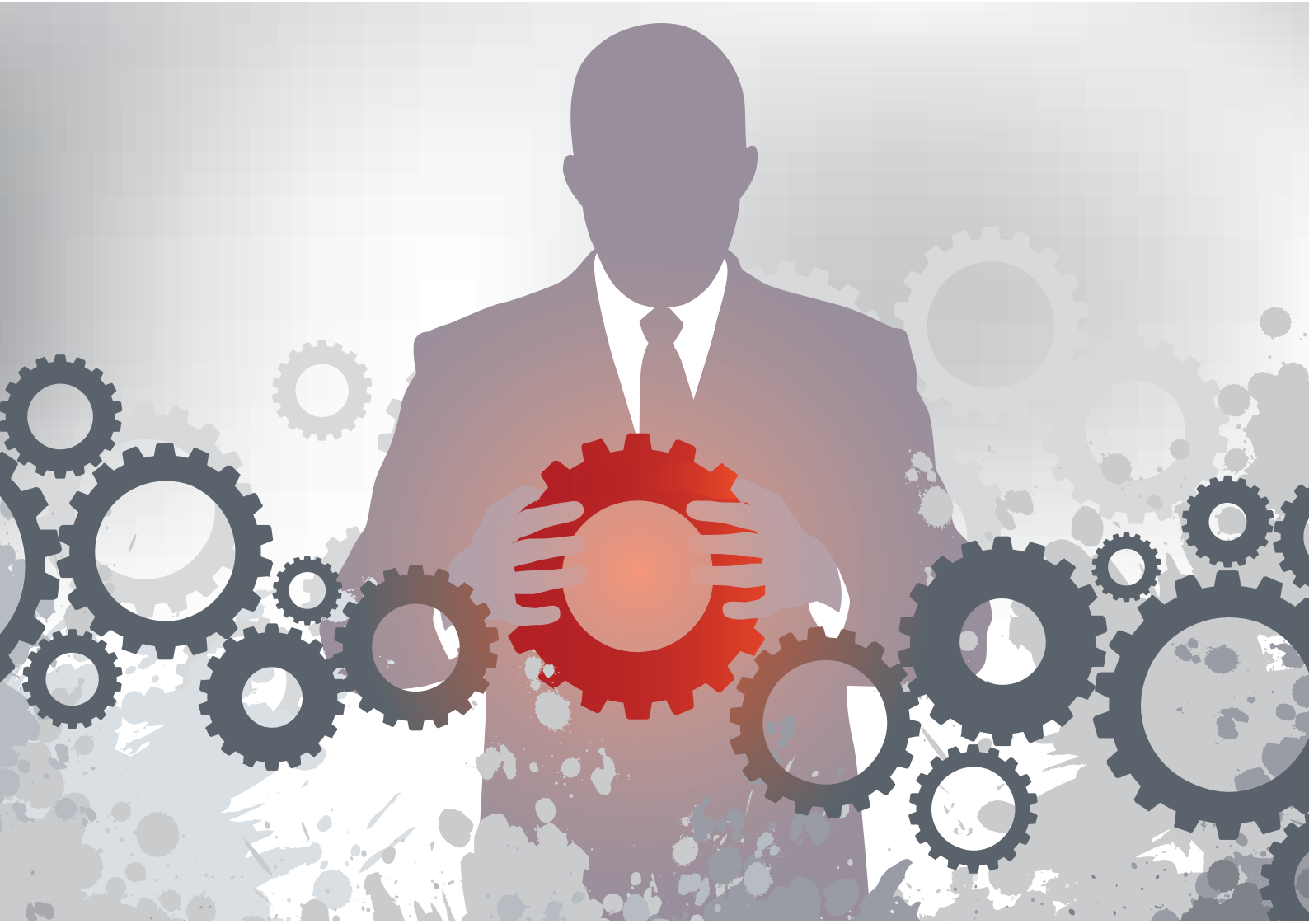


Economic importance of engineers

Prepared by:
DKM Economic Consultants Ltd.

Explanatory Note

The Economic Importance of Engineers was commissioned and funded by Engineers Ireland but is an independent report prepared by DKM Economic Consultants.

Contents

Section 1: Introduction 1

Section 2: A profile of engineers in Ireland and Northern Ireland 3

2.1 Engineers in Ireland 3
2.2 Regional distribution of engineers 7
2.3 Engineers in Northern Ireland 7
2.4 Engineers in other roles 8
2.5 Future supply of engineers 9
2.6 Employment of engineers by nationality 11

Section 3: Economic importance of engineering 13

3.1 Contribution to economic output 13
3.2 Engineers' contribution to the knowledge economy 18
3.3 Engineers' contribution to sustainability 21
3.4 Long-term return to improved infrastructure 26

Section 4: International benchmarking 29

4.1 Engineering graduates worldwide 29
4.2 Ireland's competitive position with respect to the knowledge economy 30
4.3 Ireland's science and technology profile 30
4.4 Engineers and economic growth 31

Section 5: Outlook to 2020 33

5.1 Economic outlook 33
5.2 Labour force outlook 34
5.3 Construction sector outlook 34
5.4 Future demand for engineers 36

Appendix: Results of Engineers Ireland Membership Survey 37

Executive summary

1 Background

The aim of this study is to highlight the importance and contribution of engineers to the economy of the island of Ireland. For the purpose of this study we use the following definition of an engineer:

A member of the engineering profession can be defined as any individual who has successfully completed a level 6 or above engineering programme in an Irish university or institute of technology, or the equivalent international qualification from an educational institute.

2 Profile of the engineering profession

There were 68,500 professional engineers at work on the island of Ireland in 2008 (48,900 or 71% in Ireland and 19,600 or 29% in Northern Ireland)

- The number of engineers employed in the Irish economy has increased by 82% over the last ten years, compared to a 36% increase in total employment.
- Employment peaked in 2006, at the height of the economic boom, when engineering professions made up 2.4% of the total workforce. Numbers fell by 4% in 2007, but grew again by 4% in 2008.

Engineers contribute to a variety of economic sectors

In Ireland:

- Based on a survey of Engineers Ireland members, at the end of 2008, close to a third of Engineers Ireland members were working in construction-related fields: civil/structural engineering accounted for 23%, while construction made up 9%. According to the CSO's Quarterly National Household Survey (QNHS), engineers and engineering technicians accounted for 5% of total construction sector employment in 2008.
- Engineering consultancy and utilities/public sector employment was very important with 18% and 15% of respondents, respectively, falling into these categories.
- Traditional mechanical/manufacturing was less important at 6%, than the more knowledge intensive sectors of ICT/software /computers, electronics/electrical, healthcare/medical devices and pharmaceutical/chemical sectors, which together accounted for 15% of all respondents.
- Research and academic work accounted for 4% of the total.

In Northern Ireland:

- Over half of the respondents in Northern Ireland were working in construction-related sectors: civil and structural engineering accounted for 37% and 17% worked in construction.
- 14% were engaged in consultancy.
- Utilities and public sector employment accounted for 11%.
- Manufacturing made up 7%, with an even split between the traditional and high tech sectors.
- 3% were engaged in research and academic work.

Engineers show great flexibility in their working lives

- Half of the respondents to the survey have worked in another industry sector previously.
- Half of the respondents worked in a technical role, while a quarter were in senior management and another quarter worked as operational managers.
- 31% of Irish Chief Executive Officers have a background in engineering.

Engineers are internationally mobile

- In 2008, 16% of engineering professionals working in Ireland were foreign nationals.

Graduates from engineering courses

In Ireland:

- There were 6,783 graduates of engineering courses (level 6+) in 2006/07 (a fall of 5% over the previous year). This represented 9% of all graduates in that academic year (down from 11% in 2005/06).
- In 2006, 20% of new engineering graduates with a PhD emigrated.

In Northern Ireland:

- There were 700 engineering and technology graduates in 2006/07, accounting for 5% of total graduates that year. This represents a 4% increase in graduates on the previous year.

Based on current enrolment figures, the future supply of engineers on the island of Ireland is expected to decline, not only in numbers, but also in terms of the proportion of total graduates.

3 Economic importance of engineering

Contribution to economic output

- The engineering profession makes important contributions to the economy, both from the direct addition to economic output from the work they do, and the contribution of the sectors in which they work.
- One can also consider the long run return to the economy of improvements in physical infrastructure, in which engineers have played a vital role, and the contributions engineers make to the knowledge economy and to sustainability.
- Engineers represent 2.3% of the workforce on the island of Ireland, and their estimated earnings amount to €5.5 billion or 3.4% of total Gross Value Added (GVA; equivalent to GDP) in Ireland, and €2.16 billion or 6.7% of total GVA in Northern Ireland.
- Engineers are particularly well represented in the high-tech industrial sectors (chemical, pharmaceutical, healthcare, electronics, ICT). In Ireland, these sectors account for almost 80% of merchandise exports, 40% of industrial employment, and between themselves and their suppliers account for approximately 40% of industrial output.
- They generated GVA of €42.3 billion in Ireland in 2007, 25% of total GVA for the entire economy.
- The Irish-owned engineering sector accounts for 17% of exports and approximately a quarter of the payroll, employment and value-added generated by indigenous manufacturing.
- The engineering sector is a major element of the Northern Ireland economy, with approximately 40,000 persons engaged in 2008 in 1,780 establishments, approximately 5% of total employment in Northern Ireland. The sector accounts for 8.1% of total GVA in Northern Ireland.
- At a broader level, the sectors of the Northern Ireland economy where engineers are most active generate 33% of total employment, 45% of payroll, 25% of GVA and 70% of total expenditure.
- The indirect and multiplier benefits from expenditure by the engineering-related sectors support large sections of the wider economy north and south. This is of particular significance now that the economies are moving away from full employment.

Engineers' contribution to the knowledge economy

"The engineering professions are repositories of technological knowledge, and their practitioners are the primary agents of technological change in their respective industries."

- Ireland's economic success has in large measure been due to a restructuring of the economy towards high skill value-added sectors. This has been of particular importance given the increased competition from emerging low cost economies.
- There has been increasing emphasis in recent years on promoting a knowledge economy on the island of Ireland. This has been demonstrated in a number of key policy developments by Government north and south.
- Essential ingredients for the creation of a competitive knowledge economy include education, R&D and innovation. This emphasises the importance of creativity, the accumulation of knowledge, and the development of ideas and designs as well as the application of technology.
- Key elements of the Irish Government's plans for progress towards a knowledge economy:
  - a steep increase in the amount of R&D to be undertaken on the island of Ireland;
  - increases in PhD numbers; and,
  - the promotion of collaboration between industry and academia, campus companies and incubator programmes.
- Engineers, thanks to their skill sets, are agents of the knowledge economy, as they transfer new methods from one area of industry to other areas that are often unrelated in terms of final product.
- Engineers not only work in a wide range of sectors, but they are dynamic in terms of career path, spending time working in many different sectors. This reflects the fact that their skills are easily transferable between sectors.
- Over 90% of the Engineers Ireland Membership Survey respondents believe that continuing professional development is either important or very important to them. Approximately 20% of respondents are involved in or have completed business courses.

Engineers' contribution to sustainability

Sustainable economic development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

- Parallel to the development of the knowledge economy, engineers' skills will be vital to delivering a sustainable economy. Technology transfer, the embodiment of new technology in buildings and other physical structures, as well as solving challenging technical problems around energy generation, usage and conservation, are all areas where engineers are well placed to make a key contribution.
- Ireland's carbon footprint is high by international standards, and the State is already struggling with its 2010 greenhouse gas (GHG) reduction targets under the Kyoto protocol.
- In December 2008, the EU Commission ratified their proposals for Kyoto II, setting targets to achieve a reduction of 20% in GHG emissions over the period 2005 to 2020, rising to 30% if international commitment and cooperation is attained.
- Ireland has had a GHG emission reduction target of 20% imposed, while the UK target is -16%. These impose significantly more reductions than under the original Kyoto Protocol, to be achieved over a shorter timeframe. Given the difficulties with the existing commitments, these new targets represent a considerable challenge.
- Irish Government policy to achieve these targets is centred around a significant improvement in the energy efficiency of buildings and the large scale adoption of renewable energy. Both will be challenging and require significant ongoing investment. Schemes include the continuing resetting of building regulations, measures to encourage the retrofitting of buildings, and the re-orientation of the national grid to accommodate greater proportions of electricity from renewable sources.
- These schemes will require significant investment but will generate significant opportunities. As an example, we estimate that in order for the residential stock to comply with the 2007 Building Regulations in Ireland, there will need to be expenditure of approximately €600 million per annum on an ongoing basis, with a requirement for 7,000 workers at various levels. Proportionately similar figures would apply to Northern Ireland.
- The Irish State sector has a very ambitious programme of investment in environmental, energy and transport infrastructure, which will see €7.25 billion invested in 2009. The delivery of this infrastructure will generate a requirement for 50,000 construction workers at various levels, of whom at least 2,500 could be expected to be engineers. Private sector investment, particularly in renewable energy, is also expected to be substantial.
- There is likewise a large programme of infrastructure investment in Northern Ireland, which would see expenditure of €8.9 billion per annum over the next ten years, generating employment of 6,200 per annum, at least 300 of whom could be expected to be engineers.

Benefits of improvements in infrastructure

- Success in building an internationally competitive, knowledge-based economy is dependent on having strong supporting physical infrastructure in place.
- The decision of multinationals to choose to locate on the island of Ireland is dependent on factors such as the quality of telecommunications, transport links (road, rail, airports and ports) and of education and research facilities.
- In Ireland, under various National Development Plans since 1989, there has been a transformation in the public physical infrastructure, most obviously in roads but also in telecoms, public transport, water, waste management and energy. The aggregate level of construction-related investment under these headings since 1990 has been €57 billion.
- Private built infrastructure has also been transformed over this period, with over 900,000 additional housing units built since 1990 and an unprecedented quantum of modern office space.
- The improvement in the infrastructure stock has delivered and continues to deliver significant economic and social benefits. It is estimated that over half of the economic growth that has been experienced in Ireland since 1990 is due to improved capital stock, and that this improved stock contributed approximately €50 billion towards Ireland's total GNP in 2008.
- Northern Ireland has not experienced the same level of investment in physical infrastructure over the last two decades, although it had a superior legacy of infrastructure, and investment has been substantial in recent years.
- Engineers of various branches, but most notably civil engineers, have been key to the delivery and maintenance of this physical infrastructure, and will continue to be in the future.

4 International benchmarking

- There is a wide range of international economic literature focussing on "engines of growth". Engineers are widely credited in this literature with helping to bring about and fostering productivity gains.
- According to the OECD, the number of science and engineering degrees as a percentage of all new degrees is an indicator of a country's potential for assimilating, developing and diffusing advanced knowledge and supplying the labour market with the human resources that are critical skills for research and development.
- Engineering degrees as a proportion of total degrees in Ireland, while on a par with the UK, were 30% below the OECD average in 2005.
- Ireland's innovation progress to date has been strongly influenced by the openness of its economy and the extensive involvement of foreign direct investment. However, there is a sizeable gap in innovation performance between indigenous and foreign owned firms, and the latter contribute disproportionately to Ireland's R&D and innovation performance.
- When measured against the World Bank's Knowledge Economy Index (KEI), Ireland is lagging well behind the leading countries (in 14th position).
- The "EU Innovation Scoreboard" states that while Ireland's innovation performance was above the EU 27 average, it lagged behind "innovation leaders" such as Sweden, Finland, Germany, Denmark and the UK. Ireland was, however, the fastest improving country among the "innovation followers".

