

ALL-ISLAND ENERGY MARKET:
Renewable Electricity – A ‘2020 Vision’
Preliminary Consultation Document

July 2005

FOREWORD

Angela Smith MP, Minister for Enterprise, Trade and Investment, Northern Ireland and Noel Dempsey T.D., Minister for Communications, Marine and Natural Resources, Republic of Ireland have started a period of consultation on the development of a shared vision of how the future energy needs for Northern Ireland and the Republic can be best met in a sustainable way. At a bilateral meeting on 21 June they agreed that this process should be initiated with the publication of a joint high level consultation paper that seeks to map out a possible ‘2020 Vision’ for policy cooperation on the development of sustainable energy supplies for the island of Ireland.

Their agreement is set within the framework of the All Island Energy Market Development Framework and the need to bring long term and mutual economic and social benefits to consumers, North and South. The Sustainable Energy Working Group (SEWG) of the Joint Steering Group (JSG) for the All Island Energy Market was asked to prepare a series of papers on the topic of sustainable energy. This first paper deals with the approach to creating a vision for renewable energy in electricity supply to 2020 and beyond¹. Other papers dealing with heat supply, energy efficiency and CHP will follow.

Recognising the limitations of markets to provide for certain public goods, Ministers have agreed that the opportunities presented by renewable energy are worthy of a detailed joint assessment with a view to the formulation of policies to capture, at least cost, the benefits to consumers North and South.

This work has an urgency to it. There are a series of pressures relating to the achievement of environmental targets, the need to foster rural development and not least the design of the Single Electricity Market (SEM) itself. In the longer term, security of energy supply for the island of Ireland is a paramount concern of both governments. These pressures must be balanced against a requirement to safeguard competitiveness and promote competition in the sector. This consultation process, and the ensuing work-stream priorities, will meet several of these pressures and inform a host of other actions and policies.

Both administrations recognise that there are many factors to be balanced in building such an ambitious but necessary collaboration on achieving sustainable energy futures across two jurisdictions. Large investments demand, in the public interest, a sophisticated and informed analysis. We are anxious that such analysis be timely, well directed, efficiently executed and ultimately actionable. In this regard comments and input will be greatly appreciated.

¹ 2020 is considered a reasonable timeframe in which to explore these issues. It is in line with various UK energy policy scenarios, as well as that of the EC in this sector.

The consultation process is open to all. We particularly want to stimulate debate with industry participants and representatives, potential investors and consumer groups. This is an opportunity to help shape future policy within both jurisdictions and set challenging yet realistic goals for the long-term development of the renewable energy industry, North and South.

Finally we would like to express our thanks to the project team which was drawn from both Departments, SEI and Action Renewables who have prepared this ground breaking view of the prospects for renewable energy in electricity supply on the island of Ireland.

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EXECUTIVE SUMMARY

As both Northern Ireland and the Republic of Ireland look to the future in considering energy requirements it will be critical to ensure that cooperation on an all-island policy is capable of providing clear signals to which the market can respond effectively. This will be doubly important for the developing market in sustainable energy.

Renewable energy (RE) policy is an important subset of industrial and energy policy, and thus needs to be aligned with the energy policy priorities of sustainability, competitiveness, and security. Our common and only long-term natural advantage in the energy sector stems from renewable energy resources such as wind, biomass, and ocean energy.

Climate change mitigation and security of supply have become the focus of many recent national energy policies. Renewable energy resources can play an important part in addressing both of these concerns.

Against a current background of high and volatile fossil fuel prices and strong demand growth for energy this document focuses on one aspect of sustainable energy, namely renewable electricity. Thus, the areas of energy efficiency, sustainable heat and CHP are outside the scope of this consultation. They are being developed for consideration in parallel with this process. It is important that all of the above be considered along with renewable electricity as having a role to play in helping reduce greenhouse gas emissions on the island. Indeed, it is essential that a full analysis of the greenhouse gas emissions savings associated with an increased level of renewables on the system compared to other alternatives be carried out so as to inform the all island renewable electricity vision for 2020.

Consumers demand secure, dependable and competitively priced electricity and producers must be responsive to these market requirements.

The objective of this preliminary consultation is to inform and seek stakeholders’ views on the potential for electricity generated from renewables (RES-E), the basis for a ‘2020 Vision’, and the further work that would need to be undertaken to produce a joint vision, which includes policy measures and possible targets.

The document brings together for the first time a summary of the existing knowledge on:

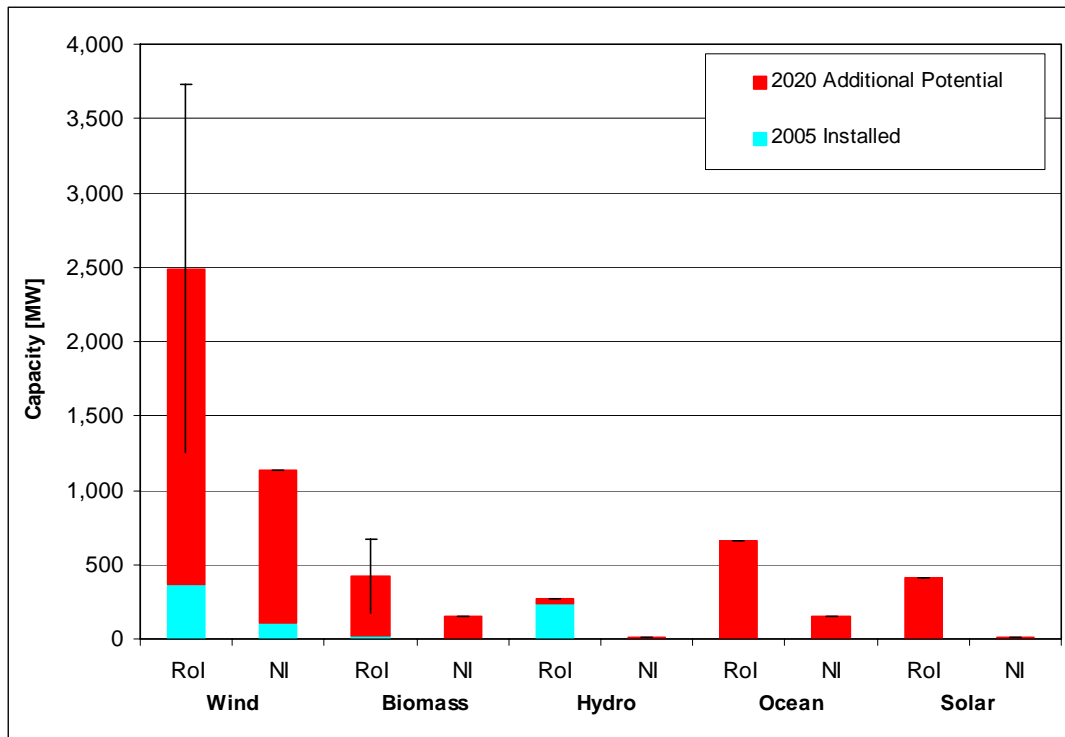
- i) The renewable energy resource for both jurisdictions;
- ii) Current policies implemented in each jurisdiction, and;
- iii) Projections of the investment costs of generating electricity from renewables through to the year 2020.

It posits a range of illustrative RES-E generation scenarios and identifies the policy and electricity system issues that would require examination to establish a vision for 2020. The level of contribution that renewable energy could and/or should make to electricity supply on the island of Ireland by 2020 will need to be identified by addressing the economic, technical and regulatory facets of RES-E implementation. In this regard, any vision for 2020 needs to address a number of key questions, each of which is inserted into the text of the document at an appropriate point and subsequently aggregated in the conclusion. These questions are intended to inform the structure of respondent’s submissions.

Figure I illustrates the very significant renewable energy resource potential for electricity generation (RES-E Potential) on the island of Ireland. The data presented in Figure I represents

the outputs from different bodies of work in this area. The assumptions upon which these bodies of work are based can vary widely from study to study.

Figure I: RES-E Potential vs. Currently Installed Capacity (RoI and NI)



Reasoned responses to the questions will contribute to the robustness of a joint North - South work programme which will inform and underpin an all-island ‘2020 Vision’ for RES-E. This work programme will be specified and undertaken over the next 12-18 months so as to provide rigorous and defensible information on the costs and benefits of renewable electricity generation (RES-E) penetration in 2020. Key areas that need to feed into the development of common policy themes and options over the next 12 months will be prioritised and addressed so that either preliminary or final outcomes are available to inform the work underway to achieve that goal. Elements of a proposed work programme are outlined in this consultation document.

This paper begins with a list of questions to be addressed, followed by a brief contextual discussion of the current status and policies employed in the RoI and NI. The document then outlines the various underpinning analyses and studies that will be needed to inform long-term policy formation, including resource studies for each RES-E technology. Illustrative scenarios representing different levels of RES-E penetration in 2020 are included, along with the associated investment costs. Finally, a proposed future work programme is included. A discussion of the issues involved in the integration of wind energy into the power system is appended.

Questions for consideration:**Sustainable Energy Policy**

- Q1. What are the drivers for RES-E policy, and can they be prioritised?
- Q2. How should RES-E policy interact with other government policies (e.g. waste, agriculture, environment, etc.)?

Regional Energy Markets

- Q3. Do the opportunities or obstacles facing RES-E differ between the two jurisdictions?
- Q4. Are there areas of RES-E policy that should not be considered on an all-island basis, and why?
- Q5. To what degree are RES-E policies currently aligned – North & South?
- Q6. How should all-island RES-E policy inform and be informed by EU and UK RES-E Policy?
- Q7. What effects will interconnection (North-South & East-West) have on RES-E, and how should it be operated and regulated?

RES-E Resource

- Q8. What could the level of penetration of RES-E electricity be in 2020 on the island of Ireland? (Please include any analysis that supports your response.)

‘2020 Vision’

- Q9. How should suggested levels of penetration be decided?
- Q10. Should NI and RoI be seeking to lead in any technologies?
- Q11. What type of plant (RES-E) should be promoted through appropriate financial, regulatory and / or planning policies?
- Q12. What primary policy mechanisms should be put in place to meet the suggested penetration level and how should it be applied? What prices are required? (Please include any analysis that supports your response.)
- Q13. What supporting policies are appropriate, and for what technologies?

Challenges to be Addressed

- Q14. What are the principal obstacles for RES-E penetration to 2020? How can they be addressed?
- Q15. What are the impacts of increased RES-E on the power system and operation? How can they be addressed?
- Q16. What are the implications for future policy of different scales of RES-E (e.g. distributed generation vs. large scale wind)? How could they be planned for and facilitated?
- Q17. How should the costs and benefits of RES-E electricity be measured and quantified?
- Q18. What are the costs and benefits of increased RES-E penetration in the island of Ireland?

Future Work Programme

- Q19. What work streams should be included in a work programme to facilitate RES-E goals?

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1.0 OBJECTIVES

1.1 *Vision for 2020*

It is important that both Northern Ireland (NI) and the Republic of Ireland (RoI) look to the longer term (in this case to 2020 and beyond) in considering their future energy policies, in order to provide clear signals to the market. This is best undertaken jointly by both jurisdictions collaborating in the context of the All-Island energy market. Member States across the EU, and the Commission itself, are also at the early stages of formulating policy in the 2020 time frame.

The Framework for the All-island Energy Market states that it should, “...provide for competitive, sustainable and reliable markets in electricity and natural gas on the island of Ireland at the minimum cost necessary.” The framework also states that, “the All-island Energy Market should be capable of meeting the increasing energy requirements of the island in ways that are compatible with national and EU sustainable energy policies and targets. Policies should be developed that encourage and facilitate greater contributions from renewables, CHP and energy efficiency.” It is within this context that the request for this paper originates.

