SUSTAINABLE ENERGY IRELAND

Demand Side Management in Ireland

EVALUATING THE ENERGY EFFICIENCY OPPORTUNITIES

Main Report

Demand Side Management in Ireland

Evaluating the Energy Efficiency Opportunities

A Study by Kema for Sustainable Energy Ireland

January 2008

Table of Contents

Table of Contents

List of Appendices

Executive Summary

1. Introduction

The Government's energy policy framework 'Delivering a Sustainable Energy Future for Ireland' places sustainability of energy supply and usage at the heart of Irish energy policy objectives. A key facet of this is energy efficiency, now placed at the top of the sustainable energy agenda. Energy efficiency helps to reduce greenhouse gas emissions and energy costs and contributes to the security and affordability of energy supply, economic competitiveness and environmental sustainability.

Recognising the importance of energy efficiency, the Government has established ambitious targets. The central commitment is to a national energy-savings target of 20 per cent across the whole economy by 2020. This target will require contributions from all sectors of the economy and will bring significant economic and environmental benefits. A higher target of 33 per cent efficiency savings is set for the public sector, recognising its role as leader and exemplar. The energy policy framework also highlights the importance of addressing peak electricity demand through demand side management initiatives, and sets out Government's commitment to developing enhanced, cost-effective demand side management programmes to deliver both energy efficiency gains and peak demand reductions.[1]

Ireland's draft National Energy Efficiency Action Plan (NEEAP) was released for public consultation in September 2007. The plan proposes a range of actions and measures that will deliver Ireland's energy-efficiency targets as set out in the energy policy framework, the programme for Government, and at EU level.[2]

This report, analysing the Irish residential, commercial and industrial sectors and their usage of oil, gas and electricity, considers the paths to delivering these targets and the costs and benefits entailed. It also examines the potential in these sectors for peak electricity demand reduction to underpin efficiency, security and carbon reduction objectives.

The analysis offers important information as to where the greatest and most cost-effective opportunities for energy usage and demand reduction lie in the Irish economy. It also assesses the likely costs of capturing this potential through demand side management programmes, as well as the, far greater, environmental and financial benefits of doing so. The analysis will inform future policy-making by guiding measures and actions towards the areas of greatest opportunity and reward.

2. Technical and Economic Potential

This study models the Irish residential, commercial and industrial sectors in order to assess the potential for efficiency gains and peak demand reduction. The analysis encompasses four categories of energy-efficiency potential:

Technical potential models the complete penetration of all energy-efficiency and demand-reduction measures that are considered technically feasible from an engineering perspective, without taking cost into account.

Economic potential refers to the potential of those measures that are cost effective under current conditions.

Programme potential concerns energy expected to be saved as a result of a specific programme based on a defined level of incentives and cost. These savings are above and beyond those that would occur naturally in the absence of any market intervention.

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[1] For the purpose of this report, demand side management (DSM) is taken in the widest definition to include energy efficiency and peak demand reduction measures.

[2] Directive 2006/32/EC on energy end-use efficiency and energy services, commonly referred to as the Energy Services Directive, sets energy efficiency targets for all member states for 2016.

Naturally occurring potential refers to energy saved as a result of normal market forces, that is, in the absence of any utility or governmental intervention.

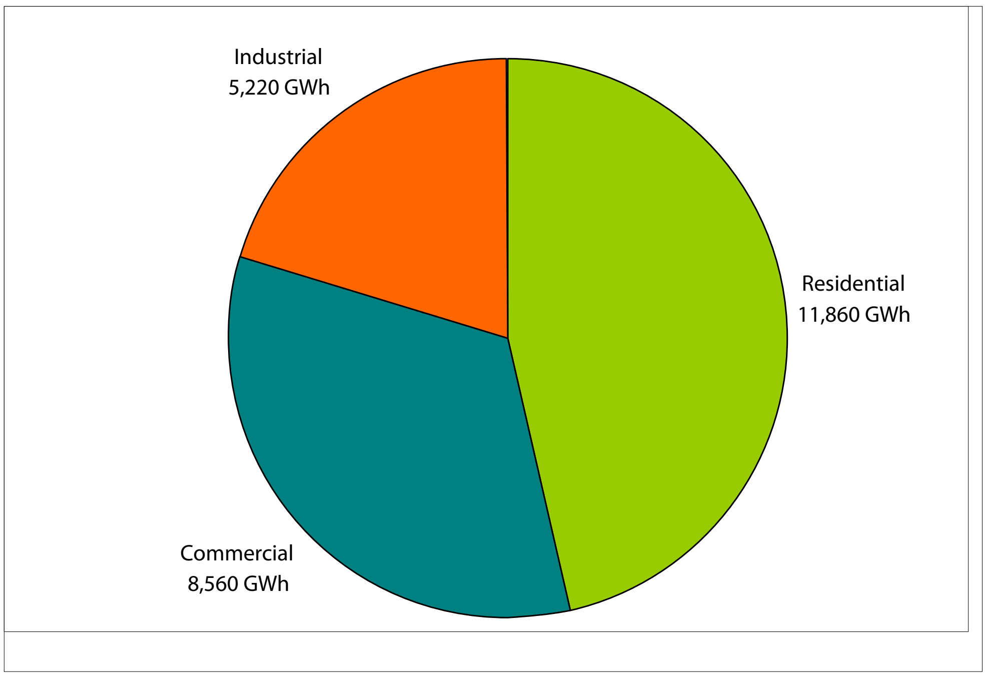
The assessment compares the current use of energy with the most energy-efficient measures that could be adopted to derive a technical potential for each fuel. An economic potential is then derived to reflect the measures that could be introduced economically, given the value of savings they would provide versus the cost of implementing these measures. The analysis estimates the savings available in energy usage in terms of GWh and percentage savings against the reference base usage.[3] These are also converted to savings in CO_2 emissions, a central policy dimension of the energy-efficiency agenda. The analysis also generates estimates of the savings in peak electricity demand that would result from these efficiency actions. The following sections detail the modelling results for each of these parameters.

3. Efficiency Potentials by Sector

The modelling shows that there are significant efficiency opportunities across all fuels and all sectors studied that would lead to reduced energy use. The vast bulk of these opportunities are available on an economically rational basis. Figure 1 below gives an overview of the split of economic potential between the residential, commercial and industrial sectors. This demonstrates that the residential sector provides the greatest opportunities to reduce carbon, followed by the commercial and then the industrial sector.

This analysis suggests that economic savings totalling approximately 25,640 GWh or 26 per cent of the reference base usage of the fuels and in the sectors examined are available.

Figure 1 Economic Efficiency Savings Potential by Sector (GWh)[4]



[3] The reference energy usage is calculated as the average of the most recent five-year period of energy usage expressed as 'primary energy equivalent'. This is the methodology set out in the Energy Services Directive and that employed in the NEEAP.

[4] All energy figures in this report are given in terms of primary energy equivalent, taking account of conversion losses in the generation of electricity.

Table 1 Potential for Economic Savings by Energy Form

	Economic saving potential GWh – Primary energy equivalent		
	Electricity	*Oil*	*Gas*
Residential	6,590	3,420	1,850
Commercial	6,000	1,560	1,000
Industrial	2,170	2,290	760
Total	14,760	7,270	3,610
% of reference base usage	**27%**	**24%**	**24%**

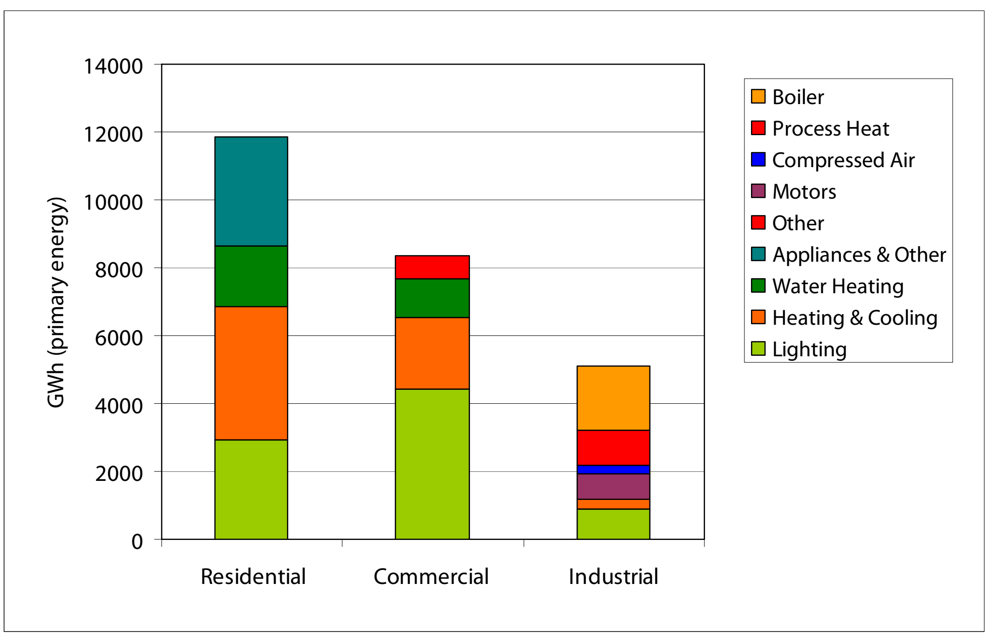
In comparing fuels, it is clear that electricity offers the most significant potential for energy savings (greater than those of oil and gas combined). This reflects both the nature of electricity use in society and also the losses associated with its generation.

It should be noted that these estimates of savings potential are based on an assessment of current economic opportunities for deploying the best available technologies in all areas. New innovations and technological developments, which are not factored in, will bring additional savings potential over time. This is likely to be particularly the case for the industrial sector, where innovation in process design is already exhibiting considerable energy-savings potential.

4. Efficiency Potentials by End-use

Assessment of the technical and economic potential indicates the key focus areas that vary across the different fuels and across the different sectors (residential, commercial and industrial). Figure 2 below summarises where the main savings opportunities lie in each of the sectors examined.

Figure 2 Economic Efficiency Savings Potential by Sector and by Technology



As can be seen, lighting offers the most potential for efficiency gains, amplified by the fact that electricity savings equate to greater primary energy savings due to conversion losses. Heating and cooling also offer significant savings potential in all sectors.

5. Potential for CO_2 Savings

Using emissions factors for each energy form, the above energy savings potentials can be converted to equivalent CO_2 savings. Table 2 below illustrates the savings that can be achieved from the different fuels on an economic basis.

Table 2 Economic Potential for Carbon Savings

	Kilotonnes (kt) of CO_2		
	Electricity	Oil	Gas
Residential	1,678	878	366
Commercial	1,529	401	198
Industrial	552	589	150
Total	**3,759**	**1,868**	**714**
		Total economic potential savings	**6,341 kt**

The largest potential is seen in the residential sector, deriving from the high energy savings identified above. As expected, the conversion losses associated with electricity generation mean that it represents the largest source of CO_2 savings – as much as oil and gas combined.

6. Potential for Peak Demand Savings

In addition to energy usage and associated energy emissions, demand-side management is also vitally important in controlling peak electricity demand. This influences the costs and carbon efficiency of the overall electricity system, and also can be an important tool in managing the balance of supply and demand and the need for new generating plants.

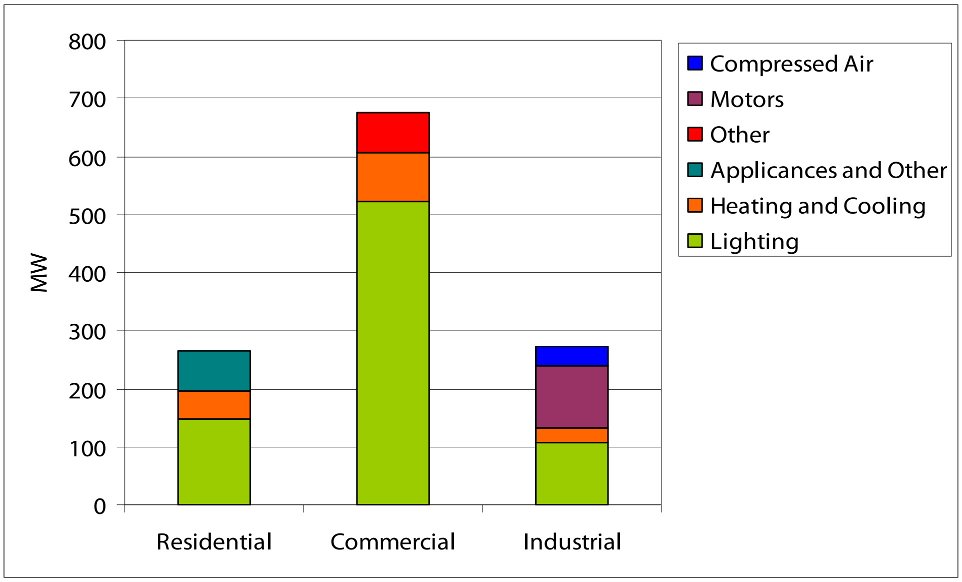
Improvements in energy efficiency will lead to peak demand reduction as well as energy-usage savings, and the modelling undertaken for this report allows for quantification of this. Table 3 indicates the economic potential for reducing peak electricity demand.

Table 3 Economic Potential for Peak Demand Reduction

	Economic saving potential (MW)
Residential	269
Commercial	676
Industrial	287
Total	**1,233**

Economic potential for peak-load reduction measures is estimated at 1,233 MW reduced in the modelled time period (3 p.m. to 8 p.m.). Figure 3 shows that commercial customers can bring the largest proportion of savings, reflecting their ability to reduce peak-time demand through their installation of energy-efficiency measures, in lighting in particular.

Figure 3 Economic Peak Demand Savings Potential by Sector and by Technology



7. Modelled Targets and Programmes

Once the economic potential for savings and demand reduction is established, the next step is to consider the ways to capture these potentials. International evidence shows that programmatic intervention is needed to persuade many businesses and individuals to take energy-saving actions, even when the economic case for doing so is clear.

Modelling undertaken as part of this study pinpoints the best kinds of programmes for stimulating these savings by identifying the sectors and technologies showing the greatest opportunities and considering the existing policy and programme mix in Ireland. The model also estimates the financial costs and benefits of capturing this potential.

The modelling process is based on setting indicative savings targets and then analysing different scales of programme intervention to determine the feasibility of the targets and the levels of intervention required to meet them.

For the purposes of this analysis, three energy-savings targets were assessed against the feasibility, costs and benefits of meeting them. The targets addressed only the savings associated with the sectors and fuels examined in the study and not the whole economy. The targets examined were:

- **2016 target** – A 9 per cent reduction in reference base energy use by 2016 in the three sectors assessed. This represents a subset of the whole-economy target articulated in the NEEAP to meet the requirements of the EU Energy Services Directive. This target equates to 7,770 GWh savings in the sectors and fuels examined.

- **2020 target** – A 20 per cent reduction in reference base energy use by 2020 in the three sectors assessed. As with the 2016 target, this represents a subset of the whole-economy targets being used in the NEEAP – in this case, the main 2020 national energy savings target. This target equates to 20,010 GWh savings in the sectors and fuels examined.

- **Aggressive 2020 target** – A hypothetical target to assess the implications of saving 20 per cent of the projected usage in 2020 through a very aggressive series of measures. This target equates to 28,430 GWh savings in the sectors and fuels examined.

These targets are analysed against three programme scenarios of different scale (in cost terms) and level of ambition: a base case, a central case and an aggressive case. The base case was set at a lower, but still ambitious, level to surpass the 2016 target. The central case was set at a level of expenditure required to reach the 2020 NEEAP target. The aggressive case was modelled with very high levels of programme spending. All estimated budgets include the costs of administration, marketing and any financial incentives that may be needed to persuade customers to take action.

The analysis also included an estimate of the amount of energy that would be saved by the proposed improvements in energy performance in the building regulations (to be introduced in 2008), which will provide substantial savings in the period to 2020. Table 4 presents a summary and indicates the ability of the different scenarios to meet the established targets.

Table 4 Impact of Scenarios Against Targets[5]

Scenario	2016 results (GWh)	% of 2016 target	2020 results (GWh)	% of 2020 target	% of Aggressive 2020 target
Base programme spend	13,250	171	18,220	91	64
Central programme spend	15,020	124	20,190	101	71
Aggressive programme spend	19,250	248	25,700	128	90

The analysis demonstrates that the 2016 target can be delivered with a 'base' level of expenditure on efficiency and demand-management programmes. It also indicates that, in the Irish case, this will be far exceeded by programme actions currently in place or in development, including the significant impacts of the proposed building regulation changes in 2008. The 2020 NEEAP target can be met using a 'central' level of expenditure on a programme mix that includes the building regulation changes. The modelling suggests that the hypothetical aggressive 2020 target would require aggressive programmes and significant spend.

The estimated annual programme costs for each of the programme scenarios are shown in Table 5 below.

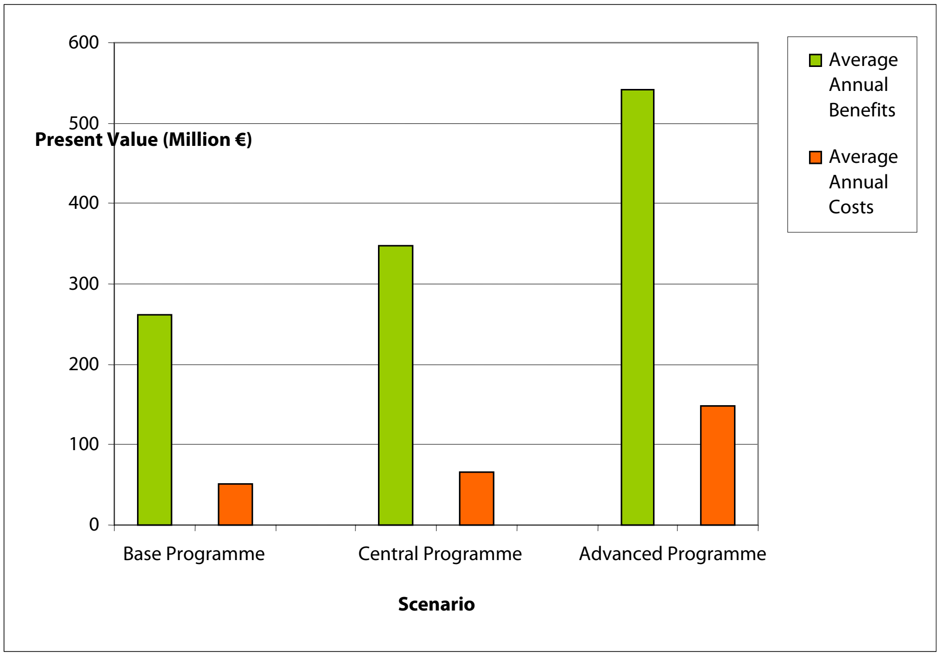
Table 5 Estimated Annual Programme Costs for the Three Scenarios

Programme cost (€million)	Electricity	Oil	Gas	Total
Base	11.6	8.2	6.8	26.7
Central	17.1	11.2	8.9	37.2
Aggressive	50.8	25.9	23.2	99.9

While some of these estimates entail a ramp-up from current levels, there will be an overall significant benefit to the Irish economy in delivery of all three levels of programme. This is shown in Figure 4 below, which shows the total economy costs (both state and consumer spending) and benefits in each scenario. These are based on current information and on assumptions about prices and other important factors, but are robust estimates of the likely costs and benefits of pursuing the available energy efficiency opportunities.

[5] All programme results include estimated savings attributed to residential building regulation changes due in 2008. This equates to 5350 GWh for 2016 target, and 7730 GWh for 2020.

Figure 4 Average Annual Total Economy Costs and Benefits (2007 – 2020) for the Three Programme Scenarios



As can be seen, the analysis indicates a very strong business case for action, with a *net* average annual benefit of over €200m if the base programme were implemented, and additional large net benefits from the central and aggressive programmes.

8. Recommended Programme Designs

The estimates of costs and benefits outlined above indicate the scale of effort required to pursue energy efficiency, and underline that the benefits far outweigh the costs. The precise design of the set of programmes needed to deliver these outcomes will depend on many factors – including existing programmes, market conditions and policy. Much is already known through the Sustainable Energy White Paper and the NEEAP.