5 Outlook to 2020

- One of the key drivers of future demand for engineers is economic growth. Forecasting growth represents a particular challenge at the moment, given the rapid deterioration in economic performance during 2008 and the extreme uncertainty looking forward in the short term at least.
- The economy north and south has experienced a sharp slowdown in 2008, and further is expected in 2009, with some stabilisation in 2010 and a return to growth from 2011.
- The Irish economy is expected to shrink by approximately 10% between 2007 and 2010. Thereafter, in the first half of the next decade, growth of between 2.5% and 4% per annum is expected to return, depending on how well Ireland regains international competitiveness. Growth is expected to moderate towards 3% per annum in the second half of the next decade.
- Northern Ireland is expected to experience a shallower slowdown in 2009 than is forecast for Ireland, and thereafter to return to similar growth rates.
- The slowdown in the Irish economy is having serious implications for the labour market, with unemployment already at 7.5%. Employment is expected to shrink by more than 100,000 in 2009 and again in 2010, with the result that the unemployment rate will reach almost 12% by 2010.
- The implications for the construction sector are especially serious. Output of the sector in Ireland peaked at €38.5 billion in 2007, or at almost 25% of GNP. This compares with an average of 12% of GDP across Western Europe.
- Estimates for construction output in 2008 are around €29 billion or 18% of GNP. Looking forward, output could be expected to stabilise at 12-15% of GNP over the medium term.
- That said, investment growth by the public sector in Ireland and Northern Ireland is expected over the coming years.
- We estimate that the total investment in infrastructure by the public and private sector in Ireland over the five years 2009-2013 will be in excess of €80 billion, and that the delivery of this investment will maintain employment of over 110,000 each year, of whom at least 5,500 could be expected to be engineers.
- The Northern Ireland Executive likewise plans to invest over €24 billion in public infrastructure between now and 2018. This should generate employment of approximately 17,000, of whom at least 850 could be expected to be engineers.
- Growth and opportunities for engineers will also arise from ongoing private sector investment in the medium term, as well as measures to develop the knowledge economy and to improve the sustainability of the economy.
- Over the last decade in Ireland, there has been an almost one-for-one relationship between economic growth and growth in employment of engineers. On the basis that this relationship is retained, employment of engineers in Ireland could be expected to fall in 2009 before recovering thereafter, reaching approximately 57,000 in 2015 and 67,000 in 2020, almost 40% higher than the 2008 level.
- On the basis that the engineering intensity of the Northern Ireland economy is similar to that in Ireland, then numbers of engineers employed should grow from 19,600 in 2008 to 23,000 in 2015 and 27,000 in 2020, an increase of over 35% over the period.
- In summary, demand for engineers could be expected to grow at an average of 1,500 per annum in Ireland and 600 per annum in Northern Ireland between now and 2020.

6 Summary of Engineers Ireland Membership Survey results

Characteristics of engineers

- 91% of those who answered the survey are Irish nationals.
- 38% of respondents are located in the Dublin area, Co. Cork accounts for 12% and Co. Galway for 7%. Engineers from the North make up a small proportion of the survey, with only 3% coming from the six counties.
- A considerable proportion of members are male (86%).
- 72% of respondents are between the ages of 21-40, with a figure of 22% for the age group 41-60.
- 95% of respondents are satisfied with their career choice.

Educational background

- Most engineers have an honours degree (53%) as their highest qualification. Masters degrees are also fairly common (21%). Ordinary degrees (14%) and doctorates (3%) are less common.
- The majority of engineers qualified as civil, environmental or structural engineers (51%) with many also qualifying as mechanical, mechatronics or material engineers (18%).
- Nearly 12% of the respondents are students.
- Circa 20% of engineers have some form of business qualification.

Sector

- Most engineers qualified as civil or mechanical engineers (over 68%), yet only approximately 30% have remained in these sectors. Large proportions enter consultancy (18%) and construction (9%).
- Nearly 80% of engineers work in firms that employ more than 25 workers.
- Many engineers have changed sectors during their careers, with engineering consultancy, construction, mechanical/manufacturing and civil/structural sectors being among the most frequently cited previous sectors.

Professional development

- 94% of engineers feel that professional development is either important or very important.
- 93% of businesses see professional development as useful, with 23% saying it is critical and 40% calling it necessary.
- 71% of respondents feel that professional development is either critical or necessary in keeping up with job requirements.
- 55% of respondents spend 3-10 days on professional development annually.

Economic issues

- Engineers believe that they can have a positive impact on a range of issues, such as energy (68%), the Government's green agenda (48%), healthcare (12%) and the developing world (18%).
- 88% believe that engineers have a significant role to play in Ireland's economic recovery.

Section 1: Introduction

The engineering sector accounts for a diverse range of occupations across a number of disciplines and provides approximately 110,000 jobs on an all-island basis.[1] The engineering profession has played a key role not only in that sector, but right across the whole economy. The skills acquired during university education and continuing professional development allow engineers to contribute to different sectors and in a range of roles, from technical to managerial.

Engineers have made a major contribution to the island economy in the past and are well placed to play a key role in its transformation to a competitive knowledge economy in line with Government policy. In addition, engineers' expertise will contribute to the implementation of the Governments' green agenda.

The skill set and adaptability of engineers have never been more important than in the current global economic downturn.

This study profiles and focuses on professional engineers and engineering technicians and assesses their economic contribution on an all island basis. It is set out as follows:

Section 2
presents a profile of the engineering profession.

Section 3
considers the economic contribution of engineers.

Section 4
puts Ireland into an international context.

Section 5
looks forward to 2020.

The Appendix contains the detailed results of the Engineers Ireland Membership Survey.

The Executive Summary contains the summary and conclusions.

[1] *Expert Group on Future Skills Needs (2008). All-Island Skills Study.*

Section 2: A profile of engineers in Ireland and Northern Ireland

Definition

A member of the engineering profession can be defined as any individual who has successfully completed a level 6 or above engineering programme in an Irish university or institute of technology (or the equivalent international qualification from an educational institute).[2]

Here we present data from published statistics, supplemented by results from a survey of the Engineers Ireland membership which was conducted in December 2008.

2.1 Engineers in Ireland

2.1.1 Employment trends in engineering occupations in Ireland

There were 48,900 engineers and engineering technicians at work in Ireland in 2008. The number of engineering professionals, as measured by the Quarterly National Household Survey (QNHS) has increased dramatically over the past ten years.

Included in the following Table are:

- civil/mining engineers;
- mechanical engineers;
- electrical engineers;
- electronic engineers;
- software engineers;
- chemical engineers;
- design and development engineers;
- production engineers;
- planning and quality control engineers;
- other engineers and technologists not elsewhere classified;
- engineering technicians; and,
- building and civil engineering technicians.

The number of engineers employed in the Irish economy has increased by 82% over the last ten years, compared to a 36% increase in total employment.

Not surprisingly, employment peaked in 2006, at the height of the economic boom, when engineering professions made up 2.4% of the total workforce, having grown by 12% since 2005.

However, numbers fell by 4% in 2007, but have grown again in 2008.

2.1.2 Professional engineers in Ireland and their educational profile

Focusing on the professional engineer, we have commissioned a special tabulation from the 2006 Census, which allows us to get a picture of the number of engineers and the level of qualification they held.

There were 32,319 persons who described themselves as engineers and engineering technicians in Ireland in 2006 and who held a level 6 or a higher degree.[4]

Table 2.1 Engineers in employment in Ireland, 1998-2008[3]

	Engineers '000	% Increase
1998	26.9	-
1999	30.5	13%
2000	33.3	9%
2001	36.1	8%
2002	37.8	5%
2003	40.4	7%
2004	41.1	2%
2005	43.9	7%
2006	49.2	12%
2007	47.0	-4%
2008	48.9	4%
Increase in engineers 1998-2008		82%
Increase in total employment 1998-2008		36%

Source: CSO QNHS

[2] *Working definition from Engineers Ireland for the purpose of this study.*

[3] *Persons aged 15 years or over, in employment. Data refer to Quarter 3 (June – August for every year in the table)*

[4] *For technical reasons, the CSO could not extract figures for SOC 304 (Building and civil engineering technicians). They are thus not included in the table.*

It is important to note that these figures relate to 2006, but we do not believe that the situation with respect to educational attainment of engineers would have changed significantly. This is confirmed by the Engineers Ireland Membership Survey, which found that in 2008, 90% of respondents had a level 7 qualification or higher, 2% had a level 6 qualification, with an additional 6% currently studying (**Table 2.2**).

- In 2006, 82% of professional engineers held a level 7 qualification or higher, while 16% held level 6 degrees.
- Software engineers constituted the largest group, accounting for 29% of those who classified themselves as engineers and engineering technicians.
- Civil and mining engineers were the second largest group making up 20% of the total.

While engineering, manufacturing and construction was the most frequently held degree among engineering professionals, a wide variety of other qualification were held. This is an indication of the diverse nature of the profession (**Table 2.3**).

- The most popular higher level degree was engineering, manufacturing and construction (held by 59% of engineers with degrees), followed by computing (18%) and life science, physical science, mathematical and statistics (6%). 11% held degrees in multiple subjects.
- The distribution of level 6 qualifications followed a similar pattern, with engineering, manufacturing and construction most important at 65%.

2.1.3 Engineering employment by sector

Engineers are active in and contribute to many sectors of the Irish economy. The Quarterly National Household Survey (QNHS) breaks down the 48,900 engineers and engineering technicians (as enumerated in **Table 2.1**) into broad industrial sectors and finds that:

- 18,500 engineers (38% of all engineers) worked in the production sector;
- 12,000 (equivalent to 25% of all engineers) were employed in construction;
- 11,100 (23%) worked in financial and business services; and,
- 7,300 engineers (15%) found employment in other sectors.

Overall, construction employment as per QNHS Q3 2008 was 257,300. Engineers and engineering technicians thus accounted for 4.7% of total construction employment.[6]

The Engineers Ireland Survey affords us an up-to-date snapshot of the engineering sectors[7] in which its members work.

Table 2.2 Engineering professions by level of third level education, 2006[5]

	Degree or higher (level 7+)	Level 6	Not stated	Total
Software engineers	8,315	1,071	94	9,480
Civil and mining engineers	5,778	755	88	6,621
Electrical and electronic engineers	3,635	1,101	81	4,817
Chemical production, planning and quality control engineers	2,935	551	60	3,546
Mechanical engineers	2,623	582	27	3,232
Other engineers and technologists n.e.s.	1,567	380	70	2,017
Design and development engineers	1,254	229	19	1,502
Engineering technicians	510	509	85	1,104
Total	26,617	5,178	524	32,319
% share	82%	16%	2%	

Source: CSO, Census 2006

5 *Persons (males and females) aged 15 years and over with a third-level qualification attained after completing two or more years of study classified by main subject area, distinguishing those with degree or higher and non-degree qualifications, 2006. Collected under different methodologies, these numbers are not directly comparable with the CSO QNHS data presented in the previous table.*

6 *CSO (November 2008), Quarterly National Household Survey Quarter 3, 2008.*

7 *It is important to note that these engineering sectors are not strictly comparable to the CSO's NACE industrial sectors, referred to above.*

- At the end of 2008, close to a third of Engineers Ireland members were working in construction-related fields: civil/structural engineering accounted for 23%, while construction made up 9%.
- Engineering consultancy and utilities/public sector employment was very important with 18% and 15% of respondents, respectively, falling into these categories.
- Traditional mechanical/manufacturing was less important at 6%, than the more knowledge intensive sectors of ICT/software/computers, electronics/electrical, healthcare/medical devices and pharmaceutical /chemical sectors, which together accounted for 15% of all respondents.
- Research and academic work accounted for 4% of the total (**Table 2.4**).

The 2006 Census also gives a breakdown of engineering professions by sector. It is important to note that the sectors used by the Census are not strictly comparable to the Engineers Ireland Membership Survey. Taken at the height of the economic and, in particular, the property boom, the main Census results are, however, broadly in line with the Survey.
The next table gives the details.

- 40% of the engineers and engineering technicians, as enumerated by the 2006 Census, worked in real estate, renting and business activities and the construction industry.
- Manufacturing industries accounted for 28% of employment of engineers and engineering technicians in 2006.

Table 2.3 Engineers by qualification and subject, 2006

	Degree (level 7+)	Level 6
Engineering, manufacturing and construction	59%	65%
Computing	18%	19%
Life science, physical science, mathematics and statistics	6%	3%
Social sciences, business, law	3%	3%
Humanities and arts	2%	1%
Multiple subjects	11%	6%
Other	1%	3%
Total	100%	100%

Source: CSO, Census 2006.

Table 2.4 Engineers at work by engineering sector (2008)

Answer Options	Response Percent
Civil/structural	23%
Engineering consultancy	18%
Utilities/government depts/local authority sector	15%
Construction	9%
Mechanical/manufacturing	6%
ICT/software/computers	4%
Research/academic	4%
Electronics/electrical	4%
Healthcare/medical devices	4%
Pharmaceutical/chemical	3%
Other	9%
Total	100%

Source: Engineers Ireland Membership Survey 2008, Question 12.
(Column does not add due to rounding.)

Table 2.5 Engineering professions at work by intermediate industrial group, 2006

Industrial sector	%
Real estate, renting and business activities	38%
Manufacturing industries	28%
Metals, metal products, machinery and engineering	*19%*
Chemical, rubber and plastic products	*6%*
Food industries	*1%*
Glass, pottery and cement	*1%*
Other manufacturing (incl. transport equipment)	*1%*
Construction	12%
Transport, storage and communications	6%
Public administration and defence	5%
Banking and financial services	3%
Electricity, gas and water supply	2%
Wholesale and retail trade	2%
Education	1%
Other community, social and personal service activities	1%
Other industries	1%
Industry not stated	1%
All industries	100%

Source: Census 2006

2.1.4 Engineering graduates[8]

In 2006/07 6,783 graduates emerged from a wide range of engineering-related courses at Irish third-level institutions (universities and institutes of technology). This represented 9% of all graduates in that academic year (down from 11% in 2005/06) and a 5% fall in graduate numbers over 2005/06. The break-down by type of degree is shown in **Table 2.6**.

- The number of students taking level 6 degrees, all at institutes of technology decreased significantly, from 1,688 to 1,448, a drop of 14%.
- Level 7 degrees also fell strongly, by 9%. Virtually all of these graduates came from institutes of technology.
- The number of graduates with level 8 degrees rose by 3% overall. The number of university engineering graduates with that qualification actually fell (-2%), while the institutes of technology sector recorded an increase of 8% of such graduates.
- The number of graduates with masters degrees fell by 2% overall, with institutes of technology recording a larger fall (-3%) than universities (-1%).
- The overall number of PhD graduates in engineering disciplines has increased by 3% and stood at 159 in 2007. This could be seen as making progress towards the goal of doubling the number of PhDs from all third-level institutions, as stated in the NDP 2007 – 2013. This is a key element of the knowledge economy.

The first destinations of the class of 2006[9] confirm that the main sectors of employment for engineers are still as outlined above. Among graduates who found employment in Ireland:

- the manufacturing industry was the most important first destination of employment (31%), in particular the computer and electronics and pharmaceutical industry;
- 26% went into the business, finance and insurance services (18% consultant engineering and architectural services); and,
- construction was the third most important destination of engineering graduates, with 14% finding employment there.

Those who found employment overseas followed a similar pattern. It is significant that 20% of engineering graduates with a PhD emigrated. This was the second highest proportion recorded among all faculties and compared to 51% of PhDs from the science faculties.

International mobility is important in a professional's career. It is a key means of enhancing scientific knowledge through the development and transfer of research competencies, and the promotion of excellence in research. As such, initial employment abroad does not necessarily indicate a loss to the Irish economy and research system, but rather the natural progression of a successful professional's career. The current economic turmoil may push many more graduates abroad in the coming years.

Attracting the best engineers back to Ireland after they have gained international experience will be a challenge but is necessary to ensure that Ireland will remain competitive internationally.

Table 2.6 Engineering graduates, by level of qualification, Ireland

	Graduates 2005/06	% shares	Graduates 2006/07	% shares	% Change
Higher certificate (level 6)	1,688	24%	1,448	21%	-14%
Diploma/3yr ord degree (level 7)	2,116	30%	1,924	28%	-9%
Degree/4 yr hons (level 8)	2,505	35%	2,581	38%	3%
Masters (level 9)	683	10%	671	10%	-2%
PhD (level 10)	155	2%	159	2%	3%
Total	**7,147**	**100%**	**6,783**	**100%**	**-5%**

Source: HEA Higher Education Facts and Figures 2006/07, www.hea.ie, Department of Education and Science. (Note: Colums may not add due to rounding.)

[8] *Engineering, manufacturing and construction.*

[9] *Higher Education Authority (Oct 2008), What do Graduates do? The Class of 2006.*

2.2 Regional distribution of engineers

There are no official statistics on the geographic distribution of engineers in Ireland telling us where engineers work. The Engineers Ireland Membership Survey[10] (**Table 2.7**) casts some light on this question by showing where respondents live. However, it must be borne in mind that people may live in one region and work in a different one, as long commutes to work have become the norm in recent years.