The publication of this document is expected to inform dialogue on long-term goals, targets and aspirations to 2020 and beyond for renewable energy generated electricity (RES-E) on an all-island basis. It is recognised that consultation initiated by this document is no more than a beginning. It does however signal the high-level political commitment of both Governments to consult on a long-term strategy for sustainable energy by, as a first step, focusing on the renewable electricity dimension.

Renewable energy comes from energy sources that are continuously replenished by nature. The main sources of renewable energy are the wind, the sun (solar energy), moving water (hydropower, wave and tidal energy), heat below the surface of the earth (geothermal energy) and biomass (wood, biodegradable waste and energy crops).

The objective of this document is to inform and seek stakeholders’ views on the potential for electricity generated from renewables, the basis for a ‘2020 Vision’, and the further work that would need to be undertaken to produce the joint vision.

It is recognised that both the RoI and NI have ongoing policy groups in this area. Once a 2020 framework is established, it would be most useful for these two groups to work together on shared goals, and in doing so leverage human and financial resources North and South.

1.2 *Engagement Process*

Examination of possible RES-E targets to 2020 has informally commenced in the EC. It will be useful to work concurrently within both jurisdictions to inform any common positions for negotiations within that process. This paper does not propose fixed targets for RES-E to 2020, nor is it prescriptive in how targets are to be achieved. Rather it poses questions as to how best RES-E policy on the island of Ireland can be considered and implemented as a high priority segment of energy policy.

This paper begins with a brief contextual discussion of the current status of renewable energy and policies employed in both NI and RoI. It goes on to explore the various underpinning analyses and studies that will inform long-term policy formation, including resource studies in each renewable energy technology. Illustrative scenarios representing different levels of RES-E penetration in 2020 are included, along with their associated investment costs. Finally, a

proposed future work programme is included. A discussion of the issues involved in the integration of wind energy into the power system is appended. (This has been highly topical in the last 2-3 years on the island, and will form a critical part of the short-term work programme.)

Measures to stimulate the renewable heat market and energy efficiency will be considered in parallel with RES-E. It is recognised that supply-side electricity policy should not be undertaken without due consideration for the demand side and the heat market. Such consideration will serve to assist in achieving policy goals, such as the effective reduction in greenhouse gas emissions.

Submissions are requested from all stakeholders on the questions posed. The questions are embedded in the document and then aggregated in the conclusion section. Ideally, responses should follow the structure of the questions as they are posed.

2.0 POLICY CONTEXT

2.1 Sustainable Energy Policy

2.1.1 Overview

Renewable energy sources are those which are effectively inexhaustible (such as wind, wave, solar, hydro etc) or which are replenished at or about their rate of consumption (such as managed forests and energy crops and other forms of biomass).

In identifying a way forward for RES-E policy on the island of Ireland, it is necessary to consider the wider context of energy policy. The policy should help to meet the energy requirements for the island of Ireland, ‘...in an environmentally and economically sustainable way having regard for forecast economic growth and security of supply objectives’. There is an implicit assumption in most OECD countries that there is a need for public state support for increased penetration of renewable energy electricity generation until it is directly competitive with conventional, already mature generation technology. The reasons for, and the levels of, support vary widely. It is a complex question that cannot be simplified to the minimisation of generation cost; a number of other objectives are equally important.

Support of RES-E has a legislative basis in the EU under the RES-E Directive (2001/77/EC). The Directive asserts the EC’s need to promote renewables to contribute to:

...environmental protection and sustainable development. In addition this can also create local employment, have a positive impact on social cohesion, contribute to security of supply and make it possible to meet Kyoto targets more quickly (Preamble 1).

The principal current justification for supporting RES-E technologies is linked to climate change mitigation. However, increasing the penetration of RES-E is only one element in the effective reduction of greenhouse gas emissions associated with energy. Other key elements include:

- End use efficiency gains;
- Changes in the plant mix and operation of the power system;
- Fuel switching;
- Future energy conversion technologies.

The formation of a robust policy for renewable energy requires the explicit discussion of goals and the acknowledgement of the underlying impetus for supporting this particular approach to power (and heat) generation. The main drivers for supporting RES-E have historically included:

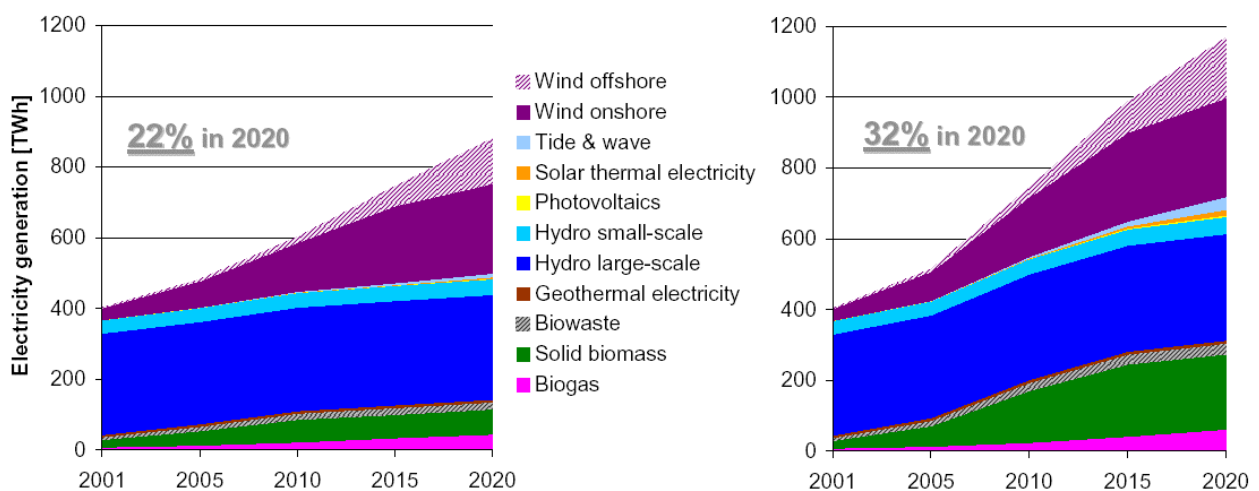
- Climate change mitigation;
- Air (and water) pollutant mitigation (SO₂, NO_X, Hg, particulates, etc.);
- Fuel diversity (a subset of security of supply²);
- Hedging against fossil fuel price volatility;

² It should be noted that security of supply is not always a well-defined or quantifiable goal. That being said, at least two subsets (fuel diversity, and hedging against volatile fossil fuel costs on international markets) can be justified under this heading.

- Indigenous industry (and associated job creation);
- Consumer demand;
- Rural development;
- Dispersed (distributed) energy generation.
- Technology development

There is significant potential for development of the RES-E sector across several key technologies between now and 2020. Figure 1 illustrates one view of RES-E generation by technology across the EU-25 in 2020 under business-as-usual and accelerated deployment scenarios. These scenarios were modelled to inform 2020 RES-E policy in the EU.

Figure 1: RES-E Development in EU-25 to 2020



Source: Fraunhofer Institute Systems & Innovation Research

Renewable energy deployment impacts all three pillars of energy policy; environment, security of supply, and competitiveness. Some brief discussion of these three areas is included for context.

2.1.2 Environment

Environmental considerations have become increasingly important in formulating energy policy. The serious threats posed by climate change are being prioritised currently in the UK's presidency of the EU and G8. The realities of a carbon-constrained future will have impacts across the power sector. RES-E technologies have very low lifecycle emissions compared to other generating technologies.

There are a number of important international and EU initiatives on environmental protection that act as drivers for the increased deployment of RES-E. These include, *inter alia*:

- The Kyoto Protocol & EU burden sharing agreement;

- Emissions Trading Directive (2003/87/EC) (ETS);
- National Emissions Ceilings Directive (2001/81/EC);
- Large Combustion Plant Directive (2001/80/EC).

The cumulative impacts of these Directives on fossil-fuel plants are posited to have a beneficial impact on the financial competitiveness of RES-E (“levelling the playing field”). In regards to the EU Emissions Trading Scheme (ETS), this is by no means clear. The allocation of permits and the manner in which the cost of carbon is “passed through” will impact on the economics of RES-E generators in the market. The impact of RES-E penetration on other transboundary pollutants requires further investigation³.

2.1.3 Security of Supply

Energy plays a vital role in our society, underpinning all areas of economic activity. The economic impact of supply disruptions can therefore be high and wide-ranging. This creates an incentive for governments to ensure that secure and reliable energy sources are readily available. RES-E can be either dispatchable or non-dispatchable and this has implications for the system and operating costs and ultimately for penetration levels. (Some of the issues concerning the integration of non-dispatchable intermittent RES-E technologies into the system are discussed as in Annex A4.)

Security of Supply is not always a well-defined term. It can be roughly separated into consideration of endogenous (national) and exogenous (international) risks. It can also be classified as price or quantity risks. In both cases there are not always clear distinctions. Security of supply can also be considered as encompassing fuel diversity and hedging against volatile fossil fuel costs on international markets.

The EU White Paper on Renewable Energy (COM (97) 599) acknowledges the important role of RES-E in responding to security of supply and this theme is again reiterated in the EU Green Paper on Security of Energy Supply (COM (2000) 769):

Supply policy needs to consider the immediate and longer-term availability of energy products at a price which is affordable to all consumers (domestic and industrial), while respecting environmental requirements and the needs for sustainability.

This is especially relevant on the island of Ireland due to both the high levels of imported energy resources (99.8% of TPER in NI⁴ and 89% of TPER in RoI) and the relatively isolated electricity infrastructure. In this context, the potential for RES-E to deliver the benefits associated with greater fuel diversity in the generation mix should be examined. As it is necessary to consider security of supply risks at a regional or global level, the provision of metrics to inform the market may be considered.

³ Further investigation is also required on the impact of increased levels of RES-E penetration on emissions from conventional plant on the island.

⁴ The Northern Ireland Renewables Obligation – Preliminary Consultation June 2004

2.1.4 Competitiveness

The requirements of competitiveness place a high priority on the costs of electricity to consumers and the relative burden of increases in electricity prices compared to other costs.

Support for RES-E technologies has typically resulted in slight increases in electricity prices to consumers (although even this paradigm is changing with the rise in natural gas prices). RES-E would be expected to become more competitive with fossil-fired generation as the technologies mature and as the un-priced externalities (including emissions) associated with various fuels and conversion techniques are internalised. The impacts of the environmental Directives listed in Section 2.1.2 on the economics of RES-E generation, via the associated increased future cost burden on conventional plants, while not yet clear, are likely to be broadly positive.

Of course customer costs have to be taken into consideration as a priority. This in itself however, does not preclude state support for RES-E where this is required. Indeed to date customer costs have been more impacted by other factors such as rising natural gas (and coal prices), the support of peat plants (in the RoI), low plant availability, various contracts with conventional plants (in NI), rising demand growth, etc. Medium to long-term trends of fossil fuel prices and availability will also have to be taken into consideration. Thus, renewables cannot be considered in isolation in impacting consumer prices.

The costs to society of RES-E generation need to be considered in a holistic manner within the wider context of: reserve requirements, the portfolio of plant operating on the island, the dispatch philosophy utilised in operating the system, price of competing generation costs, financial incentives, rules in the electricity market, prices and volatility of fossil fuel generation, energy and industrial development policies, and a host of other variables. (This is further addressed in Section 5.2.3).