The final step in the modelling process for this report was to filter the market-sector analysis into a number of specific programmes that – based on international best practice and Ireland-specific characteristics – are worth further consideration to enable Ireland meet its energy-efficiency goals. These international programmes are archetypes and in each case individual programmes would need localisation at the detailed design stage. The recommended programmes for the sectors investigated are:

Residential Sector

- *Residential Online Audits*

  Audits that typically centre on an online tool that allows consumers to estimate their usage by end-use and to identify measures to save energy in their homes. Many such tools exist, and an Irish version could make links to the 'Power of One' campaign and to the roll-out of the Building Energy Rating (BER) for all homes.

- *Lighting and Appliance Programmes*

  Marketing and financial incentives to increase the number of installed energy-efficient lights and appliances.

- *Residential Retrofit*

  Increasing the efficiency of existing housing stock through, for example, an audit and installation programme for a range of energy-efficient technologies. A large support programme for insulation/home heating in existing houses is under development by the Department of Communications, Energy and Natural Resources (DCENR) and this will address much of this area.

- *Residential New Construction*

  Going beyond the standards of the new requirements in the amended building regulations, and building on the success of SEI's House of Tomorrow programme.

Commercial and Industrial Sectors

- *Business Financial Support Programme*

  Providing financial incentives for new equipment or retrofits identified by audits or other assessments to seek energy-saving and peak-load reduction for business customers. Existing SEI business programmes are already addressing much of the potential and could be used as a platform for broader initiatives.

- *Commercial New Construction Programme*

  As with the residential new buildings programme, such a programme could provide financial incentives for savings in new buildings for energy-efficiency measures that exceed the building regulations for non-residential buildings.

All of these programmes could be delivered via central bodies such as SEI or through more dispersed models such as demand side management programmes by energy suppliers. The full version of this report provides more detail on the potential design of these programmes. It also draws on international experience in order to compile a set of best-practice elements likely to be key to the success of any such programmes. A high-level list of these best practices, particularly those relevant to Ireland, is presented below.

– *Keep participation simple* – Easier for participants and any stakeholders, encourages higher participation.

– *Establish the potential for long-term energy savings* – Provides an understanding of what could be achieved with different levels of funding.

– *Clearly designate the organisations responsible for administering programmes* – Prevents confusion on who is implementing different programmes. Links to simple participation as there is a need for participants to be clear on who should be contacted.

– *Have participation strategies that are multi-pronged and inclusive* – Allows for more flexibility and greater participation.

– *Keep programmes stable over time and establish funding for multi-year periods* – Makes programmes predictable and easier for all participants.

– *Use incremental costs as the basis for incentives* – If incentives are used it is more economic to base them on incremental cost.

– *Use electronic means as much as possible* – More efficiency in processing.

- *Establish single point of contact* – Easier for participants, more efficient.

- *Make participation part of an existing transaction* – Easier for participants, more efficient.

- *Use trade allies and wider stakeholders as much as possible* – Engages them as programme partners, reduces marketing costs.

- *Provide training to trade allies* – Increases knowledge of more efficient technologies and encourages broader market transformation as higher standards become the norm.

- *Sell the customer the benefits first, energy efficiency later* – Emphasises other attributes of efficiency that appeal to businesses.

- *Develop robust measurement and verification methods* – Provides confidence in figures, demonstrates the success of programmes, and assists the business case for future programme selection.

- *Evaluate programmes on a regular basis* – Informs results and future programme design.

- *Tie new construction programmes to codes and standards* – Easier for participants, more efficient.

9. Key Conclusions

Significant energy-efficiency opportunities can be found in all fuels in all of the sectors considered.

In the three sectors (residential, commercial and industrial) and the three fuels (electricity, oil and gas), Ireland can meet its 2016 Energy Services Directive Savings target for energy efficiency by using a base level of programme spend.

For the sectors and fuels examined Ireland can meet its 2020 national energy savings target through a set of strong programmes and central level of programme spend.

Of the three sectors considered, the residential sector offers the most opportunities to reduce carbon.

There are significant opportunities to reduce Ireland's carbon emissions, especially if all fuels are considered.

The 2008 amendments to the building regulations will provide substantial savings over time and represent a significant contributor towards targets.

Across all sectors, a large part of the potential is economic, but will not be undertaken without stimulation.

The aggressive programmes proposed are at the forefront of worldwide proposed achievements and will require significant programmatic investment in energy efficiency. This will require the strong support and involvement of stakeholders, including the energy industry.

Modelling of the 2020 target suggests that, while challenging, it will succeed in delivering the target.

Achieving these energy-savings targets will require the use of best-practice and localised designs when implementing the programmes.

The benefits far outweigh the costs of action to capture the available savings.

1. Introduction

1.1 Background to the Project

The Irish Government's energy policy framework (2007-2020) 'Delivering a Sustainable Energy Future for Ireland' released in March 2007 placed sustainability of energy supply and use at the heart of Irish energy policy objectives. One of the key strategic goals to achieve such sustainability is maximising energy efficiency. This is now recognised as pivotal to meeting Ireland's sustainable energy goals. If these goals are met, it is expected that this will give rise to major contributions to security of energy supply, sustainable transport, affordable energy, competitiveness and environmental sustainability. Alongside these benefits, the development of energy-efficiency products and services will also support jobs and growth in the energy sector. All of these benefits have promoted energy efficiency to a priority area for Ireland. [6]

A demonstration of the importance to Ireland of energy efficiency is seen in the public declaration of a range of ambitious targets. These build up as:

- An overall national energy-saving target of 9 per cent for 2016, as part of the EU Energy End Use Efficiency and Energy Services Directive (ESD).
- A 20 per cent savings in energy across the electricity, transport, and heating sectors by 2020 as outlined in Ireland's National Energy Efficiency Action Plan (NEEAP).
- An indicative 30 per cent energy-saving target for Ireland by 2020 to surpass the EU ambition.

These are challenging targets that will require significant investment in energy-efficient equipment and a change of customer attitudes to the use and conservation of energy.

1.2 Scope of this Project

An essential starting point to achieving the levels of energy efficiency proposed for Ireland is a comprehensive understanding of where and how energy use is occurring now. This report provides an assessment of the potential for energy-efficiency gains and peak demand reduction in Ireland. The study considers electricity, gas and oil usage in the industrial, commercial and residential sectors and compares the current methods of energy use with the more energy-efficient methods that could be used. Typical measures include improved insulation, more efficient appliances, lighting, heating and cooling savings, process efficiency, and so on.

Within this project a model has been developed showing the usage of electricity, gas and oil across the industrial, commercial and residential sectors. This usage is broken down further into major end uses (e.g. lighting, heating, cooling) with an assessment of the potential reduction that could be achieved if the end use service was provided by more efficient equipment. This provides an overall

[6] The authors and SEI wish to thank everyone who provided information for and comment on this report. They would like to acknowledge particularly the valuable input of members of the Project Advisory Group, who gave of their time and expertise generously.

technical potential for energy efficiency for Ireland which is an inspirational goal to aim for whilst maintaining the same level of comfort and services.

An important consideration for policy-makers is the energy efficiency that can be effectively delivered coupled with an assessment of the impact on the Exchequer and/or customer bills. This report considers the costs and benefits of the different measures and the likely cost of suggested programmes. The analysis costs both the administration and financial incentives that will be needed to exploit energy-efficiency measures beyond the relatively low naturally occurring level.

Ireland is not alone in recognising the importance that energy efficiency will need to play in future energy-supply decisions. In considering potential programmes for Ireland, this report has considered the best practice internationally and compared these to the suite of existing programmes already operating successfully in Ireland. The report also highlights the key energy-efficiency measures identified in the model. Finally, this report provides a recommendation and an implementation approach for a series of programmes across the sectors of the Irish economy considered that will contribute to meeting the challenging targets established by the Irish Government.

Whilst the scope of the project is wide-ranging and covers over 200 potential measures, there are some practical restrictions that have meant that certain matters have not been included in this assessment of energy efficiency; they are:

- The transport sector was excluded from this analysis. A separate analysis would be needed using different techniques to assess the potential in this sector.

- No fuel switching measures have been considered within this analysis. Additional carbon savings may be feasible by moving from one fuel to another, but there are various benefits and disadvantages associated with each of the fuel options and it is not the purpose of this report to guide future fuel selection in Ireland.

- No assessment has been made for future technological change. It is to be expected that over the next 15 years additional technological changes will result in more ways to save energy.

An additional assessment of these final two factors would add to the potential that could be achieved in Ireland.

1.3 Objective of the Project

The high level objectives of the project can be summarised as:

(i) Improved understanding of current energy usage in Ireland as a starting point for consideration as to how to reduce usage.

(ii) Quantification of the potential for energy-efficiency savings in Ireland at both a technical and economic level.

(iii) Recommendation of indicative programmes for Ireland based on modelled potential, operation of Irish energy markets and international best practice in demand side management (DSM) programme design.

1.4 Structure of this Report

This study has been structured as follows:

- Section 1 provides an introduction and sets the context for the study.
- Section 2 examines the structure of energy markets in Ireland and the current suite of DSM programmes (including energy-efficiency and peak demand reduction) that are already operational.
- Section 3 examines international programmes in order to consider lessons for Ireland.
- Section 4 outlines the energy-efficiency methodology that has been used for this assessment.
- Section 5 provides a detailed examination of the technical and economic potential for DSM in Ireland.
- Section 6 builds on the previous analysis and develops estimates of achievable potential by sector.
- Section 7 provides an outline of the key recommended programmes.
- Section 8 provides conclusions on key sectors and programmes to deliver DSM savings for Ireland.

There are also a number of appendices:

- Appendix A – International DSM Programmes.
- Appendix B – DSM ASSYST Model.
- Appendix C –Assumptions.
- Appendix D – Indicative Programme Designs for Ireland.

2. Review of Market Arrangements and DSM in Ireland

2.1 Introduction

Market structures have an impact on the potential and mechanisms for achieving energy savings through DSM programmes. An overview of Ireland's electricity, gas and oil markets is therefore given in this section, together with the influence, particularly of the competitive electricity and gas markets, on the design of the current DSM programmes.

Following on from the overview of the markets is an examination of the current programmes in Ireland. This analysis provides an indication of which energy-efficiency measures are already well served by current programmes. Making a comparison of the current programmes with the key measures identified in the technical and economic potential provides a gap analysis of where additional programmes are likely to yield the highest savings in a cost-effective manner.

2.2 Electricity Supply in Ireland

Overview

The electricity market in Ireland is de-regulated into supply, distribution, transmission and generation activities with separate businesses active in each area. Distribution and transmission are both natural monopoly activities. Distribution is provided by ESB Networks as the licensed distribution system operator (DSO). Transmission is provided by EirGrid, licensed by the Commission for Energy Regulation (CER) as Ireland's Transmission System Operator (TSO).

Generation is a competitive activity. The majority of capacity is still provided by ESB Power Generation. However, the level of independent capacity has been growing rapidly with several companies owning new major CCGT power stations and Airtricity, among others, having significant wind capacity. There is also an interconnector to Northern Ireland, with a second interconnector to the UK mainland planned.

The retail market has been fully open to competition for all customers since February 2005. As of January 2007, there were seven independent suppliers active in the market. ESB's supply business is still the largest participant, but now consists of two parts. ESB Public Electricity Supply is the default supplier for all customers that have not chosen to switch supplier and ESB Independent Energy supplies customers at unregulated prices. There are also a number of independent suppliers operating – particularly in the large-business sector of the market.

The Irish wholesale electricity market is undergoing a major change through the All-Island Project, a joint initiative run by the Commission for Energy Regulation (CER) and the Northern Ireland Authority for Utility Regulation (NIAUR). The first phase of this is the creation of an all-island wholesale market known as the Single Electricity Market (SEM), which commenced operation in November 2007. The SEM is a gross pool market, into which all electricity generated on or imported onto the island of Ireland must be sold, and from which all wholesale electricity for usage on or export from the island of Ireland must be purchased.

The SEM is expected to bring a number of advantages in terms of liquidity, transparency and dispatch efficiency. The arrangements will immediately reduce the market dominance of any one player as the market will consist of both Northern Ireland and the Republic of Ireland. The development of a larger single market with a clear and stable trading mechanism should boost investor confidence and allow investors to properly assess the risks and rewards of investing with prices signals for when new generation investment is needed. Equally, because of the gross pool, suppliers should face a stable market that is easier to enter in comparison to the previous bilateral contracts regime. Supply competition should also be enhanced by the larger total market size and potential economies of scale.[7]

The All Island Market will allow direct participation by demand sites that will be able to bid into the pool. Alternatively – and more applicable for smaller customers – is that innovative suppliers may contract with customers for energy supply tariffs that allow their demand to be reduced at times of peak demand in exchange for a lower price. Because of these opportunities for participation in the pool, there has been some discussion about the necessity of continuing the current peak demand reductions programmes. At least in the short term, these programmes are expected to continue as they provide an important service to reduce peak demand in what can be a low-margin network. Judging by experience from elsewhere, it may also take some time for direct demand side participation to develop. This participation could be accelerated by the use of demand side unit aggregators in the SEM.

Current Demand Side Management

There are a number of market participants that play some part in contributing to peak demand reduction, including:

- ESB Networks who have a distribution tariff that has cheap night time electricity. This encourages peak demand reduction with a shift from day to night units.

- EirGrid who operate a number of peak demand reduction programmes to reduce demand, particularly during the peak periods and periods of tight capacity margin.

- ESB Customer Supply who offer the Winter Peak Demand Reduction Initiative which rewards suppliers for reducing maximum demand in peak winter periods.

- Other suppliers also offer tariffs to try and reduce demand in peak periods.

The market's competitive nature makes it difficult for utilities to offer directly on a large scale the type of energy-efficiency services that are sometimes provided by monopoly utilities in the US and parts of continental Europe (e.g. subsidised insulation, lighting, etc.). Any such services required would need to be designed carefully to apply to all suppliers to avoid penalising any market participants unfairly.

One other important development is the White Paper commitment to move to 'smart metering'. Currently, most customers (with the exception of a few large customers) have conventional metering which records total usage with two-rate delineation at most. Smart metering could provide all customers with time-of-use metering and increase the range of DSM options.

[7] All Island Project – The Single Electricity Market – Proposed High Level Design 31 March 2005, AIP/SEM/06/05.

2.3 Gas Supply in Ireland

Overview

The gas industry has traditionally been controlled by Bord Gáis, but this has been changing gradually since 1995 when the company started allowing third-party access to the transmission network. Initially, only about 50 large customers were eligible for competition, but subsequent additional phases have progressively opened more of the market to competition. This included the full non-domestic market in July 2004 with the final opening to include domestic customers in July 2007. In addition, as the gas market has been expanded to new towns, a CER competition invited independent suppliers to bid for the franchise of newly connected towns. Flogas Natural Gas Ltd was successful in winning the competition for supplying several of these towns, representing several thousand domestic customers. However, this should be compared with Bord Gáis who have 500,000 domestic customers. As much of the market is still a monopoly, the gas tariffs/prices are regulated by the CER.

In the gas retail sector there are two distinct activities: shipping and/or supplying. An individual or organisation can be licensed to supply or ship gas or both. A gas shipper is responsible for liaising with Bord Gáis Networks to ensure that gas is delivered to premises. The supplier is responsible for processes that support the sale of gas to individual customers. Bord Gáis indicate that there are currently twelve shippers signed up to the Code of Operations in Ireland.

Bord Gáis Transportation is responsible for managing access to the gas pipeline system by all shippers and generates revenues for Bord Gáis Networks by applying the relevant transmission and distribution tariffs for the use of the pipeline system by shippers. All shippers (including Bord Gáis) are treated in a fair and non-discriminatory manner and have equal access to the network.

Bord Gáis Networks' 11,318 km network includes transmission (cross-country) and distribution (towns) networks in Ireland. They are also responsible for two sub-sea interconnectors linking Ireland with Scotland, and for pipelines to the Corrib terminal and Northern Ireland, where they also operate part of the network.

Demand Side Management

Gas shippers need to purchase capacity to be able to use the network which gives them the right to input and/or offtake gas capacity at the exit point specified by the shipper. Capacity is available both short term and long term, but at peak times there is a shortage of capacity which constrains gas usage. Some customers may also have interruptible contracts which will restrict their ability to use gas at certain peak times, but the gas they do consume will be provided at a cheaper price.

Most gas customers in Ireland are non-daily metered. Of approximately 540,000 sites in 2005, less than 250 were daily metered. This low level of metering reduces the potential for any peak-demand reduction for these sites. There is the potential for energy-reduction schemes to try and encourage less usage, although the potential is less than for electricity as it is primarily only construction and residential retrofit programmes that would be applicable.

Future Changes

One goal of the All Island Energy Market is the delivery of an all-island gas market with joint gas infrastructure, an overall transmission policy and all-island gas storage. This will follow the introduction of the SEM and similarly may encourage new entrants, innovation and increased opportunities for DSM programmes.

2.4 Heating Oil

The heating oil market is a competitive market: heating oil suppliers buy the product from a number of wholesalers and supply to end customers. There is a relatively large number of independent suppliers and, whilst some of these companies are national, there is also a number of smaller regional companies. While companies compete primarily on price, payment terms and flexibility can also be value added service.

There is currently no demand side management in the heating oil market. Suppliers have offered no incentives to provide solutions to their customers to reduce demand. Moreover, imposing any obligation on heating oil suppliers would be difficult as – unlike gas and electricity suppliers – they are not licensed or regulated.

2.5 DSM Programmes in Ireland

National DSM programmes aimed at improving efficiency are operated by Sustainable Energy Ireland and the Department for Communications, Energy and Natural Resources. There are a number of DSM programmes (both efficiency and peak demand) operated by market participants, notably ESB Customer Supply and EirGrid. These industry-led programmes have already resulted in significant energy savings and peak demand reductions.

Table 2-1 lists the DSM programmes divided by category of customer (business or residential) and four major areas where the programmes deliver benefits which are:

- Buildings improvements.
- Appliance and lighting improvements.
- Behavioural changes.
- Peak Demand reduction.

Some of these programmes will deliver benefits across a number of these areas. As ESB Customer Supply offer a large number of energy efficiency initiatives these are listed separately in Table 2-2.

Table 2-1 DSM Programmes in Ireland

	Buildings Improvements	Appliance and Lighting	Behavioural Change	Peak Demand Reduction
Residential	• House of Tomorrow • Warmer Homes scheme • Energy Performance of Buildings Directive[8] • Greener Homes scheme	• Energy Labelling scheme	• Power of One Programme • Home Energy survey	• Nightsaver
Business	• Energy Performance of Buildings Directive • Combined Heat and Power Deployment programme • Public Sector programme		• Energy Agreements programme • Large Industry Energy Network • Energy Map Action programme	• Winter Peak Demand Reduction • Short Term Active Response programme • Powersave • Winter Demand Reduction Initiative

Table 2-2 ESB Customer Supply Energy Efficiency Programmes in Ireland

	Building Improvements	Appliance and Lighting	Behavioural Change
Residential	• Value of Insulation • Online Interactive House • Electricity Consumption Check List	• Promotion A Rated Appliances • Promotion Lagging Jackets • Promotion CFLs • Fuel Poor programme • Energy Efficiency Advertising Campaigns • Energy @ Home bill inserts	• Online Appliance Cost calculator • Online Advice and Tips • Online Audit • Schools DVD • Consumer shows participation • Money Advice and Budgeting Service • Know your Neighbour
Business	• Promotion of Building Management Systems • Promotion of Energy Audits.	• Online Hotel Lighting Guide • Online Warehouse Lighting Guide. • Lighting and Control Gear Promotions • Promotion of A Rated Air Con Units. • Dedicated Business Contact Centre	• Sponsorship of National Energy Awards, etc. • Online GEM and Energy Extra (monitoring and benchmarking tools) • Key Account Managers and Stakeholder Relationships • Online Energy Efficiency Library • Energy Efficiency Newsletters and Ezines

[8] Not strictly a programme but has been included as the implementation policies from the new Directive will have impacts on the use of energy in buildings.

2.6 Aspirations of the Sustainable Energy White Paper

The Irish Government's Sustainable Energy White Paper, 'Delivering a Sustainable Energy Future for Ireland' was released on 12 March 2007, setting out Ireland's energy policy framework 2007–2020. It details a number of aggressive energy-efficiency policies and targets.