- The Dublin region is home to 38% of respondents, and 15% of respondents live in the South-West (Counties Cork and Kerry).
- 12% are domiciled in the Mid East (Counties Kildare, Meath and Wicklow).
- 3% of those who responded to the survey live in Northern Ireland. By contrast, the Engineers Ireland membership register shows that 5% of active members are domiciled in the North.

2.3 Engineers in Northern Ireland

Northern Ireland has a large engineering sector. The engineering industry in 2008 employed 39,600 persons, including self-employed and casual labour. However, this would include many non-professional workers, and would thus not satisfy our definition of level 6 and higher degree holders. In addition, there are many engineers working outside the narrow confines of engineering work, as we have seen above.

According to the Northern Ireland Labour Force Survey, July-September 2008, there were 17,000 persons in employment as engineers in Northern Ireland in 2008. This excludes self-employed, and we have reason to believe, may underestimate the number of engineers working in Northern Ireland for other reasons.[11]
As of September 2008, the total workforce in Northern Ireland was 850,000, compared to 2.12 million in Ireland. Thus the Northern Ireland workforce is 40% of the size of the workforce in Ireland. If engineers represent proportionately the same number of persons in work in Northern Ireland as they do in Ireland, then there would be approximately 19,600 engineers at work in Northern Ireland in 2008 (48,900 x 40%).

2.3.1 Engineering employment by sector

The following table (**Table 2.8**) gives a breakdown into sectors of the engineers in Northern Ireland who responded to the Engineers Ireland Membership Survey.[12]

- Over half of the respondents in Northern Ireland were working in construction-related sectors: civil and structural engineering accounted for 37% of engineers in Northern Ireland and 16% worked in the construction sector.
- 14% of engineers were engaged in consultancy.
- Utilities and public sector employment accounted for 11% of employment for Engineers Ireland members in Northern Ireland.

Table 2.7 Regional distribution of engineers in Ireland

Planning region (counties)	
Dublin (Dublin City, Dun Laoghaire-Rathdown, Fingal and Dublin South)	38%
South-West (Cork City, Cork County, Kerry)	15%
Mid-East (Kildare, Meath, Wicklow)	12%
West (Galway City, Galway County, Mayo, Roscommon)	10%
Mid-West (Clare, Limerick City, Limerick County, North Tipperary)	7%
Border (Cavan, Donegal, Leitrim, Louth, Monaghan, Sligo)	6%
South-East (Carlow, Kilkenny, South Tipperary, Waterford City, Waterford County, Wexford)	5%
Midlands (Laois, Longford, Offaly, Westmeath)	4%
Northern Ireland (Antrim, Armagh, Down, Fermanagh, Londonderry, Tyrone)	3%
Total	100%

Source: Engineers Ireland Membership Survey, derived from Question 3

Table 2.8 Engineers in Northern Ireland by engineering sector

Sector	Percentage
Civil/structural	37%
Construction	16%
Engineering consultancy	14%
Utilities/government depts/local authority sector	11%
Mechanical/manufacturing	3%
Research/academic	3%
Electronics/electrical	2%
Healthcare/medical devices	2%
ICT/software/computers	0%
Pharmaceutical/chemical	0%
Other	13%
Total	100%

Source: Engineers Ireland Membership Survey, Questions 1 and 12
(Note: Column does not add up due to rounding.)

[10] *See Appendix for more detailed results.*

[11] *Based on SOC codes 211 (mechanical engineers), 212 (electrical engineer) and 213 (electronic engineer). Other categories, notably civil engineers (code 210) are not recorded, but may be included under one of the three listed headings.*

[12] *It is important to note that the sample size for this cross tabulation was small and therefore sample errors are expected to be large.*

2.3.2 Recent graduates from Northern Irish third-level institutions

In Northern Ireland, there were 700 engineering and technology graduates in 2006/07, representing a 4% increase on the previous year.

- Level 6/7 qualifications only played a minor role in the higher education sector in Northern Ireland, accounting for 5% of total graduates in 2006/07.
- Level 8 degrees have grown in importance from 62% of all graduates in 2005/06 to 71% in 2006/07.
- The share of postgraduate degrees has fallen from 32% to 24% over the same period.

2.4 Engineers in other roles

2.4.1 Engineers moving between different sectors

Engineers as a profession are very adaptable and can not only be found working in many different industries, but also move frequently between different sectors, as the following table shows. It is a cross tabulation of Questions 12 and 15 from the Engineers Ireland Membership Survey.[14]

We will return to this issue in Section 3 and show that this flexibility of engineers is a vital ingredient in the transfer of knowledge and innovation and therefore for the success of Ireland as a knowledge economy.

Table 2.10 shows that engineers across the spectrum have worked in other sectors. In particular:

- 80% of engineers currently working in research/academia have worked in other sectors previously;
- 71% of engineers in the pharmaceutical/chemical sector have experience in other sectors; and,
- Healthcare/medical devices engineers and those working in the public sector also have extensive experience in other sectors (67% and 65%, respectively).

2.4.2 Engineers in other positions

A qualification in an engineering discipline has long been a pathway to many careers outside the engineering sector as such. Training as an engineer, together with active continuing professional development (CPD) equips the leaders and managers of many leading businesses.

The Engineers Ireland Membership Survey[15] reveals that a significant proportion of engineers hold business qualifications:

- 14% of respondents held a business/management degree, (4% held a masters degree), and
- 7% of respondents were currently studying for a business/management-related degree.

The Survey also found that only half of the respondents worked in a technical role, while a quarter were in senior management and another quarter worked as operational managers (**Figure 2.1)**.

Table 2.9 Students gaining qualifications at Northern Ireland Higher Education Institutions by qualifications obtained[13]

	2005/06		2006/07	
	Engineering and Technology	% of total	Engineering and Technology	% of total
Undergraduate (level 6/7)	40	6%	35	5%
First degree (level 8)	410	62%	495	71%
All postgraduate (level 8+)	215	32%	170	24%
Total	**665**	**100%**	**700**	**100%**

Source: http://www.delni.gov.uk/he_qual_0607.pdf

[13] *Only covers Higher Education Institutions (universities), excludes Further Education Institutes.*
[14] *Full results in Appendix.*
[15] *Question 35 - full survey results in the Appendix.*

This is confirmed by the results from a recent Irish Management Institute (IMI) survey[16] which found that 31% of the Chief Executive Officers who responded to the questionnaire, had risen to that position from a background in engineering.
Thus, engineers are significant agents in the transfer of knowledge not only from sector to sector, but also from non-management to management roles.

2.5 Future supply of engineers

2.5.1 Ireland

The number of students entering engineering/technology courses has fallen for both Level 8 and Level 6/7 courses. This might be expected as the total number of students sitting the Leaving Certificate is declining and is not projected to rise again until 2013. However, the table shows that the proportion of those taking engineering/technology courses has also fallen steadily over the last five years.

- This trend has been more pronounced for level 8 enrolments, which made up 12% of total enrolments in 2003 and had fallen to 8% in 2007.
- Level 6/7 enrolment in engineering/technology courses fell by two percentage points over the period from 2003 to 2007.

Table 2.11 shows the volume of students accepted, in Ireland, into engineering and technology based subjects since 2003 and their share of total enrolments in each year.

Table 2.11 Net acceptance by subject area, all third-level institutions, Ireland

Level 8	Engineering/technology	As % of all courses
2003	2,853	12%
2004	3,257	13%
2005	2,913	12%
2006	2,910	11%
2007	2,323	8%
Level 6/7[17]	Engineering/technology	As % of all courses
2003	4,560	32%
2004	3,922	31%
2005	4,111	31%
2006	3,968	32%
2007	3,595	30%

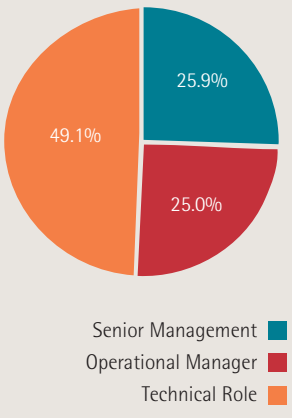
Source: CAO Directors' Report 2007.

Table 2.10 "Have you worked in another industry sector(s) previously?"

Current area of work	Yes (%)
Engineering consultancy	48
Construction	44
Electronics/electrical	46
Healthcare/medical devices	67
ICT/software/computers	49
Pharmaceutical/chemical	71
Mechanical/manufacturing	57
Civil/structural	27
Research/academic	80
Utilities/government depts/local authority sector	65
Other	61

Source: Engineers Ireland Membership Survey
(Multiple answers possible, thus column does not add up to 100%).

Figure 2.1 Employment of engineers by role, Ireland



Source: Engineers Ireland Membership Survey, Question 13

[16] *IMI (2008), Executive Salaries in Ireland 2008/09.*

[17] *A breakdown of this total to show level 6 and level 7 enrolments is not available.*

The number of students entering the education system to study on engineering courses provides a measure of the domestic supply of new engineers. By studying the enrolment rates of students onto level 6/7 and level 8 courses, and comparing this to the drop-out rate of students, one can form an idea of the levels of new engineering graduates per annum. Given that there is typically a two- to five-year lag between students enrolling and graduating, forecasts can be made over the short term, based on present enrolment figures.

We assume that level 8 courses typically take four years to complete, while level 6/7 are usually around three years. As there has clearly been a steady decline in the numbers of students taking up engineering and technology courses, in absolute and relative terms, one would also expect future forecasts to decline.

The new supply of engineers is dependent on the number of students who finish their studies and qualify. As not all students who enter university finish their course, the figures in the above table must be deflated based on survival rates. According to the OECD,[18] the survival rate on average in Ireland is 78% across all courses, which is well above the OECD average of 70%.

Engineering, however, is known to have one of the highest rates for drop-outs and, as a result, the survival rate is likely to be lower[19] than the average. Indeed, research by the National Audit Office in the UK[20] suggests that engineers' survival rates are approximately 5% lower than average; thus, in Ireland a reasonable estimate for the survival rate for engineers would be 73%.

Table 2.12 uses the enrolment figures, appropriate time lags and survival rates to forecast the domestic engineering supply in Ireland. As anticipated, given the decrease in enrolments onto engineering and technology courses, the future domestic supply of engineers is also expected to decline:

- the number of level 8 graduates is expected to fall by 29% between 2008 and 2011; and,
- level 6/7 graduates are expected to decline in number by 27%.

2.5.2 Northern Ireland

The total number of students enrolled on engineering courses in Northern Ireland for 2005 and 2006, is shown below (**Table 2.13**). The table shows that while level 8 enrolment has increased slightly (3%), the number of students attending level 6/7 courses has fallen by 29%. The figures in **Table 2.13** include all the students enrolled in each calendar year, and are not partitioned by year of study. For this

Table 2.12 Forecast future supply of engineering graduates, Ireland

Level 8	Engineering/technology
2008f	2,378
2009f	2,126
2010f	2,124
2011f	1,696
Level 6/7	**Engineering/technology**
2008f	3,001
2009f	2,897
2010f	2,624
2011f	2,191

Note: For Level 8 a four year lag was used, for Levels 6/7 a three year lag was used.

Table 2.13 Total enrolment by subject area, all third-level institutions, Northern Ireland

Level 8	Engineering/technology	As % of all courses
2005	2,257	6
2006	2,322	6
Level 6/7	**Engineering/technology**	**As % of all courses**
2005	1,297	6
2006	917	5

Source: Higher Education Statistics Agency, UK

Table 2.14 Forecast future supply of engineering graduates all third-level institutions, Northern Ireland

Level 8	Engineering/technology
2008f	564
2009f	580
Level 7	**Engineering/technology**
2008f	432
2009f	306

18 *http://www.dius.gov.uk/policy/documents/Teaching_and_the_Student_Experience_Appendices.pdf*

19 *http://74.125.77.132/search?q=cache:6nGneKpJ1QoJ:www.independent.co.uk/ news/education/education-news/163800m-funding-fails-to-slow-university-dropout-rates-784406.html+engineering+university+drop+out+rates&hl=en&ct=clnk&cd=5&gl=ie*

20 *National Audit Office UK (2007), Staying the course: The retention of students in higher education*

reason it is assumed that the survival rate is partially embedded into this figure, as those who have not survived will not be included in the figure above.

Using the figures from Ireland as a proxy, it is assumed that the total numbers of students are evenly split among each year of study. **Table 2.14** gives the forecasts for the domestic engineering supply in Northern Ireland for 2008 and 2009, based on the aforementioned assumptions.

- The supply of domestic engineers with level 8 qualifications is forecast to remain fairly stable (+3%).
- There is a large decrease forecast for the supply of engineers with level 7 qualifications (-41%).

2.6 Employment of engineers by nationality

Engineers are internationally mobile and it is accepted that many professionals need to gather experience abroad. Coupled with the unprecedented level of economic activity during the boom years of Ireland's Celtic Tiger, a shortage of engineers ensued in Ireland. Engineering qualifications are internationally recognised and thus many non-Irish national engineering professionals found employment here.

The latest National Skills Bulletin[21] found significantly higher than average proportions of non-Irish nationals among some engineering and technologist occupations, as **Table 2.15** shows:

- 16% of the selected occupations were non-Irish nationals (compared to an average of 14.9% for the economy as a whole);
- Almost a quarter of software engineers were non-Irish nationals;
- Mechanical engineers also had a higher than average non-Irish share;
- By contrast, planning and quality control engineers (2.5%), design and development engineers (5%) and chemical engineers (7.5%) had very low proportions of non-Irish nationals.

The Engineers Ireland Membership Survey 2008[22] found that just 9.4% of its members were non-Irish nationals. This discrepancy can be explained in two ways:

1) Non-Irish professionals have begun to leave Ireland to seek work elsewhere.
2) Irish nationals may be more inclined to join a local professional organisation.

The following table (**Table 2.16**) gives a breakdown by nationality.[23]

- Eastern Europe was the most important region of origin (26%).
- 25% of non-Irish members of Engineers Ireland came from the UK.
- 17% of non-Irish members were Asian.

Table 2.15 Selected engineering occupations by nationality, 2007

Occupation	Numbers employed ('000)	% Non-Irish nationals
Software engineers	9.1	24.9
Mechanical engineers	4.7	17.7
Civil/mining engineers	12.7	14.9
Electronic engineers	2.8	14.2
Electrical engineers	4.1	11.3
Chemical engineers	1.4	7.5
Design and development engineers	1.5	5.0
Planning and quality control engineers	2.0	2.5
Other engineers and technologists.	5.7	16.4
Total engineers and technologists	**43.9**	**16.0**
National average		**14.9**

Source: National Skills Bulletin 2008.
(Column does not add up due to rounding.)

Table 2.16 Nationality of non-Irish members of Engineers Ireland

Area	Percentage
Eastern European	26%
UK	25%
Asian	17%
Western European (excl UK)	12%
African	11%
Australian/New Zealand	5%
North American	4%
South American	1%
Total	**100%**

Source: Engineers Ireland Membership Survey, derived from Question 1.
(Column does not add up due to rounding.)

[21] *National Skills Bulletin, (2008), FAS and Expert Group on Future Skills Needs.*

[22] *Detailed results in Appendix.*

[23] *Given the small proportion of non-Irish persons among the respondents, the figures in this table are subject to large sample error and thus not statistically robust.*

Section 3: Economic importance of engineering

The engineering profession makes important contributions to the economy on a number of different levels. In the first place, there is the direct addition to economic output from the work they do, which can be measured by engineers' earnings, i.e., payroll plus profits earned.

Then we can consider the contribution that engineers make to the output or Gross Value Added (GVA) of the various sectors in which they work,[24] and the benefits these sectors have throughout the economy in terms of purchases from suppliers, spending by workers and so on.

At a wider level, the engineering profession is a repository of knowledge, technology and experience of key economic importance, and is thus vital to ongoing economic development and growth. Two areas we consider specifically in this chapter are the contributions engineers make to the knowledge economy and to sustainability. We also consider the long run return to the economy of the improvement in physical infrastructure delivered in recent years, in which engineers have played a vital role.

