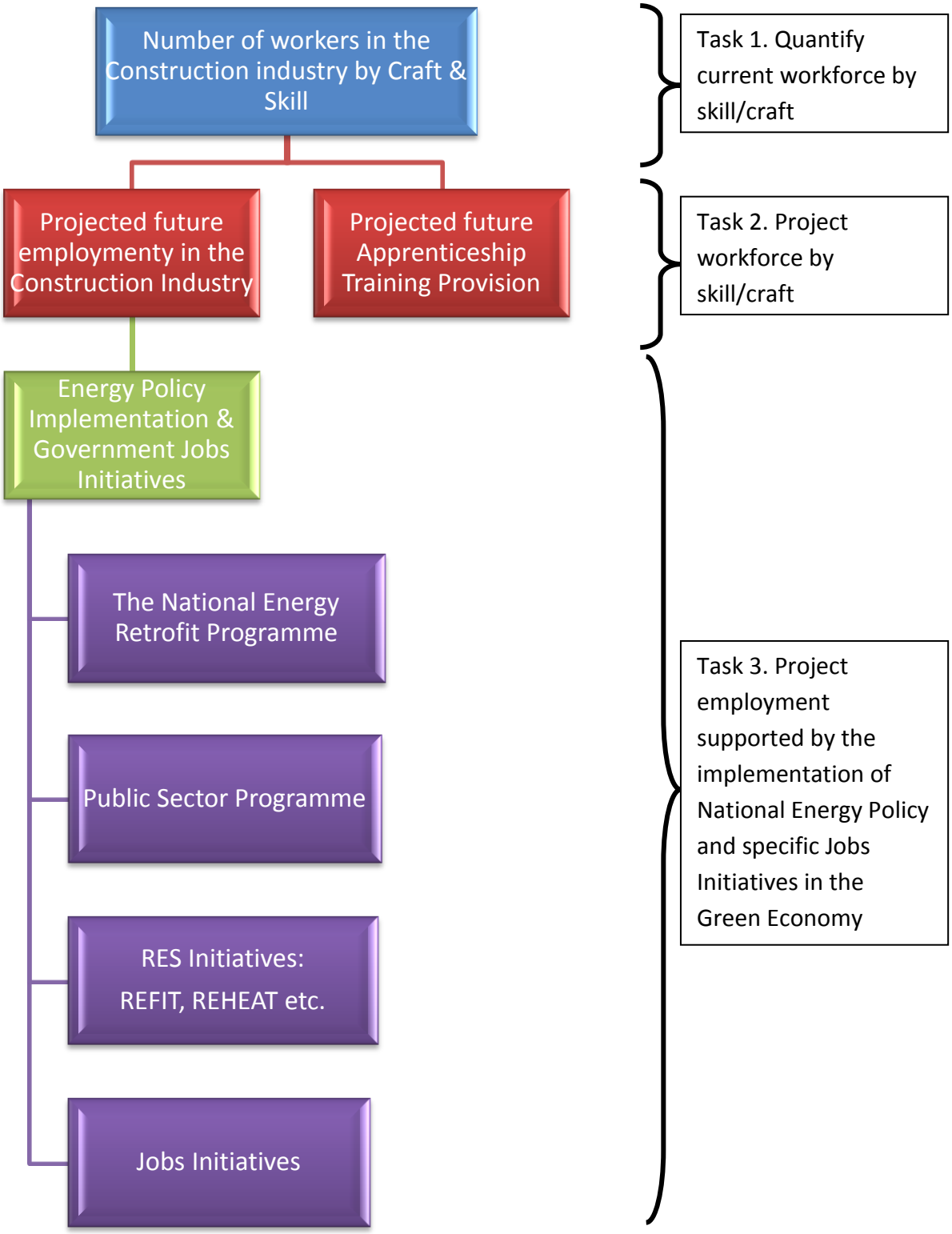


Figure 2.2: Quantitative Gap Analysis for workforce to support 2020 targets

3. Characterisation of the Irish Building Sector

Figure 3.1 outlines the dramatic change in the economy in Ireland and relates to the the change in construction output. Emerging out of the recessions in the 1980's the growth in the construction sector from the late 1990s up to 2007 was significant.

The Construction sector generated €38.6billion for 2007 which was one quarter of total value of the Irish economy in that period. Employment at peak in 2007 was established at 280,000 direct construction jobs which supported nearly 100,000 indirect jobs. The main driver of construction output for 2000 to 2007 was residential construction, which for 2006 saw 90,000 residential units being constructed which was five times the EU average. Ireland was building residential property at the highest level of any country in the developed world.

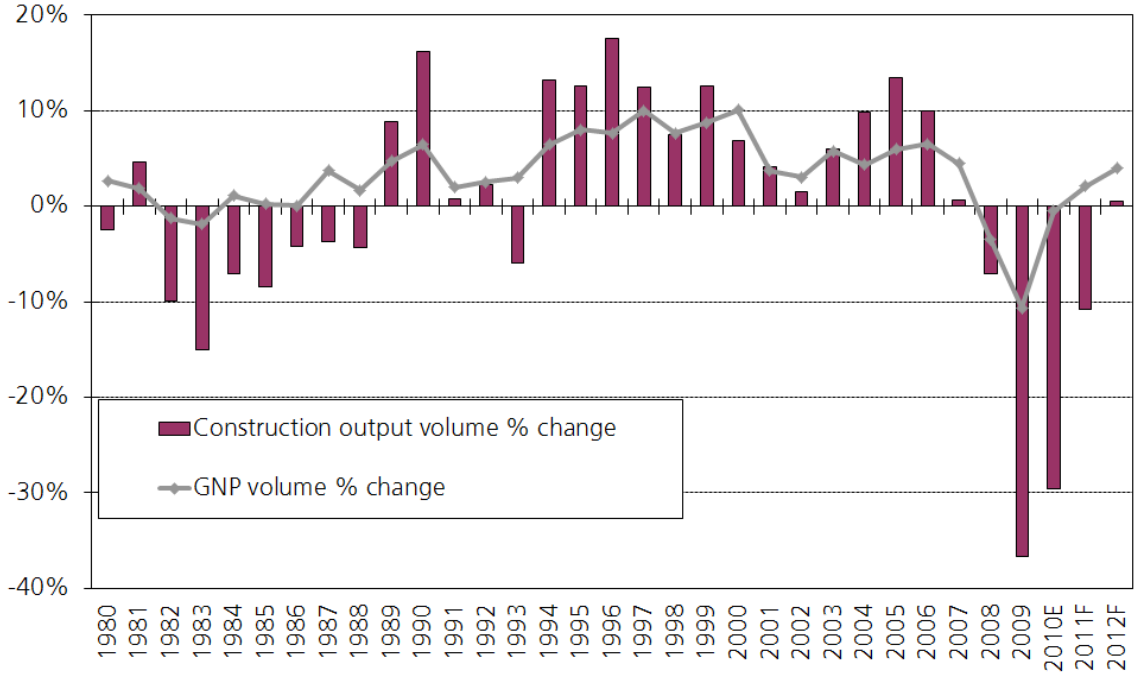


Figure 3.1: Construction and GNP trends 1980-2012[1]

The trends in the total volume construction in the following sectors is as follows

- - residential construction – both new and repair, maintenance and improvement (RM&I) – declined by 48.3%, after allowing for a double digit decline in residential tender price inflation (-15.5%).

[1] CSO, DEHLG, 2010-2012 DKM estimates

- - private non-residential construction sector (new RM&I) fell by a substantial 51.6%, driven by sharp falls in the volume of investment in commercial buildings (-50.5%), tourism buildings (-48.5%) and agricultural buildings (-74.4%).
- Productive infrastructure (new and RM&I) was down by 3.3% in volume terms compared to 2008.

There was continuing strong investment in airports/seaports (+20.4%) and water services (+17.8%) in 2009. These were offset by a decline in investment in road (-13.7%) and public transport (-13.2%) investment.

The volume of construction output from investment in communications also declined, by 28.4%.

The volume of social infrastructure construction fell by 7.4% in 2009. The volume of Construction output associated with investment in hospital buildings increased by 23.6%, but this was offset by a fall in investment in public buildings (-29.5%) and other public social buildings (-21.4%). The total public capital spends on construction to around €8.3 billion in new and RM&Iin 2009.

Today the construction sector is valued at €7- €8 billion which is approximately 5% of the total Irish economy. Currently construction employment stands at 100,000 directly employed, which is expected to continue falling throughout 2012.

Residential construction is currently at a standstill, with an estimated 6,000 residential units to be completed in 2012 of which 80% will be one off builds.

Any recovery in house building is unlikely before 2013. Thus any recovery in the volume of new residential construction is unlikely before 2013. The annual projections for 2010-2012 represent the lowest level of house building since records began in 1970. They reflect weak consumer and business sentiment, the protracted economic situation, the uncertainty over NAMA and a lack of clarity regarding the availability of finance and future capital values.

Construction output can be divided into non voted exchequer expenditure, private non-residential and residential construction, which accounts for €3 billion of current expenditure. There is no real prospect of short term recovery as the private non-residential sector where the vast bulk of developments are under the direct control of NAMA.

Public sector expenditure has been in decline since 2006 due to the economic downturn. The medium to long term construction section is closely tied to the wider economy.

Migrant workers accounted for 13% of labour in 2006 at peak in construction sector, while currently this figure is now 8%. At peak employment in 2007, over 50,000 immigrant workers were employed in construction accounting for 17% of the workforce. This figure had reduced to 9,000 in 2011, with Irish nationals now comprising 92% of the total employed in the sector.

Based on the extent of the contraction forecast, output in the industry looks set to decline by almost two-thirds between 2007 and 2011. In terms of the construction cycle, the current

contraction in such a short time period is the most severe since records began in 1980, but may well be the most severe in the history of the State.

4. National policies and strategies towards EU 2020 targets

This chapter reviews the energy policy and associated strategies for Ireland, and specifically, where they relate to energy efficiency and renewable energy technologies in the built environment. The chapter begins with an outline of the main actors responsible for implementation of the national energy policy. The two national energy action plans, on renewable energy and on energy efficiency, are then analysed to provide a summary of the actions deemed to be most relevant to energy use in buildings. The impact of these policies and the recast European Performance of Buildings Directive (EPBD) 2010 on revisions to Building Regulations is assessed. Since the most recently published energy action plans date from 2009/2010, a summary of updated actions and information on planned revisions will be provided where available. Recent government job strategies are considered where they relate to energy use in the building sector.

Overall, the review of energy policy actions provides an indication of the scale of demand on skills to support their implementation, thereby identifying the pertinent skills gap.

4.1 Irelands Energy Profile

Ireland, as an island nation, has developed as the most import dependent country in the EU. Current figures show an 89% import dependency. The primary energy fuels are oil and natural gas (see Figure 4.1). There is increased penetration of renewables but this remains a low portion of overall consumption at present.

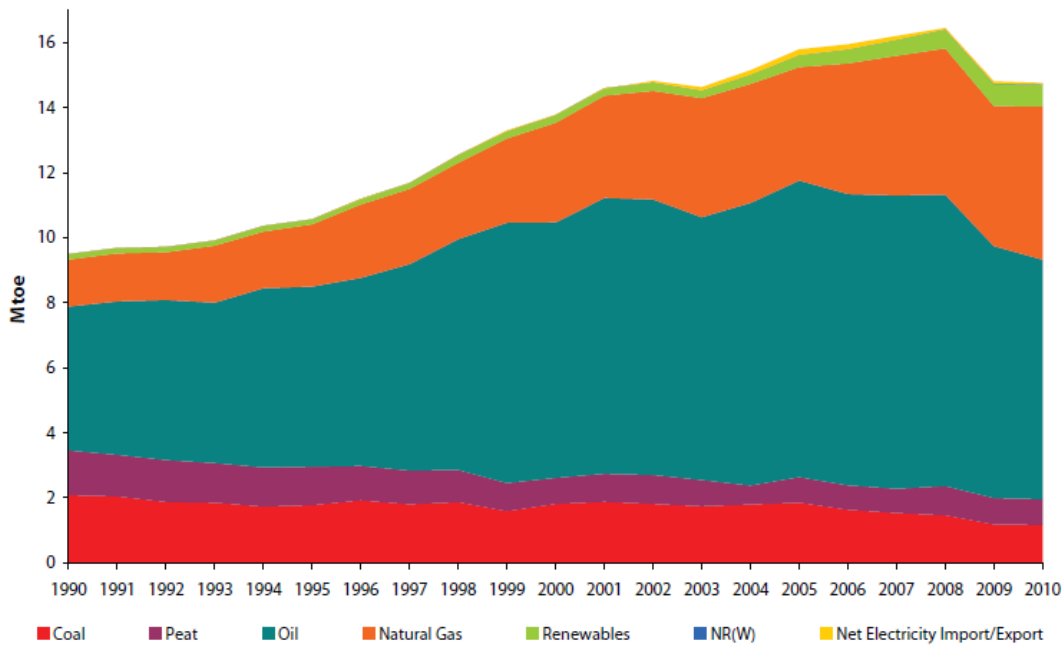


Figure 4.1: Total Primary energy requirement (TPER)

Source: SEAI, 2011

4.2 Institutional Support Infrastructure

The government departments and agencies in Ireland with direct and indirect responsibilities for energy policy and implementation are outlined in the Table 4.1. The relationship between these actors is depicted in Figure 4.1.

Table 4.1: Institutional Support Infrastructure

Organisation	Description	Responsibilities
Department of Communications, Energy and Natural Resources (DCENR)	Government Department	• Determining & implementing national energy policy • Better Energy: the national upgrade programme • Energy supply sector regulation • Energy efficiency & affordability
Department of Environment, Community and Local Government (DECLG)	Government Department	• Legislative framework for the Irish planning system • Building standards & regulations • Social housing through local government
Sustainable Energy authority of Ireland (SEAI)	Government agency	• To promote and assist energy efficiency and renewable sources of energy • The administration of the Better Energy upgrade programme • The administration of the Public Sector programme • To provide advice, information and guidance on energy efficiency and renewable energy implementation
Commission for Energy Regulation (CER)	Independent Regulator for the electricity and natural gas sectors	• To regulate the energy supply sectors energy demand reduction obligation scheme
Office for Public Works (OPW)	Public body managing all state properties	• Procurement and implementation of energy efficiency and renewable energy policy

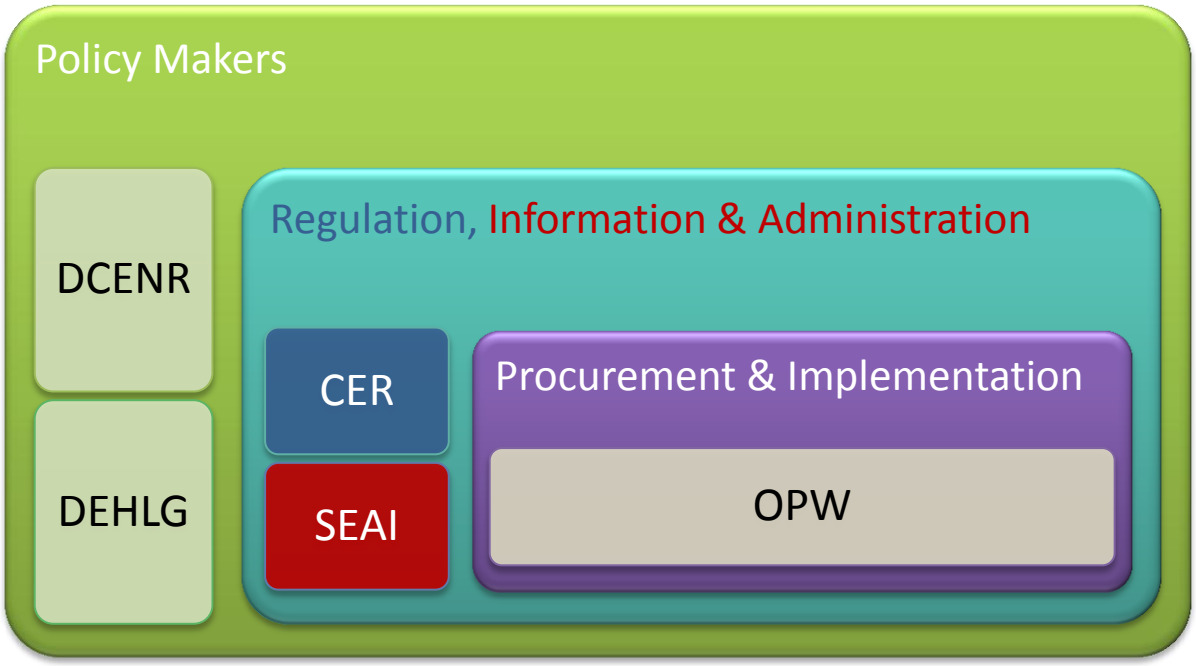


Figure 4.2: Relationship between the main actors responsible for energy policy implementation

4.3 Energy Policy in Ireland

The government's policy and strategies in relation to energy are set out in the "**White Paper on Energy: Delivering a Sustainable Energy Future for Ireland"** which was launched in 2007. The document provides a framework for the actions and targets for energy policy to 2020. The specific targets for Ireland include: achievement of 20% energy savings by 2020; 16% of total primary energy to be provided from renewable sources by 2020; 20% reduction in CO_2 emissions by 2020. The document also set out strategic goals which are relevant BUSI project, including:

- Actions to promote the sustainability of energy supply and use;
- Addressing climate change by reducing greenhouse gas emissions;
- Accelerating the growth of renewable energy sources;
- Maximising energy efficiency and conservation;
- Ensuring affordable energy for everyone;
- Creating jobs, growth and innovation in the energy sector.

The majority of Irish Energy Policy is now driven by relevant EU Legislation and Directives. Specifically the goals outlined in the White Paper can be directly linked to:

- the Energy Performance of Buildings Directive

- the National Renewable Energy Action Plan (NREAP) as part of the RES-E Directive 2001/77/EC
- the National Energy Efficiency Action Plan NEEAP, as part of the Energy Services Directive 2006/32/EC

Ireland's response to the above is summarised in the following sections, with a focus on components which are relevant to the built environment.

4.3.1 Energy Performance of Buildings Directive

Building energy rating legislation was adopted into Irish law in 2006 in response to the Energy Performance of Buildings Directive (2002). Statutory Instrument 666 outlined the regulatory framework which controls, for the first time in Ireland, the provision of energy ratings for buildings. SEAI were charged with the development and management of the energy rating systems. As of January 2009 energy ratings are required for all buildings which are sold or rented. Specific methodologies, and associated software systems, have been developed to allow for energy assessments to be completed by competent, trained energy assessors. Currently the following classifications of energy ratings, and associated energy assessor levels, exist

- Domestic Building Energy Rating (BER): for residential dwellings
- Display Energy Certificate (DEC): for public buildings
- Non Domestic Building Energy Rating: for non-residential buildings

As of April 2012 there are 889 Domestic BER Assessors, 140 Non Domestic BER Assessors and 117 Display Energy Certificate Assessors listed on SEAI's website. A significantly larger number of assessors have received training but are no longer active in the market.

The energy rating approach is now used as a key mechanism for policy makers to measure the impact of regulatory measures and incentives that are put in place. The relevant methodologies and technical standards are update to reflect relevant changes in building regulations and standards.

4.3.2 National Renewable Energy Action Plan

Irelands National Renewable Energy Action Plan (NREAP) was submitted in 2010 to the European Commission under Directive 2009/28/EC. The plan sets out national targets for the share of energy from renewable resources in electricity, transport, heating and cooling by 2020. Irelands NREAP set an overall target of 16% of energy from renewable resources by 2020. This figure of 16% is broken down into the following sub targets

- 40% supply of electricity from renewables
- 12% supply of heat from renewables
- 10% supply of transport fuels from renewables

Wind energy, wave energy and large scale renewable electricity projects have been the main focus on supports to date. The policies and measures relevant to the building sector are summarised in Table 4,2 largely as they appeared in the NREAP, with additional information on current status provided.

Table 4.2: Overview of policies and measures in NREAP relevant to the built environment

Name and reference of the measure	Type & description of measure	Expected result	Targeted group or activity	Update on current status (2012)	Potential Impact on skills demand
Part L of the second schedule of the Building Regulations 1997-2008	**Regulatory:** an amendment to Part L (Conservation of Fuel and Energy) requiring a minimum contribution to the energy consumption in dwellings from renewable energy sources	An increase in use of renewable energy in dwellings	Domestic dwellings	Further amendment to Part L in 2011 does not increase minimum contribution from renewable energy but provides for a 40% improvement in energy & carbon performance	
ReHeat	**Financial Incentive:** Provides financial assistance for boilers fuelled by wood chips & pellets, solar thermal collectors and heat pumps	Increased deployment of renewable heating technologies in the commercial, industrial and public sectors	Commercial, agricultural, industrial and services sectors, as well as energy supply companies (ESCOs)	Existing from 2006. Closed December 2010 citing non-availability of budget resource for 2011	
Combined Heat & Power (CHP) Deployment Programme	**Financial Incentive:** grant scheme supporting 30% on equipment purchase and 40% for feasibility studies	Increase in the deployment of small-scale CHP in accordance with requirements of EU directive on CHP	Commercial, agricultural, industrial and services sectors, as well as energy supply companies (ESCOs)	Existing from 2006. Closed May 2011 citing non-availability of budget resource for 2011	
Greener Homes Scheme	**Financial Incentive:** grant scheme supporting the installation of domestic solar, biomass and heat pump heating systems	Wider deployment of renewable energy heating systems in the residential sector	Homeowners	Existing from 2006. Replaced by the Better Energy Homes scheme in May 2011 which now supports only solar heating installation	
Renewable Energy Feed-in Tariff scheme (REFIT)	**Financial Incentive:** a feed-in tariff mechanism (initially up to 1,450MW, but to be extended in 2010, subject to state clearance, to cover 2020 targets	Increase in electricity from renewable energy sources	Generators and suppliers of electricity from renewable sources	Existing from 2007. Closed for new applicants on 31/12/09. 1242MW in REFIT was included in the 2011/2012 PSO decision.	
REFIT 3	**Financial Incentive**	310MW of biomass technologies (anaerobic digestion, high efficiency CHP and biomass combustion and co-firing)	Generators and suppliers of electricity from renewable sources	Scheme planned for opening in January 2012.	
Accelerated Capital Allowances (ACA) for Energy Efficient Equipment	**Financial Incentive:** tax relief on purchase of energy efficient and renewable energy technologies	Incentivising deployment of energy efficient and renewable energy technologies which meet specific technical standards	Companies paying corporation tax	Existing from 2009. List of products qualifying for the scheme has been extended to over 7,000	

In relation to renewable energy in the built environment, the relevant NREAP actions include

- micro-generation of electricity - solar PV, small scale wind, and
- space heating/hot water technologies - solar thermal, biomass and heat pump.

Additionally, there are a number of other measures described in the document which have a direct or indirect relevance to the building sector and are summarised below.

Legislation on certification and qualifications schemes for installers of renewable energy systems in buildings

The SEAI, in partnership with Action Renewables Association of Northern Ireland, established the Renewable Energy Installers Academy (REIA)[2] in 2004 with funding from the EU Interreg programme. The project developed a framework of accredited training for installers of renewable heat and electricity technologies. The technologies covered include biomass boilers, solar thermal and heat pumps for heat generation and solar PV and wind for small/micro scale electricity generation. This action preceded Article 14 (3) of Directive 2009/28/EC requiring member states to have qualification schemes in place by December 2012 for installers of small-scale biomass boilers and stoves, solar photovoltaic and solar thermal systems, shallow geothermal and heat pump systems.

Initially, the training standard for the heat generation technologies were registered with the Further Education and Training Awards Council of Ireland (FETAC) followed by the wind and solar PV micro-generation technologies in 2010These qualifications are significant in that, they are SEAI recognised for inclusion on the list of approved installers on grant supported renewable technology initiatives such as the Greener Homes Scheme and its successor in 2011, the Better Energy programme.

There are approximately 10 - 15 training centres (mix of public and private) now offering these programmes in Ireland. Further details are available in section **Error! Reference ource not found.** later.

District heating and cooling infrastructure developments

The NREAP acknowledges the significant challenge of implementing district heating on a large scale in Ireland. The penetration of district heating in the national scale is currently negligible. Concentrated residential developments such as apartment complexes were noted as offering the most realistic opportunity with a further possibility in the commercial sector. Biomass and geothermal were identified as the main energy conversion technologies with suitability for district heating utility in Ireland. The NEEAP also stated that, due to the high capital cost of implementing district heating, feasibility of their use in retrofit projects may be unrealistic.

Among the actions required and indicated in the NREAP include, the development of a regulatory framework for parts of the residential, industrial and institutional heat market and the security of biomass supply chains. Also it is noted that *"a significant amount of up-skilling in the building sector will be required, and it is likely that there will be planning and access*

[2] www.actionrenewables.org/services/reia/overview/

issues to be resolved". The considerable potential for the promotion of district heating through regional and county development plans was also acknowledged.

However, recent reviews by Tipperary Energy Agency (TEA) indicate that district heating is increasingly becoming a viable option due to the increasing price of oil. The emergence of Energy Service Companies (ESCOs) and energy performance contracting (EPC) were seen as a further possibility to increase the implementation of district heating as part of shared heating networks for clients.

A number of local authority demonstration programmes have since been completed regionally in 2010/2011 which has successfully adopted district heating on a small scale to achieve significant energy efficiencies. The newly introduced REFIT 3 (see Table 4.2) is expected to stimulate CHP deployment and may have an indirect effect on the future implementation of district heating as knowledge and skills are gained which would potentially be transferable to this application.

Micro-Generation of Electricity from Renewable Energy Systems

The investigation of policy options for utilising micro-generation of electricity via small scale technologies is also mentioned. The Electricity Supply Board (ESB) introduced a micro-generation feed-in tariff support scheme in 2010 which supported the installation of small scale wind turbines, photovoltaic panels, hydro power and Combined Heat and Power (CHP). This covered small-scale generators subject to a rated maximum output of 6 kW, when connection is single phase, and 11 kW, when connection is three phase. The support package includes the free installation of an import/export meter and a payment made up of 2 elements:

- 9 cents / kWh
- 10cents / kWh capped at 3,000 kW per annum for up to a maximum of 5 years

The scheme was instigated with a provision for free metering to the first 4,000 domestic customers but uptake as of April 2011 was just 364 customers[3]. The SEAI was due to complete an 18 month pilot monitoring performance of a variety of micro-generation systems in August 2011. This pilot scheme was to inform SEAI and DCENR of the feasibility of future micro-generation implementation schemes. The scheme was discontinued in February 2012 and there are currently no specific supports available for micro generation deployment.

4.3.3 National Energy Efficiency Action Plan

The National Energy Efficiency Action Plan (NEEAP) for Ireland was published in 2009 as a response to the EU Energy End Use Efficiency and Energy Services Directive (ESD). The ESD required the submission of initial action plans from member states followed by more advanced plans on 2011 and 2014. The NEEAP outlined Ireland's commitment to a 20% reduction in energy demand by 2020. More specifically, the actions referred to at the time were projected to deliver 23,730GWh of energy savings in 2020, equivalent to a 15% saving

[3] http://stanton.ie/2011/04/12/stanton-seeks-improved-micro-generation-supports/

on the baseline period or reference energy consumption. The document attempts to provide a roadmap outlining the measures and policies required to achieve this target. Energy reduction potential is determined for; Public sector, Business sector, Residential sector, Transport sector, and the Energy supply sector.

The estimated savings indicated in the NEEAP were to account for approximately 75% of Ireland's 2020 target. It was recognised that further potential existed in the various sectors that required specific future measures and programmes to be implemented to realise the balance. An overview of the NEEAP's implications for the built environment is outlined in Table 4.3. A detailed explanation of current actions in each sector that are likely to have a significant impact on the demand for skills, are subsequently provided. The specific effect on changes to building regulations is considered separately to assess the direct impact on changes in approach to construction and renovation.

Table 4.3: Overview of policies and measures in NEEAP relevant to the built environment

Name and reference of the measure	Type & description of measure	Expected result	Targeted group or activity	Update on current status (2012)	Potential Impact on skills demand
Public sector					
Centralised advice and monitoring services	support structures for public sector organisations to integrate energy management and energy efficiency initiatives	To promote and support a 33% reduction in energy consumption in the public sector by 2020	All public sector bodies	Public Sector Programme administered by the SEAI	
Annual energy reports	A requirement on public sector bodies to publish annual reports that include energy consumption and energy efficient actions undertaken	To monitor the achievement of public sector targets and to encourage engagement	All public sector bodies	Effective from January 2011	
Business & Industrial sector					
Accelerated Capital Allowances (ACA)	tax incentives for the purchase of energy efficiency equipment	Incentivising deployment of energy efficient technologies which meet specific technical standards	Companies paying corporation tax	List of products qualifying for the scheme has been extended to over 7,000	
Building Regulations for Non-Domestic Buildings	**Regulatory:** revision of standards for non-residential sector	Improved energy performance of new & existing buildings	Non-residential buildings	Publication of amended regulations is advised as being imminent	
Inspection of air-conditioning systems	**Regulatory:** inspection of efficiency of systems	Maximising the efficiency of installed air-conditioning	Public and commercial sector	Consultation on new draft regulations is on-going	

Name and reference of the measure	Type & description of measure	Expected result	Targeted group or activity	Update on current status (2012)	Potential Impact on skills demand
Residential sector					
Building Regulations for Domestic Buildings	**Regulatory:** revision of standards for non-residential sector	Improved energy performance of new & existing buildings	Residential buildings	Revised standards published in 2011 with further revisions planned	
Grant support for energy retrofit	**Financial:** Incentive for homeowners to retrofit	Improved energy performance of existing buildings	Residential buildings	A number of schemes operated by SEAI and the introduction of a National Energy Retrofit Programme in 2011	
Demand side energy saving	**Regulatory:** energy demand reduction obligation scheme	Improved energy performance of existing buildings	Residential sector	Introduction of a Pay as You Save (PAYS) scheme planned	

The Public Sector

The SEAI are currently administering a comprehensive Public Sector Programme (Figure 4.3) in pursuit of the 33% energy savings target on the estimated energy spend of €500 million per annum. The programme is designed to support public sector organisations to integrate energy management and energy efficiency initiatives by providing advice and monitoring services. The benefits of the use of ESCOs (Energy Service Companies) are indicated as being widely promoted. .

Figure 4.3: SEAI Public Sector Programme[4]

There have been a number of grants made available over the last two years for energy efficiency upgrades to approximately 70 government agencies. A number of these projects have payback periods of less than three years and have, therefore, clearly demonstrated the

[4] www.seai.ie/Your_Business/Public_Sector/Public_Sector_Programme/

potential in this sector (see Other Schemes in section *5.3.3 Technologies/measures for energy efficiency and renewable energy* in buildings

Table 5.4 outlines the measures and technologies currently being deployed for each of the main elements of energy efficient building construction and renovation. This information has been derived from an analysis undertaken in Appendix *A4 Review of existing and emerging technologies and skills in energy efficiency and renewable energy in buildings.*

Table 5.4: Energy efficient and renewable energy technologies/measures in buildings

Building Element	Measure/Technology
Building Fabric	• External insulation • Internal dry-lining • Full fill cavity wall insulation • Cavity walling with 150mm partially insulated cavity • High performance timber frame external walling • Insulation and air tight retrofit measures for raised timber ground floors • Concrete slab on ground floors with under slab and perimeter insulation • Twin layer quilt insulation at ceiling level of pitched roofs • Multi-layer insulation of flat roof construction • Blown loose fill loft insulation • Sprayed foam insulations direct to rafters and underside of roof membranes in lofts • Insulation of pitched ceilings in room in roof • Air tightness membranes and materials • Thermal bridging detailing
Ventilation	• Passive Stack Ventilation • Mechanical Ventilation • Positive Input Ventilation • Mechanical Heat Recovery Ventilation (MVHR), • Hybrid Ventilation Systems
Space Heating/ Cooling, Water Heating and Controls	• High efficiency heating appliances • High performance insulation of primary and distribution pipe work and storage vessels • Underfloor heating (low temperature heating circuits) • Heating controls - automatically regulating operation in zones by temperature • Combined systems – i.e. systems combining different energy sources for primary and secondary heating and hot water • Air-conditioning (industrial/commercial applications)
Lighting	• Lighting controls • Low energy lamps

Renewable Energy Systems	• Renewable heat :
	  ○ Solar Thermal
	  ○ Biomass
	  ○ Heat Pump
	• Renewable electricity:
	  ○ Solar Photo-Voltaic (PV)
	  ○ Small-Scale Wind Generation

Building Energy Management	Building Management Systems (BMS)

5.3.4 Retrofit of Existing Dwellings for Energy Performance Improvement later)

Business Sector – Industrial & Commercial

The SEAI is now providing support to businesses under two categories of large energy users and SMEs (Small and Medium Enterprises) and are summarised below.

- The Energy Agreements Programme (EAP), which supports the implementation of the EN 16001 energy management standard, and the Large Industry Energy Network (LIEN) has expanded to include 135 of the largest industry energy users in Ireland. The LIEN members account for approximately 70% of the energy usage in Ireland's industrial sector.

- Over 2,000 SMEs to date have availed of energy management training, access to tools and resources, and mentoring provided by the SEAI. Advice on the potential and procurement of ESCOs is also central to this programme. Average savings of 10% have been experienced in the first year of engagement with the SME programme.

- Financial assistance is available for businesses through the ACA (Accelerated Capital Allowances) and the Better Energy Workplaces scheme. The ACA offers tax incentives for the purchase of energy efficiency equipment and has expanded to include over 7,000 products encompassing 52 technologies. The Better Energy Workplace scheme, administered through the SEAI, provides financial support for a range of sustainable energy projects in the public, commercial, industrial and community sectors. The scheme was closed in November 2011 for new applications due to the large volume already received relative to the strict budget available.

Residential Sector

In March 2009 the Home Energy Savings scheme (HES) and the Warmer Homes Scheme (WHS) were introduced and administered by the SEAI to provide grant assistance to homeowners for energy retrofitting measures. The impact of these measures is outlined in more detail in section 5.3.3 Technologies/measures for energy efficiency and renewable energy in buildings

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	  ○ Heat Pump
	• Renewable electricity:
	  ○ Solar Photo-Voltaic (PV)
	  ○ Small-Scale Wind Generation

Building Energy Management	Building Management Systems (BMS)

5.3.4 Retrofit of Existing Dwellings Retrofit of Existing Dwellings for Energy Performance Improvement later.

The **WHS** was introduced as a targeted measure to tackle the issue of fuel poverty. Home heating has been statistically shown as an expenditure that is curtailed when the means of householders are diminished. The current economic climate in Ireland combined with a consistent rise in fuel costs has exacerbated this social issue. Eligible homes are identified locally through statutory and voluntary networks (local community groups).

The DECLG is responsible for social housing provision and is sponsoring a number of demonstration projects through local authorities and voluntary/co-operative housing associations. In the prescribed criteria, energy efficient housing developments which attain a

minimum standard of A2 Building Energy Rating will be supported with €10million allocated for commencement in 2010. It is anticipated that a significant indirect benefit of this initiative will be the acquisition of wider experience of energy efficient design and technologies.

A **National Energy Retrofit Programme** (NERP) was introduced into the Irish market in 2011. The multi-annual programme is targeting the retrofit of one million buildings and facilities by 2020. The far reaching benefits of such an ambitious programme have been identified, including the potential for job creation in the construction sector, addressing fuel poverty and improving energy security for Ireland. The development of the programme followed the publication of "Greenprint for a National Energy Efficiency Retrofit Programme" by the Institute of International and European Affairs (IIEA) in 2009 which forecast the creation of between 23,000 and 35,000 direct jobs resulting from an investment of €1 to €1.5 billion per annum under a national programme of retrofit. Initial presentations on the NERP by DCENR in 2010 indicated a potential for 20,000 jobs. This contrasts with the figure of 4,500 jobs currently supported according to the governments "Action Plan for Jobs 2012 (see section 4.5 National policy and strategy related to green skills and jobs later).

The real challenge that exists is to identify a mechanism to drive and incentivise deep retrofit uptake while recognising the limited financial capacity of the Irish Exchequer to provide direct financial support. The first step of the programme was the introduction of the Better Energy scheme through the SEAI in March 2011 which replaces the HES, WHS and the Greener Homes Scheme (GHS). This programme is divided into Better Energy Workplace, providing supports to businesses for energy savings measures, and Better Energy Homes which supports the residential sector. The scheme is designed to incorporate supports for renewable energy and energy efficiency measures under a single brand while building on the achievements of the previous SEAI grant programmes.

The Better Energy Homes scheme incorporates the WHS, HES and the solar heating grant aid formerly available under the now discontinued GHS (supports for heat pump and small scale biomass technologies have been discontinued). Grant aid packages have been revised to take in to account building typology and the lower cost of insulation systems available in the market.

While this scheme, in its initial form, resembles previous initiatives, the Irish government has indicated its intention to move away from a grant incentivised approach to achieving retrofit targets. It is envisaged that as the Better Energy programme evolves a more market-based approach to supporting energy efficiency retrofits will develop with a more significant contribution from energy supply companies, energy services providers and lending institutions. The obligation scheme for energy suppliers to incentivise energy demand reduction is seen as a key driver and will need to be clarified with the actors to progress the programme forward.

The funding available for retrofitting homes has increased in 2011 but this is under review as budgetary constraints continue in the current economic climate. The current programme for government indicates that the funding will be phased out by 2014. The intention is to replace publicly funded incentives with a Pay as You Save scheme (PAYS) operated through the energy utilities.

Energy Supply Sector

As part of Better Energy – The National Upgrade Programme, the government has introduced an obligation scheme for energy utilities and fuel importers to meet specified energy saving targets. This initiative is designed to fulfil the action for demand side energy reduction saving from the energy supply sector that was indicated in NEEAP. The obligated parties will be offered the opportunity earn energy saving credits by incorporating the Better Energy Homes grants scheme into their own service offerings. The energy saving credits is awarded against measures included on the Better Energy Homes scheme (see **Error! eference source not found.** later) plus window and external door replacement, boiler servicing and replacement of light bulbs with CFL/LED alternatives. Significantly, bonus credits will be available in some instances where a combination of measures is supported in order to incentivise 'deeper' retrofit. Those wishing to avail of this opportunity will sign an agreement with SEAI and be known as a **Counterparty**, operating as part of the Better Energy Homes scheme as outlined in Figure 4.4.

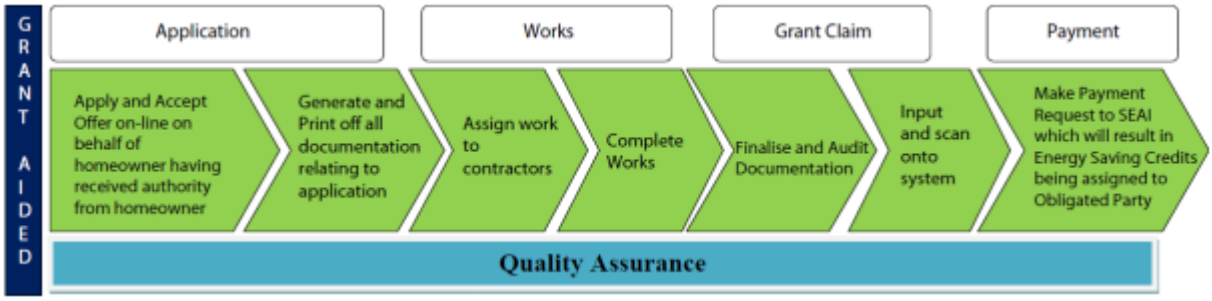

Figure 4.4: Requirements for Counterparties operating under Better Energy Homes scheme[5]

The SEAI retains overall responsibility for governance, standards and quality assurance for the Better Energy programme and will continue to promote and disseminate the results of the initiative. It is anticipated that the Counterparty agreement will evolve with the move away from exchequer grant support for measures, to a new Pay as You Save (PAYS) scheme after 2013 (see section 5.3.3 Technologies/measures for energy efficiency and renewable energy in buildings

Table 5.4 outlines the measures and technologies currently being deployed for each of the main elements of energy efficient building construction and renovation. This information has been derived from an analysis undertaken in Appendix *A4 Review of existing and emerging technologies and skills in energy efficiency and renewable energy in buildings.*

Table 5.4: Energy efficient and renewable energy technologies/measures in buildings

Building Element	Measure/Technology

5 www.seai.ie/Grants/Better_energy_homes/I_am_a_Counter_Party/Obligated_Party_and_Counterparty_Guide.pdf

Building Fabric	• External insulation • Internal dry-lining • Full fill cavity wall insulation • Cavity walling with 150mm partially insulated cavity • High performance timber frame external walling • Insulation and air tight retrofit measures for raised timber ground floors • Concrete slab on ground floors with under slab and perimeter insulation • Twin layer quilt insulation at ceiling level of pitched roofs • Multi-layer insulation of flat roof construction • Blown loose fill loft insulation • Sprayed foam insulations direct to rafters and underside of roof membranes in lofts • Insulation of pitched ceilings in room in roof • Air tightness membranes and materials • Thermal bridging detailing
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	  ○ Heat Pump
	• Renewable electricity:
	  ○ Solar Photo-Voltaic (PV)
	  ○ Small-Scale Wind Generation

Building Energy Management	Building Management Systems (BMS)

5.3.4 Retrofit of Existing Dwellings for Energy Performance Improvement later).

Future Policy Changes

A public consultation document for Irelands NEEAP 2 was released in February 2011[6]. It acknowledged that while targets for renewable energy are largely in line with projections, the contribution from energy efficiency is falling behind. Irelands revised NEEAP is due for release in June 2012.

6 http://www.dcenr.gov.ie/Energy/Energy+Efficiency+and+Affordability+Division/NEEAP2+Consultation+Paper.htm

In addition, a new EU Energy Efficiency Action Plan was also published in February 2011 which also emphasised that that the 2020 targets for energy efficiency will not be achieved under current estimates. The document proposes a number of actions to boost the efforts of member states.

The EPBD Recast 2010 is to be transposed in Ireland by July 2012 with the new requirements enforced by early 2013. Key points of the document include:

- **Cost –optimal regulation for the energy performance of buildings**: Consultation is to be completed in 2012 to establish cost optimal standards
- **Mandatory requirements for the retrofit of existing dwellings**: TGD included reference to existing dwellings in 2008 and 2011. Further amendments will reflect the requirements of the recast EPBD. DECLG is also investing in the retrofit of social housing stock (130,000 units). A code of practice on retrofit for designers and installers is to undergo a public consultation in mid - 2012.
- **Nearly zero energy buildings by 2020:** A Transposition Plan for the recast EPBD is to be released for public consultation in 2012 and the second NEEAP is imminent.

The EU Energy Efficiency Directive, proposed in June 2011, has been developed in an attempt to step up Member States efforts to use energy more efficiently at all stages of the energy chain – from the transformation of energy and its distribution to its final consumption. The EC proposed simple but ambitious measures: legal obligation to establish energy saving schemes in all Member States, public sector to lead by example and major energy savings for consumers

4.4 Building Regulations

The Building Control Act 1990 led to the introduction of the 1991 Building Regulations, which were then superseded by the 1997 Regulations. The Regulations apply to the construction of new buildings, extensions to existing and material alterations and changes of use. The Regulations serve as an aid to Building Control Authorities in the inspection and enforcement of building standards.

It should be noted that the building control regime, which was introduced in 1990, is considered to be effectively “self-regulation” as it relies primarily on certificates of compliance issued by architects/engineers. While local authorities are empowered to carry out inspections and to take enforcement action, the reality is that only limited resources are available. The introduction of the Building Control Act 2007 has had a limited impact on the level of enforcement. This may be a significant factor when relating the actual energy performance of a building to the active building regulations at time of construction.

The Regulations are divided into a number of parts (listed A to L) and are supported by Technical Guidance Documents (TGD) which provide guidance for the construction of buildings towards compliance with regulations. This does not prohibit alternative approaches to construction once compliance with regulations is met. The regulations relevant to energy are:

- Building Regulations Part L – Conservation of Fuel and Energy

- Building Regulations Part F – Ventilation and
- Part J – Heat Producing Appliances

A number of amendments to the Building Regulations Part L – Conservation of Fuel and Energy have been made since 2002 in response to the EPBD and its recast in 2010. In relation to dwellings, revisions were made in 2002, 2005, 2007 and 2011. Regulations for Buildings other than Dwellings were amended in 2005 and 2008 with a further revision expected in 2013. In 2008, accompanying documents, "Limiting Thermal Bridging & Air Infiltration - Acceptable Construction Details" (ACDs) and "Heating and Domestic Hot Water Systems for dwellings – Achieving compliance with Part L 2008" were introduced to provide additional guidance for designers and contractors. The 2011 regulations amount to a 60% aggregate improvement on 2005 levels of energy performance for Dwellings and further amendments will be necessary in line with the recast EPBD and 2020 energy targets (Figure 4.5). They also set the minimum indicative air permeability standard of 7m³/(h.m²) at 50 Pa air pressure. Achievement of the prescribed energy and carbon performance coefficients in the regulations generally require a level closer to 5 m³/ (h.m²).

The DECLG acknowledges that the 2011 regulations have practically exhausted the potential of passive measures to achieve the prescribed energy and carbon performance coefficients. It is anticipated that building designers will have to consider alternative energy options such as renewable energy systems, heat recovery ventilation and Combined Heat and Power (CHP). DECLG are also developing a retrofit Code of Practice in conjunction with the National Standards Authority of Ireland (NSAI) and SEAI in acknowledgment of the increasing obligations in the building standards for existing dwellings and the consequential impact on skills for implementation. This will potentially be an important reference for the development of training in building energy retrofit.

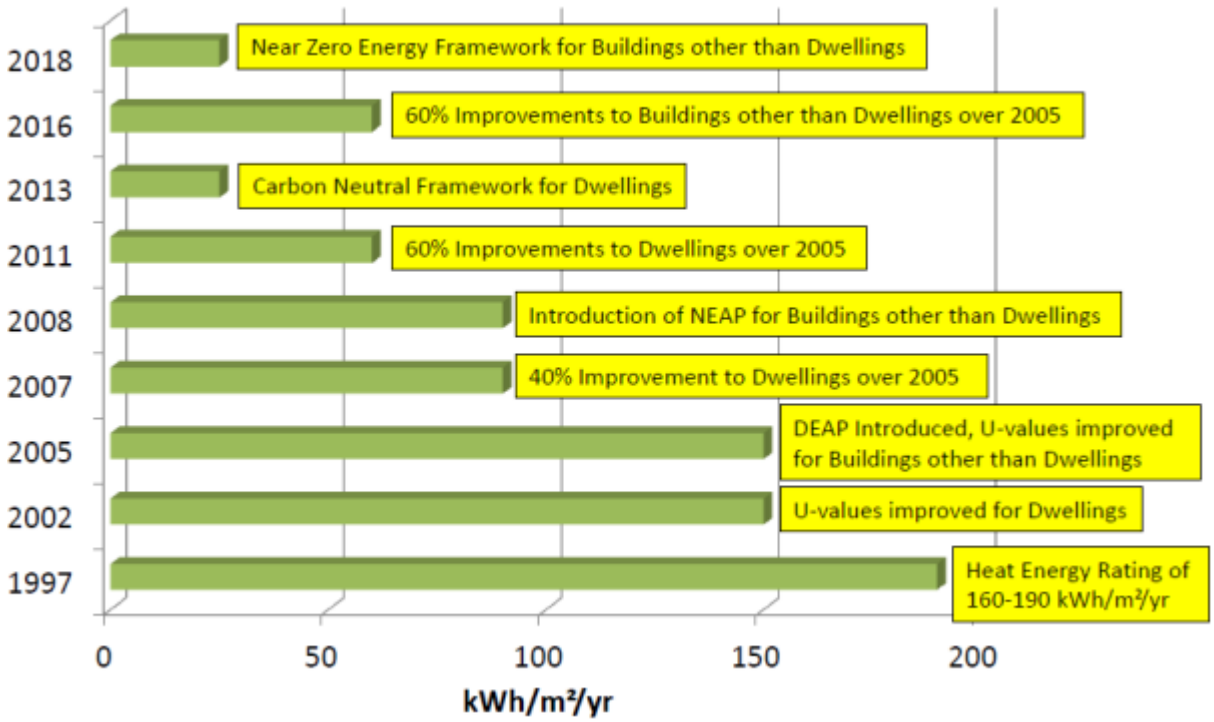


Figure 4.5: Evolution of Building Regulations for Conservation of Fuel and Energy

Building Regulations Part F – Ventilation and Part J – Heat Producing Appliances have also either been amended or have revised editions imminent and need also be considered for their effect on implementation of building energy technologies. The 2009 regulations for ventilation (Part F) are the first version to provide guidance for ventilation when air permeability levels are 5 m^3/ ($h.m^2$) and below. Guidance on the adoption of passive stack, mechanical ventilation and mechanical heat recovery ventilation (MVHR) systems are provided and are indicative of the new ventilation technologies that building designers will have to adopt in order to achieve energy performance and ventilation standards. In order to assess the impact of the evolution of the regulations on skills needs for crafts and system installers an analysis of the amendments to Building Regulations since 2002 was completed and is included in the appendices of this report (see Appendix A1).

4.5 National policy and strategy related to green skills and jobs

The **National Recovery Plan 2011–2014** of 2010 acknowledges the potential growth in the green economy sector and notes the construction jobs potential of the National Retrofit Programme. The need for education to provide skills for green enterprise is also specifically mentioned in, "*Identification of skills needs to capitalise on the green economy and design of appropriate courses and training to deliver these skills".*

This has been addressed in some part by the government announcement in May 2011 of the higher education "Springboard"[7] initiative for the up-skilling and retraining of the unemployed. The programme aimed to provide 6,000 places in higher education targeted at those who were previously employed and who, with some up-skilling, could fill current or future jobs shortages across a number of sectors. The programme has been retained for 2012 in acknowledgment of the need to support the return to employment for those sectors hardest hit by the continuing economic recession. Education providers were supplied with guidance on relevant programme provision including the Forfás published **"Future Skills Needs of Enterprise within the Green Economy in Ireland**". FÁS, the national training agency, has also adopted a policy of developing and providing supplementary training programmes for construction workers with a 'green' theme and are available free of charge to the unemployed.

The construction sector is acknowledged as having being severely hit from an employment perspective. Oversupply of building stock is seen as a major contributor to the slowdown in this sector and it is accepted that employment is unlikely to reach the previously high levels. Stabilising the sector and retaining skills and expertise in support of future activity is noted as a priority.

With a new government elected in 2011, a **Jobs Initiative** was announced in May 2011 which also highlights potential job creation through the National Energy Retrofit Programme. It was indicated that an additional €19 million would be given to DCENR in support of the

[7] www.springboardcourses.ie/

programme in 2011. It is acknowledged that these works are labour intensive and will support additional jobs.

The Action Plan for Jobs 2012 was published in February 2012. With regard to the construction sector, it acknowledges that the green agenda domestically is *"giving rise to employment opportunities for craft-workers with the skills to install renewable energy heating systems, ventilation systems and insulation".* It also lists the following actions to be undertaken in 2012:

- **A review of the current apprenticeship model with a view to providing a workforce with the necessary skills while taking into account changes in the economy to achieve a balance between supply and demand.**
- **To ensure that labour activation programmes continue to support the re-skilling and up-skilling of unemployed construction workers to enhance employability and access to specific opportunities arising in the labour market.**
- **To ensure that higher education institutions and other providers meet the emerging and future skills needs of enterprise within the green economy.**
- **Continue to support *4,500* jobs in the green economy through grant supported programmes for retrofit and other energy efficiency initiatives.**

An accompanying document "Pathways to Work – Government Policy Statement on Labour Market Activation" was published alongside the Action Plan for Jobs. This outlines an intention to increase engagement with the unemployed to access training and job opportunities

A key challenge in the current economic climate in Ireland is attempting to model the impact of supports within the energy sector on job creation/retention. Various reports and indicators have listed a range of different numbers including:

- IEEA noting potential for 23,000 – 35,000 jobs through a national programme of retrofit
- DCENR presentations in 2010 noting potential for 20,000 jobs
- Action Plan for Jobs focused on sustaining 4,500 jobs

The volatility in the Irish economy and increasing pressure on public finances has made it very difficult to provide significantly accurate assessments on the total employment potential within the green economy and specifically the construction related aspects.

4.6 EU education and training policies in the building sector

The information in the following section is taken from *"A bridge to the future: European policy for vocational education and training 2002-2010 National Policy Report – Ireland".* This is one of a number of national reports on VET policy development produced within

CEDEFOP's *ReferNet* network[8] using a common template and prepared by the FÁS Planning and Research department.