Consider:

- Q1. What are the drivers for RES-E policy, and can they be prioritised?**
- Q2. How should RES-E policy interact with other government policies (waste, agriculture, environment, etc.)?**

2.2 Regional Energy Markets

2.2.1 Single Electricity Market – the SEM

The Energy Ministers’ *All-Island Energy Market Development Framework* sets the policy context for the creation of an All-island energy market. Both Regulatory Authorities have signed a Memorandum of Understanding in which they commit to working together to develop a Single Electricity Market (SEM) by July 2007. The SEM vision is for “*wholesale electricity trading arrangements which deliver an efficient level of sustainable prices to all customers, for a supply that is reliable and secure in both the short and long-run on an all-island basis.*” The development of the regulated market to 2020 will have a significant impact on the implementation of RES-E.

It will be important to create a market that will:

- Allow true market signals to be seen;
- Allow all generators to compete on a level playing field
- Minimise market distortion;
- Minimise system and market operation costs to the final customer;
- Afford greater transparency.

It is important to note that this market design will inevitably require adjustment and therefore built-in flexibility. Inevitably, the issue of dominance, and the regulatory response to it, will impact the market in more significant ways than many of the design principles.

In practice there is very little empirical data or experience with RE intermittent generators participation in gross pool electricity markets. RE intermittent generators have, in the main, either opted for policy mechanisms that place them outside the scope of market participation, or have been granted non-dispatchable or must-run status. The issue of the treatment of intermittent generation should be thought through carefully so as to ensure the overall robustness and maintain the clarity that will be demanded of the new market for electricity. The Regulatory Authorities are currently working on the high-level design phase of the SEM prior to commencement of a detailed implementation phase where the detailed solutions to questions and comments posed here will be given due consideration.

The development of a ‘2020 Vision’ for renewable energy in electricity will need to be constructed with considerable interaction with, and reference to, the SEM. It serves as the core of the framework from which to consider all-island electricity issues. The lessons learned from establishing the requisite operations, governance, processes, legislation, human resources, etc will all inform the development of a 2020 RES-E vision.

Consider:

- Q3. Do the opportunities or obstacles facing RES-E differ between the two jurisdictions?**
- Q4. Are there areas of RES-E policy that should not be considered on an all-island basis, and why?**
- Q5. To what degree are RES-E policies currently aligned – North & South?**

2.2.2 Wider Regional Context

In addition to the links between NI and RoI, it will be necessary to consider the alignment of energy markets between the islands of Ireland and Britain – on a ‘two-islands’ basis – or on a wider regional basis. This will become more significant with increased electricity interconnection. A full treatment of this topic is outside the scope of this consultation, however. Opportunities and risks associated with integration with such alignment will need to be explored going forward. UK policy and markets will inevitably influence this all-island vision to 2020.

Consider:

Q6. How should all-island RES-E policy inform and be informed by EU and UK RES-E Policy?

Q7. What effects will interconnection (North-South & East-West) have on RES-E, and how should it be operated and regulated?

3.0 RES-E ELECTRICITY ON THE ISLAND OF IRELAND: 2005 – 2010

Details of RES-E implementation statistics on the island of Ireland are to be found in the joint Action Renewables and SEI published document *Renewable Energy in Ireland: Trends and Issues 1990-2003*. This document is available on SEI’s web site (www.sei.ie), and provides considerably more data than can be usefully presented and discussed in this document⁵. There are a number of other published documents that cover areas relevant to this Consultation Document in more detail, including:

- UK White Paper (2003) on Energy
- NI Energy Study 2002
- DCMNR 2010 RES-E Consultation Document (2003)

3.1 Levels of RES-E Penetration

3.1.1 Current Status

RES-E penetration in the RoI and in NI is for now, mostly based on wind energy and additionally in the RoI, hydro. The percentage of electricity provided by RES-E remains modest in both jurisdictions. This is the case even with the considerable recent growth in wind deployment. Projected growth (in short-medium term) will be primarily in wind energy.

Table 1 summarises the current installed RES-E generation capacity in the Republic of Ireland, Northern Ireland and on an all island basis.

⁵ In addition, the Department of Communications, Marine and Natural Resources (DoCMNR) publishes information on RES-E installed capacity in the Republic of Ireland (www.dcmnr.gov.ie/Energy/).

Table 1: RES-E Installed Capacity Currently Generating			
Technology	Republic of Ireland¹	Northern Ireland²	All-Island
Wind	403 MW ³	107 MW ⁴	510 MW
Biomass	24 MW	3 MW	28 MW
Hydro	237 MW	3 MW	240 MW
Ocean	0 MW	0 MW	0 MW
Solar PV	0 MW	<1 MW	<1 MW
Totals	624 MW	113 MW	778 MW
<u>Notes</u>			
1. All RoI data from DoCMNR website			
2. All NI data from NIAER 2005			
3. As of end May 2005, there is approximately 1,300 MW of wind plant with connection offers in RoI.			
4. Includes Snugborough plant (located in RoI but connected to NI system).			
5. As of beginning of July 2005 there was approximately 46 MW of wind with connection offers in NI (NIE).			

3.1.2 Short-Term RES-E Targets

2010 targets are in place for both jurisdictions. They are briefly outlined below.

Northern Ireland

EU Directive 2001/77/EC sets out national indicative targets for member states for the contribution of electricity produced from renewable energy sources to gross electricity consumption by 2010. The relevant UK target is 10% of gross national electricity consumption, which is defined as “national electricity production, including auto-production, plus imports, minus exports”. Large-scale hydro capacity can contribute to this target but pumped storage plants cannot. The policy paper *Energy – A Strategic Framework for Northern Ireland* (June 2004) sets out a target that 12% of electricity supplied in Northern Ireland should come from renewable energy sources by 2012. It is stated that 15% of this target, about 1.8% of the total, should come from non-wind technologies (this has not, as yet, been disaggregated by technology).

In addition to the 12% target, under the Northern Ireland Renewables Obligation (NIRO) electricity suppliers are obliged to source 6.3% of the electricity supplied to NI customers from renewable energy sources by 2012. The NIRO came into effect in April 2005 and the obligation level will rise each year up to 2012. In 2009/2010, the obligation level will be 3.5% or, in absolute terms, 325,000 Renewable Obligation Certificates.

Republic of Ireland

The Republic of Ireland’s 2010 RES-E target, as set out in EU Directive 2001/77/EC, is 13.2% of gross national electricity consumption⁶.

Table 2 summarises a short-term RES-E generation scenario for 2010 and 2012 in both jurisdictions. The calculation of capacity and energy targets requires assumptions around such factors as capacity and availability, house loads of other generation, demand, and the establishment of the technology scenarios to be investigated. Thus, the figures are indicative.

	Republic of Ireland			Northern Ireland²		
Technology	2010¹ Requirement		Gap	2012 Requirement		Gap
	[GWh]	[MW]	[MW]	[GWh]	[MW]	[MW]
Wind	3,420	1,100	697	1,062	335	228
Biomass	537	92	68	164	26	23
Hydro	820	240	3	15	4	1
Ocean	3	1	1	13	4	4
Totals	4,780 ³	1,433 ³	769	1,254	369	256
<u>Notes</u>						
1. Taken from DoCMNR’s REDG STAG Report. Installed capacity required by end 2009 to meet 13.2% RES-E target by 2010.						
2. Action Renewables						
3. Based on High Demand Forecast in <i>Generation Adequacy Report 2004 - 2010</i>						

3.2 Policy

There is still considerable work to be undertaken to meet the 2010 targets. There are a number of instruments in place to support these targets. Some of the key instruments are set out briefly⁷ in this section.

⁶ Turlough Hill pumped storage generating station cannot contribute to this target.

⁷ This document does not purport to set out the detailed scope of current policy in this field in both jurisdictions. Additional information on this topic is available at www.detini.gov.uk/energy (NI) and www.dcmnr.ie/energy (RoI).

3.2.1 Primary Support Mechanisms

Primary policy⁸ refers to the principal financial support mechanism utilised to support RES-E. There is considerably more detail on the discussion of primary financial support mechanisms available in the DCMNR 2003 Consultation Document. That document includes discussion of instruments in place in both in NI and the RoI.

Northern Ireland

Northern Ireland Non-Fossil Fuels Obligation

In 1993 the Department of Economic Development in NI, in line with UK policy, introduced the Non-Fossil Fuel Obligation (NI-NFFO). This placed an obligation on NIE plc to initially secure approximately 16 MW declared net capacity (DNC) from renewable energy sources, rising through successive NFFO rounds to 45 MW DNC by 2005. Prospective developers were invited to tender in two successive competitive rounds i.e., NI-NFFO1 in 1993 and NI-NFFO2 in 1996. NI-NFFO1 resulted in 20 contracts being awarded, representing a total of 15.7 MW DNC, including onshore wind, hydro and sewage gas plant. The average bid price paid to successful generators was 6 p/kWh. The NI-NFFO2 tender process awarded contracts to 10 projects in 1996, totalling 16.271 MW DNC. The average bid price paid to generators was approximately 4 p/kWh. By 1998 16 schemes had been commissioned totalling 14.933 MW DNC for both NFFO1 and NFFO2⁹.

Northern Ireland Renewables Obligation

The Northern Ireland Renewables Obligation (NIRO), which came into force on 1st April 2005, is a legal obligation on electricity suppliers to source a certain percentage of the electricity supplied to NI customers from renewable energy sources, rising to 6.3% by 2012. Compliance with the obligation will be demonstrated through a system of certification using Renewable Obligation Certificates (ROCs), which are mutually recognised and can be traded freely throughout the UK. These are issued to qualifying, accredited renewable generators to provide confirmation that the specified quantity of electricity produced from renewable sources has been supplied to a licensed supplier for consumption in NI. By trading ROCs with suppliers either separately or together with the associated renewable electricity, generators are able to receive a premium price for their electricity. Where a supplier does not have sufficient ROCs to meet his obligation in a particular period he may purchase additional ROCs from the marketplace or pay a ‘buy out’ fee, currently £32.33 per MWh¹⁰. The latest auction¹¹ of UK ROCs indicates a price premium of £46.05 per MWh over and above the wholesale price of electricity.

⁸ There are many ways to analyse and classify RES-E financial support instruments. There is considerable experience across the EU with mechanisms that specify either a price or a quantity (or in some cases a mixture of the two). Economic theory has been used to consider these options. However abstracting policy instruments to fit within the confines of economic theory does not always produce useful outputs. Rather financial instruments must be analysed according to their specific design. It is this detailed design that will normally have a larger impact on the success of the instrument and its affect on society, than its economic classification.

⁹ *A Study into the Economic Renewable Energy Resource in NI and the Ability of the Electricity Network to Accommodate Renewable Generation up to 2010*, DETI/NIE (2003)

¹⁰ OFGEM, 2005

Renewables Output Factor

The Renewables Output Factor (ROF) is a market enabling mechanism for industrial and commercial renewable electricity trading which was introduced in 2002/03. This scheme enables supply companies to provide accredited renewable electricity to industrial and commercial customers as a means of reducing energy costs, establishing environmental credentials and offsetting the Climate Change Levy (CCL). The scheme has successfully encouraged a number of new supply companies to enter the market.

Under the normal half-hourly top-up and spill mechanism, if a supplier purchases more electricity than is required to meet their customers' demand, they receive a spill payment from NIE (Summer Rate: 1.4-1.8 p/kWh.) and where they under-purchase they must pay a top-up payment to NIE. (Summer Rate: 2.1 - 5.4 p/kWh.) This system is unfavourable for suppliers of renewable energy due to the variability and unpredictability of wind. To overcome this, the ROF mechanism allows renewable energy suppliers a method of cash flow management by viewing their demand on an accumulative basis, rather than a standard half-hourly basis, providing that over the year the supplier purchases 20% more renewable energy than their demand level. Due to the introduction of the NIRO, from 2005/06 onwards the ROF factor will increase from 20% to 60%. However, for all suppliers already operating under the ROF mechanism, the higher factor will only apply to demand in excess of their 2004/05 level. Their 2004/05 demand level will still only require the 20% factor. It is likely that the ROF incentive will be phased out over the coming years however a timeframe for this has not yet been finalised¹².