3.1 Contribution to economic output

3.1.1 Engineers' earnings

Ireland

The latest data available on the earnings of engineers comes from the Engineers Ireland Salary Survey, undertaken in early 2008. This indicates that the average earnings plus bonuses of members in 2008 amounted to €67,700. Additional payroll costs (benefits, pension contributions, etc.) amounted to on average €47,900, to give a total of €115,600. This includes earnings by self-employed members, who represented 7% of respondents to the survey. It also includes members with level 6 qualifications, who represent 2.6% of respondents.

As of late 2008, Engineers Ireland had a total membership of 17,060 (excluding students), of whom approximately 90% were resident in Ireland, 5% were resident in Northern Ireland and 5% were resident outside the island of Ireland. On this basis, the total payroll of Engineers Ireland members in Ireland in 2008 amounted to €1.775 billion.[25]

However, the majority of engineers working in Ireland are not members of Engineers Ireland. As described in Section 2.1.1, the QNHS indicates that there were 48,900 engineers working in Ireland in Q3 2008, out of a total workforce of 2.12 million, indicating that engineers represent 2.3% of the total workforce. Furthermore, **Table 2.2** indicates that some 16% of engineers in Ireland are qualified to level 6 only. For current purposes we assume that these are equivalent to technicians as per the salary survey. Re-weighting the results of the survey to cater for this higher percentage of technicians implies average total earnings for engineers in Ireland of €112,600.

Based on this figure, aggregate earnings of engineers in Ireland in 2008 amounted to €5.5 billion,[26] which represents 3.4% of total Irish GVA.

Northern Ireland

Engineers Ireland has in the region of 1,100 members in Northern Ireland, or 5% of its total membership. This would represent a small proportion of the total number of engineers working in Northern Ireland, many of whom could be expected to be members of various UK-based engineering institutions.

According to the Northern Ireland Labour Force Survey, July-September 2008, there were 17,000 persons in employment as

---

[24] *The Gross Value Added (GVA) of a business equals payroll plus profit before depreciation and tax, and is the standard measure of the economic output of the firm. The sum of GVAs from all businesses and other employers in the State equals Gross Domestic Product (GDP). This includes the earnings of engineers themselves, so care is needed not to double count.*

[25] *17,060 x 90% x €115,600.*

[26] *48,900 x €112,600.*

engineers in Northern Ireland in 2008. This excludes the self-employed, and it may underestimate the number of engineers working in Northern Ireland for other reasons.[27]

As of September 2008, the total workforce in Northern Ireland was 850,000, compared to 2.12 million in Ireland. Thus the Northern Ireland workforce is 40% of the size of the workforce in Ireland. If engineers represent proportionately the same number of persons in work in Northern Ireland as they do in Ireland, then there would be approximately 19,600 engineers at work in Northern Ireland in 2008 (48,900 x 40%), which appears reasonable compared with the Labour Force Survey figure.

As for earnings, the Annual Survey of Hours and Earnings 2008, produced by the UK Office for National Statistics, indicates that the average salary of engineering professionals working in Northern Ireland in 2008 was Stg£33,163 (€41,647).[28] This is well below the average figure per the Engineers Ireland Salary Survey, and would appear not to include additional payroll costs, as well as excluding the self-employed.[29]

Based on the Engineers Ireland Salary Survey we estimate that engineers resident in Northern Ireland earn 98% of the average for the island as a whole (due to excluding Dublin-based engineers who earn more than the average). On this basis average total earnings of Engineers Ireland members in Northern Ireland would be €110,300.[30] Assuming that total earnings of engineers working in Northern Ireland are comparable with those of Engineers Ireland members, then the earnings of engineers in Northern Ireland in 2008 would have amounted to €2.16 billion,[31] or 6.7% of total Northern Ireland GVA. This proportion is significantly higher than in Ireland, but reflects the fact that GVA per capita in Ireland is considerably higher than in Northern Ireland.

Table 3.1 Sector of employment of Engineers Ireland members 2008

Pharmaceutical/chemical	3.1%
Healthcare/medical devices	3.6%
Electronics/electrical	3.8%
ICT/software/computers	4.1%
Research/academic	4.1%
Mechanical/manufacturing	6.5%
Other	9.4%
Construction	9.5%
Utilities/government depts/local authorities	15.0%
Engineering consultancy	18.2%
Civil/structural	22.8%
Total	100.0%

Source: Engineers Ireland Membership Survey 2008

3.1.2 Contribution of engineers to output in the wider economy

Ireland

Engineers work widely across the Irish economy, as the Engineers Ireland Membership Survey indicates (**Table 3.1**), and thus engineering contributes to the delivery of the range of outputs in these sectors.

The three main published sources of sectoral economic information in Ireland are:

- the Annual Services Inquiry (ASI);
- the Census of Industrial Production (CIP); and,
- the Census of Building and Construction (CBC).

These CSO publications cover respectively the services, industrial and construction sectors, and the latest detailed information relates to 2006 (preliminary CIP data are available for 2007). As Table 3.1 indicates, these three broad sectors cover the main areas of the economy where engineers are employed.

Starting with the 2006 ASI, this includes the category architectural and engineering activities and related technical consultancy,[32] covering 4,880 firms whose GVA amounted to €1.76 billion. **Table 3.1** indicates that 18% of Engineers Ireland members work in this sector.

[27] Based on SOC codes 211 (mechanical engineers), 212 (electrical engineer) and 213 (electronic engineer). Other categories, notably civil engineers (code 210) are not recorded, but may be included under one of the three listed headings.

[28] At Stg£0.796285/Euro. Average exchange rate 2008, per www.centralbank.ie

[29] It also only includes mechanical, electrical and electronic engineers, as with the Labour Force Survey.

[30] €112,600 x 98%.

[31] 19,600 x €110,300.

[32] NACE category 74.2.

It is not possible to obtain a split of the data between architectural and engineering practices from the CSO, for confidentiality reasons. However, the Royal Institute of Architects of Ireland (RIAI) currently has 592 practices as members. While it is not obligatory for an architectural practice to be a member of the RIAI, we understand that the majority of practices are members. This would indicate that the number of engineering consultancy firms in Ireland in 2006 was in excess of 4,000, which would indicate that the majority of the GVA from this sector related to engineering.[33]

Table 3.1 indicates that just over 20% of Engineers Ireland members work in industry, with a further 15% in utilities and the public sector. The CIP provides data on the economic importance of these sectors.[34] Referring back to the industrial sectors listed in **Table 3.1**, we summarise some of the most important data for these sectors, in **Table 3.2**.

Table 3.2 Key industrial sectors for employment of engineers in Ireland, 2007

	Proportion of total EI members working in these sectors	Engineers employed in sector (2008)	Total sectoral employment	Engineers as % of % total sectoral workforce	Number of enterprises	GVA (€M)	Profit (€M)	Domestic inputs from Irish suppliers (€M)	Exports 2006 (€M)
Pharmaceutical/chemical	3.1%	1,500	24,600	6%	211	14,256	13,028	1,883	27,754
Healthcare/medical devices	3.6%	1,700	20,700	8%	86	2,578	1,813	619	4,530
Electronics/electrical	3.8%	1,800	21,800	8%	327	3,957	3,116	1,023	7,988
ICT/software/computers	4.1%	1,900	17,300	11%	63	4,757	3,963	1,737	31,495
"Modern" sector	**14.6%**	**6,900**	**84,400**	**8%**	**687**	**25,548**	**21,920**	**5,262**	**71,766**
Mechanical/ manufacturing	6.5%	3,100	132,400	2%	4,486	14,520	9,492	23,748	20,799
Utilities/government depts/ local authorities	15.0%	7,100	86,200	8%	103	2,187	1,544	1,643	336
Totals	**36.1%**	**17,100**	**303,000**	**6%**	**5,276**	**42,255**	**32,956**	**30,653**	**92,901**

Note: Estimate of engineers employed per sector is based on a total population of engineers in 2007 of 47,000 per the QNHS (**Table 2.1**); profit equals GVA minus wages and salaries; total employees of utilities/government depts/local authorities includes 77,000 working in the civil service and local authorities; other data under this sector relate to utilities only. Exports data relate to 2006. Domestic inputs from Irish suppliers are based on percentages per the 2000 Input-Output tables, and are net of imported elements of these inputs.

Sources: CSO Census of Industrial Production 2006; Census of Industrial Production 2007 Early Estimates; Public Sector Employment and Earnings June 2008; Input Output Tables 2000.

[33] On a pure pro rata basis, engineering firms would have generated approximately €500 million in annual profits. However, we have no way of knowing if it is appropriate to split profitability on a pro rata basis.

[34] While there are many categories of industry that would have a significant engineering input, only one category in the CIP specifies engineering (General Mechanical Engineering, NACE code 2852), and this is modest in size recording profits of €12 million in 2006.

The key points are:

- these industrial sectors generated GVA of €42.3 billion in 2007, compared with a total GVA for the entire economy of €167.6 billion;[35] and,
- total employment in these sectors was in excess of 300,000, and engineers represented 6-8% of the workforce in most of them (11% in ICT/software/computers).

They purchased €30.6 billion in domestic inputs from other Irish businesses; combined with their own GVA this represents €73 billion of domestic output, or 43% of total GVA for the Irish economy. Engineers are particularly well represented in the high-tech industrial sectors (chemical, pharmaceutical, healthcare, electronics, ICT). These sectors account for almost 80% of merchandise exports, 40% of industrial employment (84,000), and between themselves and their suppliers account for approximately 40% of industrial output in Ireland.

The Census of Building and Construction covers all firms in the sector with 20 or more persons engaged.[36] It relates to NACE code 45, and its subdivisions, as follows:

NACE 45.1	Site preparation, demolition and wrecking of buildings, earth moving, test drilling and boring.
NACE 45.2	Building of complete constructions or parts thereof; civil engineering, construction of highways, roads, water projects and other construction work involving special trades.
NACE 45.3	Building installation, installation of electrical wiring and fittings, insulation, plumbing and other installation.
NACE 45.4	Building completion, plastering, joinery installation, floor and wall covering, painting and glazing and other building completion.
NACE 45.5	Renting of construction or demolition equipment with operator.

It is likely that engineers would be most closely involved in NACE codes 45.1 and 45.2. **Table 3.3** summarises the data for these. The table indicates that:

- these are major sectors, employing over 70,000 in 2006;
- engineers represent one quarter of employment in the firms covered by the census;
- these sectors generated GVA of €7.7 billion in 2006; and,
- they purchased over €10 billion in domestic inputs from other Irish suppliers, thus in total being responsible for GVA of over €18 billion. This represents 12% of total Irish GVA in 2006.

We can also look at the Irish-owned engineering manufacturing sector as defined by Forfás in its Annual Business Survey of Economic Impact 2007. This comprises the following sectors:

- general machinery;
- fabricated metal products;
- electrical and electronic equipment;
- professional goods; and,
- transport equipment.

Table 3.3 Key construction-related sectors for employment of engineers in Ireland, 2006 (NACE 45.1 and 45.2)

Proportion of total Engineers Ireland membership working in these sectors	32.3%
Est. of engineers employed in sector	17,800
Total employment in firms covered by census	71,424
Engineers as % of total workforce covered by census	24.9%
Number of enterprises	858
GVA (€ million)	7,698
Profit (€ million)	3,795
Domestic inputs from Irish suppliers (€ million)	10,556

Source: CSO Census of Building and Construction 2006.

Table 3.4 Irish-owned "engineering sector", 2007

	€M	% of total
Sales	4,002	18.6%
Exports	1,456	16.7%
Value added	1,693	24.3%
Payroll	1,033	27.1%
Employment		27.3%
Purchases – total	1,872	16.3%
Purchases – Irish	731	9.5%

Source: Forfás (2009) Annual Business Survey of Economic Impact 2007.

[35] *CSO National Income and Expenditure 2007, Table 2*

[36] *The majority of firms in the construction sector have less than 20 persons engaged. Total employment in the firms covered in the Census is 97,500, while total construction employment in Q2 2006 per the QNHS was 263,000. Thus the Census covers less than 40% of the sector as measured by employment. However, employment of engineers is most likely to be concentrated in the larger construction firms, and hence the Census data should be reasonably representative.*

Table 3.4 summarises the position. The Irish-owned engineering sector is clearly an important element of the Irish economy, accounting for 17% of exports and approximately a quarter of payroll, employment and value-added generated by indigenous manufacturing.

Northern Ireland

The engineering sector is a major player in the Northern Ireland economy. A study on behalf of Department for Employment and Learning in Northern Ireland[37] indicates that in 2008:

- the engineering sector had approximately 40,000 persons engaged in 1,780 establishments. This represents approximately 5% of total employment in Northern Ireland;
- and,
- the sector accounted for 8.1% of total GVA in Northern Ireland, indicating that GVA per employee in engineering is considerably higher than the average for the economy as a whole.

We can also look at data for key industrial sectors of the Northern Ireland economy, based on the Northern Ireland Annual Business Inquiry (latest available 2006), as per **Table 3.5**.

This indicates that the sectors of the Northern Ireland economy where engineers would be most active generate 33% of total employment in Northern Ireland, 45% of payroll (indicating higher than average earnings), 25% of GVA and 70% of total expenditure.

Table 3.5 Key industrial sectors for employment of engineers in Northern Ireland, 2006

	Employment	Payroll Stg £ million	GVA at basic prices Stg £ million	Purchases and Net Capital Expenditure Stg £ million	SIC codes
Manufacturing					
Food and beverages	18,681	374	1,053	2,341	DA
Electrical and optical equipment	9,120	236	424	1,165	DL
Transport equipment	9,831	293	407	644	DM
Paper and publishing	5,635	123	262	245	DE
Rubber and plastic products	7,608	179	296	645	DH
Basic metals and metal products	8,514	164	311	583	DJ
Other machinery	6,787	186	355	795	DK
Other	21,980	448	901	1,678	
Total manufacturing	**88,156**	**2,003**	**4,009**	**8,096**	**D**
Utilities	1,894	77	449	1,285	E
Construction	47,227	909	2,358	4,261	F
Transport, storage and comm'ns	27,925	626	1,244	1,792	I
Total	**165,202**	**3,615**	**8,060**	**15,434**	
% of total Northern Ireland economy	**33%**	**45%**	**25%**	**70%**	

Source: DETI Northern Ireland, Northern Ireland Annual Business Inquiry 2006.

[37] *Sector Skills Council for Science, Engineering and Manufacturing Technologies (SEMTA), 2008, Engineering Skills Balance Sheet – Northern Ireland: An analysis of Supply and Demand issues.*

3.1.3 Indirect benefits and multipliers

The industrial and construction sectors that engineers are active in are sectors of key importance for the economy north and south. In addition to payroll and profits, they

(i) purchase a wide range of goods and services from other firms in the economy, and

(ii) generate a high proportion of the exports, as demonstrated in the tables above.

Payroll and profits are often referred to as the *direct* effect of economic activity, and demand for domestically produced inputs as the *indirect* effect. In addition, these generate further benefits, as the recipients spend their money elsewhere in the economy.[38] This third benefit is generally referred to as the *multiplier effect*.

In particular, this expenditure supports the domestic services sector, where much of the growth and employment has been in the Irish economy over the last decade. For instance, the retail sector in Ireland currently employs over 300,000 persons, well in excess of total employment in the private sector industry.

The domestic services sector is important also because it generates employment at a range of skill levels. This contrasts with the industrial sector where skills levels have been rising steadily as a result of moving up the value chain. In this way, highly skilled workers such as engineers support wider economic activity and employment. Over the last decade, as Ireland in particular has enjoyed full employment, additional demand in the economy from the indirect and multiplier effects would have encouraged price inflation, which has dissipated some of the benefits. However, it is now forecast that the economies north and south are entering a period of less than full employment, and in these circumstances the support that the industrial sector provides for the wider economy is increasingly vital. A case in point at the moment is the recent decision by Dell to significantly reduce their workforce in Limerick. Local reports highlight the feared impact on upstream and downstream sectors, which point to potentially several thousand additional job losses.[39]

3.2 Engineers' contribution to the knowledge economy

"Economic progress has always involved knowledge. What makes the 21st century distinct, though, is that never before have so many well-trained minds and such powerful computers come together. When firms and organisations successfully combine the two and transform the result into economic value, what you have is the Knowledge Economy."[40]

Most developed and many emerging economies are now striving to become more knowledge intensive, and the challenge for Ireland North and South is to become and remain a competitive knowledge-based economy.