In recent years, considerable attention has been given to sustainable environment issues and how requirement for the realisation will affect government policy. The report of the High Level Group on Green Enterprise Opportunities[9] was issued in 2009, following which future skills needs arising in "green economy" were identified. As a result many training provides have begun to deliver and develop training courses in this area. One such initiative being the, Training in Sustainable Energies Technologies programme developed by FAS. These programmes were developed in line with the increased demand for sustainable energy technologies and improved insulation due to new energy efficiency standards in buildings. They were aimed at helping those in construction convert or upgrade their skills to take advantage of the new wave of green and clean-technologies coming on-stream nationally, with a primary target audience of plumbers, electricians, fitters and other suitably qualified people and in particular supplementing the apprenticeship training of this group. However, difficulties in finding work experience to finish apprenticeship schemes have meant that emigration is increasing significantly.

This National Skills Strategy was published in 2007 and sets out to identify the education and training provision required long-term to meet Ireland's economic and social development goals. It has considered existing provision throughout the VET area and has concluded that the majority need to be up-skilled by at least one level on the National Framework of qualifications (NFQ). The National Skills Strategy is directed towards the Irish labour market in general, as well as examining future VET needs and the adequacy of existing provision. Areas within the Irish economy with potential for future growth were also examined. Obstacles were identified, in particular the downturn in the Irish economy, and the consequential restrictions on government expenditure which are curtailing public expenditure on training for the employed. However, this strategy is likely to have an influence on future Government labour market policies and has been incorporated into the National Development Plan for 2007-2013.

Workers are, however, making use of the EU Europass (see: 6.2.1 The International Context programme, which makes skills transferable across EU borders. This was launched in 2005 in Ireland. Since the year 2006, 833 mobility documents have been issued, with 339 in 2009, evidence of the increasing emigration in recent years. The National Europass Centre is expecting this number to increase year on year with programmes such as Leonardo da Vinci Lifelong Learning and the requirement to possess a mobility document for funded exchanges.

Mobility of Irish workers has also been enhanced by increasing numbers of VET programmes incorporating a period of work placement which can be completed in Europe with financial support. While obstacles such as language barriers do exist, there is a growing European focus in some VET courses and opportunities exist in developing and designing courses with EU VET partners. Programmes in place include, FÁS Apprentice Mobility

[8] www.cedefop.europa.eu/EN/about-cedefop/networks/refernet/3314.aspx

[9] Developing the Green Economy in Ireland, Departments of Enterprise, Trade and Employment and Communications Energy and Natural Resources, November 2009.

Programme which was developed due to the economic downturn as many apprentices in the construction industry were finding it difficult to either complete their apprenticeship as their employer have ceased trading, or could not find an employer who would offer them an apprenticeship. This programme offers redundant apprentices the opportunity to gain work experience abroad and complete their apprenticeship; and the German Meister Programme for Irish Learners. The aim of this initiative was to raise the technical ability of selected FÁS trainers by attending a Meister programme in Germany. This would enable the trainers to develop training courses designed to provide progression opportunities for craftspeople in wood technology and to ensure level 7 HETAC requirements are met.

The government funding for VET has become more structured in recent years. This is primarily due to the inclusion in the National Development Plan of allocation for the various publically funded VET providers. In particular, the Irish Government has significantly increased the funding for VET provision for the unemployed, achieved through additional measures introduced in a Supplementary Budget in April 2009 and further provision announced in the December 2009 Budget. However, the key challenge lies in the prioritisation of the investment to those most at risk in the current recession, to optimise access, participation and those with low skill sets. This has been prioritised in the Social Partnership Agreement "Towards 2016" strategy. Training for employed people is seen as essential for the building of a skilled workforce and there still remains quite a significant number of employed who are poorly qualified or possess a low skill set. The use of Lifelong Learning programme funds is being used to address this need. Due to the funding available within the EU Life Long Learning, in particular the Leonardo da Vinci Programme, the mobility of Irish learners has generally increased between the years 2002 and 2009. The Training and Skills Development Programme has been allocated quite significant amounts of funding through a number of sources and has been divided into two main sections; up-skilling the workforce and the Activation and Participation of Groups outside the Workforce.

4.7 Conclusions

- Reduced exchequer funding support has led to the cessation of a number of potentially significant renewable energy implementation initiatives, e.g. Reheat, CHP Deployment Programme, Greener Homes Scheme. This may have an adverse impact on renewable technology contribution to 2020 targets.

- While training programmes for renewable heating and electrical micro-generation have been developed and registered with FETAC, the withdrawal of exchequer supports for biomass and heat pump (GHS) and the lack of a feed in tariff scheme to support small-scale wind and solar PV has resulted in solar thermal technology only being incentivised financially.

- The potential of district heating and Combined Heat and Power (CHP) is referred to in NEEAP. There is a likelihood of significant support for Industrial biomass CHP through the REFIT 3[10] scheme. This may provide opportunities for the up-skilling of plumbers and electricians for the installation and maintenance of such plants. The

[10] http://www.dcenr.gov.ie/Energy/Sustainable+and+Renewable+Energy+Division/REFIT.htm

skills and experience gained may become significant in relation to future implementation of district heating.

- While various government jobs initiatives cite a need to sustain jobs in the construction sector, no reference is made to a need for up-skilling the existing workforce to support the implementation of energy policy for buildings.
- Funding being made available to support up-skilling is largely directed at the unemployed, e.g. Springboard, FÁS provision. This is significant as employers in the current economic climate are unlikely to be willing or able to carry this cost.

5. Statistics on Building and Energy Sectors

This chapter provides outlines of the current status of the building sector including the size of the existing building stock, trends in the construction industry for employment and production output, and energy consumption in old and newly constructed buildings. Statistics from the Building Energy Rating (BER) are considered in terms of the indicative energy performance of new and existing residential and non-residential buildings. Analysis of residential building typology provides insight into the challenge that exists for the refurbishment of building stock to meet energy saving targets for 2020. A review of the energy efficiency and renewable energy measures being supported through SEAI programmes for residential, public sector, industrial and commercial buildings and the level of their implementation is also provided.

Energy in Ireland

The following figures provide a summary of the energy profile within Ireland to provide context to energy use within the building stock in Ireland. Figure 5.1 outlines the direct link between the energy demand in Ireland and its economy growth. GDP grew by 160% between 1990 and 2010 with a 55% increase in Total Primary Energy Requirement (TPER). Between 2005 and 2010 the figures were 0% and -1.3% respectively.

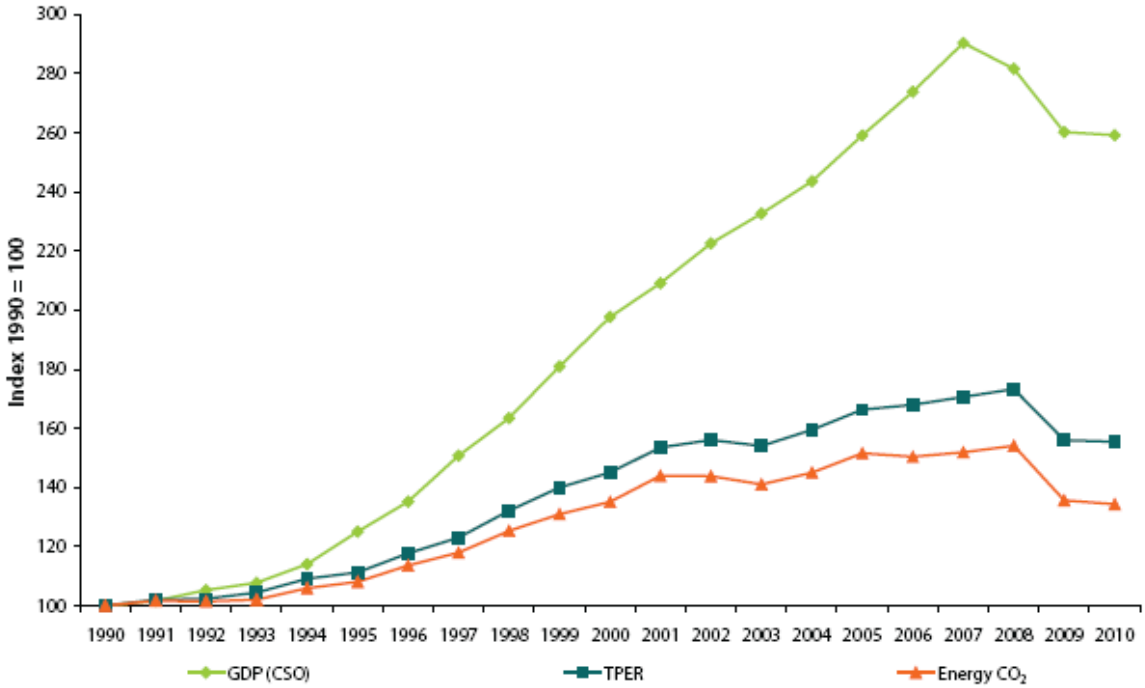


Figure 5.1: Index of Gross Domestic Product (GDP), Total Primary Energy (TPER) and Energy Related CO_2

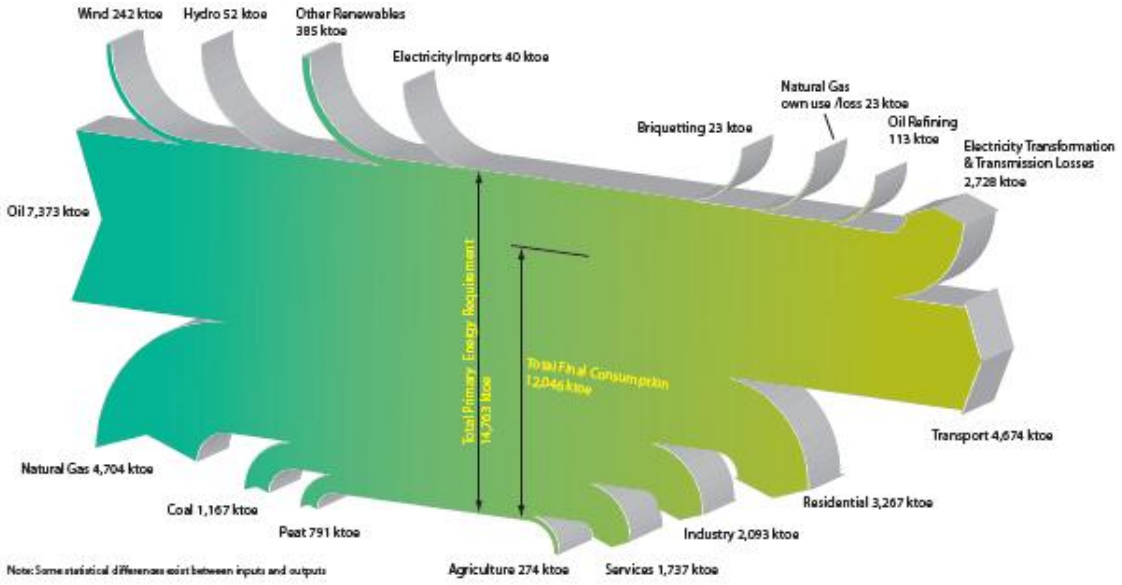


Figure 5.2: Energy Flow in Ireland 2010

SourceL SEAI, 2011

Figure 5.2 demonstrates that of the 14,763 ktoe of TPER in Ireland 50% and 32% was provide from oil and gas respectively. Based on 2010 data the transport sector outstripped the residential sector as the largest user of energy (31.7%). The residential and commerical/public sector account for 28.4 and 18.5% of TPER respectively with the majority of this energy use being attributable to buildings (see Figure 5.3).

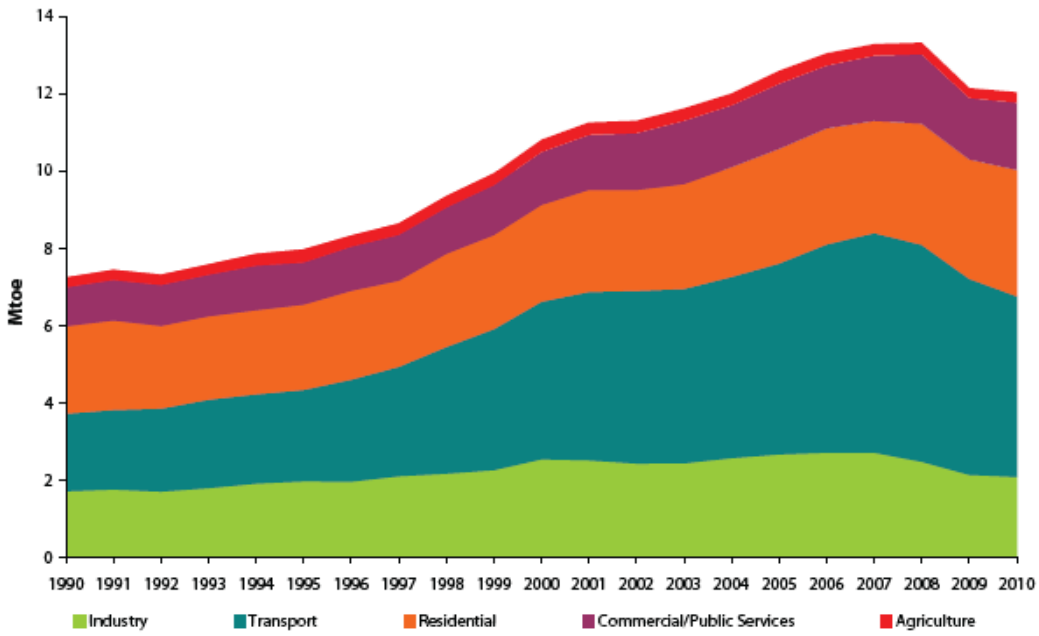


Figure 5.3: Total Final Energy Consumption by Sector

Source: SEAI, 2011

5.1 Building Stock

The construction boom began in Ireland in the mid-1990s and reached its peak in 2007. Subsequently, a profound decline in rates of new build has been experienced in both the residential and non-residential sectors which have left the state with a surplus of building stock in most parts of the country.

5.1.1 Residential Building Stock

Statistics from 2011[11] estimated a total housing stock of 2,004,175 with vacant dwellings numbering 294,202, amounting to a vacancy rate of 14.7%. Recently published statistics from the Census 2011 indicate a total occupancy figure of 1,649,408 (see Figure 5.4) As 2005 Building Regulations were adopted from the beginning of 2006, the majority of this more modern stock is likely to be below a Building Energy Rating (BER) of C1, 150 – 175 kWh/m²/yr.

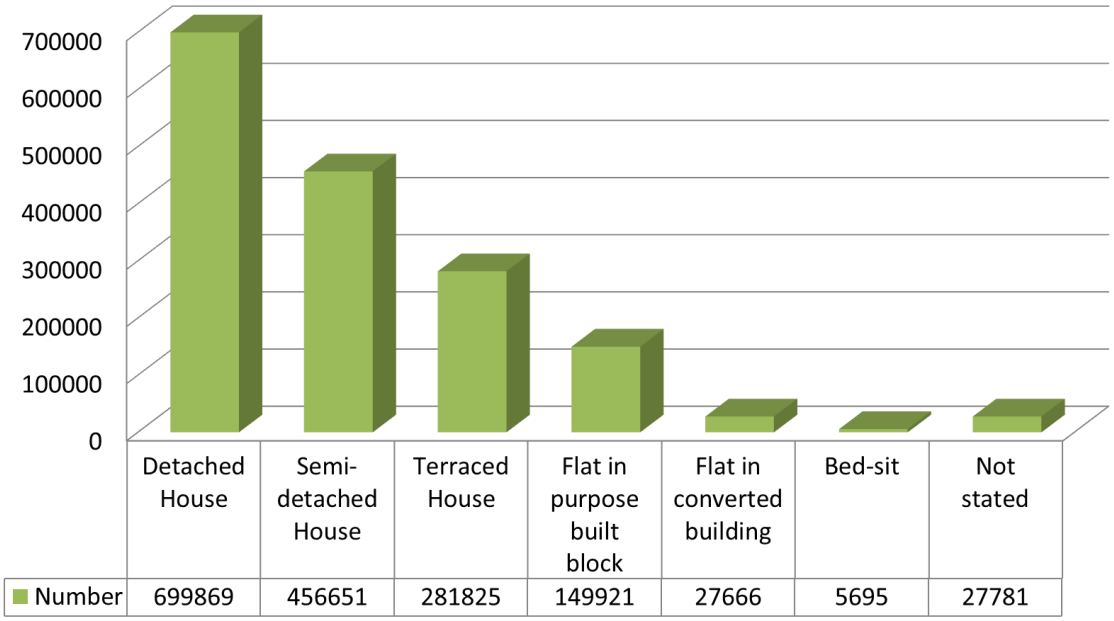


Figure 5.4: Private households in permanent housing units by type of accommodation
Source: CSO.ie Census 2011

Figure 5.4 also illustrates the high incidence of single family housing (detached, semi-detached and terraced) in Ireland which is the highest percentage in the EU[12].

[11] The Irish Construction Industry in 2012 report , CSO Census 2011 preliminary figures

[12] BPIE survey

5.1.2 Non-Residential Building Stock

Irish non-residential building stock was estimated to be at approximately 130,000 units in 2009[13]. This figure includes; private non-residential buildings e.g. administration/office, industrial, agricultural, tourism; and public buildings e.g. administrative/office, education, health, public sports facilities, local authority services.

5.1.3 Residential Building Typology

The EU project "Tabula", which ran between 2009 and 2011, developed national building typology for each participating country which focuses on the characteristic energy properties of buildings. The data in Table 5.1 is taken from the project website country pages for Ireland.

Table 5.1: Residential Building Typology Ireland
Source: www.building-typology.eu/country/typology-ie.html

Dwelling Type	Detached House	Semi-Detached House	Terraced House	Flat or Apartment in a Purpose Built Block	Flat or Apartment in a Converted building	Bed-sit	Not Stated	Total
Before 1919	82,941	15,748	37,111	3,037	11,235	2,678	1,592	154,352
1919 to 1940	48,394	22,056	29,146	2,552	3,339	978	1,180	107,645
1941 to 1960	49,140	40,935	43,461	4,634	2,300	661	1,283	142,414
1961 to 1970	41,777	40,435	22,727	5,248	1,369	486	927	112,969
1971 to 1980	98,182	67,698	37,306	5,763	1,348	417	1,668	212,382
1981 to 1990	85,700	45,064	24,337	7,977	1,134	396	1,413	166,021
1991 to 1995	43,071	30,232	8,341	9,604	927	243	668	93,086
1996 to 2000	71,973	51,327	11,455	17,093	1,450	355	1,121	154,774
2001 or later	94,408	71,378	32,957	44,991	2,230	783	2,696	249,443
Not stated	10,392	13,487	10,681	8,967	4,674	1,754	19,255	69,210
Total	625,988	398,360	257,522	109,866	30,006	8,751	31,803	1,462,296

While this data was based on Census 2006 figures, it does illustrate the existence of a high proportion (60% or approximately 1,000,000 dwellings) of pre-1996 residential building stock, that were constructed with ***limited or no energy performance standards in place***. The data from the Tabula project also indicates the magnitude of potential energy savings that could be achieved through refurbishments, i.e. deployment of a package of measures for upgrade of the building's thermal envelope and heating systems. For example, 1970's hollow block built homes with Building Energy Ratings (BERs) of D1, could be upgraded to

[13] Construction Industry Federation submission to DCENR Consultation on Energy Demand Reduction Target

B1 status through a combination of measures addressed to roof, wall, window and space heating efficiencies.

5.1.4 Annual Rate of Construction/Renovation

The most recent DKM report on the outlook for employment "The Irish Construction Industry in 2012", considers that the Irish economy should be capable of sustaining an industry of around 12% of GNP over the medium term (approximately €15 billion). However, Ireland has been operating below this level since 2010 and will be at half this level in 2012. Construction activity in the residential sector is noted as having a significant effect on the rate of recruitment of apprentices in construction related trades. It is estimated that 11,000 housing units will be completed in 2015, which is well below the generally accepted equilibrium level of 45,000 per annum.

The report forecasts new dwelling completions of 5,000 for 2012 compared with a peak of 93,419 in 2006 (Figure 5.5). Repairs, Maintenance & Improvements (RM&I) account for approximately 80% of work in the private residential sector. RM&I activities are estimated to have been worth €2.83 billion in 2010 and are also enhanced by investment in local authority housing stock. This sector is considered to be significantly more labour intensive than new construction. However, while grant-supported SEAI schemes for energy efficiency improvements are stimulating the sector, the effect of government austerity measures on household incomes and local authority budgets is resulting in a decline in the annual expenditure, amounting to an estimated 10% fall in 2011 over the previous year.

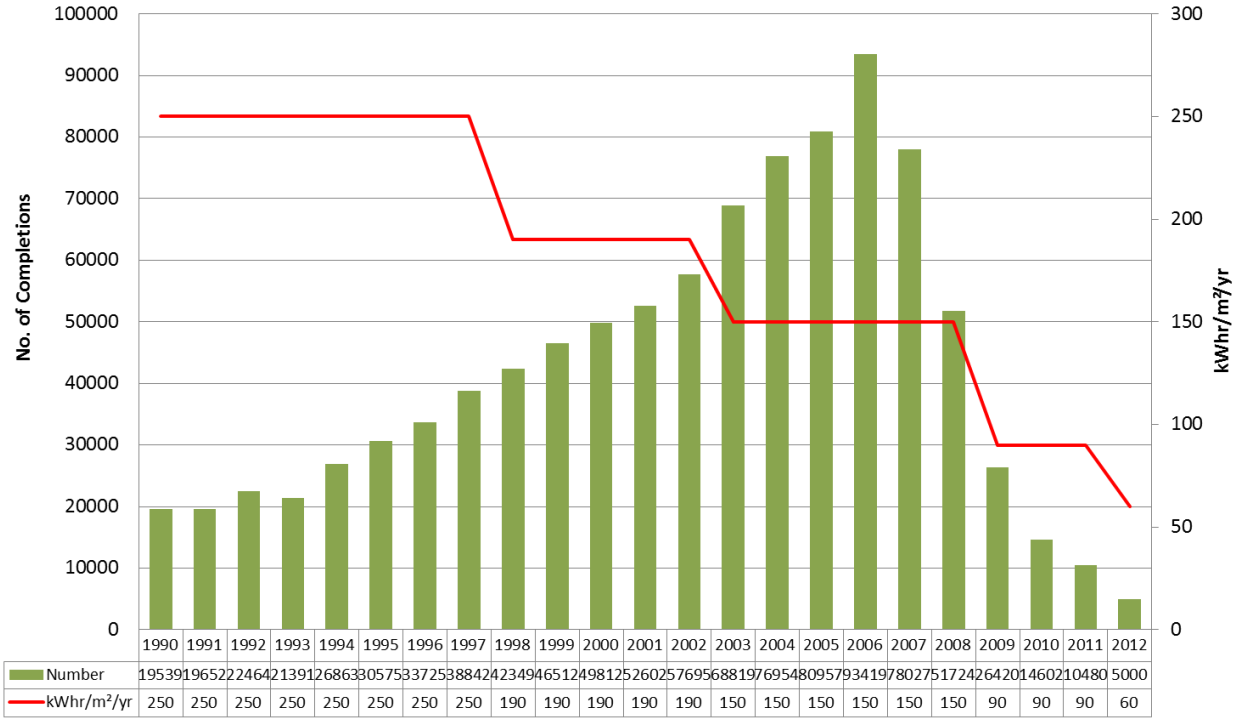


Figure 5.5: Housing Completions 1990 – 2011 and relationship with Building Standards for energy performance

*Note: pre-1997 energy performance standard is approximate and 2012 completions are forecasted
Source: DECLG, www.environ.ie

Figure 5.5. also links the rate of construction with the National Energy Standards for new dwellings (kWh/m^2/yr). This again highlights the fact that the majority of dwellings (60%) were constructed when building energy standards was significant worse than at present.

The private non-residential sector has also experienced a significant decline since 2007. Demand for office and retail premises is particularly low in Dublin, with a significant amount of vacant stock available. There is evidence of strong demand in the medium term from companies in growth areas for the construction of data processing centres and factories. Although the public non-residential sector has been affected by the deferral of a number of government Capital Investment Programme projects, investment in public buildings in the health and education sectors accounted for 65% of total non-residential construction output in 2011 (Table 5.2).

Table 5.2: Share of production output in construction 2011
Source: Irish Construction Industry in 2012, DKM Economic Consultants

Construction type	Output in 2011	
	(€million)	% share
Residential Construction	3,763	43%
Private Non-residential Building	575	7%
Public Non-residential Building	1,166	13%
Total Building	5,503	63%
Productive Infrastructure – Civil	3,181	37%
Total Construction Output	8,684	100%

5.2 Current Workforce in the Building Sector

The severe downward trend in construction output from 2007 has been reflected in a reduction in the number of companies operating in the sector, particularly SMEs (Table 5.3).

The majority of larger building firms are focusing on securing overseas projects, particularly in the UK and the Middle East. The contraction has led consequentially to a dramatic drop in the number of workers employed in the building sector, from a peak of 280,000 in 2007 to just over 100,000 directly involved in 2011.

Table 5.3: Construction Enterprises by NACE Rev 2, 2009

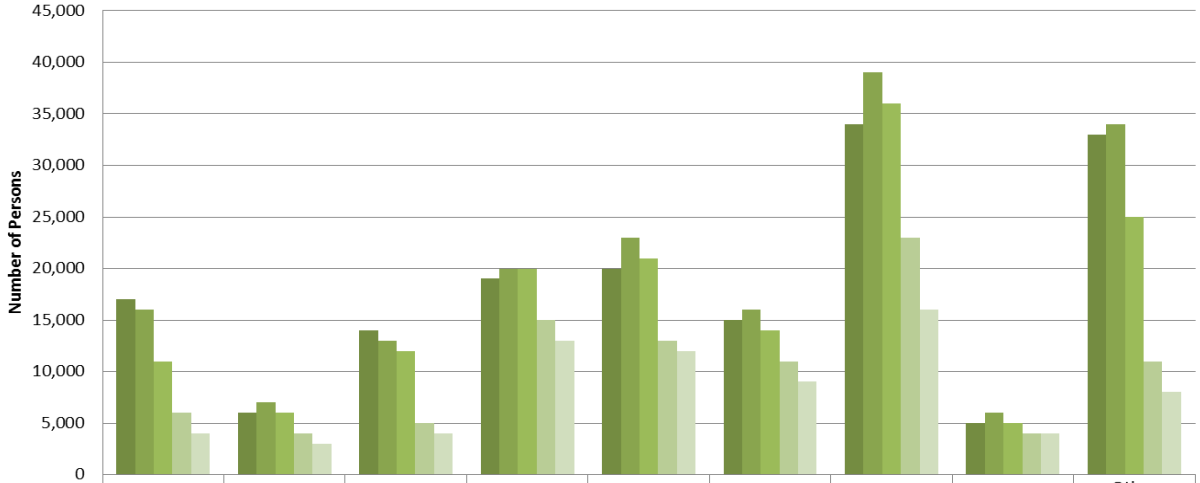
Note: available data prior to 2008 is for enterprises with 20 or more people only, no figures yet available post 2009

Source: www.cso.ie

NACE Activity	2008	2009
Construction of Residential and Non-Residential Buildings		
Construction Enterprises (Numbers)	10,369	8,163
Persons Engaged – Total (Number)	59,661	32,933
Electrical, plumbing and other construction installation activities		
Construction Enterprises (Number)	9,728	8,965
Persons Engaged - Total (Number)	28,862	19,592
Building Completion and Finishing		
Construction Enterprises (Number)	15,615	10,988
Persons Engaged - Total (Number)	22,546	12,148
Other Specialist Construction Activities		
Construction Enterprises (Number)	7,911	5,483
Persons Engaged - Total (Number)	18,330	11,165

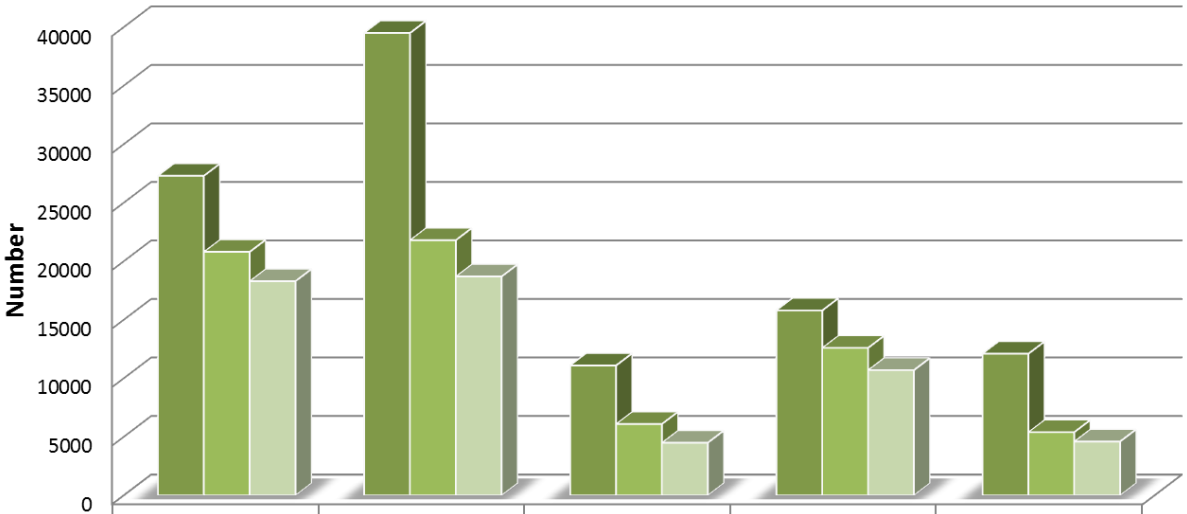
No licensing system exists in Ireland for general building contractors and this has meant that wide variations in technical competencies exist. Traditionally, the majority of site foremen and general building contractors are Carpenter/Joiners by trade with some bricklayers, plasterers and ground workers also operating. Plumbers and Electricians are more likely to operate as supervisors or contractors in their own discipline and are subject to some regulation, e.g. registered with RGII or RECI for gas and electrical installation.

Many skilled construction workers have been left with no option but to emigrate in order to secure employment. At peak employment in 2007, over 50,000 immigrant workers were employed in construction accounting for 17% of the workforce. This figure had reduced to 9,000 in 2011, with Irish nationals now comprising 92% of the total employed in the sector. Figures 5.6 and 5.7 below illustrate trends in employment in the construction sector between 2006 and 2010 with a specific focus on the key crafts/trades relevant to the construction sector.



	Bricklayers, Masons	Roofers, Slaters, Tilers, Sheeters, Cladders	Plasterers	Builders, Building Contractors	Electricians, Electrical Maintenance Fitters	Plumbers, Heating and related Trades	Carpenters and Joiners	Construction and Related Workers	Other Building and Civil Engineering Labourers
2006	17,000	6,000	14,000	19,000	20,000	15,000	34,000	5,000	33,000
2007	16,000	7,000	13,000	20,000	23,000	16,000	39,000	6,000	34,000
2008	11,000	6,000	12,000	20,000	21,000	14,000	36,000	5,000	25,000
2009	6,000	4,000	5,000	15,000	13,000	11,000	23,000	4,000	11,000
2010	4,000	3,000	4,000	13,000	12,000	9,000	16,000	4,000	8,000

Figure 5.6: Total Numbers Employed in Construction Related Occupations 2006 -2010
Source: FÁS SLMRU



	Electricial	Carpentery & Joinery	Brick & Stone Laying	Plumbing	Plastering
2008	27300	39500	11100	15800	12100
2009	20800	21800	6100	12600	5400
2010	18300	18700	4500	10700	4600

Figure 5.7: Numbers employed in the main construction related trades 2008-2010
Source: FÁS SLMRU

5.2.1: Construction Enterprise activity in Energy Efficiency and Renewable Energy

A number of companies and sole traders have recognised the potential opportunities for work on the grant supported schemes administered by the SEAI, both in energy efficient renovation and renewable energy installation. For example, Figure 5.8 shows the number of contractors that were registered on the SEAI list of approved installers of renewable heating technologies under the now discontinued Greener Homes Scheme.

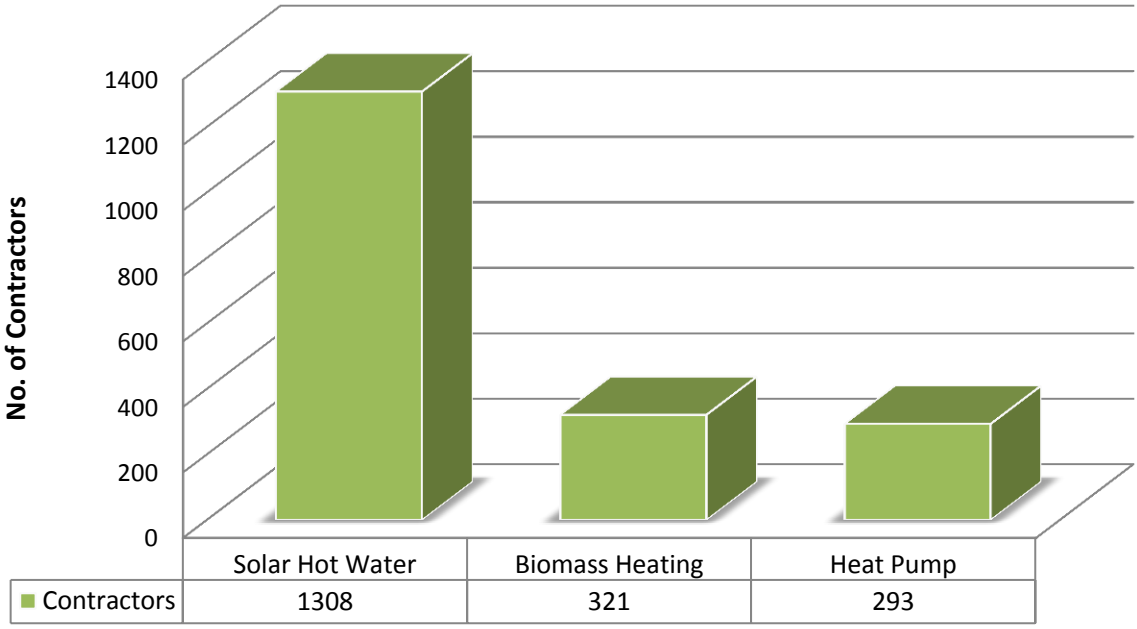


Figure 5.8: Contractors on SEAI Register of Installers for the Greener Homes
Note: some contractors were registered for more than one technology
Source: www.seai.ie/Grants/GreenerHomes/Installers/Installers_List/

In May 2011, the Better Energy Homes scheme replaced the Home Energy Saving scheme (see: 4.3.3 National Energy Efficiency Action Plan and incorporated the Greener Homes Scheme support for solar thermal. This scheme currently has 2,009 companies/sole traders registered for the implementation of a variety of energy saving measures. A number of the contractors are registered for one or more of the technologies supported under the scheme (Figure 5.9). It is worth noting that the majority of these enterprises would employ 2 -3

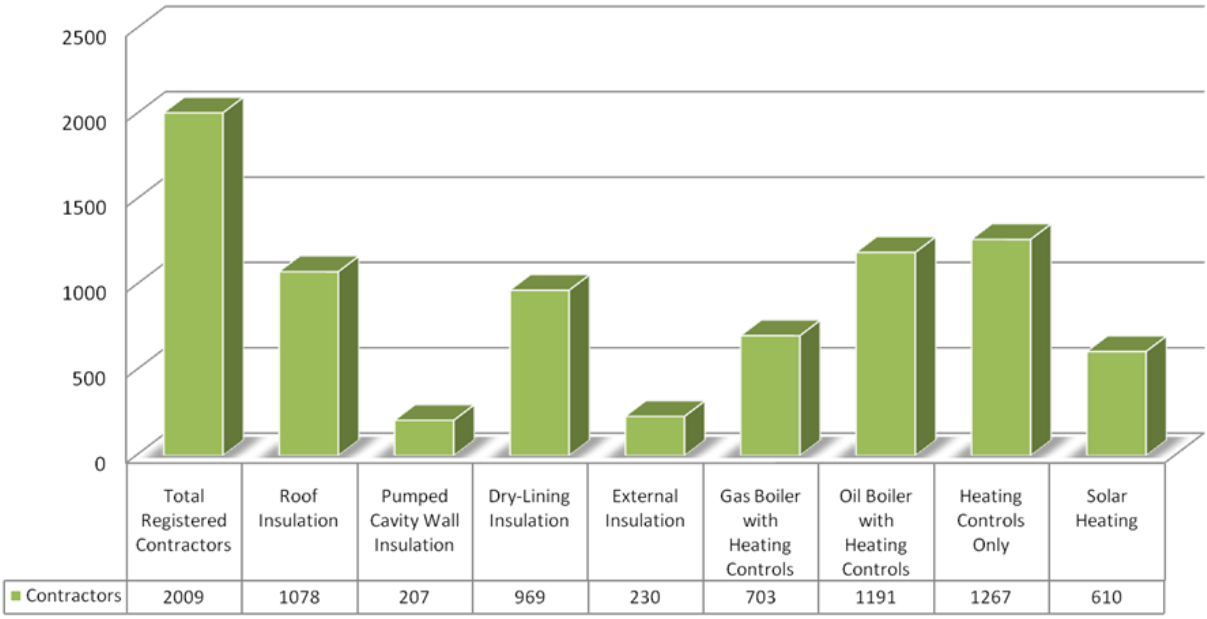


Figure 5.9: SEAI Register of Installers for the Better Energy Homes Scheme
Source: https://hes.seai.ie/GrantProcess/ContractorSearch.aspx

5.3 Energy Efficiency and Renewable Energy Deployment

5.3.1 Profile of Energy Use in Buildings

Buildings account for over 40% of total final energy consumption in the EU. Apart from transport, the residential and services sector are the other main energy consumers in Ireland with a combined total consumption of 40% (Figure 5.10).

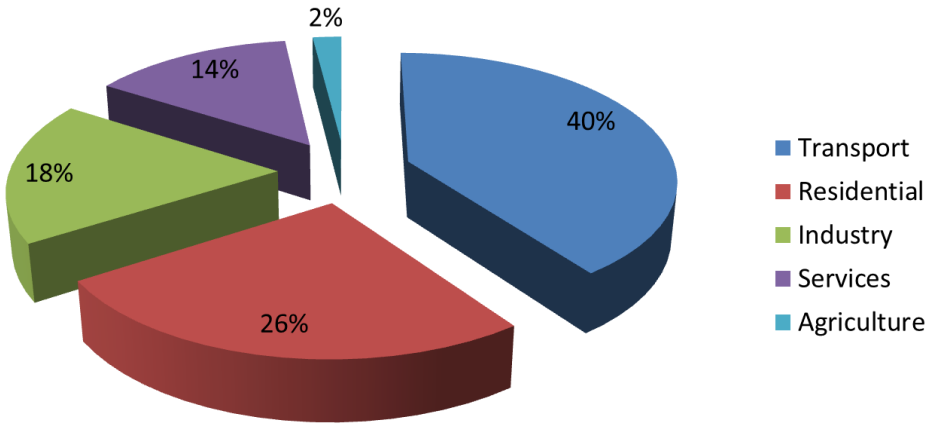


Figure 5.10: Total final energy consumption in Ireland by sector (in % of total Mtoe)
Source: EC (ESTAT, ECFIN), EEA – June 2011

Energy Use in the Residential Sector

Energy consumption in the residential sector accounts for 26% of Ireland's total consumption. At national policy level it is estimated that energy saving of approximately 27% is achievable in this sector by 2020 making it potentially the most significant contributor towards the targeted reductions for buildings.

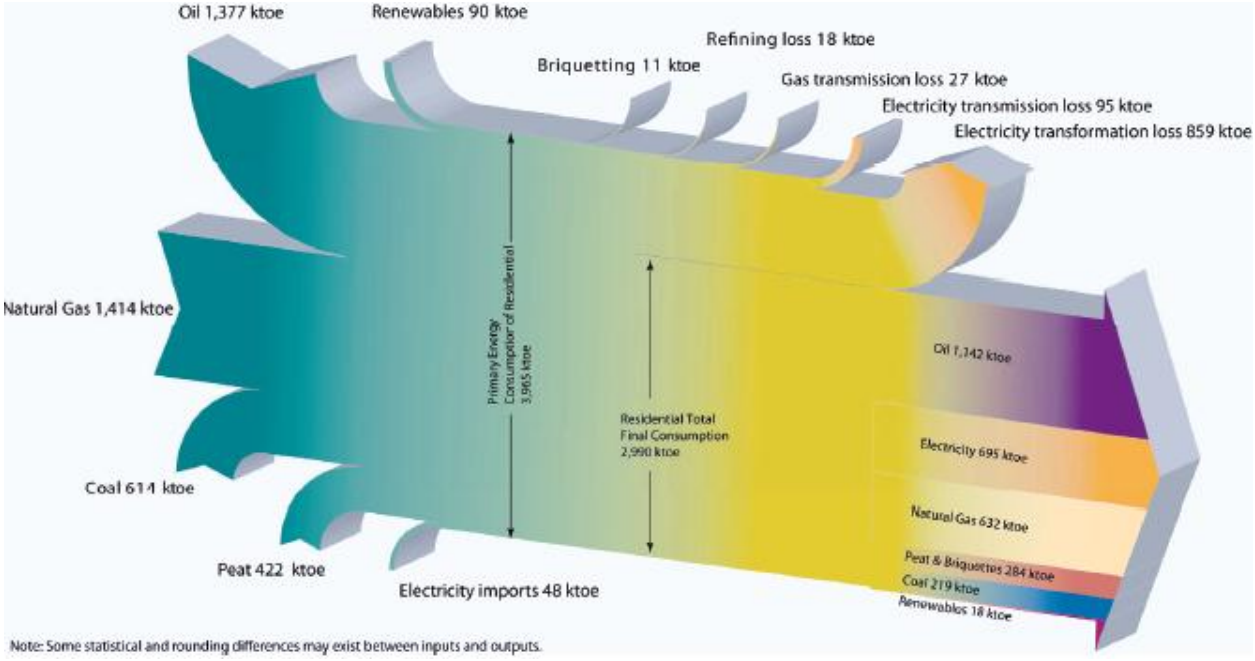


Figure 5.11: Residential Energy Balance 2006

Source: SEAI, 2008

Data from the SEAI 2008 Energy in the Residential Sector report (Figure 5.11) shows that energy use mirrors that of the National trends i.e. primary energy supply is from Oil and Natural Gas. A trend that emerged in the residential sector between 1990 and 2006 was a 21% fall in energy usage per square meter (Figure 5.12). However, over the same period, average floor area is estimated to have increased by 15%. Energy usage by dwelling statistics (Figure 5.13) show that in 2006 Ireland was 26% above the UK average and in 2005, 36% above the EU 27 average.

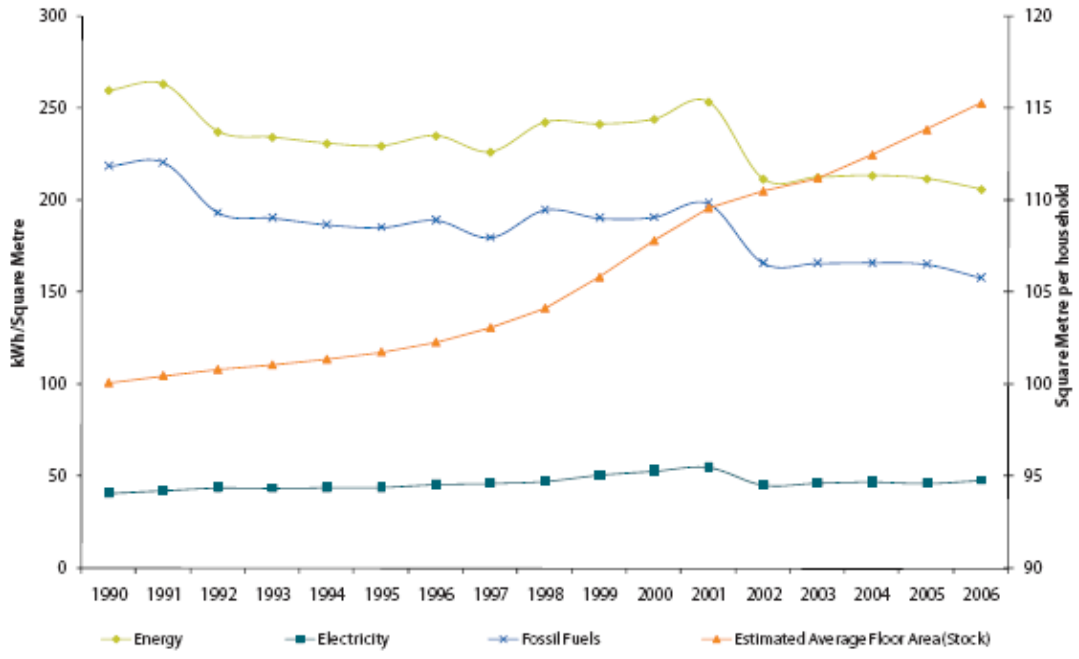


Figure 5.12: Estimated Energy Usage per Square Meter 1990 – 2006
Source: SEAI and CSO

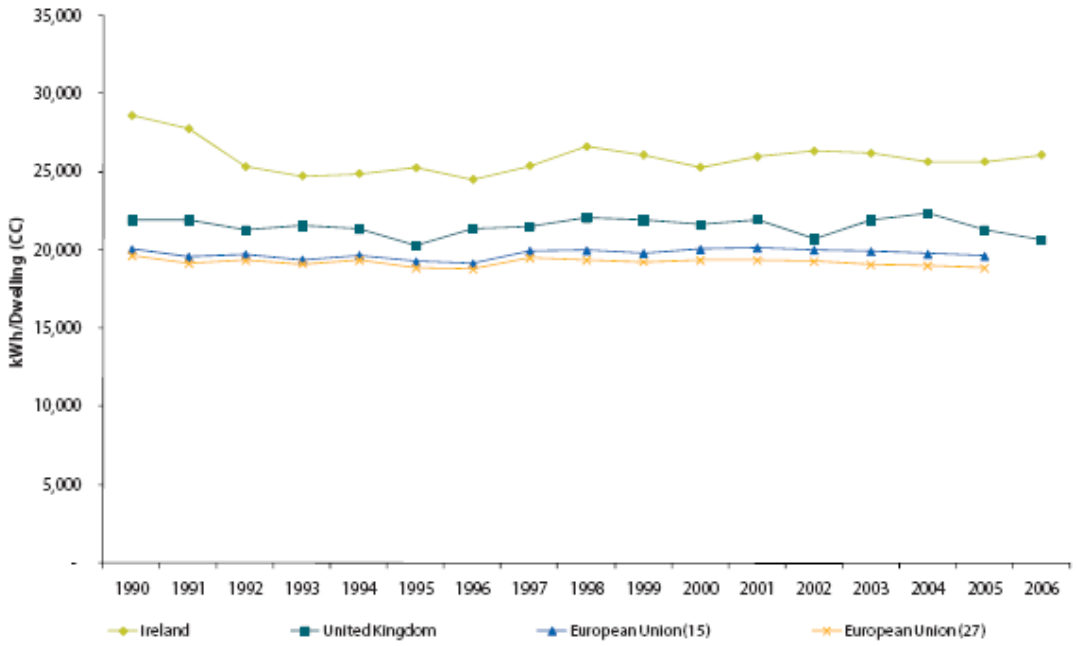


Figure 5.13: Energy usage per dwelling climate corrected
Source: ODYSSEE

Space and water heating account for 84% of consumption (Figure 5.14) in the residential sector, hence; these have been the main target of amendments to building regulations and the implementation of retrofit measures administered through SEAI programmes. Improvements to building fabric performance, installation of high efficiency gas and oil boilers, insulation of storage and distribution, heating controls and renewable heating technologies have been the main focus for achieving significant reductions in energy use.

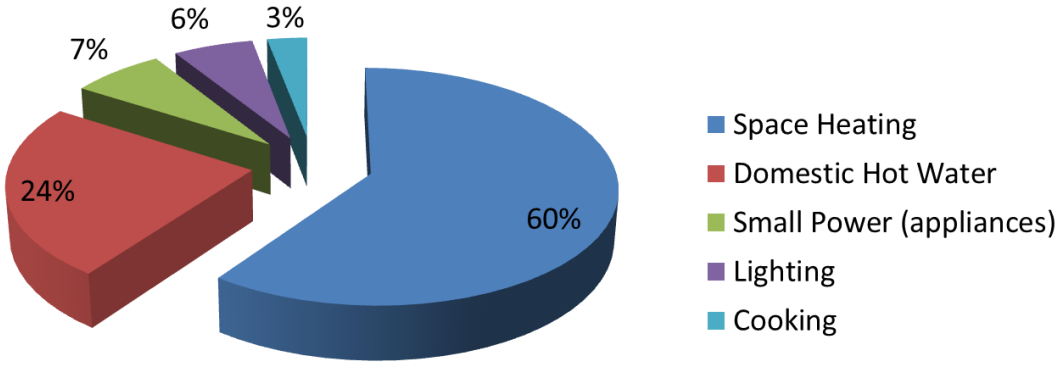


Figure 5.14: Energy Use in the Home Ireland
Source: Householders – be your own energy manager, SEAI[14]

Energy use in Non-Residential Sector

Energy consumption in the commercial sector has increased at approximately 3 times the rate of the domestic sector. This increase can be explained in part by an increase in floor area, with offices for example occupying almost double the floor space in 1994 relative to 1970[15].

More recently, the industrial sector has seen a decrease in energy consumption (5.4% in 2008 relative to the previous year). This is considered to be primarily the result of greater efficiencies in modern manufacturing processes and technologies.

The commercial sector has seen the most significant increase in energy consumption for space conditioning (heating & cooling), lighting and Information Technology (IT). Trends from 1998 - 2008 show a 52% decrease in oil demand, a 130% increase in natural gas and 91% increase in electricity demand. Figure 5.15 shows that for all building use categories, the highest proportion of energy demand is for space heating/cooling, hot water and lighting. These are the areas that are affected by the performance of the buildings envelope and services.

[14] http://www.seai.ie/Publications/Your_Home_Publications/Householders_be_your_own_energy_manager_guide.pdf

[15] SEAI Commercial Buildings Special Working Group - Guidance Document

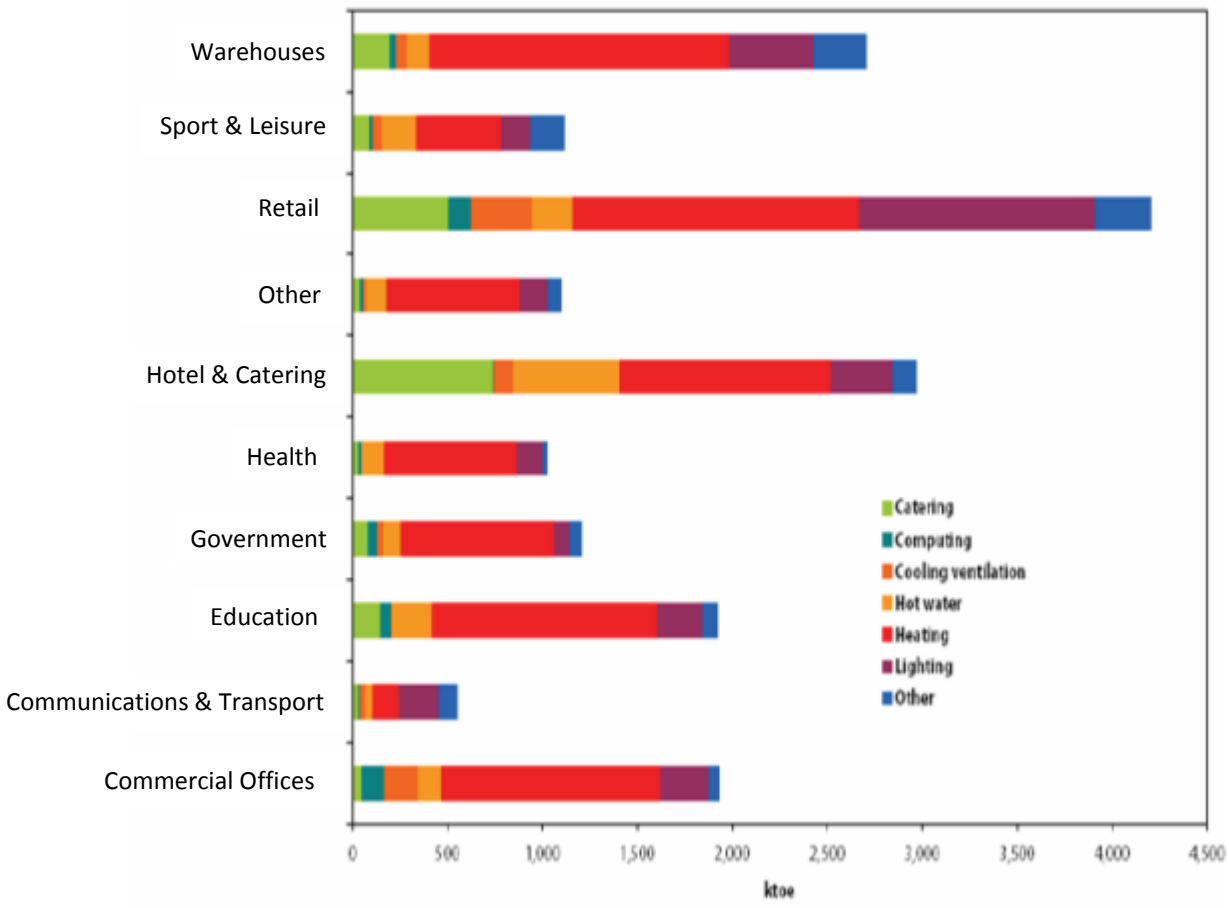


Figure 5.15: Energy Demand by Utility (Commercial Sector)
Source: SEAI Commercial Buildings Special Working Group - Guidance Document

5.3.2 Building Energy Rating (BER)

Building energy rating legislation was adopted into Irish law in 2006 in response to the Energy Performance of Buildings Directive (2002) which led to the introduction of Building Energy Rating (BER) and certification (Figure 5.16 (a)) for all new dwellings from 2007 and for the sale and letting market after January 2009. From the data in SEAI BER statistics for March 2012, it is notable that the ratings for new dwellings (Figure 5.16 (b)) are based on assessments from 2007 and are for buildings subject to either 2005 or 2008 building regulations (regulations apply to planning permission rather than date of construction). SEAI is planning is planning to provide a public research tool to allow users to analyse the BER data that has been collected but initial indications are that the level of full compliance with 2008 regulations for energy and fuel conservation may be as low as 46% based on published BER data.