Republic of Ireland

The Alternative Energy Requirement (AER) is the principal mechanism for providing financial support for renewable energy implementation in RoI. It was launched in the mid 1990s. It is a competitive bidding process for power purchase agreements. The government administers the programme by periodically inviting tenders from private developers for specified amounts and types of RES-E, and for Combined Heat and Power capacity. Under the programme there have been six AER competitions to date that oblige ESB Customer Supply (CS) to purchase the output from supported new green electricity generating stations at a fixed price for a period of up to 15 years. Applicants to the competitions submitted bids up to a cap price designated for specific technology categories (i.e. wind, hydro, biomass). The applicants with the lowest bids in each category were selected up to a capacity threshold designated by the Minister. The AER programme is supported through a public service obligation charge levied on all customers. AER VI, the most recent competition, was announced in 2003.

The Minister for Communications, Marine & Natural Resources recently¹³ announced his intention to introduce a new market support mechanism based on a fixed feed in tariff system in order to stimulate sufficient capacity to meet at least the 13.2% RoI target. This support system will be designed specifically to encourage new capacity development and will only apply to

¹¹ 27th April 2005

¹² NIE, July 2005

¹³ Speech by the Minister for Communications, Marine and Natural Resources, Noel Dempsey T.D., to the Irish Wind Energy Association Annual Conference, Fairways Hotel, Dundalk (7 April 2005)

newly built projects. In order to ensure that projects qualifying for support are in a position to build within a reasonable timeframe, the minimum conditions necessary to apply for support will be updated to include a requirement to have a valid grid connection offer in place.

3.2.2 Secondary Supports

Secondary supports can be defined as those support instruments and tools that allow for the support of less mature technologies, or that work synergistically to improve the efficacy of primary supports.

Northern Ireland

A number of secondary support mechanisms have been introduced in Northern Ireland in the last 10 years to help promote RES-E deployment, including:

- NIE Small Renewables Spill Tariff, currently 4.5 p/kWh, which is available to RES-E generators providing capacity is less than 100 kW and providing the generator surrenders the associated ROCs to NIE.
- RES-E generators accredited by NIAER to receive Levy Exemption Certificates (LEC).
- The NIE SMART Programme was developed in response to the current regulatory agreement between NIE and the Electricity Regulator. Under this framework, NIE Transmission and Distribution is encouraged to seek alternatives to the conventional methods of managing and developing the electricity network in Northern Ireland. A fund of £250,000 per annum is available to encourage the ‘pump-priming’ of near-market renewable energy technologies. In addition, funding is available for embedded generation and demand-side management projects that provide an alternative to conventional means of network reinforcement.
- Short Rotation Coppice Challenge Fund, a DARD/BSP programme to increase the amount of willow grown for energy use in NI.
- Energy Demonstration Scheme, a DETI grant programme to help fund renewable energy demonstration projects. The scheme ran from 2001 to 2003/04.
- Various UK-wide grant programmes, including Clear Skies, the Major Photovoltaic Demonstration Scheme and the Bioenergy Infrastructure Scheme.

Republic of Ireland

A number of secondary supports were introduced over the past decade to help promote RES-E deployment. These include:

- 100% market opening to green suppliers from February 2000 in advance of full market opening (February 2005).
- The balancing regime for green sales and green energy is set within a generous 5 % margin on an annual basis. This balancing period is initially set at 2-years to assist new entrants.

- There are more favourable arrangements in place in the trading rules for green generators than for brown generators in terms of limits and pricing for accessing ‘top-up’ from the ESB.
- Section 486B of the *Finance Act 1998*, which offers tax relief for corporate investors in renewable energy projects;
- The Business Expansion Scheme (BES), which allows individual taxpayers to write off qualifying investments against personal income where the investment is in renewable energy projects. This scheme is of particular interest to small-scale projects.
- SEI’s Renewable Energy Research, Development and Demonstration Programme.
- Grid Upgrade development Programme for Renewables: The CER determined to support the funding of the programme through Transmission Use of System (TUoS) revenue up to the value of €30 million.

The Department of Communications Marine and Natural Resources (DoCMNR) has indicated that it wishes to see a more coordinated and structured approach taken to the creation and maintenance of Research, Development and Demonstration (RD&D) capacity in the field of energy on the island as a whole, including establishing opportunities for collaboration on research and innovation north and south. The DoCMNR recently published a consultation document¹⁴ on this topic.

3.2.3 Moving Towards 2020

It is proposed that RES-E deployment targets and policies will be examined on an all-island basis as both jurisdictions seek to expand their RES-E generation capacities between now and 2020.

Detailed techno-economic analyses of the costs and benefits of RES-E penetration will be required to inform future target setting policy in this area. This will include a full analysis of both direct and indirect costs and benefits associated with increased RES-E penetration and an analysis of the greenhouse gas emissions savings associated with an increased level of RES-E on the system compared to other alternatives, to inform the 2020 all-island RES-E vision.

¹⁴ *Energy Research, Development and Demonstration – Consultation Paper*, Department of Communications Marine and Natural Resource (April 2005)

4.0 RES-E ELECTRICITY ON THE ISLAND OF IRELAND: 2005 – 2020

A key question that must now be addressed is what steps we need to take to arrive at a view on the appropriate level of renewable penetration for the island of Ireland in 2020. At the outset, an understanding of the resource potential of different RES-E technologies on the island is required. It is also vital to investigate the technical and financial aspects of increased RES-E penetration. Estimates of demand going forward will also be required to inform decision making in this area. The outcome of this work can then inform target setting and policy formulation in the area of RES-E for 2020.

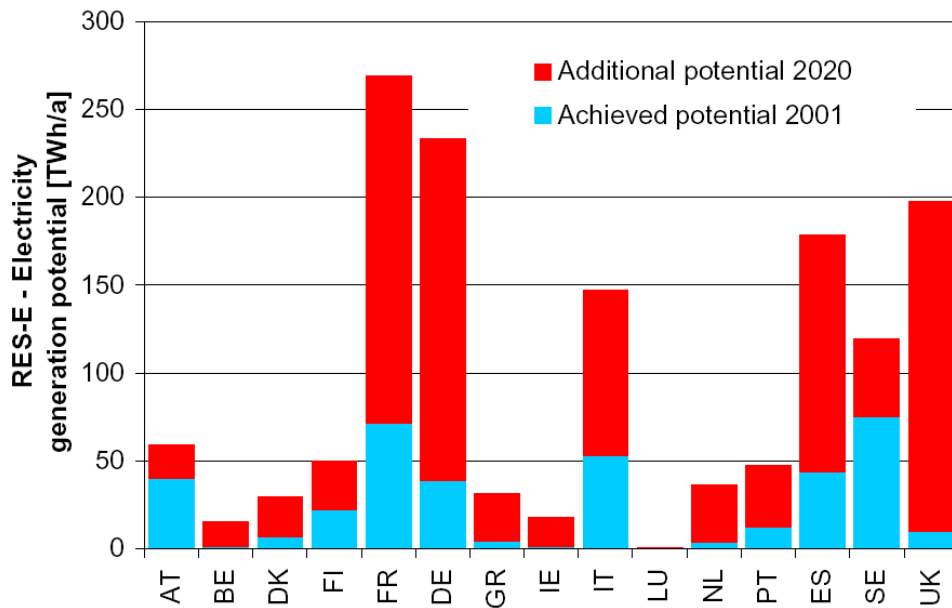
A lot of studies have been done to date in this area by different bodies on the island (see Annex A2). It is now necessary to review these studies and identify what additional work needs to be done in order to reach decisions regarding targets and policy for 2020.

Some renewable energy sources such as wind, wave and solar are intermittent and somewhat unpredictable (this varies temporally), and thus only available to supply electricity in relation to the available wind, sea state, or level of insolation at a given time. This combination of intermittency and limited predictability has limited impact on the electricity system at penetrations up to 10-15 % of system capacity. At penetration above these levels it becomes a progressively more difficult factor to be taken into account in system design and operation.

4.1 RES-E Resource

4.1.1 Methodology for Assessing RES-E Resources

Over the last decade, several assessments have been made of the resource potential of different RES-E technologies. Estimates based on one assessment are set out in Figure 2 below for different RES-E technologies in the EU-15 countries. This illustrates one view of the gap between current installed capacity and the 2020 potentials.

Figure 2: Achieved (2001) & Additional Mid-Term RES-E Potential (up to 2020) in EU-15 Countries

Source: Fraunhofer Institute Systems & Innovation Research

Unfortunately, it is difficult to align the outputs from different bodies of work in this area as the assumptions upon which the assessments are based can vary widely from study to study. Key assumptions include expected rates of deployment for different technologies, changes in technology costs over time, future competing (fossil) fuel prices and the future cost of capital (see Figure 4 below).

SEI recently commissioned consultants to develop a methodology¹⁵ for the assessment of renewable energy resources in the RoI. An important element of this work was a re-assessment of resource definitions as used previously in quantifying the available energy at each stage in the attenuation process that exists between the raw theoretical resource as it occurs in nature and the more limited fraction of the resource that is commercially accessible for utilisation. A set of definitions applicable to both the electrical and heat markets and describing the scale of the renewable resources available was established. These are set out in Table 3.

It should be noted that the resource values set out in this consultation document for the different technologies are not all based on this methodology. However, something similar would ideally be applied consistently on an all-island basis in order to provide the necessary cohesion in considering targets, costs, etc.

¹⁵ Renewable Energy Resources in Ireland for 2010 and 2020 – A Methodology, SEI (Nov 2004)

Resource Level	Definition
Theoretical	Gross energy content of the particular form of renewable energy that occurs within a given space over a given time thereby having the potential to displace fossil energy.
Technical	Theoretical resource as above constrained by the efficiency of the currently available technology to respectively extract renewable energy from the resource or inject it to an electricity or heat using system over a given time thereby displacing fossil energy.
Practicable	Technical resource as above, constrained by practical physical or other incompatibilities e.g. where resource capture or injection systems simply cannot meaningfully be located due to physical interference or other practical reason e.g. crops do not grow on roads.
Accessible	Practicable resource as above but constrained by manmade, institutional/regulatory deletions that limit energy extraction e.g. environmental, health and safety, energy policy, zonal planning, by-product management criteria etc. In general not all of the accessible resource may be commercially viable.
Viable Managed Market (VMM)	Accessible resource as above, constrained by what is considered to be commercially viable at a particular time in the managed or supported market in terms of development cost, scale, resource distribution, market reward level, timing or other risk.
Viable Open Market (VOM)	Accessible resource as above constrained by what is considered to be commercially viable at a particular time without market support in terms of development cost, resource distribution, market reward level, timing or other risk (variable over time).