The economic success of the island of Ireland has been largely due to the success of policies aimed towards structural change, opening the economy and encouraging investment by multinationals. These multinationals have created a strong export sector and were drawn to the highly skilled labour force that the island of Ireland offered. This is reflected in the types of firms and industries that have been attracted here in recent years, notably in ICT, biomedical/ pharmaceutical, aerospace, communications and financial services. The island of Ireland is therefore well placed to specialise in high tech, knowledge-intensive and highly capital-intensive manufacturing and services, creating its competitive advantage in a global economy, with knowledge-intensive human capital at its core.

There has been increasing emphasis in recent years on promoting a knowledge economy on the island of Ireland. This has been demonstrated by the establishment of Science Foundation Ireland (SFI) and the publication of a number of key policy documents, including:

- Building Ireland's Knowledge Economy – The Irish Action Plan For Promoting Investment in R&D to 2010 (2004);[41]
- Strategy for Science, Technology and Innovation 2006-2013 (2006);[42]
- Building Ireland's Smart Economy: A Framework for Sustainable Economic Renewal" (2008); and,
- Economic Vision for Northern Ireland (2005).[43]

---

[38] *Although profits of foreign-owned firms are repatriated and there would be some leakage due to the purchase of imports.*

[39] *For example http://www.irishtimes.com/newspaper/breaking/2009/0108/breaking21.htm*

[40] *Ian Brinkley, Director of The Work Foundation (UK). http://www.theworkfoundation.com/pressmedia/news/newsarticle.aspx?oItemId=82*

[41] *http://www.entemp.ie/publications/enterprise/2004/knowledgeeconomy.pdf*

[42] *http://www.entemp.ie/publications/science/2006/sciencestrategy.pdf*

[43] *http://www.detini.gov.uk/cgi-bin/downutildoc?id=936*

The National Development Plan 2007-2013[44] has committed significant resources to research and technological development and innovation (RTDI), with a view to developing the knowledge economy. A sum of €8.2 billion has been allocated for scientific research under the NDP and the Strategy for Science, Technology and Innovation (SSTI), of which €1.4 billion is being channelled through Science Foundation Ireland (SFI).

Building Ireland's Smart Economy is to establish a series of venture capital funds worth a total of €500 million in a bid to lure innovative industries to Ireland and boost R&D activity, while Budget 2009 provided a further €179 million towards scientific and engineering research.

The SSTI sets ambitious targets for growing public and private sector R&D in Ireland. It sees as one of its key visions, a "significant increase in the numbers of people with advanced qualifications in science and engineering". It establishes among other things:

- Discover Science and Engineering (DSE), which will "complement the developments in the school system through enhanced awareness measures, improved teacher training initiatives, enhanced internet-based support materials, careers information and guidance, and pilot initiatives on awareness and teaching methodologies";
- Centres for Science, Engineering and Technology (CSETS), which "have a specific industrial orientation and involve direct linkages with an industrial partner";
  and,
- "A new function will be put in place within Enterprise Ireland to provide centralised support to the institutions and maximise the commercialisation of institution-generated IP." Incubator facilities and campus companies are to be promoted under this heading.

SFI will "invest in academic researchers and research teams who are most likely to generate new knowledge, leading edge technologies and competitive enterprises in the fields of science and engineering underpinning three broad areas:

- biotechnology;
- information and communications technology;
  and,
- sustainable energy and energy-efficient technologies".

IDA Ireland and other agencies north and south are tasked with promoting the knowledge economy, as a means of moving up the value chain, in the context of an ever more competitive global economy, and the migration of industrial employment to lower cost economies.

The private sector is also active, notwithstanding the current economic difficulties. To quote IDA Ireland's website:[45]

"There is a significant and evolving overseas engineering sector in Ireland today. Over 170 international engineering companies have invested in Ireland and use their operations to carry out a broad range of activities in key sub-sectors such as automotive, electrical engineering, aerospace, materials handling and automation. These are supplemented by approximately 450 Irish-owned engineering companies.

- Many leading engineering companies are now undertaking sophisticated value-adding activities within their groups.
- These activities include advanced manufacturing, supply chain management, research and development, shared services and tax-based initiatives such as international trading hub and intellectual property management.
- Major global engineering companies operating in Ireland include; ABB, Cardo, Eaton, Honeywell, Ingersoll Rand, Magna, Kostal, Kone, Liebherr, Pratt & Whitney, and Siemens.
- These sectors and activities are supported by a highly developed sub-supply network, high quality engineering skills, university level research and advanced logistics."

In addition, IDA Ireland works with world-leading firms in the biopharma, medical technologies, chemicals and ICT/software firms based in Ireland.[46] Recent announcements include Houghton Mifflin Harcourt's decision in September 2008 to invest €350 million in eLearning technologies.

---

[44] *http://www.ndp.ie/documents/ndp2007-2013/NDP-2007-2013-English.pdf*

[45] *http://www.idaireland.com/home/index.aspx?id=59*

[46] *http://www.idaireland.com/home/index.aspx?id=59*

The role of engineers

"Engineering professions are repositories of technological knowledge, and their practitioners are the primary agents of technological change in their respective industries."[47]

Engineers have a key role to play in this process, as articulated in the report Engineering a Knowledge Island 2020 (2005) published by the Irish Academy of Engineering and Engineers Ireland. The World Bank's Knowledge Economy Index (KEI),[48] which assesses a country's readiness or level of preparation for a knowledge economy, highlights the following four pillars to show what underpins a knowledge economy:

- economic incentives and institutional regime;
- education and training;
- innovation and technological adoption; and,
- ICT infrastructure.

Engineers and associated professions have a significant part to play in enabling the island of Ireland to excel with regard to the above "pillars", particularly with respect to ICT infrastructure and innovation and technology adoption. The latter emphasises the importance of creativity, the accumulation of knowledge, and the development of

Table 3.6 Sectors engineers work in vs sectors previously worked in

	Please indicate which of the following best describes the engineering sector in which you work.									
Please indicate which industry sector(s) you have worked in previously.	Engineering consultancy	Construction	Electronics/electrical	Healthcare/medical devices	ICT/software/computers	Pharmaceutical/chemical	Mechanical/manufacturing	Civil/structural	Research/academic	Utilities/govt depts/local auth
Engineering consultancy	14	12	3	1	1	4	5	15	6	27
Construction	26	7	2	1	1	1	3	20	3	26
Electronics/electrical	13	3	12	10	14	7	9	2	9	10
Healthcare/medical devices	13	3	2	16	5	13	20	2	11	8
ICT/software/computers	13	5	13	5	17	3	6	4	12	14
Pharmaceutical/chemical	28	10	2	9	4	3	13	4	11	7
Mechanical/manufacturing	14	8	4	10	5	9	12	4	8	9
Civil/structural	14	13	0	0	1	0	3	21	7	29
Research/academic	14	1	4	5	11	1	9	7	21	16
Utilities/govt depts/local auth	28	8	3	2	0	3	5	12	5	19

Key

20%> 2%-10%

10%-19% <2%

Source: Engineers Ireland Membership Survey 2008

[47] *Helpman (1998), General Purpose Technologies and Economic Growth.*

[48] *www.worldbank.org/kam*

ideas and designs, as well as the application of technology. See further discussion of the KEI in Section 4.3.

Engineers and the skills they possess are clearly vital to this process. Engineers act as agents of change and development as they (i) play an important role in the technology transfer process from academia to industry, and (ii) take new methods from one area of industry to other areas that are often unrelated in terms of final product. The range of industries that engineers can contribute to is also extremely wide and permeates the entire economy, as **Table 3.1** demonstrated.

As **Table 3.6** shows, engineers not only work in a wide range of sectors, they are also dynamic in terms of career path, spending time working in many different sectors. This reflects the transferability and flexibility of engineers' skills.

In addition, engineers are increasingly client and market orientated. **Table 3.7** indicates that approximately 20% of Engineers Ireland members are studying for or have completed a business-related further education course. Engineers are therefore well placed to commercialise knowledge and inject it into the economy.

This echoes other findings from the Engineers Ireland Membership Survey: 94% of engineers felt that professional development was either important or very important to them, while 71% felt that professional development is either critical or necessary in keeping up with their job requirements (Questions 14, 15 and 16).

It is clear therefore that the engineering profession regards knowledge accumulation as an important component of their industry. This trait will be important in creating a sufficient base for a strong knowledge economy.

Table 3.7 Participation of Engineers Ireland members in business-related courses

Answer options	Response %
Masters in Business Administration	4.4%
Masters in Industrial Engineering	4.8%
Management or Business Degree	2.8%
Management or Business Diploma	7.2%
Currently studying for one of above	6.6%
None	59.0%
Other	15.3%

Source: Engineers Ireland Membership Survey 2008.

3.3 Engineers' contribution to sustainability

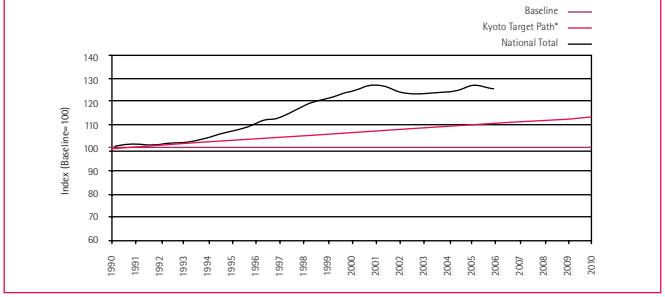
Sustainable economic development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[49]

As population, economic development and consumption increases, the impact of human activity on the environment represents an ever increasing challenge. Climate change specifically is a threat demanding an urgent global response. The 2006 Stern Review in the UK[50] concluded that, on a business-as-usual scenario, the results of global warming could lead to at least a 5% and as much as a 20% reduction in global GDP, indefinitely, and that the benefits of strong, early action on climate change outweigh the costs.

As **Figure 3.1** shows, Ireland is already struggling with its targets under the Kyoto Protocol. Under the EU-wide emissions trading system (ETS), if these targets are not met Ireland will have to purchase additional allowances at a market rate, or pay a penalty of €100 per tonne of additional greenhouse gas (GHG) emitted. In 2006 Ireland was 6.96 million tonnes over its target.

Ireland's carbon footprint is high by international standards. Electricity usage per dwelling in 2005/6 was 20% above the UK average, 17% above the average for the EU-15 and 29% above the average for the EU-27. Likewise, CO_2 emissions per average Irish dwelling were 47% higher than the UK average, 92% higher the average for the EU-15 and 104% more than the EU-27 average.[51]

Figure 3.1 Index of Ireland's GHG emissions to 2006 vs Kyoto target 2010



Source: http://www.epa.ie/downloads/pubs/air/airemissions/ghg_provisional_20061.pdf.

[49] *Brundtland Commission, United Nations. 1987."Report of the World Commission on Environment and Development." General Assembly Resolution 42/187, (1987).*

[50] *Stern Review, "The Economics of Climate Change", UK HM Treasury (2006).*

[51] *http://www.sei.ie/News_Events/Press_Releases/Energy_in_the_Residential_Sector_FNL.pdf*

In December 2008, the EU Commission ratified their proposals for Kyoto II, which set a target to reduce GHG emissions by 20% over the period 2005 to 2020, rising to 30% if international commitment and co-operation is achieved.
Ireland has had the greatest reduction in GHG emission imposed (along with Denmark and Luxembourg) under these proposals, of 20%. The figure for the UK is 16%. These commitments impose a significantly greater reduction in emissions than under the original Kyoto Protocol, to be achieved over a shorter timeframe. Given our difficulties with the existing commitments, these new targets will represent a particular challenge for Ireland.
While climate change is one of the major issues in sustainable development, there are many other serious environmental challenges for Ireland and the rest of the world. Population and consumption growth place an increasing and ongoing pressure on the world's resources, most notably on energy, water, land usage and biodiversity.

Policy responses

In response to these challenges, the Irish Government has produced a number of important policy documents, including:

- the National Climate Change Strategy 2007-2012[52]
- the National Energy Efficiency Action Plan (NEEAP);[53] and
- the 2007 Energy White Paper Delivering a Sustainable Energy Future for Ireland[54]

The Agreed Programme for Government 2007-2012 also introduces a number of ambitious targets in the environmental sphere.
Likewise, the Government in Northern Ireland has produced First Steps Towards Sustainability – A Sustainable Development Strategy for Northern Ireland.[55] Among the targets in the strategy is the plan to improve the energy efficiency of Northern Ireland households by 25% and that of the Northern Ireland Housing Executive (i.e., public sector) housing stock by 40% by 2025.
At EU level a number of policy-related Directives including the Energy End-Use Efficiency and Energy Services Directive ("Energy Services Directive", 2006/32/EC)[56] and the Energy Performance of Buildings Directive (EPBD, 2002/91/EC) are in place.

The Irish Government's Energy White Paper includes the following targets:

- EE 20% – Energy efficiency improvement of 20% will be achieved by 2020.
- RES-E 33% – Renewable energy will contribute 33% to national electricity consumption by 2020.
- RES-H 12% – 12% of thermal energy will come from renewable sources by 2020.
- EE 9% – Energy efficiency will be improved by 9% by 2016 in order to comply with the Energy Services Directive.

The Governments north and south have introduced a range of measures aimed at improving energy efficiency, especially in the construction sector, including energy rating systems and ongoing improvements to building regulations.
The policy impetus on sustainable development is therefore gathering pace, with increasingly ambitious targets that will require innovative technical, social and economic solutions. These targets will represent a major challenge as well as an opportunity, which engineers will have a central role in delivering.

The role of engineers

Delivering the green agenda and achieving sustainable development as well as improving the environment has the potential to deliver economic growth. Given the global nature of sustainable development, engineers from the island of Ireland working on green issues are likely to be operating in one of the most consistently growing sectors of the world economy over the next 50 years.
Solutions aimed at delivering sustainable development will require a broad skills base. Engineers are ideally placed to provide these services and skills, as discussed in Section 3.2. **Table 3.8** summarises the contribution engineers can make:

[52] *http://www.environ.ie/en/PublicationsDocuments/FileDownLoad,1861,en.pdf*
[53] *http://ec.europa.eu/energy/demand/legislation/end_use_en.htm*
[54] *http://www.dcenr.gov.ie/NR/rdonlyres/54C78A1E-4E96-4E28-A77A-3226220DF2FC/27356/EnergyWhitePaper12March2007.pdf*
[55] *http://www.ofmdfmni.gov.uk/sustain-develop.pdf*
[56] *http://eur-lex.europa.eu/LexUriServ/site/en/oj/2006/l_114/l_11420060427en00640085.pdf*

As **Table 3.9** indicates, engineers themselves feel that many of the issues of sustainable development will be of an importance to them in the next few years, including energy (68%), and the Government's green agenda (48%). In addition to this, nearly all engineers (96%) surveyed believed that they could make a positive impact on the green agenda.

Considering specifically the policy responses by the Governments to the challenge of sustainable development, as discussed above, what are the implications of these policy measures? The policy areas we examine here are residential housing stock, and public expenditure on environmental, energy and transport infrastructure.

Table 3.8 The role of engineers with respect to different facets of sustainable development

Aspect of sustainability	Role of the engineer
Environmental protection and enhancement	■ Ensure all relevant ecological legislation is followed ■ Minimise pollution to air, land and water ■ Evaluate options for environmental enhancement
Social integration and well-being	■ Consider impacts on communities ■ Avoid possible health impacts ■ Improve amenities and quality of life
Economic issues	■ Evaluate whole life costs ■ Minimise potential costs of environmental risks ■ Encourage the use of local labour and resources to stimulate local economies
Resource use	■ Ensure the most efficient use of materials, energy, water and other resources ■ Avoid the use of materials known to be exceptionally scarce or environmentally damaging ■ Evaluate the use of the latest resource efficiency technologies

Source: "The Role of the Engineer in Achieving Sustainable Development", Matt Grace, Director, Ferguson Brown Sustainability.

Table 3.9 What do you think are the key issues that will concern engineers in the next few years?

Answer options	Response %
The Irish economy	69%
Energy	68%
The Global economy	56%
The Government's green agenda	48%
Engineering education	37%
Globalisation	19%
The developing world	17%
Healthcare	12%
Other	6%

Source: Engineers Ireland Membership Survey 2008 (Question 69).