The data for existing dwellings (Figure 5.16 (c)) include assessments which were carried out as part of SEAI schemes where energy efficiency measures were also supported (75,200 of the total 258,744 ratings) so the ratings may in these instances reflect post-improvement performance. The statistics for non-domestic buildings provide a more accurate reflection of the energy performance in this sector and illustrate the potential for significant energy savings (Figure5.16 (d)).

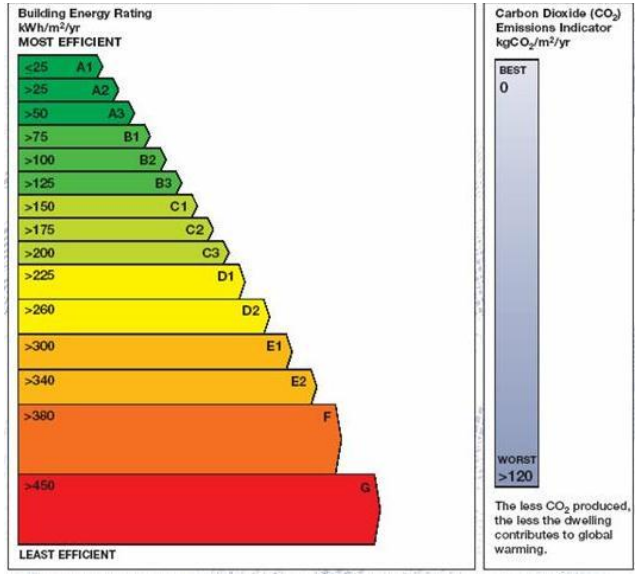
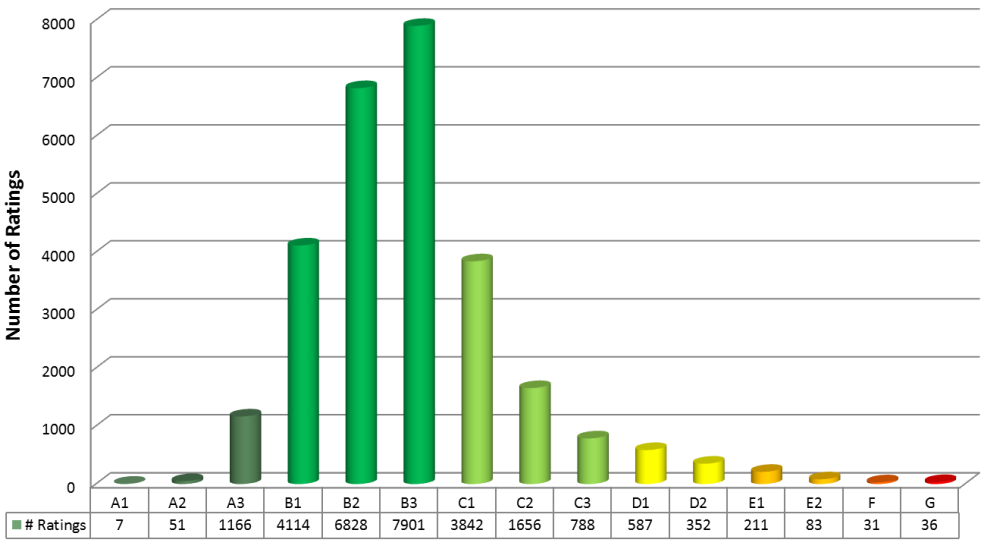
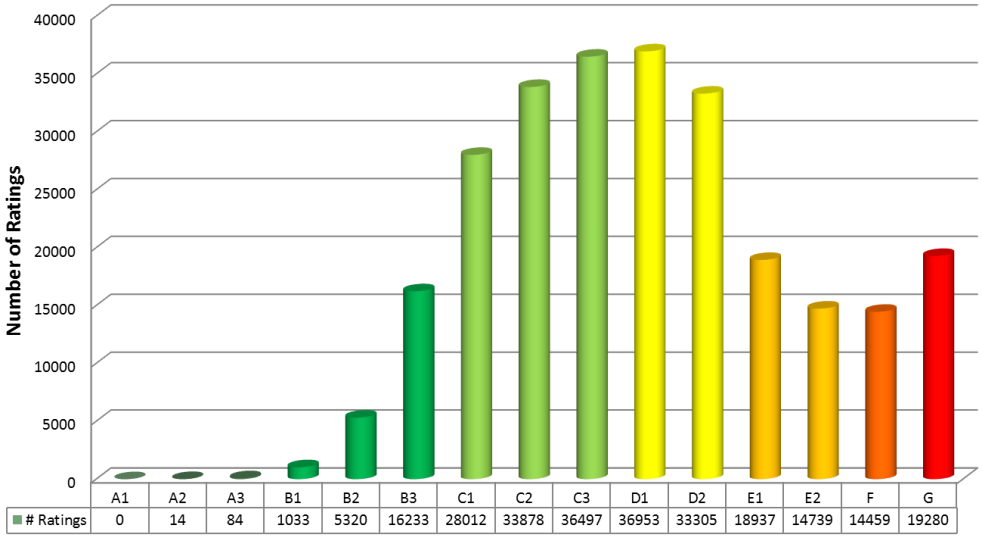


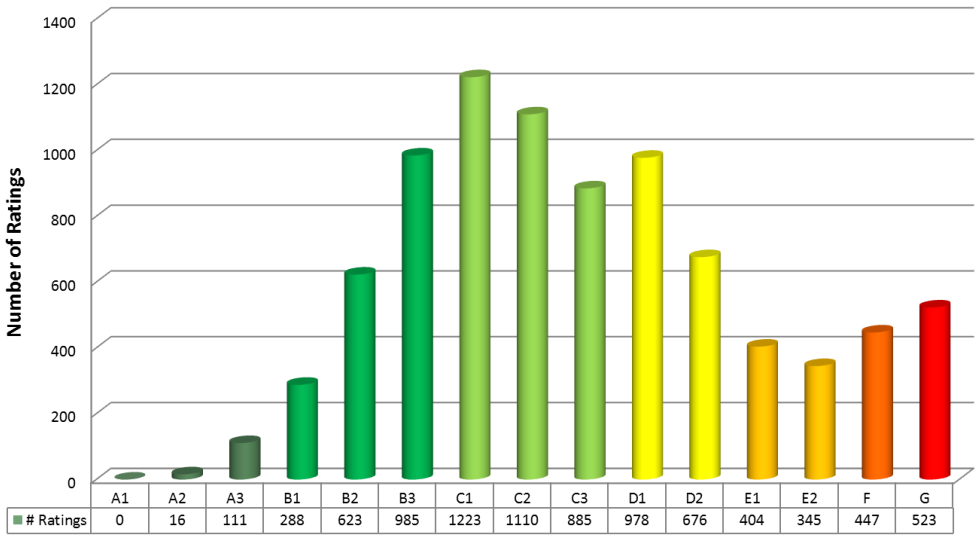
Figure 5.16: (a) Building Energy Rating (BER) categories



(b) Distribution of Ratings for New Dwellings



(c) Distribution of Ratings for Existing Dwellings



(d) Distribution of Ratings for Non-Residential Buildings

5.3.3 Technologies/measures for energy efficiency and renewable energy in buildings

Table 5.4 outlines the measures and technologies currently being deployed for each of the main elements of energy efficient building construction and renovation. This information has been derived from an analysis undertaken in Appendix *A4 Review of existing and emerging technologies and skills in energy efficiency and renewable energy in buildings.*

Table 5.4: Energy efficient and renewable energy technologies/measures in buildings

Building Element	Measure/Technology
Building Fabric	• External insulation • Internal dry-lining • Full fill cavity wall insulation • Cavity walling with 150mm partially insulated cavity • High performance timber frame external walling • Insulation and air tight retrofit measures for raised timber ground floors • Concrete slab on ground floors with under slab and perimeter insulation • Twin layer quilt insulation at ceiling level of pitched roofs • Multi-layer insulation of flat roof construction • Blown loose fill loft insulation • Sprayed foam insulations direct to rafters and underside of roof membranes in lofts • Insulation of pitched ceilings in room in roof • Air tightness membranes and materials • Thermal bridging detailing
Ventilation	• Passive Stack Ventilation • Mechanical Ventilation • Positive Input Ventilation • Mechanical Heat Recovery Ventilation (MVHR), • Hybrid Ventilation Systems
Space Heating/ Cooling, Water Heating and Controls	• High efficiency heating appliances • High performance insulation of primary and distribution pipe work and storage vessels • Underfloor heating (low temperature heating circuits) • Heating controls - automatically regulating operation in zones by temperature • Combined systems – i.e. systems combining different energy sources for primary and secondary heating and hot water • Air-conditioning (industrial/commercial applications)
Lighting	• Lighting controls • Low energy lamps

Renewable Energy Systems	• Renewable heat :
	  ○ Solar Thermal
	  ○ Biomass
	  ○ Heat Pump
	• Renewable electricity:
	  ○ Solar Photo-Voltaic (PV)
	  ○ Small-Scale Wind Generation

Building Energy Management	Building Management Systems (BMS)

5.3.4 Retrofit of Existing Dwellings for Energy Performance Improvement

Over the last number of years, domestic energy performance retrofit programmes have been supported through a number of schemes administered by the SEAI. The initial approach was to support incremental measures that addressed fuel poverty for low income householders under the Warmer Homes Scheme (WHS), followed by incentive for renewable heating technologies with the Greener Homes Scheme (GHS, introduced 2006) and subsequently, the energy efficiency upgrade measures under the Home Energy Savings scheme (HES, introduced March 2009). These schemes were replaced in May 2011 by the Better Energy programme which covers all energy efficiency upgrades for homes and workplaces under a single identifiable brand.

Warmer Homes Scheme

The WHS has employed community based organisations since 2000 and private contractors since 2009. The scheme supports a number of shallow energy efficiency measures such as attic insulation and draught proofing measures, insulation jackets for hot water cylinders, replacement low energy light bulbs and energy advice. Pumped cavity wall insulation is also offered in some parts of the country. Figure 5.17 shows the number of homes and associated implementation costs for the scheme, from its inception as WHS to its current status as Better Energy Warmer Homes (BEWH). It is notable that the average cost per dwelling changed significantly in 2006. From 2000 to 2005 the average investment was €226 per dwelling while from 2006 to 2011 this increased to €1049. A wider range of, and more expensive measures were being applied in these homes which is to be welcomed. Figure 5.18 provides a breakdown of the number and type of measures employed under the scheme in 2011.

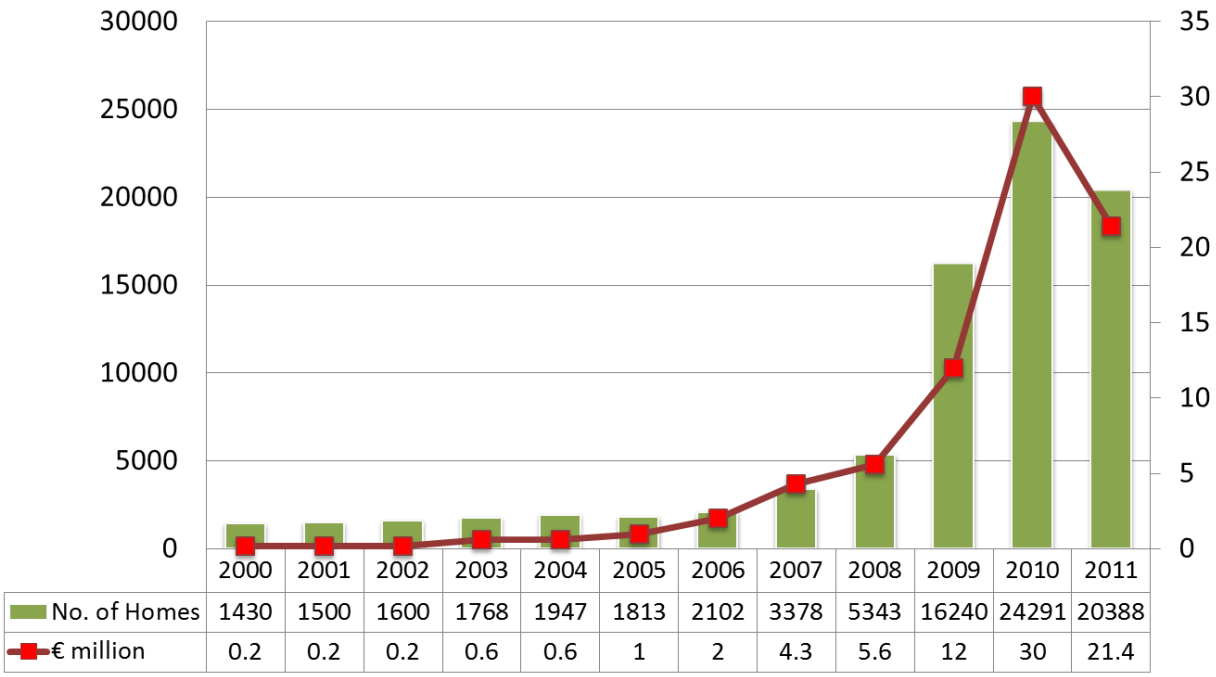


Figure 5.17: Number of Homes and Cost of Measures for BEWH

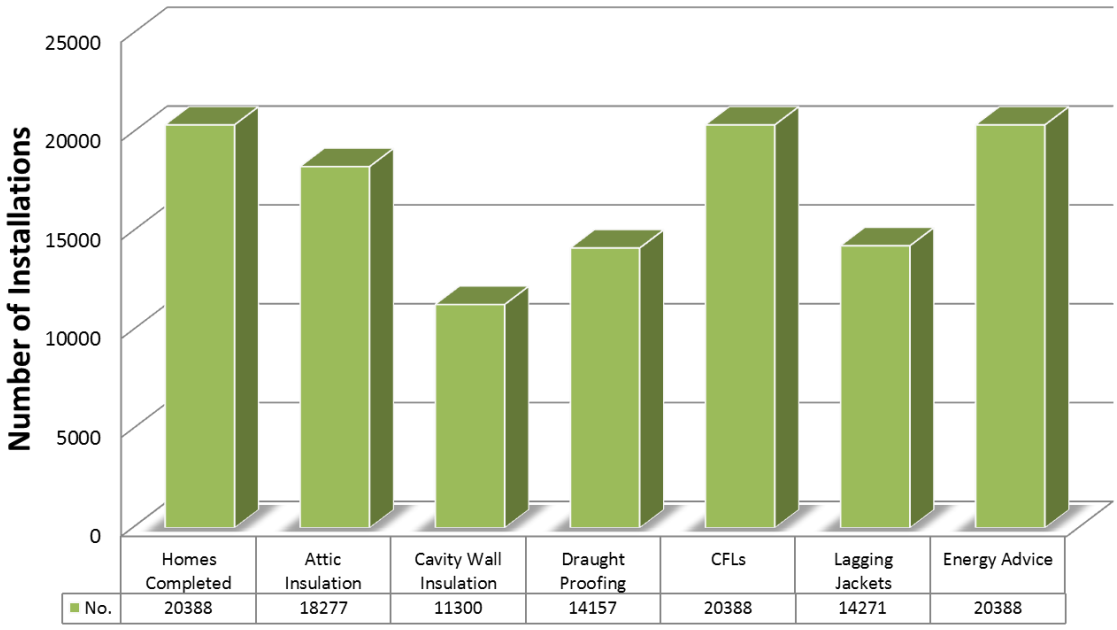


Figure 5.18: Breakdown of Measures Installed under BEWH in 2011
Source: SEAI

Greener Homes Scheme

The Greener Homes Scheme provided specific support for the installation of a wide range of renewable energy technologies. It was responsible for the establishment of a significant number of renewable energy installation companies. Table 5.5 shows the percentage share of support for each renewable heating technology under the Greener Homes Scheme (GHS).

Table 5.5: Greener Homes Scheme (GHS) measures and applications
Note: There were 33,067 applications in the lifetime of the initiative which ceased in May 2011.

Technology		Maximum grant	Scheme applications split by volume %
Biomass	Boiler	€2,500	18%
	Stove	€800	
	Stove w/Integral back boiler	€1,400	
Heat Pump	Vertical ground	€3,500	18%
	Horizontal ground	€2,500	
	Water to water	€2,500	
	Air source	€2,000	
Solar	Flat plate	€250/m² (max. 6m²)	63%
	Evacuated tube	€300/m² (max. 6m²)	
Wood gasification		€2,000	0.5%

Better Energy Homes

Better Energy Homes (BEH) supports solar thermal heating only and provides similar grant funding to the HES scheme with some adjustments for lower market prices of insulation technologies. The measures approved since the introduction of HES and BEH up to June 2012 are outlined in Table 5.6. A total of 197,936 applications had been approved from March 2009 to 20th June 2012 under this scheme and its predecessor, the HES scheme.

Table 5.6: BEH measures approved by percentage (March 2009 - 20th June 2012)
Source: http://www.seai.ie/Grants/Better_energy_homes/Better_Energy_Statistics/

Measure Type	Percentage %
Pumped Cavity Wall Insulation	24%
Attic/Roof Insulation	29%
Internal Dry-Lining Insulation	3%
External Insulation	3%
High Efficiency Gas Boiler with Heating Controls Upgrade	5%
High Efficiency Oil Boiler with Heating Controls Upgrade	5%
Integral Building Energy Rating	23%
Heating Controls Upgrade only	3%
Solar Heating	1%
Before/After BER	4%

Other Schemes

Two specific projects secured funding under the EU CONCERTO programme. The SERVE Project in Tipperary and the HOLISTIC project in Dundalk were fore runners to the majority of the National support programmes. Within the SERVE Region in North Tipperary 350 dwellings were upgraded and some additional measures were supported including high efficiency lighting, wood stoves. A minimum energy reduction of 40% was required as part of the SERVE project which required home owners to do a minimum of 3 measures, with many homeowners completing 4-6 measures.

Local Authorities have invested approximately €80 million on the retrofit of dwellings from 2009-2011. Over 5,995 houses have been upgraded as a result. Much of this work is contracted out to private companies who would also be completing work under the other schemes mentioned above.

Total Retrofitting

The combined number of dwellings which have completed upgrades under the various programmes is outlined in Table 5.7.

Table 5.7: Total numbers of dwellings with energy retrofit measures applied

Scheme	Number of Dwellings
Better Energy Warmer Homes (incorporating WHS)	81,800 (2000 – 2011)
Better Energy Homes (incorporating HES)	197,936 (to June 2012)
SERVE	350 approximately
HOLISTIC	200 approximately
Local Authority	5,995 (2009-2011)
Total	**286,281**

The current total of 286,281 dwellings completed represents 28.6 % of the 1,000,000 buildings projected to be retrofitted under the National Retrofitting Programme. SEAI data indicates that the average investment within the residential sector is €3,000, i.e. a shallow retrofit, with a need to move to deeper retrofits with potential investment cost of €15,000 per dwelling.[16]

5.3.5 Energy Efficiency in the Public and Private Sectors

The SEAI is operating a number of programmes to support the implementation of energy efficiency and renewable energy technologies in the public sector and the industrial commercial sector (see: **4.3.3 National Energy Efficiency Action Plan**). The ambitious target of 33% reduction in energy use in the public sector is being sought through a number of measures including direct funding support for energy efficient upgrades of public buildings though the Better Energy Workplace scheme in 2011[17]. Typical projects that have received support include energy management systems, energy efficient lighting and building fabric upgrade for educational institutions, local authority office buildings and hospitals.

Large industry sector has received grants towards projects to improve process and lighting efficiency. Some SMEs have also received support for upgrades to insulation, heating, cooling and lighting systems. Significantly, where uptake of home energy improvement schemes has been modest, not fully utilising allocated annual budget, the Better Energy Workplace scheme was closed in November 2011 for new applications due to over subscription. The energy savings achieved relative to investment under the scheme (Figure 5.19) may well concentrate future efforts in the public and private sectors.

[16] Jim Scheer – Why Consumers Upgrade presented at SERVE Conference http://servecommunity.ie/wp-content/uploads/2011/09/04-SERVE-Why-Consumers-Upgrade.pdf

[17] http://www.seai.ie/Grants/Better_Energy_Workplaces/Better_Energy_Workplaces_projects_2011.pdf

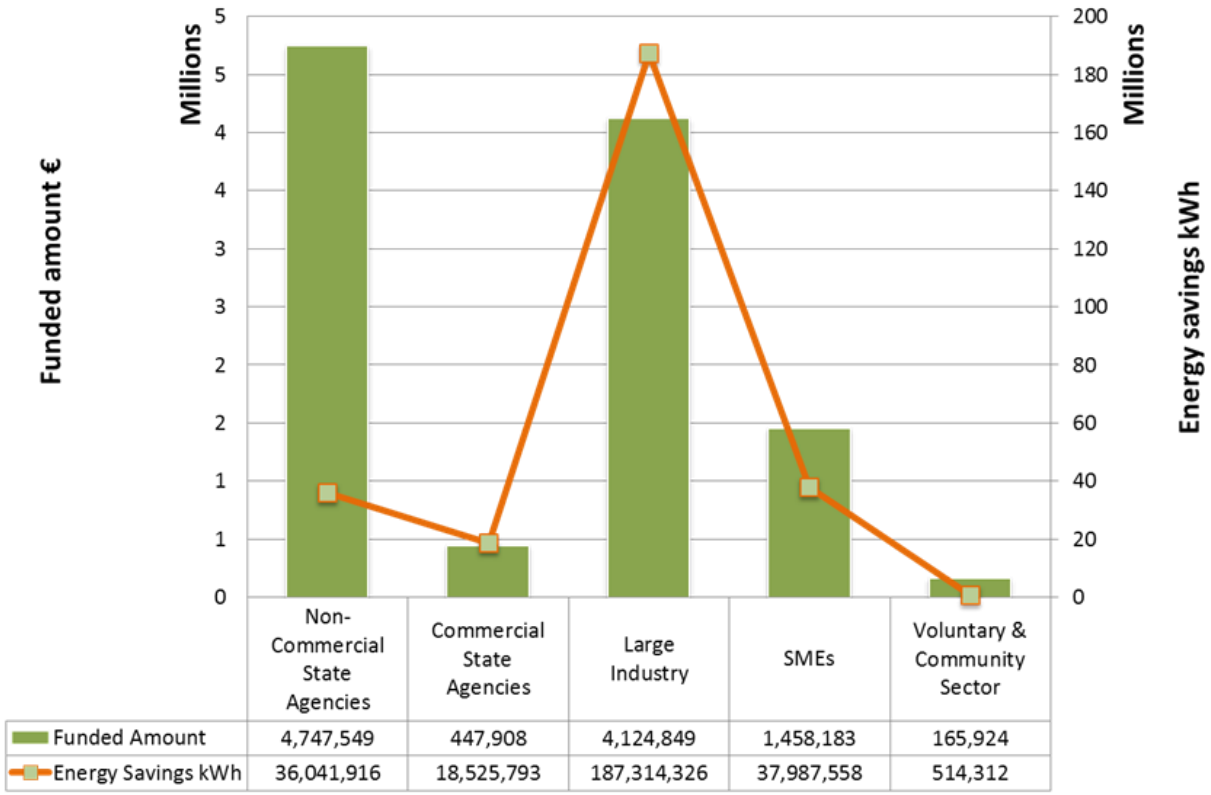


Figure 5.19: Better Energy Workplaces 2011 – energy savings in kWh and funding amounts per sector
Source: SEAI

Conclusions

- The majority of Irish building stock was constructed prior to 2002 (approximately 70%) when regulations required a BER of C1 (150 – 175 kWh/m²/yr), and therefore typically have poor energy performance with significant opportunities for upgrading.

- The annual rate of new construction of residential and non-residential property has declined dramatically from the highs of 2006/2007 and the forecasts indicate that there will be limited growth in rates of new construction to 2020. Therefore the contribution of energy savings from buildings toward 2020 targets will logically need to be met predominantly through the refurbishment of existing stock.

- The drop in the output in construction industry has led to a large reduction in the associated workforce and, consequently, widespread unemployment in the sector. A large proportion of those unemployed are skilled construction workers that were trained in significant numbers to meet the demands of peak output in the industry.

- Energy efficiency related building retrofit measures have supported some employment in the construction sector, but at only a fraction of the level predicted by the National Energy Retrofit programme (see: 4.3.3 National Energy Efficiency Action Plan).

- Energy use in buildings account for over 40% of energy consumption in Ireland with the residential sector accounting for almost 30% of this total. The highest proportion of this consumption is attributed to space heating, water heating and lighting, all areas of energy use which can be significantly reduced through energy efficient construction/renovation methods.

- The savings predicted in NEEAP will have to be revised significantly to reflect the reduced savings that will be achieved through building regulation actions. A significantly larger proportion of savings will have to come from the retrofitting actions.

- Retrofitting to date has mainly been confined to a limited number of measures per building (i.e. shallow retrofit). Both the number of measures completed per building (deep retrofit) and the volume of buildings completed per year will need to be increased significantly.

- A significant escalation in energy retrofit activity will be required to meet 2020 targets, both in terms of numbers of units and the depth of improvement measures.

- Significant progress is likely to be made in the public sector where the government can exercise a much greater level of control over procurement and refurbishment work and can provide direct exchequer funding support for energy saving initiatives.

- The returns on energy savings achieved in the private sector relative to investment and the appetite in the sector to reduce costs is highlighting the potential in this area.

6. Existing Vocational Education & Training Provision

This chapter provides an overview of the training structure and the associated programmes for the building workforce in Ireland. It describes the relevant providers and the associated qualifications awarding bodies. The National Framework of Qualifications (NFQ) and its relevance to quality assurance and recognition, in Ireland and abroad, of the training of construction workers are explained. Relationship between the NFQ and the European Qualifications Framework (EQF) is illustrated to contextualise the competences achieved.

A description is provided of the formal apprenticeship training structure for the construction related trades. The curricula for each of the trades covered (including relevant construction related skills outside of formal apprenticeship programmes) are analysed to identify the extent to which requisite skills for energy efficiency (EE) and renewable energy systems (RES) have been addressed. Training provisions on EE and RES for craft workers and installers that have recently emerged within the NFQ are described, and where available, data on training participation rates are provided. Examples of EU supported energy training initiatives are also provided as additional perspective on the evolving skills needs for a proactive implementation of low energy building construction and renovation.

6.1 Training and Qualification Bodies

Vocational educational training in Ireland is largely the responsibility of the Vocational Education Committees (VECs) and the National Training and Employment Authority (FÁS[18]). VECs are education authorities which have responsibility for vocational educational training, youth work and a range of other statutory functions. VECs also manage and operate secondary schools, further education colleges, pilot community primary schools, and a range of adult and further education centres.

FÁS has the responsibility for the administration of apprenticeship training nationally, and which they deliver in conjunction with employers and the existing Institutes of Technology (IoTs). FÁS has a number of regional training centres that are geared to provision of appropriate training for jobseekers for re-entry into the labour market. In recent years, FÁS has offered up-skilling programmes in EE and RES, specifically for construction craft workers. Its accredited training programmes are predominantly at Further Education and Training Awards Council (FETAC) levels 1-6 in the National Framework of Qualifications (NFQ). The IoTs are higher education providers that focus on preparing graduates for roles in business and industry.

In July 2011, the Irish government announced the intention to establish a new further education and training authority – SOLAS – which will have the strategic responsibility for further education that is currently under Vocational Education Committees (VECs) and training programmes that are currently delivered by FÁS. At the time of writing this report, the new structures and implications for future apprenticeship training were yet to be clarified. Administration of SOLAS will be under the jurisdiction of the Department of Education and Skills.

[18] www.fas.ie

In the last few years, the training provision for craft workers and system installers in EE and RES technologies has been supplemented by a number of Institutes of Technology and private training providers. There are currently, fourteen IoTs located regionally around the country, with most having delegated authority for awarding of qualifications up to NFQ Level 10. The majority of the institutes have partnered with FÁS for the provision of apprenticeship training, including construction related trades.

The IoTs make awards under delegated authority from the Higher education and Training Awards Council (HETAC), with the exception of Dublin Institute of Technology (DIT) who are an autonomous organisation and make their own awards. FETAC, HETAC and the National Qualifications Authority of Ireland (NQAI) are currently in the process of amalgamating to establish one body, the ***Qualifications and Quality Assurance Agency*** *(QQAI).* This process is due to be completed in the summer of 2012. Table 6.1 describes the main actors in the VET sector relevant to the building workforce

Table 0.1: Principal organisations involved in VET provision for craft workers and systems installers

Organisation	Description	Responsibilities	Training Offered Relevant to the Construction Workforce
FETAC (Further Education and Training Awards Council)	Statutory Awarding Body	Makes and promotes awards at NFQ Levels 1-6 Monitoring quality assurance on programmes and services	N/A
HETAC (Higher Education and Training Awards council)	Statutory Awarding Body	Setting standards, accrediting programmes and awarding qualifications at NFQ Levels 6-10	N/A
FÁS	National Training & Employment Authority	Design and administration of apprenticeship training Training provision designed for jobseekers	Phase 2 of apprenticeship, Energy efficiency & renewable energy training, Health & Safety training
Vocational Education Committee (VEC's)	Statutory Education Authority	Management and operation of second level schools, further education colleges, pilot community primary schools and a range of adult and further education centres	2 further education colleges deliver Phases 4 & 6 of apprenticeship for some construction related trades
Institutes of Technology	Higher Education Provider	Institutes of Technology make their own awards at NFQ Levels 6 - 10, under delegated authority from HETAC	Phases 4 & 6 of apprenticeship Energy efficiency & renewable energy training
Dublin Institute of Technology (DIT)	Higher Education Provider	Awards at NFQ levels 6-10	Phases 4 & 6 of apprenticeship Energy efficiency & renewable energy training
Private Training Companies	Private Training Providers	Private training provider offering a number of energy related training programmes	Gas, Oil and renewable energy technology training for installers

6.1.1 FETAC

FETAC is the statutory awarding body for further education and training in Ireland. FETAC makes quality assured awards that are part of the NFQ from levels 1-6 (see: www.fetac.ie/fetac/).

FETAC makes 4 award types, including: ***Major***, ***Minor***, ***Special Purpose*** and ***Supplemental*** at NQF Levels 1 to 6. All awards are devised in line with the determinations and guidelines of the National Qualifications Authority of Ireland (NQAI). FETAC accredited courses account for the majority of awards achieved by construction workers and systems installers in Ireland.

6.1.2 HETAC

The Higher Education and Awards Council (HETAC) is the qualifications awarding body for third-level education and training institutions outside of the university sector (see: http://www.hetac.ie) HETAC is a full member of the European Association for Quality Assurance in Higher Education (ENQA). HETAC awards qualifications at all NFQ Level 6 to 10. HETAC's principal quality assurance processes include registering providers of higher education and training, validating programmes, monitoring quality, reviewing institutions and conducting related system-level research.

6.2 The National Framework of Qualifications (NFQ)

The National Framework of Qualifications provides a structure to compare qualifications from different awarding bodies across ten different levels based on nationally agreed standards knowledge, skill and competence. This aids learners to make informed decisions about their

qualification choices and to consider progression opportunities available to them on completion of training programmes. The NFQ also makes it easier for learners to demonstrate both here and abroad, the qualifications that they hold or are studying for. Figure 6.1 shows the NFQ award scheme which superimposes number of other national awarding bodies in the framework in addition to FETAC, HETAC and DIT. A particular nuance of the Irish education system is the overlap between responsible authorities and providers related to awards positioned at Level 6 on the framework, the level at which the majority of awards to construction workers are made.

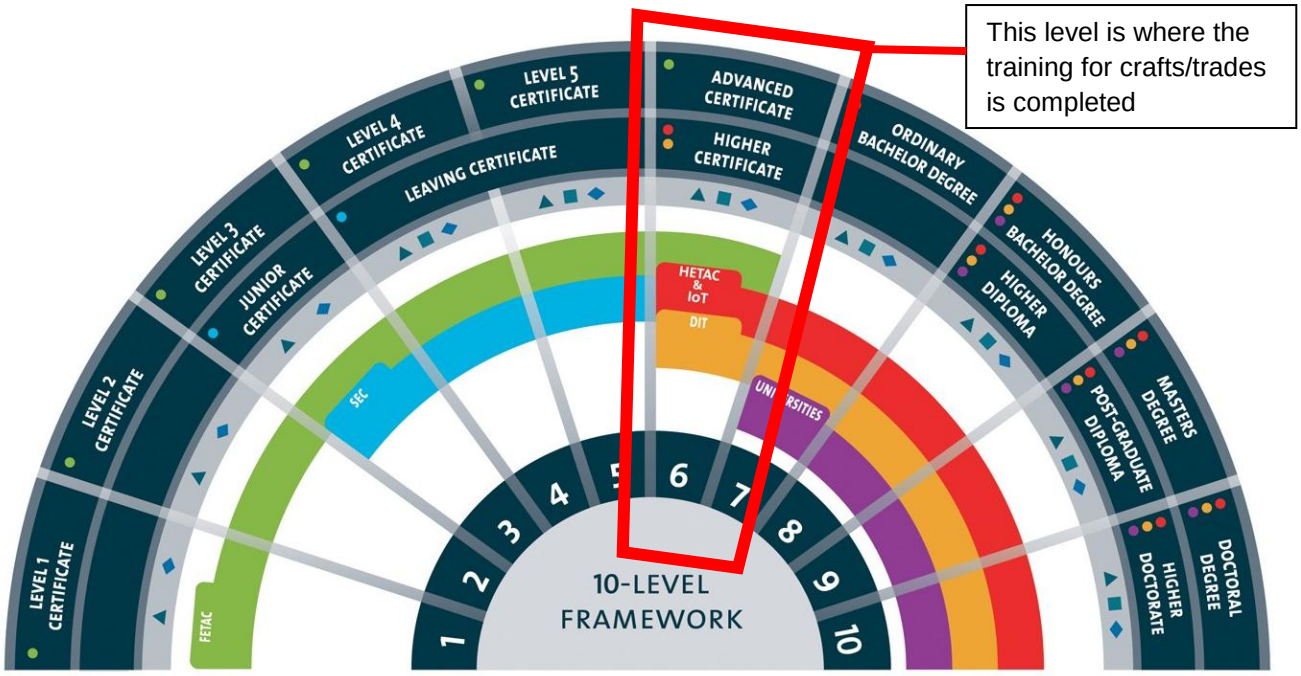


Figure 0.1: National Framework of Qualifications
Source: HETAC, 2011

6.2.1 The International Context

Ireland has been actively seeking to establish links with other countries and education/training authorities to facilitate mutual recognition of Irish qualifications by international training collaborators and partners. Such mutual recognition is to facilitate mobility of labour, particularly in the EU countries. The two European frameworks which deal with higher education (NFQ Levels 6 to 10) are the **'Bologna framework'**, created by the European Higher Education Area (EHEA), and the **European Qualifications Framework (EQF)**, which deals with all educational levels including schools, further education and training, and higher education and training. The NFQ was referenced to the 'Bologna framework' in 2006 and was mapped to the EQF in June 2009 (Table 6.2).

Europass was established in 2004 by the European Parliament and Council to provide a single transparency framework for qualifications and competences (see: http://www.europass.ie/europass/). Europass aims to facilitate the mobility of European learners and workers by making their skills and qualifications more easily understood across Europe.

The Europass Certificate Supplement is provided to learners who hold a vocational education and training award. The Certificate provides additional information about the skills and competences, the level of the Cert, entry requirements and access opportunities for progression to higher levels. Ordinarily, such information is not highlighted in the original award certificate. In Ireland, Europass Certificates are issued by FETAC.

Table 0.2: Mapping of EQF, Bologna Framework and NFQ

EQF Level**	EHEA Framework (Bologna)*	National Framework of Qualifications (NFQ) Level	NFQ Major Award-Types
EQF Level 1		NFQ Level 1	Level 1 Certificate
		NFQ Level 2	Level 2 Certificate
EQF Level 2		NFQ Level 3	Level 3 Certificate; Junior Certificate
EQF Level 3		NFQ Level 4	Level 4 Certificate; Leaving Certificate
EQF Level 4		NFQ Level 5	Level 5 Certificate; Leaving Certificate
EQF Level 5	Short Cycle within First Cycle	NFQ Level 6	Advanced Certificate (FET award); Higher Certificate (HET award)
EQF Level 6	First Cycle	NFQ Level 7	Ordinary Bachelor Degree
		NFQ Level 8	Honours Bachelor Degree; Higher Diploma
EQF Level 7	Second Cycle	NFQ Level 9	Master's Degree; Post-Graduate Diploma
EQF Level 8	Third Cycle	NFQ Level 10	Doctoral Degree; Higher Doctorate

6.3 Review of Apprenticeship Training for the Construction Related Trades

6.3.1 Overview of Apprenticeship Training Structures

Traditionally, apprenticeship training in Ireland was conducted on a "time served" basis with little emphasis on the achievement of pre-determined standards of competence and knowledge. However, this has changed with the introduction of new "Standards-Based" programmes that were designed as a system of employment-focused training and education, and first implemented on a phased basis in 1993. Each of the Apprenticeship Programmes for the "Standards Based" construction crafts were developed on the basis of industry surveys and research into the skills, knowledge and competence required by craftspeople.

FÁS has the statutory responsibility for the organisation and control of apprenticeships in Ireland and has responsibility for promoting and overseeing the training and education of all apprentices, including the construction related crafts Brick & Stone-Laying, Carpentry & Joinery, Plastering, Electrical, Plumbing and Refrigeration & Air-Conditioning.

Apprenticeship training programmes consist of alternating phases of On-the-Job and Off-the-Job training and education as outlined in Table 6.3. The alternating phases of training generally consist of three Off-the-Job phases and four On-the-Job phases, although differences do occur in some apprenticeships.

Table 0.3: Typical Apprenticeship Training Phase Duration

Phase		Duration/Weeks	Location
1	On-the-Job	12	Employer
2	Off-the-Job	20	FÁS Training Centre
3	On-the-Job	26	Employer
4	Off-the-Job	10/11	Institute of Technology
5	On-the-Job	26	Employer
6	Off-the-Job	10/11	Institute of Technology
7	On-the-Job	12	Employer

The apprenticeship Programme is deemed to be completed when the apprentices has reached the minimum qualifying standard in all modular and competency based assessments and has completed the minimum duration of 4 years in employment as an apprentice in the specified trade (exception Print Media 3 years)On successful completion of an apprenticeship programme, candidates are awarded a FETAC Advanced Certificate in a named trade at Level 6 on the NFQ. Such certificates may serve as an entry qualification for progression into appropriate degree level programmes.

Off-the-Job training generally takes place in FÁS Training Centres during Phase 2 and Institutes of Technology or other approved training centres for Phase 4 and Phase 6 (two Vocational Education Colleges currently deliver Phases 4 & 6 also). During the designated off-the-job phases of training, the apprentice is paid a training allowance by FÁS which is funded from the National Training Fund (NTF). The allowance is equivalent to the net pay normally received by the apprentice from his employer at the active industrial rates of pay plus a contribution towards travel/accommodation costs.

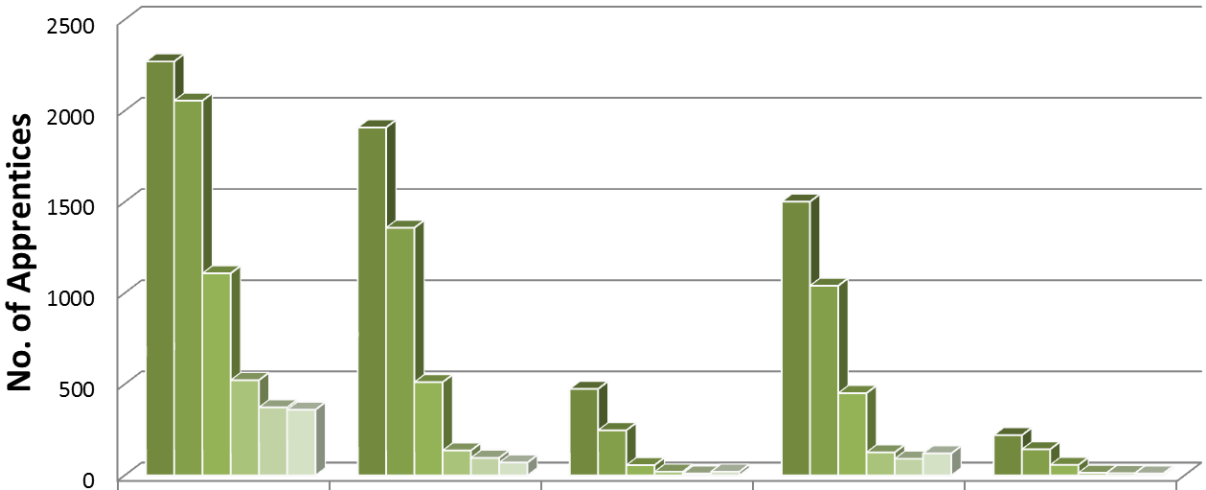
Instructors in the Off-the-Job Phase 2 (FÁS) must be a qualified Craftsperson, with minimum of five years post-apprenticeship experience. The teaching staffs in the Institutes of Technology, who deliver Phases 4 and Phase 6 of training, are required to hold a degree or its equivalent in their subject area or be a qualified Craftsperson with three years of relevant postgraduate experience. In recent years, FÁS introduced formal qualifications in training and development for their own trainers and instructors. A series of programmes were developed and accredited by the National University of Ireland (NUI) from Foundation level to Degree and Masters Level. These programmes have now been made available to those practicing or planning a career as trainers in vocational colleges as well as the commercial, voluntary and community sectors.

6.3.2 Overview of Apprenticeships for Construction Related Trades

Construction related trades include Carpentry and Joinery, Brick and Stone Laying, Electrical, Plumbing, and Plastering. This outline is intended to identify the extent to which the respective trainees demonstrate the competences (knowledge and skills) that are necessary to implement energy efficient construction techniques and renewable energy technologies in the built environment. Detailed course descriptions (subject contents and learning tasks) for each Phase of these trades are provided in the Appendices volume of this report (A2).

Apprenticeship Numbers

Figure 6.2 illustrates the unprecedented decline in apprentice intake for the main construction related trades from the peak outputs in the construction boom in 2006/2007. Current apprentice registrations for 2012 indicate an intake which is even lower than 2011 forecasts.



	Electrical	Carpentry & Joinery	Brick & Stone Laying	Plumbing	Plastering
2006	2270	1908	474	1501	220
2007	2055	1358	247	1040	143
2008	1108	511	56	451	57
2009	522	136	20	126	14
2010	373	96	10	91	12
2011F	360	70	20	120	10

Figure 0.1: Apprentice Intake for Construction Related Trades 2006 – 2011
Source: FÁS Skills and Labour Market Research Unit (2011 figures are forecast)

Curricula and Updating

It is noteworthy that, while subject contents are prescribed in the curricula, the onus for keeping up to date with changes in the building industry and in building regulations lies with

individual trainers/lecturers. In relation to new technology introduced at Phase 2 it is normal practice to arrange for the appropriate updating of instructors through national training programmes, as was undertaken with the last curriculum review for certain trades i.e. Motor and F-gas technology. However, there is no formal continuing professional development structure in place for the teaching staffs responsible for Phases 4 and 6. For example, while some plumbing lecturers may have completed gas installation and renewable heating training, there is currently no coordinated response to the general need for up-skilling of trainers to reflect the evolution of the building standards to a near zero carbon framework . The pace of changes to building regulations for energy performance and the fact that the vast majority of currently employed trainers have not had experience of on-site implementation of new standards has exacerbated this issue.

Since the standards-based apprenticeship training model was introduced in 1993, a number of the construction related trades have had revisions made to their curricula (see Table 6.4).

Table 0.4: Revisions to Curricula for Construction-Related Trades

Trade	Year Curricula Introduced	Year of Revision
Carpentry & Joinery	1993	2002
Brick & Stone Laying	1993	due in August 2012
Electrical	1993	2009
Plumbing	1993	2006
Plastering	1993	2009

"The National Apprenticeship Advisory Committee oversees the development of the standards based process and advises the Board of FÁS on all matters pertaining to apprenticeship. This committee is made up of representatives of the social partners in industry, the educational sector and FÁS. In 2003 the National Apprenticeship Advisory Committee commissioned an independent consultant to examine the relevance of the existing Standards Based Apprenticeship system against contemporary requirements. Nominated social partner, educational and FÁS technical experts reviewed each individual apprenticeship. Following the curricula re-design phase a comprehensive, structured and inclusive consultation process was initiated by the National Apprenticeship Advisory Committee.

As a consequence of this process the National Apprenticeship Advisory Committee presented recommendations to the FÁS Board for approval on 26 different recommendations. On receiving FÁS Board approval, FÁS commenced the implementation of the revised curricula into the training and educational system on a phased basis in 2006"[19].

These revisions are not related to building energy efficiency and renewable energy systems with the exception of the plumbing syllabus, where changes are outlined in the following section describing the training for each trade.

Carpentry & Joinery

Carpentry & Joinery is a very wide and varied trade and, as such, requires the apprentice to work in a number of identifiable domains within the overall trade. Training activity requires demonstration of competence in a number of common skills, core skills, specialist skills and personal skills. The main subject headings covered include Joinery, 1st and 2nd Fixing (including Roofing) and Maintenance. The curriculum also prescribes contents that are relevant to energy efficiency in buildings, including:

- Building regulations for timber frame construction, stairs, first fixing and windows. However, there is little or no emphasis on conservation of fuel and energy, with no reflection of recent changes to building standards, and also, the content on timber frame construction are largely unchanged since 1993.
- Condensation and its control in relation to windows.
- Thermal insulation and heat transfer.

There is a proportionately small amount of delivery time allocated to these topics. For example, thermal insulation and heat transfer is only allocated 3 contact hours. The underpinning principles of energy efficient construction such as thermal bridging, air tightness, ventilation, insulation continuity and building energy use are not covered in the

[19] Michaél Martin, TD, Minister for Enterprise Trade and Employment 2007

current curriculum. This is a significant omission for a trade that is actively involved in the construction/renovation of building fabric and, regularly, site supervision.

Brick & Stone-Laying

The training for the craft of brick & stone-laying covers the core walling construction techniques commonly used in Ireland, i.e. Brick, Solid, Hollow and Cavity Walling and the construction of chimneys. While the brick/block layer is required to install the cavity insulation to a cavity wall and is responsible for the closing of cavities at openings/junctions etc. there is no reference in the current curricula to principles such as thermal bridging, the importance of insulation continuity, insulation material properties/selection, elemental U-value or structural air tightness. The majority of buildings in Ireland are constructed using solid or cavity wall construction.

The syllabus for the apprenticeship programme in brick and stone-laying has not been updated since the original version was adopted in 1993. While the skills and related knowledge included in the modules for each of the seven phases address the requirements for an artisan, it is a considered opinion that it is falls short in technical content on the principles required to construct building fabric to high standards of energy efficiency.

The syllabus generally makes no direct reference to building regulations for energy performance. The omission is particularly notable in relation to cavity walling where the brick/block layer has direct responsibility for the cavity insulation layer.

Plastering

The training for the craft of plastering is mainly focussed on the application of internal and external plastered finishes to walls and ceilings. The plasterer will also have responsibility for the installation of dry-lining systems to internal walls and the slabbing of walls and ceilings with plasterboards. The emphasis of external works is on the application of and properties of external renders.

The apprenticeship curriculum for the craft of plastering was updated in 2009 <u>but this revision does not reflect the evolution of building standards from 2002 in relation to energy performance,</u> i.e. the introduction of concepts such as air tight construction and thermal bridging detailing. The section on dry-lining includes reference to thermal insulation and modes of heat transfer without specifically mentioning the importance of continuity of insulation and detailing at reveals and junctions to avoid thermal bridging. The subject of condensation and the use of vapour checks and barriers are also included but air tightness, use of air tightness membranes and provision of ventilation requirements is absent. The sections on external works do not cover the application of external wall insulation systems.

Electrical

Electricians deal with the installation, commissioning, testing and maintenance of electrical wiring systems and services, electrical plant and control equipment, and process monitoring and control systems. Modern process plant includes electrical, electro-mechanical, electro-pneumatic, and electronic and microprocessor based systems. The electrician is required to

have a broad base of technical knowledge complementary to information gathering and analytical skills. This includes the interpretation of technical data and the proper use of test instruments for system maintenance, fault diagnosis and rectification, and the installation/calibration of sensors, transmitting and controlling devices.

The subject areas covered which are relevant to the energy efficiency in the built environment are largely limited to lighting and wiring of domestic and industrial heating systems. The design of energy efficient lighting systems is not included in the curriculum. Also, the sections on heating controls include only cursory content on the design and layout of the mechanical aspect of the installation.

The emphasis on learning the fundamental scientific principles of the craft means that the electrician's core competencies allow them to follow mechanical/electrical specifications and plans successfully. However, it is often the case in domestic extension/renovation projects that such specification will not be provided. Often on this type of project, lighting installation and coordination with the heating system installer in the wiring of controls will be the responsibility of the electrician on site. It is in these instances that the limitations of the existing training curricula are exposed.

Electricians are also responsible for running services through and within the building fabric. However, the present curriculum does not cover the maintenance of insulation and air tight building envelopes as part of electrical technician training.

Plumbing

Plumbing is a broad and varied trade and, as such, requires the apprentice to work in a number of domains within the overall trade. Generally, the work carried out by plumber's falls into 3 categories, namely; industrial/commercial, domestic and maintenance projects and tasks. Those engaged on industrial/commercial projects will carry out specific tasks under supervision, and such could range from large diameter pipefitting, to work in a high technology industrial environments, where little design knowledge is required since detailed specifications and plans are normally provided on projects of this scale. However, it is often the case in domestic extension and renovation work that detail of mechanical installations are agreed ad hoc between installer and client. In such cases, the responsibility for system design lies largely with the plumbing contractors or their employees.

Maintenance work requires the Plumber to carry out a variety of tasks in general maintenance and upkeep of public and private buildings, e.g. dwellings, shops and factories. Many apprentice plumbers may mainly be engaged in maintenance work, therefore gaining little knowledge of installation or system design.

The standards based system was first introduced to the plumbing apprenticeship in 1993 and has since been reviewed once. The review which began in 2002 resulted in a number of changes to the original programme, mainly on the upgrading of technologies that were not previously covered, and led to a new syllabus implementation in 2006. The updates to Phases 4 and 6 of the training programme included several topics relevant to energy efficiency and renewable energy technology covering:

- Heating Systems, Zones, Controls and Efficiency;

- Underfloor Heating;
- Solar Heating and Heat Pumps;
- Sectional Boilers;
- Domestic Heating Controls and Building Management Systems (Electrical);
- Building Regulations – Plumbing and Heating.