Within the White Paper the Irish Government has indicated its desire to achieve a national energy-saving target of 20 per cent across the whole economy by 2020. This has been progressed with the publication of Ireland's National Energy Efficiency Action Plan (NEEAP), which sets out a path to achieve these energy savings. In addition to the 20 per cent target, a more aggressive indicative target of 30 per cent energy savings has been set for 2020, and the public sector has a target of 33 per cent energy savings to demonstrate its leadership and exemplar role.

To deliver these targets, the Government has selected enhanced DSM measures as a priority for the next five years, and, as determined in the NEEAP, a comprehensive and fully costed DSM Plan will be produced in 2008. The plan will include measures such as the roll-out of smart meters, with a trial phase already under development for 2008.

A key area of focus is to improve energy efficiency is in the stock of buildings. Building Energy Ratings (BERs) are already being introduced, as part of Ireland's requirements under the Energy Performance of Buildings Directive (EPBD), with coverage to be expanded over the next couple of years. The Government is in the process of amending building regulations to enhance the energy efficiency of new dwellings and dwellings subject to major renovations. A full review of the current regulations (Part L of the Building Regulations) is being undertaken, with the aims of the next amendment to:

- Provide for the systematic upgrading of energy performance standards.
- Ensure that Ireland's standards are among the best in Europe and that they make the maximum practical contribution to achieving CO_2 emission targets.
- Reflect technological developments.
- Reduce energy demand by 40 per cent relative to current standards.
- Further reduction in 2010 to 60 per cent improvement relative to current standards.

Alongside building improvements as part of the National Development Plan and Regional Operational Programmes 2007–2013, funding will continue to be available for energy-efficiency programmes and targeted initiatives at a national and regional level. The Government will continue to support and expand SEI energy-efficiency programmes in the built environment, large-industry programmes and in the new targeting of the SME sector in conjunction with the national 'Power of One' energy-efficiency campaign. Moreover, the core principles of the Irish Standard for Energy Management (IS393) will be promoted, particularly in the SME sector.

3. International Programmes

Ireland is not alone in recognising the importance of energy efficiency to a sustainable future. A starting point for this investigation has therefore been to consider the successful programmes that have been implemented internationally and to clarify what lessons these can provide for Ireland.

The investigation focused on five main countries. These were:

- UK – similar climate and electrical standards to the Ireland.
- Canada – innovative DSM programmes.
- Japan – short of natural resources.
- New Zealand – two small islands with limited interconnection and cold spells.
- Vermont – One of the most aggressive states in the United States in pursuing DSM.

In addition, selective examples have also been chosen from other regions at the suggestion of the DSM Advisory Group who were consulted throughout the development of this study. Appendix A provides the detailed analysis of each of these programmes. The sections below provide a summary of findings in respect of these programmes and the most relevant lessons for Ireland.

3.1 International Experience in Domestic Energy Efficiency Programmes

The most common target areas for domestic energy efficiency found in all countries that were investigated were lighting and insulation programmes. Depending on the existing stock of housing and lighting, these programmes can achieve impressive carbon savings in relation to cost. Many of the insulation programmes, which constituted a more significant investment, were targeted at the 'fuel poor'. However, more of the lighting programmes were general and available to all customers, sometimes for example using discount vouchers for purchase of compact fluorescent light bulbs (CFLs).

A design issue for domestic energy-efficiency programmes is the degree to which they aim to reduce energy use and/or assist with fuel poverty. Many schemes are spending significant sums of money in improving properties or the stock of appliances. Understandably, there is a desire to target these savings at the less well off members of the community. Whilst this is a sensible aspiration, the introduction of this split objective is likely to reduce the amount of carbon saving that can be achieved for each Euro invested in a DSM programme, as there is a cost associated with targeting only a subset of customers.

In addition to inducements to improve the existing housing stock, there are also incentives to ensure that new houses being built embody a high standard of energy efficiency through design and materials. This is generally achieved through a mixture of mandatory standards hand in hand with incentives to builders/developers to build to a standard significantly above that which is legislated.

As an alternative to financial incentives, many countries have information programmes aimed at customers to encourage them to reduce their usage. In Canada, Ontario offers customers online software that analyses a home's energy usage and provides personalised information on potential cost-saving upgrades. Japan has a 'CO_2 diet programme' where customers pledge to make changes to their lifestyle to reduce their CO_2 emissions. In Ireland, the Power of One campaign delivers a high level of publicity aimed at informing consumers on ways to reduce their own energy usage both at home and in the workplace.

Finally, some of the successful programmes in terms of reducing energy use through improving the stock of appliances have involved the adoption of voluntary or mandatory energy-efficiency standards for manufacturers (e.g. Japan's 'Top Runner' programme and the EU Energy Labelling Directive). Such programmes are only effective if the agency/country setting the standards has sufficient market power/influence to persuade manufacturers to change the design of their products. The introduction of energy labelling or rating schemes in many countries, particularly when backed by consumer education, is one voluntary way of gradually improving the stock of appliances that exist. If this can be run alongside programmes that mandate the removal of low-standard appliances, this will be more effective. The US Energy Star programme provides a good example of a rating programme that has been successfully incorporated into other programmes. The Irish Government has recently committed to supporting this initiative in Ireland to promote energy efficiency in office equipment as detailed in the NEEAP.

Lessons for Ireland

- Lighting and insulation are likely to be the largest areas of opportunity.
- Mandatory standards can be used to achieve improved efficiency of new housing and appliance stock although programmes with incentives are also required to achieve gains beyond these standards.
- It is important to increase awareness of energy-saving opportunities.

3.2 International Experience in Industrial Energy Efficiency Programmes

The use of financial incentives is often a key driver to encouraging increased energy efficiency in business. These can exist in various forms, including reductions in tax bills through enhanced capital allowances, loans for investing in certain technologies and grants or rebates towards the cost of certain equipment that is significantly more energy efficient compared to standard models. Generally, such programmes produce good results in terms of take up, but are potentially high cost.

A particular focus of some of the financial incentives has been on new-build programmes for commercial buildings. Canada's High Performance Building Construction programme provides incentives for energy efficient lighting for new builds through technical and economic assistance. Vermont in North America also runs a new construction programme that provides design and financial assistance for new buildings. Such programmes seek to maximise the potential long term benefits that exist with highly efficient commercial buildings assisting competitiveness through lower energy bills.

Grants exist internationally for renewable energy technologies being installed by business. Technical and design assistance can generate substantial market transformation impacts particularly in terms of spill-over benefits. These should be included in programmes where appropriate.

Smaller business customers can be more challenging to reach. Sometimes a 'direct install' approach can be used where a vendor identifies opportunities, then with permission, installs the relevant technology for the customer with some customer contribution. Examples include National Grid USA's Small Commercial and Industrial programme.

Improved provision of information to customers to enable appropriate business decisions is critical to improving energy efficiency. A number of the programmes provide free or subsidised audits to companies that meet various criteria. These include energy audit programmes run in Japan and Canada and 'Emprove' in New Zealand. Some countries (including Japan and Italy) have introduced a mandatory requirement for an energy manager for all firms above a certain size. This is intended to raise the profile of energy within an organisation and to make it compulsory to undertake certain activities with a payback within a specified time. It can also be used to create a network of managers to share ideas on achieving energy savings. However, merely the existence of an energy manager may not be sufficient to persuade a firm to undertake actions leading to energy efficiency gains and there is a need for top management to commit to reducing energy usage in order to exploit the maximum potential.

Lessons for Ireland

- Direct financial incentives make a significant difference to the take-up and cost of programmes.

- Opportunities in lighting and in new construction are particularly attractive.

- Improved information is critical to business undertaking energy-efficiency investment.

3.3 International Experience in Peak Demand Reduction

The majority of peak-demand reduction programmes are aimed at larger customers; by international standards Ireland already provides a high level of programmes for these customers.

There is a limited amount of 'time of use' metering in Ireland below the threshold of very large customers. It is possible that, if smart meters that record usage in each settlement period are available, suppliers will offer tariffs that reward smaller business or domestic customers for reducing usage in peak periods as this will save purchase costs. Evidence of the ability of consumers to respond to these types of price signals is shown in the Critical Peak Pricing programme in California and some of the ISO programmes in the US. These pilots also suggested that not all the peak-demand reduction leads to increased usage later so this will also result in an efficiency gain.

There is a resurgence of demand response in the US with the support of the Federal Energy Regulatory Commission and ISOs. There is increased use of electronic technologies such as smart thermostats to control load as well as some programmes using advanced metering infrastructure to enable programmes in the US. Some utilities, such as those in Texas, have achieved successful reductions in usage based on cycling of air conditioning in peak times.

Traditionally, many of the peak-demand reduction programmes are based on reductions in load during defined time slot periods such as the winter peak afternoon demand. Some of the international programmes focus on reducing demand in a more variable way. For example, in Ontario a voluntary programme allows participants to receive monthly payments in return for reducing demand based on short-term (3-hour ahead) price forecasts. Participants in the programme need to offer a strike price at which they are prepared to reduce their usage.

Lessons for Ireland

- The introduction of smart metering may allow for more peak-demand reduction from smaller consumers who can get rewarded for this service.
- Direct load control devices are becoming more common, although a primary use on air conditioning is not particularly applicable to Ireland.
- The introduction of the single electricity market (SEM) on the island of Ireland may lead to greater price incentives for larger customers to reduce demand at peak times with potential schemes similar to Ontario.

3.4 High Level Best Practices for Energy Efficiency

Best practices for energy-efficiency programmes have been recently reviewed in several research efforts. This section summarises the findings of those recent studies to inform the potential programme-design opportunities for Ireland. The first of these studies is the best-practices review that was completed for the California utilities.[9] In addition, a recent US Environmental Protection Agency report also provided a number of energy-efficiency best practices. A high-level list of best practices, particularly those relevant to Ireland, is presented below in Table 3-1. It should be noted that in addition to best-practice design a programme champion and high-level management involvement are essential for successful delivery.

Table 3-1 High Level Best Practices for Energy Efficiency

Best Practice	Rationale
Keep participation simple.	Easier for participants and any stakeholders, encourages higher participation.
Establish the potential for long-term energy savings.	Provides an understanding of what could be achieved with different levels of funding.
Designate which organisation (s) is responsible for administering programmes.	Avoids confusion on whose is implementing different programmes. Links to simple participation as there is a need for participants to be clear on who should be contacted.
Have participation strategies that are multi-pronged and inclusive.	Allows for more flexibility and greater participation.
Keep programmes stable over time and establish funding for multi-year periods.	Makes programmes predictable and easier for all participants.
Use incremental costs as the basis for incentives.	If incentives are used it is more economic to base them on incremental cost.
Use electronic means as much as possible.	More efficiency in processing.
Single point of contact.	Easier for participants, more efficient.
Make participation part of an existing transaction.	Easier for participants, more efficient.
Use trade allies[10] and wider stakeholders as much as possible.	Engages them as programme partners, reduces marketing costs.
Provide training to trades allies.	Increases knowledge of more efficient technologies and encourage broader market transformation as higher standards become the norm.

[9] From www.eebestpractices.com.
[10] Trade allies are market actors such as lighting distributors, electric motor dealers, appliance stores, architects, engineers, HVAC installers, etc (i.e. any business working in the value chain relating to energy use in building).

Best Practice	Rationale
Sell the customer the benefits first, energy efficiency later.	Emphasise other attributes of efficiency that appeal to businesses.
Develop robust measurement and verification methods.	Provides confidence in figures demonstrating the success of DSM programmes and assists the business case for future programme selection.
Evaluate programmes on a regular basis.	Informs results and future programme design.
Tie new construction programmes to codes and standards.	Easier for participants, more efficient.

4. Energy Efficiency Methodology

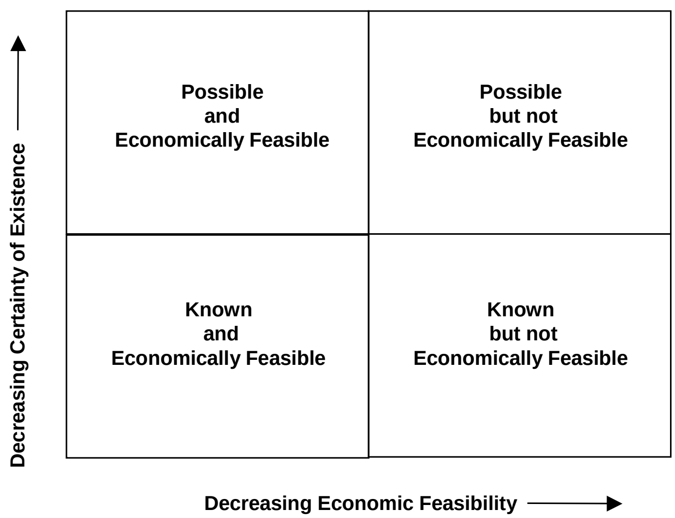
This section provides a brief overview of the concepts, methods, and scenarios used in this study. The key part of the analysis is the development of a model demonstrating how energy is used across the different sectors and fuel types in Ireland. Additional methodological details for this model are included in Appendix B.

4.1 Defining Energy Efficiency Potential

Estimating the market potential of various energy-efficiency measures became popular throughout the utilities from the late 1970s through to the mid-1990s. Coinciding with the advent of the so-called 'least-cost' or 'integrated resource planning' (IRP), these studies became one of the primary means of characterising the resource availability and value of energy efficiency within the overall resource planning process.

Similar to the resource studies developed for fossil fuels, the energy-efficiency market potential can be characterised and estimated based on the techno-economic definitions applied in this study. For example, fossil fuel resources are typically characterised along two primary dimensions: (i) the geological probability that the reserves will be found with the existing technology and (ii) the feasibility that extraction of the resource will be economic (Figure 4-1).

Figure 4-1 Conceptual Framework for Estimating Resources



The potential for energy efficiency has been assessed in a similar way considering technical feasibility, economic feasibility and take-up of possible measures. The study therefore defines four types of energy-efficiency potential:

1. ***Technical potential*** models the complete penetration of all energy-efficiency and demand-reduction measures that are considered technically feasible from an engineering perspective – regardless of cost.

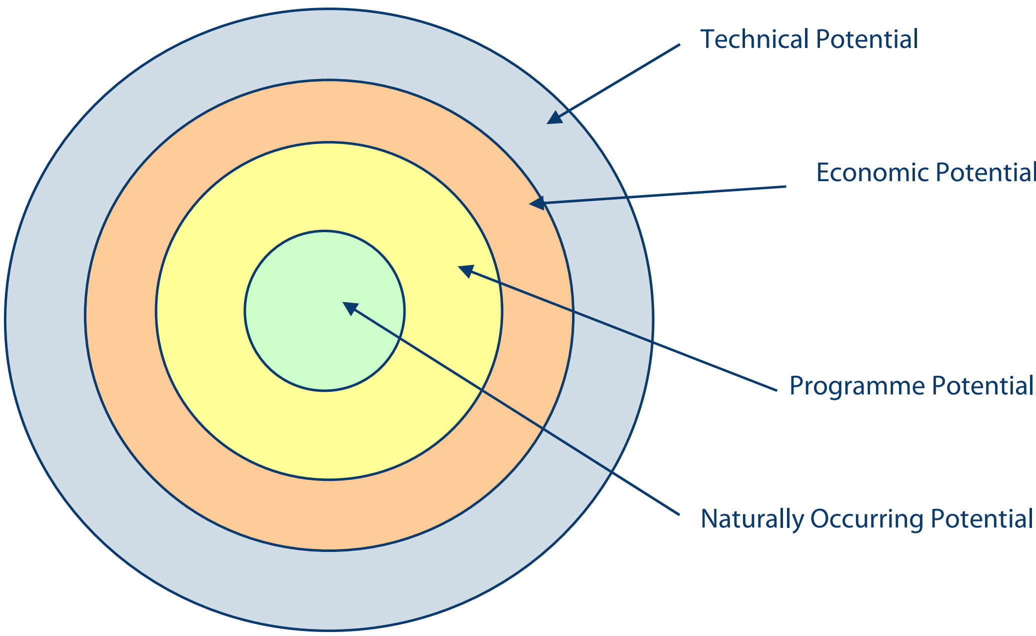
2. ***Economic potential*** refers to the potential of those measures that are cost effective when compared to supply-side alternatives.

3. ***Programme potential*** concerns energy saved as a result of a specific programme based on a defined level of incentives and cost. These savings are above and beyond those that would occur naturally in the absence of any market intervention.

4. ***Naturally occurring potential*** refers to energy saved as a result of normal market forces, that is, in the absence of any utility or governmental intervention.

As can be expected, these different definitions will result in different estimates of the potential for energy savings (Figure 4-2).

Figure 4-2 Conceptual Relationship of Energy-Efficiency Potential Definitions



4.2 Identification of Potential Savings in Ireland

The approach described below was undertaken in order to estimate the various energy-efficiency potentials. The bulk of the analytical process was performed using a model developed for conducting energy-efficiency potential studies. The model, DSM ASSYST™, is an MS-Excel-based tool that integrates technology-specific engineering and customer behaviour data with utility market saturation data, load shapes, rate projections, and marginal costs into an easily updated data management system.

The three key steps taken are as follows:

Step 1. Develop Initial Input Data

This was composed of three activities:

- Developing a list of energy-efficiency measure opportunities defined for Ireland.

- Gathering and developing the technical data (costs and savings) on efficient measure opportunities.

- Gathering, analysing and developing information on building characteristics, including: total square footage and total number of households; electricity, oil, and natural gas usage and intensity by end use; end-use load patterns by time; market shares of key equipment; and market shares of energy-efficiency technologies and practices.

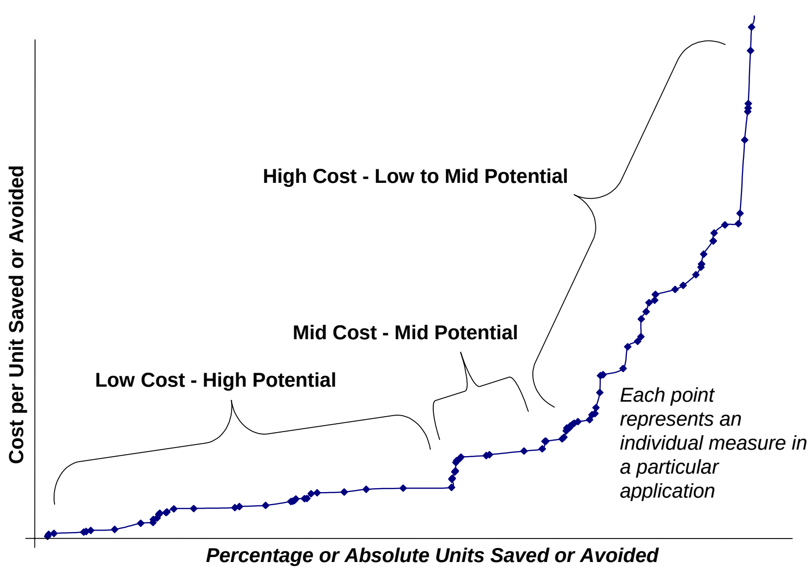
At the end of this stage the model contains a detailed picture of how energy is used in Ireland across sectors and end users. This understanding of current energy usage is an essential prerequisite to determining how energy can be saved.

Step 2. Estimate Technical Potential and Develop Supply Curves

This required matching and integration of the possible energy-efficient measures with the data on existing building characteristics to produce estimates of technical potential and energy-efficiency supply curves for Ireland.

Figure 4-3 shows a generic example of a supply curve. As the figure shows, a supply curve consists of two axes – one that captures the cost per unit of saving a resource or mitigating an impact (e.g., €/kWh saved or €/tonne of carbon avoided) and the other that shows the amount of savings or mitigation that could be achieved at each level of cost. The curve is typically built up across individual measures that are applied to specific base-case practices or technologies by market segment. Savings or mitigation measures are sorted on a least-cost basis, and total savings or impacts mitigated are calculated incrementally with respect to measures that precede them. Supply curves typically, but not always, end up reflecting diminishing returns, i.e., as costs increase rapidly and savings decrease significantly at the end of the curve.