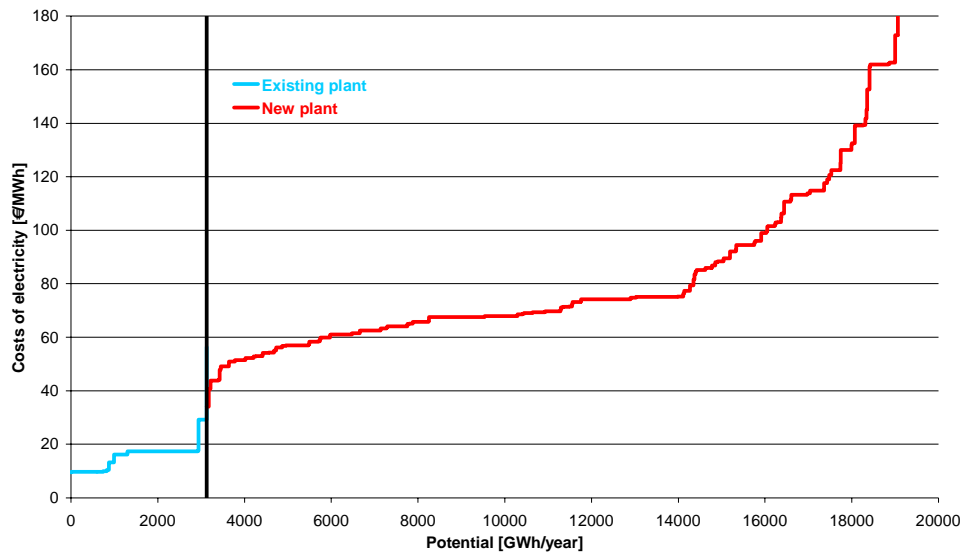
A cost analysis methodology was then developed in the same study based on the following three analytical elements:

1. Financial Analysis – an estimation of the potential return to a project developer from investment in alternative renewable energy technologies, under stated conditions with inclusion of all life time costs including overheads and revenues;
2. Economic / Levelised Cost Analysis – comparison and ranking of technologies in terms of snapshot economic efficiency expressed in terms of energy output. The method utilises the capital, operating, maintenance and fuel prices together with the annual electrical output to produce a levelised electricity cost expressed as €/kWh and is widely used to compare power plants.
3. Resource Cost Analysis – a means of comparing costs of different projects both within and between specific technologies. When plotted as curves the output can be used to determine the energy contribution that each technology can make based on the economics and the availability of the resource. An example of a static cost resource curve is shown in Figure 3. (This cost curve is separated between existing and future by the vertical black line. It indicates a cost on the y-axis, and a potential on the x axis. It is included to illustrate the normal upward slope of a cost-resource curve where the expectation is that the cheaper resources are utilised first.)

It should be noted that the above cost analysis methodology only considers the direct costs to the developer and does not take account of the wider system costs and resultant costs to end users. This methodology could now serve as a base for the development of a more comprehensive study

on an all island basis that would incorporate all appropriate costs and set these against the aggregate benefits.

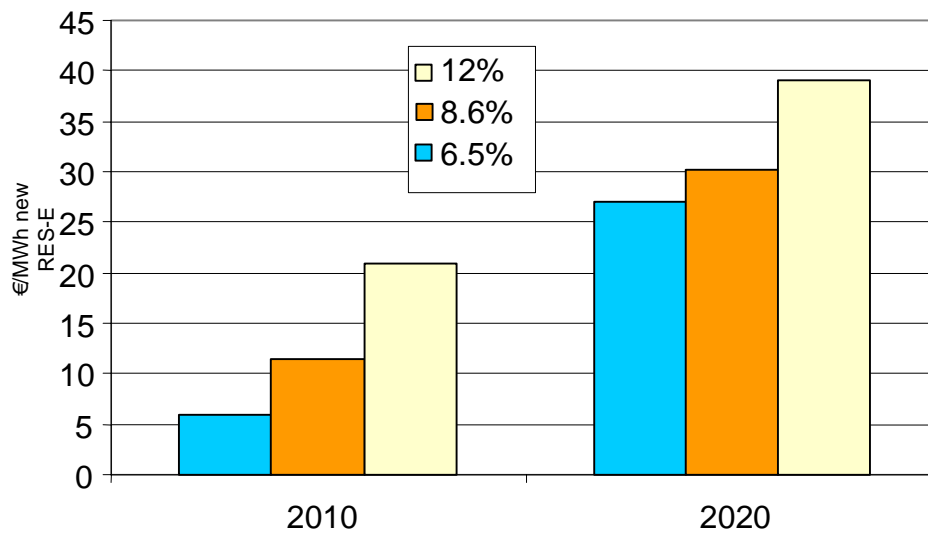
Figure 3: Static Resource Cost-Curve for RES-E in RoI (All RES-E technology Options)



In analysing issues related to financing and profitability the choice of discount rate is critical in estimating the levelised cost of development of small or developmental renewable resources¹⁶. Figure 4 illustrates the significance of choosing various values for discount rate or the weighted average cost of capital (WACC) in order to determine the absolute costs of a support mechanism. A methodological approach to calculating costs of support for RES-E in the 2020 timeframe will need considerable further discussion. Sensitivity studies are a requisite part of any analysis. (The figures should be viewed as indicative of the impacts of assumptions on outputs, rather than as useful absolute values.)

¹⁶ A lower discount rate results in lower cost for capital intensive technologies such as RES-E, but is likely to better reflect society's value of infrastructure investment than a commercial WACC or an equity return rate.

Figure 4: Comparison of Additional Financial Support for New RES-E with Three Different Rates for Weighted Average Cost of Capital (WACC)



4.1.2 2020 RES-E Resource by Technology

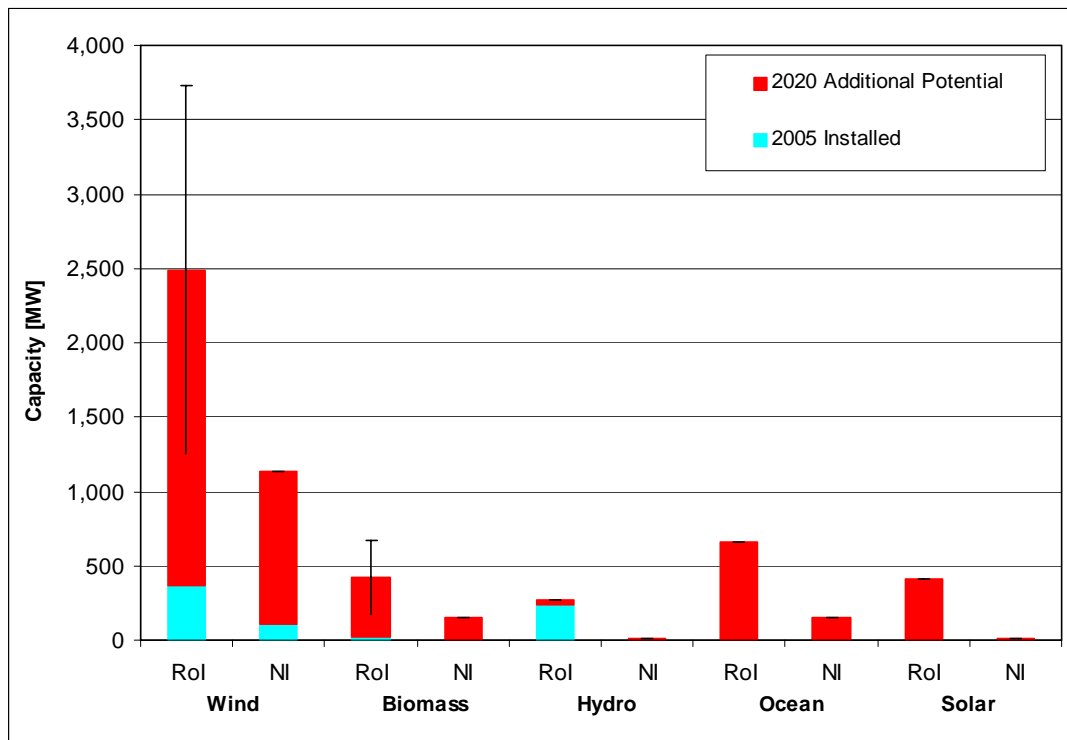
As mentioned, assessing resource potentials to 2020 is a complex task. The assumptions on technology cost, efficiencies and current legislation are often dynamic. As such, resource assessments should be updated from time to time, and particularly when major technology or cost shifts occur. Table 4 and Figure 5 overleaf summarise the most recent output from a variety of assessments undertaken on the resource potential of different RES-E technologies in both jurisdictions. These resource totals are inclusive of currently generating plant.

The data presented in Table 4 and Figure 5 represents the outputs from different bodies of work in this area. The assumptions upon which these bodies of work are based can vary widely from study to study. Therefore, the comprehensive aggregation of resource data on common definitions will be required for a ‘2020 Vision’.

Technology	Republic of Ireland		Northern Ireland		All-Island	
	[MW]	[GWh]	[MW]	[GWh]	[MW]	[GWh]
Wind	1,250 ^{1,2} – 3,725 ^{1,3}	3,832 ^{1,2} – 11,421 ^{1,3}	1,140 ⁷	3,670	2,390 – 4,865	7,503 – 15,091
Biomass – Wood Residues	35 ⁴ – 250 ⁴	214 ⁴ – 1,532 ⁴	20 ⁸	128	55 – 270	342 – 1,660
Biomass – Dry Agricultural Residues	30 ⁴ – 121 ⁴	176 ⁴ – 719 ⁴	6 ⁸	38	36 – 126	214 – 757
Biomass – Wet Organic Residues	25 ⁴ – 64 ⁴	135 ⁴ – 345 ⁴	14 ⁸	97	39 – 78	231 – 441
Biomass – Landfill Gas	10 ⁴ – 58 ¹	57 ⁴ – 434 ¹	24 ⁷	136	34 – 82	193 – 570
Biomass – Waste to Energy MSW	62 ⁴ – 91 ⁴	309 ⁴ – 453 ⁴	75 ⁹	479	137 – 166	788 – 932
Biomass – Energy Crops	12 ⁴ – 84 ⁴	72 ⁴ – 492 ⁴	18 ⁸	112	30 – 102	184 – 604
Hydro	269	930 ⁴	8 ⁷	30	277	960
Wave	6 ⁴	19	0	0	6	19
Tidal	651	2,103 ⁵	150 ¹⁰	484	801	2,587
Solar PV	408	500 ⁶	4	5	412	505
Total	2,758 – 5,727	8,348 – 18,948	1,458	5,180	4,216 – 7,185	13,529 – 24,129

Notes

1. *Renewable Energy Resources in Ireland for 2010 and 2020 – A Methodology*, ESBI (Nov 2004)
2. Based on the continued deployment of CCGT as up to 2020
3. Based on the use of large open cycle aero derivative gas turbine plant coupled with provision of gas and pumped storage facilities
4. *Bioenergy in Ireland – A Strategy for Action*, DoCMNR Bioenergy Strategy Group
5. SEI values for 2010 Accessible Resource
6. *Options for Future Renewable Energy Policy, Targets and Programme*, DoCMNR (12/2003)
7. *A Study into the Renewable Energy Resource in the Six Counties of Northern Ireland*, Action Renewables (2004). Figures shown are 2010 feasible resource.
8. Estimate of feasible resource in 2020, DARD 2005
9. Estimate of potential resource in 2020, Action Renewables and DOE, 2005
10. *The Potential for the Use of Marine Current Energy in Northern Ireland*, DTI/DETI/NIE (2003) Figures based on 1st generation technology only.

Figure 5: RES-E Resource Potential 2020

A catalogue of the geographical distribution of the resource would be helpful in identifying the regional and local implications of deploying renewable energy in the volumes envisaged. (A number of the resource studies (e.g. wind, dry agricultural waste and tidal) have been, or are being, conducted on an all-island basis. To date this has not been entirely disaggregated at the county level in the RoI.)

A resource study conducted by PB power was undertaken on behalf of Action Renewables and published in 2004. Among other technologies it investigated the wind energy resource at a county level. It is included here (Table 5) to illustrate the future possibility of conducting such an evaluation on an all-island basis.

County	MW	GWh/annum
Antrim	94	313
Armagh	12.5	42
Down	92.5	308
Fermanagh	89.3	297
Derry	70.5	235
Tyrone	205.8	685
Total	564.6	1880

Consider:

Q8. What could the level of penetration of RES-E electricity be in 2020 on the island of Ireland? (Please include any analysis that supports your response.)