Refrigeration & Air Conditioning

Refrigeration/Air Conditioning craftsperson deals with the installation, service and maintenance of high, medium and low temperature refrigeration and air conditioning equipment in industrial, commercial and domestic environments. Key aspects of the occupation include close control of temperature/humidity environmental conditions; supply/extraction/filtration of air conditioned heat pumps and energy management systems, storage of blood and medical items, cryogenics and electronic motor applications.

This trade is considered to be quite specialist training, which is reflected in the low numbers of apprentices relative to the general construction trades (see Figure 6.3), but has also been affected by the slowdown in the economy and the construction industry particularly. In January 2012, only 15 apprentices were registered for Phase 1 training. On the same date, the total number of apprentices in all seven phases of training amounted to 192, of which 33 were redundant. The current training curriculum covers a number of sections relevant to energy efficiency and renewable energy technology, including:

- Advantages of using heat pump over conventional heating systems (cost savings in energy)
- Heat recovery, energy conservation and cost per kWh Methods of reducing energy consumption in refrigeration through equipment selection and maintenance.
- Estimate energy savings available using heat recovery techniques/ Calculation of electrical energy savings using heat recovery systems
- Efficient methods of the usage of electrical energy relative to the refrigeration industry
- Supply authority literature on efficient use of electrical energy and tariffs

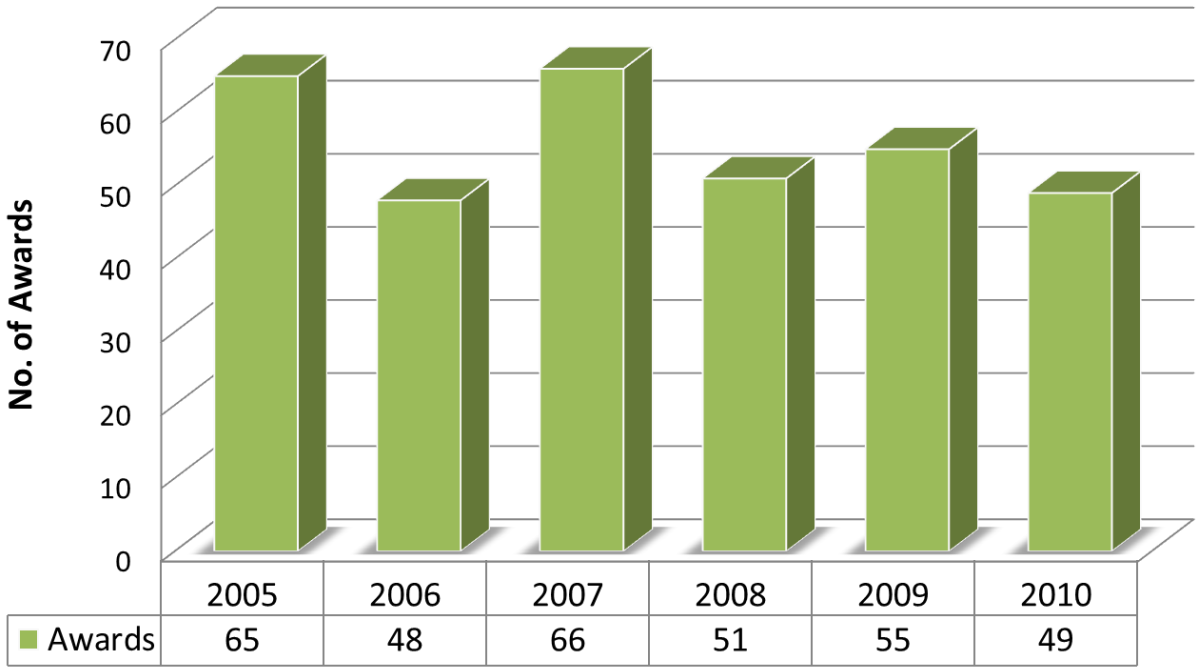


Figure 0.2: FETAC Awards for the Craft of Refrigeration & Air Conditioning 2005-2010

6.4 Review of Construction Skills Training Outside Formal Apprenticeship

A number of construction skills fall outside of the formal apprenticeship system including concrete workers, steel workers, roofers and glaziers. All of these workers are associated with the construction and renovation of building fabric and, in light of the new technologies and standards being applied to this field, warrant consideration of requirement for upgrading of skills. These occupations are described in the following sections with reference made to potential gaps in existing knowledge and skills.

Concrete Worker

In Ireland, onsite work with concrete is considered to be a semi-skilled job and is therefore mainly carried out by general operatives. Most concrete workers will have completed on-site training through experiential learning. Initially, requisite skills are acquired through working under more experienced general operatives who possess the skills required for working with concrete in its different forms. There are currently no formal training courses on offer for concrete workers, although some may have previously trained in other areas of the construction sector and obtained a National Craft Certificate in a related trade e.g. bricklaying, plastering or carpentry.

Generally, concrete workers would be responsible for construction tasks such as positioning of insulation layers, including perimeter insulation, prior to laying concrete slabs on ground floors and potentially the filling of insulated formwork systems that have recently been introduced to the sector. They may also be responsible for providing service pathways in the building fabric. These workers would be unfamiliar with the principles of thermal bridging, air

infiltration and modes of heat loss etc. and, therefore, the importance of adherence to specification and detailing to achieve high energy performance standards.

Steel Workers

Steelworkers in the construction industry can be responsible for the installation and positioning of steel girders and columns in the construction of bridges, high-rise office buildings and various other types of buildings. In addition, they may also contribute to roadway construction projects, positioning steel and concrete mesh used in the reinforcement of roads. Some steel workers have a background in welding while most others will have learned their skills on an informal basis through on-the-job training and experiential learning.

Steel frame construction for commercial and industrial buildings is relatively widespread in Ireland. Structural steel elements will also be used frequently in residential buildings, in combination with masonry or timber frame construction. In light of the high thermal conductivity of steel as a building material, the potential for thermal bridging in fabric construction is high. Structural steel elements may also breach the air and insulation envelopes of the building to achieve bearing. Although the overall building design may be the responsibility of the architect/engineer, correct on-site implementation and construction will be the responsibility of the site supervisor and ultimately the steel worker.

Roofer

Onsite constructing of roofing structures is the responsibility of carpenters or steel workers, while weathering of the roof structure is the responsibility of the roofer. There is no formal training programme for basic roofing skills in Ireland, therefore, such are gained through onsite experiential learning process (on-the-job-training). Roofing is generally carried out by crews of workers, usually 2-6, with larger crews usually comprised of two skilled roofers, two apprentices/learners and two operatives who are typically assigned to manual tasks.

As well as the felting, tiling or slating of flat and pitched roofs, the roofer will also be responsible for the fitting of membranes, flashings and roof windows. The emphasis on reducing heat loss and vapour control in current building standards is adding to the complexity of the materials and systems that roofers are likely to encounter onsite. Generally, they will not be familiar with the principles of wind tightness, air tightness or the breathability of the materials and membranes that they would use.

Glazier

A glazier measures, cuts, repairs and installs various types of glass and mirrors. Glaziers in Ireland are also trained through informal on-the-job-training programmes. This will be divided between tasks carried out in a glazing workshop and onsite installation work. Their activities will range between residential and commercial applications. Glazing may be pre-fitted to frames and windows etc. in the workshop, or it may be transported to site for installation. Commercial glaziers are often involved in the layout, preparation, fabrication and replacement of architectural metal components like storefront systems, entrance ways, windows, skylights and curtain wall systems.

The energy efficiency technologies being incorporated into the design and manufacture of window and glazing systems is becoming increasingly sophisticated (see: Appendices A4.1). Thermal transmittance is now a crucial consideration for design of frames, glazing and glazing cavity spacers. While regulated manufacturing processes may dictate the energy efficiency of glazing units, it is in the installation, maintenance and repair that the glazier may suffer skill deficits relating to new technologies. Draught sealing of units, casements and at junctions with other fabric elements is becoming increasingly important in the pursuit of higher energy performance standards (see section *4.4 Building Regulations* "Acceptable Construction Details" published by DECLG, accompanying documents to TGD L, http://www.environ.ie/en/TGD/)

Insulation Installer

With the increasing emphasis on energy performance of buildings in the last decade, the number of companies specialising in the supply and installation of insulation products has increased significantly. Insulation contractors supply and install a variety of products and systems including loft insulation, pumped cavity wall insulation, external insulation, sprayed/blown insulation, acoustic insulation and fire-stopping insulation.

Some of the workers employed are from a construction trade background but the majority are either un-skilled or have completed short specialist training programmes such as product/system specific offerings to obtain NSAI Agrément recognition (see *6.6 Training courses outside of the VET system*). An Industrial Insulation apprenticeship has been developed by FÁS in the last couple of years in acknowledgment of the increasing complexity of insulation installation in the industrial/commercial sector with regard to thermal insulation, sound proofing and fire proofing. This apprenticeship is not currently running in any training centres and no awards for completion have been made since its inception.

6.5 VET Provision on Energy Efficiency and Renewable Energy in Buildings

In the last five to six years, a number of add-on or supplemental training programmes in energy efficiency and renewable energy have become available for the up-skilling of construction craft workers and system installers in Ireland. Energy policy implementation has led to the development of approved qualifications for renewable energy installers and new regulations for domestic gas installation have resulted in a mandatory qualification requirement for installers.

The introduction of SEAI grant aided retrofit programmes covering the installation of high efficiency oil and gas boilers, heating controls, insulation systems and renewable energy technologies have further boosted the market demand for appropriate training. The currently available provision of accredited training in these areas includes:

- FÁS and Private training provision accredited by FETAC;
- HETAC accredited training at NFQ level 6 offered by the Institutes of Technology.

An array of training programmes outside the NFQ is also being offered countrywide. This varies between; quite formally structured programmes such as the OFTEC oil installation

training (see section 6.6); some newly introduced FÁS programmes; and product/system specific training offered by suppliers and manufacturers.

6.5.1 Overview of Training Providers

Training on energy efficiency and deployment of renewable energy in buildings is provided by a combination of providers, including, FÁS, IoTs, Skillnets and a range of private organisations. Some manufacturers and materials/systems suppliers to the building construction sector have also developed product/system specific training. Skillnets is a state funded and enterprise-led support body which promotes and facilitates training and up-skilling with the objective of sustaining national competitiveness. Skillnets receives funding from the National Training Fund (NTF) through the Department of Education and Skills. The training programmes on offer lead to a mixture of NFQ and non-NFQ accredited awards. In 2010, an eco-construction skillnet was formed, which supported the Irish Timber Frame Manufacturers Association (ITFMA) with training programmes in eco home, passive house and retrofitting.

Since 2005, a number of private training providers, such as Midlands Energy Training & Assessment Centre (METAC) and Chevron Training, have emerged in the Irish market, predominantly in response to market demand for energy related training. The training programmes they offer are largely accredited by FETAC, and are on the NFQ, while a number of other awarding bodies including, European Registration Scheme for Personnel Competence (ERS), City and Guilds and the independent UK Blueflame also provide certification. Training fees are paid directly by the participant or their employers.

6.5.2 Further Education Provision

The introduction of SEAI grant aided retrofit programmes, covering the installation of high efficiency oil and gas boilers, heating controls, insulation systems and renewable energy technologies, along with revised building standards for energy performance have driven demand for training in related courses. This section outlines the available programmes by award titles and award types, and where available, participation rates have been discussed. A more detailed description of content and learning outcomes for each is available in the Appendices volume accompanying this report (see: A3.1).

The renewable energy systems training accredited by FETAC is divided into minor and supplemental awards, some of which have been adapted exclusively for FÁS training provision (Table 6.5). It should be noted that the awards are mainly associated with training provided by private trainers, i.e. fee paying and that the FÁS programmes are free to jobseekers while the other awards.

Table 0.5: FETAC awards for renewable energy systems installation

Award Title		Award type
Solar Domestic Hot Water Systems	FÁS	Minor Award
Domestic Biomass Heating Systems	FÁS	Supplemental Award
Domestic Heat Pump Installation	FÁS	Supplemental Award
Domestic Photo-Voltaic Systems	FÁS	Supplemental Award
Solar Domestic Hot Water Systems		Minor Award
Biomass Heating Systems		Minor Award
Heat Pump Systems		Minor Award
Implementation of Small Scale Wind Systems		Special Purpose Award
Implementation of Micro Solar Photo-Voltaic Systems		Special Purpose Award

Participation rates on training programmes leading to these awards were initially quite high as employment opportunities were anticipated in renewable energy system installation. Demand was also proportionally influenced by increased deployment of solar thermal technologies over heat pump and biomass heating systems (Figure 6.4 for number of awards issued). The marginal market penetration of small scale wind energy and solar photo-voltaic systems is reflected in the low participation on related training. However, participation rates for FÁS programmes on renewable energy installation have not experienced such a severe drop-off (Figure 6.5 for participation rates). This may be in part due to the training being available free to the unemployed.

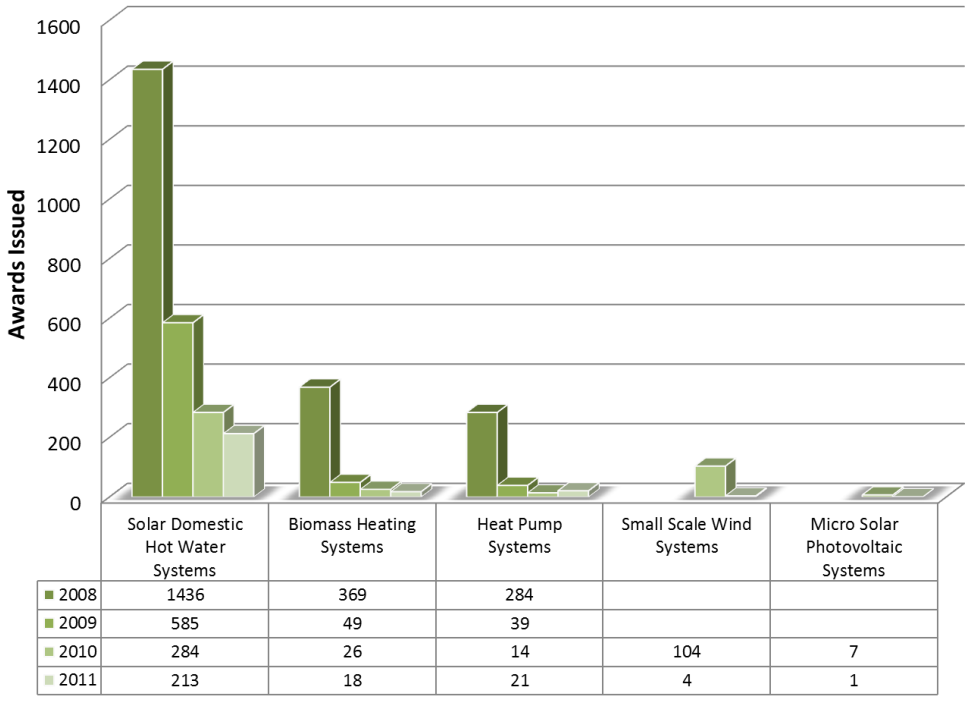


Figure 0.3: Number of FETAC Awards for Renewable Energy Systems Training 2008-2011

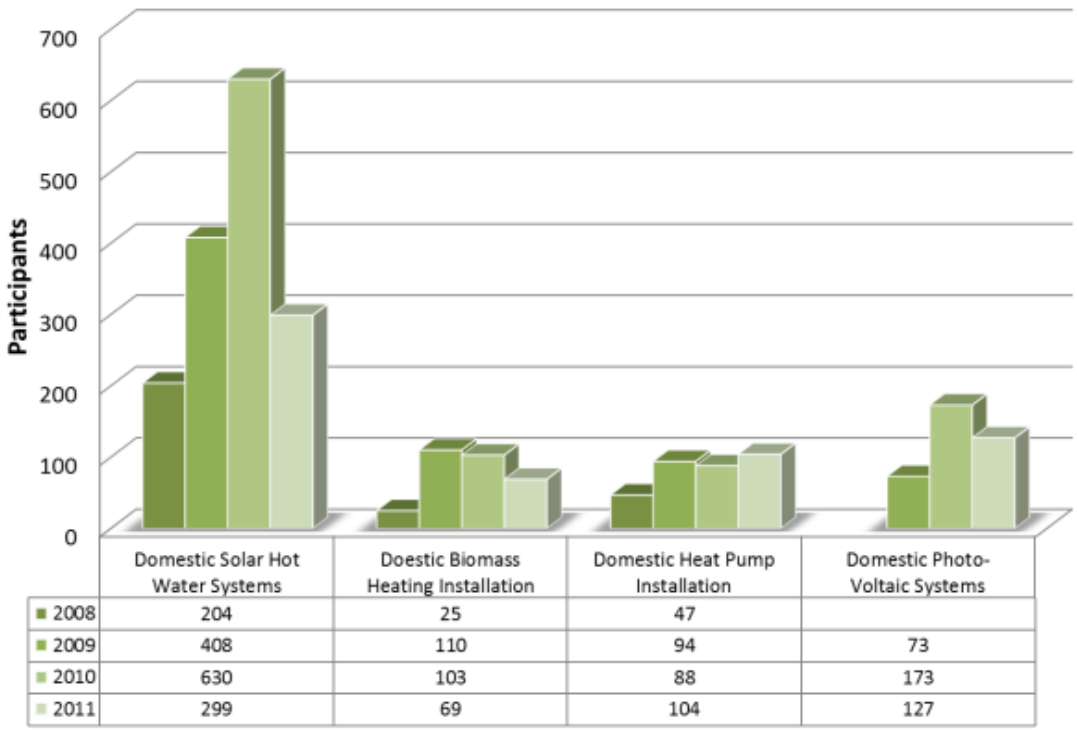


Figure 0.4: FÁS Participation Rates on Renewable Energy System Training 2008-2011

FÁS also offer a number of programmes relevant to energy efficient installation and construction, leading to a mixture of mandatory and non-mandatory qualifications, and including the following:

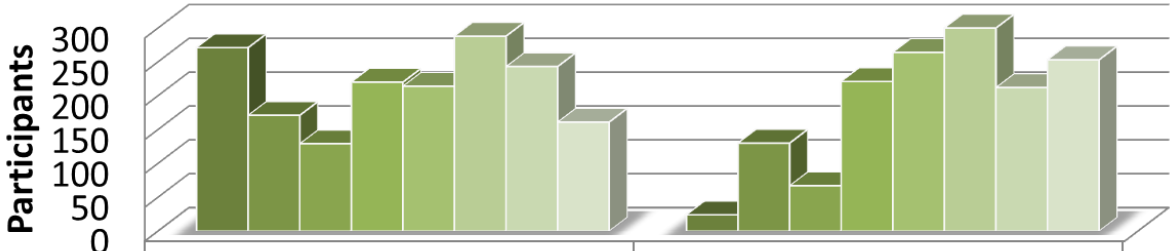
Mandatory Qualifications

- Gas Installation Safety (GIS): This is a six day gas safety introductory course open to holders of a national craft qualification in an allied trade or equivalent and holders of OFTEC Certification. The course is accredited at FETAC level 6. This training is also offered by private providers such as METAC and Chevron Training.

- Gas Installation Domestic (GID): This is a 12 day gas installation and safety course for holders of a GIS certificate and plumbers who have completed gas safety training as part of their apprenticeship (on curriculum since 1999). Main course elements include electrical control, combustion safety, meters and commissioning of appliances. The course is accredited at FETAC Level 6 (also available at HETAC level 6 at ITB, this training is also offered by private training providers such as METAC and Chevron Training). This award is a requirement to become a Registered Gas Installer (RGI). In order to be retained in the register, RGIs are required to complete re-assessment every 5 years.

  From January 2009, it is a legal requirement that any individual involved in domestic gas installation be certified as a RGI. This has resulted in consistently strong participation on GIS and GID training programmes (Figure 6.6) and is a good

example of the influence of regulation of professional competences on motivation for gaining qualification.



	Gas Installer Safety (GIS)	Gas Installer Domestic (GID)
2004	271	24
2005	171	130
2006	129	67
2007	220	221
2008	214	264
2009	288	300
2010	243	212
2011	161	253

Figure 0.5: FETAC Awards for Domestic Gas Installer Training 2004-2011

Non-Mandatory Qualifications

- Domestic Thermal Insulation: Ten day course designed for the up-skilling of construction craftspeople in the installation of domestic insulation system in line with current building standards. Accredited by City & Guilds (equivalent to NFQ level 5 or 6).
- Air Tightness Installation: Four day course for qualified craftspeople with experience in construction on the installation of air tightness materials. It is un-accredited.
- Air Tightness Testing: Four day course for qualified craftspeople with a minimum of 5 years' experience in construction on air permeability testing and reporting using the Fan Pressurisation method. Non-accredited.
- Passive House Construction – Building Envelope: Ten day course for construction craftspeople on the fabrication of residential buildings to Passive House standards (see; www.passivhaus.org.uk/standard.jsp?id=37). This is a newly developed training initiative which is available at FÁS Finglas training centre in Dublin. It is accredited by the Passiv Haus Institut, Germany.

- Passive House Construction – Mechanical Systems: This is a five day course for plumbing, electrical, fitter, refrigeration craftspeople or holders of a FETAC level 6 award in a related building field on the installation of mechanical systems to Passive House standards. This is a newly developed training initiative which is available at FÁS Finglas training centre in Dublin. Accredited by the Passiv Haus Institut, Germany

The participation rates for the above programmes are shown in Figure 6.7.

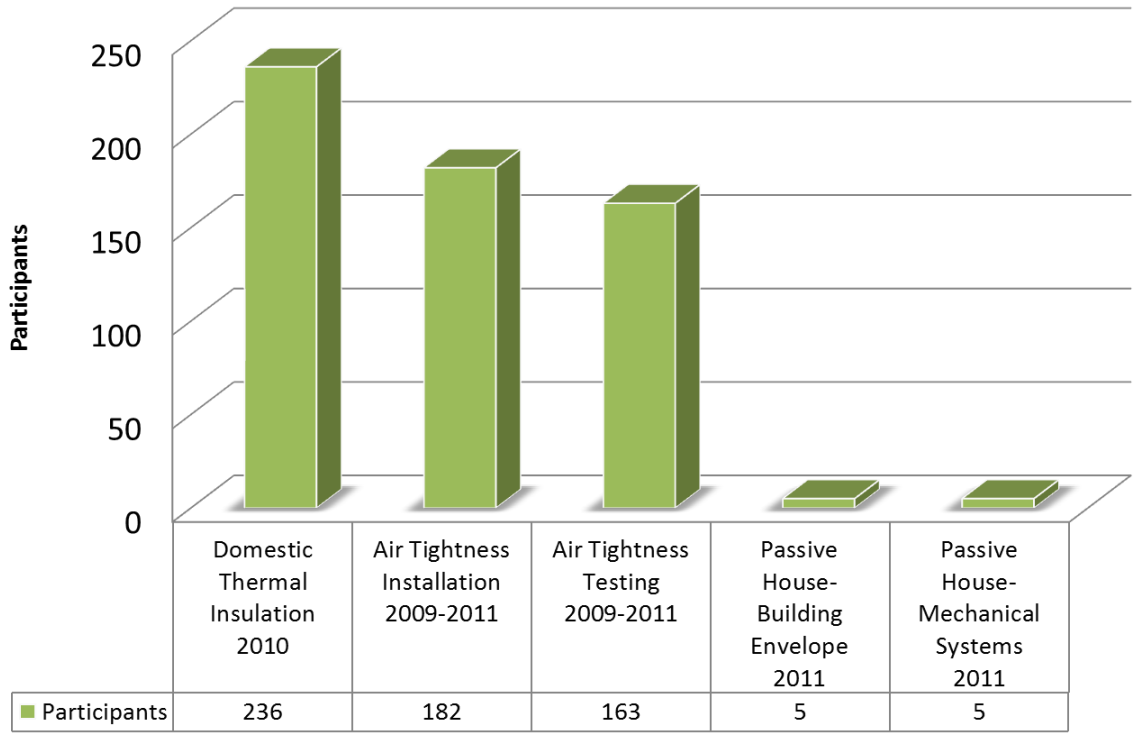


Figure 0.6: Participation Rates on FÁS Building Energy Efficiency Training Programmes 2007-2011

The VET sector further education provision for energy efficiency and renewable energy technology training, relevant accreditation on the NFQ Level 5-6 are outlined in Table 6.6.

Table 0.6: Existing Further Education provision for construction workers on energy efficiency and renewable energy systems in buildings

Course Title (year introduced)	NFQ Level	Accreditation Body	Training Providers	Duration	Approval Body	Award Type	Target Group
Energy Efficient Construction/Renovation							
Thermal Insulation Installation (2010)	5	FETAC		4 days		Minor	Construction Trades
Energy Conservation in Dwellings	5	FETAC				Minor	Construction Trades
Domestic Thermal Insulation (2010)		City & Guilds	FÁS	10 days			Construction Trades
Air Tightness Testing & Measurement (2009)	6	FETAC	FÁS	4 days			Construction Trades
Renewable Energy Systems							
Solar Domestic Hot Water Systems (2008)	6	FETAC	FÁS, METAC, Chevron	3 – 5 days	REAI/ SEAI	Minor	Plumbers, Electricians
Domestic Biomass Heating Installation (2008)	6	FETAC	FÁS, METAC	3 days	REAI/ SEAI	Minor	Plumbers, Electricians
Domestic Heat Pump Installation (2008)	6	FETAC	FÁS, METAC, Chevron	5 days	REAI/ SEAI	Minor	Plumbers, Electricians
Electrical installation of Micro-generators (2010)	6	FETAC	FÁS			Special Purpose Award	Electricians
Implementation of Micro Solar Photovoltaic (PV) Systems (2009)	6	FETAC	FÁS	10 days	REAI/ SEAI	Special Purpose Award	Construction Trades or related award at level 6
Implementation of Small Scale Wind Systems (2010)	6	FETAC	Chevron	4-5 days	REAI/ SEAI	Special Purpose Award	Construction Trades or related award at level 6
Space Heating, Hot Water Systems and Controls							
Gas Installation Safety - GIS (2004)	6	FETAC	FÁS, METAC, Chevron	6 days	RGII	Supple-mental	Allied trades
Gas Installation Domestic - GID (2004)	6	FETAC	FÁS, METAC, Chevron	12 days	RGII	Supple-mental	GIS holders, Plumbers

6.5.3 Higher Education Provision

There are a limited number of higher education programmes covering energy efficiency and renewable energy in buildings that are available through the Institutes of Technology (IoTs). These are generally part-time or full-time programmes to degree level in areas such as construction site management, building services, electrical engineering/technology which offers progression for the different crafts to more advanced qualifications, thereby allowing them to fulfil roles in supervisory, senior technician and junior engineer equivalent positions. This report limits its focus to training for construction workers specific to energy efficiency and renewable energy applications onsite.

In the last 3 to 4 years, IoT's have developed a range of competence specific training programmes, leading to Minor or Special Purpose awards, as part of the government's labour market activation initiatives, specifically targeting the unemployed. These programmes have focussed on the up-skilling of workers from industry sectors that have been most adversely affected by the current economic recession, by providing skills for emerging sectors with employment opportunities.

The current labour market activation programme for higher education, Springboard, is administered by the Higher Education Authority (HEA). Under Springboard, a number of programmes were offered in 2011 which were designed to up-skill unemployed construction related craft workers for opportunities in the renewable energy sector and the domestic retrofit market. The related courses include the following (see more detailed descriptions in the Appendices volume accompanying this report, A3.2):

- **Certificate in Home Energy Consultancy (30 ECTS Credits)** - Level 6 Supplemental Award offered at Dundalk Institute of Technology (DKIT): The programme is designed for the up-skilling of construction craft workers or holders of Higher Certificates in engineering or technology. Cross skill training and knowledge is provided to enable learners to carry out energy assessments for domestic dwellings and assist householders in the implementation of improvement measures. The programme is delivered part-time over 1 academic year (2 semesters, approx. 30 weeks). Approximately 12 participants completed this programme under Springboard 2011.

- **Certificate in Sustainable Plumbing and Heating Installation (15 ECTS Credits)** - Level 6 Supplemental Award offered at Dundalk Institute of Technology (DKIT): designed for the up-skilling of qualified plumbers in the adoption of sustainable and renewable plumbing and heating technologies and their integration in buildings. Delivered part-time over 1 semester (15 weeks). 16 participants completed this programme under Springboard 2011.

- **Certificate in Energy Efficient Heating Systems (20 ECTS Credits)** – Level 6 Special Purpose Award offered at Institute of Technology Blanchardstown (ITB): up-skilling programme for qualified plumbers and electricians on the installation of gas, oil and solar thermal heating technologies including the implementation of heating control technology with a strong emphasis on system efficiency. Each subject is covered as an individual module which qualifies for industry recognition, i.e. gas

award accepted by RGII, oil recognised by OFTEC and solar thermal/heating controls by SEAI. Delivered part-time over 20 weeks. 45 participants completed this training in May 2012 (Springboard 2011) and funding has been approved for a further 48 under Springboard 2012.

- **Certificate in Energy Efficient Domestic Retrofit Technology (25 ECTS Credits)**: Level 6 Special Purpose Award offered at Institute of Technology Blanchardstown (ITB): designed for the up-skilling of construction craft workers to operate as supervisors/project managers of domestic energy retrofits. Learners acquire the skills to assess the performance of existing dwellings and apply their knowledge of energy saving technologies to tailor retrofit solutions for different building types to achieve targeted improvements. Delivered part-time over 30 weeks. 13 participants completed this training in May 2012 and funding has been approved for 32 participants under Springboard 2012.

- **Certificate in Renewable Heating Systems (60 ECTS Credits)**: Level 6 Special Purpose Award offered at Athlone Institute of Technology (AIT): up-skilling programme for qualified plumbers in renewable heating technologies; solar thermal, biomass and heat pump. Learners acquire the skills for installation, servicing and maintenance. Modules on Instrumentation, Introduction to Engineering Science & Calculations and Entrepreneurship are included. The programme is delivered part-time over one academic year (2 semesters). 5 participants completed the programme under Springboard 2011.

- **Diploma in Roof Construction Design & Energy Efficiency (40 ECTS Credits)**: Level 7 Diploma award offered at Dublin Institute of Technology (DIT): up-skilling programme designed for qualified carpenter/joiners to attain a broader understanding of roof design and construction with an emphasis on the requirements of Building Regulations Part L – Conservation of Fuel and Energy. A module on entrepreneurship is also included on the programme. The programme is delivered part-time over one academic year (2 semesters). 10 participants completed the training under Springboard 2011.

- **Certificate in Wind Energy Technology (90 ECTS Credits):** Level 6 Minor award offered at Letterkenny Institute of Technology (LYIT): up-skilling programme for electrical or mechanical craftsperson's focussing on wind turbine maintenance. The course includes a 30 day work placement with a wind turbine maintenance team. This programme is additionally accredited by BZEE (German centre for renewable energy). Duration is 11-17 contact hours per week over an academic year (2 semesters). 28 participants graduated from the programme in 2012.

- **Certificate in Sustainable Energy Systems (15 ECTS Credits):** Level 6 Special Purpose Award offered at Cork Institute of Technology (CIT): programme targeted at the unemployed in sectors such as construction and manufacturing with modules in Energy Management, Sustainable Energy in Buildings and Marine Engineering. Duration is one evening per week over an academic year (2 semesters). 26 participants completed the programme under Springboard 2011.

- **Certificate in Domestic Sustainable Energy (20 ECTS Credits):** Level 6 Special Purpose Award offered at Limerick Institute of Technology (LIT) Tipperary: up-skilling programme targeted at architects, engineers and builders with an interest in energy and sustainability. The programme focuses on the potential for deployment of small scale renewable heating and electricity technologies in the domestic/residential sector. Duration is one evening per week over an academic year (2 semesters). Approximately 15 participants have completed this programme annually for the last 4 years.

The VET sector higher education provision for energy efficiency and renewable energy technology training, relevant accreditation on the NFQ Level 6-7 is outlined in Table 6.7

Table 0.7: Existing Higher Education provision for construction workers on energy efficiency and renewable energy systems in buildings

Course Title (year introduced)	NFQ Level	Accreditation Body	Training Providers	Duration	Approval Body	Award Type	Target Group (number of participants)
Energy Efficient Construction/Renovation							
Energy Efficient Domestic Retrofit Technology (2011)	25 ECTS credits Level 6	HETAC	Institute of Technology Blanchardstown (ITB)	Part-time over 1 academic year		Special Purpose Award	Construction Trades (13)
Roof Construction design & Energy Efficiency (2011)	40 ECTS credits Level 7	DIT	Dublin Institute of Technology (DIT)	Part-time over 1 academic year		Diploma	Carpenter/ Joiners (10)
Certificate in Home Energy Consultancy (2011)	30 ECTS credits Level 6	HETAC	Dundalk Institute of Technology (DKIT)	Part-time over 1 academic year		Special Purpose Award	Construction Trades (12)
Renewable Energy Systems							
Certificate in Renewable Heating Systems (2011)	60 ECTS credits Level 6	HETAC	Athlone Institute of Technology (AIT)	Part-time over 1 academic year	REAI/ SEAI	Special Purpose Award	Plumbers (5)
Certificate in Wind Energy Technology (2011)	90 ECTS credits Level 6	HETAC	Letterkenny Institute of Technology (LYIT)	Part-time over 1 academic year	REAI/ SEAI	Minor	Plumbers, Electricians (28)
Certificate in Sustainable Energy Systems (2010)	15 ECTS credits Level 6	HETAC	Cork Institute of Technology (CIT)	Part-time over 1 academic year		Special Purpose Award	Construction workers (26)
Certificate in Domestic Sustainable Energy (2007)	20 ECTS credits Level 6	HETAC	Limerick Institute of Technology (LIT) Tipperary	Part-time over 1 academic year		Special Purpose Award	Construction workers (60)

Course Title (year introduced)	NFQ Level	Accreditation Body	Training Providers	Duration	Approval Body	Award Type	Target Group (number of participants)
Space Heating, Hot Water Systems and Controls							
Energy Efficient Heating Systems (2011)	20 ECTS credits Level 6	HETAC	Institute of Technology Blanchardstown (ITB)	part-time 12 hours per week for 20 weeks	RGII, OFTEC, REAI/ SEAI	Special Purpose Award	Plumbers, Electricians (45)
Certificate in Sustainable Plumbing and Heating Installation (2011)	15 ECTS credits Level 6	HETAC	Dundalk Institute of Technology (DKIT)	part-time 12 hours per week for 15weeks	REAI/ SEAI	Supple-mental	Plumbers (16)

6.5.4 Existing Monitoring Instruments for Skills Needs

There is no formal skills' monitoring body for the construction industry in Ireland. However, a number of government agencies and bodies have responsibilities to report to the Department of Jobs, Enterprise and Innovation (DEJI). These include the FÁS Skills and Labour Market Research Unit (SLMRU) who are responsible for the National Skills Database. The SLMRU provide the Forfás Expert Group on Future Skills Needs (EGFSN) with the relevant data to compile skills analysis reports which are considered by DJEI in the formulation of policy. The National Standards Authority of Ireland's (NSAI) Agrément section is responsible for the issuing of technical certification for new and innovative products and processes in building and materials technology.

The Liaison Group on Construction includes representatives from government departments/agencies (DECLG, SEAI, NSAI Agrément, NSAI Standards) who consider issues that affect the sector, including evolving Building Standards33 (see: 4.4 Building Regulations and skills needs). Sometimes the process is driven by regulation in a sector, e.g. regulation of domestic gas installation resulted in the formation of a gas standards committee consisting of experts in the field who were tasked with identifying the skills and knowledge required in the area.

A government minister or industry body may approach the NSAI with a request for the development of a new standard. DECLG, for example, have requested the development of a code of practice for retrofit, which is currently in development. It is anticipated that this may provide some guidance to training providers and awarding bodies in relation to education provision in this field.

6.6 Training courses outside of the VET system

In recent years, a number of manufacturers/suppliers of building energy efficiency systems and products have developed their own training courses. These range from insulation and air tightness systems for building fabric to renewable energy heating technologies. These companies are focussed on ensuring the correct onsite implementation of their systems so

that claimed performance may be achieved. It is also based on the perception that the existing VET training provision is not producing skills at a sufficiently comprehensive level. The following section provides a number of examples of such training courses, outlining the indicative content and scope:

- **Oil Fired Technical Association (OFTEC) Training:** OFTEC is a trade association and members' organisation (see http://www.oftec.org/technicians/get-trained) representing technicians and manufacturing companies throughout the UK and Ireland. OFTEC provide training courses through a number of approved providers in Ireland (includes private training centers and some FÁS training centers countrywide), which lead to registration with the organisation as oil fired technicians. Approximately 40% of homes in Ireland use oil for water and space heating, which equates to approximately 500,000 boilers. In the absence of regulation for oil installation in Ireland, similar to the legal requirements for gas installers, OFTEC qualifications have become the most recognised in the Irish market for oil fired boiler technicians. Since September 2009, a 'Boiler Passport' has been supplied with every new oil boiler from the main manufacturers such as Firebird, Grant, Turkington and Warmflow (see: www.firebird.ie, www.grantengineering.ie/, www.turkingtonengineering.com/, www.warmflow.co.uk/). The Boiler Passport is prepared in consultation with OFTEC and is designed to provide a means by which consumers will receive a properly installed and commissioned appliance that meets current building regulations. Any future warranty is conditional upon correct installation of the boilers along with the completion of a Boiler Passport and the commissioning certificate submitted to the manufacturer. Approximately 2,600 participants have completed OFTEC training programmes in Ireland with another 80 currently in training. The SEAI Better Energy Homes programme sets out conditions for contractor qualification for inclusion on the list of approved installers (see: www.seai.ie/Grants/Better_energy_homes/Code_of_Practice_and_Technical_Specification.pdf) , and OFTEC qualifications are accepted as meeting the requirements for installers of oil heating appliances.

- **Ecological Building Systems (see: www.ecologicalbuildingsystems.com/technical-articles/training/):** The company has been a supplier of airtight and wind tight building products and natural insulation for the last 10 years, significantly pre-dating the widespread use of these technologies in the building sector in Ireland. The product range reflects the Scandinavian/German/Austrian approach to timber frame construction of using intelligent building membranes, wood-fibre and Hemp breathable insulations. Over the years, the company has organised informal training for contractors and craftspeople to support the implementation of their products in construction/renovation projects. This approach has recently been extended with the opening of a "Centre of Knowledge" at their premises in Athboy which provides lecture based and practical courses covering a range of related subjects.

- **Saint Gobain Ireland (see: www.isover.ie/technical-help-and-training/technical-academy/40):** A number of companies in Ireland dealing in building energy related products and systems are part of the worldwide Saint Gobain Group. They include Gypsum Industries, Weber (external insulation), Isover (insulation, membranes) and Saint Gobain Glass. The group opened a Technical academy in May 2010 for the training

of craftspeople on best practice for implementation of their products and systems range. The courses, usually of a 1 or 2 day duration, cover theory and practical applications including external insulation, dry-lining, roof insulation systems, air tightness and moisture management. Approximately 1,200 building merchants and construction workers have participated on the programmes thus far.

- **Siga Air Tightness (see: www.siga.ch/en/application-training-at-siga/mobile.html)**: The company provides a one day course at a nominal fee in the METAC training centre. The course covers the theory on air tightness and wind tightness, practical demonstration of the application of Siga air and wind tight sealing tapes/membranes, air tight planning details and air pressure testing. The training is targeted at contractors, insulation installers, developers, architects, BER assessors and energy consultants.

- **Kingspan Renewables Solar Thermal Training (www.kingspansolar.ie):** Kingspan Solar is one of the largest suppliers of solar thermal systems in Ireland. It runs a number of training sessions for installers either at their factory in Portadown, Northern Ireland, at the Institute of Technology in Blanchardstown (ITB) or Limerick Institute of Technology (LIT) where practical workshop facilities complement the delivery of theory presentations. Currently, there are approximately 500 installers who have completed the training and are registered with the company.

- **NSAI Agrément Installer Training (www.nsai.ie/Agrement.aspx):** The National Standards Authority of Ireland (NSAI) Agrément section is responsible for the certification of new building materials, products and processes. They offer registration to installers of external wall insulation, full fill cavity wall insulation and blown loft insulation who have completed training and an application process. Only installers on this register qualify to have their work grant supported for clients when carried out through the SEAI Better Energy Scheme. The holder of the product/system certificate is required to provide training to installers before they can apply to be included on the register. This training is often 1 or 2 days in duration and where specific demonstration of installation procedures is given.

6.7 EU energy training initiatives for building workers

The following table outlines some of the training projects and initiative which have been funded under a range of EU Initiatives in Ireland. In general there has been limited EU funded training activity focused on sustainable energy. There are a number of Skillnets which have been established which were mainly supported using Government funds but some are now progressing to receive funding under various EU funds. These however are not specifically for construction workers.

Table 0.8: Training projects and initiative which have been funded under a range of EU Initiatives in Ireland

Project Name	Website Address	Objectives
Sustainable Energy Heating Systems for Plumbers - HEATPlus	LIT website http://www.lit.ie/Tipperary/News/HEATPlus.aspx	Provide an opportunity for plumbers and heating system installers to increase their knowledge of sustainable heating systems and water efficiency by completing an exchange programme to an expert centre in Germany.
Trainenergy	Trainenergy website http://www.trainenergy-iee.eu/english/about/partners/partners.html TEA webpage http://tea.ie/training/trainenergy/ ITB webpage http://www.itb.ie/StudyatITB/trainenergy.html	The Trainenergy project aims to address the knowledge gap within the construction sector on energy efficiency by producing a training programme for tradesmen in the construction industry. The training would focus on innovations and how they can be used to meet the EU Energy Performance of Building Directives 2002 and Energy End-Use Efficiency and Energy Services 2006.
Competence Enhancement in Sustainable Building through European Mobility (CESBEM I, II & III)	LIT webpage http://www.lit.ie/Tipperary/News/CESBEM%20III.aspx	Provide exposure and upskilling to construction workers on German Standards of timber frame construction, retrofitting and sustainable building through a placement based programme in KOMZET in Germany
Online Vocational Training of Renewable Energy Technologies (INNOVRET)	Main website http://www.innovret.com/ GMIT webpage http://www.innovret.com/gmit-team/	The objectives of the project involving partners from Ireland, Austria and Belgium include: • transferring innovative online learning methodologies tools and techniques from Technical University of Graz to GMIT; • developing novel online training methodologies and tools for the • delivery of online engineering laboratories and training content from GMIT; • developing online training materials to support installation of heat pump systems; • developing online laboratories using the online energy laboratory at GMIT; • delivering online energy training to heat pump installers Europe wide • Accrediting energy training to EU standards.
Sustainable Energy for the Rural Village Environment (SERVE)	Project Website http://servecommunity.ie/	Training has been provided through the following programmes : • Building Contractors and Building Energy Rating Assessors: 20th May 2009 • Heating Controls for Plumbers: 29th May 2009 • RETScreen – Feasibility Analysis and Assessment • Strategic Planning and Energy Policies • Strategic Energy Management for Organisations • TI Accredited Training Programmes

Project Name	Website Address	Objectives
Sustainable Energy for Rural Communities (SUSTAINCo)	Temporary website http://www.swea.co.uk/SustainCo/	The main aim of SUSTAINCO is to increase the visibility of front-runners, for both new build and renovation. SUSTAINCO will directly select and facilitate development of 8 high profile proposed NZEB projects (1 per each participating region) and also provide support to 50 NZEB projects as follow ups to already launched pilot projects. The project will also provide training of key market actors, policy makers and also an extensive information campaign to rural communities' citizens. Another important aspect of SUSTAINCO project is the focus on rural communities, which are often neglected in implementing European or national schemes or programmes. Through the development of this capacity within the partner regions engagement of rural regions in the Covenant of Mayors will be facilitated.
GeoTrain Net	Main EU website http://www.geotrainet.eu/moodle/ No website for GT Skills Ireland	To develop the training of professionals involved in Ground Source Heat Pump installations (GSHP) To support the geothermal heating and cooling market in Europe through the training of professionals involved in in Ground Source Heat Pumps installations.

6.8 Conclusions:

- The imminent formation of SOLAS, the new national body with responsibility for further education and training, and the amalgamation of the two main accreditation bodies, FETAC and HETAC, establishing the QQAI, has created a level of uncertainty over the future direction in VET.
- The broad training provision for the construction workforce in Ireland has not evolved to reflect the recently legislated change in the approach to building construction and renovation. Apprenticeship training for the construction trades do not emphasise energy performance or renewable energy technology in the curricula.
- In the main construction related crafts, approximately 15,500 apprentices have been trained in Ireland in the period 2006 to 2011. The vast majority of these have had little or no exposure to the revised building regulations, new standards and emerging technologies within their relevant fields as part of this training.
- Participation rates in construction craft apprenticeship programmes are at their lowest in over two decades, reflecting the effect of the current economic recession and severe drop in construction output.
- The array of newly introduced programmes related to energy efficiency and renewable energy deployment are generally technology specific and do not strive to provide learners with an understanding of the fundamental principles of low energy buildings and system efficiency.

- Participation rates on training courses related to energy efficiency and renewable energy technologies have been significantly affected by regulatory requirements for qualifications or perceived opportunities stemming from SEAI grant supported works. The cost of this training is carried by participants or their employers but is available free to the unemployed on FÁS and Springboard programmes.

- The potential for the retrofitting of existing building stock is consistently referred to in skills needs reports. However, no regulation or licensing system of the sector set against training qualification exists to stimulate either provision of or participation on such up-skilling programmes in this field. Mandatory training requirements, such as those that exist for gas installation, have experienced strong participation.

- Participation rates on renewable energy technology training programmes, particularly for micro-generation of electricity, have experienced a significant decline in the last two years.

- The emergence of product/system specific training courses that are run by companies in the sector may be indicative of an industry perception of a gap in the existing VET provision.

- The existing structures for the monitoring of skills needs and developments in technologies are fragmented with no organisation taking overall responsibility for this function.

7. Skills gaps between the current situation and the needs for 2020

Skills gap defines that disparity between the skills needed for specific job descriptions against those presented by the applicants. In this chapter, the training required to provide the skills needed for the achievement of 2020 energy saving targets from buildings for Ireland are estimated. Estimates for the number of workers requiring up-skilling is based on employment and apprenticeship training provision forecasts to 2015 and the published statistics on the share of production output in construction sub-sectors. Skills demand relating to the implementation of energy policy actions in Ireland is also considered. It is important to note that given the significant economic and societal changes within Ireland it is difficult to accurately model future workforce numbers in the construction sector.

7.1. Gap Analysis Methodology

Data from the most recently published skills analysis reports towards the development of green economy are referenced where they are relevant to the built environment. Existing and emerging technologies and skills for energy efficiency and renewable energy technology in buildings are reviewed (Appendix A4) and mapped against existing VET provision to identify the inherent skills and knowledge gaps in the sector.

The identified skills need provides a basis for the proposed qualification needs for building construction workers. The NFQ levels suggested for these proposed programmes are indicative of the accreditation structures for the corresponding awards. Consideration is given to the potential of the existing VET infrastructure to accommodate the training requirements, both in terms of number and qualification of trainers and available facilities. Finally, skills monitoring structure for the sector and formal procedures for forecasting of demand are suggested as a plausible means of ensuring timely interventions in order to minimise the potential skills mismatch.

7.2 Labour Force Evolution

The data used in this following section was provided by the Skills and Labour Market Research Unit of FÁS (SLMRU) which is responsible for maintaining the national skills database. The 2011-15 forecast of apprentice intake into selected construction and non-construction trades in Ireland[20]forms the basis of this section of the gap analysis. The forecast report provides the current data on employment and apprentice intake forecasts for the main construction trades.

The data on future employment in the construction related trades are based on detailed output forecasts (DKM economic consultants). The forecasts assume that there will be no recovery in activity or employment in the sector prior to 2013. The output forecast data was translated into employment forecasts using the model illustrated below in Figure 7.1.

[20] Forecasts of Apprentice Intake into Selected Construction and Non-Construction Trades to 2015

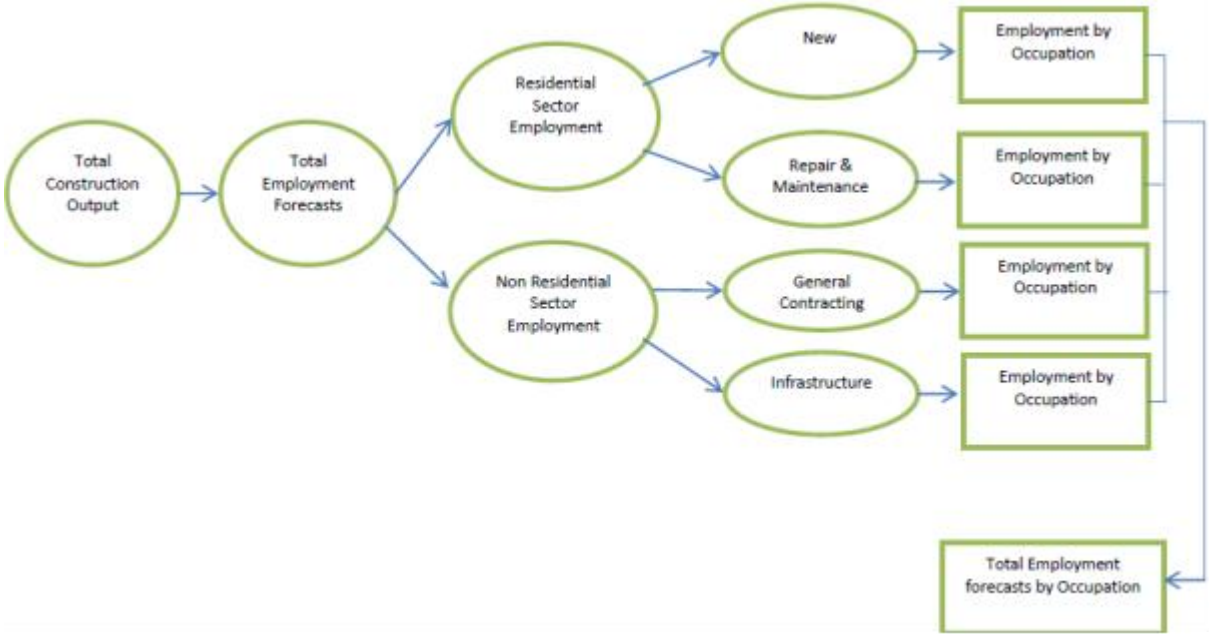
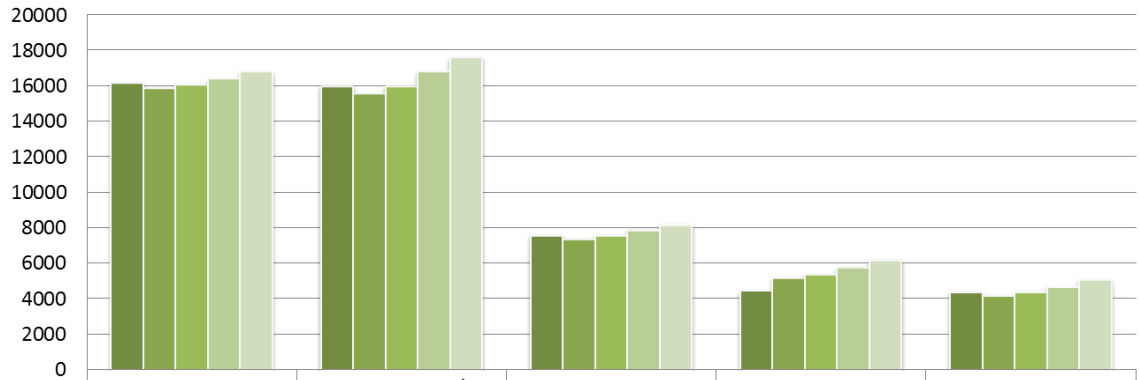


Figure 0.1: FÁS Construction Employment Forecasting Model

Employment forecasts to 2015 for each of the main construction trades are illustrated in the Figure 7.2. The forecasts predict a very modest increase in employment in the main construction trades for the period covered.