Table 3.10 Age of private housing stock in Ireland, April 2006

Year house built	'000	Proportion of total stock
Pre 1919	154	10.6%
1919 to 1940	108	7.4%
1941 to 1960	142	9.7%
1961 to 1970	113	7.7%
1971 to 1980	212	14.5%
1981 to 1990	166	11.4%
1991 to 1995	93	6.4%
1996 to 2000	155	10.6%
2001 or later	249	17.1%
Not stated	69	4.7%
Total	1,462	100.0%

Source: CSO Census of Population 2006.

[57] *http://www.sustainableconcrete.org.uk/PDF/ICT%20Convention%202006%20-%20paper%20-%20Grace.pdf*

Housing

Table 3.10 summarises the age of the housing stock in Ireland, at the time of the 2006 Census of Population.

Taking into account housing completions in the period April to December 2006, and in 2007 and 2008, per DKM's Review of the Construction Industry 2007 and Outlook 2008–2010 (CIRO 2007),[58] and allowing for obsolescence of 2% per annum, we estimate that the total housing stock as at end 2008 was approximately 1.55 million.

Approximately 45% of this housing stock is quite new, having been built since 1990. However, a significant proportion (approximately one quarter) is pre-1960.

The first set of building regulations in Ireland that dealt with thermal requirements were put in place as recently as 1979, with a significant enhancement and broadening of scope in the 1991 regulations. Two-thirds of the stock pre-dates this latter date.[59] A further improvement was introduced with the Building Regulations 1997 (S.I. No. 497 of 1997).

The impact of these improved thermal standards has been remarkable. It is estimated that:

- GHG emissions per household have fallen by 30% since 1990.[60]
- The space heating demand of a dwelling built to the current standards is 76% less than an equivalent dwelling built in the 1970s.[61]

Looking forward, a number of significant developments are in progress:

- New building standards in Ireland, which became operational from July 2008, impose a target of a 40% improvement in energy performance and GHG emissions on new houses, vis a vis that achieved under the 1997 Regulations (SI 854 of 2007).[62]
- In compliance with the EPBD, new houses will require a Building Energy Rating (BER) from July 2008, and from the 1st of January 2009 a BER certificate will be compulsory for all homes being sold or rented.
- The Agreed Programme for Government includes a commitment to introduce further regulations in 2010, to deliver a 60% improvement in energy performance and GHG emissions vis a vis the 1997 standards. Other commitments include:
  - "Incentivise people to move towards greater energy efficiency in their homes especially through improved attic and wall insulation.
  - Ensure that the ESB installs a new smart electronic meter in every home in the country, which will allow people to reduce their bills by cutting back on unnecessary use of electricity."

These developments have the potential to deliver further significant reductions in residential energy usage and GHG emissions over time, as well as reducing costs for householders and tackling fuel poverty. They will require significant amounts of additional skilled work to be carried out in the form of assessing the built stock and improving building processes.

The Regulatory Impact Assessment (RIA) of the 2007 Regulations estimates that the required additional works will add approximately €10,000 to the construction cost of an average dwelling, with some scope for this to fall over time due to economies of scale (for the purpose of this study we have estimated this to be €8,000). At the time of writing housing output is at a low point, but underlying demand will mean that output will recover over time. The ESRI's Medium Term Review 2008-2015 forecasts that new housing completions over the next decade will average approximately 45,000 per annum.

Thus the extra work required to meet the 2007 regulations might be expected to cost 45,000 multiplied by say €8,000 (€10,000 less a saving due to economies of scale), to give approximately €360 million per annum over the next decade.

In addition, each new house that comes on the market now requires a BER, and each second-hand house will require a BER from 2010. The BER is estimated to cost on average €300 per existing dwelling and less (say €200) per new dwelling,[63] and will be valid for ten years.

On this basis the provision of BERs for new dwellings will cost €9 million per annum.[64] If we assume that 5% of the existing stock of dwellings turns over (either via purchase or rent) annually, then approximately

---

[58] *Based on completions of 66,000, 78,000 and 43,000 units in April-December 2006, and full year 2007 and 2008, respectively. http://www.dkm.ie/uploads/pdf/reports/DKM%20CIRO%202008%20Report%20FINAL.pdf*

[59] *SEI (2008) Energy in the Residential Sector. http://193.178.1.196/News_Events/Press_Releases/Energy_in_the_Residential_Sector_FNL.pdf*

[60] *Due to a combination of better thermal regulations and the switch to natural gas for space heating. National Change Strategy 2007-2012. http://www.environ.ie/en/Environment/Atmosphere/ClimateChange/NationalClimateChangeStrategy/PublicationsDocuments/FileDownLoad,1861,en.pdf*

[61] *Department of the Environment, Heritage and Local Government (2007), Regulatory Impact Assessment Building Regulations Part L and Technical Guidance Document L.*

[62] *http://www.environ.ie/en/DevelopmentandHousing/BuildingStandards/RHLegislation/FileDownLoad,16434,en.pdf*

[63] *http://www.myhome.ie/residential/advice-centre/1119-1121-2426/building-energy-rating-(ber)-certificate-in-ireland.asp 45,000 x €200.*

[64] *45,000 x €200.*

80,000 existing dwellings will require a BER each year.[65] The cost of this would be €24 million per annum.

It is likely that the BER system will encourage the retrofitting of some of the existing housing stock on an ongoing basis, particularly in a more competitive market environment, where existing units must compete against new, more energy efficient units. In addition, the Agreed Programme for Government indicates that incentives will be introduced for certain retrofitting steps. How much retrofitting will occur is impossible to predict with accuracy, but if we work on the basis that half of the units transacted (representing the pre-1990 proportion of the stock) will have on average €5,000 worth of work undertaken, then the annual cost would be €200 million per annum.

On the basis of the above calculations, meeting the requirements of the 2007 regulations with respect to the residential sector would generate approximately €600 million each year.

The construction sector is labour intensive, and thus the above expenditure should encourage significant additional employment. CIRO 2007 indicates that the total value of construction output (including materials used) in 2007 totalled €38.5 billion, while direct and indirect employment totalled 357,000, implying that every €108,000 of output generates one year of work. Housing tends to be more labour intensive than the average construction activity; however, no statistics are available on this. For current purposes we adjust the figures by 25% to cater for this, implying one year of work for every €86,000 of output.[66]

Applying this ratio to the €600 million as estimated above, implies that an additional 7,000 jobs would be created on an ongoing basis by the requirement to meet the 2007 regulations.[67] The QNHS indicates that approximately 5% of those working in the construction sector are engineers. On this basis approximately 350 engineers could be expected to be employed on this task.

We do not have detailed data on the age of the housing stock in Northern Ireland, but information for the UK as a whole indicates that it would be at least as old as that in Ireland. The EPBD applies equally to Northern Ireland, and thus there should then be proportionally a similar amount of work to be undertaken and employment generated in Northern Ireland.[68]

Public expenditure on environmental, energy and transport infrastructure

Ireland

Budget 2009[69] sets out the Public Capita Programme (PCP) in Ireland from 2009 to 2013 (end of the current National Development Plan). This indicates capital expenditure of €52 billion, or just over €10 billion per annum (including PPP projects).

In addition, semi-state companies are due to spend €5.6 billion in capital investment in 2009. In the longer run, these semi-state companies are planning very substantial investments:

Table 3.11 Public capital expenditure on environmental, infrastructure and public transport, Ireland, 2009

	€ million
Forestry and bio-energy	121.4
Sustainable energy programmes	53.7
Energy research programme	17.4
Waterways Ireland	11.0
Science and technology programme [Science Foundation Ireland]	309.3
Water and sewerage services programmes	730.0
Environmental services	200.0
Recycling and landfill remediation	15.0
ESB	960.0
Eirgrid	148.0
Bord na Mona	36.0
Bord Gáis	438.0
Public transport	1,032.0
Road improvements	2,470.0
Airports/aviation	710.1
Total	**7,251.9**

Source: Department of Finance, Budget 2009 (includes PPP projects).

[65] This is a conservative figure, to avoid double counting of rental accommodation in particular, and to take account of slowing market conditions. In recent years the number of second-hand dwellings being sold each year has exceeded 200,000. Rental transactions would increase this number further.

[66] €38.5 billion /[357,000/(1.25)]

[67] €600 million /€86,000

[68] For example, the UK Government announced in its November 2008 pre-budget report a plan to bring forward capital spending and create more than 10,000 jobs in the construction industry by insulating homes in the private and public sectorshttp://www.guardian.co.uk/business/2008/nov/24/pre-budget-home-insulation-jobs

[69] http://www.budget.gov.ie/2009/downloads/CombinedBudgetEstimates2009andSPCP.pdf

- the ESB has recently announced a €22 billion investment programme between now and 2020 to deliver and accommodate a greatly enhanced level of renewables in the system. This will see the firm halve its carbon emissions over the period, with the aim of achieving carbon net-zero by 2035;[70]

  and,
- in 2008, Bord Na Mona announced that they are investing €1.2 billion over the next five years in renewable energy.[71]

Planned capital expenditure on environmental, energy and public transport infrastructure for 2009 is summarised in **Table 3.11**: as can be seen, some €7.25 billion is planned to be spent on environmental, energy and transport infrastructure by the Irish Government in 2009. This represents approximately 50% of the total PCP for the year.

This will generate significant employment. From above, the average output per work year for the construction sector as a whole is €108,000. Infrastructure and civil engineering activity is less labour intensive than say housing, so we adjust this figure by 25%. On this basis, the expenditure set out above should generate approximately 50,000 work years of employment.[72]

Engineers are clearly key to the delivery of this infrastructure. The QNHS indicates that engineers represent approximately 5% of employment in the construction sector, implying that the delivery of this infrastructure will generate employment for 2,500 engineers each year. The actual figure could be higher, as these projects are likely to have a higher than average engineering content.

Significant investment is also expected from the private sector in Ireland, particularly in the renewable energy sector. We estimate the value of this could be in the region of 20% of the public sector figure, i.e., approximately €300 million per annum. On a similar basis, private sector investment should generate approximately 2,200 work years, approximately 100 of which should relate to engineers.

Northern Ireland

The Investment Strategy for Northern Ireland 2008-2018, published by the Northern Ireland Executive, sets out a public capital expenditure programme totalling Stg19.4 billion (€24.3 billion) over the period. **Table 3.12** sets out the investment on environmental, energy and transport infrastructure.

3.4 Long term return to improved infrastructure

Success in building an internationally competitive, sustainable knowledge-based economy is dependent on having strong supporting physical infrastructure in place.

The decision of multinationals to choose to locate on the island of Ireland, rather than elsewhere, is dependent on factors such as the quality of telecommunications, the quality of transport links (road, rail, airports and ports) and the quality of education and research facilities. Only economies which can offer quality in these regards will be able to gain a competitive advantage in the global economy.

In Ireland, under various National Development Plans since 1989, there has been a transformation in the public physical infrastructure, most obviously in roads but also in telecoms, public transport, water, waste management and energy. The aggregate level of construction-related investment under these headings since 1990 has been €57 billion, and as discussed above a further ambitious investment programme is in place out to 2013.

The private built infrastructure has also been transformed over this period, with over 900,000 additional housing units built since 1990 and an unprecedented quantum of modern office space added to the stock over the last 10 years. The capacity to deliver high quality buildings and utilities (telecoms, energy, water) has been key to attracting and retaining high-end

[70] *http://www.esb.ie/main/news_events/press_release337.jsp*

[71] *http://www.bnm.ie/files/20080722034947_Press%20Release%2021%20July%202008.pdf*

[72] *€7.25 billion/(108,000/0.75)*

industrial and business activities in Ireland. The improvement in the infrastructure stock as a result of this investment has delivered and continues to deliver significant economic and social benefits. It has accommodated an extra 900,000 residents and 980,000 workers since 1990 and will continue to do so over the coming years.

The latest estimate of the capital stock for Ireland relates to 2004, and values the stock at that point at €1,380 billion, compared to €246 billion in 1990 (all in 2003 prices).[73] This implies that the capital stock has been growing at 13% per annum over the period. Further research indicates that a 1% increase in the capital stock is likely to increase output by 0.25%,[74] or alternatively that a 1% increase in capital stock reduces costs by 0.19%. Thus the increased investment in capital stock over the period 1990 to 2004 is likely to have contributed 3.25% to annual economic growth over the period (13% x 0.25).

GNP growth over the same period has averaged 5.8%, so on this basis the improvement in the capital stock has been responsible for more than half of the economic growth that has been recorded over the period. The implication is that approximately €50 billion of Ireland's total GNP of €164 billion in 2008 (or 30%) is due to the improvement in capital stock since 1990.

Table 3.12 Public capital expenditure on environmental, energy and transport infrastructure, Northern Ireland, 2008-2018

	Stg £ million	€ million
Environment	65.0	81.6
Water	2,617.0	3,286.5
Waste management	436.0	547.5
Energy	174.0	218.5
Public transport	725.0	910.5
Roads	3,095.0	3,886.8
Total	**7,112.0**	**8,931.5**

Source: Northern Ireland Investment Strategy 2008-2018.

The reduction in costs generated by improved infrastructure is of vital importance going forward, particularly in the current context where reducing domestic costs is seen as key to recovering international competitiveness and driving economic recovery. It points to the importance of continued investment in productive infrastructure.

Northern Ireland has not experienced the same level of investment in physical infrastructure over the last two decade, although it had a superior legacy of infrastructure, and investment has been substantial in recent years.

Engineers of various branches, but most notably civil engineers, have been key to the delivery and maintenance of this physical infrastructure, and will continue to be in the future.

[73] *Keeney MJ, (2007) "Measuring Irish Capital" in The Economic and Social Review, Vol.38 (1), Spring 2007*

[74] *Bradley, J et al (2005) "An Integrated Micro-macro Approach to the Evaluation of Large-scale Public Investment Programmes: The case of the EU Structural Funds", ESRI Working Paper No. 167.*

Section 4: International benchmarking

In this section, we examine the international trends of engineering education and compare Ireland's performance to that benchmark. Ireland's international competitiveness as a knowledge economy and international comparisons of science and technology indicators are also considered. Finally, we briefly review the international literature on engineers as drivers of economic growth.

4.1 Engineering graduates worldwide

International studies/international definitions

Above, we have discussed the difficulty of defining an "engineer" in an all-Ireland context. This becomes even more relevant when it comes to international comparisons.

The talent pool for professionals has become globalised, following the same market forces as production facilities. The huge number of engineering graduates emanating from China has given rise to concern in more established economies such as the United States. Reports have stated that the United States graduates roughly 70,000 undergraduate engineers annually, whereas China graduates 600,000 and India 350,000.[75]

However, in China, the word "engineer" does not translate well into different dialects and has no standard definition. A motor mechanic or a technician could be considered an engineer, for example. Thus official numbers of engineering graduates are most likely widely inflated.

In China, the number of first university degrees in engineering more than doubled between 2000 and 2004 and quadrupled over the past two decades. This has given rise to fears of under-provision of engineering graduates, particularly in the US. Historically, almost half of bachelor's recipients in China earned degrees in engineering, but although the numbers of degrees in engineering have increased, the percentage has been steadily decreasing over time. In 1994, 46% were in engineering; by 2004, 37% were in engineering as the number and percentage of degrees in business, literature, education, and law increased.[76]

Figure 4.1 puts Ireland's performance[77] into context.

It shows that in 2005, 8.7% of first degrees in Ireland were in engineering – a figure similar to the UK experience. Assuming that Northern Irish rates were similar to the UK's, the position of the island of Ireland would be unchanged at just below 9% of total graduates. This is significantly lower than the OECD average.

As we have seen, the definition of an engineering degree varies greatly across the world. However, it is interesting to see that among European countries, where definitions are expected to be more comparable, Sweden and Finland, two countries with well developed knowledge economies, were in the top positions.

27% of all degrees awarded in Korea were in engineering, but the caveat of differing definitions must be applied here. According to the OECD,[79] science and engineering degrees as a percentage of all new degrees is an indicator of a country's potential for assimilating, developing and diffusing advanced knowledge and supplying the labour market with human resources that possess critical skills for research and development. It is thus imperative that Ireland improve its position in this measure.

Figure 4.1 Engineering degrees[78] as a percentage of total new degrees, 2005

Source: OECD Science, Technology and Industry: Outlook 2008.