4.2 Completed Supporting Studies

Several important supporting renewable energy studies have been undertaken in the last few years and these are informing the development of policy to increase the deployment of RES-E on the island of Ireland. Annex A2 lists some of the key relevant supporting studies that have been completed and sets out the field of study, technology and jurisdiction addressed in each body of work. They are all publicly available.

Action Renewables, SEI and other stakeholders are continuing to undertake additional work in this field to help develop the policy required to deliver 2020 RES-E target(s). Studies in a number of areas are underway, including one on an economic analysis of ocean energy, and another on geothermal energy. However more work is needed to fully quantify the feasible energy potential of these sources (and for this reason, figures for geothermal power have not been included in the 2020 scenarios in this consultation document¹⁷).

Studies have also been undertaken in the following general categories:

- Longer Term Resource Potential / Targets (2020);
- Short Term Resource Potential;
- Resource Methodology;
- Support Options;
- Integration into Wider Electricity System;
- Energy Markets;
- Economic Assessment.

Relevant conclusions derived from this work must be assimilated into policy going forward.

¹⁷ CSA Group Limited (2005)

5.0 REQUIREMENT FOR FUTURE POLICY TO 2020

5.1 ‘2020 Vision’

5.1.1 Methodology for Determining Vision

Indicative levels of RES-E for 2020 on an all-island basis are set out in Section 5.1.3. These are based on projected electricity demand and are derived on the basis of illustrative RES-E penetration level scenarios of 15%, 20% and 30%. Such penetration levels are indicative only. They could be conveniently considered as approximating to *BAU* (15%), *EU Norm* (20%), and *Ambitious* (30%).

Only one scenario is included for each penetration level. It should be noted that there are various portfolios of RES-E plant that could meet any levels of penetration. The scenarios developed here are primarily intended to facilitate dialogue on the subject. Nevertheless they are not arbitrary and for the most part are informed by sources such as the several technology strategy groups (i.e. the Biomass strategy group, etc.), resource studies, current implementation status, 2010 targets and other analyses.

The formatting of these penetration levels is the same as that for the 2010 targets as set out in 2001/77/EC for member states, i.e. a target percentage of gross (national) electricity consumption, defined as “...national electricity production, including auto-production, plus imports, minus exports”. As was stated above, large-scale hydro capacity can contribute to the target but pumped storage plants, such as Turlough Hill¹⁸, cannot.

Consider:

Q9. How should suggested levels of penetration be decided?

5.1.2 Electricity Demand Forecast

The first step in calculating penetration levels is estimating demand in 2020. Forecasts for gross national electricity consumption¹⁹ up to 2020 are set out in Table 6 and Figure 6 for NI and the RoI.

Northern Ireland

Table 6 shows NIE's demand forecasts up to 2020. These show the amount of electricity required to meet total final consumption in Northern Ireland, including an allowance for transmission and

¹⁸ The operation of Turlough Hill will need to be further investigated in its role of providing power system support in relation to RES-E.

¹⁹ As defined in *Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market*

distribution losses. The figures assume a growth in electricity demand of 1.5% per annum for the next 10 years and 1% per annum thereafter, and assume an estimated ‘house load’ of 7%.

In its most recent *Seven Year Statement*²⁰ SONI states that maximum demand load growth has reduced from 2% per annum in the late 1990s to a present stable level of increase of 1.8%. It is assumed that this level of growth will continue until 2015. Thereafter annual maximum demand load growth may either maintain this rate or reduce due to Government incentives in demand reduction through more efficient electrical equipment and energy efficient housing stock.

Republic of Ireland

Electricity demand forecasts for RoI up to 2011 are set out in the ESBNG’s *Generation Adequacy Report 2005 - 2011*. The demand forecasts presented are Total Energy Requirement (TER) figures representing the total Irish electricity generation at the plant exported level plus imports, less exports. The TER is the amount of electricity required to meet total final consumption in the Republic of Ireland including an allowance for transmission and distribution losses.

The RoI forecasts were calculated by firstly modifying the 2005 – 2011 median TER values so as to account for generation plant ‘house load’²¹, and then determining the values for 2012 – 2020 at the assumed growth rates of 3% per annum between 2012 and 2015, and of 2% per annum between 2015 and 2020.

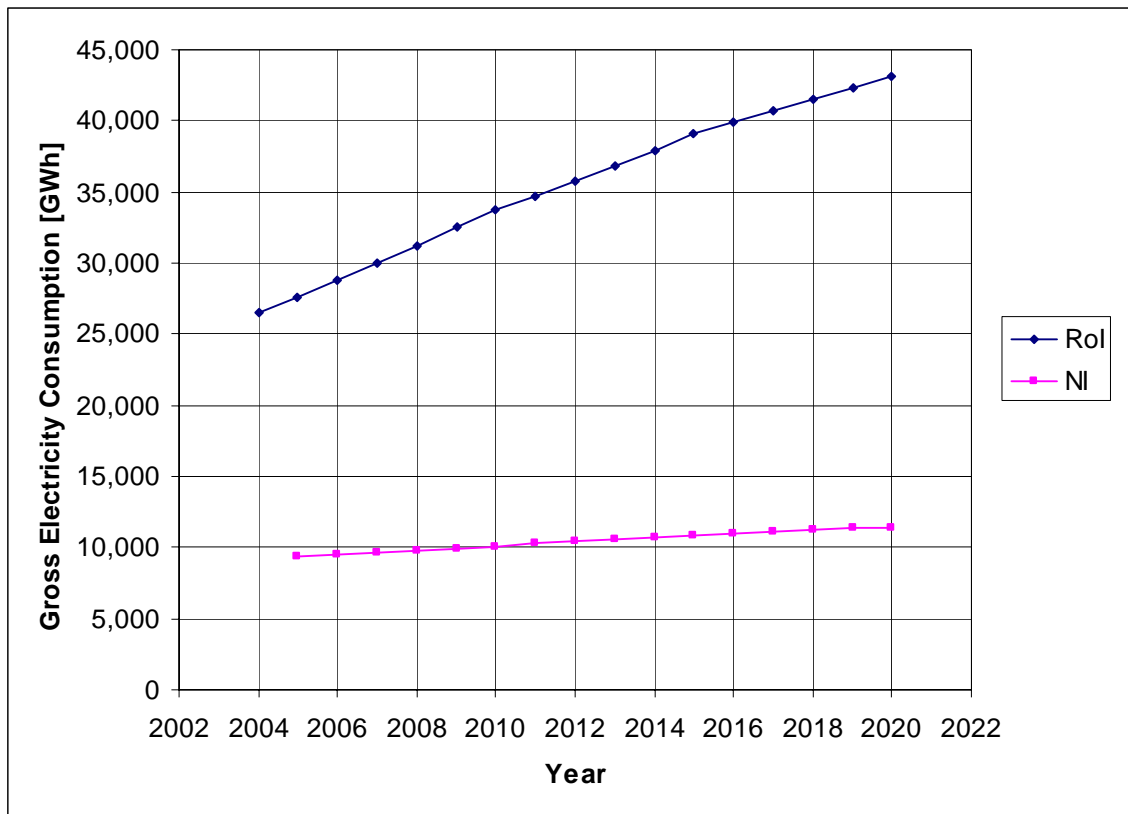
Year	Republic of Ireland		Northern Ireland ²		All-Island
	Gross Consumption [GWh]	Demand Growth [%]	Gross Consumption [GWh]	Demand Growth [%]	Gross Consumption [GWh]
2005	27,580	3.8%	9,381	1.5%	36,960
2010	33,708	3.8%	10,106	1.5%	43,813
2020	43,162	2% ¹	11,442	1.1%	54,604

Notes

1. ESB National Grid estimate
2. NIE estimates.

²⁰ December 2003

²¹ ESBNG estimates a weighted average of 3.5% for house loads.

Figure 6: Gross Electricity Consumption

(Growth in energy demand is closely correlated to economic growth. The RoI projects higher demand growth and thus the disparity between the slopes of the curves in the above figure.)

Both forecasts utilised in this consultation document are based on median scenarios. It may be more appropriate to estimate targets to 2020 based on the high scenarios. This would allow for a more conservative approach to policy setting.

5.1.3 2020 RES-E Levels

A vision of RES-E to 2020 is likely to involve consideration of what might constitute an appropriate level to be adopted for the penetration of RES-E generation in NI / RoI by 2020. There are a number of important factors to be taken into account in determining 2020 penetration level(s) including:

- Meeting existing and possible future emission reduction²² commitments which are likely to become more onerous beyond the initial Kyoto period;
- Costs and benefits and methodologies for determining and quantifying them;
- Providing a robust and durable framework to facilitate industry in establishing its longer term strategic plans;

²² Any emissions implications arising from changes required to the operating efficiency of conventional plant to accommodate increased penetration of renewables (in particular wind) should be considered.

- Setting targets that require continuously growing contributions from RES-E at a pace which i) considers any economic burden to the consumers, ii) maintains a relatively low-risk technical development schedule and iii) provides sufficient incentive to industry to become involved;
- Incorporating the need to utilise technologies that are close to maturity and to bring forward other technologies that are further from maturity but which are likely to be required in the longer term.

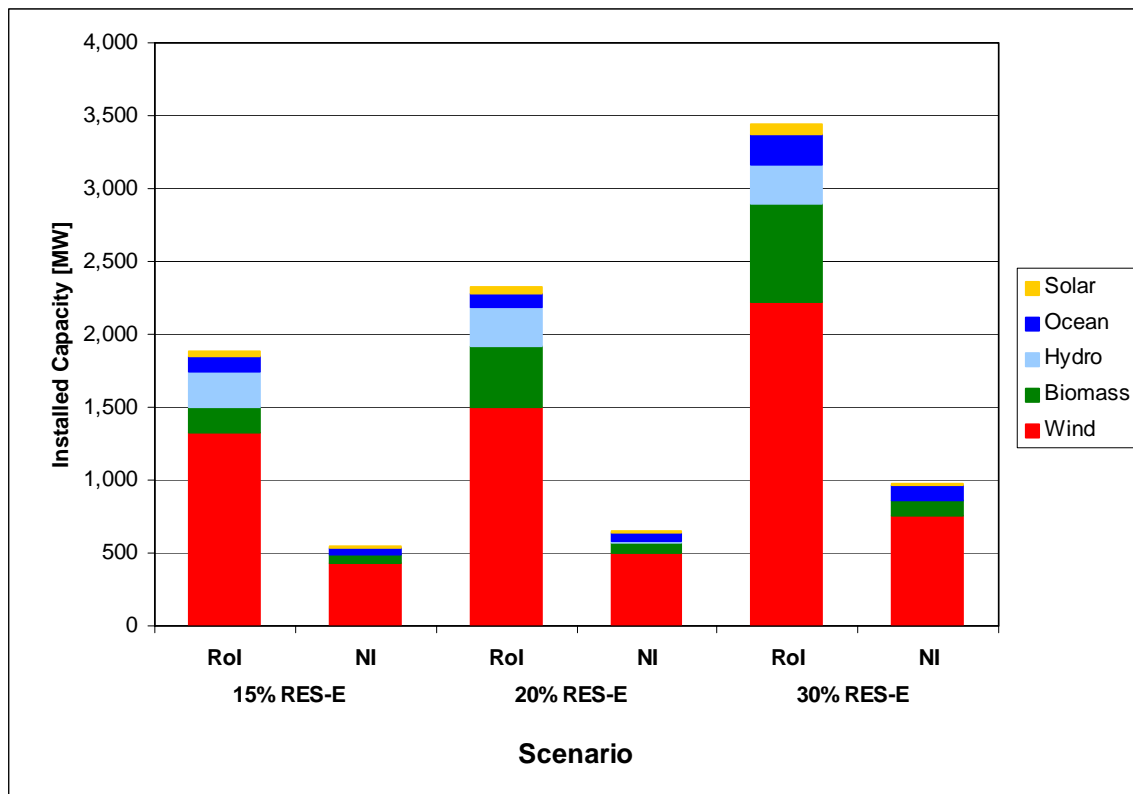
Table 7 below sets out the amount of RES-E generation required in 2020²³ to meet three different illustrative RES-E generation scenarios, viz. 15%, 20% and 30% of gross (national) electricity consumption, based on the electricity demand growth scenarios presented in Section 5.1.2.