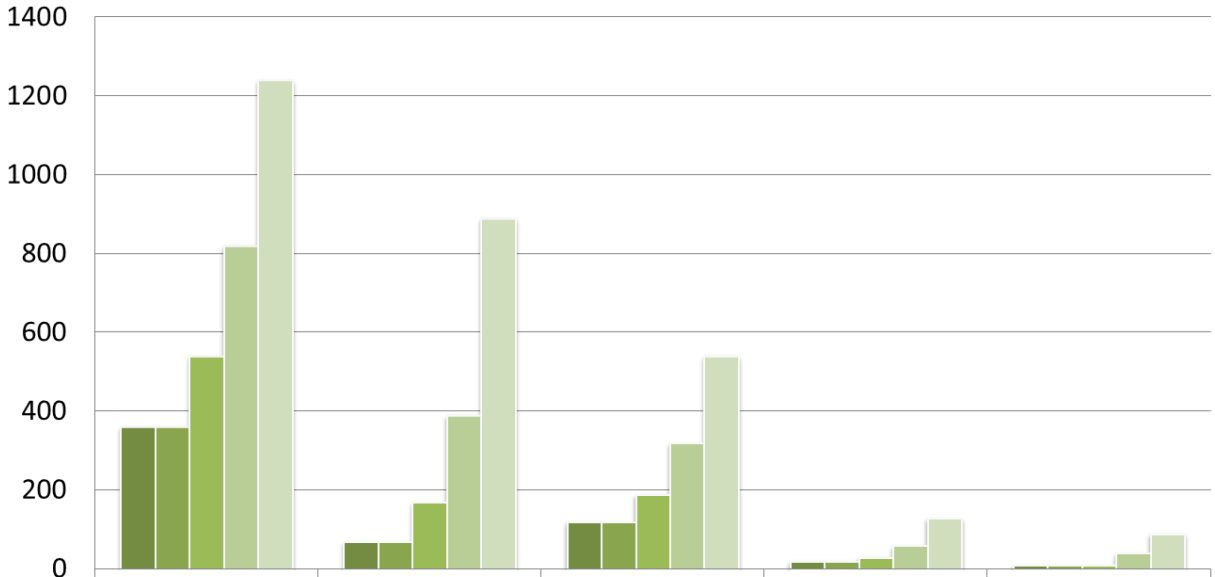
	Electrician	Carpenter/ Joiner	Plumber	Bricklayer	Plasterer
2011	16200	16000	7600	4500	4400
2012	15900	15600	7400	5200	4200
2013	16100	16000	7600	5400	4400
2014	16400	16800	7900	5800	4700
2015	16800	17600	8200	6200	5100

Figure 0.2: Forecasts of employment in the main construction related trades 2011-2015

The SLMRU report focuses mainly on forecasts for apprentice recruitment to 2015. The forecasting methodology adopted considers three different average ratio scenarios as follows:

- 1998-2010 period, i.e. the longest period for which historical data is available
- 2007-2010 period coinciding with the economic downturn during which construction was heavily curtailed
- 2010, the ratio for the most recent year

For the purposes of the BUSI project analysis, the first scenario forecasts, 1998-2010, will be used as this provides the broadest base data for the projection of apprenticeship training provision (Figure 7.3).



	Electrician	Carpenter/ Joiner	Plumber	Bricklayer	Plasterer
2011	360	70	120	20	10
2012	360	70	120	20	10
2013	540	170	190	30	10
2014	820	390	320	60	40
2015	1240	890	540	130	90

Figure 0.3: Construction related trades - apprentice intake forecasts for 2011-2015

The forecasts above are obviously based on a scenario of a return to at least modest levels of growth in the construction industry by 2015. This in itself carries an assumption of a level of economic recovery. It is the view of the BUSI Consortium that accurate predictions to 2020 are impossible until the Irish economy will have gained some level of stability.

The other main factor that may affect the numbers employed in the sector is the level of implementation of government energy policy actions. As previously noted, the National Energy Retrofit Programme is currently supporting the employment of approximately 4,500 workers. Initial estimates from DCENR for the programme indicated a figure closer to 20,000[21] will be required to achieve the improvements to 1 million buildings by 2020. An escalation of activity in this sector and a move towards 'deeper' retrofit approaches will inevitably lead to a significant increase in demand for skilled labour.

The deployment of renewable energy technologies in buildings is now largely dependent on the decisions of building designers, who determine how they meet the prescribed energy and carbon targets of current and future building regulations. The likely corresponding increase in demand for skilled installers is very difficult to forecast. However, the decision to support biomass CHP in the industrial sector through the REFIT scheme will inevitably lead to opportunities for maintenance technicians that may be from a mechanical (plumber, fitter) and electrical background.

7.2 Identified Skills Needs

This section provides a breakdown of the skills needed to underpin the implementation of energy efficient building technology towards 2020 energy targets. Recently published skills analysis reports for the green economy are summarised where they are relevant to the building sector. A comprehensive review of existing and emerging technologies and skills (see Appendices A4) was undertaken for all elements of an energy efficient building resulting in identified skills needs for each. Feedback from the implementation of SEAI retrofit schemes and the SERVE[22] initiative in North Tipperary has also contributed. This analysis provides the basis of the conclusions for current and future skills needs. A number of assumptions are made when quantifying the numbers requiring up-skilling including:

- **Current employment statistics for the construction industry and forecasts to 2015 from FÁS SLMRU are adjusted against production output percentages for the building sector, i.e. very modest increases in building construction activity are assumed.**
- **An escalation in energy retrofit activity is assumed as necessary for the achievement of 2020 energy saving targets and employment in this sector is adjusted upwards accordingly.**
- **For general building works an industry accepted ratio of 1:10 supervisor to worker is assumed.**
- **In relation to REFIT 3 supported Combined Heat and Power installation, an assumption of 30 full-time maintenance technicians for every 50MW is assumed.**

[21] DCENR presentation at SERVE Conference 2010

[22] Sustainable Energy for the Rural Village Environment (SERVE), www.servecommunity.ie

7.2.1 Review of Green Economy Skills Needs Analysis Reports

Recently, there have been a number of high level reports on the jobs potential within the green economy in Europe and Ireland which make specific mention of the need for training and up-skilling in the construction sector. The elements of these reports that are relevant to the building workforce are outlined in the following sections.

Skills for Green Jobs – European Synthesis Report 2010

This report was published by the European Centre for the Development of Vocational Training (CEDEFOP) in 2010 and acknowledges the significant potential for job creation in the green economy, particularly in renewable energy and eco-construction. One of the key findings of the report is ***"that few of the critical skills for transition to a low carbon economy are new"*** and that the emphasis should be on investment in the development of training to 'top-up' the skill sets of existing occupations.

The specific challenges for the construction industry are also acknowledged, mainly in relation to the scale of action required to up-skill the workforce. However, it is noted that the main concerns are based on ***"the volume of workers requiring upgrading of skills – even if the actual skill requirement for the individual is relatively low".*** The report also indicates a number of other potential barriers, including access to finance for small and medium sized enterprises (SMEs) to support the required up-skilling training. The barriers to participation on training are mentioned, "Persuading the workforce to up-skill requires convincing them that it is both affordable and profitable". The importance of national skills monitoring structures and strategies to anticipate demand is seen as crucial for ensuring that the workforce is equipped to fully realise the potential of future growth sectors.

Future Skills Needs of Enterprise within the Green Economy in Ireland 2010

Forfás[23] is Ireland's policy advisory board for enterprise, trade, science, technology and innovation. It was established in 1994 as an agency of the Department of Enterprise, Trade and Employment. One of its policy functions is to coordinate the work of independent advisory groups. The Expert Group on Future Skills Needs (EGFSN) advises the Irish Government on current and future skills needs of the economy and on other labour market issues that impact on Ireland's enterprise and employment growth. The FÁS Skills and Labour Market Research Unit (SLMRU) provide the Group with data, analysis and research while also managing the National Skills Database. The EGFSN published the "**Future Skills Needs of Enterprise within the Green Economy in Ireland**" in November 2010. The report considers the Green economy under a number of sub-sector headings that include Renewable Energies and Efficient Energy Use & Management. The indications provided for skills in the renewable energy sector focus mainly on the need for technician skills to support the operation and maintenance of wind turbines, solar energy and other renewable technologies. Specifically, it is identified that there is a demand for technicians with multi-disciplinary skill training encompassing electrical, mechanical and electronic skills. No specific mention is made of demand in the building sector for small-scale renewable electricity and heat generation.

[23] www.forfas.ie

The report notes the business potential in the efficient energy use and management sector for areas such as the domestic energy retrofit market, the delivery of energy efficient buildings, LED lighting and zone control for domestic and small commercial buildings. The need for the up-skilling of insulation workers is specifically recognised. The report includes a section on assessment of future skills demand including anticipated employment and skills demand trends and examples of types of green jobs. The content relevant to the building sector is reproduced in Tables 7.1 and 7.2.

Table 0.1: Anticipated employment and skills demand trends

Sectors	Anticipated Trends
Renewable Energy technologies -Wind -Photovoltaic -Solar Thermal Energy -Geothermal -Modern Biomass -Hydropower	**Employment:** It is estimated that there are currently 300,000 persons employed in the Renewable Energy Sector in Europe. Achieving the EU target of a share of 20% for renewable energies for electricity production in 2020 (double 2006 level) would mean almost a million jobs in the industry by 2020 – an additional 700,000 jobs. Additional jobs are expected in manufacturing, installation and maintenance. **Skill Trends:** Many positions will require highly skilled technicians, engineers and skilled trades.
Buildings	**Employment:** Due to the demand for green building components and energy-efficient equipment, 'green' manufacturing jobs will increase**.** **Skill Trends:** Higher-skilled employment will arise from the need for energy-efficient equipment installations. Existing Jobs will be redefined in terms of new skills and certification.

Table 0.2: Examples of Types of "Green Jobs"

Sector	Sub-sector	Jobs
Renewable energy generation	Wind Energy	wind generating installer, field service technician
	Solar Energy	energy system installer, solar and PV installation roofer, installation electrician, engineering technician, electrician
	Geothermal Energy	plant installation technician, plant efficiency operator
Efficient energy use/management	Eco-Construction	Air sealing technician, insulation installer, carpenter, electrical system installer, plumber and pipe fitter, service technician, roofing and skylight installer
	Energy management/efficiency services	Residential, commercial, industrial field auditor
	Combined Heat and Power (CHP)	CHP operator (steam boiler background), technical services representative, maintenance supervisor

Skills and Training for a Green New Deal 2010

Comhar SDC is the main organisation in Ireland providing for sectoral and stakeholder engagement on implementing sustainable development. It was first set up in 1999 as Comhar, the National Sustainable Development Partnership and is now known as Comhar Sustainable Development Council (SDC). The council is made up of 25 members drawn from five sectors; the state sector, economic sector, environment Non-Governmental Organisations (NGOs), social/community NGOs and the professional/academic sector. It published a report entitled "**Skills and Training for a Green New Deal**" in September 2010 with a "**Conclusions and Recommendations**" summary report published in the same month. The report is summarised in the following section where it is relevant to training of building workers in the fields of energy efficiency and renewable energy technology.

- **Training for the Unemployed:** The report acknowledges that FÁS is already providing some training provision for the construction trades covering skills for carrying out retrofitting work and labour market activation initiatives, such as Springboard. Opportunities for renewable energy technicians and those with specialist construction skills that may support infrastructural development are noted.

- **Research and Education:** While the report finds that the Irish education sector has already somewhat responded to the demands for training in green technologies, it recommends that existing courses in areas such as building services engineering and construction studies should be adapted for emphases on energy efficiency and renewable energy technologies.

- The report also identifies a need for FÁS to **review the current craft apprenticeship curricula and consider the suite of apprenticeships on offer in relation to the need for multi-disciplinary skills.** The following areas are indicated as having growing importance:

    - *Wall insulation (new build and retrofitting) for blocklayers and plasterers.*

    - *Heating controls and renewable energy technologies for electricians and plumbers.*

    - *Skills in energy management and possibly even some business skills relevant to retrofitting for craftspeople likely to get involved in domestic retrofitting.*

- The restrictions on funding for educational institutions in the current economic climate are also acknowledged in relation to investment in resources for the delivery of green training programmes. It is recommended that the Department of Education and Skills provide a modest fund to assist higher education and further education institutions in support of this delivery.

- **Training for Industry:** The report outlines the necessity for government intervention in training provision for those in employment, while acknowledging that the primary responsibility lies with the employer. The report notes that when up-skilling is required

in support of government policy, it is important to offset the tendency of small and medium enterprises (SMEs) to under-train.

- A specific recommendation for the management of **domestic energy retrofits is included**. It is acknowledged that both technical and business skills are needed to support quality of work and enhance retrofit as a marketable product. It is indicated that a significant responsibility for this provision should lie with SEAI.

- Reference is also made to the SEAI role in promoting residential and commercial renewable heat and CHP. It is recommended that they should also take responsibility to address gaps in training provision in this sector.

FETAC Sector Needs Analysis for Green Economy 2011

This consultation document was compiled for FETAC in early 2011 by produced by Energy Solutions. It lists relevant training provision in this sector while identifying potential programmes for development in support of the anticipated skills demand in the future. The report acknowledges the legislative and policy drivers in the sector and the aforementioned sectoral studies from Forfás and Comhar. Reference is also made to the European Centre for the Development of Vocational Training (**CEDEFOP**) and its 2010 "**Skills for Green Jobs – European Synthesis Report**".

The document also outlines the extent to which existing training provision is meeting industry demand and identifies areas where there is a potential need for development of new training programmes such as:

- Non-domestic Heating Technologies: Training for installation and maintenance technicians for renewable and low carbon heating technologies in non-domestic buildings.

- Eco-construction and Retrofit: it is noted that the forthcoming "Retrofit Code of Practice" from the DECLG, a response to the Regulatory Impact Assessment for TGD L 2011, is expected to define key areas of knowledge for those participating on retrofit projects.

- Heating Controls and System Efficiency: up-skilling needs for Plumbers are anticipated in response to the NSAI "Plumbing and Heating Code of Practice" and the DECLG TGD L accompanying document "Heating and Domestic Hot Water – a Guide to achieving compliance with Part L" (see: *4.4 Building Regulations).*

- Energy Efficient Construction Technologies: Skills needs in this field are being driven by Air tightness testing requirements, DECLG/SEAI/Homebond acceptable construction details, DECLG retrofit code of practice, knowledge of building physics, knowledge of factors affecting condensation and measures for mitigation, and need for knowledge of factors affecting thermal bridging and measures to mitigate against this.

- Energy Efficiency / Energy and Carbon Management: The NEEAP has identified significant potential for reduced energy use for all sectors. Skilled practitioners of the implementation of energy efficient and renewable technologies could support this objective. These skills requirements could be met through adaptation and refinement of traditional engineering and technical skills.

All of the main elements of an energy efficient building, from fabric to mechanical and electrical services, are considered in the following sections. Section *5.3.3 Technologies/measures for energy efficiency and renewable energy in buildings* and Appendix *A4 Review of existing and emerging technologies and skills in energy efficiency and renewable energy in buildings* are the basis of the skills identification for each building element.

7.2.2 Building Fabric

The evolution of Irish building standards relating to energy performance is having a profound influence on the design and construction of building fabric elements. The fabric standards set by the Regulations for Dwellings (2011) are similar to Passive House criteria. This approach is largely based on the principles of continuity of insulation and air tight construction. The necessity for adherence to specification and approved detailing of fabric elements to account for insulation levels, thermal bridging and air tightness has been reinforced by the introduction of BER (Building Energy Rating) and a testing regime for building air permeability standards.

The core skills required to implement energy saving technologies for building fabric already exist onsite. The ability to dimension, cut, shape, position, fix and seal fabric elements are part of the traditional skill set of operatives and craft workers. The gap that exists is one of knowledge. Those involved in construction and renovation are generally unaware of the underpinning principles for low energy building. These may apply to all elements of the building envelope and include: Modes of heat transfer; Air infiltration and air tightness; Properties, selection & positioning of insulation materials; Selection & positioning of building membranes; Continuity of insulation layers; Thermal bridging; Ventilation, vapour control & condensation.

Based on 2010 employment figures and forecasts to 2015 (Figures 5.6, 5.7 and 7.2), the number if workers requiring training within the NACE activities F41.2 - Construction of residential and non-residential buildings, F43.3 – Building completion and finishing and F43.9 – Other specialised construction activities, are represented in Table 7.3.

Table 0.3: Numbers of workers requiring training on Building Fabric

Building Element	Knowledge/ Skills Need	ISCO 7114 Concrete placers, concrete finishers and related workers	ISCO 7121 Roofers	ISCO 7214 Structural – metal preparers & erectors	ISCO 7125 Glaziers	ISCO 7112 Bricklayers	ISCO 7115 Carpenters and Joiners	ISCO 7123 Plasterers
Fabric	Thermal Bridging	5,000	2,500	1,500	1,000	4,000	16,000	4,000
	Air tightness							
	Insulation							
	Ventilation							
	Building Regulations							

7.2.2 Ventilation

Building regulations are the main driving force behind the adoption of new ventilation technologies (see: 4.4 Building Regulations). The adoption of a nearly zero energy building framework for building standards in Ireland will inevitably lead to a greater market penetration for systems other than the traditional natural ventilation from background ventilators (see:). Installers of these systems will require a range of knowledge and skills pertaining to:

- Building regulations for ventilation
- Air infiltration and air tightness
- Analysis of ventilation rates
- Design and selection of ventilation systems
- Location and maintenance of mechanical units
- Fire safety regulations
- Controls for mechanical ventilation systems
- Ventilation requirements for combustion appliances
- System efficiency
- Heat recovery
- Ducting (i.e., positioning, insulating, jointing, sealing and moisture control).

While Refrigeration and Air-conditioning exists in Ireland as a specialist craft relevant to ventilation, the numbers trained and employed in the sub-sector are relatively small. To satisfy the future demand for implementation of ventilation technologies, it is proposed that

plumbers and electricians are targeted for the up-skilling programme in this field since they hold the most appropriate skill set.

The numbers requiring training for works within the NACE activity F43.2.2 (Plumbing, Heat and Air-conditioning) of 500 workers is estimated from a projected return to residential construction activity of 20,000 units annually by 2015 and is represented in Table 7.4.

Table 0.4: Numbers of workers requiring training on Ventilation Installation

Building Element	Knowledge/ Skills Need	ISCO 7126 Plumbers and pipe fitters	ISCO 7411 Building and related electricians	ISCO 7127 Air conditioning and refrigeration craft workers
Ventilation	Air tightness/ Air infiltration	300	100	100
	Ventilation			
	System Design			
	System Efficiency			
	Controls			
	Building Regulations			

7.2.3 Space Heating/ Cooling, Water Heating and Controls

The shift in emphasis on space and water heating technology is towards appliance efficiency, system optimisation/balancing, reduction of storage and distribution energy losses, integration of renewable heating technologies, and the zoned control of systems.

Plumbing has been particularly affected by the fragmentation of the building sector. On-the-job training is generally limited by the specialisation of workers in industrial/commercial, domestic or maintenance sectors which is restricting the opportunities for craft workers to practice skills in real work situations. Generally, more knowledge and technology awareness of the factors affecting energy use in buildings, installations, and system efficiency enhancement is required.

The numbers requiring this training for works within the NACE activity F43.2.2 Plumbing, heat and air-conditioning are outlined in Table 7.5 and are based on the 2010 employment figures and forecasts to 2015 (see Figures 5.6, 5.7 and 7.2 previously).

Table 0.5: Numbers of workers requiring training on Space Heating/ Cooling, Water Heating and Controls

Building Element	Knowledge/ Skills Need	ISCO 7126 Plumbers and pipe fitters
Space Heating/ Cooling, Water Heating and Controls	Modes of heat transfer Distribution and storage losses Efficiency of appliances Hydraulic balancing Integration of systems Heating Controls Ventilation & condensation	9,000

With the high contribution to energy savings expected from the retrofitting of existing dwellings through the National Energy Retrofit Programme (see: 4.2.2), there is a need for technicians with an in depth knowledge of heating system design, integration and control. With many retrofit projects being incorporated as part of major renovation or extension works, multiple systems may need to be integrated, e.g. oil/gas fired central heating with radiators in main dwelling, secondary heating from multi-fuel stove with boiler, underfloor heating to extension and solar thermal system for hot water.

The onus for the efficient operation of domestic heating systems lies with the installer/contractor. However, existing training programmes are generally single technology specific, e.g. gas installation, oil installation, solar thermal, biomass, heat pump. In most cases, the training fails to provide the multi-disciplinary skills that may be required to design and integrate multiple systems. These are skills and competences that domestic heating contractors and supervisors need to effectively participate in and oversee works.

The numbers requiring this training for works within the NACE activity F43.2.2 Plumbing, heat and air-conditioning are outlined in Table 7.6 and are approximate numbers based on the SEAI Better Energy Homes installers list, specifically numbers registered for multiple domestic heating upgrades, with an allowance for the proportion of plumbers working in the residential sector and a supervisor to worker ratio of 1:10:

Table 0.6: Numbers of workers requiring training on domestic heating installation

Building Element	Knowledge/ Skills Need	ISCO 7126 Plumbers and pipe fitters
Domestic Heating Installation	System design	1,350
	Properties, selection & installation of insulation for primary and distribution pipework and storage vessels	
	Hydraulics & fluid mechanics	
	Heat loss calculations	
	Heating control system design and installation	
	Integration of multiple heating systems including renewable energy	
	Access to and insulation of water tanks	
	Building regulations and DEAP requirements	

The noted potential of the REFIT 3 programme (see section 4.3.1 Energy Performance of Buildings Directive

Building energy rating legislation was adopted into Irish law in 2006 in response to the Energy Performance of Buildings Directive (2002). Statutory Instrument 666 outlined the regulatory framework which controls, for the first time in Ireland, the provision of energy ratings for buildings. SEAI were charged with the development and management of the energy rating systems. As of January 2009 energy ratings are required for all buildings which are sold or rented. Specific methodologies, and associated software systems, have been developed to allow for energy assessments to be completed by competent, trained energy assessors. Currently the following classifications of energy ratings, and associated energy assessor levels, exist

- Domestic Building Energy Rating (BER): for residential dwellings
- Display Energy Certificate (DEC): for public buildings
- Non Domestic Building Energy Rating: for non-residential buildings

As of April 2012 there are 889 Domestic BER Assessors, 140 Non Domestic BER Assessors and 117 Display Energy Certificate Assessors listed on SEAI's website. A significantly larger number of assessors have received training but are no longer active in the market.

The energy rating approach is now used as a key mechanism for policy makers to measure the impact of regulatory measures and incentives that are put in place. The relevant methodologies and technical standards are update to reflect relevant changes in building regulations and standards.

4.3.2 National Renewable Energy Action Plan) to facilitate the deployment of 310MW of biomass technologies (anaerobic digestion, high efficiency CHP and biomass combustion and co-firing) offers an opportunity to up-skill plumbers and electricians to operate as maintenance technicians. While it is recognised that this initiative is for the deployment of large scale CHP in the industrial sector, skills acquired for maintenance/servicing combined with knowledge of installation and the principles of district heating, are also transferrable to support future implementation of this technology in the services and residential sectors.

The projected numbers of 180 (ISCO 7126 Plumbers and pipe fitters, ISCO 7411 Building and related electricians) requiring training are based on an assumption of 30 maintenance operators per 50MW of CHP deployment against the total to be supported under REFIT 3.

7.2.4 Lighting

Appropriate training is required to develop skills in relation to lighting design and in particular the selection and use of lighting design software. To assist in the selection of appropriate lighting, product knowledge training will be required on a continual basis. This training would most likely be provided by product vendors.

The emerging trend within the lighting sector is integration of lighting within a Building Energy Management system. In order to be successful in implementing these sophisticated controls training will be required in intelligent building systems.

Based on employment figures for 2010 and forecasts to 2015, the projected numbers of electricians requiring up-skilling is outlined in Table 7.7.

Table 0.7: Numbers to be trained on energy efficient lighting

Building Element	Knowledge/ Skills Need	ISCO 7411 Building and related electricians
Lighting	Lighting Controls Factors affecting energy use for lighting Efficacy, colour rendering, colour temperature Lamp types Energy saving potential of lamp replacement Building Regulations Part L- Buildings other than Dwellings – Artificial Lighting	16,000

7.2.5 Renewable Energy Systems

Renewable energy relates to energy that is replenished at a rate equal to that at which it is being consumed. The renewable energy systems being employed in the built environment generally fall into two categories, namely; renewable heat technologies utilising solar thermal, heat pump and biomass technologies, and; the micro-generation of electricity from small scale wind and solar photo-voltaic (PV) installations.

Renewable Heating Technology

The range of renewable heat technologies is likely to broaden over the coming years. Renewable heat systems will deliver greater yields in well insulated homes (due in the most part to the lower operating temperatures of heat pump systems) therefore linking these installations with energy efficient dwellings will deliver better returns/cost savings for the consumer.

Energy efficiency improvement is also a necessary condition for deployment of electric heat pumps. Otherwise the heat pumps would need to be increased significantly in size (therefore more expensive) to cope with the demands of larger radiator systems in poorly-insulated buildings, and in extreme cases would not be able to provide adequate levels of warmth[24].

Appropriate training will be required to:

- support designers/installers conducting site surveys which will determine the optimum type of renewable energy heating system for a given site/location
- enable designers/installers assess the suitability of specific renewable systems to different dwelling types and installations
- enable designers/installers assess and ascertain the suitability of already installed heating systems to allow integration/interlinking of renewable energy systems
- oversee/supervise/install the low temperature energy gathering device (for ground and water source heat pumps - closed pipe loops/open loops/)(for air source heat pumps – correct orientation and location)
- develop skills to fully implement the requirements of current Building Regulations in relation to renewable energy systems

As the vast majority of these systems will require integration/interlinking to existing heating systems, the requirements of '**7.2.3 Space Heating/ Cooling, Water Heating and Controls'** section will also need to be met.

The numbers requiring training will be determined in part by the uptake of consumers of the retrofit renewable energy technologies for their homes, which may well be influenced by the availability of government grant aided schemes. Sufficient numbers are currently undertaking available single technology training to satisfy demand, i.e. solar thermal, biomass and heat

[24] Committee on Climate Change, 2011, The Renewable Energy Review

pump (see: 6.5 VET Provision on Energy Efficiency and Renewable Energy in Buildings)

Under the current building regulations there is no mandatory requirement for use of renewable energy for heating of existing dwellings. However, any newly constructed dwelling requires that part of the energy for heating and/or lighting be provided by a renewable energy source (see *4.4 Building Regulations*). Suitable training will be required to enable designers/installers to specify one or more renewable energy systems to meet the demands of the regulations and at the same time maximise energy efficiency.

It is the opinion of the author that, in most part, plumbers/system installers/designers are already competent in basic energy system installations and therefore do not require - retraining specifically for renewable energy systems installation. Rather, appropriate training should be geared learning of installation and design practices that will enhance efficiencies of systems such as proposed in Table 7.6 for domestic heating installation. Comprehensive training will be required at technician level in the areas such as: Thermodynamics/mechanics of fluids, electrical control systems, mechanical control systems, electro-mechanical integration, troubleshooting and fault finding of the above systems of control and implications for energy loss through inadequate installation.

Perhaps there is a need to evolve and/or up-skill to a new “mechanical-electrical” domestic technician/trade in the near future.

Micro-generation

Micro generation embraces a range of technologies that are presently at varying stages of development and commercial availability. These include: small wind generators, micro-hydro generation, small-scale photovoltaic (PV) arrays and domestic scale Combined Heat and Power (DCHP) equipment. Currently, taking into account the low level implementation of micro-generation technologies, it is considered that there is no short to medium term demand for skilled workers in this field.

7.2.6 Building Energy Management

Training is needed to develop skills in relation to major design and integration issues related to the automated & networked intelligent devices in building applications. This would need to cover advanced hardware/software design and system integration concerned with the control and communication of different manufacturers’ devices. It would also be important to design training that covered conceptual, theoretical, social, technical, and design issues associated with universal design of intelligent building systems and smart technologies for example location and application of automated control of appliances, advanced control of lighting, and climate systems. The introduction of sophisticated control equipment within a domestic situation (which includes BEMS, energy management, fire/intruder as well as video/audio) may require a new type of technician for market, design, installation and maintenance).

7.2.7 Building Energy Retrofit/Construction Supervision

The move toward near zero carbon buildings and energy improvement renovation will require additional skills and knowledge on the part of project supervisors. The emphasis will now be on close supervision of installations and the coordination of onsite workers through the entire construction process toward the achievement of energy performance standards. In contrast to the 'topping-up' training requirements for operatives and crafts, this will require a comprehensive up-skilling programme for site supervisors. The additional complexity inherent in retrofitting existing buildings will necessitate the acquisition of further skills and knowledge.

The relevant knowledge and skills that are common for low energy building construction supervision include: construction technology, Building Physics, energy use, principles of space and water heating systems and controls including the potential for utilisation of renewable energy technologies, thermal bridging, building air permeability and properties of insulation materials, Building Regulations, emphasis on energy conservation but including all those relevant to building renovation and communication skills / report writing.

The additional skills needs for domestic energy retrofit project managers include: history of Irish construction technology, calculation of energy use and cost savings, energy performance assessment tools and procedures, entrepreneurship skills and project management.

Figure 7.4 illustrates the main areas requiring up-skilling for craft workers to supervisor level dependent on their role. The currently provided training provides the worker with the traditional technical skills of their craft but does not provide core knowledge of low energy building or emphasise the need for onsite coordination with other crafts, i.e. systems thinking. The need for improved pedagogical skills is an acknowledgement of the significant proportion of learning that takes place onsite. As the craft worker progresses into supervisory roles a need arises for a much broader skill set and extending to entrepreneurship skills for domestic retrofit in recognition of the direct contractor/customer relationship inherent in these projects. .

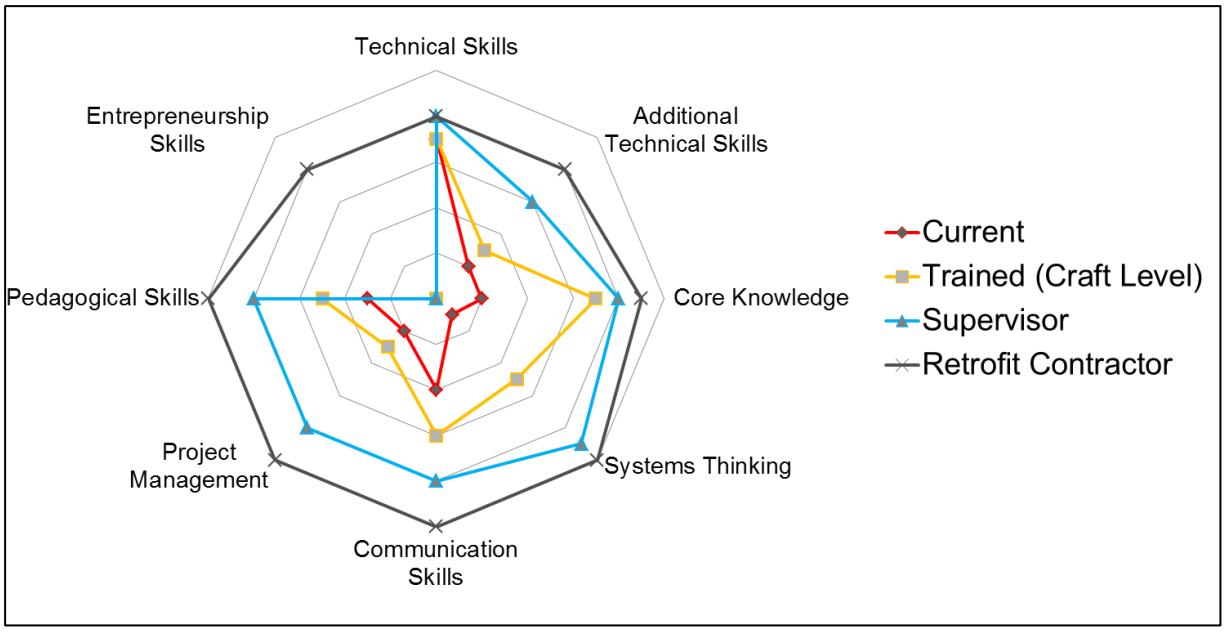


Figure 0.4: Skills and knowledge needs by role

The numbers requiring training/up-skilling to operate as supervisors within the NACE activity F41.2 Construction of residential and non-residential buildings are outlined in Table 7.8 and are approximate numbers based on construction employment figures and forecasts to 2015 and an allowance for a ratio of supervisor to worker of 1:10 as follows:

Table 0.8: Numbers requiring training for building construction supervision

Building Element	Knowledge/ Skills Need	ISCO 3123 Construction supervisor
Building construction supervision	Construction technology Building Physics Energy use Principles of space and water heating systems and controls including renewable energy technologies Thermal bridging, building air permeability and properties of insulation materials Building Regulations	3,000

The projected numbers requiring training/up-skilling to operate as domestic energy retrofit supervisors within the NACE activity F41.2 Construction of residential and non-residential buildings are outlined in Table 7.9 and are on based the SEAI Better Energy Homes installers list, specifically numbers registered for multiple types of insulation upgrades, with an allowance for a projected escalation of the National Energy Retrofit Programme to support 100,000 projects per year to 2020.

Table 0.9: Numbers requiring training for domestic energy retrofit supervision

Building Element	Knowledge/ Skills Need	ISCO 7111 House builders
Domestic energy retrofit supervision	History of Irish construction technology Calculation of energy use and cost savings Energy performance assessment tools and procedures Entrepreneurship skills Project management.	2,200

7.3 Qualification Needs

The qualification needs assessment for construction workers considers that there will be structured grades or levels of employment at which qualifying workers may be engaged. For the purpose of this analysis, the following three occupational tiers relating to either existing craft qualifications or the responsibilities and role of the worker are considered (Table 7.10).

Table 0.10: Occupational Tiers

Level	Description
Operative level	Defines the skill level outside of the formal apprenticeship training structure, i.e. skills acquired through on site experiential learning, e.g. concrete workers, steel workers, glaziers, roofers.
Craft level	Defines the occupation level where a formal craft apprenticeship or equivalent training has been successfully completed.
Supervisory level	Defines the specialist, supervisory or project manager level where a craft worker has progressed to autonomous roles such as a system installation specialist, site supervisor, small/medium sized building contractor or similar roles.

Within the three tiers, the requisite skills or knowledge needs that may be common across a number of trades/skills and where specialist training is required to progress from an existing qualification level will be identified and mapped. The indicative considerations are outlined in sections 7.3.1 through 7.3.3.

7.3.1 Operative Level

This tier covers skills outside the formal construction trades education/skills structure and includes general operatives, concrete workers, steel workers, roofers and glaziers, all of which contribute to the construction/renovation of the building fabric.

In light of the fundamental changes in approach to construction and renovation of building fabric (see section 7.2.2 Building Fabric), there is clear need for the up-skilling of this cohort. A general training programme, at perhaps NFQ level 5, of not more than 3 day duration (21 contact hours) may be appropriate. Such training will be focussed on basic understanding of the principles of energy efficient construction. It is essential that this should be technology focussed training, and supported by the demonstration/illustration of practical examples and case studies.

It is noteworthy that all site workers are required to complete 'Safe Pass' training in Ireland where health and safety in construction is covered. The Safe Pass programme was launched by FÁS in 2000 with the objective of ensuring that *"over the course of time, all workers in construction will have a basic knowledge of health and safety, and be able to work on-site without being a risk to themselves or others who might be affected by their acts or omissions"*[1]. All onsite workers are required by law to hold a valid Safe Pass registration card, the renewal of which is dependent on the holder updating their safety awareness training every 4 years. The programme is a unique example in Ireland of **mandatory** training which has to be completed by all construction site workers, regardless of whether or not they hold other formal skills qualifications.

7.3.2 Craft Level

This occupation tier is at craft skill level and the indicative training will be in two stages approach, namely:

Stage 1 - Be able to demonstrate common knowledge and skills base for all crafts involved in the construction/renovation process, including the importance of team working and coordination on site.

Stage 2 - Be able to demonstrate the application of underpinning knowledge and skills gained from Stage 1 to specialist areas of each craft as may be necessary.

The change in approach to building for enhancement of energy performance (see section 4.4 Building Regulations) requires integrated effort and approach by all crafts involved in the construction/renovation process. Therefore, there are underpinning knowledge and skills needs for all crafts to facilitate a coordinated approach to the achievement of any active energy performance standards. It is envisaged that this will require a training programme of sufficient duration to allow for adequate assessment of learning outcomes and could be delivered as a daytime or part-time evening/weekend programme for those in employment (Stage 1 and 2 training combined to 5 ECTS credits in total) . There is an advantage to

delivering this training to groups from mixed trades in the possibilities for discussion and exchange of learning within the class. Such an approach also provides an opportunity to clarify the responsibilities of each craft and provide real examples of the consequences of a lack of coordination.

The indicative training will be developed at NFQ Level 6 Award, i.e., the same level as existing craft qualification in Ireland.

Stage 2 training will be craft specific for more comprehensive coverage of each craft. Delivery strategy will comprise of classroom theory lessons supported by workshop practical where the student will have an opportunity to apply their acquired knowledge to practice. Once again, these programmes could be delivered as a daytime or part-time evening/weekend programme for those in employment. The indicative training contents by craft will include:

- **Brick & Stone Laying:** Low energy building fabric construction technology relevant to masonry walling, building ventilation requirements
- **Carpentry & Joinery:** Low energy building fabric construction relevant to first fixing/roofing, timber frame construction and window/door installation. Building ventilation requirements.
- **Plastering:** Low energy building fabric construction technology including external and internal wall insulation systems, building ventilation requirements.
- **Electrical:** Energy efficient lighting, heating control technology.
- **Plumbing:** Increasing efficiency of space heating/cooling and hot water systems, integration of renewable energy systems, insulation of storage vessels and pipes, heating control technology, energy consumption of pumps/fans.

7.4.3 Supervisory level

This tier will be at a specialist, supervisory or project manager level where a craft worker will have progressed to roles such as system installation specialist, site supervisor, small/medium sized building contractor or equivalent. Due to the specialist nature of construction projects, the indicative training for this tier will be sub-divided into: System Installer/Specialist and Site Foreman/Supervisor or Building Contractor.

It may be possible to integrate some of the proposed training into existing higher education programmes such as Construction Site Management (See examples in: BSc of DIT, and BSc of IT Sligo and) and Building Services Technology/Engineering (See example in: Plumbing and Heating Technology of DIT) . It is envisaged that the proposed programmes will be offered at NFQ level 7 in most cases to reflect the significant progression of training from craft level.

1. **System Installer/Specialist**

The range of existing system installer/specialist training is considered (see section 6.5 VET Provision on Energy Efficiency and Renewable Energy in Buildings). The existing training programmes would be enhanced in the achievement of practical learning objectives when complimented by the completion of craft level occupational tier training for existing craft skills. Learners completing craft level tier 2 training (see

7.3.2 Craft Level) will have gained knowledge of the underpinning principles of energy efficient systems, thereby allowing a greater focus on the acquisition of specialist skills, e.g., product/system specific skills.

However, there is an inherent flaw in the system specific nature of this existing training provision. For insulation and air tightness technologies, the core skill set already exists with the construction crafts, therefore only a limited amount of 'topping-up' of knowledge and skill is required. If the craft worker has completed the proposed craft level occupational tier training, there may be no need for further 'specialist' programmes. This approach is favourable as a progression to near zero carbon building standards will result in air tightness and installation of insulation to high performance levels being standard practice rather than a specialist skill.

Similarly, the deployment of renewable energy systems for heating and electricity generation has been shown to require multi-disciplinary skills and knowledge. Emerging technologies are showing trends towards hybrid systems which combine more than one technology and there is a growing realisation of the need for correct integration of multiple systems to ensure proper function and optimum energy performance.

The following new programmes are proposed for System Installers/Specialists in areas where a specific skills deficit has been identified, the corresponding designated craft qualifications for up-skilling are indicated in brackets:

- **Domestic Heating Technician** (Plumbers):

  Firstly, it noted that the Higher Certificate in Advanced Heating and Plumbing has been available at DIT for the last 20-25 years. The programme places an emphasis on system design, plant selection, ICT and communication skills to support progression of plumbers into supervisory roles. However, it is designed with a

relatively broad scope with an emphasis on industrial/ commercial applications and duration of 3 years part-time (1 day and 2 evenings per week). This model may be more suitable for graduates who wish to progress to building services engineering rather than domestic heating installation.

In light of the fact that such a large proportion of energy reduction targets for buildings are to be achieved through the retrofitting of domestic dwellings, the need for heating system installers with competences to handle relatively sophisticated design and installation has arisen. The programme should address the skills identified in section

7.2.3 Space Heating/ Cooling, Water Heating and Controls as required for those working on domestic installations and section 7.2.5 Renewable Energy Systems for skills related to the implementation of renewable heat technologies.

Assuming completion of craft level occupational tier training for plumbers, this training can focus on the more specialist level required for the design and integration of domestic heating systems (including renewable energy options) and their efficient operation. It is envisaged that this training will be 20-25 ECTS credits at NFQ level 7.

- **Combined Heat & Power-CHP Utility Operation and Maintenance** (Plumbers and Electricians):

  Training will focus on the acquisition of skills and knowledge to enable technicians to operate and maintain CHP installations at optimal efficiency and will include content on heat distribution (district heating).

- **Ventilation Systems Installer** (Electricians, Plumbers, Refrigeration & Air-Conditioning):

  Relevant training will focus on the design and installation of ventilation systems for domestic and non-domestic projects, including: Passive Stack Ventilation, Mechanical Ventilation, Positive Input Ventilation and Mechanical Heat Recovery Ventilation-MVHR.

  The skills identified in section 7.2.2 will form the core of the training which will be delivered through a combination of classroom theory and practical workshop lessons for 5 ECTS credits at NFQ level 7.

2. Site Foreman/Supervisor or Building Contractor

Supervisory level roles will require a broader and higher level of knowledge on the integration of energy efficiency and renewable energy technologies, both for new build and renovation. It is envisaged that compatible training will be delivered as add-on programme for those already qualified or working as supervisors or contractors. It is envisaged that the programme would lead to 20 ECTS credits at NFQ Level 7.

Additional content (further 10 credits at level 7) will be necessary for a domestic retrofit project manager qualification. The qualification needs for building construction workers are summarised in Table 7.11.

Table 0.11: Qualification needs by occupational tier

Occupational Tier	Qualification Need	NFQ Level	Numbers
Operative Level	Foundation energy training (all construction operatives including concrete workers, steel workers, roofers and glaziers)	5	10,000
Craft Level	Stage 1: Foundation energy training (for all construction crafts)	6	49,000
	Stage 2: Craft specific energy training (for all)		
	• Carpentry & Joinery		16,000
	• Brick & Stone Laying		4,000
	• Plastering		4,000
	• Plumbing		9,000
	• Electrical		6,000
	Total		49,000
Supervisory Level	Domestic Heating Technician	7	1,350
	Ventilation Installation Technician	6	500
	Combined Heat & Power (CHP) Technician	7	180
	Site Supervisors/Foremen	7	3,000
	Domestic Energy Retrofit Project Management	7	2,200
	Total		7,230
	*Note: completion of craft level training assumed		

7.4 Infrastructural Capacity for Training

This section assumes the outline of staged apprentice training programmes has been covered in section 6.3.1 Overview of Apprenticeship Training Structures. At the peak intake in 2006, 6,373 apprentices were registered in Carpentry & Joinery, Brick & Stone-Laying, Plumbing, Plastering and Electrical training programmes (see Figure 0.1: Apprentice Intake for Construction Related Trades 2006 – 2011). Apprentice intake forecasted for 2011 was 580 for the same five trades, which amounts to just over 9% of 2006 figures. At peak levels of intake, it is estimated that there were over 220 instructors engaged in Phase 2 training for the five trades listed above. There are currently 116 still engaged as of 18/05/2012[25].At peak intake there were approximately 240 lecturers delivering training in Phase 4 and 6. This number is also estimated to have reduced significantly, with reduced numbers of temporary contract staff and the redeployment of a number of lecturers to programmes outside of trades.

For the purpose of assessing the potential for implementing the BUSI initiative for up-skilling, we assumed 100 trainers allocated to the delivery of an 8 day duration training (average for a 5 ECTS module at NFQ level 6), for 200 days (40 weeks) annually per trainer, and a class size of 20, then 50,000 participants could theoretically complete the training in a calendar

[25] Source: FÁS

year. This model could accommodate the completion of Operative and Craft Level short training programmes as proposed in section 7.3 Qualification Needs. It can be reasonably assumed that Supervisory level training programmes, which are of a significantly longer duration, could be incorporated into the part-time offerings of higher education institutions around the country, a number of which have already been active in the development of similar training (see: 6.5.3 Higher Education Provision).

Taking the outlined decline in apprentice intake into consideration, the availability of adequate facilities including classrooms and appropriate workshops may be questionable as in some cases these facilities may have been converted for other uses and therefore unavailable. While a number of training providers may have workshop facilities for the delivery of renewable energy system training, there is generally no widespread availability of purpose built rooms for practical demonstration of building fabric technologies, although the workshops traditionally used for construction craft delivery could be adapted for such purpose where they are still available.

7.5 Monitoring Needs

Skills monitoring in sector-specific workforces are necessary to check the potential negative impacts of skill gaps and shortage, by projecting appropriate training needs in order to maintain or boost labour productivity. Currently in Ireland, there is no formal continuous skills monitoring structure, but there are a number of bodies which report on such skill needs (on an ad hoc basis) to the Department of Jobs, Enterprise & Innovation (DEJI). This approach has led to a number of uncoordinated initiatives which do not seem to be addressing the skills and knowledge gaps in the construction sector and the potential for transferable, cross-sector skills.

In order to provide a sectoral context to the importance of skills needs monitoring, the following section provides an overview of the workings of the Sector Skills Councils (SSC) in the United Kingdom (UK). The performance of SSC in Northern Ireland, as our closest neighbour, provides a number of similarities and valid expectation specific to construction.

The SSCs are independent, employer-led, organisations operating across the UK. There are currently 22 SSCs covering over 90% of the economy. The network of licensed SSCs strives to address skills needs within and across sectors in the UK. For example, in 2009/2010 eight SSCs, including ConstructionSkills, as the licenced SSC for the construction industry, worked as a consortium to develop the Renewable Energy Skills Strategy for the UK. In April 2010, a new skills funding agency took responsibility for adult learning and skills policy. The agency is tasked with ensuring the availability of training provision to meet the skills needs priorities based on regional skills strategies.

ConstructionSkills is a partnership between the Construction Industry Council (CIC), Construction Industry Training Board (CITB)-ConstructionSkills Northern Ireland and CITB-ConstructionSkills, which represent England, Scotland and Wales.

CITB-ConstructionSkills Northern Ireland represents the combined operations of the CITB and the SSC for construction in Northern Ireland. They are governed by a board comprising

of employer, employee and education representatives which is appointed by the Department of Employment and Learning. The main role of the organisation is to ensure:

- That existing employees and new entrants to the industry have the right skills
- That employers provide access to training for staff
- The identification of current and future industry skills needs
- That the appropriate qualifications are available to support these needs

The funding mechanism is from a levy scheme at a rate of 0.65% on earnings paid by employers to direct labour and labour only subcontractors. This amounted totalled to just over £3 million (approximately €3.7 million) in 2010/2011. The largest proportion of expenditure is on grants to employers with the majority of the balance allocated to training services and direct training provision. No grant aid is received from government or public authority sources.

In the UK, the Energy Act 2011 allows for a new 'Green Deal' which aims to increase the energy efficiency of British buildings and reduce CO_2 emissions. The initiative is adopting the approach of taking away the upfront cost of energy efficiency measures by including them on the energy utility bill of the building owner/occupier, similar to the proposed Pay as You Save (PAYS) scheme which is planned for Ireland (see: 4.3.3 National Energy Efficiency Action Plan CITB Construction Skills has allocated £500,000 from its growth fund, which is being supplemented by £2 million from the UK Department of Energy and Climate Change (DECC), to train workers to install solid wall insulation under the Green Deal.

As part of its responsibilities of its Sector Skills Council role, Construction Skills has also developed a number of qualifications and standards to enable the skills for delivering the Green Deal while acknowledging that *"Many of these skills are already in everyday use in the workplace and can be adapted to deliver Green Deal requirements"*[26]. This level of response to skills needs has not been matched in Ireland under the current monitoring structure. The example of the UK system, where policy makers, industry representatives, employee representatives and training developers/providers combine within a formal entity with responsibility for ensuring skills availability, is one model that we could potentially employ in Ireland to improve our response to future skills needs.

[26] http://cutcarbon.info/training/green-deal-qualifications

8. Barriers

There are a number of potential impediments to the implementation of a new up-skilling initiative for the construction workforce in Ireland at such a scale as is proposed. Significant coordination, investment of finance and resources will be required to ensure the success of such a far reaching programme of training. The following section identifies a number of potential barriers under four classifications; Institutional, Structural, Financial and Participation.

Institutional Barriers

- **Multi-Stakeholder Coordination:** This report on the national status quo highlights the sheer number of government departments and agencies, accreditation bodies, training authorities, training providers and industry group representatives that are directly or indirectly involved in the implementation of energy policy for the built environment. For any national initiative for up-skilling in this sector to be successful, there must be a broad agreement and endorsement across this stakeholder group.

  The timing of the Build Up Skills project also coincides with a period of significant change of structures within a number of key national actors in VET provision. FÁS, the national training authority of Ireland, are currently in a process of restructuring which will result in the formation of a new body with overall responsibility for vocational education and training in Ireland. The two most relevant accreditation bodies, FETAC and HETAC, are also in the process of amalgamating to form a new body, the Qualifications and Quality Assurance Agency (QQAI).

- **Establishment and maintenance of standards for professional practice:** Lack of requirement on those operating in the construction industry to provide proof of competence has been the subject of much discussion in recent years. While a standards based apprenticeship system is in place for craft workers, the reality is that workers are rarely required to produce evidence of certification, particularly at SME level. Perhaps even more significant is the fact that no licensing system exists for those operating as building contractors. Contractors and subcontractors may set up as sole traders or register as companies without any vetting of competence or qualification.

  Regulation has been introduced in recent years for domestic gas installation and electrical installation. This was motivated primarily from safety concerns rather than work quality assurance. However, related training programmes have since experienced strong participation. This is a major motivational factor for participation on training schemes. The affect has been twofold in that; legal requirements for qualification are related to access to employment opportunities, and secondly, there exists a greater awareness of the relevance of the training.

  The SEAI grant supported schemes for renewable energy technologies require approved qualifications for enrolment to the register of approved installers. Similarly, SEAI only support installation of external wall insulation, pumped cavity fill and blown loft insulation by NSAI certified installers. These qualifications are therefore associated with access to

job opportunities; hence, participation on the training programmes has been generally strong. The introduction of a minimum share of renewable energy for space heating/hot water or electricity generation in dwellings in the 2008 Building Regulations has also had an impact on training demand. In this regard, solar thermal technology for the provision of domestic hot water has been the primary choice in the majority of cases.

Structural Barriers

- **Structure of the Building Sector:** In recent years, medium to large sized construction companies have reduced the number of directly employed skilled workers in favour of subcontracting for specialist skills. While the scope of craft apprenticeship training has remained broad, the consequence is that the work carried out on site has become much more task/function specific, e.g. carpenters can be deployed exclusively to formwork, roofing, first fix or second fix (finishing) and Plumbers/Electricians to either domestic, maintenance or industrial applications.

  Smaller companies operating in construction/renovation have continued to employ a core staff with a broad range of skills on groundwork and fabric construction, only engaging subcontractors for mechanical/electrical installations etc. In many cases, the same subcontractors are employed repeatedly in different projects as a team.

  These differences in approach raise a number of questions in relation to up-skilling requirements, e.g. does a finishing carpenter require the same training as a timber frame specialist. As a result, contractors and subcontractors may not always see the relevance of energy related training for their employees.

- **Language Barriers:** During the building boom from the mid 1990's to 2007, the construction workforce in Ireland had been significantly supplemented by intake of immigrant workers. At peak construction levels in 2007, it was estimated that non-nationals accounted for 18.3% (48,000) of all workers employed in the sector. By 2010, only 12,200 remained, the equivalent of 9.7% of all those employed in construction. This still accounts for a significant proportion of the construction workforce and would require consideration

- **Capacity of Training Providers:** as a result of the recent downturn in construction, the demands on the traditional providers of craft apprenticeship training have been greatly reduced. In many cases, facilities may be available in FÁS training centres and Institutes of Technology around the country that previously supported apprentice training. Experienced teaching staffs are also less engaged with craft training and therefore could potentially be re-deployed to deliver new programmes. However, availability of capital investment to fit out laboratories and workshops is severely hampered by the prevailing budgetary restrictions in the public sector. Teaching staff may also require up-skilling in the majority of cases.