[75] *Wadhwa V. et al (2007), Where the Engineers Are.*
[76] *National Science Foundation (US), Science and Engineering Indicators 2008.*
[77] *This relates to Ireland only, i.e., excludes Northern Ireland.*
[78] *Not directly comparable to the analysis in Section 2, as different definitions were used.*
[79] *OECD (2008), Science and Innovation: Country Notes, Definitions, Annex 3.A1*

4.2 Ireland's competitive position with respect to the knowledge economy

Engineering is the art of science; it transforms abstract concepts into useful technology and, as such, preserves and expands human knowledge. On the other hand, knowledge is expressed by action and work and these, together with technology, provide added value. As such, engineering becomes perhaps the most important vehicle for value creation.[80]

We have seen above that engineers are important agents of the knowledge economy. Engineering consultancy and related services are by nature intellectual services and therefore intangible,[81] but make an important contribution to the dispersal and adoption of new technologies and knowledge.

The World Bank's Knowledge Economy Index (KEI)[82] was referred to above. Country KEI rankings are, to a very large extent, positively correlated with income categories. In 2008, Denmark occupied the top rank in the KEI listing, a position unchanged from 1995. Ireland was in 14th position out of 140 countries, an improvement of just one place since 1995.

Thus, Ireland is lagging well behind the leading countries, despite an expressed Government objective to create a knowledge economy here.

4.3 Ireland's science and technology profile

Ireland's failure to advance significantly in the World Bank's Knowledge Index ranking can be explained by reference to the expenditure on research and development.

Ireland's innovation progress to date has been strongly influenced by the openness of its economy and the extensive involvement of foreign direct investment. However, there is a sizeable gap in innovation performance between indigenous and foreign owned firms, whereby the latter contribute significantly to Ireland's research and development and innovation performance.

However, in the current economic climate, the continued involvement (indeed leadership) of foreign owned firms cannot be relied upon any longer.

As part of the 'Lisbon Agenda', EU Member States have a target for GERD (total R&D expenditure) of 3% of GDP by 2010. The OECD Science, Technology and Industry Outlook 2008 found that:

- due to Ireland's rapidly growing economy, its R&D intensity has not changed much over the past decade, even though expenditure has expanded: at 1.32% of GDP (or 1.56% of GDP), GERD was well below the OECD average;
- around two thirds of gross domestic expenditure on R&D is undertaken by the business sector, two thirds of which in turn by multinational companies operating in Ireland;
- the share of researchers per 1,000 in total employment rose from five in 2,000 to six in 2006, below the OECD average of 7.3, but in line with the EU average. The Government's stated aim to double the annual output of PhDs in science, engineering and technology by 2013 will need to be put into action to ensure that this situation is improved; and,
- as we have seen above, in Ireland, engineering degrees as a proportion of total new degrees were 30% below the OECD average. However, the combined science and engineering degree proportion in Ireland is 8% above the OECD average.

Ireland has a mixed record on research outputs:

- The number of scientific publications per 1,000 inhabitants (440.49) is just above the OECD average.
- The number of firms with new-to-market products is high (many new ideas and knowledge originate from these firms, with the full economic impact of their innovations depending on their adoption by other firms).
- Co-patenting levels are well above average. This is a measure of the internationalisation of research. It constitutes an indicator of formal R&D co-operation and knowledge exchange between inventors located in different countries.

[80] *Institute of Electrical and Electronics Engineers, Inc. http://www.ieee.org*

[81] *http://www.efcanet.org/menuOnder/What_Engineering_Consultants_Do.aspx*

[82] *www.worldbank.org/kam*

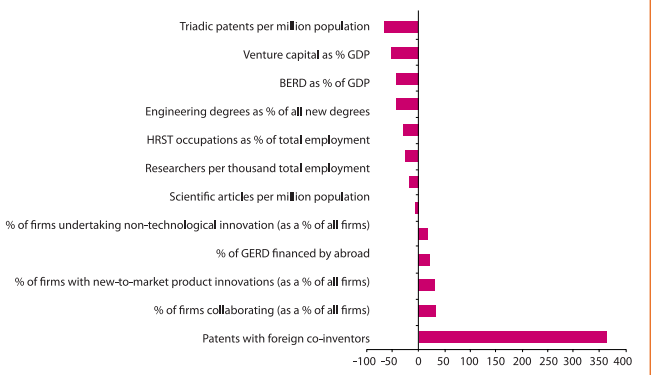
- A large proportion of companies undertake non-technological innovation (this is particularly relevant for service firms).
- However, the number of triadic patents per million of population[83] is low (14.95 compared to 76.38 in Germany and 117.21 in Japan).

Figure 4.2 shows Ireland's performance relative to the OECD average. Positive values indicate that Ireland performed better than the OECD average, while negative values mean that Ireland fell below the OECD average value of the particular indicator.

Where

HRST	occupations as a percentage of total employment is an indicator of the extent of innovation-related skills in the workforce.
GERD	is total R&D expenditure
BERD	is business enterprise R&D

Figure 4.2 Science and innovation profile Ireland vs OECD average, percentage difference, 2005



Source: OECD Science, Technology and Industry: Outlook 2008.

A study with a similar aim, the "EU Innovation Scoreboard" [84] states that while Ireland's innovation performance was above the EU 27 average, it lagged behind "innovation leaders" such as Sweden, Finland, Germany, Denmark and the UK. Ireland was, however, the fastest improving country among the "innovation followers".

Ireland's relative strengths lay in human resources, marked by its strong growth in science and engineering and social sciences and humanities doctorate graduates. Indeed, we have seen in Section 2 that the number of engineering PhDs has increased by 3% between 2005/06 and 2006/07, bucking the trend of most other degree levels in the engineering sector.

The study agrees with the OECD Science, Technology and Industry Outlook and points out that one of Ireland's weak points is BERD investment. However, the EU finds that co-operation between firms is weak.

4.4 Engineers and economic growth

There is a wide range of international economic literature focusing on "engines of growth".[85] The pervasive use of certain technologies in a wide range of sectors and the technological dynamism of professions such as engineers are credited with helping to bring about and fostering productivity gains.

Different strands of the literature use different forces to explain economic growth, but all introduce some type of capital, the accumulation of which overcomes the diminishing returns to physical capital accumulation.

One school uses human capital accumulation to sustain growth (e.g., Lucas, 1988; Jones and Manuelli, 1990; Rebelo, 1991; Stokey, 1991).

Another model perpetuates growth through the accumulation of knowledge, either through learning by doing (Romer, 1986; Stokey, 1988; Young, 1991) or through R&D (Romer, 1990: Grossman and Helpman, 1991; Aghion and Howitt, 1992).

Engineers and related professions play a role in both human capital models (education and training) and in the knowledge economy, as we have seen above.

[83] *This is an indicator of innovation outputs, adjusted to account for the size of the country. Triadic patents are a set of patents taken at the European Patent Office, the Japan Patent Office and the US Patent and Trademark Office that protect the same invention. The use of triadic patents as an indicator eliminates the problems of home advantage and influence of geographical location, that are encountered with single-office patent indicators and thus improves the international comparability of the data.*

[84] *European Union (January 2009), European Innovation Scoreboard 2008. http://www.proinno-europe.eu/metrics*

[85] *For example Bresnahan T.F and Trajtenberg M. (1995), General Purpose Technologies – Engines of Growth, in* Journal of Econometrics *pp 83-108*

Section 5: Outlook to 2020

5.1 Economic outlook

Ireland

The Irish economy is clearly in transition to a new phase of its development. The deterioration in economic conditions during 2008 plus the contraction in residential investment and the weak consumer sentiment levels will result in a severe contraction in economic activity this year and next. The turbulence in international financial markets looks set to continue, resulting in continued difficulties securing credit and thus less scope for consumer and businesses activity. The serious deterioration in the Exchequer finances is generating significant budgetary pressures, and the Government has recently announced an economic recovery package which focuses on cutting public spending and pay.

One of the key drivers of future demand for engineers is economic growth. Forecasting growth represents a particular challenge at the moment, given the rapid deterioration in economic performance over 2008 and the extreme uncertainty looking forward in the short term at least. In view of this we present two future economic scenarios, based broadly on the ESRI Medium Term Review 2008-2015, published in May 2008, but adjusted for subsequent developments in the short run. This comprises a "Benchmark" scenario, whereby growth returns to its trend rate in the next decade, and a "Low growth" scenario, whereby below-trend growth persists, as a result of a failure to tackle economic problems and regain competitiveness.

The basis of our economic forecasts for each year is:

- 2008, 2009: the ESRI Quarterly Economic Commentary Winter 2008;
- 2010: DKM estimate based on Davy stockbrokers' macroeconomic forecast per Davy on the Irish Economy (December 2008); and,
- 2011-2020: the ESRI Medium Term Review 2008-2015 Benchmark and Low growth scenarios.

These generate a GNP forecast whereby the economy experiences a sharp slowdown in 2008 and 2009, with some stabilisation in 2010 and a return to growth from 2011. The forecast growth rates can be seen in **Table 5.1** and **Figure 5.1**.

These scenarios foresee a sharp contraction in the economy over the period to 2010. The "bounceback" post 2010 can be seen as catching up lost ground to a large degree.

Northern Ireland

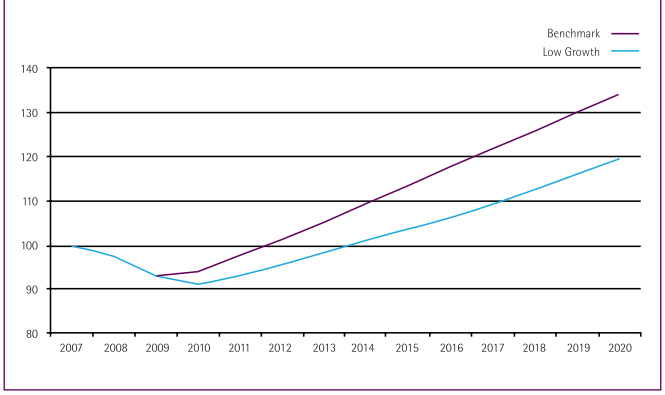
Forecasts for the Northern Ireland economy also see a slowdown in 2009, but a much shallower one than is expected in Ireland (**Table 5.2** and **Figure 5.2**). Over the next decade growth is forecast as between the Benchmark and Low scenarios in Ireland, but because of the shallower recession, cumulative growth in Northern Ireland between 2007 and 2020 is expected to be somewhat stronger than in Ireland (cumulative growth = 37% in Northern Ireland compared to 34% in the

Table 5.1 GNP annual growth rates forecasts to 2020, Ireland

Year		
2008	-2.6%	
2009	-4.6%	
	Benchmark	Low
2010	1.0%	-2.0%
2011-2015	3.9%	2.6%
2016-2020	3.4%	2.9%

Sources: ESRI QEC Winter 2008 and MTR 2008-2015; Davy December 2008.

Fig 5.1 GNP annual growth rates forecasts to 2020, Ireland



Sources: ESRI QEC Winter 2008 and MTR 2008-2015; Davy's, December 2008.

Ireland benchmark forecast).

5.2 Labour force outlook

Ireland

We use the same sources for the labour force outlook as for the GNP growth forecasts. As with GNP, there is expected to be a sharp disimprovement in labour market prospects in the short term, with negative employment growth and increasing unemployment. This is tempered to some degree by an expected reduction in labour force growth as a result of outward migration. The forecasts are as per **Table 5.3**.

As can be seen, it is expected that the labour force will shrink by in excess of 100,000 over the next two years. Employment will shrink even more rapidly, by more than 100,000 in each of the next two years, with the result that the unemployment rate is expected to reach almost 12% by 2010.

Thereafter, in the Benchmark scenario where Ireland recaptures international competitiveness, the unemployment rate falls back towards 5%. In the Low growth scenario where competitiveness remains impaired, unemployment remains somewhat higher at 7%.

Northern Ireland

Northern Ireland labour force forecasts are not available, but current developments indicate that the labour market in Northern Ireland will experience a similar downturn to that expected in Ireland over the coming years.

5.3 Construction sector outlook

Construction is one of the main sectors for employment of engineers, and as such is worthy of specific attention. The following discussion relates to Ireland only. There is a lack of detailed data on or forecasts for the construction sector in Northern Ireland. However, many of the issues facing the sector in Ireland are also relevant for the Northern Ireland economy, albeit to a lesser degree.

Current position

As with the economy in general, the construction sector is in a period of transition from the peak levels of activity in 2006 and 2007. The correction underway in the housing market will require housebuilding levels to undershoot for a number of years. This combined with the difficulties securing finance does not augur well for building projects over the next two years. Confidence in the sector is at a low as new business continues to weaken, the pace of employment losses accelerates and companies remain pessimistic about the short-term future.

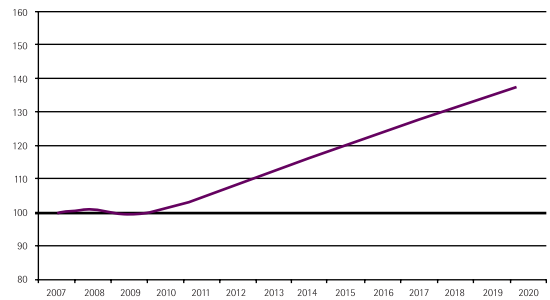
The value of output in the construction industry peaked at €38.5 billion in 2007, or almost 25% of GNP.[86] This compares with a value of €17.6 billion in 2000 or almost 20% of GNP. These proportions were unsustainable, and compared with an average of approximately 12% of GDP across Western Europe.

Table 5.2 GVA annual Growth forecasts to 2020, Northern Ireland

Year	
2008	1.0%
2009	-1.4%
2010	1.4%
2011-2015	3.4%
2016-2020	2.8%

Source: Oxford Economics, December 2008.

Figure 5.2 GVA annual growth forecasts to 2020, Northern Ireland



Source: Oxford Economics, December 2008.

[86] *Review of the Construction Industry 2007 and Outlook 2008-2010, September 2008*

It would appear that the optimum size of the Irish construction industry over the medium term will be substantially below where it was in 2007, with consequences for construction employment. Estimates for construction output in 2008 suggest that the value of output declined to around €29 billion or 18% of GNP.

On this basis the volume of construction output had declined by around 20% from the 2007 peak by the end of 2008. If the Irish construction industry is to align itself, not just with the rest of Europe, but with its own historical averages,[87] it is conceivable that construction output could fall to around 12% to 15% of GNP over the medium term.

However, construction has been a major sector of the economy and has had significant positive effects on employment both direct and indirect. Total employment in construction peaked at 282,600 in 2007 (Q3).

An important factor explaining the growth in construction employment has been that the growth in construction output has been accompanied not just by higher standards and new methods of construction but also by a more rigorous regulatory environment and an increasing emphasis of new areas of activity, which have generated a demand for more construction skills and new occupations. We would include here, for example, the National Spatial Strategy, sustainability, energy efficiency, rural housing, environmental impact assessment and urban planning.

Thus there has been a significant addition to both the skills capacity and knowledge of the construction labour force over the boom years. Every opportunity to retain those skills and support productive construction output should be explored.

Other benefits of the substantial investment to date in construction include the improvement in the quality of the building stock, progress on alleviating residential and infrastructure deficits and the provision of productive infrastructure, which has helped improve the competitiveness of the economy.

Construction output forecasts

The most recent construction output forecasts for the medium term published are from Euroconstruct (November 2008), prepared by DKM (**Table 5.4**).

These projections imply that the size of the construction industry would be around €25 billion by 2010, with some recovery projected for 2011 on the back of a recovery in housebuilding. The 2010 projection for construction output is equivalent to just under 16% of GNP.

One concern is that the prospects for private non-residential construction are not known. With confidence amongst developers and construction clients currently weak, there is a risk that there will be very limited investment in private buildings (offices, retail, industrial, hotels) over the next two years.

The main area where there is likely to be growth is in the public sector where substantial capital investment is planned (see Section 3). The total multi-annual capital provision for the period 2009-2013 is €52 billion, to which can be added €5-6 billion of investment per

Table 5.3 Labour force and employment annual forecasts to 2020, Ireland

Year	Labour force growth (000)	Employment growth (000)	Wage growth (%)	Unemployment rate (%)*
2008	26	-10	2.6%	6.1%
2009	-45	-116	0.0%	9.4%
2010	-67	-110		11.7%
2011-2015				5.3% (7.2%)
2016-2020				4.4% (7.0%)

Sources: ESRI QEC Winter 2008 and MTR 2008-2015; Davy December 2008.
*Brackets indicate Low growth scenario.