RES-E Level	Republic of Ireland	Northern Ireland	All-Island
15% of GEC	6,474 GWh	1,716 GWh	8,191 GWh
20% of GEC	8,632 GWh	2,288 GWh	10,921 GWh
30% of GEC	12,949 GWh	3,433 GWh	16,381 GWh

Looking forward, different combinations of RES-E technologies could contribute to overall RES-E generation by 2020. In the context of the renewable resources available in the island of Ireland and the current status of different technologies and their supply chains, it is to be expected that wind, hydro and bioenergy would be the dominant technologies.

Figure 7 shows just one view of how different RES-E technologies could contribute to the three 2020 RES-E illustrative generation scenarios set out in Table 7. The contributions from different RES-E technologies presented in Figure 7 all lie within the bounds of the RES-E resource potential data set out in Table 4. The load factors used to determine the capacity options for each technology are set out in Annex A3.

²³ It should be noted that in order to meet this 2020 energy-based options, RES-E plant must be operating by the end of 2019.

Figure 7: 2020 RES-E Capacity Options for 15%, 20% & 30% RES-E Generation Scenarios**Consider:**

Q10. What type of plant (RES-E) should be promoted through appropriate financial, regulatory and / or planning policies?

Q11. Should NI and RoI be seeking to lead in any technologies?

5.1.4 2020 Primary Policy

It is a widely held view that market based mechanisms provide the most economically efficient means of achieving renewable energy policy objectives. Market-based mechanisms are those that enhance private sector interest in a field through some form of economic incentive, as opposed to command and control instruments, which achieve policy objectives through direction. These include fiscal measures, subsidy measures, and obligations imposed on market players, and can be expected to be the principal means of achieving our common goals. Market based mechanisms can be roughly categorized in terms of how they address the market, providing an incentive based on output by offering a price support directly or indirectly, or as a means of upfront capital support.

It is not a simple task to consider policy for all RES-E technologies together. They vary in resource availability, technological maturity, cost, “dispatchability”, etc. If financial support is appropriate, then it should be optimised for the difficult equation of maximising the societal benefit, whilst maintaining value for money for consumers North and South. As an example one could consider that financial support for some mature and environmentally benign technologies

will no longer be required by 2020, if previous support has allowed for cost reduction enabling them to compete on a purely economic basis. Others will require support at an early stage to ensure technological improvement takes place in time to help support the desired ‘2020 Vision’ for RES-E.

Detailed techno-economic analyses of the costs and benefits of delivering the targeted levels of RES-E penetration through different policy options will be required to refine policy in this area. Some of this work is already underway. Recent work completed for SEI indicates that when specific support for less mature technologies is not made available early the cost of deploying these technologies in the future, when the resource available for the more mature technologies are exhausted, is significantly increased.

The analysis is intended to be illustrative only, and does require further consideration of future possible alignment in policy between RoI and NI, and a host of other details. The primary support employed in each jurisdiction does not have to be the same. However, the interaction of two different support mechanisms would need to be carefully evaluated. Evaluation of the impacts to both markets and possible distortions or perverse incentives across borders will need to be considered in detail.

Consider:

Q12. What primary policy mechanisms should be put in place to meet the suggested penetration level and how should it be applied? What prices are required? (Please include any analysis that supports your response.)

5.1.5 Secondary Policy

There have been arguments posed under the heading of environmental economics, which cite the elegance and efficacy of a single instrument for a single policy goal. However, this has rarely been demonstrated in practice. Different and interacting goals do exist in public policy, technologies vary dramatically in their operation and development, different sectors of the economy can require different policy signals, and the effects of market incentivisation cannot always be predicted in full. Thus, secondary support mechanisms have often proved essential in successful policies.

A production support mechanism ensures that a project only receives public funding when it is successfully operated. While this guarantees that the public receives value for the funding, it is not always sufficient to overcome the substantial barriers faced by those attempting to deploy new technologies. For these reasons, it may be appropriate to operate an up-front investment support scheme along side the price support mechanism that is designed primarily for more mature technologies. It is noteworthy that the timing of such support can be as important as the structure and magnitude of the support. Examples of investment support schemes applied in other jurisdictions are:

- Investment incentives through grant funding;
- Tax credits on personal income tax or on corporate income tax;
- Accelerated tax depreciation for expenditure on renewable energy equipment;
- Government funded and administered low or interest free loans programme.

It has been found in many other countries that the most successful policies include a range of policy support tools, not simply one primary mechanism.

Consider:

Q13. What supporting policies are appropriate, and for what technologies?

5.1.6 Calculation of Investment Costs for 2020 RES-E Illustrative Generation Scenarios

Estimates of the investment costs (only) of deploying the 15%, 20% and 30% RES-E generation levels for 2020 are set out in Table 8. The costs are calculated on the basis of estimated investment cost levels for different RES-E technologies between 2005 and 2020. The CO₂ emissions savings for the different deployment scenarios are also included in the table²⁴. This is a simplified calculation and does not include the “costs to consumer” per se. In other words, it does not provide an estimate of the overall net present value of the support as a function of its price above the marginal cost of electricity. The methodologies employed for estimating the costs to consumer and impacts on the electricity prices of policies for supporting RES-E to 2020 will require considerable analysis and dialogue. Table 8 is useful as a first step in that process.

The cost data set out in Table 8 is a first estimate of the level of total investment likely to be required to deliver the different RES-E generation levels by 2020. Historically, the assessment of the costs of support associated with RES-E deployment in RoI has been based on the calculation of the cost above the CER’s Best New Entrant (BNE) price²⁵. Note that this cost analysis methodology only considers the direct costs to the investor rather than the wider system costs and resultant cost to end-users.

Renewable energy projects will need to offer sufficiently competitive and secure returns to attract the financial capital required to finance the multi-billion euro investment necessary to meet indicative RES-E targets. A secure framework where policy is predictable will help ensure that projects are replicable, and technology risk is low or mitigated.

²⁴ This simplified calculation of CO₂ savings does not account for any increased CO₂ emissions from conventional plant.

²⁵ It is envisaged that under the new market arrangements the average wholesale price will be used for this value.

	Republic of Ireland			Northern Ireland ¹			All-Island		
RES-E Penetration level	15%	20%	30%	15%	20%	30%	15%	20%	30%
Forecast Median Gross Electricity Consumption	43,162			11,442			54,604		
Target RES-E Generation [GWh]	6,474	8,632	12,949	1,716	2,288	3,433	8,191	10,921	16,381
Capital Cost Required for Additional Capacity (Now – 2020) [€m / £m]	€1,705 / £1,159	€2,313 / £1,573	€3,665 / £2,492	£382 / €62	£519 / €763	£795 / €1,169	€2,267 / £1,541	€3,076 / £2,092	€4,834 / £3,287
CO ₂ Emissions Savings per Annum (v/s Average RoI Generation Mix) [Mt]	4.230	5.659	8.455	1.051	1.397	2.087	5.281	7.056	10.543
CO ₂ Emissions Savings per Annum (v/s Natural Gas Generation – BNE) [Mt]	2.295	3.070	4.587	0.611	0.811	1.213	2.906	3.882	5.800
<u>Notes</u>									
1. All figures are in 2005 € / £									
2. Exchange rate used for calculations: € = £0.68									

The next phase of this work programme should include a detailed analysis of the direct and indirect costs to the consumer of deploying the different RES-E options by 2020.

However, at this early stage, it is worth noting the general historical trends in BNE price and RES-E deployment costs. Figure 8 shows the historical rise in BNE price (€/MWh) over recent years and includes the CER’s draft BNE price for 2006. Increases in natural gas price have driven the BNE price up by 75% since 2001 and have significant effects on the competitiveness of RES-E compared to gas fired generation. (In the RoI, all RES-E projects under the AER system are based on prices below the new BNE price, and most have at least 10 years remaining on their contracts.)

Figure 8: BNE Price (2001 – 2005)

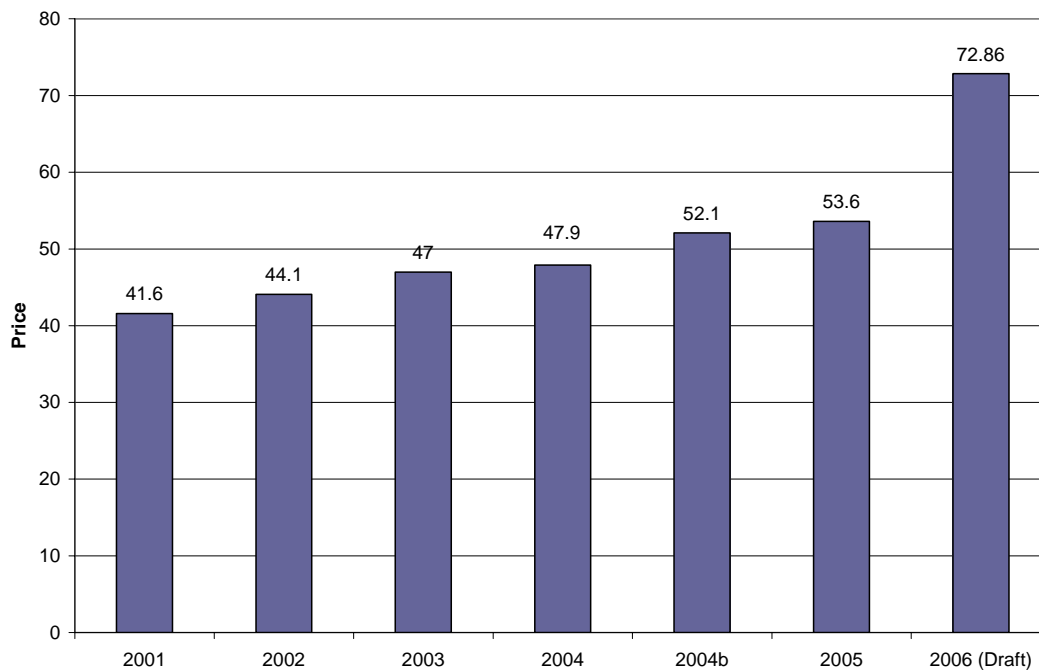


Table 9 shows the projected generation costs of a number of technologies (at different discount rates) in the UK in 2010 (IEA, 2005). They are likely to be of a similar scale for the island of Ireland.