Figure 4-3 Generic Illustration of Energy Efficiency Supply Curve

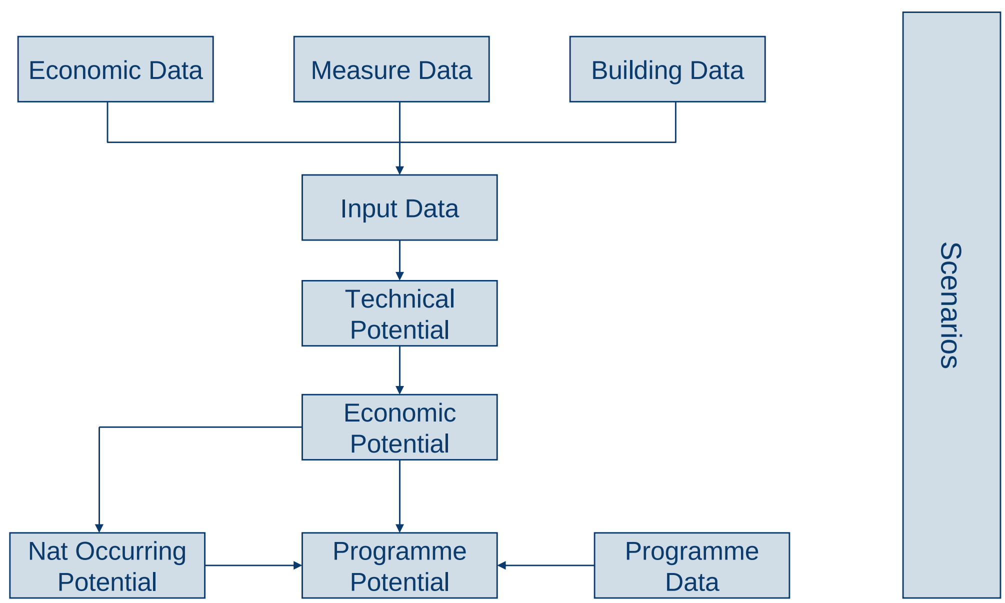


Step 3. Estimate Economic Potential

The estimate of economic potential builds on the technical potential identified in Step 2. The first action was the collection of economic input data, such as current and forecasted retail energy prices and costs of electricity generation. This included estimates of other potential benefits of reducing energy supply, such as the value of environmental impacts associated with electricity production.

The measure and building data were then matched and integrated with economic assumptions to produce indicators of costs from different viewpoints (e.g. societal and consumer). Based on the economic costs and on the range of applicable measures, the total economic potential can be estimated. An overview of this process is shown in Figure 4-4:

Figure 4-4 Conceptual Overview of DSM ASSYST Model



4.3 Business Case for Selected DSM Programmes

Using high-level programme concepts, the DSM ASSYST model was run to estimate the programme potential and the naturally occurring potential for energy efficiency. An estimate of programme costs (e.g. for administration and marketing as well as any financial incentives) and programme savings was produced for each market sector programme. Within this analysis, an estimate of the customer adoption of energy-efficiency measures utilising historic experience, based on the economic attractiveness of the measures, barriers to their adoption and the effects of programme intervention was also included.

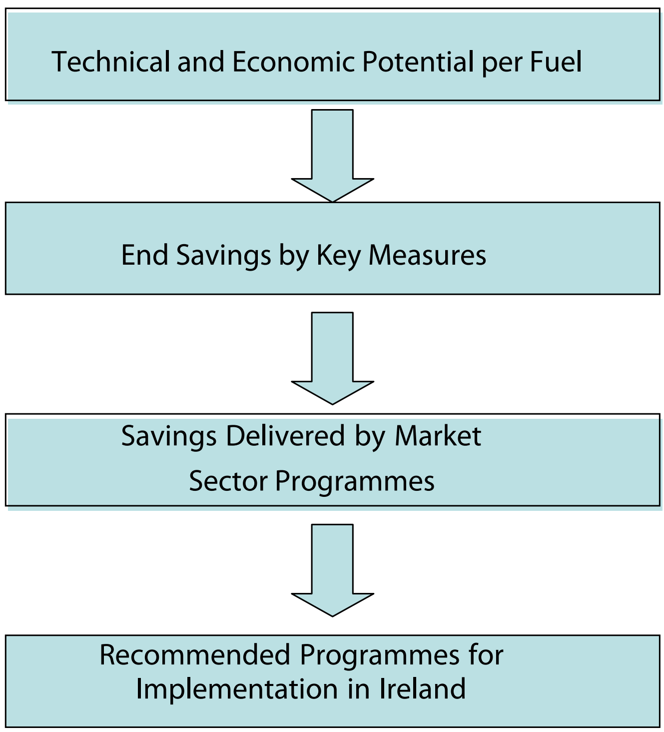
The end result is a table estimating the programme potential that can be achieved for each of the recommended programmes based on a defined level of incentive and cost. This maximum programme potential will vary with the level of incentive being provided and some sensitivity analysis was carried out to consider the potential at different levels of incentive. There will also be some overlap between programmes that implement measures that combine to reduce energy usage and these need to be factored into the modelling to avoid any double counting.

In developing the business case, not only the savings that can be provided by the programme but also the barriers to adoption that may not have been identified as part of the customer adoption rate were considered. Potential barriers, together with potential mitigation strategies, were assessed. These are detailed further in the implementation and detailed programme design later in this report.

4.4 Overview of the Modelling Process

Figure 4-5 below provides an overview of the different steps within the modelling process. The supporting description indicates how each of these steps link together to reach the final stage of potential energy savings and associated indicative DSM programmes for Ireland.

Figure 4-5 Process for Determining DSM Programmes



i) Economic and Technical Potential per Fuel – The first key output from the model is the overall economic and technical potential for each fuel, summing all of the measures that can achieve energy-efficiency savings in Ireland.

ii) Energy Saving by Key Measures – The next step is to break down the economic and technical potential into the individual key measures that make up the total potential. Key elements include lighting, heating, refrigeration, etc. Identifying these key measures helps to target the programme concepts that can deliver measure savings.

iii) Savings delivered by Market Sector Programmes – This is based on market sector programmes that can deliver the energy saved by the key identified measures. These programmes include funding for the key measures and allow a calculation of the total savings that could be delivered by broad market sector programmes.

iv) Recommended Programmes for Implementation in Ireland – Finally, a somewhat more detailed assessment of the individual recommended programmes for Ireland is provided. These programmes are more specific than the programme concepts and have been selected after an assessment of international best practice and characteristics of the Irish market as well as the energy-efficiency potential from each of the programme concepts. These descriptions include complementary services that enhance the broad programmes.

5. Technical and Economic Potential

This study analysed the potential for more than 200 energy-efficiency measures across dozens of market -segment applications. This section first provides some of the assumptions necessary to conduct this analysis and then moves on to give an overview of the technical and economic potential for Ireland. This is followed by a more detailed breakdown by customer class, end use and type of measure.

5.1 Explanation of Results and Assumptions

An explanation of the different types of energy efficiency was provided in Section 2. This section focuses only on the technical and economic potential. The *technical potential* represents the sum of all savings from all the measures deemed applicable and technically feasible. The e*conomic potential* is a subset of the technical potential and is based on efficiency measures that are cost-effective based on the total resource cost (TRC) test.

The TRC test is a benefit-cost test that compares the value of avoided energy production and power plant construction to the costs of energy-efficiency measures and programme activities necessary to deliver them. The values of both energy savings and peak demand reductions are incorporated into the TRC test. The test measures the net costs of a demand side management programme as a resource option based on the total cost of the programmes, including both participant and utility/government costs of a programme. This test is applicable for energy efficiency, load management and fuel substitution.

The key benefits in any programme are the energy costs saved which are defined as the economic value of the energy and demand savings that are stimulated by the measures that are assessed. These benefits are measured as induced changes in energy usage using some mix of avoided costs. In the case of electricity this is typically avoided distribution costs, transmission costs and most importantly avoided generation costs. In the case of oil and gas this would typically be the wholesale costs of the fuel and transportation costs.

Participant costs are comprised mainly of incremental measure costs, which are essentially the costs of obtaining energy efficient equipment. In the case of '*add-on devices'* (e.g. adjustable speed devices or roof insulation) the incremental cost is simply the installed cost of the measure itself. In the case of equipment that is available in various levels of efficiency (e.g. fridge freezers) the incremental cost is the excess of the cost of the high-efficiency unit over the cost of the base (reference) unit.

The administrative costs (Government, government agency or utility) encompass the real resource costs of programme administration, including the costs of administrative personnel, programme promotions, overhead, measurement and evaluation.

All new residential buildings were modelled to be 40 per cent more efficient than existing buildings to reflect the proposed changes in building regulations in 2008.

A summary of some of the key economic assumption and technical assumptions that have been used to derive the factors used in the TRC test is given below.

5.1.1 Economic Assumptions

As part of the modelling, assumptions have been made about the future trends of economic variables that will determine the value of energy benefits. These assumptions are detailed in Appendix C, but the approach to calculations of these assumptions is detailed below.

Electricity prices were forecast at two levels: (i) an avoidable cost of generation and (ii) the retail cost to the consumer of power. The avoidable cost is used for the societal benefits costs test and the retail cost is used for the consumer economics (i.e. how they value savings). Retail costs were derived for 2007 from ESB published tariffs. The avoidable cost of generation was based on the LOOP2 data produced by EirGrid.

Wholesale gas prices (avoided cost) have been produced from the price of wholesale gas at the UK NBP with additional transportation costs added for Ireland. The retail gas prices were derived from Bord Gáis prices for 2007. The retail heating oil prices were estimated from a number of regional prices using websites including irishfuelprice.com.

A central value of carbon of €20 tonne was used for estimating avoidable costs. In addition, a capacity charge based on the best new entrant cost has also been included in the avoidable costs and spread over the winter peak hours.

The cost of VAT was included for residential customer and excluded for business customers as it is assumed they will reclaim this cost. Economic growth was assumed to be 5.7 per cent until 2010 and 2.4 per cent from 2010 to 2020. The inflation rate was assumed to be 2 per cent p/a until 2020.

Prices were forecast over the lifetime of the modelling period and by customer class.

5.1.2 Building Stock Assumptions

Residential building stock was modelled using two building types – detached homes/bungalows and flats. Building stock data came from the Census of Housing. The major end uses modelled were: space heating, space cooling, lighting, water heating and appliances. Usage data was derived from SEI data along with data on measures from the Department of Environment, Food and Rural Affairs (DEFRA) (UK).

The following building types were modelled for the commercial sector:

- Offices
- Shops
- Education
- Health
- Transport
- Warehouses
- Hotel and Catering
- Miscellaneous

The major end uses for commercial were: Heating, ventilation, air conditioning and cooling (HVAC), lighting, cooking, refrigeration and office equipment. Historic usage by building type came from the Irish energy balance data and end use data was derived from this data.

The following industries were modelled:

- Rubber
- Food
- Mining
- Non-metallic minerals
- Chemicals
- Textiles
- Wood
- Machinery
- Electrical
- Transport
- Other Manufacturing
- Paper

The major end uses modelled were: lighting, pumps, motors, process, HVAC, refrigeration, and other. Historic usage data came from the Irish Energy Balance Spreadsheet and end use data was derived from this data and UK usage per square foot data.

5.1.3 Measure Data

Kema derived individual measure data from interviews with selected market actors in Ireland, data from the Department for Business, Enterprise and Regulatory Reform (UK), DEFRA (UK) and previous studies. The following data was collected: percentage energy savings, percent demand savings, lifetime, applicable square footage, awareness and other penetration curve parameters.

5.1.4 Lifetime data

A number of technical assumptions had to be made to determine the quantity of energy that would be saved by the introduction of measures.

The key area of debate has been the lifetime of the individual measures. Primarily, these have been derived from Kema's database of energy-efficient resources. However, the EU is producing standard lifetimes for the calculation of savings measures towards the Energy Services Directive target. Within the EU Energy Service Directive, there are a number of example lifetimes of measures and whilst these lifetimes are still to be agreed it was felt appropriate to use the figures that are currently included within the Directive (see Table 5-1). The approach has been to identify where such figures vary significantly from those in the database and comment on the variation.

Table 5-1 Example Measure Life in the Energy Services Directive

Measure	Lifetime (years)
Loft Insulation of Private Dwellings	30
Cavity Wall Insulation of Private Dwellings	40
Glazing E to C rated (in m^2)	20
Boilers B to A rated	15
Heating controls – Upgrade with boiler replacement	15
CFLs – retail	16

The lifetime figures for lighting seemed high in comparison with Kema's international experience and the expectation of some members of the DSM Advisory Group.

The savings available from each fuel are also influenced by the degree to which each fuel is used for space heating and water heating. Kema has used the following figures as a guide to the existing penetration of the different fuels for residential space and water heating:

Table 5-2 Penetration of Space and Water Heating

Fuel	Space Heating (%)	Water Heating
Electricity	10	30
Gas	35	30
Oil	40	30
Other	15	10

Saturation levels of the key appliances and current levels of insulation were the final major items that had an impact, particularly on residential potential. Estimates of these saturation levels were derived from a mixture of Irish and UK data and discussed with the DSM Advisory Group in order to reach agreed assumptions to be used in the modelling. Where possible, prices for each of these measures, including the incremental costs based on the reference non energy-efficient product, were calculated from Irish price data from a variety of sources.

5.2 Technical and Economic Potential

5.2.1 Electricity

This section presents an overall estimate of total technical and economic potential for peak demand reduction and electricity saving in Ireland.

Peak Demand Reductions – If all the electricity measures analysed in this study were implemented whenever technically feasible, technical potential would be approximately 1,344 MW, reduced between 3 p.m. to 8 p.m. This is additional to the savings that are produced by the current DSM programmes as they are already built into the base demand. If only the measures that pass the TRC test were implemented, economic potential would be 1,233 MW (about 25 percent and 22 percent of total base load, respectively). The largest proportion of this savings is derived from commercial customers reflecting their ability to reduce peak time demand through some of the energy efficiency measures, particularly lighting, that they could install. This is shown in Figure 5-1 and Table 5-3 below.

Figure 5-1 Technical and Economic Potential Electricity Demand Reduction

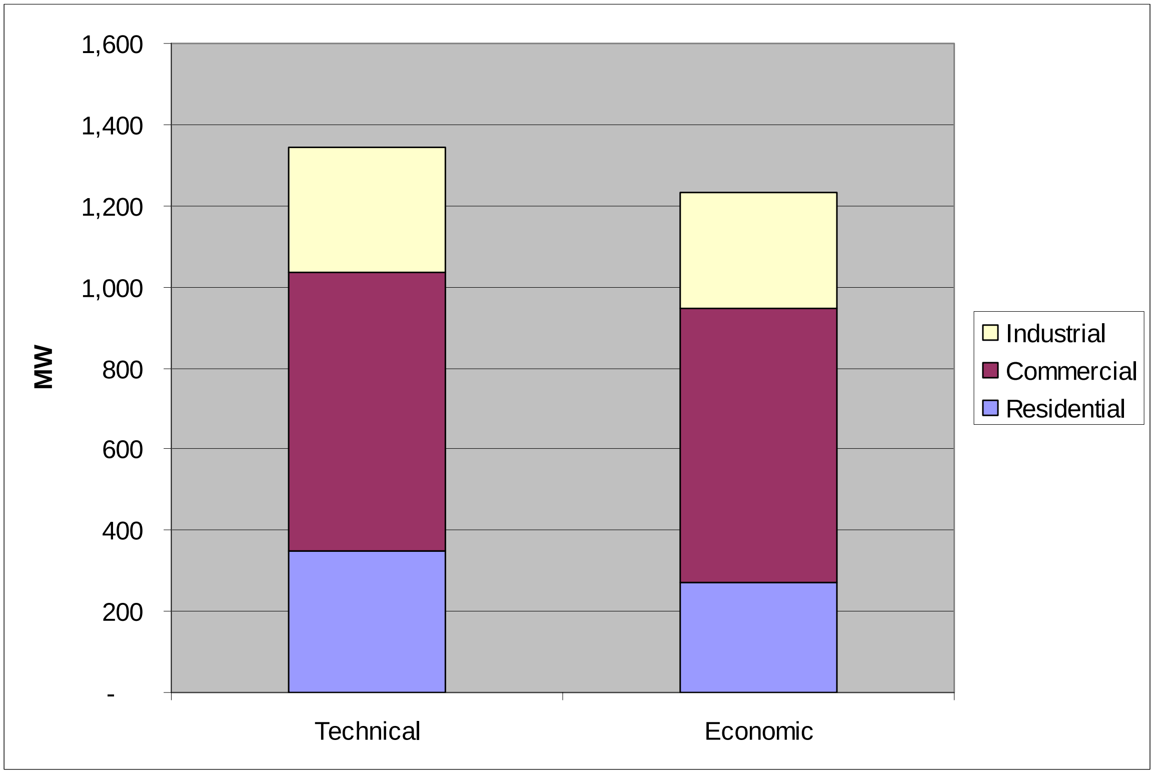


Table 5-3 Technical and Economic Electricity Demand Savings Potential in Ireland by Market Sector in MW

MW	Technical	Economic
Residential	349	269
Commercial	687	676
Industrial	308	287
Total	1344	1233

A key point worth noting from this table is that almost all of the commercial sector technical potential is also economic.

Electricity Savings – Technical potential for electricity savings is estimated at 6,578 GWh, and economic potential at 5,901 GWh. The most significant proportion of this is the residential sector. However, this also has the most technical potential that is not economic as shown in Figure 5-2 and Table 5-4 below.

Figure 5-2 Technical and Economic Potential Electricity Energy Savings

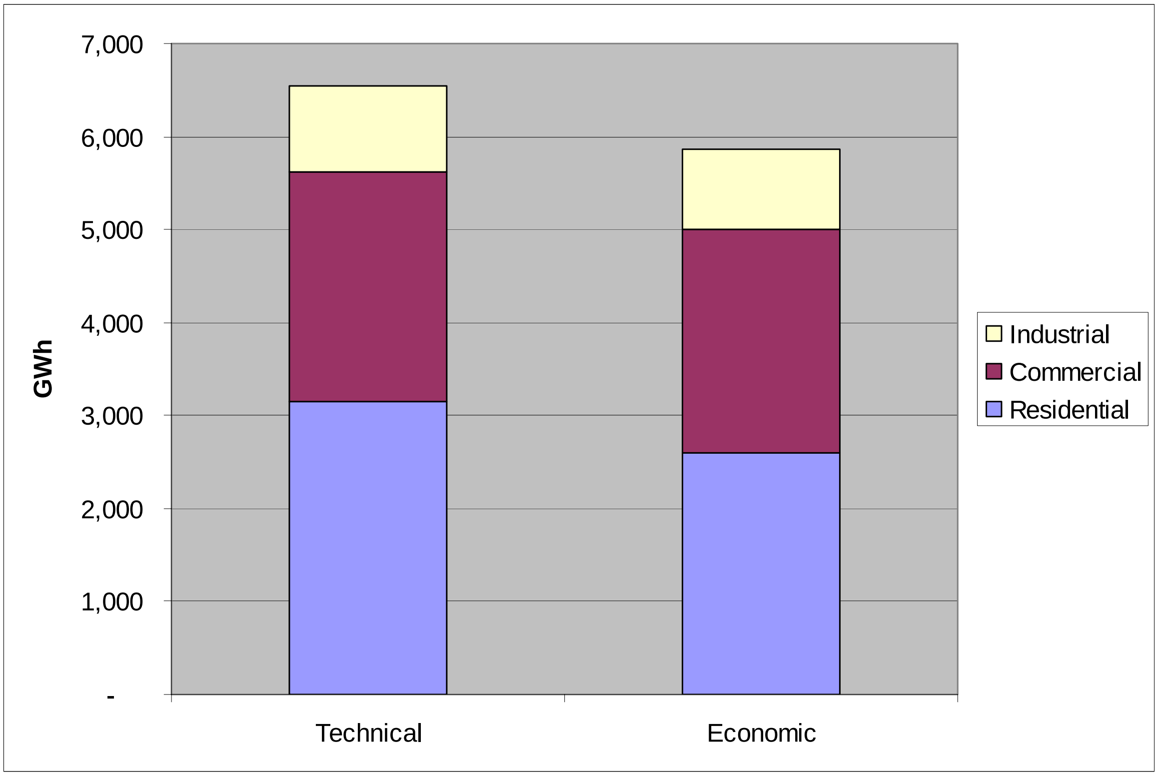
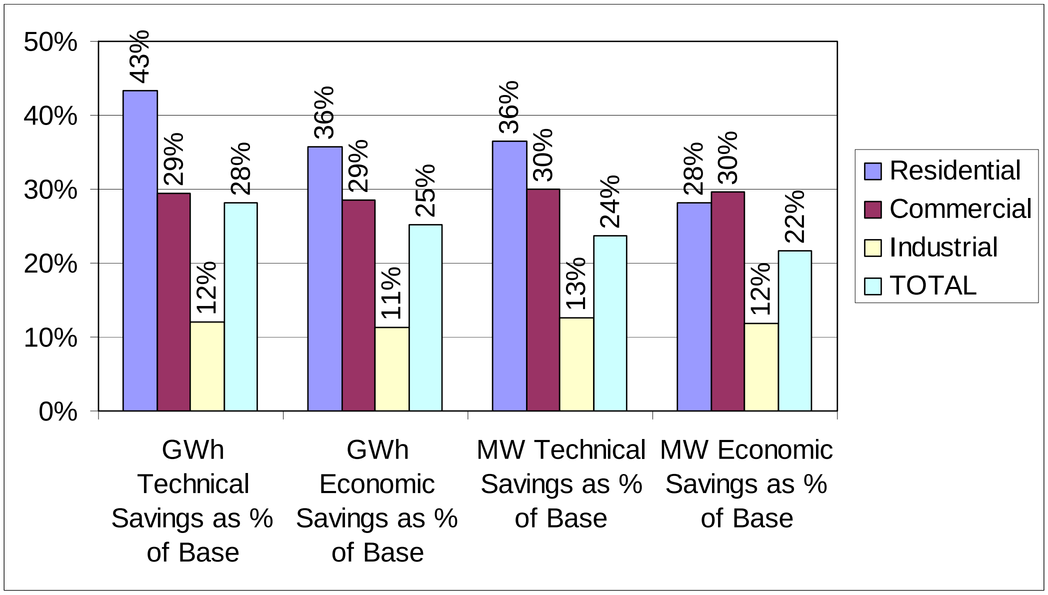


Table 5-4 Technical and Economic Electricity Savings Potential in Ireland by Market Sector in GWh

GWh	Technical	Economic
Residential	3,191	2,635
Commercial	2,468	2,400
Industrial	919	866
Total	6,578	5,901

A final part of the evaluation is to consider the size of the peak demand reductions and electricity savings as a percentage of the current demand. This is shown in Figure 5-3 below. Overall, 25 per cent of base demand fits into the economic potential for saving energy.