  A number of private training providers have invested heavily on facilities for the delivery of energy related training, particularly in the areas of gas installation and renewable

heating technologies. Some equipment manufacturers/suppliers have also developed training capacity on a smaller scale.

Financial Barriers

- **Financial support for energy policy implementation:** The current economic situation in Ireland has led to a significant reduction in government expenditure across all sectors. The withdrawal of financial supports for existing energy policy actions (ReHeat, CHP Deployment, GHS, see: Table 4.2: Overview of policies and measures in NREAP relevant to the built environment) and the plans to discontinue exchequer grant supports through the Better Energy Homes scheme have the potential to impact the level of implementation of energy efficient and renewable energy technologies. This situation is creating an uncertainty, particularly with regard to the potential deployment of renewable technologies in buildings.

- **Funding of Training:** there are number of government initiatives in place to support up-skilling of the unemployed, such as Springboard, FÁS training for jobseekers and social welfare funding. Although there is currently no financial support provided to those in employment for up-skilling, in recent years, there have been a number of training funds administered through the trade unions and Skillnets that have subsidised employee participation. However, this funding is no longer available as a result of the economic downturn.

  This lack of exchequer funding is in spite of strategic energy policy and legislative priorities for the reduction of energy use. This has been exacerbated by a lack of perception on the employer's part of a real demand for energy skills and is likely to affect investment in training.

- **Access to training:** SMEs may find it particularly restrictive to allow employees to attend training during working hours. One of the possible impacts of the current economic crisis on construction companies has been a reduction in profit margins as cost-competiveness becomes a vital criterion to securing business. Any reduction in productivity as a result of employee absence from work (including attending training) is likely to be a major barrier to participation. Training providers may therefore need to tailor courses for part-time or quasi part-time delivery to facilitate those currently in employment.

Barriers to Participation

- **Employment Opportunities:** the main motivation for a construction worker to engage with an up-skilling programme is to improve their prospects for gaining or sustaining employment. Any national programme of training will have to clearly identify a relationship with existing job opportunities. For example, initial engagement with training for solar thermal installation was very strong as the perception was that significant business opportunities existed in this area. As the scale of demand became clear, the participation on solar training programmes dropped significantly.

There was also a significant focus on the introduction of the National Retrofit Programme in 2011. As figures of 100,000 Irish homes per year to 2020 were suggested, estimates of 20,000jobs to support the implementation were believed to be realistic by DCENR. However, the rate of retrofit activity since suggests that only approximately 4,500 jobs could be sustained. Unless there is a focused promotion of this sector as an important area of employment, the demand for training is likely to remain low.

- **Awareness:** experience from the recruitment of building workers for energy related training programmes suggests that there is a significant lack of awareness of the relevance to construction, with the exception of mandatory training for those wishing to install gas, oil or renewable technologies. The impact of recent amendments to Building Regulations for conservation of energy (Part L) has not fully filtered down to the onsite worker in many cases. This is an important development for the significant numbers that have become unemployed in the last two to three years. The 2008 amendments to Part L only became active in 2009 and construction activity has been very modest in the years since. However, feedback from participants on programmes such as Trainenergy (www.trainenergy-iee.eu) indicates that once the relevance has been explained through training, there is an overwhelming opinion that up-skilling in some form on energy related competences should be provided for all construction workers.

9. Conclusions

1. The Irish government has responded to EU directives with policies that set out current and future actions that they believe will achieve 2020 energy targets. However, the current economic crisis has significantly curtailed exchequer financial support for these actions.
2. Building Regulations have been amended significantly since 2002 with further revisions imminent towards the establishment of a carbon neutral framework for buildings. However, new building standards will need to be implemented if they are going to have a significant impact on energy performance.
3. The current recession has had a particularly severe effect on the rate of new building construction. With a relatively modest level of new construction forecast to 2020, achievement of energy reduction targets for buildings will require a large scale programme of retrofitting of existing dwellings to significantly improved performance levels. The figure of 1 million buildings by 2020, proposed by DCENR, will require a significant up-scaling of current works to be achievable, both in terms of numbers of buildings and the level of measures applied.
4. In terms of future skills needs, a number of national reports have identified areas within the “Green Economy” relating to building energy which will require competent technicians/installers.
5. The existing training provision for the construction workforce is comprised of skills gained through experiential learning on site, formal apprenticeship for the main construction trades and add-on or supplemental training programmes for system specialists/installers. Neither the informal skills learning nor the apprenticeship system have evolved sufficiently with the movement toward low energy building construction in recent years. No concerted effort has been made to up-skill the trainers in this sector to emphasise the change in emphasis to building energy.
6. While a number of nationally recognised qualifications have been developed for renewable heating and micro-generation, the training programmes are of relatively short duration and competence levels achieved may be affected by the prior experience and learning of participants. This is also the case with training on building fabric technology, e.g. thermal insulation installation, air tightness. Learners lack fundamental knowledge of how and where heat is lost or gained and energy is used in buildings. It should be acknowledged that the core skills for implementing low energy building technology already exist, requiring only modest levels of add-on or supplemental training.
7. Combined Heat and Power (CHP) and district heating training programmes should be developed to up-skill plumbers and electricians in support of current and future implementation of these technologies. These technologies provide significant potential to reduce building energy consumption and, while not achieving a widespread penetration currently, demonstration programmes at local authority level around the country have proven the energy saving possibilities.
8. With the retrofitting of existing buildings expected to make such a significant contribution to the reduction in building energy use, competent practitioners in this field will be essential to support successful implementation. The largest proportion of this retrofit work will be carried out in domestic dwellings. The average budget for such projects is unlikely to sustain the engagement of building professionals, such as

architects and engineers, in project management roles. Retrofit is complex in that it requires the application of energy efficient technologies to a multitude of different building types and requires attention to overall building function and compliance with all relevant building regulations. Without licensed and recognisable qualifications as proof of competence to advise on and carry out such works, successful implementation and increased consumer confidence in the 'product' will be extremely difficult to achieve.

9. A move to a building standard of near zero carbon is as fundamental a change in approach as the construction industry has experienced in many years. What has been perceived up to now as a niche market for "green buildings" or "eco-construction" will not remain a reality. Building regulations apply to all buildings and, therefore, all workers involved in the construction process will need to be equipped with the skills and knowledge to enable their implementation.
10. While an intensification of energy saving measures over the coming years to 2020 is likely to provide job opportunities for the unemployed, sustainability of employment in the construction industry is an important socio-economic issue. Recent government jobs initiatives have focussed on funding the up-skilling of the unemployed to re-enter the workforce. Consideration to the skills needs of the existing workforce has been lacking, even though this would directly support the implementation of national energy policy.

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12. Glossary[27]

Air-conditioning system: a combination of all components required to provide a form of air treatment in which temperature is controlled or can be lowered, possibly in combination with the control of ventilation, humidity and air cleanliness [EPBD, 2002/91/EC]

Boiler: the combined boiler body and burner-unit designed to transmit to water the heat released from combustion [EPBD, 2002/91/EC]

Building envelope: A building envelope is the separation between the interior and the exterior environments of a building. It serves as the outer shell to protect the indoor environment as well as to facilitate its climate control [http://en.wikipedia.org/wiki/Building_envelope]

Building Physics: Building Physics refers to Applied Science dealing with the hygrothermal, acoustical and light related properties of building components (roofs, facades, windows, partition walls etc.), rooms, buildings and building assemblies. Basic considerations include requirements for thermal, acoustic and visual comfort, healthy environment within limitations imposed by architectural, material-related, economic and ecological considerations [Building Physics – Heat, Air and Moisture, Hugo Hens, 2007, Ernst and Sohn]

Combined heat and power (CHP): the simultaneous conversion of primary fuels into mechanical or electrical and thermal energy, meeting certain quality criteria of energy efficiency [EPBD, 2002/91/EC]

Commercial building: A commercial building is a building that is used for commercial use. Types can include office buildings, warehouses, or retail 9i.e. convenience stores, ‘big box ’ stores, shopping malls, etc.0

Cost-optimal level: Cost-optimal level means the energy performance level which leads to the lowest cost during the estimated economic lifecycle [EPBD, recast, 2010/31/EC]

Deep Retrofit: We define deep retrofit as an investment in energy efficiency which saves the homeowner 40% or more on energy bills. A deep retrofit investment will generally involve a combination of roof and wall insulation, a new renewable or highly efficient heating system, and heating controls. [Thinking Deeper – Financing Options for Home Retrofit, Joseph Curtin & Josephine McGuire, 2011]

District heating/cooling: means the distribution of thermal energy in the form of steam, hot water or chilled liquids, from a central source of production through a network to multiple buildings or sites, for the use of space or process heating or cooling [EPBD, 2010/31/EC]

Energy audit: a systematic procedure to obtain adequate knowledge of the existing energy consumption profile of a building or group of buildings, of an industrial operation and/or

[27] A number of the definitions in this Glossary are extracted from the BPIE 2011 report “Europe’s Buildings under the Microscope”

installation or of a private or public service, identify and quantify cost-effective energy savings opportunities, and report the findings [ESD, 2006/32/EC]

Energy consumption: The amount of energy consumed in the form in which it is acquired by the user. The term excludes electrical generation and distribution losses.

Energy performance certificate: a certificate recognised by the Member State or a legal person designated by it, which includes the energy performance of a building calculated according to a methodology based on the general framework set out in the Annex of Directive 2002/91/EC [EPBD, 2002/91/EC]

Energy performance of a building: the amount of energy actually consumed or estimated to meet the different needs associated with a standardised use of the building, which may include, inter alia, heating, hot water heating, cooling, ventilation and lighting. This amount shall be reflected in one or more numeric indicators which have been calculated, taking into account insulation, technical and installation characteristics, design and positioning in relation to climatic aspects, solar exposure and influence of neighbouring structures, own-energy generation and other factors, including indoor climate, that influence the energy demand [EPBD, 2002/91/EC]

Energy service company (ESCO): a natural or legal person that delivers energy services and/or other energy efficiency improvement measures in a user' s facility or premises, and accepts some degree of financial risk in so doing. The payment for the services delivered is based (either wholly or in part) on the achievement of energy efficiency improvements and on the meeting of the other agreed performance criteria [ESD, 2006/32/EC]

Final energy: Energy supplied that is available to the consumer to be converted into useful energy (e.g. electricity at the wall outlet). (Intergovernmental Panel on Climate Change, IPCC)

Green Economy: The 'green economy' has been identified as an area of potential business and employment growth across many countries. However, it is recognised that there is no exact boundary around the sector and that it is not well defined within existing classification systems. The six subsectors identified as having significant business and employment growth potential are:

- Renewable Energies
- Efficient Energy Use and Management
- Water and Waste Water Treatment
- Waste Management, Recovery and Recycling
- Environmental Consultancy Services
- 'Green' ICT Applications/Software

Heat pump: a device or installation that extracts heat at low temperature from air, water or earth and supplies the heat to the building [EPBD, 2002/91/EC]

Nearly zero energy building: a building that has very high energy performance, as determined in accordance with Annex I of the EPBD recast. 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 [EPBD recast, 2010/31/EC]

Pay as You Save Scheme (PAYS): A method of financing dwelling energy retrofit improvements. The debt on capital cost for energy retrofit improvements is charged on the property or directly to the energy utility supplier meter in a dwelling by way of a legal charge on the energy bill (PAYS tariff) or property tax. The capital cost is then offset by the accrued energy savings, either on the energy bill or in the form of a carbon credit reduction to the rate of property tax.

Payback time/period: the length of time required to recover the cost of an investment

Primary energy: Energy from renewable and non-renewable sources which has not undergone any conversion or transformation process

Public building: building owned or occupied by any public body

Residential building: A structure used primarily as a dwelling for one or more households. Residential buildings include single-family houses (detached houses, semi-detached houses, terraced houses (or alternatively row houses) and multi-family houses (or apartment blocks) which includes apartments/flats

U-Value: is the measure of the rate of heat loss through a material. Thus in all aspects of home design one should strive for the lowest U-Values possible because the lower the U-value ‐ the less heat that is needlessly escaping. The calculation of U-values can be rather complex - it is measured as the amount of heat lost through a one square meter of the material for every degree difference in temperature either side of the material. It is indicated in units of Watts per meter Squared per Degree Kelvin or W/m2 [Irish Energy Centre - Funded by the Government under the national Development Plan with programmes partly financed by the European Union.]

BUILD UP Skills

The EU Sustainable Building Workforce Initiative in the field of energy efficiency and renewable energy

BUILD UP Skills is a strategic initiative under the Intelligent Energy Europe (IEE) programme to boost continuing or further education and training of craftsmen and other on-site construction workers and systems installers in the building sector. The final aim is to increase the number of qualified workers across Europe to deliver renovations offering a high energy performance as well as new, nearly zero-energy buildings. The initiative addresses skills in relation to energy efficiency and renewable energy in all types of buildings.

BUILD UP Skills has two phases:

I. First, the objective is to set up national qualification platforms and roadmaps to successfully train the building workforce in order to meet the targets for 2020 and beyond.

II. Based on these roadmaps, the second step is to facilitate the introduction of new and/or the upgrading of existing qualification and training schemes.

Throughout the whole duration of the initiative, regular exchange activities are organised at EU level to underline the European dimension of this important initiative and to foster the learning among countries.

The BUILD UP Skills Initiative contributes to the objectives of two flagship initiatives of the Commission's 'Europe 2020' strategy — 'Resource-efficient Europe' and 'An Agenda for new skills and jobs'. It is part of the Commission's Energy Efficiency Action Plan 2011. It will also enhance interactions with the existing structures and funding instruments like the European Social Fund (ESF) and the Lifelong Learning Programme and will be based on the European Qualification Framework (EQF) and its learning outcome approach.

BUILD UP Skills –IRELAND

Analysis of the national status quo

August 2012

IEE/11/BWI/460/S12-604350

Appendices

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Further information

More details on BUILD UP Skills can be found at www.buildupskills.eu

More details on the IEE programme can be found at http://ec.europa.eu/intelligentenergy

Appendices

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A1 Evolution of Building Regulations Part L – Conservation of Fuel and Energy

A number of amendments to the Building Regulations Part L – Conservation of Fuel and Energy have been made since 2002 in response to the EPBD and its recast in 2010. In relation to dwellings, revisions were made in 2002, 2005, 2008 and 2011. Regulations for Buildings other than Dwellings were amended in 2005 and 2008 with a further revision expected imminently. The new regulations amount to a 60% aggregate improvement on 2005 levels of energy performance. Technical Guidance Documents (TGDs) are provided in support of the Building Regulations as guidance towards the achievement of revised standards. In general, the regulations provide information on maximum elemental u-values for building fabric, limiting heat loss through thermal bridging and air infiltration and the efficiency of space heating/hot water systems and their controls. An outline is provided below of the TGD L revisions over this period.

TGD L 2002 - Dwellings

- Heat Loss Calculation: the document indicates that any of the three following methods to demonstrate acceptable levels of heat transmission through building fabric elements may be used, the Elemental Heat Loss method, the Overall Heat Loss method or the Heat Energy Rating.
- Building Fabric: Maximum elemental u-values are provided for new dwellings, extensions to new dwellings and material alterations/changes of use. Window, door and rooflight values are indicated by a ratio between the average elemental u-value and the maximum combined area of the elements as a percentage of floor area. TGD L 2002 was the first to provide guidance for the limitation of heat loss through thermal bridging and air infiltration. This consisted of reference to included and available published construction details for thermal bridging and air tightness. Methods of calculation of heat loss taking into account thermal bridging and permitted levels for different junctions were also provided.
- Space Heating/Hot Water Systems and Controls: The document set out minimum criteria for the provision of controls of space and water heating systems. This was provided as:
    - *Automatic control of space heating on the basis of room temperature;*
    - *Automatic control of heat input to stored hot water on the basis of room temperature;*
    - *Separate and independent time control for space heating and for heating of stored water should be provided;*

- *Shut down of boiler or heat source when there is no demand for space or water heating from that source;*

- Insulation of Hot Water Storage Vessels, Pipes and Ducts: the minimum standard specification for the insulation of storage vessels and pipe work associated with space and water systems is provided.

TGD L 2005 - Dwellings

- Heat Loss Calculation & Limitation of CO_2 emissions: guidance is provided on the methodology for calculation of the Maximum Permitted CO_2 Emission Rate (MPCDER) for new dwellings (the Heat Energy Rating method was excluded because of its similarity). The use of renewable/ low carbon technologies and high efficiency boilers are indicated as a means of facilitating compliance with MPCDER.

- Building Fabric: maximum elemental u-values remained unchanged from 2002. Guidance on reducing heat loss through thermal bridging and air infiltration are also not revised.

- Space Heating/Hot Water and Controls: Previous reference to British Standards (BS) as an alternative method of achieving compliance on space and water heating controls were amended to include the 2003 I.S. EN 12828 Heating Systems in Buildings.

- Insulation of Hot Water Storage Vessels, Pipes and Ducts: A note was added in relation to the need to insulate storage vessels and water pipes in unheated spaces to avoid freezing.

TGD L 2005 – Buildings other than Dwellings

- Heat Loss Calculation & Limitation of CO2 emissions: guidelines for the use of the Overall Heat Loss and Elemental Heat Loss methods are provided.

- Building Fabric: The same maximum elemental u-values as for dwellings are indicated. Similar guidance for thermal bridging and air infiltration as for dwellings is provided with an additional reference to BRE (British Research Establishment) BR 448 *Air Tightness in Commercial and Public Buildings* included. A section on avoiding solar overheating is also added with a reference to the importance of maintaining thermal comfort for the occupants of buildings with extensive areas of glazing.

- Building Services: Guidance for building services is provided under the following headings:

- Heating Plant Efficiency: It is indicated that oil and gas fired boilers should comply with S.I. No. 260 of 1994 European Communities Regulations;
- Space and Water Heating System Controls: The document outlines the requirement for controls to maximise the efficiency of space and water heating systems including the zoning of buildings with timed temperature levels based on occupancy (also allowing for the protection of the building from low temperatures during periods of non-occupancy where applicable), efficient operation and design of hot water systems while limiting the risk of legionella bacteria growth and consideration of the use of renewable energy technologies for the provision of hot water;
- Air Conditioning and Mechanical Ventilation (ACMV): for buildings in excess of 200m² floor areas, design should be such that the requirement for ACMV is not excessive as a result of glazing ratios and potential solar overheating. Efficiency of system components such as fans, pumps and refrigeration equipment and the operational efficiency of the system should be duly considered. Specific fan Power (SFP) levels should be appropriate to building usage. Variable flow control systems should be incorporated in mechanical ventilation systems to maximise efficiency;
- Insulation of Hot Water Storage Vessels, Pipes and Ducts: The specification for insulation of pipes, ducts and vessels for space heating, cooling and hot water systems is provided.;
- Artificial Lighting: guidelines for lighting systems where the total installed lighting capacity is greater than 1,000 W is provided. Maximising the use of available daylight to reduce the requirement of artificial lighting is recommended through the use of dimming switches and room daylight/occupancy sensors;

TGD L 2008 – Dwellings

Specific guidance for existing dwellings was included in Part L for the first time and the TGD was divided into two sections under the headings New Dwellings and Existing Dwellings.

Section 1 - New Dwellings:

- Calculation of energy consumption and CO_2 emissions: the document indicates the introduction of the Dwelling Energy Assessment Procedure (**DEAP**) as the methodology for calculating primary energy consumption and CO_2 emissions. Dwellings are now to be assessed for compliance with regulations based on meeting a Maximum Permitted Energy Performance Coefficient (**MPEPC**) of 0.6 and a

Maximum Permitted Carbon Performance Coefficient (**MPCPC**) of 0.69 which can be derived using DEAP.

- Renewable Energy Technologies: for the first time a requirement for a contribution renewable energy is stated in relation to dwellings, "a reasonable proportion of the energy consumption to meet the energy performance of the dwellings is provided by renewable energy sources". TGD L outlines the specifics of how this may be achieved as:

  - 10 kWh/m²/annum contributing to energy use for domestic hot water heating, space;
  - heating or cooling; or
  - 4kWh/m²/annum of electrical energy; or
  - A combination of these which would have equivalent effect;

  It is indicated that the use of small scale CHP (Combined Heat and Power) which contributes to space and water heating will be acceptable as an alternative to the above.

  Restrictions on the use of Heat Pump systems is also outlined as "*only energy in excess of 2.5 times the electrical energy directly consumed by the heat pump can be counted towards meeting the minimum level of energy provision from renewable technology".* Biomass systems are to be designed to run on biomass fuels only.

- Building Fabric: maximum elemental u-values for fabric elements remain largely unchanged from 2002, although an allowance is accommodated for higher values of individual elements (or parts of elements) once average area-weighted values are maintained overall. Maximum values for windows, doors and rooflights are lowered. Detailing for thermal bridging is now indicated as being at a higher specification as indicated in an accompanying document entitled *"Limiting Thermal Bridging & Air Infiltration - Acceptable Construction Details*". Calculation methodology is provided for the calculation of linear thermal transmittance and permitted levels for different types of junctions are extended to include intermediate floors, balconies, eaves, gables and corners. Most significantly, air infiltration is dealt with under a new heading of *Building Envelope Air Permeability*. The need for consideration at design stage to the continuity of the air tight envelope is outlined and reference to the aforementioned Acceptable Construction Details is recommended. The document also introduces mandatory air pressure testing of dwellings to demonstrate a compliance level of 10m³/(h.m²) which *"represents a reasonable upper limit for air permeability"*.

- Building Services: this new section incorporates previously published guidance on space heating and hot water system supply controls, insulation of hot water storage vessels, pipes and ducts with new guidelines provided under the headings for Heating Appliance Efficiency and Mechanical Ventilations Systems. Oil and gas boiler efficiency for fully pumped hot water based central heating systems of a minimum of 86% is specified (as per the Home-heating Appliance Register of

Performance HARP database maintained by the SEAI). Guidance on good practice with regard to energy efficiency of dwelling ventilation systems is indicated as being contained in GPG 268 *Energy efficient ventilation in dwellings – a guide for specifiers*.

- Construction Quality and Commissioning of Services: Significantly, this new heading has been included to reinforce the importance of onsite quality control to ensure insulation continuity, air tightness, avoidance of thermal bridging and an emphasis on commissioning of space and water heating systems for efficient operation. Prior to 2008, reference to workmanship and quality was more generally given with regard to the 2000 TGD D – Materials and Workmanship. This indicates a growing realisation of the importance of attention to details and specifications onsite in the achievement of more ambitious performance targets. The appropriate procedure for the commissioning of space and hot water systems is to be outlined in "Heating and Domestic Hot Water Systems for Dwellings – Achieving Compliance with Part L".

- User Information: another new heading which addresses the need for correct handover of a building by providing owners with sufficient information for them to be able to operate and maintain building systems to optimise energy performance. With the increasing sophistication of modern building energy technologies and systems, the need to educate owners/occupiers in their operation has become more fundamental to ensure projected performance levels. The role of the installer/contractor in effectively communicating this information is significant.

Section 2 – Existing Dwellings:

This section provides guidance on insulation, thermal bridging and air infiltration for material alterations or extensions. The performance levels should also be taken as a **requirement** in the case of a material change of use of a building to a dwelling.

- Building Fabric: Guidance in this section is largely similar to new dwellings with the same maximum elemental u-values for plane elements given. Replacement of existing external doors and windows is also required to meet the performance levels as set out for new dwellings.

- Building Services: Guidance, similar to that for new dwellings, is provided for the efficiency of replacement heating appliances, the provision of space and hot water system controls, and the insulation of hot water storage vessels, pipes and ducts.

TGD L 2008 – Buildings other than Dwellings

- Calculation of energy consumption and CO_2 emissions: the document indicates the introduction of the Non-domestic Energy Assessment Procedure (**NEAP**) as the methodology for calculating primary energy consumption and CO_2 emissions for

buildings other than dwellings. Building energy consumption is measured in kWh/m²/yr while CO_2 emissions are calculated as kg CO_2/m²/yr. The assessment for compliance with regulations is based on meeting a Maximum Permitted Energy Performance Coefficient (**MPEPC**) of 1.0 and a Maximum Permitted Carbon Performance Coefficient (**MPCPC**) of 1.0 which can be derived using NEAP.

- Renewable Energy Technologies: no specific measurable requirement is stated for buildings other than dwellings but it is indicated that primary energy *"does not include energy derived from on-site renewable energy technologies. In addition, as renewable energy technologies generally are characterised by zero, or greatly reduced, CO_2 emissions, the calculated EPC and CPC are reduced by the extent that they replace traditional fossil fuels".* Therefore, building designers are indirectly encouraged to utilise renewable technologies to meet energy and carbon coefficients.

- Building Fabric: The same maximum elemental u-values as for dwellings are indicated. Similar guidance for thermal bridging as for dwellings is provided. Air Infiltration is also given a separate heading for the first time with guidance on measures to reduce its impact and reference to BRE (British Research Establishment) BR 448 *Air Tightness in Commercial and Public Buildings* included. The measurement of air permeability utilising air pressure testing is explained but no minimum level is set for compliance. A section on avoiding solar overheating is also included with a reference to the importance of maintaining thermal comfort for the occupants of buildings with extensive areas of glazing.

- Building Services: Guidance for building services is provided under the headings Heating Plant Efficiency, Space and Water Heating System Controls, Air Conditioning and Mechanical Ventilation (ACMV), Insulation of Hot Water Storage Vessels, Pipes and Ducts, Artificial Lighting remain unchanged from 2005.

TGD L 2011 – Dwellings

Section 1 – New Dwellings

- Calculation of energy consumption and CO_2 emissions: DEAP is maintained as the methodology for calculating energy consumption and CO_2 emissions. Dwellings are now to be assessed for compliance with regulations based on meeting a Maximum Permitted Energy Performance Coefficient (**MPEPC**) of 0.4 and a Maximum Permitted Carbon Performance Coefficient (**MPCPC**) of 0.46 which can be derived using DEAP which is approximately a **33%** reduction on 2008.

- Renewable Energy Technologies: remains unchanged from 2008 aside from the provision of a formula to calculate the energy saving contribution from CHP as an alternative to the use of renewable technologies.

- Building Fabric: elemental u-values have been reduced for the majority of building elements, in most cases by approximately 15% and for windows/external doors by 20%.

  A greater emphasis is placed on the use of certified details to avoid thermal bridging.

  The air permeability level has been lowered to 7 $m^3/(h.m^2)$ and, once again, this performance must be corroborated by air pressure testing onsite.

- Building Services: the required efficiency of oil or gas fired boilers has been increased to 90% minimum. The guidance in relation to controls, insulation of vessels and pipes, and mechanical ventilation remains unchanged with the exception of SFP being reduced from 2 to 1.5 W/litre/second.

- Construction Quality and Commissioning of Services: largely unchanged with the exception of a reference to a revised “Heating and Domestic Hot Water Systems for Dwellings – Achieving Compliance with Part L 2011” (to be published).

- User Information: unchanged from 2008.

Section 2 – Existing Dwellings

- Building Fabric: Unchanged with the exception of the reference to the new lower elemental u-values as per new dwellings.

- Building Services: unchanged with the exception of the requirement for 90% efficient oil and gas boilers for replacement (as per new dwellings).

A2 Review of apprenticeship curricula for the main construction related trades

A2.1 Carpentry & Joinery

The design and development of the Carpentry and Joinery Curriculum has been co-ordinated by FÁS Curriculum and Quality Assurance Department in conjunction with subject matter experts, employer trade unions, educational and training interests, and reflects NFQ requirements for awards at Level 6.

The Apprenticeship Programme for Carpentry and Joinery was founded on the results of industry based surveys and research into the skills, knowledge and competence required by craftspeople prior to 1993. The curriculum is standards-based, written as learning outcomes and structured in a modular format. All modular learning objectives, unit activity statements and key learning points are based on the National Outcome Standards for the craft. This modular standards based structure comprises of 7 alternating phases of on-the-job and off-the-job training and development over a four year period culminating in a Level 6 FETAC Advanced Certificate in Carpentry & Joinery. The standards based system was first introduced to the carpentry & Joinery apprenticeship in 1993 and has been reviewed once in its 19-year history. This review, which began in 2002, resulted in very few change to the original programme.

Carpentry & Joinery is a very wide and varied trade and, as such, requires the apprentice to work in a number of domains within the overall trade. This requires the acquisition of competence in a number of common skills, core skills, specialist skills and personal skills for use but not limited to the areas outlined below.

1. Joinery Shop:

This section of the occupation requires the Carpenter & Joiner to engage in setting out, production and assembling items of joinery which include stairs, doors, windows and built-in furniture.

2. Site Work:

Site work is the construction of buildings or houses which require 1st fixing, formwork roofs and 2nd fixing. This section is split into two categories, constructing/civil engineering contracts.

3. Maintenance:

Maintenance work requires the Carpenter & Joiner to carry out a variety of tasks in general maintenance and upkeep of public and private buildings, e.g. shops and factories. There are

other areas associated with the trade which include: renovating buildings, shopfitting, and exhibition/display work.

On-the-job Phases

In Phase 1, the apprentice is introduced to basic skills in the workplace environment. The apprentice works with experienced craftspeople on on-the-job phases and is supervised in the acquisition and practice of these skills.

All apprentices (for all trades working on building sites) are required to undergo a Safe-Pass training programme. Phase 1 basically consists of an induction and an introduction to Health and Safety, tools, equipment and basic skills.

The On-the-Job training and development Phases 3, 5 & 7 provide apprentices with the opportunity to practise and hone the skills acquired in the Off-the-Job Phases 2, 4 and 6. The assessment during these phases requires the employer to assess the apprentice on a number of specific tasks from a pre-determined list. As each employer will differ in relation to the scale and scope of their specific field of work, the apprentice experience between employers can be quite varied. Each of the on–the-job phases require that 5/10 pre-determined assessments to be passed correctly. There are a limited number of tasks that are potentially relevant to the energy efficiency of building fabric as follows; Phase 3: Hanging Door: Fit and hang a standard door; Phase 5: Trap-Door Construction: Cut out and construct a trap-door in ceiling joists including framing, slips and architrave to opening; Construction and Fitting of an External Door Frame: Set out, construct and fix a solid external door frame; Phase 7: Window Construction: Mark out and construct one of the following windows: casement, up and down, pivot or bay window.

It is noteworthy that the assessment tasks for phase 3, 5 or 7 make no reference to knowledge of energy efficient construction.

On-the-job phases consist of a list of tasks which must be checked off and signed by the employer and apprentice when the apprentice has completed them successfully.

Although each employer must satisfy FÁS that they are capable of providing access to the range of work specified in the curriculum for that craft, as well as the necessary tools and equipment prior to employing an apprentice, some smaller or specialised employers may not be in a position to provide the complete list of tasks specified.

Off-the-job Phases

The training consists of 4 separate modules (see Table A2.1). The content of each module includes the learning experiences to address competence for specific skills along with associated theory, mathematic, scientific and geometric principles.

Table A2.1: Elements of the Off-the-job Phases of Carpentry & Joinery

Phase 2 Off-the-job			
Module	**Title**		**Allocated Time/Hrs**
1.	Basic Hand Tools and Joints		120.5
2.	Roofs		103
3.	1st and 2nd Fixing		221
4.	Machinery & Joinery		180.5
Phase 4 Off-the-job			
1.	Site Works		96
2.	Roofs		65
3.	Joinery		189
Phase 6 Off-the-job			
1.	Roofs		86
2.	Joinery		223
3.	Site setting out & levelling		41

Phase 2 is the first of the off-the-job phases and is undertaken in a FÁS training centre over a period of 20 weeks. Integrated learning experiences which are designed to develop the skills, knowledge and competence specific to carpentry and joinery activities are undertaken by the apprentice during this phase.

The subjects covered in Phase 2 with sections relevant to the energy efficiency of building fabric are outlined below (including comments in brackets) with the delivery time allocated to each:

Module 3, 1st & 2nd Fixing:

Suspended Ground Floors

- Building Regulations (for the construction and ventilation of the floor, energy conservation not referenced).
- Ventilation, preservation and insulation methods (location of insulation only is indicated, not material selection or elemental U-values).

Mastic Sealants (part of 3 hours)

- Selection and application of mastic sealants around window/door frames (structural air tightness, building air permeability and related Building Regulations not covered).

Module 4, Machinery & Joinery:

Windows (part of 30 hours)

- Building Regulations for windows (no reference to energy conservation).
- Weather sealing methods.

Condensation (1 hour)

- Describe how condensation occurs.
- Describe and identify how to reduce condensation.
- Describe how mould growth effects finish.
- Occurrence of condensation.
- Overcoming condensation by insulation, ventilation, double and triple.
- Problem solving re condensation.

Phase 4 & 6 off-the-job

Phase 4 and 6 off-the-job are undertaken over a period of 10 weeks in an Institute of Technology or other learning centre approved by FÁS. Once again, integrated learning experiences which are designed to develop the skills, knowledge and competence specific to carpentry and joinery activities are undertaken by the apprentice during this phase.

Phase 4 & 6 each consist of 3 separate modules. The content of each module includes the learning experiences to address competence for specific skills along with associated theory, mathematic, scientific and geometric principles.

The subjects covered in Phase 4 with relevance to the energy efficiency of building fabric are outlined below with the delivery time allocated to each:

Module 1, Site Works:

Timber Framed Buildings: (part of 4 hours)

- Identify principles of design and construction (air tight construction, thermal bridging, elemental U-values and continuity of insulation are not covered).
- Describe fixing of joinery to timber frame (air tight connection between window/door frames and wall fabric is not discussed).
- Specify various types of vapour barriers and insulation (vapour and moisture barriers are covered but no reference is made to air tight membranes and details at

openings/junctions, insulation material selection and elemental U-value are not discussed in any detail).

- Summarise building regulations related to timber framed buildings (regulations concerning structure, fire stops and cavity closers are generally covered).
- Sketch a section through a wall showing details of moisture barrier, window opening and door opening (details used are unchanged for approx. 10-15 years and do not reflect recent changes in the approach to timber framed construction to high energy performance standards).
- Identify different types of sheeting and cladding.

First Fixing (part of 6 hours)

- Identify correct method of fixing door and window frames (no reference to air tightness, thermal bridging).
- Identify and describe correct method for construction of upper and ground floors (no reference to air tightness, thermal bridging).
- Distinguish what insulation to use in walls and ceiling (does not generally include material properties, thermal conductivity, U-value, breathability or importance of continuity).
- Draw a section through an upper and ground floor (no reference to air tightness, thermal bridging).

Building Regulations (part of 1 hour)

- Explain the purpose and administration procedures of the building regulations.
- Summarise technical guidance documents.

Module 3, Joinery:

Doors and Screens (6 hours)

- No reference to air tightness, thermal breaks.

Windows (9 hours)

- No reference to air tightness, thermal breaks.

The subjects covered in Phase 6 with relevance to the energy efficiency of building fabric are outlined below with the delivery time allocated to each:

Module 1, Roofs:

Thermal Insulation and Heat Transfer (3 hours)

- Principles of thermal insulation and heat transfer.
- Conduction, convection and radiation.
- Thermal resistance of materials.
- Properties of thermal insulation materials.
- Thermal conductivity.
- Factors affecting heat transmission.
- Simple 'U' value calculation.

Although the building regulations are mentioned on a number of occasions throughout the syllabus, there is no reference in relation to acceptable construction details that focus on thermal bridging or air tightness.

Unit 16, for example, contained within module 3 during Phase 6 in relation to thermal insulation and heat transfer does begin to address some of the underlying theory, but with a timeframe of 3 hours and without any reference to recent amendments to Building Regulations Part L, Conservation of Fuel and Energy.

A2.2 Brick & Stone-Laying

Introduction

The syllabus for the apprenticeship of (B&S) Brick and Stone-laying has not been changed or updated since its original draft in 1993. Where the skills and related knowledge included in the modules for each of the seven phases address the requirements for an artisan, it is short in technical content on the principles required to effectively construct energy efficient building fabric to the specifications being developed toward 2020 targets. For example, changes to the Building Regulations for Conservation of Fuel and Energy are not reflected within the existing syllabus.

The on-the-job phases are designed to assess the competencies of the trainee in performing various tasks, usually based upon their psychomotor skills and related knowledge. The off-the-job phases are more focused, using modular assessment.

On-the-job Phases

Phase 1 is on-the-job and consists of an apprenticeship induction and introduction to Basic Trade Skills, Health and Safety, and Tools and Equipment. Phases 3, 5 and 7 are performed on-the-job where an apprentice is required to successfully undertake 5 of 10 designated tasks under the supervision of an employer who will sign off on completion. The tasks predominantly involve construction of walling in brick/block, archwork, bridging openings, chimneys, paving/kerb laying, setting out and interpretation of drawings. No reference is made to energy efficient construction techniques.

Off-the-job Phases

Phase 2 (Table A2.2) covers the core walling construction techniques commonly used in Ireland, i.e. Brick, Solid, Hollow and Cavity Walling. While the brick/block layer is required to install the cavity insulation to a cavity wall and is responsible for the closing of cavities at openings/junctions etc. there is no reference to principles such as thermal bridging, the importance of insulation continuity, insulation material properties/selection, elemental U-value or structural air tightness.

Table A2.2: Elements of Off-the-job Phases of Brick & Stone Laying

Phase 2 Off-the-job			
Module	**Title**		**Allocated Time/Hrs**
1.	Brickwork		278
2.	Blockwork (Solid and Hollow)		208
3.	Cavity Walling/Chimney Breast Construction.		208
Phase 4 Off-the-job			
1.	Kerblaying and Paving		71
2.	Fire Opes, Flues and Chimneys		104
3.	Brickwork		172
Phase 6 Off-the-job			
1.	Arch Construction (Axed)		149
2.	Decorative Brickwork/Tiling		117
3.	Stonework		83

Phase 4 (Table A2.2) covers the areas of kerb laying and paving, the construction of chimneys and artisan techniques for brickwork. No reference is made to thermal bridging, insulation properties or structural air tightness.

Phase 6 (Table A2.2) mainly focuses on artisan skills in Arch Construction, Decorative Brickwork/Tiling and Stonework. Once again, no reference is made to thermal bridging, insulation properties or structural air tightness. The current syllabus makes no mention of Building Regulations Part L. Potential negative impacts on achievable competence by learners is particularly notable in relation to cavity walling, where the brick/block layer has direct responsibility for the cavity insulation layer.

A2.3 Electrical

The electrical craftsperson is concerned with the installation, commissioning, testing and maintenance of: - electrical wiring systems and services; electrical plant and control equipment; process monitoring and control systems.

Modern process plant includes electrical, electro-mechanical, electro- pneumatic, electronic and microprocessor based systems. In order to function effectively and efficiently, the electrical craftsperson must have a broad base of technical knowledge complementary to information gathering and analytical skills. The ability to interpret technical data and the proper use of test instruments is critical for effective system maintenance, fault diagnosis and rectification and the installation/calibration of sensors, transmitting and controlling devices. An electrical craftsperson must maintain effective communications with colleagues, clients and equipment suppliers. Proper maintenance and updating of job-related and equipment-related documentation is critical.

All work undertaken by electricians is subject to statutory regulations governing the safety of personnel, plant, premises and the environment. (FÁS, 2006).

Phase1

During Phase 1 the apprentice is introduced to basic skills in the workplace environment. The apprentice works with experienced craftspeople and is supervised in the acquisition and practice of these skills. Phase 1 On-the-Job provides an induction and introduction to health and safety, tools and equipment, and basic skills.

Off-The-Job Phases

The modules covered in the off-the-job phases of electrical are listed in Table A2.3. The subjects covered in Phase 2 with relevance to the energy efficiency in the built environment/renewable energy is outlined below with the delivery time allocated to each:

Power and Energy:

- Determine the relationship between potential difference, current and power in circuits.
- Connect instruments to measure power in a circuit.

Lighting Circuits:

- Install PIR and security light.
- Install time clock on lighting circuit.

Lamps and Light Fittings:

- Install fluorescent light fittings.
- Install tungsten halogen light fittings.
- Install lighting circuits controlled by 1 way, 2 way, intermediate and 'master on' switching.
- Install ELV downlighters.

Table A2.3: Elements of Off-the-job Phases of Electrical

Phase 2 Off-the-job		
Module	**Title**	**Allocated Time/Hrs**
1.	Electricity 1	
2.	Installation Techniques 1	
3.	Installation Techniques 2	
4.	Panel Wiring and Motor Control Circuits	
	Phase 4 Off-the-job	
1.	Electricity 2	
2.	Power Distribution 1	
3.	Electronics 1	
	Phase 6 Off-the-job	
1.	Electricity 2	
2.	Power Distribution 1	
3.	Electronics 1	

The subjects covered in Phase 4 with relevance to the energy efficiency in the built environment/renewable energy fabric is outlined below with the delivery time allocated to each:

Motor Power and Control Circuits:

- Develop and interpret schematic diagrams of the listed motor power and control circuits.
- Install and programme digital temperature controllers.
- Differentiate between different thermocouples and select appropriate type.
- Install a thermistor relay on a direct-on-line motor control circuit.

Batteries and Emergency Lighting Systems:

- Inspect and test, maintained, non-maintained and sustained emergency lighting circuits and control equipment.

Domestic, Industrial and Commercial Heating:

- Select the cables, accessories and protective devices required to install storage heating circuits.
- Design and install a heating system incorporating a programmable time clock.

The subjects covered in Phase 6 with relevance to the energy efficiency in the built environment/renewable energy is outlined below with the delivery time allocated to each:

Tariffs and Metering:

- Distinguish between domestic, commercial and industrial tariffs.
- State the causes and penalties arising from poor PF relative to the consumer and the supply authority.
- Connect up three phase kWh meters via CTs to measure power consumption.

A2.4 Plumbing

On-the-job Phases

In Phase 1 the apprentice is introduced to basic skills in the workplace environment. The apprentice works with experienced craftspeople and is supervised in the acquisition and practice of these skills. These skills are specified in the objectives for each section of the Phase 1 On-the-Job training specification. Phase 1 training manuals contain a list of tasks

which must be checked off and signed by the employer and apprentice when the apprentice has completed them successfully.

The On-the-Job training and development Phases 3, 5 & 7 provide apprentices with the opportunity to practise and hone the skills acquired in the Off-the-Job Phases 2, 4 and 6. The assessment during these phases requires the employer to assess the apprentice on a number of specific tasks from a pre-determined list. As each employer will differ in relation to the scale and scope of their specific field of work, the apprentice experience between employers can be quite varied. Each of the on –the-job phases require that 5/10 pre-determined assessment to be passed correctly.

Although each employer must satisfy FÁS that they are capable of providing access to the range of work specified in the curriculum for that craft, as well as the necessary tools and equipment prior to employing an apprentice, some smaller or specialised employers may not be in a position to provide the complete list of tasks specified.

Off-the-job Phases

The modules covered in each phase of off-the-job training in plumbing are shown in Table A2.4. Phase 2 is the first of the off-the-job phases and is undertaken in a FÁS training centre over a period of 20 weeks. Integrated learning experiences which are designed to develop the skills, knowledge and competence specific to carpentry and joinery activities are undertaken by the apprentice during this phase.

Phase 2 consist of 3 separate modules. The content of each module includes the learning experiences to address competence for specific skills along with associated theory, mathematic, scientific and geometric principles.

Table A2.4: Elements of the Off-the-job Phases of Plumbing

Phase 2 Off-the-job		
Module	**Title**	**Allocated Time/Hrs**
1.	Thermal Processes and Mild Steel Pipefitting	235
2.	Domestic Hot and Cold Water Services	280
3.	Domestic Heating/MMA Welding	109
	Phase 4 Off-the-job	
1.	Thermal Processes and Mild Steel Pipefitting	148
2.	Advanced Copper and Plastic Pipework	70
3.	Oil Fired Boilers and Heating Systems	104

4.	Pipework Systems	54
	Phase 6 Off-the-job	
1.	Thermal Processes and Pipefitting	155
2.	Advanced Pipework, Water and Waste Water Systems	44
3.	Heating and Air Conditioning	83
4.	Gas Installation Safety	44
5.	Plant and Process Systems	52

The subjects covered in Phase 2 with relevance to the energy efficiency in the built environment/renewable energy is outlined below with the delivery time allocated to each:

Module 3, Domestic Heating/MMA Welding

Domestic Heating Systems:

- List common and alternative sources of heat energy.
- Alternative sources of energy – solar, geothermal, wood pellets etc.
- Heat transfer in heating systems.
- Calculate the kilowatt rating of boilers.
- Thermal insulation.

The subjects covered in Phase 4 with relevance to the energy efficiency in the built environment/renewable energy is outlined below with the delivery time allocated to each.

Module 2, Advanced Copper and plastic Pipework

Use of Scientific Principles in Plumbing, Installation and Design (6 hours).

Module 3, Oil Fired Boilers and Heating Systems

Heating Systems, Zones, Controls and Efficiency (20 hours)

- State the function of heating zones and the types and functions of heating controls.
- Heating zones and controls, energy conservation.
- Building regulations – heat producing appliances.
- Types of fuels, boilers and boiler efficiency.

- System design.
- Heat loss calculation, boiler and radiator sizing.

Underfloor Heating (16 hours)

- Radiant heat.
- Floor structures and insulation.
- Heat loss calculation and temperature requirements.
- Zones, circuits and loop patterns.

Oil Boilers and Burners - Commissioning and Servicing (11 hours)

- Commissioning, testing and servicing procedures.
- Combustion and efficiency testing.

The subjects covered in Phase 6 with relevance to the energy efficiency in the built environment/renewable energy is outlined below with the delivery time allocated to each.

Module 2, Advanced Pipework and Waste Systems

Hot Water for Multi-Storey Buildings (5 hours)

- Describe the function and operation of the components used in multi-storey hot water systems.
- Dead legs, secondary circulation/return, pumps.

Module 3, Heating and Air Conditioning

Air Handling Units (4 hours):

- Air handling units and ducts;
    - Terminology – comfort air conditioning, air-conditioned space, supply air, exhaust air, return air, fresh air.
    - Temperature control.
    - Humidity control, moisture content, relative humidity.
    - Air filtration.
    - Air movement and circulation.
    - Identification of air handling unit components - filters, heating coils.
- cooling coils, humidifiers, fans.
    - Functions of each component.

    - Types of filters.
- Function and position of frost sensor, air flow sensor, air temp sensor and differential pressure sensor.

Heating and Cooling Batteries (7 hours):

- Heating and cooling coils.
- Double regulating valves.
- Three-way valves - mixing and diverting.
- Purpose and applications of binder test points.
- Flow and return pipework to coils.
- Properties of chilled water - use of glycol - operating temperatures.
- Insulation of chilled water and refrigeration lines - prevention of condensation.
- Flow measuring devices, purpose and applications.

Solar Heating and Heat Pumps (10 hours):

- Radiant heat, solar energy;
    - Applications of solar heating – domestic hot water, space heating.
- swimming pool heating;
    - Advantages and disadvantages of solar heating.
    - Solar collectors.
    - Position, angle and size of solar collectors.
    - Hot water storage vessels/cylinders – separate, combined, twin coil.
    - Solar heating design considerations.
    - Solar system design – open loop, closed loop systems, integration.
- into conventional systems;
    - Pumps, controls, safety features.
    - Heat pumps.
    - Refrigeration cycle.

    - Heat sources – air, water, ground.
    - Geothermal energy.
    - Geothermal heat pumps.
    - Components – compressor, expansion valve, evaporator, condenser.
- refrigerant, motor, controls;
    - Design considerations, ground.
- requirements/characteristics/suitability.
- Applications – domestic hot water, space heating and cooling.
- residential, commercial, industrial buildings;
    - Heat pump system design – open loop, closed loop, horizontal/vertical loops, integration into conventional systems.

Plumbing and Heating Calculations (part of 16.5 hours):

- Heat.
- Temperature.
- U Values.
- Heat Loss Calculation.
- Planning, Information gathering.
- Boiler and Radiator Sizing.
- Communication.
- Power and Heat Energy.

Boilers, Pumps, Pre-Commissioning of Boiler Houses and Heating Systems (part of 12.5 hours):

- Solid fuel boilers, oil fired boilers, gas fired boilers.
- Burners - gas, oil and solid fuel.
- Combustion efficiency testing.
- Calorific input and output.

- Open systems, sealed systems.
- Booster sets for sealed systems.
- Pumps.
- Measuring the flow rate of a pump.
- Use of a performance chart, positions and mountings of a pump.
- Calculating the capacity and head for sizing a pump.
- Preparation of pre-commissioning.

Domestic Heating Controls and Introduction to Building Management Systems (20 hours):

- Purpose of heating controls, energy efficiency.
- Building regulations – Conservation of fuel and energy.
- Basic electricity.
- Basic electrical safety tests, safe electrical isolation and verification, visual inspection, verification of function of fuse, stats, time clocks, programmers, earth continuity test, short circuit test.
- Switches, polarity.
- Earthing/bonding.
- Measuring voltage, safe use of approved test meter.
- Boiler, safety and high limit thermostats.
- Purpose and principle of operation of room thermostats, cylinder stats.
- Cause and prevention of short cycling in the boiler.
- Motorised valves, zone control.
- Time clocks and programmers.
- Setting and checking correct operation of heating controls.
- Thermostatic radiator valves.
- Wiring diagrams, functional flow diagrams.
- Interpretation of drawings, electrical symbols, Planning, communication.
- Good working practice, ability to work independently.
- Introduction to building energy management systems.
- Computerised control centre.
- Compensated circuits.

- Frost protection.
- Internal and external sensors.

Module 4, Gas Installation Safety

- Safety Legislation and Standards (5hours).
- Combustion (7 hours).
- Flues and Ventilation (8 hours).
- Installations (8 hours).
- Pressure and flow (8 hours).
- Appliances (8 hours).

Module 5, Plant and Process Systems

Building Regulations – Plumbing and Heating (12 hours)

- Building Regulations Technical Guidance Documents -
    - D - Materials and Workmanship.
    - G – Hygiene.
    - H - Drainage and Waste Water Disposal.
    - J - Heat Producing Appliances.
    - L - Conservation of Fuel and Energy.
    - B - Fire safety.
    - M - Access for People with Disabilities.

A2.5 Plastering

Introduction

The syllabus for the apprenticeship of Plastering was updated in 2009. Where the skills and related knowledge included in the modules for each of the seven phases address the requirements for an artisan, it is short in technical content on the principles required to effectively construct energy efficient building fabric to the specifications being developed toward 2020 targets. For example, changes to the Building Regulations for Conservation of Fuel and Energy are not reflected within the existing syllabus. This is significant as this trade is most likely to be involved in the installation of external insulation and internal dry lining systems for external walls.

On-the-job Phases

The on-the-job phases are designed to assess the competencies of the trainee in performing various tasks, usually based upon their psychomotor skills and related knowledge. The off-the-job phases are more focused using modular assessment. Phase 1 consists of an induction and an introduction to health and safety, tools and equipment, and basic skills. Phases 3, 5 and 7 are predominantly focussed on the finishing of internal and external plaster/renders, slabbing, planting of dry lining slabs and artisan skills such as cornice and mould work. No reference is made to insulation, thermal bridging or air tightness.

Off-the-job Phases

The modules covered in the off-the-job phases of plastering are shown in Table A2.5.

Table A2.1: Elements of the Off-the-job Phases of Plastering

Phase 2 Off-the-job		
Module	**Title**	**Allocated Time/Hrs**
1.	Slabbing, Rendering, Floating and Skimming	282
2.	External Work	93
3.	Slabbing, Skimming, Dry Lining and Floors	250
	Phase 4 Off-the-job	
1.	Expanded Metal	105
2.	External Finishes	105
3.	Decorative Plasterwork	108
4.	Pitched Roofs	35
	Phase 6 Off-the-job	
1.	Metal Systems	105
2.	Advanced Mouldwork	122
3.	External Finishes	73
4.	Wall and Floor Tiling	50

The subjects covered in Phase 2 with relevance to the energy efficiency of building fabric are outlined below with the delivery time allocated to each:

Module 2, External work

- No reference included to external insulation, thermal bridging and air tightness.

Module 3, Slabbing Skimming, Dry Lining and Floors

Slabbing Studded Walls (20 hours)

- No reference included to air tightness, thermal bridging, insulation continuity or positioning and integrity of membranes).

Plumb and Range Dots to Walls (16 hours)

- Function and advantages of dry lining.
- Thermal insulation - definition, conduction, convection and radiation (no reference to air tightness, thermal bridging or insulation properties, performance and continuity.

Planting Boards to Walls and Fixing Boards to Ceilings (12 hours)

- Squaring returns and reveals.
- Perimeters and areas of walls, ceilings and reveals (no reference is made to thermal bridging details, air tightness membranes or continuity of insulation).