Table 5.4 Forecast growth in construction output

	2007	2008E	2009F	2010F	2011
Output (€ billion)	38.5	29.7	24.8	24.8	
25.9Volume % change	1.2%	-22.9%	-16.4%	0.0%	4.4%

Source: Euroconstruct – Ireland Construction Medium Term Prospects November 2008.

[86] *DKM Economic Consultants, Review of the Construction Industry 2007 and Outlook 2008-2010, September 2008.*
[87] *Over the 25 years 1984 to 2008(E) the construction industry accounted for 16.7% of GNP on average. Excluding the exceptional boom period 2000-2008(E), construction output accounted for around 14% of GNP over the period 1984 to 1999.*

annum by the Semi-State companies.

5.4 Future demand for engineers

As of mid-2008 there were an estimated 48,900 engineers working in Ireland, and 19,600 working in Northern Ireland. We estimate that approximately 25% were employed in the construction sector. The previous discussion indicates that in the construction sector at least demand for engineers in the short term is likely to be somewhat muted, and some job losses are also likely in other sectors as a result of the economic downturn.

However, as demonstrated in Section 3 of this report, there will remain significant employment opportunities arising from public and private sector infrastructure investment.

Based on the data presented in Section 3, we estimate that the total investment in infrastructure by the public and private sector in Ireland over the five years 2009-2013 will be in excess of €80 billion,[88] and that the delivery of this investment will maintain employment of over 110,000 each year, of whom approximately 5,500 could be expected to be engineers.

The Northern Ireland Executive likewise plans to invest over €24 billion on public infrastructure between now and 2018, which will maintain significant employment. On the basis of similar employment intensities as in Ireland, this investment programme should generate employment of approximately 17,000, of whom 850 could be expected to be engineers.

In addition, there are likely to be new areas and niches of growth and opportunity for engineers. Section 3 highlighted the Irish and Northern Ireland Governments' focus on developing the knowledge economy, based on moving up the value chain and investment in human capital and R&D (notably through Science Foundation Ireland and the Strategy for Science, Technology and Innovation), as well as on delivering sustainable development, mainly through energy efficiency and more efficient utilisation of natural resources. These are both areas where the implementation of public policy will generate significant demand for engineers' skills. Significant private sector non-infrastructural investment is also in the pipeline, notwithstanding the current economic situation. Section 3 quoted the example of a major investment recently announced by Houghton Mifflin Harcourt,[89] which is estimated to generate 450 new jobs in Ireland. IDA Ireland's end of year statement for 2008[90] emphasised that their main focus is on

"securing investment from new and existing clients in the areas of High End Manufacturing, Global Services (including Financial Services) and Research, Development and Innovation. Within these areas the key sectors IDA focuses on are Life Sciences (Pharmaceutical, Biopharmaceutical and Medical Technologies), Information Communications Technology (ICT), Engineering, Professional Services, Digital Media, Consumer Brands and International Services. New opportunities are emerging in areas such as Clean Technology, Convergence and Services Innovation."

Highlights of the year per the statement were:

- "A total of 130 Foreign Direct Investment Projects won
- New Investments Secured up 14% on 2007
- Number of new companies investing in Ireland for the first time up 16% on 2007
- Over 8,800 new jobs created
- A 22% increase in Research, Development and Innovation Projects
- Circa €2 billion in investments secured."

There is a similar focus on the part of industrial development bodies in Northern Ireland, and these developments will generate opportunities for engineers. It is beyond the scope of this study to comprehensively assess future demand for engineers, but we can look at the engineering intensity of recent economic growth and on this basis project future potential employment levels. Looking at developments in Ireland over the last decade, there has been an almost one-for-one relationship between economic growth and growth in employment of engineers.[91] On the basis that this relationship is retained, employment of engineers in Ireland could be expected to fall in 2009 before recovering thereafter, reaching approximately 57,000 in 2015 and 67,000 in 2020, almost 40% higher than the 2008 level. We are not in a position to undertake the same exercise for Northern Ireland, but on the basis that the engineering intensity of the Northern Ireland economy is similar to that in Ireland, then numbers of engineers employed should grow from 19,600 in 2008 to 23,000 in 2015 and 27,000 in 2020, an increase of over 35% compared with 2008. On the basis of our economic growth forecasts north and south, demand for engineers could be expected to grow at an average of 1,500 per annum in Ireland and 600 per annum in Northern Ireland

[88] Public Capital Programme of €52 billion (including PPP projects) plus investment by the semi-states of €28 billion plus private sector infrastructure investment.

[89] http://www.jobsnews.ie/category/houghton-mifflin-harcourt/

[90] http://www.idaireland.com/home/news.aspx?id=9&content_id=1012

[91] The elasticity of numbers of engineers employed per the QNHS with respect to growth in GNP over the period 1998 to 2008 has been 0.989.

Appendix: Results of Engineers Ireland Membership Survey

between now and the end of the next decade.

The following results have been collected from a survey that was distributed to members of Engineers Ireland in December 2008. The questionnaires were sent to 19,611 members with active email accounts. Of these, 3,126 responded, giving a return rate of 16%. While the results may not be perfectly representative of the engineering profession in

A.1 What nationality are you? (Q1)

Answer options	Response %	Response count
Irish	90.6%	2,833
Other nationality	9.4%	293
	answered question	3,126
	skipped question	0

A.2 If you currently reside in Ireland, please indicate the county in which you live. (Q3)

Answer options	Response %	Response count
Dublin	37.8%	1,095
Cork	12.3%	358
Galway	7.1%	205
Kildare	5.7%	164
Limerick	3.8%	110
Wicklow	3.6%	104
Meath	3.1%	89
Kerry	2.5%	72
Clare	2.0%	57
Waterford	1.8%	52
Westmeath	1.8%	52
Louth	1.7%	50
Mayo	1.7%	49
Donegal	1.6%	46
Tipperary	1.5%	43
Sligo	1.4%	40
Kilkenny	1.2%	35
Wexford	1.2%	35
Antrim	1.1%	32
Carlow	1.0%	29
Offaly	0.8%	24
Roscommon	0.8%	24
Cavan	0.8%	23
Laois	0.8%	22
Monaghan	0.7%	19
Longford	0.6%	18
Down	0.6%	17
Armagh	0.4%	11
Derry	0.3%	10
Leitrim	0.2%	7
Tyrone	0.2%	6
Fermanagh	0.0%	1
	answered question	2,899
	skipped question	227

A.3 Please indicate your gender: (Q5)

Answer options	Response %	Response count
Male	86.2%	2,659
Female	13.8%	427
	answered question	3,086
	skipped question	40

A.4 Please indicate your age category. (Q6)

Answer options	Response P%	Response count
17-20	2.8%	85
21-25	21.0%	649
26-30	18.4%	569
31-35	19.3%	595
36-40	13.1%	404
41-45	9.1%	281
46-50	5.2%	159
51-55	4.8%	149
56-60	2.8%	85
61-65	1.9%	59
66-70	0.6%	20
71-75	0.6%	18
76-80	0.2%	5
80	0.3%	8
	answered question	3,086
	skipped question	40

A.5: Please indicate the engineering discipline of your PRIMARY QUALIFICATION. (Q7)

Answer options	Response %	Response count
Aeronautical	0.5%	14
Biosystems/agricultural, food/food processing	0.7%	23
Biomedical	1.5%	47
Building services	3.0%	93
Chemical/process	2.5%	78
Civil/environmental/structural	50.6%	1,558
Computer/software/IT	2.3%	71
Electrical	5.6%	172
Electronic/microelectronics	6.8%	208
Industrial/manufacturing/production	4.9%	151
Mechanical/mechatronics/materials	17.9%	551
Other	3.7%	113
	answered question	3,079
	skipped question	47

A.6: What is your current employment status? (Q11)

Answer options	Response %	Response Count
Full-time salaried employee	72.9%	2,222
Part-time salaried employee	1.2%	37
Self employed	6.9%	209
Short-term/temporary hourly contract	2.0%	60
Not working but seeking work	2.3%	69
Student undergraduate	8.1%	248
Student postgraduate	3.7%	112
Retired	1.5%	46
Other	1.4%	43
	answered question	3,046
	skipped question	80

A.7: Please indicate which of the following best describes the engineering sector in which you work (Q12).

Answer options	Response %	Response count
Engineering consultancy	18.2%	464
Construction	9.5%	243
Electronics/electrical	3.8%	97
Healthcare/medical devices	3.6%	91
ICT/software/computers	4.1%	104
Pharmaceutical/chemical	3.1%	78
Mechanical/manufacturing	6.5%	166
Civil/structural	22.8%	583
Research/academic	4.1%	106
Utilities/government depts/ local authority sector	15.0%	383
Other	9.4%	241
	answered question	2,556
	skipped question	570

A.8: How would you describe your role? (Q13)

Answer options	Response %	Response count
Senior management	25.9%	661
Operational manager	25.0%	640
Technical role	49.1%	1,255
	answered question	2,556
	skipped question	570

A.9: How many staff are employed in your organisation? (Q14)

Answer options	Response %	Response count
5 or fewer	8.1%	206
Between 6 and 25	12.1%	310
Between 26 and 100	13.3%	340
Between 101 and 500	25.5%	653
Between 501 and 1500	19.3%	493
Over 1500	21.7%	554
	answered question	2,556
	skipped question	570

A.10: Have you worked in another industry sector(s) previously? (Q15)

Answer options	Response %	Response count
Yes	49.9%	1,276
No	50.1%	1,280
	answered question	2,556
	skipped question	570

A.11: Please indicate which industry sector(s) you have worked in previously. (Q16)

Answer options	Response %	Response count
Engineering consultancy	21.3%	272
Construction	28.0%	357
Electronics/electrical	14.4%	183
Healthcare/medical devices	5.0%	64
ICT/software/computers	6.0%	77
Pharmaceutical/chemical	9.9%	126
Mechanical/manufacturing	22.0%	280
Civil/structural	25.0%	319
Research/academic	7.1%	91
Utilities/government depts/ local authority sector	15.8%	201
	answered question	1,275
	skipped question	1,851

A.12: What is your highest engineering qualification? (Q34)

Answer options	Response %	Response count
PhD (level 10 NFQ)	3.3%	91
Masters degree (level 9 NFQ)	20.7%	574
Honours bachelors degree (level 8 NFQ)	52.5%	1,452
Ordinary degree/diploma (level 7 NFQ)	13.6%	376
Certificate (level 6 NFQ)	1.9%	53
Currently studying for one of the above	6.0%	167
Other	2.0%	55
	answered question	2,768
	skipped question	358

A.13: Please indicate the highest of the following qualifications you have attained. (Q35)

Answer options	Response %	Response count
Masters in Business Administration	4.4%	115
Masters in Industrial Engineering	4.8%	125
Management or Business Degree	2.8%	72
Management or Business Diploma	7.2%	189
Currently studying for one of above	6.6%	172
None	59.0%	1541
Other	15.3%	400
	answered question	2,614
	skipped question	512

A.14: How important is continuing professional development to you? (Q36)

Answer options	Response %	Response count
Very important	54.6%	1,505
Important	40.3%	1,109
Not at all important	5.1%	140
	answered question	2,754
	skipped question	372

A.15 How important is continuing professional development within your organisation? (Q37)

Answer options	Response %	Response count
Critical	23.5%	648
Necessary	39.6%	1,090
Considered useful but not essential	30.2%	832
Completely neglected	6.7%	184
	answered question	2,754
	skipped question	372

A.16 How important is continuing professional development in keeping up with your job requirements? (Q38)

Answer options	Response %	Response count
Critical	26.5%	730
Necessary	44.1%	1,215
Useful but not necessary	25.5%	701
Not necessary –		
I have all the skills I need to do my job	3.9%	108
	answered question	2,754
	skipped question	372

A.17 What was your average number of days spent doing continuing professional development (CPD) over the last year? Include time spent doing CPD in the categories listed in the prior question i.e. not only attending training courses. (Q43)

Answer options	Response %	Response count
Less than 3 days	13.8%	302
3-5 days	25.5%	560
5-10 days	29.2%	640
More than 10 days	17.0%	372
None	13.6%	299
Other	1.0%	21
	answered question	2,194
	skipped question	932

A.18: Are you satisfied with engineering as your choice of career? (Q48)

Answer options	Response %	Response count
Totally satisfied	47.9%	1,298
Reasonably satisfied	46.7%	1,263
Considering another career path	5.4%	146
	answered question	2,707
	skipped question	419

A.19: What do you think are the key issues that will concern engineers in the next few years? (Q68)

Answer options	Response %	Response count
The Irish economy	69.7%	1,848
The global economy	56.1%	1,488
Energy	68.0%	1,803
The Government's 'green' agenda	48.0%	1,274
Engineering education	37.2%	986
Globalisation	19.1%	508
Healthcare	12.3%	326
The developing world	17.6%	467
Other	6.3%	167
	answered question	2,094
	skipped question	473

A.20: Do you think engineers can help contribute to the Government's 'green' agenda? (Q69)

Answer options	Response %	Response count
Yes most definitely	96.4%	2,557
No due to lack of skills in this area	3.6%	96
	answered question	2,653
	skipped question	473

A.21: Do you believe engineers have a significant part to play in Ireland's economic recovery? (Q70)

Answer Options	Response %	Response count
Yes without doubt	88.2%	2,339
No it's up to the bankers		
and economists/others	11.8%	314
	answered question	2,653
	skipped question	473

A.22: Breakdown of engineering sector by region (Q3xQ12)

Please indicate which of the following best describes the engineering sector in which you work.

If you currently reside in Ireland, please indicate the county in which you live:[92]	Engineering consultancy	Construction	Electronics/electrical	Healthcare/medical devices	ICT/software/computers	Pharmaceutical/chemical	Mechanical/manufacturing	Civil/structural	Research/academic	Utilities/Govt Depts/Local Auth	Other	Total
Border	13%	13%	3%	3%	2%	2%	10%	21%	3%	22%	8%	100%
West	18%	7%	1%	14%	5%	1%	4%	23%	8%	14%	5%	100%
Mid-West	11%	12%	10%	4%	4%	5%	6%	20%	6%	17%	6%	100%
Midlands	10%	7%	2%	3%	2%	1%	6%	27%	6%	30%	6%	100%
South-West	24%	11%	3%	3%	2%	7%	4%	22%	4%	12%	8%	100%
South-East	11%	9%	2%	4%	2%	5%	7%	26%	6%	17%	11%	100%
Mid-East	13%	11%	5%	2%	5%	4%	12%	18%	3%	17%	9%	100%
Dublin	21%	7%	4%	2%	5%	2%	6%	22%	3%	15%	11%	100%
North	14%	16%	2%	2%	0%	0%	3%	37%	3%	11%	13%	100%

Spatial planning regions

Border	Cavan
	Donegal
	Leitrim
	Louth
	Monaghan
	Sligo
Midland	Laois
	Longford
	Offaly
	Westmeath
West	Galway City
	Galway County
	Mayo
	Roscommon
South-West	Cork City
	Cork County
	Kerry
Dublin	Dublin City
	Dun Laoghaire-Rathdown
	Fingal
	South Dublin
Mid-East	Kildare
	Meath
	Wicklow
Mid-West	Clare
	Limerick City
	Limerick County
	North Tipperary
South-East	Carlow
	Kilkenny
	South Tipperary
	Waterford City
	Waterford County
	Wexford

[92] *Answers amalgamated into planning regions.*

DKM ECONOMIC CONSULTANTS

DKM Economic Consultants Ltd.
6 Grand Canal Wharf,
South Dock Road,
Ringsend, Dublin 4.
Tel: 00 353 1 667 0372
Fax: 00 353 1 614 4499
Web: www.dkm.ie

ENGINEERS IRELAND

Engineers Ireland
22 Clyde Road,
Ballsbridge,
Dublin 4.
Tel: 00 353 1 665 1300
Fax: 00 353 1 668 5508
Web: www.engineersireland.ie

ThinkMedia.ie