Figure 5-3 Technical and Economic Electricity Savings Potential as Percentage of 2006 Base



5.2.2 Oil

The technical oil savings potential are approximately 801 kilotonnes of oil equivalent (ktoe). Because of the relatively high price of oil, a significant percentage of oil savings measures that were analysed passed the TRC test, resulting in economic savings of about 625 ktoe, as shown in Figure 5-4 below.

The relatively high proportion of savings from the residential sector reflects the high level of oil used for Space Heating (40 per cent) and Water Heating (30 per cent) which would be able to benefit from the insulation upgrade measures.

Figure 5-4 Technical and Economic Potential Oil Savings

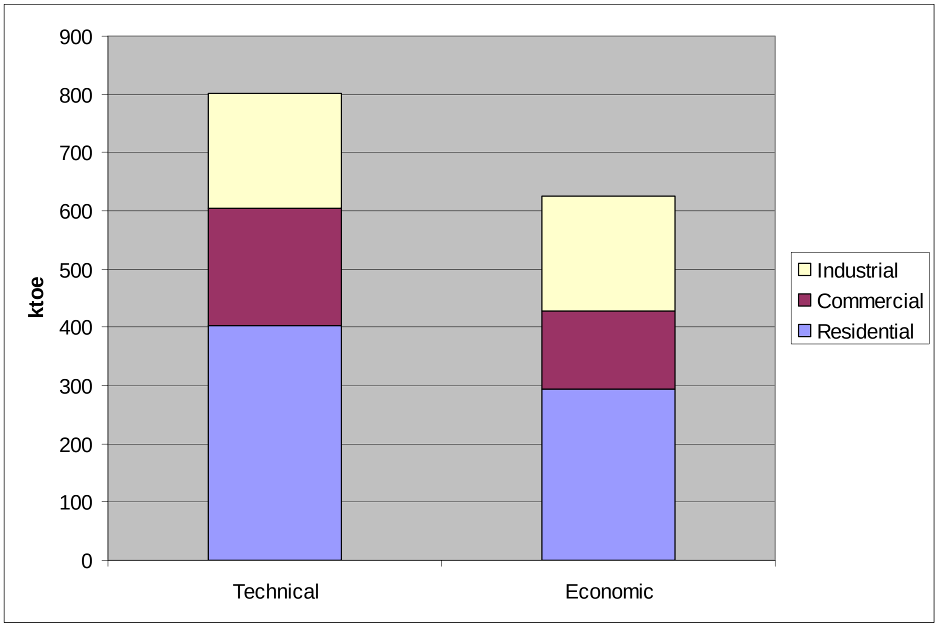
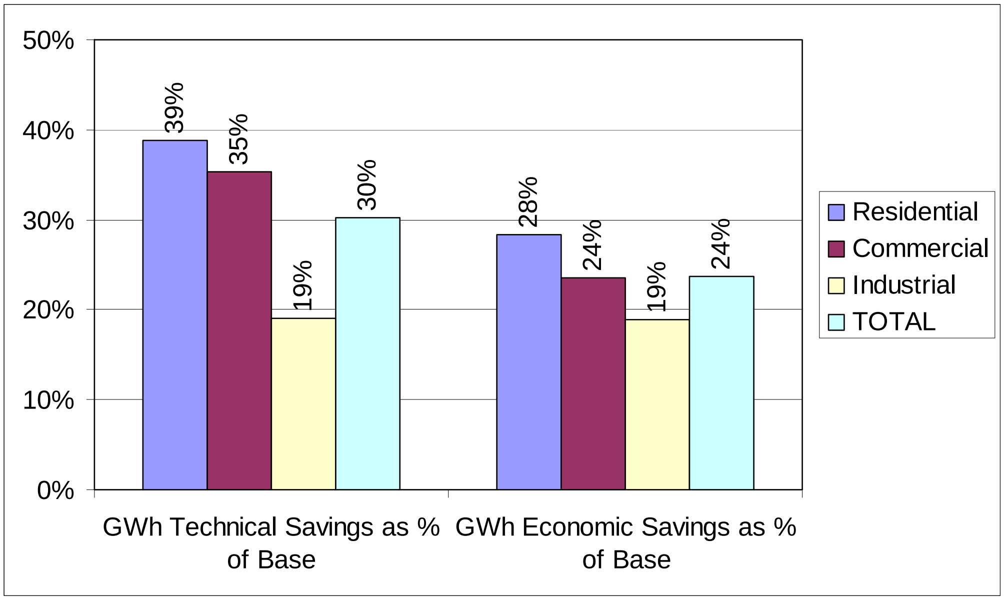


Table 5-5 Technical and Economic Oil Energy Savings Potential in Ireland by Market Sector in kilotonnes oil equivalent (ktoe)

	Energy Saving Potential ktoe		Energy Saving Potential GWh	
	Technical	Economic	Technical	Economic
Residential	402	294	4,675	3,418
Commercial	201	134	2,342	1,560
Industrial	198	197	2,301	2,290
Total	801	625	9,317	7,268

Table 5-5 above indicates that almost all (99 per cent) of the technical potential that exists for industrial customers is economic. The technical potential for both residential and commercial customers is a high proportion (39 per cent and 35 per cent) of their current demand, particularly when compared to the industrial customers' relatively low technical rate of 19 per cent. There is more similarity in the economic potential across the different customers groups, where the variation is only from 28 per cent to 19 per cent. This is shown in Figure 5-5 below.

Figure 5-5 Technical and Economic Oil Energy Savings Potential as Percentage of 2006 Base



5.2.3 Gas

The technical gas savings have been calculated as approximately 356 ktoe. As with oil savings measures, most gas savings measures that were analysed passed the TRC test, producing an economic savings potential of about 310 ktoe, as shown in Figure 5-6.

Figure 5-6 Technical and Economic Potential Gas Savings

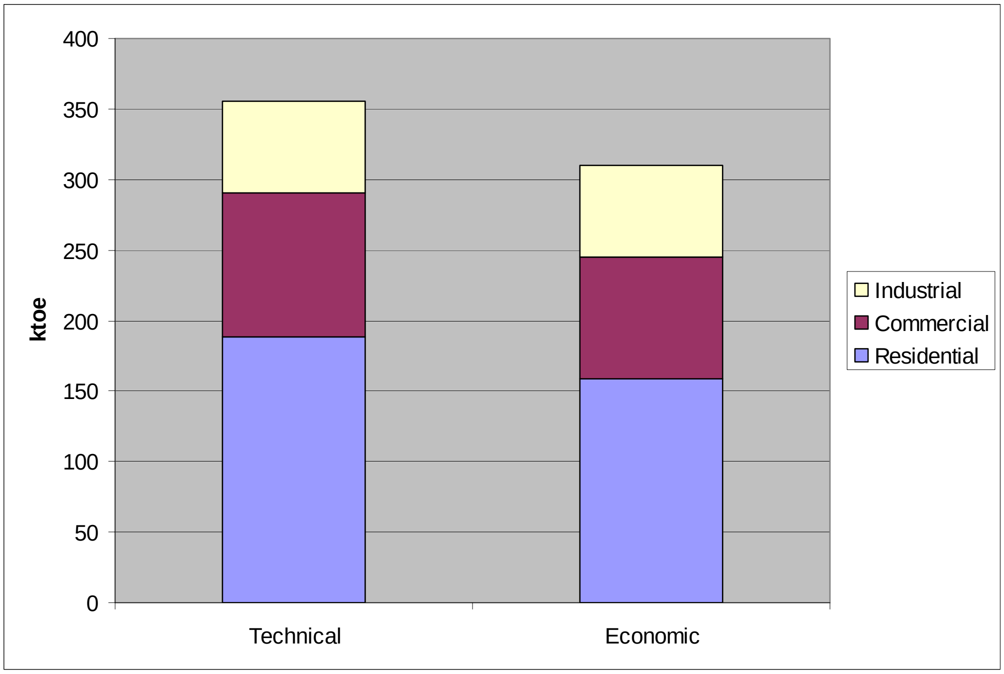


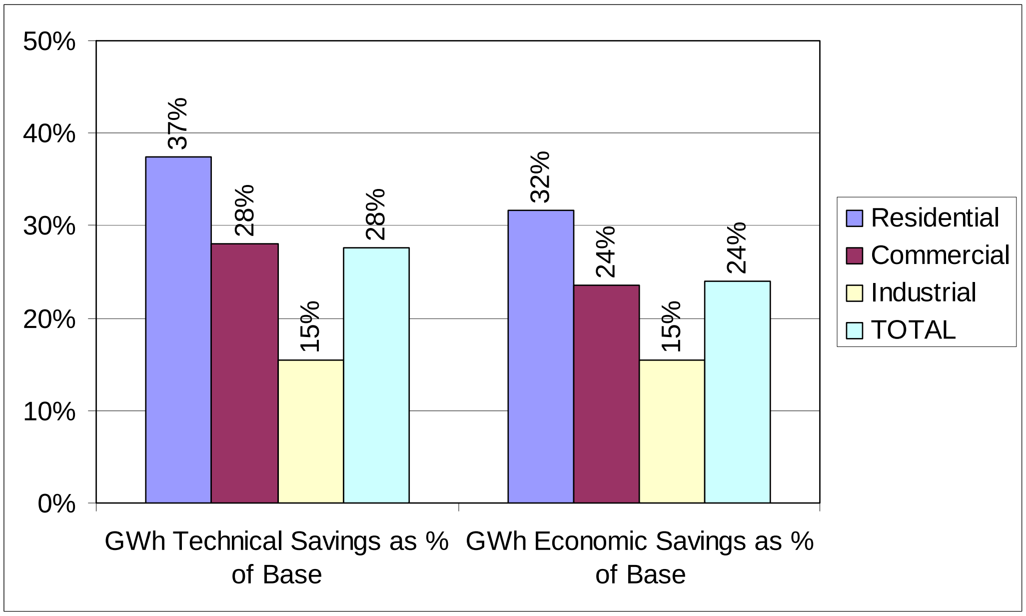
Table 5-6 Technical and Economic Natural Gas Energy Savings Potential in Ireland by Market Sector in kilotonnes oil equivalent

	Energy Saving Potential ktoe		Energy Saving Potential GWh	
	Technical	Economic	Technical	Economic
Residential	189	159	2,193	1,850
Commercial	102	86	1,187	999
Industrial	65	65	758	758
Total	356	310	4,137	3,606

As with oil savings, there is a large proportion of the potential (>50 per cent on both technical and economic) that is derived from the residential sector. This reflects the high use of gas as a heating fuel. It is interesting to note that almost all of the technical potential for industrial customers passes the TRC test and is hence considered economic.

Figure 5-7 below shows the technical and economic savings as a percentage of base use. These vary significantly across sectors, with residential having the greatest potential and industrial the least. This is consistent with the picture from all other fuels.

Figure 5-7 Technical and Economic Gas Energy Savings Potential as Percentage of 2006 Base



5.2.4 Summary of All Fuels

Table 5-7 below summarises the technical and economic potential across all fuels. This has been calculated as Total Final Consumption rather than Primary Consumption used in Section 6. This shows that the greatest potential exists in the residential sector and that oil is the fuel with the largest potential when assessed as Total Final Consumption. Oil has the greatest amount of technical potential that does not covert into economic potential.

Table 5-7 Technical Potential from all Fuels (ktoe)

	Electric	Oil	Gas	All Fuels
Residential	274	402	189	865
Commercial	212	201	102	516
Industrial	79	198	65	342
Total	566	801	356	1722

Table 5-8 Economic Potential from all Fuels (ktoe)

	Electric	Oil	Gas	All Fuels
Residential	227	294	159	680
Commercial	206	134	86	426
Industrial	74	197	65	337
Total	507	625	310	1442

5.2.5 Carbon Savings

Carbon savings have been calculated by converting the energy saved in tonnes of CO_2 saved. This was achieved by first converting all fuel savings into GWh and then applying a conversion figure of kg CO_2/kWh. These are shown in the table below.

Table 5-9 Conversion factors for CO_2 Savings

Fuel	g CO_2/kWh
Electricity	637
Heating Oil (Kerosene)	257
Gas	198

The tables and diagram below shows the carbon savings that can be achieved from the different fuels on both an economic and technical basis. Whilst the energy savings in GWh were highest in oil, the relative CO_2 conversion factors mean that the highest carbon savings potential exists in electricity rather than gas or oil.

Table 5-10 Technical Potential for Carbon Savings

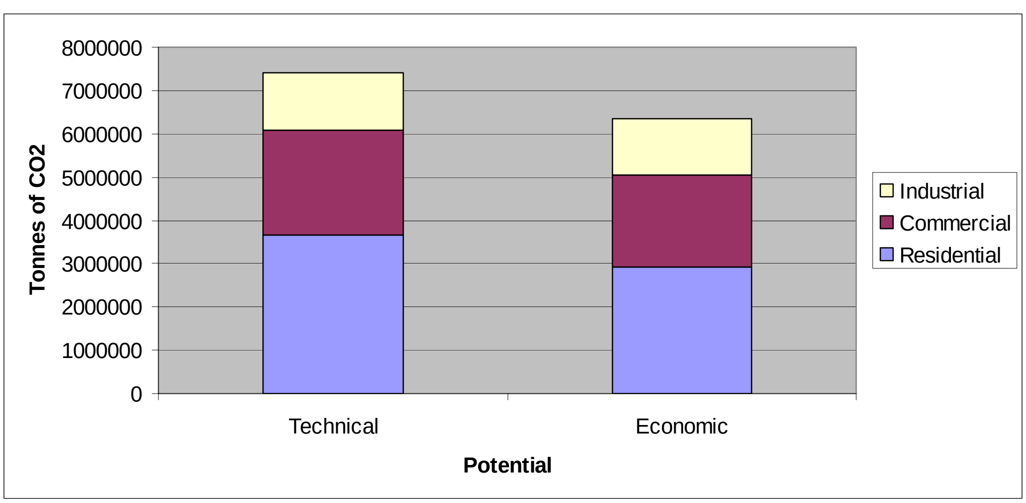
	Techical Potential in GWh			Kilotonnes of CO_2		
	Electricity	Oil	Gas	Electricity	Oil	Gas
Residential	3191	4675	2193	2033	1201	434
Commercial	2468	2342	1187	1572	602	235
Industrial	919	2301	758	585	591	150
Total	6578	9317	4137	4190	2395	819

Table 5-11 Economic Potential for Carbon Savings

	Economic Potential in GWh			Kilotonnes of CO_2		
	Electricity	Oil	Gas	Electricity	Oil	Gas
Residential	2635	3418	1850	1678	878	366
Commercial	2400	1560	999	1529	401	198
Industrial	866	2290	758	552	589	150
Total	5901	7268	3606	3759	1868	714

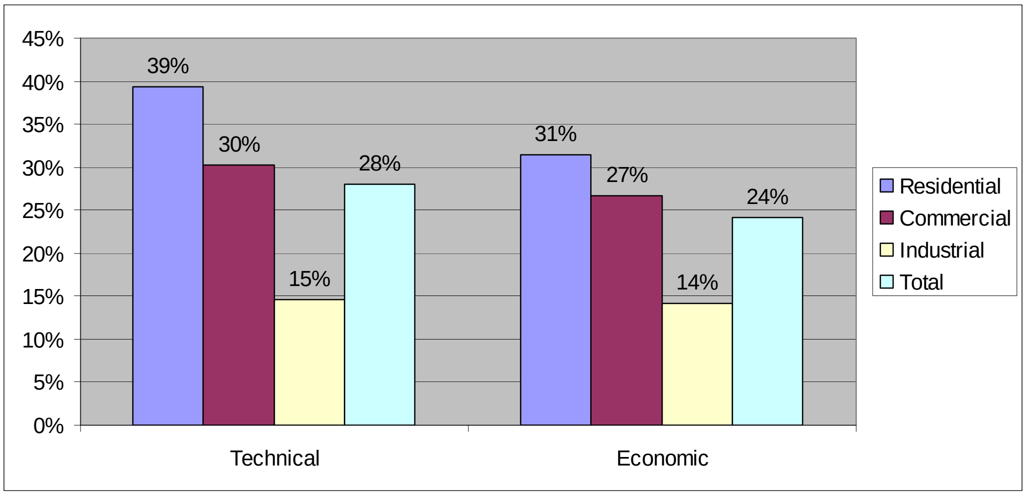
The largest potential is seen in the residential sector, reflecting the high potential residential savings from electricity. This is shown in Figure 5-8.

Figure 5-8 Technical and Economic Potential for CO_2 by Sector



The potential for saving CO_2 is also presented as a percentage of base in Figure 5-9. This shows an overall economic potential of 24 per cent of current CO_2 production.

Figure 5-9 Carbon Savings as a Percentage of Base



5.3 Savings by Sector

5.3.1 Residential Sector

Residential electricity economic potential in Ireland is presented by end-use category in Figure 5-10 (for energy savings) and Figure 5-11 (for demand reduction). Appliances and lighting are key contributors to overall economic potential. Lighting is higher for the peak demand reductions than appliances. This is a reflection of the assumption that more of it is likely to be operating at peak periods and therefore recorded in the peak demand reductions, whereas the appliances may be switched off.