Phase 4 includes a module on external finishes and pitched roofs. However, the external finishes element does not cover external insulation or air tightness. The module on pitched roofs is comprised of 30 hours allocated to lathing and felting, slating and tiling of pitched roofs but does not cover membrane selection or energy efficient construction.

The subjects covered in Phase 6 with relevance to the energy efficiency of building fabric are outlined below with the delivery time allocated to each:

Module 1: Metal Systems

Independent Wall Lining (15 hours)

- Condensation, use of vapour barriers and vapour checks, condensation in industrial building.

Module 3: External Finishes

Textured Finishes

- Properties of modern day external finishes.

A3 Training programmes on energy efficiency and renewable energy in buildings

A3.1 FETAC Awards

The following section details the currently available FETAC accredited training programmes relevant to energy efficiency and renewable energy for building workers. The training is outlined under two headings; Renewable Energy and Energy Efficiency & Eco-Construction.

A3.1.1 Renewable Energy:

A3.1.1.1 Solar Domestic Hot Water Systems

Course Overview: This course is designed to provide a basis in solar hot water technology and installation. It provides the knowledge and skills required for those intending to specify and install solar hot water systems.

Units/Modules Completed

- Introduction to solar water technology.
- Different types of Solar radiation.
- What is a solar water heating system.
- Identify the principle system components.
- Installation of collectors.
- Hot water storage cylinders.
- Controllers and secondary components.
- Identify site & system suitability.
- Preparing to install a solar water heating system.
- Installation process for solar systems.
- Commissioning and Safe Working Practices.

Entry Requirements: The entry requirements are a Level 6 Advanced Certificate in Craft - Plumbing or equivalent Practitioners with a background in related fields of technology and a number of years' experience may also be considered.

Course Duration: 3 days

A3.1.1.2 Biomass Heating Systems

Course Overview: This course is designed for people involved with deigning and/or installing domestic heating system. Ideally candidates should have a Level 6 Advanced Certificate in Craft – Plumbing or equivalent. Practitioners with a background in related fields of technology and a number of years' experience may also be considered.

Units/Modules Completed

- Global Energy and the Utilisation of Wood Energy in Ireland and Europe.
- Characteristics of Bio-fuels.
- Stages of the Biomass Combustion Process.
- Layout of Biomass Combustion Plants.
- Economics of Biomass Heat.

Entry Requirements: Level 6 Advanced Certificate in Craft Plumbing or equivalent. Practitioners with a background in related fields of technology and a number of years' experience may also be considered.

Course Duration: 3 Days

A3.1.1.3 Heat Pump Systems

Course Overview: This course is designed for people involved with designing and/or installing domestic heating system. It is designed to provide a basis in heat pump technology and installation. It will enhance the knowledge and skills required for all those intending to install heat pumps for the heating and cooling of buildings. Successful certification will allow the installer to register with SEAI as a certified Heat Pump installer essential for any SEAI funded programmes.

Units/Modules Completed

- Ecological and Economic Issues of Heat Pump Technology.
- Principles of Heat Pump Technology.
- Site Assessment, Design and Sizing of Heat Pumps.
- Heat Distribution, Integration and Controls.

- Installation and Commissioning.

Entry Requirements: Ideally candidates should have a Level 6 Advanced Certificate in Craft – Plumbing or equivalent. Practitioners with a background in related fields of technology and a number of years' experience may also be considered.

Course Duration: 5 Days

***Note:** The 3 qualifications previous on Solar Hot Water, Biomass Heating and Heat Pump are the registered standard established by the SEAI, in partnership with Action Renewables from Northern Ireland, governed by the Renewable Energy Installers Academy (REIA) which was set up in 2004 with funding from the EU Interreg. The qualifications have been adopted by the SEAI as a requirement for inclusion on the registered list of installers of the Greener Homes Scheme (GHS). The GHS was designed to support the installation of renewable heating technologies in existing dwellings through the provision of a grant aid contribution towards initial installation to homeowners. It was replaced in May 2011 by the Better Energy Homes scheme which provides grant support for Solar installation only. The register of installers has been retained however (see Table ???).

A3.1.1.4 Implementation of Micro Solar Photovoltaic Systems

Course Overview: The objective of this course is to equip the learner with the relevant knowledge, skill and competence to implement micro scale solar photovoltaic (PV) projects, up to 11kW.

Learning Outcomes:

- Describe the main solar PV cell technologies.
- Recognise the factors that affect solar PV output.
- Summarise the planning requirements for Solar PV installations.
- Identify the relevant legislation, standards and regulations governing Solar PV installations.
- Describe appropriate maintenance techniques for Solar PV systems.
- Adhere to the relevant Health and Safety requirements.

Entry Requirements: An Advanced/National Craft Certificate in the trade of Electrical or equivalent.

A3.1.1.5 Implementation of Small Scale Wind Systems

Course Overview: The objective of this course is to provide a wealth of knowledge on wind turbine systems. It provides the knowledge and skills required for those intending to specify and install wind turbine systems.

Learning Outcomes:

- Understand all applicable codes and standards pertaining to installing domestic wind turbine systems.
- Develop skills in explaining how these systems work to end-users or consumers.
- Develop knowledge in system installation techniques to a level whereby participation in an installation is possible.
- Acquire competence in the interpretation and implementation of wind electric circuit diagrams.

Entry Requirements: An Advanced/National Craft Certificate in the trade of Electrical or equivalent.

***Note:** The 2 qualifications previous on Solar PV and Small Scale Wind are the registered standard established by the SEAI, in partnership with Action Renewables from Northern Ireland, governed by the Renewable Energy Installers Academy (REIA) which was set up in 2004 with funding from the EU Interreg (see: 4.2.1).

A3.1.1.6 Electrical Installation of Micro-Generators

Course Overview: The objective of this course is to equip the learner with the knowledge, skill and competence to perform electrical installation, connection, testing and commissioning of micro generators with type approved network interfaces.

Learning Outcomes:

- Describe key characteristics of micro-generation systems.
- Identify the characteristics of different generators.
- Recognise Solar PV module types and arrays.
- Summarise the relevant aspects of the National Rules for Electrical Installations.
- Identify Health and Safety hazards during the installation process.
- Understand network connection requirements.

Entry Requirements: An Advanced/National Craft Certificate in the trade of Electrical or equivalent.

A3.1.1.7 Renewable Energy Systems

Course Overview: This module has been developed to provide the learner with an overview of renewable energy technologies and covers topics such as the non-technical issues, energy and services requirements, solar radiation, site suitability, micro-hydro systems,

biomass, solar thermal systems, building design features, photovoltaics, domestic wind turbines and battery storage. It combines both theory and its applications to real situations.

Units/Modules Completed

- Energy Systems, Services, and Terminology.
- Sustainability Issues.
- Solar Electric (PV) Energy.
- Solar Thermal Energy.
- Wind Energy.
- Hydro Energy.
- Biomass Energy.
- Geothermal Heating.
- Sustainable And Energy Efficient Building Design.

Entry Requirements: The preferred Entry level for the Renewable Energy Systems is a level 4 Certificate or equivalent. There are no special requirements needed for entry onto the course.

Course Duration: 5 days. Each day is classroom based and has a duration of 7 hours 30 minutes.

A3.1.2 Energy Efficiency & Eco-Construction

A3.1.2.1 Building Energy Rating Assessment

Course Overview: This module is a statement of the standards to be achieved to gain a credit in Building Energy Rating Assessment at Level 6. The module is designed to produce competent assessors capable of producing Building Energy Rating Assessments in accordance with the Energy Performance of Buildings Directive (EPBD). The module may be delivered alone or integrated with other modules.

Units/Modules Completed

- *Building Energy Rating (BER) in Ireland.*
- *Building Construction and Lighting Assessment.*
- *Building Energy Performance - Fabric and Ventilation Systems.*
- *Space/Domestic Hot Water, Heating Systems and their Controls.*

- *Overall Energy Performance, CO2 emissions and BER Labels.*
- *Advisory Reports for Dwellings.*

Entry Requirements: Level 6 Advanced Certificate in Craft or Construction or other relevant discipline, or equivalent qualifications and relevant life and work experiences. Training must be based on the current official version of the Building Energy Rating Software. Learners must have adequate information technology skills before completing the BER training programme.

Course Duration: 6 days when run on a daytime schedule or 10 evenings and 1 day when run as an evening course.

A3.1.2.2 Thermal Insulation Installation

Course Overview: The purpose of course is to develop the knowledge and skills required to install thermal insulation for draught proofing and loft insulation using appropriate tools and materials in compliance with health and safety requirements to achieve customer satisfaction.

Units/Modules Completed

- Prepare equipment and tools for installation.
- Prepare materials and work area for installation.
- Installation of specific thermal insulation.
- Post-installation operations.
- Safety, efficiency and effectiveness in the workplace.

Entry Requirements: Level 4 Certificate, Leaving Certificate or equivalent qualifications and/or relevant life and work experiences.

Course Duration: 18 hours (6 x 3 hour training sessions). The course has a practical "Hands-On" experience of 50% approx.

A3.1.2.3 Safety in Gas Installation (GIS)

Course Overview: On completion of this course and the examination the participant will have the acquired knowledge and skills to enable them to work safely under supervision at domestic and non -domestic gas installations.

Learning Outcomes:

- Install gas equipment and appliances safely.
- Obtain a GIS certificate that meets the required standards.

- Be able to apply for registration on the Bord Gais Register of Gas Installers.

Entry Requirement: An Advanced/National Craft Certificate in the trade of Plumbing or Electrical or equivalent.

Duration: 6 days.

A3.1.2.4 Domestic Gas Installation (GID)

Course Overview: On completion of this course the participant will have acquired the knowledge and skills to enable them to install and admit gas safely to domestic installations having passed in course assessments and the end of course examination.

Outline Syllabus:

- Gas installation level one safety review.
- Electricity and electrical control.
- Gas meter installation and isolation.
- Combustion analysers, flame protection devices and combustion safety.
- Customer relations and commissioning installations.
- End of unit written and practical tests.

Entry Requirement: An Advanced/National Craft Certificate in the trade of Plumbing after 1999 or a GIS Certificate.

Duration: 12 days.

***Note:** the GID qualification is the award recognised by RGII (Register of Gas Installers of Ireland) for inclusion on the national register of gas installers which is a legal requirement since June 2009 for anyone working on domestic gas installation.

A3.2 HETAC Awards

The following Institutes of Technology offer courses relevant to energy efficiency and renewable energies at NFQ Level 6 with entry requirements specific to construction craft qualification or construction work experience. The majority of the programmes were made available to the unemployed only under the government Springboard initiative for up-skilling. Each of these Institutions has delegated authority from HETAC to award certificates.

A3.2.1 Letterkenny Institute of Technology (LYIT)

Minor Award in Wind Energy Technology / Certificate in Wind Energy Technology (Major Award)

Course Overview

The programme is a Level 6 Certificate (Minor Award, 90 credits) in Wind Energy Technology targeted primarily at unemployed craftspeople in the electrical/mechanical or related trades. In addition to being validated under HETAC processes, the programme will have BZEE accreditation. BZEE is the German Centre for Renewable Technology (specialising in the education and training of wind energy service technicians). BZEE wind energy training is internationally recognised and approved by most of the major European wind turbine manufacturers. As part of this programme learners will participate in a 30 working day work placement as a member of a wind turbine maintenance team.

Units/Modules Covered

N/A

Entry Requirements

Applications should have a minimum of craft certificate in either electrical or mechanical engineering trades or have a higher qualification in either electrical or mechanical engineering. Applicants for this course should be at least 6 months out of the workforce to be eligible.

Duration

26 weeks over 12 Months - 20 hours per weeks.

A3.2.2 Cork Institute of Technology (CIT)

Certificate in Sustainable Energy Systems

Course Overview

The programme is targeted at qualified craftspeople and operatives who have recently become unemployed in the construction and manufacturing sectors and who now wish to work in the renewable energy sector. Certificate in Sustainable Energy Special Purpose Award – Intermediate 15 ECTS Credits. NFQ Level 6.

Units/Modules Covered

- Energy Management.
- Sustainable Energy in Buildings.
- Marine Engineering.

Entry Requirements

Minimum level 5 qualification or equivalent.

Duration

One evening per week over the academic year (3 hours per week).

A3.2.3 Institute of Technology Blanchardstown (ITB)

The following HETAC accredited programmes were delivered in 2011/2012 under the Higher Education Authority (HEA) "Springboard" initiative for the up-skilling of the unemployed:

Energy Efficient Heating Systems

Course Overview

This programme has been designed to up skill qualified plumbers and electricians. This up skilling is being driven by a combination of Building Regulation amendments and an increased level of regulation. The programme consists of modules in Oil Installation, Gas Installation, Solar Thermal Technology and Heating Control Technology with an emphasis on the efficient control and optimisation of space heating and hot water systems. System design and integration will be considered with respect to the requirements of retrofitting of existing dwellings.

Units/Modules Covered:

The programme consists of 4 modules:

Gas Installer Domestic

1. Oil Boiler Installer
2. Solar Thermal Technology
3. Heating Control Technology

NFQ Level 6

Entry Requirements:
A National/Advanced Craft Certificate in Plumbing or Electrical. Electrical entrants or those holding Plumbing qualifications prior to 1999 will require a Gas Installer Safety (GIS) Certificate to be eligible for the Gas Installer module.

Course Duration:

18 weeks (Jan-May 2012) part-time.

Energy Efficient Domestic Retrofit Technology

Course Overview:

This programme is designed to up-skill qualified construction craftspeople (Carpenters, Bricklayers and Plasterers) to enable them to effectively manage or participate in domestic retrofit projects or to operate in a supervisory position with organisations. The programme was designed in response to the demand for improving energy efficiency in domestic dwellings which is being subsidised through grants administered by the Sustainable Energy Authority of Ireland (SEAI) and will be supported by the National Retrofit Programme in 2011. This programme is designed to up-skill craftspeople to enable them to successfully manage domestic energy retrofit projects, from assessment of current performance of a dwelling, to the implementation of solutions to achieve defined performance savings and targets.

Units/Modules Covered:

The programme consists of 5 modules, giving rise to a Special Purpose Award:

- Computer Applications with Personal Development. (NFQ Level 6)
- Sustainable Technology 1.
- Sustainable Technology 2. (NFQ Level 7)
- Sustainable Building Retrofit.
- Domestic Energy Management & Controls.

Entry Requirements:

A National/Advanced Craft Certificate in the trade of Carpentry & Joinery, Brick & Stone Laying, Plastering, Plumbing or Electrical. Successful completion of Phase 6 of one of the above trade apprenticeships may also be considered.

Course Duration:

20 weeks (2 Semesters) part-time.

A3.2.4 Dundalk Institute of Technology (DKIT)

The following HETAC accredited programmes are being delivered under the Higher Education Authority (HEA) “Springboard” initiative for the up-skilling of the unemployed:

Certificate in Home Energy Consultancy - Level 6 Supplemental Award

The programme provides cross-skill training and specialised knowledge that will enable the learner to carry out the assessment of energy efficiency in dwellings and to work with householders to specify and implement measures to improve energy efficiency. The result will be to reduce dwelling running costs and carbon emissions.

Entry Requirements:

Advanced Craft Certificate (level-6) in the technology trades such as Electrician, Plumber, Carpenter-Joiner etc., or Higher Certificate in Engineering or Technology, or equivalent. Equivalences will be assessed by way of interview along with proof of prior certified learning and experience.

Duration:

Delivered over 1 academic year / 2 semesters.

- Duration of programme in weeks: 30 weeks.
- Number of proposed contact (on campus) hours per week: 13 hours.

Certificate in Sustainable Plumbing and Heating Installation - Level 6 Supplemental Award

This programme will develop a more holistic approach to the selection of appropriate sustainable and renewable technologies in the plumbing and heating of buildings in order to reduce energy consumption and carbon emissions. On completion of the programme, the person will be positioned to become an installer and maintenance technician for a variety of small scale sustainable and renewable plumbing and heating technologies. The following will be explored on the programme:

- Solar hot water systems.
- Biomass stoves and boiler systems.
- Heat pump systems.
- Ventilation & heat recovery systems.
- Rainwater and grey water harvesting systems.
- Integration of sustainable and renewable plumbing and heating technologies.

Entry Requirements:

Candidates must already hold an Advanced Craft Certificate (level-6) in Plumbing, or equivalent. Equivalences will be assessed by way of interview along with proof of prior certified learning and experience.

Duration:

- Delivered over 1 semester (approx. 15 weeks).
- Duration of programme in weeks: 15 weeks.
- Number of proposed contact (on campus) hours per week: 12 hours.

A3.3 Skillnet Provision

Table 1 lists Skillnet provision of training for construction workers in areas related to energy efficiency and renewable energy in buildings.

Table A3.1: Skillnet Provision for energy efficiency and renewable energy in the built environment

Skillnet Course List	Accreditation
BER	FETAC Level 5
BER Assessor Refresher Course	None
Eco Home Design	None
Energy Efficient Passive House Design	Passive House Institute
Energy Insulation	TBC
Heat recovery and Ventilation, Heat Distribution	TBC
Low Energy Domestic Refurbishment	None
Passive House Design	Passive House Institute
Retrofitting: Low Carbon Housing Refurbishment	RIAI
Small-scale wind Generation Design	None
Renewable Energy Systems	FETAC Level 5
Optimisation of Heating Systems	Eco Construction Skillnet

A3.4 Training programmes external to formal VET system

This section provides details of programmes relevant to energy efficiency and renewable energy in the built environment which have emerged in recent years that are not accredited under the National Framework of Qualifications (NFQ). This includes an outline of the programme content, duration and entry requirement with the training providers for each listed.

OFTEC Oil Installation Training – METAC[1], Chevron Training[2], ITB[3]

OFTEC (Oil Fired Technical Council) is a trade association and members' organisation representing technicians and manufacturing companies throughout the UK and Ireland. OFTEC training courses lead to registration for oil fired technicians with the organisation, and is delivered through a number of approved providers in Ireland. Approximately 40% of homes in the Republic use oil for water and space heating, which equates to approximately 500,000 boilers. In the absence of regulation similar to the legal requirement for gas installers, OFTEC qualifications have become the most recognised in the market for oil fired technicians. In Ireland, from September 2009, a boiler passport was supplied with every new oil boiler from the main manufacturers such as Firebird, Grant, Turkington and Warmflow. The Boiler Passport was prepared in consultation with OFTEC and was designed to provide a means by which consumers would receive a properly installed and commissioned appliance that meets current Building Regulations. Any future warranty is conditional upon the correct installation of the boilers along with the completion of a Boiler Passport and the commissioning certificate being returned to the relevant manufacturer.

The SEAI Better Energy programme sets out contractor requirements for those looking for inclusion on their list of approved installers. Significantly, the requirement states:

"The installation of high efficiency boilers must be carried out by suitably qualified individuals in accordance with manufacturer's guidelines and industry best practice as a minimum. In addition to this, they must hold a Level 6 National Craft Certificate in Plumbing or an equivalent Plumbing qualification such as City and Guilds. Plumbers must have completed an electrical module during their course in order to carry out the 'minor' electrical works involved in specific control measures. If 'Controlled Works', as defined by the Commission for Energy Regulation (CER) document entitled 'Definition of the Scope of Controlled Works' are required, a Completion Certificate must be issued. The issuance of a Completion Certificate for 'Controlled works' can only be carried out by a Registered Electrical Contractor or an Inspector of one of the two Safety Supervisory Bodies as defined in Section 2.2 in this CER guidance.

Oil Boilers

Contractors installing oil fired boilers must comply with requirements and competencies stated above. It is also recommended that the contractor should be registered with a professional organisation, e.g. ***OFTEC****."*[4]

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[1] www.metac.ie

[2] www.chevrontraining.ie

[3] www.itb.ie

[4] www.seai.ie

A summary of the training provided by OFTEC in Ireland is as follows:

- **OFTEC 50**: Domestic Oil Firing Introductory Course.
- **OFTEC 101**: Domestic/Light Commercial Oil Firing Assessment.
- **OFTEC 105e**: Domestic/Light Commercial Oil Firing Installation Course.
- **OFTEC 600a**: Oil Storage Tank Installation Course.

The training is usually offered in packages by providers such as a 3 in 1 (OFTEC 101, 105e & 600a), with a duration of 5 days, or a 4 in 1 (OFTEC 50, 101, 105e & 600a) course over 10 days. An oil module with a similar syllabus to the 4 in 1 course with 5 ECTS credits (HETAC) at NFQ level 6 is currently being delivered at the Institute of Technology Blanchardstown (ITB) and is being recognised by OFTEC for registration purposes. Similar to gas installation training, a reassessment is required every 5 years to maintain registration. A 3 day refresher course and reassessment is available from a number of providers. Assessment is carried out by an independent assessor for UK Blueflame certification which is recognised by the UKAS (United Kingdom Accreditation Service).

- **Passive House Construction – Building Envelope - FÁS**[5]

The aim of the course is to provide learners with the skills and knowledge to construct residential buildings or fabricate their parts to Passive House standard. Learners who complete the course achieve certification from the Passive House Institute of Germany.

Modules: The course content covers Passive House fundamentals and concepts, construction techniques, and standards and components.

Entry Requirements: Applicants should have a minimum of FETAC Level 6 Advanced Certificate/National Craft Certificate in a construction related trade. Applicants who hold a FETAC Level 6 award or higher in a related Building field are also eligible. Applicants must also hold current Safe Pass and Manual Handling Certificates.

Duration: 10 Days.

- **Passive House Construction – Mechanical Systems - FÁS**

This course has been designed to provide the construction industries with personnel trained in the skills of installing Mechanical systems, in particular, Mechanical Heat Recovery Ventilation, to the Passive House standard. The aim of the course is to provide learners with the skills and knowledge to install and commission these systems in residential buildings designed and constructed to this standard. Learners who complete this course will achieve certification from the Passive House Institute of Germany.

[5] www.fas.ie

Modules: The course content covers Passive House Induction, Background and Concept and Mechanical Systems

Entry Requirements: Applicants must have a FETAC Level 6 Advanced Certificate/National Craft Certificate as a Plumber, Refrigeration Craftsperson, Electrician, or Fitter. Applicants who hold a FETAC Level 6 or above award in a related building field, e.g. a Diploma/Degree in Architectural Studies or Building Services / Civil Engineering or equivalent, are also eligible.

Duration: 5 day.

- **Air Tightness Installation – FÁS:**

This course has been designed to enable learners to seek employment in the installation of air tightness materials in construction. The aim of this course is to provide learners who already have some site experience, or successfully passed phase 6 of the Standards Based Apprenticeship programme, with the skills, knowledge and competencies to install air tightness materials in new buildings, or where necessary, improve air tightness in existing buildings in accordance with current standards and regulations.

Entry Requirements: Participants must have passed phase 6 of the Standards Based Apprenticeship programme (see: 6.3 of the Status Quo Report), and possess a minimum of one year work experience in construction.

Duration: 4 days.

- **Air Tightness Testing & Measurement - FÁS:**

This course has been designed to enable learners to seek employment in the testing of properties for air tightness levels. The aim of this course is to provide learners with the skills, knowledge and competencies to test and report on the Air Permeability of Buildings, using the Fan Pressurisation method detailed in IS EN 13829:2000.

Entry Requirements: Learners must possess a recognised professional construction qualification or FETAC Level 6 construction qualification and a minimum of 5 years relevant construction experience.

Duration: 4 days.

*NB in addition to these existing courses provided by FÁS, there are a further 10 energy sector courses in development at various training centres nationwide. Details on these are not currently finalised:

- Rain Water Harvesting – to be delivered in combination with passive house building.
- Building Performance and Facilities Management.
- CHP Micro-generator.
- Air-to-Air Heat pumps.
- Large-Scale Wind Farm Operator Training.
- Large-Scale Wind Farm Safety Training.
- Central Heating Design.
- Heat Recovery Systems – combined with passive house building.
- Sustainable Building.

- **The Institute of Passive House Training** is a sister company to Target Zero and provides different levels of Passivhaus training courses to suit the needs of clients; ranging from a one-day introductory course to the full Certified Passivhaus Designer & Consultant courses & Tradesman Courses. Courses are offered in various locations in the following countries: Ireland, UK & Europe. Their focus is on developing regional networks of associated building professionals who want to play an active role in dramatically improving the energy performance of our buildings. **Target Zero & The Institute of Passive House Training** are accredited by the Passivhaus Institut Darmstadt, Germany, to conduct training courses for Passive House Designer / Consultant, examinations for certification, and to make the first correction of the exam..

- **CHP – METAC:** To provide participants with the skills relating to safety regulations, procedures and standards to enable to enable participants to install C.H.P. (combined Heat and Power) systems to manufacturers specifications in compliance with regulations and codes of practice.

  Course Syllabus: Content covers**,** Introduction**,** Understanding CHP**,** Health and Safety regulations**,** Building Regulations**,** Design and Operating Sequence**,** Technical Data**,** General Requirements**,** Installation**,** Flue System**,** Commissioning and Servicing**,** Parts/Maintenance**,** Fault Finding**,** Electrical Controls**,** Practical Workshop and Practical Training Workshops on Products, Equipment, Product Identification and Product Types.

  Trainee Profile: Registered Gas Installer (RGI) Qualified Persons involved in installation.

A4 Review of existing and emerging technologies and skills in energy efficiency and renewable energy in buildings

There have been significant changes to the technologies used in the construction and renovation of buildings in Ireland over the last eight or nine years. A number of government policies on energy use have been introduced, largely driven by EU Kyoto commitments and the EPBD (European Performance of Buildings Directive) and its recast towards 2020 targets. A series of amendments to Building Regulations have resulted, specifically to Part L: Conservation of Fuel and Energy which provide guidelines for new construction and, more recently, the retrofit of existing buildings by means of Technical Guidance Documents (TGD). The TGDs are provided for both dwellings and buildings other than dwellings and in 2008 were accompanied by supplemental documents on "Acceptable Construction Details", which deals predominantly with insulation continuity and air tightness, and others related to heating and domestic water heating for dwellings and the Dwelling Energy Assessment Procedure (DEAP). With the regular and significant increases in energy costs in recent times, there is also real financial incentive for building owners/occupiers to consider energy performance and this has been further reinforced by the following:

- Requirement for Building Energy Rating (BER) for the local market which is expected to have a positive influence on the value of a property for the owner and running costs for the occupier.
- BRE Environmental Assessment Method (BREEAM) and Leadership in Energy and Environmental Design (LEED) which are voluntary energy rating measurements for commercial buildings that multinationals are increasingly identifying as desirable for the increased value and prestige that they give a building.
- The emergence of energy service companies (ESCOs) where capital investment for energy performance measures may be offset against the savings made giving building owners increased confidence in the financial security of projects.
- The Public sector commitment to 33% energy efficiency savings by 2020. The Public sector annual energy spend is estimated at €500 million.
- Government sponsored grant initiatives for the retrofit of existing dwellings to higher performance levels and the installation of renewable energy technologies. These schemes are administered by the SEAI (Sustainable Energy Authority of Ireland).

Manufacturers of building materials and systems have responded by developing products for the market to aid in the achievement of the improved energy performance now being sought. The pace of this development and revisions to building standards is such that the skill set requirement for craft workers and system installers is changing quite rapidly. To provide clarity and context, the developments in technologies and skills will be discussed under a

number of headings to ensure that all of the main features of an energy efficient building are addressed.

A4.1 Building Fabric (Insulation and Air Tight Envelope)

Since 2003, there have been significant amendments to the building regulations in Ireland, relating to conservation of fuel and energy and this has had a profound influence on the design and construction of elements of the building fabric. The changes, largely driven by the European Performance of Buildings Directive (EPBD) 2002 and its recast in 2010, have embedded the principles of continuity of insulation and air tight envelopes into the psyche of building designers and contractors. The necessity for comprehensive detailing of fabric elements to account for insulation levels, thermal bridging and air tightness has been reinforced by the introduction of BER and the testing of building air permeability standards.

Manufacturers of related materials and systems have responded with the development of products that aim to meet the higher specification now required to ensure building fabric performance levels. The impact on the technologies and skills currently being used in the construction of building fabric will be discussed individually for each element and collectively in terms of overall energy performance.

External Walls

In the last 100 years external wall construction in Ireland has been dominated by masonry single leaf and, more recently, twin leaf (cavity wall) construction. From the beginning of the last century to the early 1970's, single leaf construction was at the fore in a number of guises. Initially, in urban areas, brick was the most common walling material while natural stone was used predominantly in rural one-off housing, both in single leaf form. These materials were largely replaced in later years by the introduction of concrete and the concrete block, facilitated by the Irish governments Cement Act of 1933 which led to a full scale production of cement from 1938. It resulted in a widespread use of mass concrete for walling up to the 1950's, both in urban housing schemes and in loose shuttered concrete walling (not mechanically vibrated) construction in rural areas.

Un-insulated solid concrete and hollow block walls rendered internally and externally dominated the period between 1950 and the late 1970,s with hollow block single leaf construction being most commonly used in the densely populated Leinster region for the past 40-50 years. Dry lining of hollow block walls was introduced in the late 1970's and has continued to be used since. This system comprises of an externally rendered hollow block with an insulation layer attached to the inner face, either using quilt insulation fitted between timber battens or a rigid board insulation mechanically fixed or glued, and a vapour barrier applied over. Gypsum plasterboard is fixed over and finished with either taped joints or with Gypsum wet applied skim coat plaster.

Dry lining has also been applied in recent times to the various types of solid single leaf walling as an energy efficiency upgrade (Figure A4.1). Types of insulation material used include expanded polystyrene (XPS), glass fibre and polyurethane (PU) boards. A vapour barrier (e.g. a polythene sheet) is installed on the warm side of the insulation. Composite boards of rigid slab insulation and gypsum plasterboard are available for internal insulation and generally incorporate a vapour barrier. It is important that the vapour barrier be well sealed at wall, floor, ceiling, door and window junctions, around light switches and at all other breaks in the insulation as interstitial condensation (within the fabric) is a real danger when insulating internally. As a result, some architects and designers believe that this system has a limited suitability in retrofit applications but this has not affected the widespread usage and the system has continued to receive grant aid from SEAI energy efficiency upgrade schemes (currently Better Energy Homes).

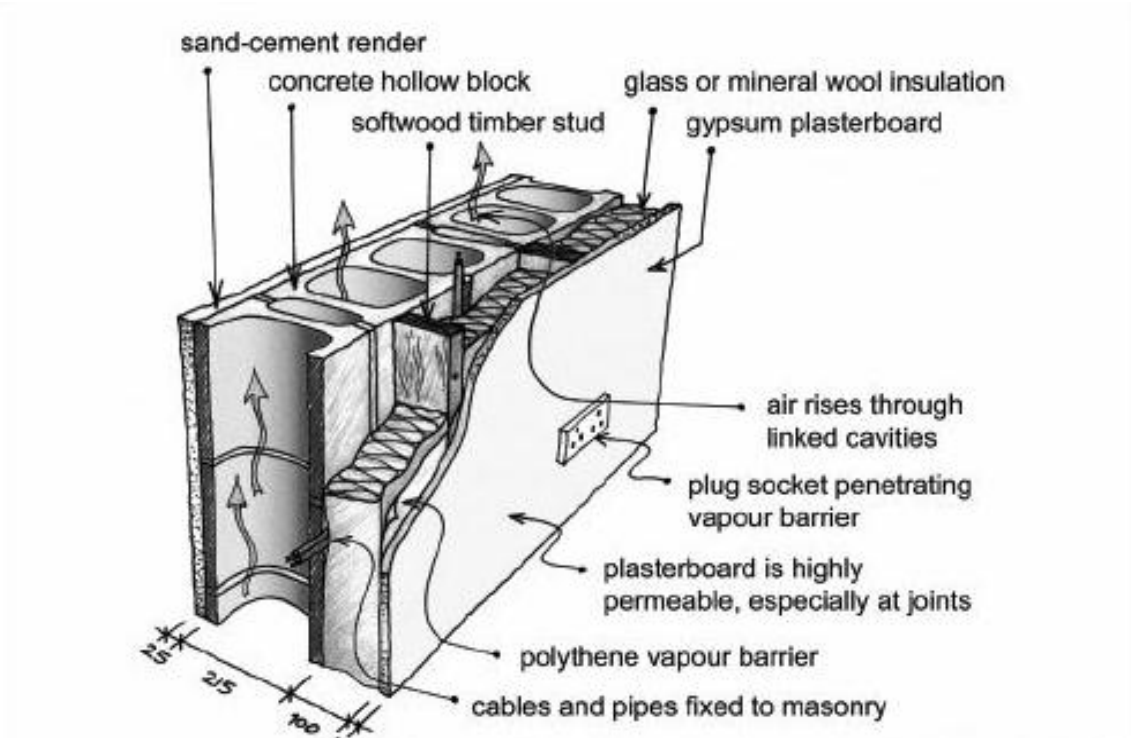


Figure A4.1: Typical dry-lined hollow block construction[6]

As with the majority of energy efficient applications, attention to detail is crucial to ensure that performance targets are achieved. A fundamental understanding of the principles of thermal bridging, air tight construction, material suitability and interstitial condensation is required to ensure successful results. Some systems, for example, using composite boards (rigid PU/XPS boards faced with gypsum plasterboard) are being supplied by builders merchants with metal mechanical fixings which will create multiple thermal bridging points

[6] Breaking the Mould 1, Joseph Little, 2009

when used to attach the boards to the walling. Typically these systems are installed by plasterers or carpenters for both new build and in retrofit applications.

External wall insulation has become widely regarded as best practice for the retrofitting of masonry walls for energy performance. Insulating externally has a number of clear advantages over internal dry lining as a continuous insulation envelope can be created which provides an opportunity to eliminate thermal bridging and significantly improve the structural air tightness of the building. By virtue of the fact that the insulation is fitted to the outside of the building, any potential interstitial condensation that may occur will be isolated externally where it will have little or no adverse effect. Also in its favour, this system of insulation does not impinge on the floor space of a building.

External insulation involves fixing insulation materials such as mineral wool, expanded polystyrene or Polyisocyanurate (PIR) slabs to the outer surface of the wall. This insulation is finished externally with an acrylic or cement-based render to provide weather resistance. A steel or fibreglass mesh is embedded in the render to provide strength and impact resistance. A thinner layer of insulation is fitted around the window and door reveals to minimise thermal bridging. Existing concrete window sills are cut back and replaced by proprietary sill covers with integrated insulation layers to reduce thermal bridging. Correct detailing at flashings, plinths and abutments is extremely important to optimise performance. Attention is also needed to fire resistance factors and maintaining function of drains, sewers, gutters and waste pipes. Most significantly, as the system is so effective in reducing air infiltration, adequate controlled ventilation requirements need to be maintained or reinstated according to the needs of the dwelling.

The uptake of this system in Ireland has been slow due to its higher cost relative to internal dry lining. However, the introduction of the SEAI Home Energy Savings (HES) scheme has increased demand as grant aid has been set at a maximum of €2,000 per household for dry lining insulation internally and a higher figure of €4,000 for external wall insulation. In most cases this would equate to a significant percentage of the overall cost of the system. The SEAI Better Energy Homes scheme, that replaced the HES in 2011, has retained this level of grant aid to homeowners. For external insulation, the SEAI insist on the use of NSAI (National Standards Authority of Ireland) Agrément certified products and only list approved contractors that have registered under the NSAI Agrément registered installer scheme as eligible for grant support.

The NSAI is Ireland's official standards body and are accountable to the Minister of Jobs, Enterprise and Innovation. NSAI Agrément, formerly the Irish Agrément Board (IAB), is responsible for the issuing of technical certification for new and innovative products and processes in building and materials technology. They offer registration to installers of Blown Loft Insulation, Full Fill Cavity Wall Insulation and External Insulation. The following is a summary of the application process for registered installer Schemes as it appears on the NSAI website:

- *Contact the Certificate Holder of the NSAI Agrément certified system for training in installing that specific system. Search our database of Agrément*

Certified Products to download certificates covered by the relevant installer scheme and get contact information for the Certificate Holders.

- *Once training has been provided by the Certificate Holder, a completed Application Form must be submitted to NSAI Agrément, along with a completed Installer Contract and the relevant Application Fee. The Application Form* ***MUST*** *be filled in by the Applicant and co-signed by the Certificate Holder.*

- *On receipt of the above documentation, the applicant shall be contacted by an NSAI Agrément Assessor to arrange an audit date. The applicant is subject to an assessment by NSAI Agrément prior to approval, and annual surveillance subsequently.*

"These schemes increase the level of confidence the homeowner will have in the product, as the insulation system has been independently tested and assessed as being fit for purpose and in compliance with the Irish Building Regulations, and the installer has been assessed that their workmanship is in compliance with the Agrément certificate.[7]

Cavity wall construction became more widespread in Ireland in the 1950's with the fitting of insulation in the cavity appearing in the late 1970's. This system of wall construction has been regarded as best practice since. The twin leaf construction initially became popular as it was extremely effective in preventing moisture ingress through external walls relative to single leaf which relies mainly on the external render for moisture protection. This was recognised as a major factor in its choice to combat the high levels of driving rain associated with the Irish climate, particularly in the exposed coastal areas of the country. The advantages of including insulation in construction to reduce heating requirement seems to have been largely influenced by the upward shift in fuel costs stemming from the oil crisis in the early 1970's. Regulations specific to energy efficiency in dwellings were introduced in 1976 and initially required 40mm of insulation in the cavity with 50mm becoming the standard after 1991. No indication of specific insulation materials or their performance value was given at this time.

The 1997 *Technical Guidance Document (TGD) L: Conservation of Fuel and Energy* to the Building Regulations listed eight sample materials for cavity insulation which could be used to achieve a maximum elemental U-value of 0.45W/m²K. The most commonly adopted cavity wall construction became a 100mm external masonry leaf with a 105mm air cavity partially filled with insulation, maintaining an air cavity on the cold side, and a 100mm inner masonry leaf. Plastic or metal cavity ties were fitted at regular intervals to provide structural stability and to retain the insulation material against the inner leaf. The insulation is fitted by the block layer as the walling is constructed in courses. With further amendments to TGD L in 2002, 2007 and 2011, the maximum elemental U-value has decreased to 0.21W/m²K and has pushed the boundaries of this construction by now requiring a cavity of 105mm, the maximum allowable under I.S. EN 1996, to accommodate high performance insulation boards while still retaining a minimum air cavity thickness of 40mm. Proprietary systems for cavity closing around openings have been introduced to the market to facilitate the achievement of thermal bridging standards set by the Building Regulations. These

[7] www.nsai.ie

performance standards necessitate particular attention to detail in cavity wall construction in order to achieve continuity in the insulation layer.

Timber frame construction has experienced a rapid growth in Ireland over the past 20 years. In the early 1990's timber frame accounted for only 5% of all construction. However, by 2006 this share had increased to 30%, predominantly due to change in consumer attitude as originally, masonry construction was perceived as essential to withstanding the harsh weather conditions. The main selling point for timber frame was the potential savings on heating bills as the system accommodated high thicknesses of insulation material relative to other constructions. During the construction boom in Ireland from the mid 1990's to 2008 this system of construction became more popular with developers, mainly due to the speed of completion possible. The main building elements are factory manufactured (walls, intermediate floors, roof trusses) and can be transported to site for rapid assembly. There is also a time saving in the drying out period needed relative to masonry construction. Typically in Ireland, external wall panels comprise of a structural timber frame inner leaf with a masonry external cladding layer of brick or rendered concrete block (see Figure A4.2). The inner load bearing layer is constructed from a softwood stud frame which is stiffened with a sheeting panel (usually OSB or Plywood) on the cold side. The void between the timber studs is filled with thermal insulation and the frame is fitted internally with vapour barrier and gypsum plasterboard over. A weather proof breather membrane is also applied on the outside of the plywood/OSB sheeting. The external masonry cladding leaf is attached to the timber frame with stainless steel ties, maintaining a ventilated drainage cavity between the two layers.

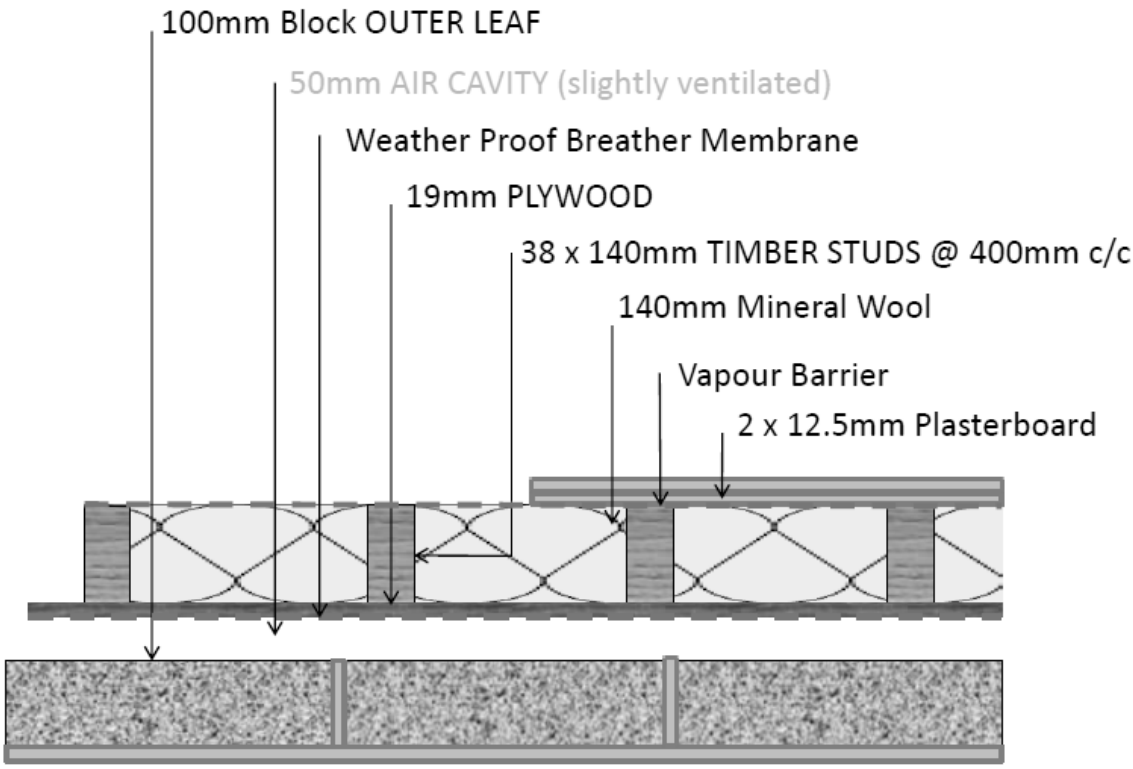


Figure A4.2: Typical timber frame external wall section

Questions began to arise in recent years as to the actual energy performance of timber frame buildings. When air permeability tests were introduced by the 2008 amendment to the Building regulations in Ireland, results for timber frame dwellings were generally poor. The typical construction details being used at this time were not focussing on air tight seals at junctions and openings. Also, little regard was being paid to thermal bridging potential, both as part of the main structure and around openings/ penetrations in the insulation envelope. In the last three years particularly, the need for compliance with revised Building Regulations for conservation of fuel and energy has meant that the approaches being taken in timber frame construction have evolved. This has led to the principles of air tightness and insulation envelope continuity being embraced by the industry. Some companies have adopted materials and systems from continental Europe, particularly Scandinavia, Germany and Austria, which emphasise energy performance.

Ground Floors

The vast majority of ground floor construction in Ireland can be divided into 3 categories, solid concrete slab on ground, suspended concrete floor and suspended timber floor. Solid concrete slab on ground has become the most common practice since the 1980's. The topsoil (vegetable layer) is removed and a layer of hardcore fill is provided and blinded with sand before a Damp Proof Membrane (DPM, sometimes incorporating a Radon barrier) is applied. TGD L 2002 defined a minimum elemental u-value of 0.25W/m²K but also the need for perimeter insulation "Care should be taken to control the risk of thermal bridging at the edges of floors. All slab-on ground floors should be provided with edge insulation to the vertical edge of the slab at all external and internal walls. The insulation should have minimum thermal resistance of 0.7 m2 K/W (25 mm of insulation with thermal conductivity of 0.035 W/mK, or equivalent). Some large floors may have an acceptable average U-value without the need for added insulation". Once again, continuity of the insulation layer and safeguarding against thermal bridging is paramount.

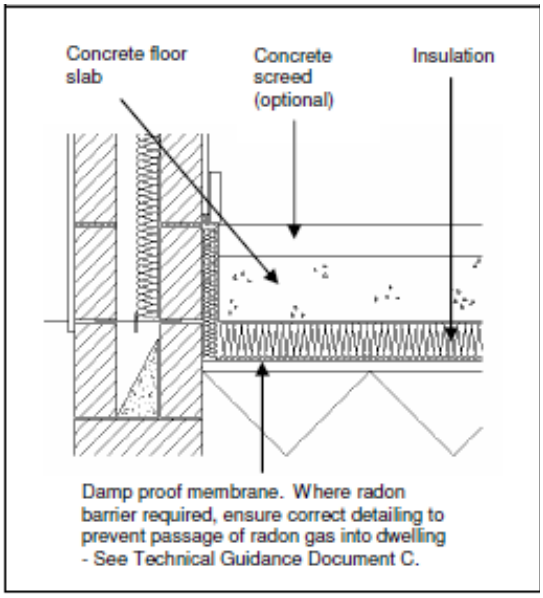


Figure A4.3: Guidance for concrete slab-on-ground floor, insulation under slab[8]

This type of construction does not offer itself to easy retrofit solutions. Where floor level and ceiling height restrictions do not apply, it may be possible to fit a rigid board insulation layer with a screed above. Outside of this scenario, removal of the existing slab and replacement with a new insulated one is one of the very few options and is often not considered to be a cost effective solution.

Suspended reinforced concrete ground floors are usually insulated above the reinforced slab which provides lower thermal mass than ground bearing slabs and, therefore, a quicker response to the space heating system. When external walls are insulated internally the insulation layer can be connected to the floor insulation providing continuity. Cavity wall construction, however, is inclined to lead to some level of thermal bridging so careful detailing is necessary to minimise this. A suspended beam and block floor (see Figure A4.4) requires similar attention when combined with cavity walling. This system is largely used in industrial and commercial applications where the void below the slab can be used to accommodate services.

[8] TGD L 2011

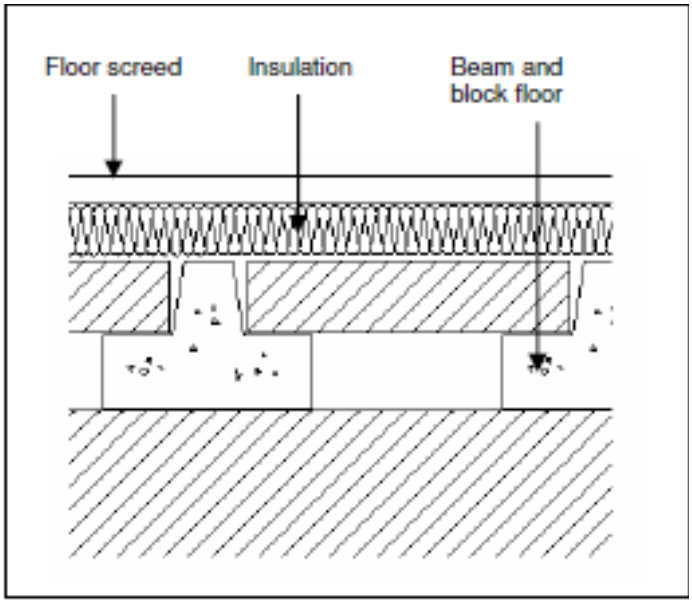


Figure A4.4: Guidance for suspended beam and block floor[9]

The raised timber ground floor is rarely used in new construction in Ireland since the late 1970's. This system comprised of the construction of dwarf or sleeper walls built of concrete subfloors or foundations with a timber wall plate bedded in mortar or mechanically fixed on top. The sleeper walls were constructed at centres usually between 1.5 – 1.8m allowing for a relatively small sectioned timber joist, often 115mm x 38mm, fixed to the wall plate and floored with tongue and grooved floorboards. This floor would then be ventilated from below with vents in the external walling providing through ventilation from front to rear of the building. The heat loss through the fabric and due to air infiltration is very significant with this system. Energy retrofit solutions vary between sealing the flooring at all joints to complete removal of flooring with insulation material fitted between joists and air tight membranes applied above with connection to the perimeter walling.

Roof Constructions

Tiled or slated pitched roofs with a ventilated roof space require insulation and vapour control at ceiling level. Traditionally, quilt insulation was fitted between the ceiling joists with no regard to the recurring thermal bridging through the joist timbers. As the thickness of insulation layer required has increased in line with a maximum elemental u-value indicated in Building Regulations in more recent construction practice, a second layer of quilt is often fitted perpendicularly over the first (see Figure A4.5). Alternatively, a composite board of insulation backed plasterboard can be fitted to the underside of the ceiling joist. Both of these options are based on the principles of continuity of the insulation layer and the minimising of thermal bridging effects. Through ventilation from eaves to eaves of the roof space also needs to be preserved so particular care is required when insulating up to the

[9] TGD L 2011

eaves to maintain air pathways. A vapour control layer (VCL), either fitted below the ceiling joist or integrated into the composite board, is essential to limit the transfer of water vapour to the roof space with particular care required to seal any penetration of services etc. through the ceiling layer.

In the past number of years, vapour barriers such as polythene and foil backed plasterboards were widely used for this application. However, scant attention was generally given to the continuity of the layer, particularly in the case of the foil backed plasterboard where breaks existed at all joints. The concept of controlled passage of moisture through the building fabric had also not been embraced at this time. Engineered vapour control membranes have become available which provide an air tight layer while allowing for breathability (vapour diffusion) and avoiding the "sweating" effect sometimes associated with polythene. Vapour permeability of the insulation material itself is now acknowledged as being significant in building fabric design. Where controlled passage of vapour is accommodated by the VCL it is important that the insulation does not trap or hold vapour resulting in interstitial condensation. This has been acknowledged in the new Building Regulations TGD L 2011 amendment "Where the thermal conductivity of insulation between and below the joists is different, the material on the warm side (i.e. below the joists) should have a vapour resistance no lower than that on the cold side (i.e. between the joists). It is preferable if the insulation on the cold side is more permeable than that on the warm side (e.g. mineral wool outside with expanded polystyrene inside)".

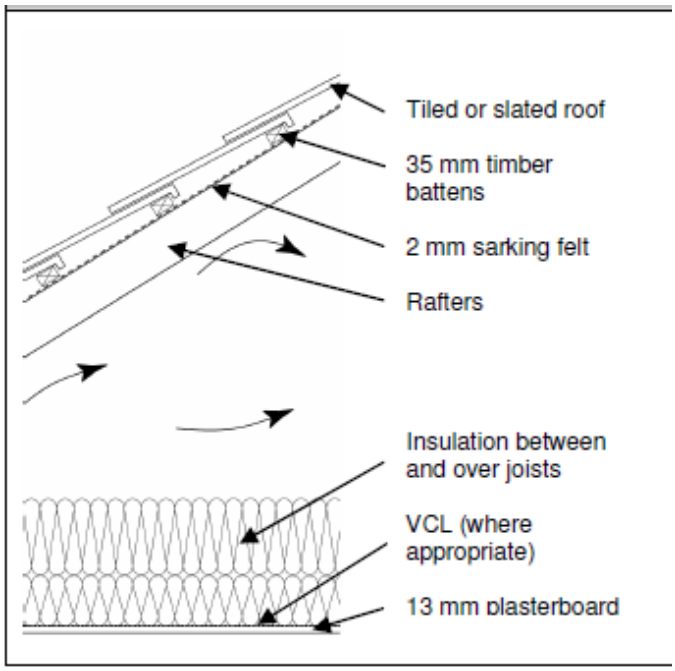


Figure A4.5: Guidance for common roof constructions with insulation between and over ceiling joists[10]

[10] TGD L 2011

A number of other factors require attention when insulating ventilated roof spaces:

- Water tanks and associated pipework should be protected against the risk of freezing. Any pipework located on the cold side of the insulation should be adequately insulated. Water tanks positioned directly over the ceiling joists should be insulated on top and all sides and raised tanks should be insulated independently.
- Electrical safety needs be carefully considered. Overheating of cables or recessed light fittings should be avoided at installation stage. Cables should be located on the cold side of the insulation if at all possible and adequate provision made for any that cannot.
- Access to tanks and services in the attic space should be provided for with walkways that maintain insulation levels but are suitably load bearing for purpose. The attic access hatch itself is often ignored in relation to insulation level and, even more significantly, air tightness. Solutions may need to be designed and installed to ensure air tight and insulation envelope continuity while accommodating ladder/roof stair systems.