Figure 5-10 Economic Potential for Residential Electricity Savings, by End Use (GWh)

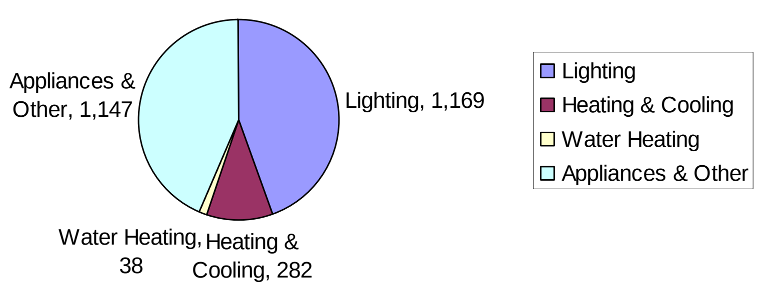
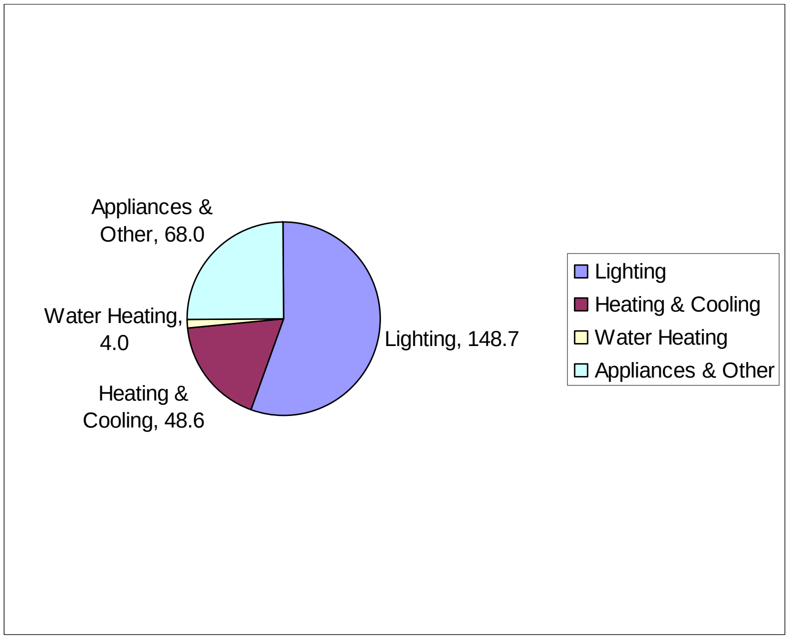


Figure 5-11 Economic Potential for Residential Electricity Demand Reduction by End Use (MW)



Oil savings are presented in Figure 5-12 and gas savings are presented in Figure 5-13. The bulk of savings coming for both oil and gas are derived from space heating measures.

Figure 5-12 Economic Potential for Residential Oil Savings, by End Use (ktoe)

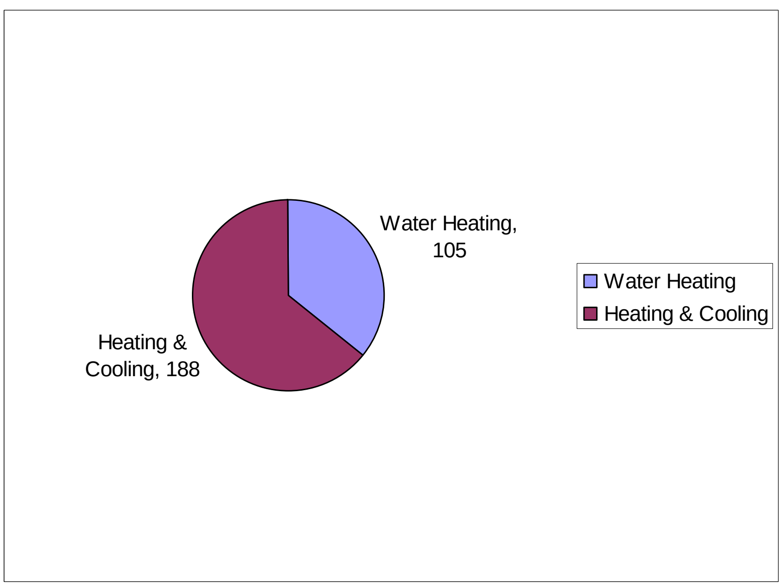
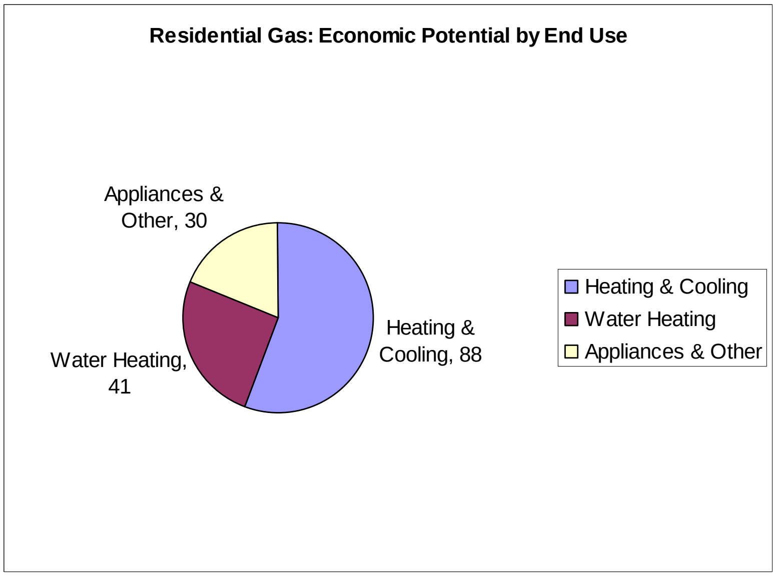


Figure 5-13 Economic Potential for Residential Gas Savings, by End Use (ktoe)



The gas usage savings from clothes washers and dishwashers reflect the reductions in gas-heated hot water as well as gas use from more efficient gas appliances such as dryers.

A summary of the residential economic potential as total final consumption is provided in Table 5-12.

Table 5-12 Residential Economic Potential for All Fuels (ktoe)

	Electricity	Oil	Gas	All Fuels
Lighting	100	0	0	100
Heating & Cooling	24	188	88	301
Water Heating	3	105	41	149
Appliances & Other	99	0	30	129
TOTAL:	227	294	159	680

5.3.2 Commercial Sector

Figure 5-14 and Figure 5-15 show commercial-sector economic potential estimates by key end use for electricity. Lighting dominates both the energy savings and demand savings. Heating, ventilation, and air conditioning measures also represent a significant portion of savings. End uses in the 'other' category include office equipment, water heating, and cooking. Figure 5-17 shows commercial sector economic potential estimates by key end use for oil, and Figure 5-18 presents the results for gas. Oil and gas savings are split relatively evenly between space heating and water heating measures being the bulk of the savings.

Figure 5-14 Economic Potential for Commercial Electricity Savings, by End Use (GWh)

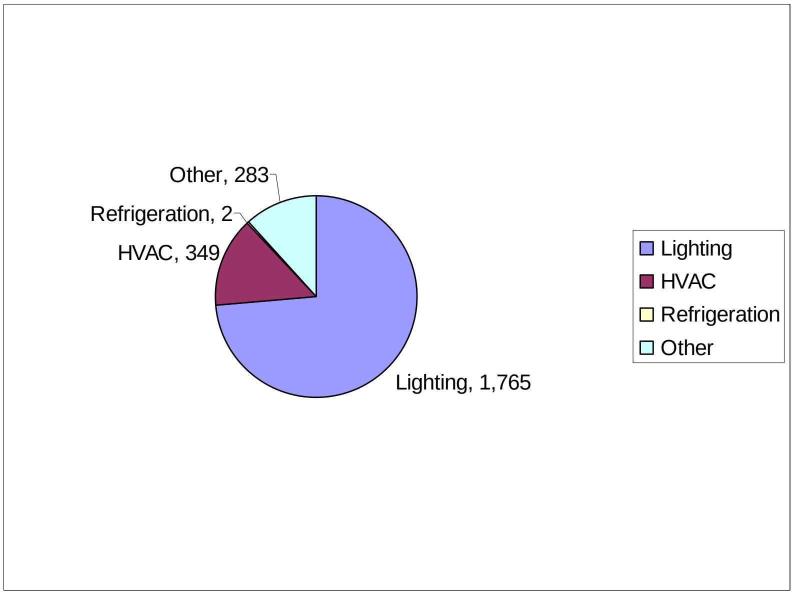


Figure 5-15 Economic Potential for Commercial/ Demand Reduction, by End Use (MW)

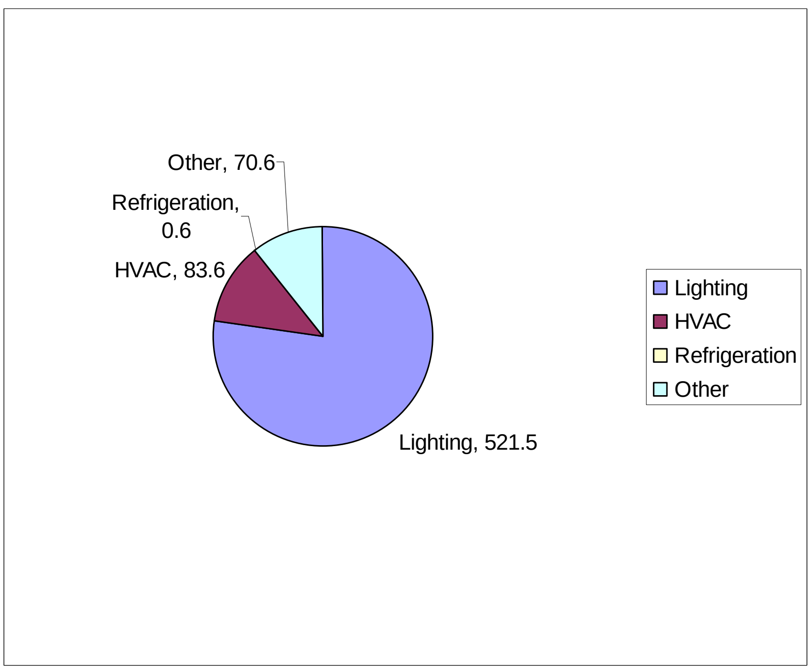


Figure 5-16 Economic Potential for Commercial Oil Savings, by End Use (ktoe)

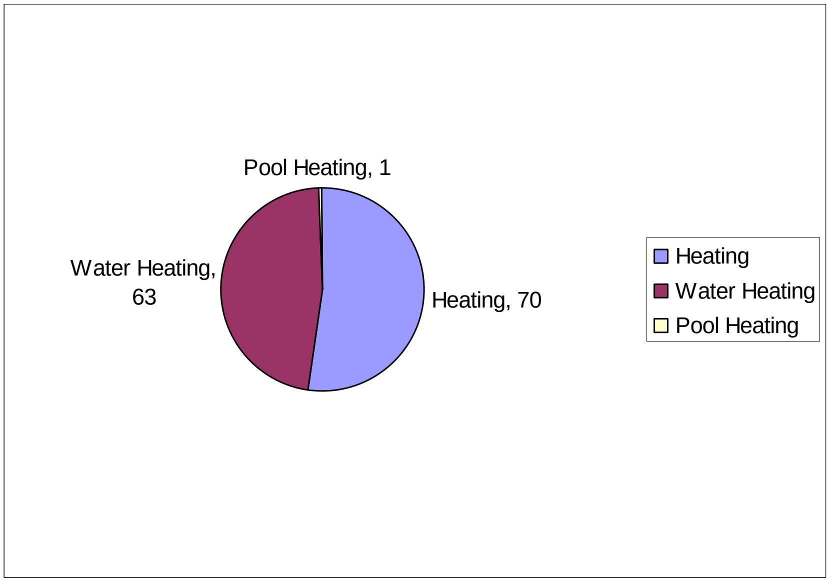
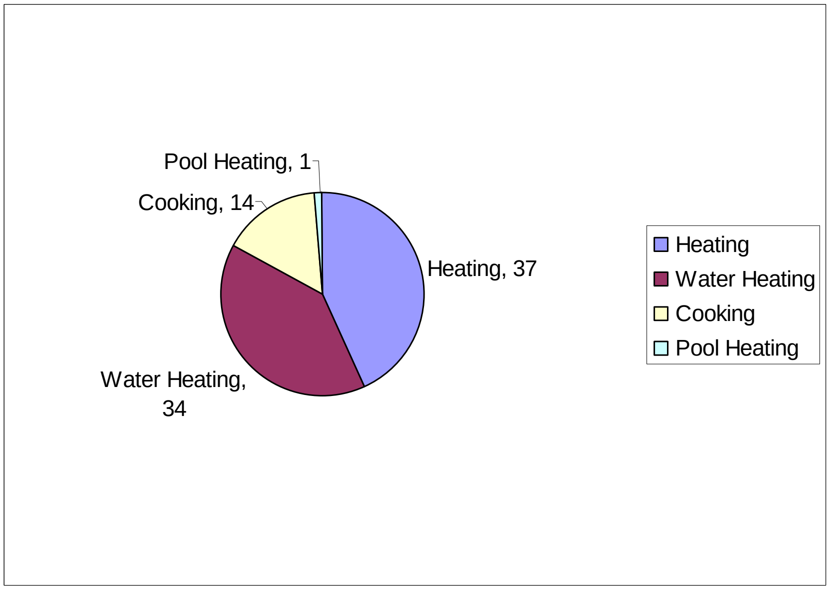


Figure 5-17 Economic Potential for Commercial Gas Savings, by End Use (ktoe)



A summary of the commercial economic potential as total final consumption is provided in Table 5-13 below.

Table 5-13 Commercial Economic Potential for All Fuels (ktoe)

	Electricity	Oil	Gas	All Fuels
Lighting	152	0	0	152
HVAC	30	70	37	137
Water Heating	0	63	34	97
Refrigeration	0	0	0	0
Cooking	0	0	14	14
Pool Heating	0	1	1	2
Other	24	0	0	24
Total	206	134	86	426

5.3.3 Industrial Sector

Figure 5-18 and Figure 5-19 show industrial-sector economic potential estimates by key end use for electricity. These show that in addition to lighting there is a significant saving that can be obtained from motors. Figure 5-20 and Figure 5-21 shows industrial sector economic potential estimates by key end use for oil and gas. Both of these fuels show a high level of potential in boilers and process heat

Figure 5-18 Economic Potential for Industrial Electricity Savings, by End Use (GWh)

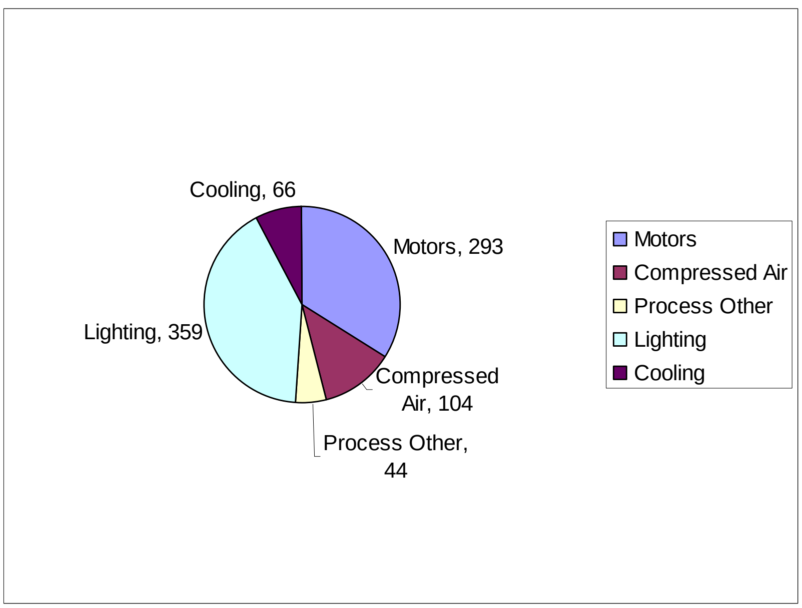


Figure 5-19 Economic Potential for Industrial Demand Reduction, by End Use (MW)

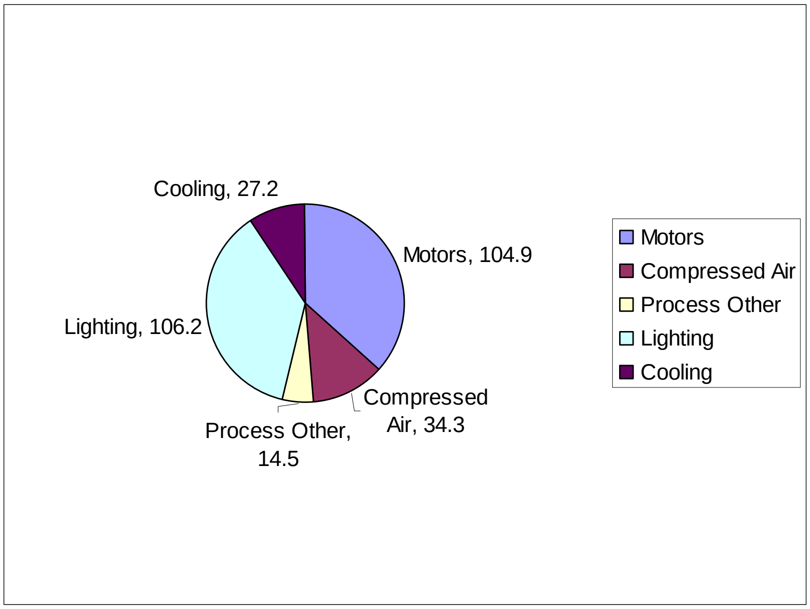


Figure 5-20 Economic Potential for Industrial Oil Savings, by End Use (ktoe)

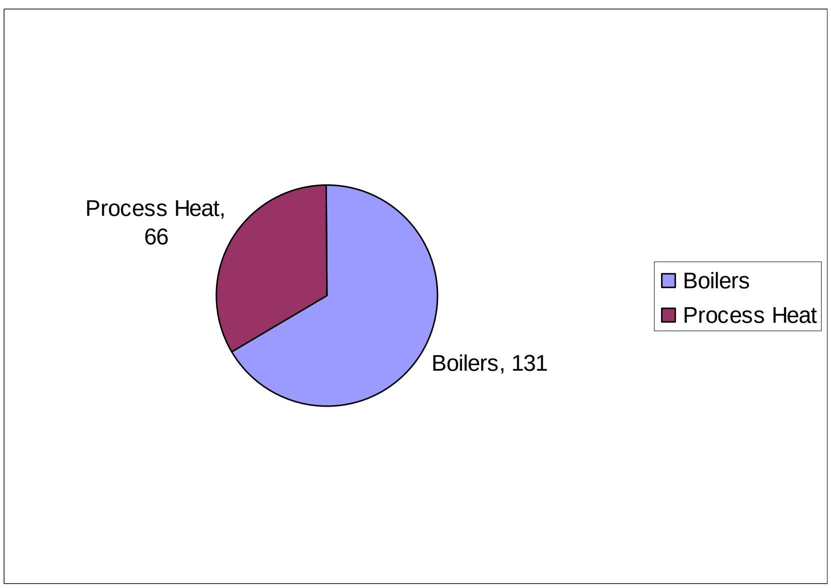
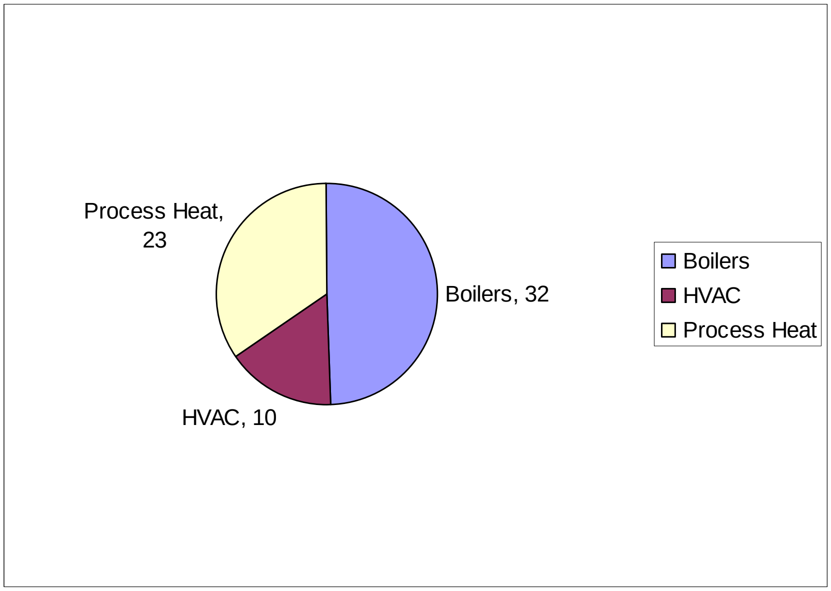


Figure 5-21 Economic Potential for Industrial Gas Savings, by End Use (ktoe)



A summary table of the industrial economic potential as total final consumption is provided below.

Table 5-14 Industrial Economic Potential for All Fuels (ktoe)

	Electricity	Oil	Gas	All Fuels
Motors	25	0	0	25
Compressed Air	9	0	0	9
Process Heat	0	66	23	89
Process Other	4	0	0	4
Lighting	31	0	0	31
HVAC	6	0	10	16
Boiler	0	131	32	163
Total	74	197	65	337

5.4 Supply Curves

As noted in Section 4 a common way to illustrate the amount of energy savings per Euro spent is to construct an energy-efficiency supply curve. A supply curve typically is depicted on two axes – one captures the cost per unit of saved electricity (e.g. levelised €/kWh saved), and the other shows energy savings at each level of cost. Measures are sorted on a least-cost basis, and total savings are calculated incrementally with respect to measures that precede them. The costs of the measures are levelised over the life of the savings achieved. In cases where there are multiple measures for the same end use, assumptions have been made about which percentages would go with which measure to ensure there was no double counting.

Figure 5-22 and Figure 5-23 present the electric energy-efficiency supply curves constructed for this study for both residential and commercial existing buildings. Each curve represents energy savings as a percentage of total energy usage in Ireland. Figure 5-24 presents the supply curve for electric industrial. End-use and measure savings are discussed later in this section.

Figure 5-22 Residential Existing Buildings Electricity Supply Curve

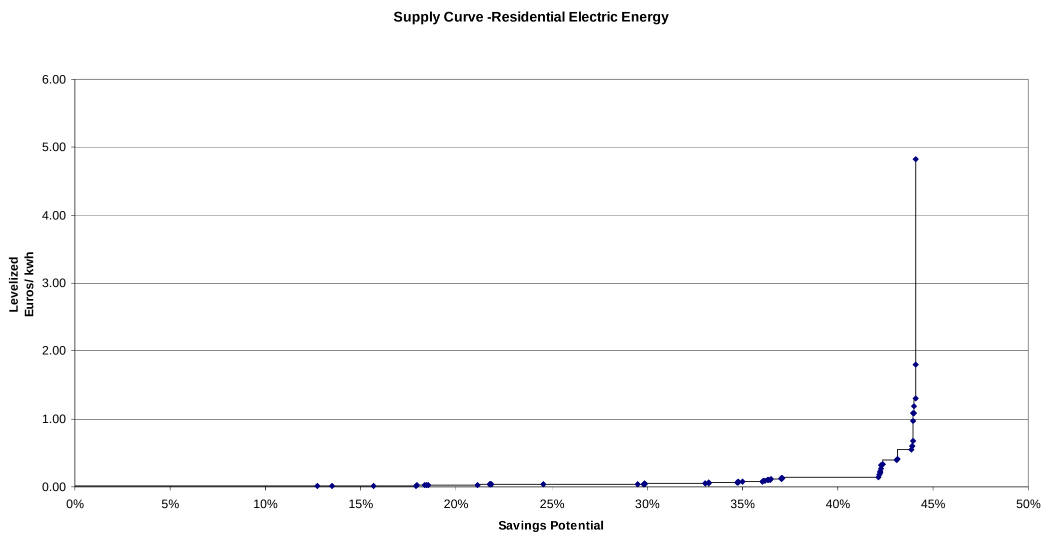


Figure 5-23 Commercial Existing Buildings Electricity Supply Curve

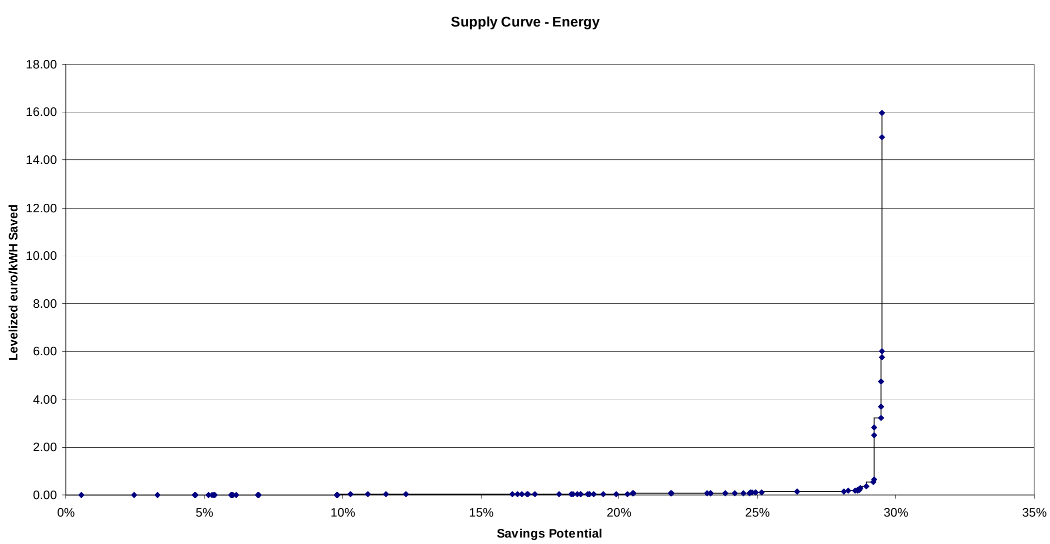
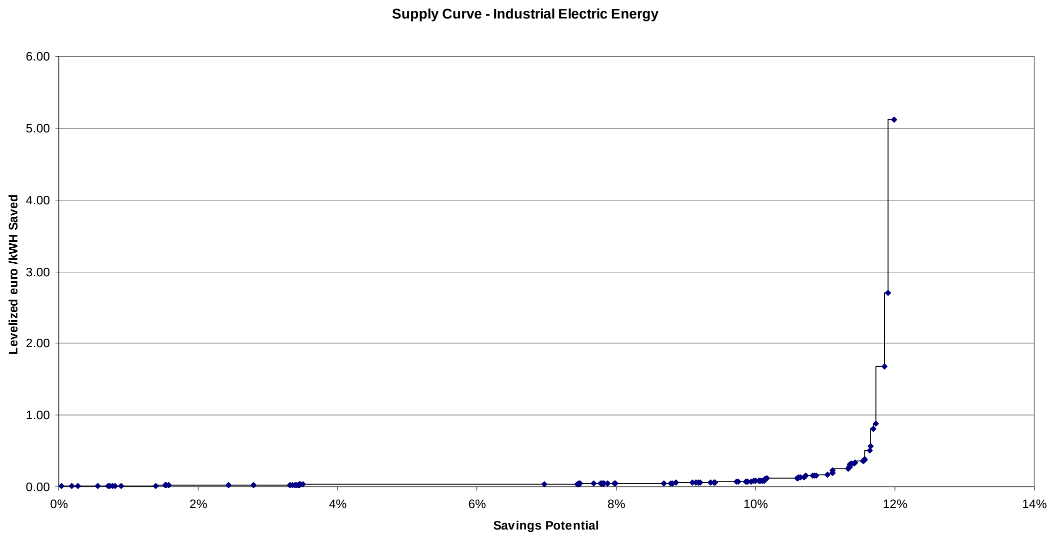


Figure 5-24 Industrial Existing Buildings Electricity Supply Curve



Gas and oil supply curves are available along with the supply curves for electricity new construction for residential and commercial.

5.4.1 Key Measures in Economic and Technical Potential

Table **5-15**, Table 5-16, and Table 5-17 list the key energy-efficiency measures that proved cost-effective in our analysis.

Table 5-15 Key Residential Measures by Sector

Market	Fuel	Key Cost-Effective Measures
Existing Homes	Electric	Compact Fluorescent Lamp (CFLs), energy efficient floor lamps, proper sizing of Central Air Conditioning, high efficiency appliances, towel warmer timers, low flow measures, tank wraps, ceiling insulation, ceiling and wall insulation, duct[11] diagnostics and repair
Existing Homes	Oil and Gas	Condensing boiler, ceiling insulation, duct insulation, duct repair, Heating Ventilation and Air Conditioning (HVAC) diagnostics & repair, programmable thermostats, water heater blankets, high-efficiency water heaters, low-flow showerheads
New Construction	Electric	CFLs, energy efficient floor lamps, proper HVAC sizing, high-efficiency water heater, high efficiency clothes washer, high efficiency dishwasher, pipe wrap
New and Existing Homes	Oil and Gas	High-efficiency appliances, water heater blankets, programmable thermostats, low-flow measures, tank and pipe wraps, ceiling insulation, high-efficiency and condensing boilers, HVAC diagnostics and repair, duct

[11] Ducts are used in HVAC systems to deliver and remove air.

		diagnostics and repair
New Construction	Oil	Condensing boilers, high-efficiency water heaters

Table 5-16 Commercial Key Measures by Sector

Market	Fuel	Key Cost Effective Measures
Retrofit	Electric	Premium T-8s, High Bay T-8s, CFLs, occupancy sensors, High Intensity Discharge (HID) lights, HVAC tune-up diagnostics, HVAC proper installation, high-efficiency AC, motors, Variable Speed Drives (VSD), exit signs, LED signs
New Construction	Electric	Premium T-8s, High Bay T-8s, CFLs, occupancy sensors, HIDs, HVAC tune up diagnostics, HVAC proper installation, high-efficiency AC, motors, VSDs, exit signs, LED signs
Existing and New Construction	Gas	High-efficiency boilers, duct insulation, tune-up diagnostics, infrared cooking appliances, pipe insulation, ceiling insulation, low-flow fixtures, high-efficiency water heaters
Retrofit	Oil	Double-glazed windows, high-efficiency boilers, high-efficiency water heaters, heat-recovery systems, stack heat exchanger, Energy Management System (EMS) installation
New Construction	Oil	High-efficiency boilers, heat recovery systems, high-efficiency water heaters, high-efficiency pool heater, pool cover, instantaneous water heater

Table 5-17 Industrial Key Measures by Sector

Market	Fuel	Key Cost Effective Measures
Retrofit	Electric	Premium T-8s, High Bay T-8s, CFLs, occupancy sensors, HIDs, HVAC tune-up diagnostics, HVAC proper installation , high-efficiency AC, motors, VSDs, exit signs, LED signs, pumps, compressed air, Clean room measures, process measures
Existing	Gas	High-efficiency boilers, duct insulation, tune-up diagnostics, infrared cooking appliances, pipe insulation, ceiling insulation, low-flow fixtures, high-efficiency water heaters, process measures
Retrofit	Oil	Double-glazed windows, high-efficiency boilers, high-efficiency water heaters, heat-recovery systems, stack heat exchanger, EMS installation, process measures

6. Achievable Potential

6.1 Approach

This section presents the overall achievable potential results under base, central and aggressive programme spend scenarios. In contrast to technical and economic potential estimates, achievable potential estimates take into account market and other factors that affect adoption of efficiency measures. The method used to estimate measure adoption takes into account market barriers and reflects actual consumer and business implicit discount rates.

Achievable potential is often referred to as *programme potential* which is the amount of savings that would occur in response to one or more specific programme interventions. Because achievable potential will vary significantly as a function of the specific type and degree of intervention applied, estimates for the three scenarios and for the impact of building regulation changes were developed. The achievable potential scenarios analysed for this study are base, central and aggressive programme spend levels which were considered for targets for 2016 and 2020.

6.2 Establishing Targets

In investigating the achievable potential, three targets have been assessed with regard to the cost and feasibility of meeting these targets. These targets focussed only on savings associated with the sector (residential, commercial and industrial) and on the fuels (gas, electric and oil) in which the comparison was made and not the whole economy (i.e. transport, agriculture and other fuels were excluded). Thus they are effectively subsets of the wider whole-economy targets set out in the National Energy Efficiency Action Plan (NEEAP). These targets are explained in more detail below.

6.2.1 2016 Energy Efficiency Target

This target was established to examine Ireland's ability to meet the 9 per cent energy efficiency target specified in the EU Energy End-use Efficiency and Energy Services Directive using a series of DSM programmes.

The baseline has been set as specified in the Directive, but is a subset based only on the usage of the residential, commercial and industrial sectors using electric, gas and oil fuels in the period 2001–2005. All the calculations have been carried out based on primary energy consumption rather than total final consumption. In the case of electricity the total final consumption was converted to primary energy consumption by multiplying by a factor of 2.5. This is consistent with the current level of plant efficiency and the mix of generation in Ireland.

The next step in establishment of the baseline as specified in the Directive is the removal of the Emissions Trading Sector from the consumption figures. This has been done using the following assumptions:

i) Emissions Trading Sector average usage for the period 2001–2005 was estimated at 1182 ktoe based on SEI figures.

ii) This Emissions Trading Sector usage was assumed to all be within the industrial sector and to be split proportionally based on usage of oil, gas and electricity. A reduction has therefore been made to industrial usage of oil, gas and electricity.

These assumptions and the calculations for this 2016 baseline are shown in Table 6-1 below.

Table 6-1 Baseline Calculation for 9% Energy End Use Directive Target

Oil		**5-year average 2001-2005 ktoe**	**Conversion to Primary Energy ktoe**	**Reduction for Emissions Trading Sector ktoe**	**Primary consumption without the Emissions Trading Sector ktoe**
	Residential	1047	1047		1047
	Commercial (inc public)	715	715		715
	Industrial	796	796	329	467
Electric		**ktoe**	**ktoe**	**ktoe**	**ktoe**
	Residential	610	1525		1525
	Commercial (inc public)	647	1618		1618
	Industrial	650	1625	673	952
Gas		**ktoe**	**ktoe**	**ktoe**	**ktoe**
	Residential	522	522		522
	Commercial (inc public)	320	320		320
	Industrial	435	435	180	255
Total energy use (ktoe)		5742	8603		7421
	9% target (ktoe)				668
	9% target GWh				7767

Meeting the 9 per cent scenario (considering only the residential, commercial and industrial sectors using electricity, oil and gas) would therefore require a saving of 668 ktoe and this was the starting point for design of the base scenario DSM programme. The aggressive scenario looks at what could be achieved by 2020 with a higher level of expenditure.

6.2.2 20 per cent Energy Efficiency Target for 2020

This target was established to examine Ireland's ability to meet the 20 per cent reduction in energy demand by 2020 in line with the commitments in the 2007 Government's Sustainable Energy White Paper.

The calculation of the baseline is consistent with the National Energy Efficiency Action Plan and is based on an average of usage in the period 2001–2005. However, the baseline is focused only on a subset of the Irish economy looking at usage in the residential, commercial and industrial sectors using electricity, gas and oil. All the calculations have been completed based on primary energy consumption rather than total final consumption and – as with Kema's 2016 target – the electricity total final consumption has been converted to primary energy consumption by multiplying by a factor of 2.5.

The National Energy Efficiency Action Plan looked at the whole economy and it has therefore been decided that the emissions trading sector should remain within these calculations. The baseline calculations are as shown in Table 6-2 below.

Table 6-2 Baseline Calculation for Sector Specific 2020 NEEAP Targets

	5-year average 2001-2005 ktoe	Conversion to Primary Energy ktoe
Oil	2558	2558
Gas	1277	1277
Electric	1907	4768
Total energy use (ktoe)	5742	8603
20% target (ktoe)		1721
20% target GWh		20009

6.2.3 2020 Aggressive Energy Efficiency Target

The 2020 target was a hypothetical target set to assess whether it was possible to save 20 per cent of the likely usage in 2020 by a very aggressive series of measures. The investigation also considered how much of this 2020 usage could be saved with a more standard level of energy efficiency programmes (and therefore expenditure), which is tested using the base scenario.

The baseline for this target looked only at the comparable sectors of residential, commercial and industrial using the three fuels of electric, oil and gas. As with the 2016 targets the comparisons have been done in primary energy equivalent terms by multiplying electricity total final consumption by a factor of 2.5. These targets are built up as shown in the table below.

Table 6-3 Baseline Calculations for 20% Saving of Estimated 2020 Primary Energy Consumption

	2020 Estimate Total Final Consumption ktoe			2020 Primary Energy Consumption ktoe		
	Oil	Elec	Gas	Oil	Elec	Gas
Residential	1064	880	928	1064	2200	928
Commercial (inc public)	899	1080	523	899	2700	523
Industrial	1526	752	501	1526	1880	501
Sector Total	3489	2712	1952	3489	6780	1952
Overall Total			8153			12221
20% target (ktoe)						2444
20% target (GWh)						28426

6.3 Market Sector Programmes

In the examination of achievable potential a number of market sector programmes have been utilised. These market sector programmes represent relatively broad programmes that deliver the measures identified in the technical and economic assessment undertaken in Section 5.

For each fuel (electricity, oil and gas) the following market sector programmes are modelled. All include some funds allocated for support programmes e.g. audits that support programme delivery.

- Residential new construction.
- Residential existing buildings.
- Commercial new construction.
- Commercial existing buildings.
- Industrial.

The buildings programmes are wide-ranging and include appliances, lighting and process improvements for commercial customers as well as improvements to the building infrastructure. Market-sector programmes are used rather than individual technology programmes to reflect some of the best practices presented earlier and to simplify the modelling at this point. Market-sector programmes have participation strategies that are multi-pronged and inclusive and allow for greater flexibility, For each sector and fuel, programme budgets are produced for marketing, incentives and administration. The model then estimated savings for each year by programme based on the programme budgets and assumptions. Only cost-effective measures were considered in this analysis.

Two assumptions that should be noted in these savings calculations are:

- The savings from electricity measures were calculated as total final consumption rather than primary energy. These savings have been scaled up by a factor of 2.5 to convert them into primary energy.

- It has been assumed that industrial energy efficiency savings fall proportionally between the traded and non-traded sectors. In the 2016 calculations the energy-efficiency savings for the industrial sector have been reduced by the approximate size of the traded sector (40 per cent) as these customers are no longer part of the baseline.

Impact of New Construction Standards for Residential Buildings

The impact of the proposed new building regulations has been estimated; these are being developed to reduce usage in residential new buildings by 40 per cent starting in 2008. The building regulations were modelled as a full-compliance case where all buildings comply immediately. This may be viewed as overly aggressive as there is usually a gradual ramp to full compliance over the first few years. The inclusion of the proposed building regulations decreased the new potential in the new construction markets.

6.4 Programme Spend Scenario

Clearly, the amount of energy-efficiency and peak load saving that can be achieved by a programme will be related to the level of expenditure. Three different levels of expenditure have therefore been established in order to meet (or approach) the three targets. These are:

- A base level of programme expenditure that is designed to meet (with the addition of the building regulations) to pass the 2016 target for the three sectors and fuels investigated.

- A central level of programme expenditure that is designed with the assistance of the building regulations to meet the 2020 target for the three sectors and fuels investigated.

- An aggressive level of programme expenditure that is designed with the assistance of the building regulations to approach the aggressive 2020 target.

For completeness, the savings from each of these levels of programme expenditure has been assessed against all three targets.

6.5 Costs and Benefits

The costs and benefits presented in the tables in this section were derived in the following manner. There are five categories of cost: (i) measure, (ii) customer, (iii) incentive, (iv) marketing and (iv) administrative costs. The measure costs are part of the measure tables described in Section 5. In programme modelling, the model splits the costs into customer costs (cost paid by the customer) and the incentives paid to the customer. The sum of the customer costs and the incentives costs for any given measure is the measure cost. The majority of the costs presented here are the incremental costs between the efficient measure and the alternative. In a few cases, full costs were used. The administrative and marketing costs are estimates developed to support these programmes based on Kema's international experience with other programmes.

The benefits used in the model are the avoided energy, avoided capacity (electric only) and avoided transmission and distribution (electric only). The sources of the avoided costs used for each fuel are presented in Section 5. Costs are projected out for the duration of the programmes. The benefit/cost ratio presented is the net present value of all the benefits and all the costs.

6.6 Summary Results

Estimates of the savings resulting from programmes[12] for each fuel under the base and aggressive scenarios are shown in Tables 6-4 through 6-6. These figures also present an average programme budget, average benefits, GWh savings, and a benefit/cost ratio.

[12] It is possible in the aggressive case for the programme potential to exceed the economic potential presented in Section 5. This is because programme potential is forecasted further out in time and because new construction is treated in a more dynamic fashion in the achievable projections.