The retrofit insulation of ventilated roof spaces is generally carried out by companies using operatives that have received limited training or instruction. A perception exists that this is a task that requires relatively unskilled labour. The significant number of factors to be accounted for in the installation process surely challenges this notion.

Tiled or slated pitched roofs require insulation at rafter level in the case of occupied or unventilated roof spaces. This can be achieved by either insulating between and below the rafters or between and above. For the former, a space of 50mm minimum should be maintained to preserve through ventilation from eaves to eaves. The latter system must be designed to prevent the occurrence of interstitial condensation as a ventilation space is no longer provided between the rafters. As a result, TGD L 2011 only allows for the use of certified systems for this application. For both constructions, vapour control layers are fitted to the warm side of the insulation and the principle of continuity of insulation continuity and minimising of thermal bridging applies. TGD L 2011 states again for this construction the importance of locating the more vapour permeable insulation material to the cold side, hence encouraging the harmless dissipation of water vapour to the outside.

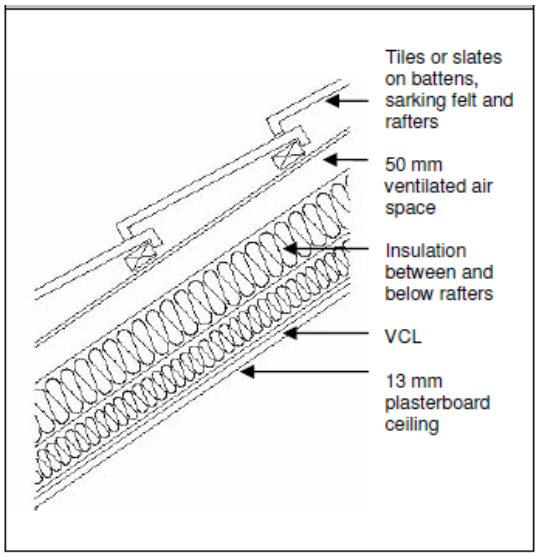


Figure A4.6: Roof constructions with insulation between and below rafters[11]

Flat roof construction may be divided into cold deck and warm deck systems. Timber flat roofs in Ireland have traditionally been constructed using the cold deck method with the insulation material fitted between the joists. In the past, this system has suffered from major problems with surface and interstitial condensation due to inadequate insulation levels, thermal bridging at junctions and inadequate vapour control measures. The most recent Building Regulations provide guidance that suggests the use of an extra insulation layer with a connection to the wall insulation to counter thermal bridging, the use of a VCL and the provision of cross ventilation in a void above the insulation envelope (see Figure A4.7). The same principle of vapour diffusion through the fabric as mentioned for pitched roof construction also applies here.

[11] TGD L 2011

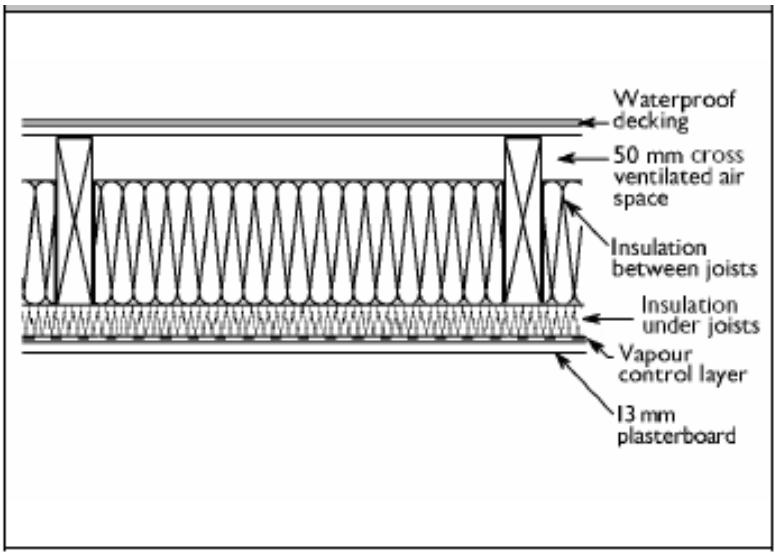


Figure A4.7: Guidance for timber flat roof, insulation between and below joists[12]

Warm deck flat roof systems are usually used under 2 categories, one having the insulation above a concrete slab/timber/metal roof with the waterproof membrane over see Figure A4.8), and the other for use with concrete slab roofs with the insulation above the waterproof layer finished with a paving slab or ballast material to accommodate foot traffic onto the roof. The first system requires particular care at installation with regard to prevention of condensation. Installation guidelines from TGD L 2011 state “At the perimeter, the vapour barrier is turned up and back over the insulation and bonded to it and the weatherproof membrane. Extreme care is required to ensure that moisture cannot penetrate the vapour barrier. The insulation should not be allowed to get wet during installation. There should be no insulation below the deck nor should this area be ventilated as this could give rise to a risk of condensation on the underside of the vapour barrier. Thermal bridging at roof/wall junctions should be avoided”. With the latter system, the choice of insulation material is critical as it must be resistant to water absorption and frost. TGD L 2011 also indicates that the insulation performance should take into account the cooling effect of water and therefore be increased by 20% to counteract this.

[12] TGD L 2011

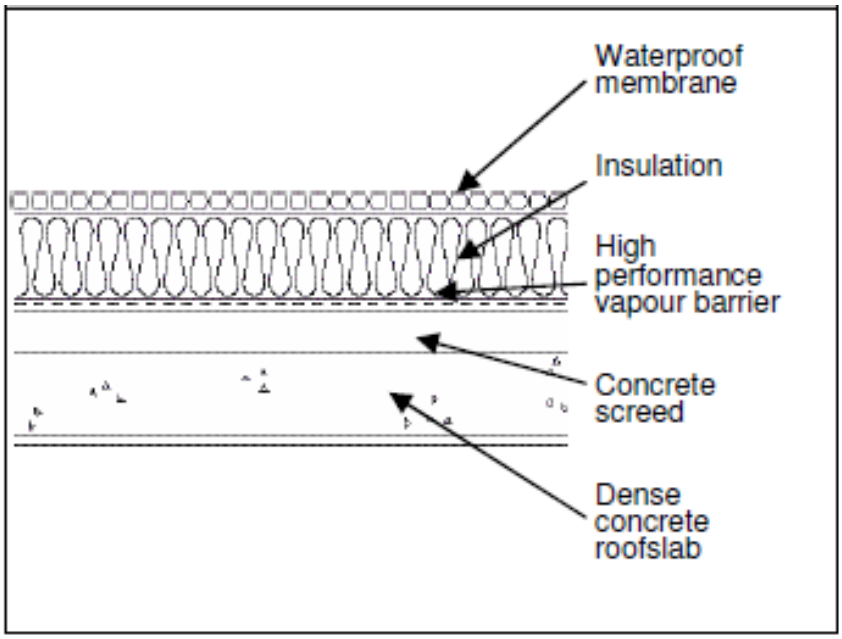


Figure A4.8: Guidance for warm deck concrete flat roof construction[13]

Windows & Doors

Single glazed timber or steel frame windows were used predominantly in Ireland up to the 1980's before the introduction of double glazing and aluminium and PVC frames. A period of widespread window replacement followed as building owners attempted to reduce energy costs. These new window types became very popular as a result of their improved glazing performance and integrated draught seals. Aluminium framed windows and doors, however, suffered from significant condensation issues as thermal break were not initially built in to their construction. Improvements in glazing technology have followed with the introduction of gas filled cavities (Argon, Krypton) and low emissions metal oxide coatings.

In more recent times, the specification of windows and doors has been dramatically affected by the move toward highly energy efficient buildings, not just in terms of the materials and assembly used, but also for integration into the building fabric to provide insulation and air tight envelope continuity. The maximum elemental u-values determined by Building Regulations are becoming increasingly problematic to achieve. This is further complicated by the fact that these values have most recently been determined by the relationship between combined window/door area and total floor area of the building. Three thermal transmittance paths (Figure A4.9) need to be calculated to determine the overall u-value of a double/triple glazed window/door:

1. Through the glazing.
2. Through point at which the cavity spacer occurs.

[13] TGD L 2011

3. Through the frame.

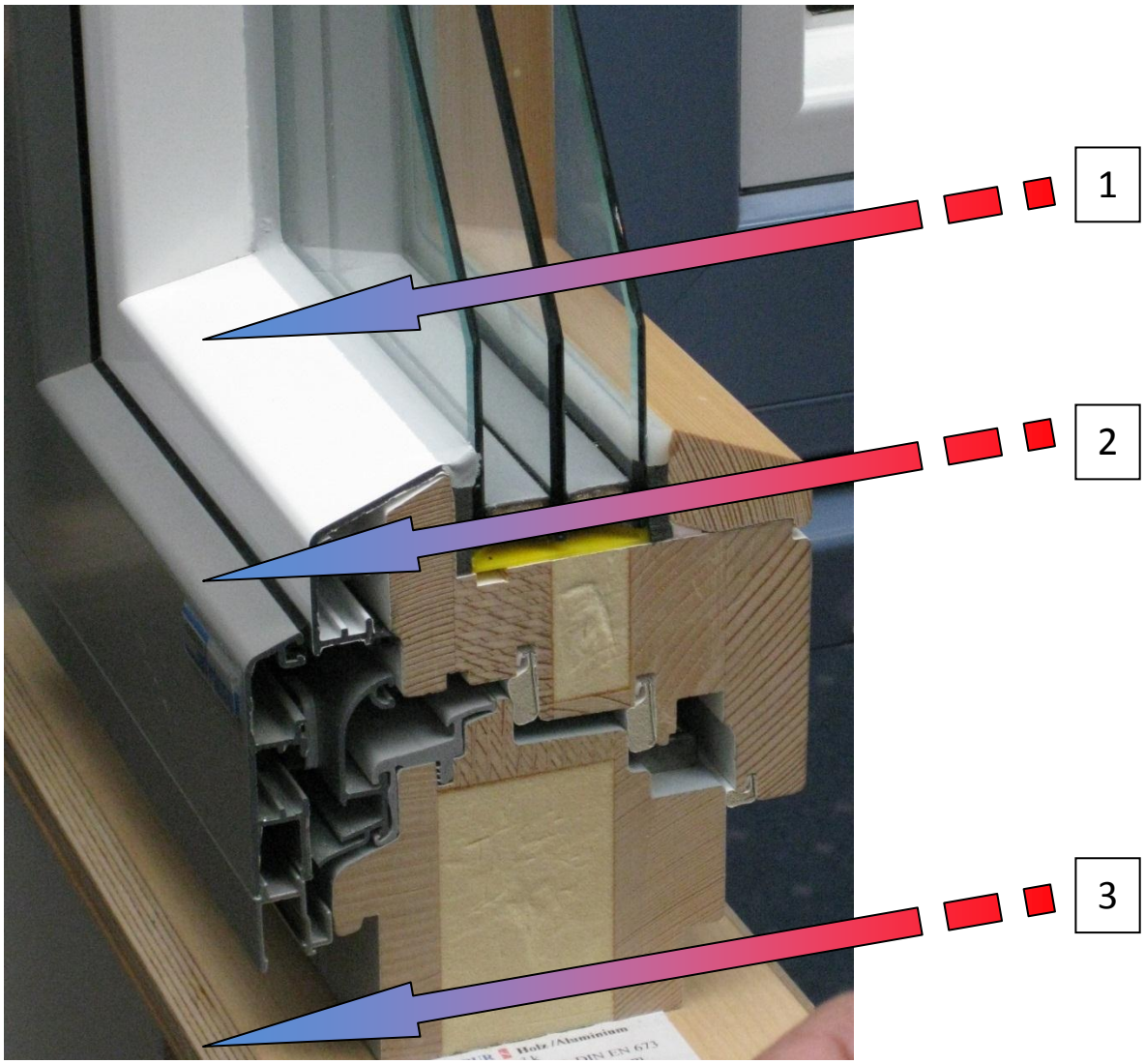


Figure A4.9: Thermal transmittance paths for double/triple glazed windows

Fractional area of frame to glazing is also to be taken into account to establish elemental u-value. Tables are provided in TGD L with indicative U-value for windows doors and rooflights[14] but should be ignored in preference to values given for products included under the Window Energy Performance (WEP) certification scheme. This system also allows for net energy gain from passive solar radiation when calculating the energy performance of the window.

There is significant scope for energy retrofit solutions to improve the performance of existing windows and doors. Outside of the relatively expensive window replacement option, glazing

[14] Table B1, TGD L 2011

units can be replaced with higher performing alternatives. The air tightness of existing window and door elements can also be improved dramatically by implementing a number of measures including repair or replacement of draught seals, ensuring that glazing gaskets are continuous and in good order, and the sealing externally and internally of junctions between the window frames and building fabric.

A4.2 Ventilation

Ventilation and energy efficiency measures in buildings have become inexorably linked. Correct provision of ventilation is fundamental to maintaining a thermally comfortable environment in which condensation is controlled and air pollutants are reduced to permissible healthy levels for building occupants. The recent advances in construction techniques which have led to more airtight building envelopes have to be balanced against the absolute need to maintain indoor air quality and remove moisture levels potentially harmful to occupants and to the building fabric itself.

Up to recent years, designed ventilation in buildings in Ireland has largely comprised of natural ventilation provided by external wall vents or integrated window trickle vents sometimes supplemented with localised mechanical ventilation in kitchens and wet rooms (see Figure A4.10 (a)). In many cases this ventilation was over designed as a result of unquantifiable levels of air infiltration in leaky buildings. Open chimneys or flues were also responsible for significant and mostly unnecessary air change that would lead to extensive heat loss from buildings. Ventilation is covered under the Technical Guidance Document (TGD) F in the Irish Building Regulations but has increasingly been referred to under TGD L, Conservation of Fuel and Energy, with reference to mechanical ventilation included in the most recent amendments of 2008 and 2011.

Newer technologies for ventilation that have been introduced more recently in Ireland include:

- Passive stack ventilation.
- Mechanical extract ventilation (centralised).
- Positive input ventilation.
- Mechanical heat recovery ventilation (MVHR).
- Hybrid ventilation.

These systems will now be explained in more detail under their individual headings.

Passive Stack Ventilation

This system consists of vents that are located on the ceiling of wet rooms that are vertically ducted to roof ridge terminals which are driven by wind and stack effects to extract air supplied through window fitted trickle vents see Figure A4.10 (b). The doors to the rooms of

the building are undercut to allow air flow when they are closed. Warm air in the building rises and flows out through the vertical ducts (stack effect) to the outside thereby causing cool outside air to be drawn into the building through the trickle vents in the lower areas. For this system to work effectively it must be properly designed and installed. It is also only suitable for buildings with a high standard of air tightness. Correct sizing, connections, bends, jointing and layout of ductwork is essential for the system to function properly.

Mechanical Extract Ventilation:

Mechanical extract systems, similar to passive stack, are ducted from vents in wet rooms and cool outside air is once again drawn into the building through trickle vents (see Figure A4.10 (c)). The draw is created in this case by a centrally located fan (usually in the roof space) with dual speed for continuous trickle and boost ventilation taking stale air out into the atmosphere. This continually extracts from wet rooms with automatic control by humidistat or manual control. This system takes away the need for multiple intermittent mechanical vents throughout the building and can be a more cost effective and quieter option. This system also requires attention to ductwork standards and balancing of the extract to ensure its effectiveness.

Positive Input Ventilation:

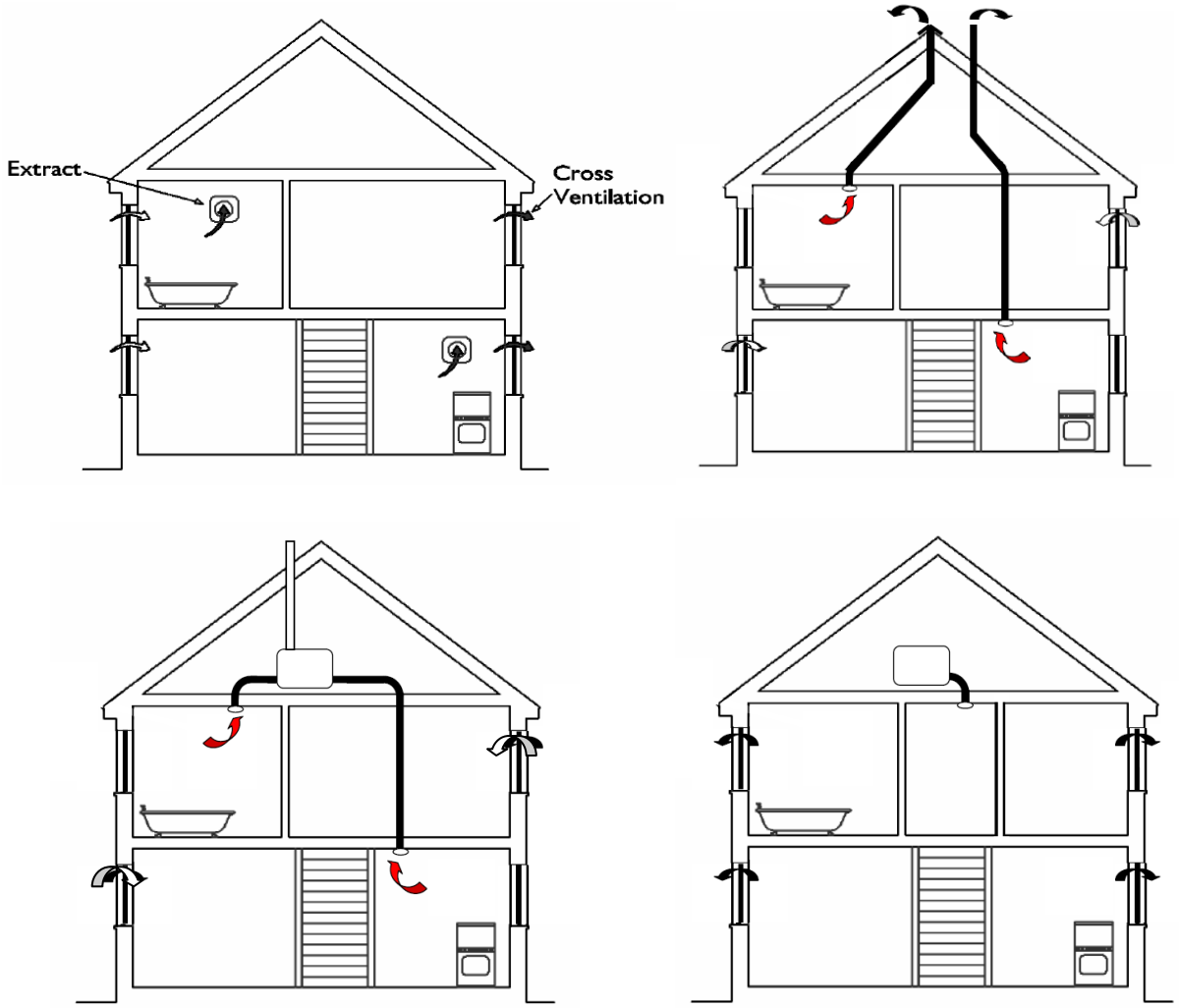
This system employs a mechanical unit located in the roof space centrally over a landing or hall space which draws fresh filtered air from outside into the building gently dispersing it around the building diluting and displacing moisture laden air through positive pressurisation (see Figure A4.10 (d)). Some heat recovery is possible as during the heating season the roof space air temperature is affected by solar gain, convection and conduction heat losses from the building. The fan unit is housed at ceiling level above a landing or hallway. The unit has very low power consumption and can be set to go on standby when loft temperatures rise above certain levels in summertime. Maintenance is low, involving replacement of filters on a set schedule. These systems claim significant success in the reduction of condensation and mould growth within buildings. Care must be taken on installation to avoid draughts being created. Correct sizing and location of the mechanical unit is essential for the system to function effectively.

Mechanical Heat Recovery Ventilation (MVHR):

This system is suitable only for very air tight buildings and offers the highest level of energy efficiency with a high level of heat recovery. A mechanical ventilation unit is located in the roof space which recovers heat from warm extract air to preheat incoming fresh air (see Figures A4.10 (e) and A4.11). Stale air is extracted is from wet rooms and supply is directed to habitable rooms. The systems also have dual speed for continuous trickle ventilation and high speed boost extract. The mechanical heat recovery unit operates on a low specific fan

power (SFP) and efficiency usually greater than 85%. Energy savings are only realised if air permeability of the building is less than 5 m^3/ ($h.m^2$).

Correct balancing of the system at installation is key successful operation. The supply and extract volumetric flow rates must be calculated at design stage to meet national standards. Supply and extract fans must be commissioned to deliver the design flow rates. Fans should be AC variable speed and should maintain design flow rates as filters become clogged between maintenance periods. An appropriate maintenance schedule should be adhered to, particularly for the replacement of filters as air quality may be adversely affected. The importance of this maintenance should be communicated to the client and the schedule explained.



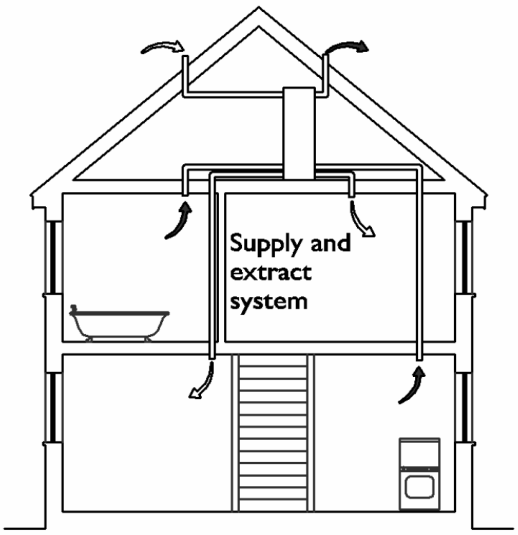


Figure A4.10: (a) Natural Ventilation with localised mechanical extract, (b) Passive Stack Ventilation, (c) Mechanical Ventilation, (d) Positive Input Ventilation, (e) Mechanical Heat Recovery Ventilation (MVHR)

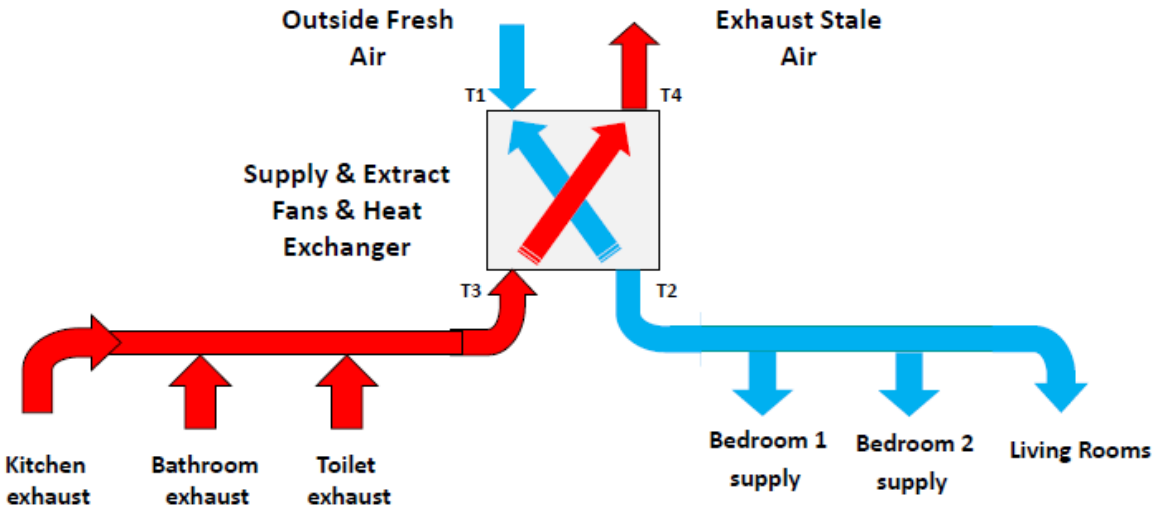


Figure A4.11: Typical MVHR Layout

Hybrid Ventilation:

Hybrid ventilation is a two mode system that combines both mechanical and natural ventilation by using the different features of the systems at different times of day or year. The objective is to provide cost savings over traditional all year air conditioning systems while maintaining air quality in the indoor environment. The system is designed to alternate between different modes for different seasons or individual daily requirements to take advantage of the ambient temperature. This requires sophisticated intelligent control systems that can automatically alternate between modes in response to the monitoring of external conditions and/or building occupancy and usage. This system is most suitable for public, commercial and industrial buildings and can provide significant reduction in energy

consumption over conventional ventilation systems. The control strategy for this type of system should be to achieve the desired flow rate patterns using the lowest possible energy consumption.

A4.3 Space Heating/ Cooling, Water Heating and Controls

Climatic conditions in Ireland mean that there is generally no demand for space cooling systems in the residential sector with air-conditioning being deployed almost exclusively in commercial/industrial buildings. The main energy demand in buildings is for space and water heating (see BUSI Status Quo Report Figures 5.8 and 5.9). Gas and oil have become the main sources of fuel used for space and water heating (see Figure A4.12) with the latter having a high incidence in rural areas where there is no access to mains gas connection.

The majority of primary space heating is provided by water based (hydraulic) central heating systems with a small proportion of radiant (underfloor) and electric storage systems also being used. Typical secondary systems would include open fires, gas fires, electric fuel effect fires and wood pellet, log, multi-fuel or oil stoves. The wet central heating systems transport the heat generated by the boiler around the building via a network of pipes to localised heat emitters in each room. The two main types of wet system are Open Vented and Sealed. The open vent system includes a vent pipe which is open to the atmosphere and relies on a feed and expansion cistern to accommodate changes in water volume with temperature. The sealed system replaces the need for a cistern by utilising a sealed expansion vessel which incorporates a rubber diaphragm to allow for variations in water volume.

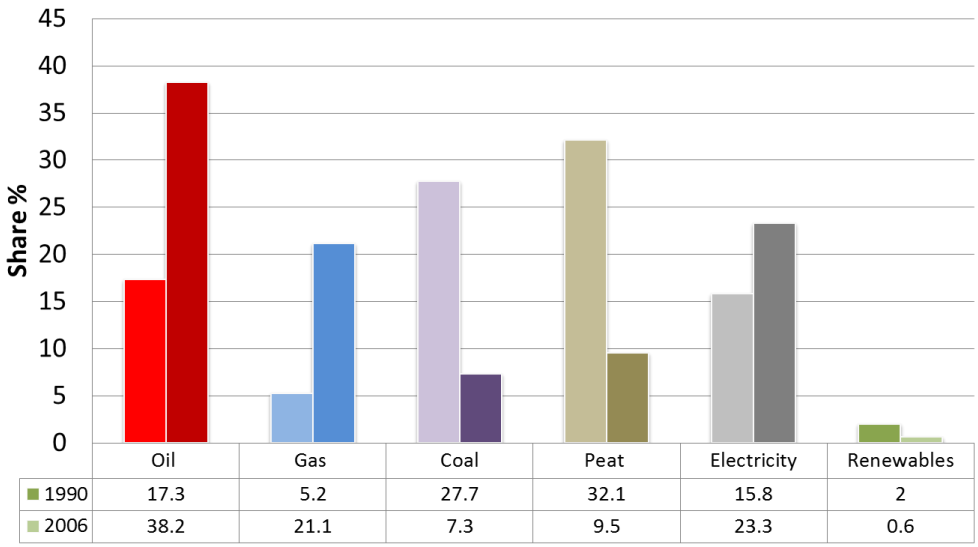


Figure A4.12: Share of final energy consumption by fuel in the residential sector

Underfloor heating has become an established technology in more recent years in Ireland. It is a radiant heating system that employs continuous pipe loops in the floor mass to distribute heat at a lower temperature than traditional central systems with heat emitters by dispersing heat in individual rooms or zones through the floor surface. This system can take greater advantage of the operating efficiencies at lower temperatures of condensing boilers and heat pump technologies. The optimum operation of this type of system is sensitive to correct installation as the thermal mass of the concrete screed which houses the pipework is directly related to the thermal response time, a factor which is particularly significant in Ireland with its inconsistency in seasonal temperatures. The extensive interface between mechanical components and electrical controls also provides challenges onsite as coordination between the plumbing and electrical trades and an understanding of the operating principles of the system are a necessity for successful installations.

Recent amendments to the Building Regulations for conservation of fuel and energy have focussed on the efficiency of heat producing appliances, the zoned control of heating systems and the insulation of primary and distribution pipe circuits and hot water storage vessels. This has led to the widespread employment of high efficiency condensing boilers using both gas and oil. The condensing boiler achieves significantly higher efficiencies over traditional boilers by extracting latent heat from the waste exhaust gases (steam) of fuel combustion by condensing the water vapour to liquid. Typically condensing boilers can achieve efficiency rates between 90-98% compared with 70-80% averages for traditional models.

These efficiencies, however, are dependent on the operating conditions of the boiler. In order for the boiler to operate in condensing mode the temperature of the water returning to the boiler should be below 55ºC, in some cases the temperature may need to be regulated by means of a control valve used to blend hot supply water. The system also benefits from the installation of a weather compensator which adjusts the flow temperature based on external temperature, ensuring that desired room temperature is achieved regardless of fluctuations in weather while minimising energy consumption. Attention is required at installation to match the output of the boiler to the actual heating load of the building. Often the boiler may be replaced as one measure in an energy improvement project in a building and this may mean that there is a significantly lower heating load than previously used to calculate the existing boiler size. Oversizing of a boiler can lead to issues with short-cycling (frequent on-off cycles) resulting in greater shell losses which significantly decrease efficiency.

Hydraulic balancing is an important contributing factor to the efficiency of a wet central heating system that is often ignored by installers. The flow rate, water temperature and size/output of heat emitter will determine if the desired temperature is being reached and overheating or under-heating of spaces can result if these factors are not in correct adjustment to individual room needs. Balancing of the flow rate of the heating medium (water) is required to ensure that the last heat emitters on the distribution network are reaching temperature while ensuring that overheating does not occur in nearer rooms. Apart from the obvious negative effect on efficiency of overheating, there is also the issue of sizing and operation of circulation pumps. The pump may be compensating for incorrect balancing and using power unnecessarily. Also, the regulation of temperature control for the system is affected by the variances between room temperatures.

Water heating systems can generally be divided into two categories, localised and centralised systems. A localised system refers to water heating occurring locally to its needs, e.g. an under-sink instantaneous heater. A centralised system stores heated water in a central location in a building with various draw off points piped from this storage. Commonly in Ireland, this water is heated by the space heating appliance in the heating months and by a secondary electric immersion heater in the summer months. In low demand applications (low occupancy buildings) a combi-boiler may be a more efficient option as the water is only heated when there is demand, hence avoiding storage losses. The efficiency of a water heating system is mainly affected by the primary circuit loses, the storage losses and losses through the network of distribution pipes to draw-of points. Particular attention is required to the continuity of and the performance level of the pipe and storage insulation used. Primary circuit losses can also be reduced by positioning the boiler as close as practicable to the storage vessel.

The provision of adequate space and water heating controls is essential to ensure a match between heating and hot water supply and demand. The Building Regulations have included prescribed standards for the provision of heating controls since 2002. The guidance provided states that the aim should be to provide the following as a minimum; automatic control of heat input based on room temperature; automatic control of heat input for hot water based on the temperature of stored water; separate and independent control of space heating and hot water; shutdown of the heat producing appliance when there is no demand. As a minimum requirement, space and water heating should be divided into two zones with independent time and temperature controls. The regulations also suggest that space heating should be split into at least two zones based on activity, i.e. living areas at a higher temperature than bedrooms. This ‘zoning’ is achieved fitting two or three port motorised valves on the flow feed to each zone which are then controlled by individual room thermostats and programmers based on temperature and time. The controls should also be arranged to create a boiler interlock which ensures that the boiler does not operate unless there is a demand.

The complexity of the heating controls and optimising system efficiency can be significantly affected by the presence of multiple space and water heating systems in the same building, e.g. a dwelling undergoing renovation with a gas fired central heating system in the main building, an extension utilising underfloor heating, a multi-fuel stove with boiler in the main living area and domestic hot water provided by a solar thermal system with top-up from the gas boiler. As an alternative to motorised valves zoning the system, multiple pumps may be used. This will allow for independent speed settings for each zone controlling the water velocity requirement. Systemlink is one example of a multiple circulating pump installation which incorporates a distribution manifold which accommodates independent zone and boiler circuits.

A4.4 Lighting

Lighting accounts for approximately 11% of average household electricity consumption and this percentage increases significantly in commercial buildings, particularly in the retail

sector. Much of this energy for lighting is wasted unnecessarily as a result of over illumination and lack of attention to occupancy patterns in buildings. Emerging technologies in energy efficient lighting includes Light Emitting Diodes, Compact Fluorescent Lights, Induction Lamps, T5 linear fluorescent adaptor products, and Voltage reduction units.

LEDs (Light Emitting Diodes) - These are solid light bulbs which are extremely energy-efficient. When first developed, LEDs were limited to single-bulb use in applications such as instrument panels, electronics, pen lights and, more recently, strings of indoor and outdoor Christmas lights. Manufacturers have expanded the application of LEDs by "clustering" the small bulbs. The first clustered bulbs were used for battery powered items such as flashlights and headlamps. Today, LED bulbs are made using as many as 180 bulbs per cluster, and encased in diffuser lenses which spread the light in wider beams. LEDs are now available with standard bases which fit common household light fixtures.

A significant feature of LEDs is that the light is directional, as opposed to incandescent bulbs which spread the light more spherically. This is an advantage with recessed lighting or under-cabinet lighting, but it is a disadvantage for table lamps. New LED bulb designs address the directional limitation by using diffuser lenses and reflectors to disperse the light more like an incandescent bulb.

The high cost of production has been the key impeding factor to widespread use of LEDs. However, a process for using inexpensive silicon wafers to replace the expensive sapphire-based technology is currently under research, and promises to bring LEDs into competitive pricing with CFLs and incandescent lighting sources.

Compact Fluorescent Lights (CFL) - These produce light differently than incandescent bulbs. In an incandescent, electric current runs through a wire filament and heats the filament until it starts to glow. In a CFL, an electric current is driven through a tube containing argon and a small amount of mercury vapour. This generates invisible ultraviolet light that excites a fluorescent coating (called phosphor) on the inside of the tube, which then emits visible light.

CFLs need a little more energy when they are first turned on, but once the electricity starts moving, use about 75 percent less energy than incandescent bulbs. A CFL’s ballast helps "kick start" the CFL and then regulates the current once the electricity starts flowing.

This entire process typically takes 30 seconds to 3 minutes to complete, which is why CFLs take longer than other lights to become fully lit. CFLs with decorative covers like globe or reflector shapes have a unique design challenge that results in the trade-off of a slower warm up time, which is why these CFLs take longer than bare spirals to reach full brightness.

Older CFLs used large and heavy magnetic ballasts that caused a buzzing noise in some bulbs. Most CFLs today — and all ENERGY STAR qualified CFLs — use electronic ballasts, which do not buzz or hum.

Induction Lamps - The basic technology for induction lamps is not particularly new. Essentially, an Induction lamp is an electrode-less fluorescent. Without electrodes, the lamp relies on the fundamental principles of electromagnetic induction and gas discharge to create light. The elimination of filaments and electrodes results in a lamp of unmatched life. Lasting 100,000 hours or 25 years, this system can outlast 100 incandescent, five HID, or thirty typical fluorescent lamp changes. Based on these well-known principles, light can be generated via a gas discharge through simple magnetism. Electromagnetic transformers, which consist of rings with metal coils, create an electromagnetic field around a glass tube which contains the gas, using a high frequency that is generated by electronic ballast. The discharge path, induced by the coils, forms a closed loop causing acceleration of free electrons, which collide with mercury atoms and excite the electrons. As the excited electrons from these atoms fall back from this higher energy state to a lower stable level, they emit ultraviolet radiation. The UV radiation created is converted to visible light as it passes through a phosphor coating on the surface of the tube. The unusual shape of an induction lamp maximizes the efficiency of the fields that are generated. Although it is not breakthrough science, until recently, it has not been so commercially viable. New developments have broken down the barriers of costs and technological setbacks, such as EMC interference, lumen depreciation, ability to dim and a useful range of available wattages.

T5 linear fluorescent adaptor products (T5 adaptors) - High frequency fluorescent lighting ballasts give circuit power savings of some 10%. By combining HF ballast with new high efficiency tubes, suitable luminaires can maintain existing lighting levels at up to 87% reduction in energy use and cost. But most users do not have suitable luminaires. The lighting world has a massive investment in conventional electromagnetically ballasted T8/T12 luminaires, which are also of the wrong size to accept new T5 high efficiency tubes. The expense and disruption of removing that existing investment and installing a whole new generation of luminaires is the greatest single barrier to achieving the cost and environmental advantages now possible. T5 adapters have been designed to remove that barrier and enable existing fittings to use latest technology. Its retrofit components electronically convert existing luminaires to HF operation and enable those converted fittings to accept the new high efficiency tubes.

Voltage reduction units (VRU) - Most fluorescent lights need the normal mains power level to start up but require a lower level of power once they are on. A voltage reduction unit is a microprocessor that provides the normal mains power for start-up and then reduces power flow for on-going operation. The drop in current is dependent on the age and type of the fluorescent fittings. Cases documented show consistent savings in excess of 25 per cent, with many over 30 per cent.

A4.5 Renewable Energy Systems

A4.5.1 Renewable Heat Technologies

Renewable energy relates to energy that is replenished at a rate equal to that at which it is being consumed. The range of renewable heat technologies is likely to broaden over the coming years; however, the majority of new systems emerging on the market are hybrids of existing technologies. The main categories that these existing technologies fall into are as follows:-

Solar Thermal

Domestic Solar Thermal systems comprise a collector (normally on roof), circulation fluid (glycol), circulation pipework (copper), storage cylinder (stainless steel/copper) and controls (solar controller). These components operate together to exchange solar radiation to heat to heat water which can then be utilised for various heating applications. Most modern systems employ a circulating pump to force circulation. The choice and orientation can have a significant impact on the overall efficiency of the system.

Heat Pumps (air-source and ground-source)

Heat pumps use electricity to extract heat from the surrounding environment (e.g. the ground or air) and transmit this for space and hot water heating. One unit of electricity from heat pumps can generate between 2.5 and 4.5 units of heat, with the extra heat generated classed as renewable. Energy efficiency improvement is a precondition for effective deployment of heat pumps. Otherwise heat pumps and the associated radiator system need to be significantly larger and therefore more expensive.

Ground Source Systems (GSHP) Heat energy is extracted from the ground using closed-pipe loops buried horizontally in trenches or in vertical boreholes that are connected back to the GSHP. The fluid circulating in the closed loop is normally a water/ propylene glycol antifreeze mixture or acceptable equivalent but some direct acting GSHPs use refrigerant. Open loops may also be used to collect water from an aquifer and discharge via a separate aquifer downstream of the water table flow; systems of this type normally require permits from the Environmental protection Agency. Heat extracted from the ground may be supplied to a dwelling either by a water-based heating system (ground to water heat pumps) or by an air distribution system (ground to air heat pumps) . However, scope for deployment is limited by the requirement for sufficient space to locate ground loops or suitability for boreholes which can also be utilised as collectors.

Water Source Systems (WSHP) Heat energy is extracted indirectly from a water source using closed pipe loops as a heat exchanger. The closed loop is connected back to the water from the water heat pump. The water source may be a lake, pond or river or other stable water source. The fluid circulating in the closed loop will normally be water but a water/propylene glycol or acceptable equivalent antifreeze mixture may be used, depending on operating temperatures. Open loops may also be used subject to the permits being obtained from the Environmental Protection Agency. Heat may be supplied to the dwelling

by a water-based heating system (water to water heat pumps) or by an air distribution system (water to air heat pumps)

Air Source Systems (ASHP) Air source heat pumps extract heat directly from the ambient air. Heat is supplied to the dwelling by a water-based heating system (air to water heat pumps) or by an air distribution system (air to air heat pumps). Air to air heat pumps may be single package or split systems. These systems will be more efficient when utilised with a low temperature underfloor heating circuit, but can also work with radiator systems and are best suited when used in conjunction with well-insulated houses with energy-efficient glazing.

All heat pump systems are at their most efficient when the source temperature is as high as possible, the heat distribution temperature is as low as possible and pressure losses in air and water systems are kept to a minimum. If installed in a new dwelling, heat pumps should use refrigerants complying with the provisions of EU Directive 2037:2000. Heat pumps should be CE marked in accordance with the relevant EU Directives where applicable, e.g. machinery safety, low voltage, pressure equipment, electromagnetic compatibility. If summer cooling is provided by the heat pump, it is recommended that condensate drainage from the fan coil units is provided[15].

Heat Pump Performance

The performance of a heat pump is described in terms of its Coefficient of Performance (COP), or the amount of heat the heat pump produces compared to the total amount of electricity needed to run it. The higher the COP, the lower the electrical energy required to deliver a given amount of heat, and therefore the better the performance.

It must be noted, also, that heat pump performance can vary considerably between installations, and is particularly sensitive to installation and commissioning practices and proper operation. Given the sensitivity of performance to design and commissioning, there is a requirement for improved training and accreditation of installers.

Biomass to energy systems

Biomass is a low-density energy source (compared to fuel oils) therefore posing considerable logistical constrains with respect to harvesting, size reduction or processing, transportation, and storage of feedstock for processing/utilisation plants. Biomass supply systems must still overcome these constraints, and also be economically competitive with traditional crops, while providing sustainable supplies. These are some of the major challenges to the success of an integrated bio-energy system such as depicted in the schematic of technically viable resources and conversion pathways in Figure A4.13. In addition, specific characteristics (standards) of feedstocks are required for energy conversion technologies to ensure optimum efficiency, minimal environmental impact and price competitiveness. Biomass supply chains must address these feedstock ‘standards’ on

[15] SEAI Guide – *“Heating and Domestic Hot Water Systems for dwellings – Achieving compliance with Part L 2008”*

a sustainable, year-round cost competitive basis, which may necessitate preferential tax treatment for bio-fuels.

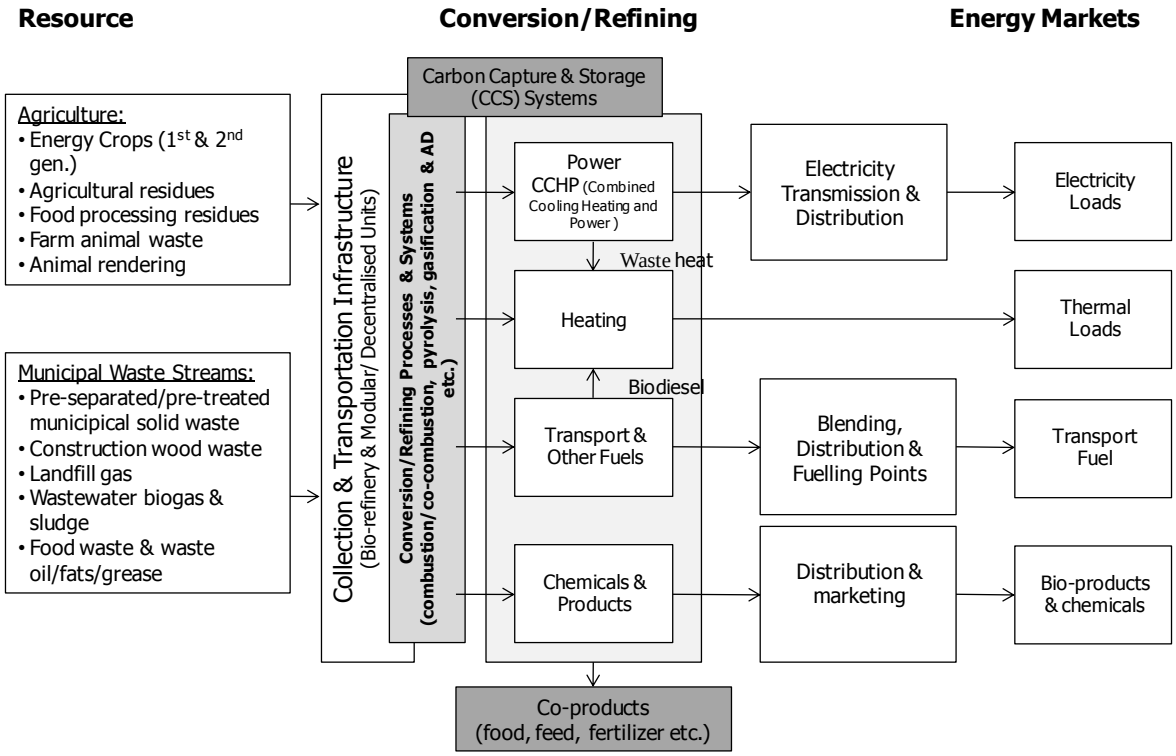


Figure A4.13: Outline of biomass-to-energy pathways[16]
1st generation feedstock includes those that are widely grown and also used for food and feed production, whereas 2nd generation are lignocellulosic material with high potential yields.

Source:
Poeschl M, SM Ward and PMO Owende. 2010. Prospects for expanded utilization of biogas in Germany. *Renewable & Sustainable Energy Reviews* 14(7):1782-1797.

A4.5.2 Renewable Electricity Micro-Generation

Micro generation embraces a range of technologies that are presently at varying stages of development and commercial availability. These include: small wind generators; micro-hydro generation; small-scale photovoltaic (PV) arrays, and; domestic scale Combined Heat and Power (DCHP) equipment.

In any local area micro generation can be installed up to an initial limit of 40% of the substation transformer capacity serving that locality. ESBN is undertaking an assessment of

[16] Source: Poeschl M, SM Ward and PMO Owende. 2010. Prospects for expanded utilization of biogas in Germany. *Renewable & Sustainable Energy Reviews* 14(7):1782-1797.

the effects of increasing micro generation beyond this limit, which will be reviewed after two years or earlier if the 40% limit is reached in a particular area.

In its consultation paper the Commission proposed working with ESBN and the Electro-Technical Council of Ireland (ETCI) to address any safety requirements. ETCI Wiring Regulations currently cover the safety of installation on the customer's side of the meter. The ETCI is also the Irish member of CENELEC. Their published standard EN504388 outlines the safety standards for micro generation in Ireland, although it does not explicitly address installation methods or wiring practices (Commission for Energy Regulation, 2007).

The Composition of a P.V Solar cell

The photovoltaic solar cell consist of a P.n. junction, i.e. Positive and negative .The positive are semi conducting materials of an unsimilar nature and negative are purely semiconductors, i.e. they only conduct a certain amount of current but not on a full capacity. These materials are made of crystalline silicon however there is a difference within the internal composition of the p and n junction. The P junction is not composed of pure crystalline but has slight surplus of impurities which were produced in the transition of "doping". The imbalance of "electrons" is what causes the fusion of the p and the n junction, which work simultaneously in the trapping of light (Boyle, 1996).

How a Photovoltaic Solar cell Operates

When light strikes at a certain wave length, the photons of light travel within the P.N. junction. This enables the transfer of energy from the photons to the internal material of the P.V cell. This symbiotic action enables a surge in energy, leading a valance bond (the lodging and attachment of electrons) to be temporarily formed. However due to the energy capacity of the electrons, there is a breech in this bond leading to the granted access of free electoral movement. The energy dissipated by the photons of light splits itself between the positive and negative junction. There is a reverse effect in both recipients the negative is positive, in the negative side, and the positive is negative in the negative side. This generates a reverse electric field. An electrical current is generated in the transition of In order for electric power to be produced; voltage and current are needed respectively. Due to this combination P.V. cells need to generate both voltage and current. The voltage is provided by the internal electric field set up at the p-n junction. (Boyle, 1996).

For the operation of P.V. cells they need to be positioned vertically in certain angles to ensure the maximum absorption of light as the rays strike at a certain angle.

A4.6 Building Energy Management

A Building Management System (BMS) can be defined as a computer-based control system installed in buildings that controls and monitors the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems, and security systems. The BMS also allows the option of adding further properties such facilities maintenance programs and monitoring and targeting in relation to energy management. A BMS consists of software and hardware that utilises protocols as C-bus, or Profibus. Vendors are also producing BMSs that integrate using Internet protocols and open standards such as DeviceNet, XML, BACnet, KNX, LonWorks and Modbus.

Ongoing research

Opportunities for growth in the involving a variety of BMS type systems have been analysed and identified. Though it is a relatively new area of growth there are examples of the types of professional required to support the industry. In Britain for example, the Rowntree Foundation highlighted the need for 'New skills particularly in understanding user requirements and in integrating and installing systems. ' In North America, the Continental Automated Building Association (CABA) produced a 'Technology Roadmap for Intelligent Buildings' in which they concluded that there is a significant shortage of trained, knowledgeable and certified professionals in the design, installation and integration of intelligent building systems. They further recommended that education must be provided and promoted at all levels. This includes architects and engineers, developers, owners and all those involved in the construction, operation and maintenance of intelligent building technologies. They suggested that education should include traditional universities and schools, and information, workshops and seminars provided through manufacturers and suppliers.

In Europe an industry-led collaborative research project called Industrialised, Integrated, Intelligent Construction (I3CON) commenced in October 2006. Its goal is to enable the transformation towards a sustainable European construction industry delivering Industrially produced, Integrated processes and Intelligent building systems using distributed control systems with embedded sensors, wireless connections, ambient user interfaces and autonomous controllers. New value based business models with highly specialised SMEs working in radically contracted supply chains will deliver high performance spaces, smart business services and lifecycle solutions.

Its education partners' prioritised three areas;

1. Life cycle performance and value-creating business models, reference model for metrics and criteria.

2. Building services concepts and systems, the main interest being around roadmap and concept for the overall BS architecture.

3. Relevant future manufacturing technologies and components for future building services systems and architecture, future technology identification and technology roadmap.

Industry partners on the project highlighted four areas;

1. Life cycle performance and value-creating business models;

2. Building services concepts and the systems to enable them; concepts for integrated smart buildings automation and control; building systems concepts (HVAC, windows, piping and pathways);

3. Relevant future manufacturing technologies and components for future building services;

4. Practical applications of concepts;

Irish Perspective in Building Energy Management

In Ireland research is taking place in the creation of 'intelligent building systems' one being the Strategic Research Cluster (2007 to 2012) IToBO Information and Communication Technology for Sustainable and Optimised Building Operation which is being funded by the Science Foundation Ireland. Academic partners include University College Cork, Tyndall National Institute of Technology, NUI Galway, and Cork Institute of Technology. The Cluster also includes several industry representatives which include ARUP, Cylon Controls Limited, Spokesoft Ltd, HSG Technischer Service GmbH, and INTEL Ireland.

Another example is the Cork Institute of Technology lead 'Networked Embedded Systems Cluster' (NEMBES). This cluster performs research, delivers learning and enables knowledge transfer to industry in the field of embedded systems, the "invisible technology" that monitors and controls electrical and electronic products, communications, transport, machinery and industrial processes. The cluster focuses particularly on the networking of embedded systems, where wireless smart objects, sensors and augmented materials will adaptively collaborate to enable the emerging Internet of Things. The Networked Embedded Systems Cluster has 45 researchers.

A further example is the Netwell Centre based at the Dundalk Institute of Technology (DKIT) with the aim to work with industry to achieve product innovation, business competitiveness, and market leadership in the emerging ambient assisted living (AAL) sector. Bosch Telehealth, Health Service Executive, Dundalk Town Council, the National Centre for Sensor Research and The Faculty of Computing and Engineering at the University of Ulster are all partners in the Netwell Centre.

Development of training in Building Energy Management

A consultation took place with FÁS in order to explore the future training requirements for the intelligent building sector. During this discussion FÁS repeatedly expressed the view that that this is an area of growth, they confirmed this by acknowledging the large number of

contact by industry leaders (Abb, Hager) requesting they provide up skilling opportunities for both individuals involved in construction, including facilities (building) managers, as well as professionals such as architects. FÁS have made an attempt to meet some of this demand for installers by launching a training programme titled 'Intelligent Building Systems.' The purpose of the three module course is to provide participants with an understanding of the key elements of design, installation and commissioning of intelligent building systems including BMS systems using KNX/EIB technologies. They expressed the view there is huge demand for this type of course especially by craftspersons from an electrical background.

KNX technology is the world's first open, royalty-free and platform independent standard for home & building control, approved as a European (EN 50090 - EN 13321-1) and a Worldwide standard (ISO/IEC 14543).

This standard is based on the communication stack of EIB but extended with additional physical layers, configuration modes as well as the application experience of BatiBUS and EHS. As KNX was not designed from scratch but bases on more than 10 years of experience of its legacy systems (BatiBUS, EIB and EHS), KNX is a truly unique standard for Home and Building Control.