Table 6-4 Electricity Achievable Summary Results

Summary of Year 2020 Programme Costs and Benefits (2007-2020) - Electricity

	Residential			Commercial			Industrial		
Result by Programme Spend	Aggressive	Central	Base	Aggressive	Central	Base	Aggressive	Central	Base
Average Annual Programme Costs €m:	26.82	6.79	4.56	14.43	6.75	4.71	9.55	3.61	2.37
Average Annual Participant Costs €m:	17.65	9.02	8.07	13.56	8.71	7.30	5.40	2.81	2.21
Average Annual Benefits €m:	125	65	46	184	166	131	69	29	19
Cumulative Net GWh Savings:	6055	3727	3087	4163	3864	3329	1360	695	508
Cumulative Net MW Savings:	300	130	111	474	443	381	173	89	65
Average Program TRC:	3.33	4.34	4.56	8.82	11.71	12.90	4.78	€5.5	5.43

Table 6-5 Oil Achievable Summary Results

Summary of Year 2020 Programme Costs and Benefits (2007-2020) - Oil

	Residential			Commercial			Industrial		
Result by Programme Spend	**Aggressive**	**Central**	**Base**	**Aggressive**	**Central**	**Base**	**Aggressive**	**Central**	**Base**
Average Annual Programme Costs €m:	13.0	4.5	3.0	10.0	4.7	3.7	3.0	1.9	1.5
Average Annual Participant Costs €m:	4.3	2.7	2.2	1.6	1.7	1.7	1.6	1.1	1.0
Average Annual Benefits €m:	49.5	23.5	14.7	20.4	13.0	11.5	19.5	15.3	13.8
Cumulative Net GWh Savings:	2388	1448	1125	988	696	640	961	812	756
Average Program TRC:	2.78	5.57	5.85	2.09	2.23	2.31	4.58	5.29	5.62

Table 6-6 Gas Achievable Summary Results

Summary of Year 2020 Programme Costs and Benefits (2007-2020) - Natural Gas

	Residential			Commercial			Industrial		
Result by Programme Spend	**Aggressive**	**Central**	**Base**	**Aggressive**	**Central**	**Base**	**Aggressive**	**Central**	**Base**
Average Annual Programme Costs €m:	12.7	4.0	2.7	7.7	3.3	2.7	2.8	1.7	1.4
Average Annual Participant Costs €m:	2.6	2.0	1.6	0.9	0.6	0.6	0.7	0.5	0.5
Average Annual Benefits €m:	47.5	19.4	12.6	15.8	7.6	6.6	11.1	8.2	7.6
Cumulative Net GWh Savings:	1143	625	495	486	253	232	424	340	324
Average Program TRC:	2.87	3.51	3.59	2.21	1.88	2.08	3.04	3.69	4.08

Table 6-7 All Fuels Achievable Summary Results

Summary of Year 2020 Programme Costs and Benefits (2007-2020) - Total

	Residential			Commercial			Industrial		
Result by Programme Spend	**Aggressive**	**Central**	**Base**	**Aggressive**	**Central**	**Base**	**Aggressive**	**Central**	**Base**
Average Annual Programme Costs €m:	52.5	15.3	10.3	32.1	14.8	11.1	15.3	7.2	5.3
Average Annual Participant Costs €m:	24.6	13.7	11.9	16.0	11.0	9.5	7.7	4.4	3.7
Average Annual Benefits €m:	221.7	107.8	73.2	219.7	186.5	148.9	99.8	52.8	40.4
Cumulative Net GWh Savings:	9586	5800	4708	5637	4812	4200	2746	1847	1588
Range of Average Programme TRC:	2.78 -3.33	3.51 - 5.57	3.59-5.85	2.09-8.82	1.88 - 11.71	2.08-12.90	3.04-4.78	3.69 - 5.50	4.08-5.62

As these tables indicate, all of the programmes modelled are highly cost effective. The TRC ratio includes programme and customer costs and the benefits are based on avoided electricity costs and retail gas and oil prices.

Table 6-8 presents the programme scenarios compared to the savings goals for 2016 and 2020. Across all programmes, the residential sector was the largest contributor reflecting:

- The high level of economic potential for that sector.
- Lower levels of naturally occurring potential.
- Historical levels of responsiveness to the programme concepts.

Table 6-8 Impact of Scenarios against Targets[13]

Scenario	2016 Results (GWh)	% of KEMA 2016 Target	2020 Results (GWh)	% of 2020 Targets	% of Aggressive 2020 Target
Base Programme Spend	13260	102%	18220	91%	64%
Central Programme Spend	15020	124%	20190	101%	71%
Aggressive Programme Spend	19250	179%	25700	128%	90%

As Table 6-8 above indicates, the 2016 target for the sectors and fuels investigated is achievable both through base programmes and is well surpassed with the impact of building regulations. The 2020 target is achievable through the central programme spend. The aggressive 2020 target is more challenging but it appears that the combination of the aggressive programme activity and the impact of the building regulations will get close to this target. The aggressive cases were based on paying 75–100 per cent of full incremental costs of the measures installed, which accounts for the high cost.

The model does not incorporate technological change so some of these estimates could increase with new developments. There is also potential for carbon reduction through fuel switching, without necessarily an energy efficiency impact.

6.7 Relative Cost Effectiveness of Programmes

Most of the programmes modelled were highly cost effective. The most cost-effective sector was the commercial electricity sector. Table 6-9 presents a summary of the cost-effectiveness of the programmes by programme modelled.

[13] All programme results include savings attributed to residential building regulation changes due in 2008. This equates to 5350 GWh for the 2016 target, and 7730 GWh for both 2020 targets.

Table 6-9 Summary of Cost Effectiveness

Relative Cost Effectiveness of the Programmes Reviewed			
Program/ Sector	Fuel	Description	Benefit/ Cost in Aggressive Case
Residential New Construction	Electric	Provides information and grants for more efficient homes, measures include shell, lighting, appliances	2.66
Residential New Construction	Oil and Gas	Provides information and grants for more efficient homes, measures include shell, and appliances	Oil -2.14 Gas -2.50
Residential Existing Homes	Electric	Provides information and grants for upgrades to building shell, rebates for lighting and appliances	3.83
Residential Existing Homes	Gas and Oil	Provides information and grants for upgrades to building shell, rebates for appliances	Oil -3.49 Gas -3.40
Commercial New Construction	Electric	Technical and Design Assistance for New Buildings and major Retrofits; grant for all cost effective measures. Major measures: lighting , HVAC	7.19
Commercial New Construction	Gas and Oil	Technical and Design Assistance for New Buildings and major Retrofits; grants for all cost effective measures. Major measures: boiler, water heat, other HVAC	Oil -1.01 Gas -1.07
Commercial Retrofit	Electric	Technical Assistance for Existing Buildings; grants for all cost effective measures. Major measures: lighting , HVAC	7.65
Commercial Retrofit	Gas and Oil	Technical Assistance for Existing Buildings; grants for all cost effective measures. Major measures: boiler, water heat, other HVAC	Oil -2.11 Gas -2.40
Industrial	Electric, Gas and Oil	Technical Assistance for Existing Buildings; grants for all cost effective measures. Major measures: boiler, water heat, other HVAC, lighting, process, pumps, motors, clean room measures	Oil -5.12 Gas -3.62 Electric – 4.87

7. Programme Descriptions and Potential Saving

7.1 Introduction

In the design of suitable programmes for Ireland it is essential to consider lessons from the best-practice designs that have evolved. Three of the key best-practice recommendations were (i) to have participation strategies that were multi-pronged and inclusive, (ii) to keep programmes stable over time and (iii) to have a single point of contact. To achieve these, it is recommended that the programmes are broad ranging and include a number of related initiatives that work together to deliver the energy-efficiency savings or peak-load reduction required in Ireland.

In addition to the potential from these programmes, there are significant savings from the introduction of changes to the building regulations which increase the efficiency of the building stock. These building regulation changes have meant that there is a lower emphasis on residential new construction programmes than is typically seen in the design of DSM programmes.

7.2 Recommended Residential Programmes

The recommended residential programmes built on the lessons from international programmes. These suggested that lighting and measures that tighten the house will be the largest areas of opportunity, that while mandatory standards can be used to increase efficiency incentives are still required, and that it is necessary to increase awareness of energy-saving opportunities. Based on this analysis the following four indicative programmes are recommended for implementation in Ireland:

- Residential Online Audits.
- Lighting and Appliance.
- Residential Retrofit.
- Residential New Construction (in addition to the new building regulations).

A description of each of these programmes is provided below with a more detailed programme design included as Appendix D.

7.2.1 Residential Online Audits

The residential online audit programme would provide an education-based customer service for those customers who are interested in learning more about how to save energy in their home. The online audit would exist on a website and would be promoted to customers via bill inserts of electricity and gas suppliers. It will allow consumers to estimate their usage by end use and identify savings measures to save energy in their home. It would also provide linkages to other proposed programmes such as the lighting and the weatherisation programmes. The costs of this would be spread across the residential retrofit and lighting and appliances programme.

This would be an expansion of the existing online tools including the Power of One campaign and the Home Energy survey. The audit would cover all fuels.

7.2.2 Lighting and Appliance Programme

The objective of this programme is to increase the number of installed energy efficient lights and appliances in Ireland. The programme offers financial incentives to residential customers or homebuilders who install measures that meet programme requirements. Customers can receive rebates[14] for retrofit or new construction homes with slightly different requirements depending on the measure and its application. Applicable measures include a variety of energy efficient measures such as lighting, fridges, freezers, washing machines and dishwashers. As the programme evolves, new measures or upgrade qualification requirements may be added to reflect changing market conditions. In addition, the programme administrator could transition some portion of the rebates in future years from a direct customer rebate to a retailer discount or other upstream effort.

The programme should begin with a portfolio of energy efficiency lighting rebates and add to or adjust those as appropriate to help influence the marketplace. The programme will include retailer coordination, and ongoing trade-ally efforts. The rebates will be offered on a year-to-year basis with a qualifying annual pool of funds available for rebates.

The Power of One programmes and energy labelling programmes should assist in raising customer awareness on the efficiency of different lighting and appliances. Note that the role of this programme may change in light of the recent announcement to set standards phasing out incandescent bulbs by 2009.

7.2.3 Residential Retrofit

The objective of the Residential Retrofit programme is to reduce energy use in homes. Opportunities would be identified by an in-home audit. The contractors providing the audit would then provide the residential retrofit measures with a customer contribution of 25–50 per cent. Measures would include air sealing, insulation, set back thermostats, water heater blankets, CFLs, appliance removal and heating system upgrades where appropriate. Services could be provided to fuel-poor customers at no customer cost.

There could be some overlap between this programme and the warmer homes programmes, although the latter is only targeted at a relatively small subset of customers. This type of programme approach could be consistent with a certificate programme if it was decided from a policy perspective that a certificate programme would be most appropriate once there is a competitive market. In that case, retailers would be most likely to play the role of programme administrator.

7.2.4 Residential New Construction

The objective of this programme is to reduce energy use in new homes above the proposed building regulations. This programme would be promoted to new-home builders. It would identify measures and actions that would allow builders to exceed the new building regulations and will also provide education about the new building regulations and the ways to meet and exceed them. The incentives in this programme would be for builders and ideally should be on both a whole-home basis and, where appropriate, for specific measures.

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[14] Rebates could be in the form of discount vouchers redeemable at shops or with contractors. The rebate programme must create rebate levels that are high enough to foster market interest, but that do not overpay for efficiency. A rebate of 50–75 per cent of the cost for lighting is suggested.

Some consideration will be needed on coordination between this programme and the House of Tomorrow programme.

7.3 Recommended Business Programmes

The lessons learnt from the international programmes were that direct financial incentives make a significant difference to the take and cost of programmes, significant opportunities exist in lighting and new construction and that improved information is critical to businesses undertaking energy efficiency investment. This led to two broad indicative programmes recommended for business customers which were:

- Business Customers Grants programme (includes audits).
- New Construction programme.

7.3.1 Business Customers Grants Programme

The intent of the programme is to deliver energy-efficiency savings for all fuels and to reduce peak electric demand. The programme would provide grant for new equipment or retrofits identified by audits or other assessments. Measures that should be included in the programme are lighting installation and retrofits, boilers, air conditioning and heating, process measures, window coatings, heating systems, lighting design, controls, motor replacements, drives and pumps, compressed air and others technologies that gain approval.

As the programme evolves, the programme administrator may chose to add new measures or upgrade qualification requirements to reflect changing market conditions. In addition, the programme administrator may chose to add a more complex custom measure approach to this programme.

Existing programmes such as the SME Audit programme and the Energy Agreement programme could be incorporated into this broad initiative. This type of programme approach could be consistent with a certificate programme if it was decided from a policy perspective that a certificate programme would be most appropriate once there is a competitive market. In that case, retailers would be most likely to play the role of programme administrator.

7.3.2 Commercial New Construction Programme

The programme provides grants for savings in new buildings for energy-efficiency measures that exceed the building regulations. Over time, it is expected that the programme administrator would develop savings worksheets for all measure categories and develop a custom measure approach to either be contained on a CD or submitted electronically. The programme administrator may also consider using payback as the criteria for future rebate design i.e. provide grants that bring down the measure to a two-year payback. This would provide consistent payback criteria for all customers.

7.4 Pilot Programmes for Peak Demand Reduction

Ireland is already well served by programmes to encourage large businesses to reduce peak demand. However, there are opportunities particularly in the smaller business and domestic levels. The international experience suggested that these may require smart meters in order for customers to be rewarded. The new market may also give more opportunity for suppliers to have price-reflective tariffs. It is suggested that there are two separate pilot programmes that should be run to prove the concept of peak pricing and to assist suppliers in determining whether they should run these types of tariffs. The programmes are:

- Residential Critical Peak Pricing programme.

- Commercial Critical Peak Pricing programme.

Both programmes will test the responsiveness of customers to price signals that reflect the high costs of electricity at peak times. These programmes will require customers to have interval meters to be able to receive changing tariffs with retailers also needing to design tariffs to allow exploitation of this infrastructure. It is expected that the pilot programme would provide both peak-demand reductions and energy savings.

7.5 Meeting Best Practice

A final part of this assessment was to consider this set of programmes and whether they deliver the best-practice criteria that were specified earlier. This analysis is shown in Table 7-1 below.

Table 7-1 Evaluation of Suite of Programmes against Best Practice Criteria

Best Practice	Programme Assessment
Keep participation simple.	Broad programmes should make it easier for participants to know who to contact and the programme designs have simple mechanisms to access the incentives.
Establish the potential for long-term energy savings	Done as part of this report and the energy-efficiency action plan.
Designate which organisation (s) is responsible for administering programmes.	A designated organisation would be given responsibility for administering programmes.
Have participation strategies that are multi-pronged and inclusive.	Broad programmes have different levels of participation that should allow all customer groups to benefit.
Keep programmes stable over time and establish funding for multi-year periods.	Programmes are designed to be set up for and run for multi years.
Use incremental costs as the basis for incentives.	Programmes are primarily designed based on the incremental costs, although higher levels of funding are required for the aggressive programmes. Some costs (e.g. insulation) do not have an incremental cost as the alternative is a ‘do nothing’ option. The level of incentive needed for these measures will depend on whether an aggressive or base take-up is required.

Best Practice	Programme Assessment
Use electronic means as much as possible.	Detailed programme design has electronic communication as the primary communication mechanism where possible.
Single point of contact.	There would be a single primary point of contact for all programmes. This could change if at some later point a certificate programme was developed.
Make participation part of an existing transaction.	With replacement purchases the programmes should allow this to be part of a normal existing transaction. In the case of specific energy efficiency investment, such as insulation, this cannot be part of an existing transaction and is a separate investment.
Use trade allies and wider stakeholders as much as possible.	Programmes have been designed to encourage the use of trades that will participate in audits and implementation of energy efficiency improvements.
Provide training to trades allies.	The programmes do not explicitly provide training to trade allies. This may be an additional role that could be provided alongside delivery of the programmes.
Sell the customer the benefits first, energy efficiency later.	The incentives in the programmes should allow the energy efficiency investments to have a short payback period.
Develop robust measurement and verification methods.	All programmes have measurement and verification built into the design.
Evaluate programmes on a regular basis.	Intention is that programmes should be evaluated regularly to confirm they are delivering.
Tie new construction programmes to codes and standards.	Much of the new construction benefits will be derived from building regulations. These programmes are additive to the building regulations.

Generally, the programmes have a good level of fit against the best-practice objectives. However, the detailed design phase will be critical as some of these best-practice intentions can be lost without careful implementation planning.

7.6 Implementation Approach

Experience shows that it typically takes longer than expected to develop and launch a programme. Even Californian utilities, given their many years of experience, still assume about a year to adequately plan, design, and implement a programme.

The high-level activities common to most programmes are listed in Table 7-2 below. Depending upon the nature of the programme, an 8–12 month lag could be expected *from the time approval is granted to spend significant funds to getting started*. Note that several key parallel activities are not included in the table, such as developing a tracking system, hiring staff, collaborative processes, rate proceedings and pre-evaluation planning.

Key activities contained within the high level column headings in

Table 7-2 are described as follows:

- Detailed Implementation Design – researching rebate levels, product availability and pricing, customer and market research, brand testing.
- Contracting – drafting and issuing requests for proposals, preparing bidders' lists, reviewing proposals, negotiating contracts, legal reviews.
- Marketing Materials – creating marketing plans, designing rebate and application forms, preparing print and electronic media advertising, website design and testing, legal reviews.
- Preparation for Launch – preparing call centre, communicating to employees, preparing media kits, distributing marketing materials, planning media events, coordination among programme administrator, implementation contractors, regulators, trade allies, etc.

Table 7-2 Implementation Schedules

Programme	Detailed Design	Contracting	Marketing Materials	Preparation For Launch	Total
Residential retrofit	3 Months	4 Months	2 Months	2 Months	11 Months
Residential lighting and appliances	3 Months	3 Months	3 Months	2 Months	11 Months
Residential CPP Pilot	5 Months	3 Months	2 Months	2 Months	12 Months
Residential all fuels new construction	6 Months	4 Months	3 Months	2 months	15 Months
Residential online audit	2 Months	3 Months	2 Months	2 Months	9 Months
C/I Programmes					
C/I Incentives	3 Months	4 Months	3 Months	2 Months	12 Months
C/I Electric New Construction	6 Months	4 Months	3 Months	3 Months	16 Months
CLP Pilot	2 Months	3 Months	2 Months	2 Months	9 Months

Note that these are purely Kema's indicative estimates. Appendix D of this report provides an initial programme design for each of the main programmes or pilot programmes recommended. Clearly, these would need to be developed in more detail during the implementation process.

8. Conclusions and Recommendations

8.1 Introduction

This section presents the key findings and recommendations of this report.

8.2 Overall Findings

The findings at the overall level include:

- There are significant energy-efficiency opportunities in all fuels in all of the sectors in Ireland.
- In the three sectors (residential, commercial and industrial) and the three fuels of electric, oil and gas, Ireland can meet its 2016 savings target goal for energy efficiency by using a base level of energy-efficiency programmes.
- The 2020 target for the three sectors and fuels investigated can be reached but will require a central level of programme expenditure and building regulations
- The 2020 target will be challenging and will require the building regulation along with aggressive programmes to get close to this target.
- The new building regulations will provide substantial savings over time.
- There are significant opportunities to reduce the carbon footprint of Ireland – especially if all fuels are considered.
- The residential sector of the three sectors considered offers the most opportunities to reduce carbon.
- Across all sectors, a large part of the potential is economic, but will not be undertaken without stimulation.
- The aggressive programmes are at the forefront of worldwide proposed achievements and will require significant programmatic investment in energy efficiency, which will need the strong support and involvement of stakeholders, including the energy industry.
- Efficiently achieving these energy-savings targets will require the use of best-practice designs when implementing the programmes.

8.3 Key Measures by Sector and Fuel

The technical and economic analysis identified the measures that had the greatest potential to deliver benefits. This included the following:

- Lighting – Across all sectors considered, the largest electrical savings are in lighting. Key lighting measures are CFL lamps and fixtures. For commercial and industrial high efficiency T-8s offer many savings.

- Oil – There are many opportunities to significantly reduce oil in all sectors considered and particularly in space heating, process heating and water heating.

- Gas – There are many opportunities to reduce gas usage in all sectors considered, particularly in space heating, process heating and water heating.

- Appliances – In the residential sector, appliances are a significant opportunity for savings.

- All fuels programmes, where appropriate, will be the most likely to deliver the most savings.

8.4 Suggestions for Additional Research

A limitation of this research is that there was limited consistent data available about end use data by building sector in Ireland. Some suggestions for future research are:

- Develop a baseline of current practices for all fuels for all sectors for both existing and new construction. This should include usage per square foot, fuel shares, market penetrations, typical measures and standard practices. This should be collected by using a sample of buildings that are audited, billing data is collected and the samples are aggregated to represent the entire sector. A less expensive option would be to conduct a saturation survey – this could be conducted over the phone.

- Develop a long-run end-use forecast by fuel, building type and sector if one does not already exist.

- For key end uses such as lighting, conduct market actor surveys to assess current practices, pricing, and interest in programmatic activities.

- Develop a standardised measure list that would include costs and savings.

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