Table 9: 2010 projected UK prices of Different Energy Technologies

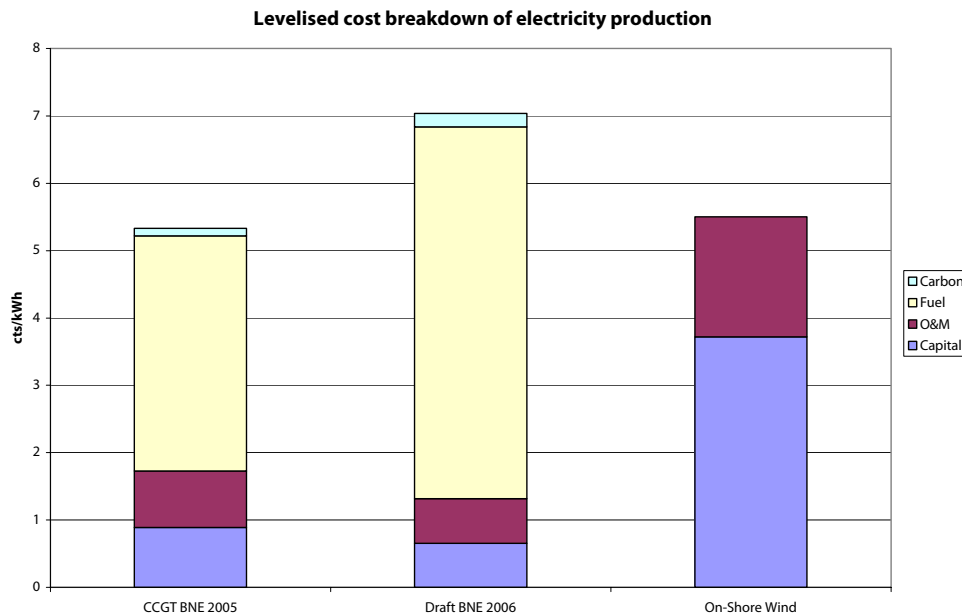
Technology	Table 1: based on generic assumptions for discount rates		Table 2: based on 5% real discount rate		Table 3: based on 10% real discount rate	
	Low	High	Low	High	Low	High
Coal	3.6	4.0	3.0	3.4	3.6	4.0
Gas	2.3	2.4	2.1	2.3	2.3	2.4
Nuclear	2.8	4.3	2.4	3.6	2.8	4.3
Coal (capture & storage)	2.8	4.3	4.3	5.4	4.9	6.2
Gas (capture & storage)	3.4	3.8	3.0	3.5	3.4	3.8
Onshore wind	2.7	3.6	2.4	3.2	3.2	4.2
Offshore wind	4.4	5.5	3.5	4.4	4.5	5.7
Energy crops	4.3	6.4	3.4	5.3	4.0	6.1
Small hydro	1.3	1.5	1.2	1.4	1.6	1.9
Waste	2.1	2.4	1.9	2.2	2.5	3.0
Marine	4.1	5.4	3.1	4.0	3.8	5.0
Landfill gas	2.7	3.2	2.4	2.9	3.3	3.9
Sewage sludge	2.1	2.5	1.9	2.3	2.5	3.0

As 2020 approaches the development costs of RES-E technologies will likely decrease as a result of economies of scale and technological effects. The degree of cost reduction over time will vary from technology to technology (based on learning by doing, economies of manufacturing scale, technological advancements, etc.). A common approach²⁶ for describing such cost changes is through a learning rate, or a progress ratio (PR). This is the percentage of initial costs that current costs will be at following a doubling of output (as an example, onshore wind capital costs may decline by 17% by 2010). PRs may differ at each stage of development, and as technologies mature the scope for cost reductions may decline²⁶. Table 10 summarises projected PRs of energy technologies taken from a recent UK DTI report (Oxera, 2005).

Table 10: Projected Progress Ratios (PR) for Different Energy Technologies		
Technology	Projected PR [%]	Time Period
Onshore wind capital cost	83 – 91	Up to 2010
Offshore wind capital cost	90	‘Long Term’
Offshore wind cost of generation	80 – 85	
Wave and tidal stream	80 – 85	
Biomass energy crops	85	
<i>Source: Oxera for DTI (2005)</i>		

Financing for RES-E is a critical facet of development. The ability to secure debt and equity funding at reasonable rates to ensure required commercial rates of return is, in most cases, the essential test of regulation and policy. The investment community is recently coming to an understanding of the unique requirements and risks in financing RES-E projects. The dramatically different cost elements that make up RES-E technologies (wind) and a typical CCGT plant (BNE) are shown in Figure 9.

²⁶ Oxera, for DTI, 2005

Figure 9: Structure of the Levelised Direct Cost of Electricity for Onshore Wind and BNE

The Figure depicts the relatively high cost of capital and non-existent fuel and CO₂ costs for onshore wind energy. This also indicates the intuitive benefit of RES-E in its ability to diversify risk in the portfolio of plant on the island. Going forward, there is a requirement to identify the indirect costs associated with increased levels of RES-E deployment.

5.2 Challenges to be Addressed

5.2.1 Overview

There are a variety of challenges that are either currently impinging on RES-E deployment on the island of Ireland or have the potential to do so before 2020. Several of these challenges arise from the complex interactions between technical, regulatory and financial elements that can combine to significantly constrain the level of RES-E deployment achievable. It is crucial to consider the role that a coherent policy can play in aligning and solving what may otherwise result and then need to be considered as a technical challenge. Thus policy should be linked to technical solutions based on scientifically credible analysis so as to maximise the benefits of renewable generation for the island of Ireland at least cost to the customer.

Some of the challenges facing the achievement of any 2020 RES-E target(s) include, *inter alia*, those associated with:

- Connection to, interaction with, and the basis of charges for use of electricity transmission & distribution networks;
- Dispatch philosophy (electricity market integration);
- Intermittent nature of wind generation (including ‘constraining-off’ of wind capacity);
- Availability of finance.

- Integration of current and emerging RES-E technologies into existing electricity systems designed primarily for large, centralised thermal plant;
- Planning processes;
- Regulatory uncertainty with respect to future electricity market structure, future EU legislation on energy markets, and future climate change mechanisms;
- Technology costs.
- Appropriate incentives for bio-energy production.

Some of the issues associated with RES-E integration into the electricity system are addressed in more detail in Annex A4.

The interactions and inter relationships between the technical issues are very complex and can make their analysis and resolution particularly difficult. Addressing each topic in isolation of all others is unlikely to yield good robust solutions. The solution methodology needs to be integrated and carefully monitored and managed so as to achieve the highest levels of success.

It is worth noting that the technical challenges facing RE deployment on the island of Ireland can also be viewed as opportunities. The understanding, insight and experience gained by successfully addressing the challenges can be harnessed and exported to other systems in the form of know how and expertise. The island of Ireland is in a unique position in this regard as it looks increasingly likely that significant penetration levels in absolute terms may soon be achieved and when expressed, as a percentage of the system size may soon be one of the largest in the world. This implies that there is a potential to develop a market leader position in the area of grid integration of renewable generation.

Consider:

Q14. What are the principal obstacles for RES-E penetration to 2020? How should they be addressed?

5.2.2 Power System Interaction

The synchronous nature of the electricity system on the island of Ireland provides an important impetus for considering the implementation and impacts of RES-E plant in a synergistic manner. So, from a technical perspective it is already one system. The grid code, connection methodology, electricity market rules, and policy all interact in how RES-E is accommodated on the system. This issue has been identified and will be progressed under the Minister’s All-Island Energy Market Framework.

The extent to which intermittent generation such as wind energy can be accommodated on the Irish electricity system(s) is determined by a number of factors including:

- The scale of wind power development in relation to system size;
- The extent to which wind power output is correlated with peak demand or periods of otherwise high loss of load probability;

- The ability to modulate demand;
- The mix of other plant on the system(s);
- The degree of interconnection with other systems and the characteristics of those systems.

Load following is a key pre-requisite for the acceptance of a large quantity of wind power onto the electricity system. If the current trend of installing combined cycle gas turbine (CCGT) plants continues, the system will be dominated by very efficient but relatively inflexible plant, poorly equipped for load following. The emerging large open cycle aero-derivative type gas turbine plants are less efficient than CCGTs but more suitable for load following. The implications of different plant mix and operational philosophies, including on emissions from the system as a whole, will need to be addressed in the 2020 proposed work programme.

Consider:

- Q15. What are the impacts of increased RES-E on the power system and operation? And how can they be addressed?**
- Q16. What are the implications for future policy of different scales of RES-E (e.g. distributed generation vs. large scale wind)? How could they be planned for and facilitated?**

5.2.3 Costs and Benefits

As alluded to throughout this paper, there is a need to fully quantify the direct and indirect costs and benefits associated with increased penetration of RES-E in the years to 2020. Initially, consideration will need to be given to the method used for quantifying and qualifying the costs and benefits. Economic methods that can take account of risks should also be considered. This includes a requirement to assess and quantify, *inter alia*; the system costs associated with increases in intermittent plant, changes to the operation of conventional generation, fuel diversity benefits, grid investment costs, other security of supply issues, environmental impacts (GHG, and other pollutants) and other direct and indirect costs and benefits of increased RES-E generation on the island of Ireland.

The risk profiles for power generation technologies and their associated fuels vary widely. These profiles will affect the choice of generating portfolio and the strategies for the operation of the power system. Table 11 shows a qualitative risk assessment of a number of conventional plants alongside some RE technologies and “future” technologies (fuel cells) (IEA, 2005). Given the volatile and high prices witnessed in the fossil fuel commodities markets alongside high CO₂ prices, many countries are reviewing other options, which include increased penetration of RE.

Table 11: Risk Assessment of Different Energy Technologies

Technology	Unit size	Lead time	Capital cost/kW	Operating cost	Fuel prices	CO ₂ emissions	Regulatory risk
CCGT	Medium	Short	Low	Low	High	Medium	Low
Coal	Large	Long	High	Medium	Medium	High	High
Nuclear	Very large	Long	High	Medium	Low	Nil	High
Hydro	Large	Long	Very high	Very low	Nil	Nil	High
Wind	Small	Short	High	Very low	Nil	Nil	Medium
Recip. engine	Small	Very short	Low	Low	High	Medium	Medium
Fuel cells	Small	Very short	Very high	Medium	High	Medium	Low
Photovoltaics	Very small	Very short	Very high	Very low	Nil	Nil	Low

Note: CO₂ emissions refer to emissions at the power plant only.

These issues are obviously not simple to consider and need to be evaluated individually as well as holistically. These important issues could be addressed in a full cost benefit analysis of the impact of accommodating increased penetration of RES-E generation capacity on the existing NI and RoI systems. Such an analysis would be essential for informing policy decisions for RES-E and also for considering the complete range of options available to achieve our wider policy objectives, including heat supply, energy efficiency and CHP, as well as RES-E.

Consider:

Q17. How should the costs and benefits of RES-E electricity be measured and quantified?

Q18. What are the costs and benefits of increased RES-E penetration on the Island of Ireland?

5.3 Stakeholders and Responsibility

Cooperation will be required to realise a ‘2020 Vision’ for RES-E and provide processes for deployment. This needs to be founded on a clear and transparent policy. Appropriate policy can and should provide a framework to resolve technical issues and incentivise build. It can also serve as a boundary in which to quantify impacts. A clear signal and policy from government will allow supporting agencies and state bodies to work in a coherent and supportive manner with the commercial market. This is the beginning of that process and the requirement to seek wide stakeholder input.

There is also a need to consider capacity building on the island of Ireland, and optimal resource (fiscal and human) allocations to areas that require further analysis.

6.0 FUTURE WORK PROGRAMME AND DELIVERABLES

It is recognised that a significant work programme will be required over the next 12-18 months. Key areas that need to feed into the development of common policy themes and options over the next 12 months will be prioritised and addressed so that either preliminary or final outcomes are available to inform the work underway to achieve that goal²⁷.

This work programme should consist of several inter-related work areas that will address:

1. Gaps in the assessment of the resource potential for different RES-E technologies on the island of Ireland in 2020.
2. The quantification of future RES-E portfolio and penetration levels in an all-island and EU context.
3. Formulation of strategic planning processes to achieve identified RES-E objectives and targets.
4. The impacts of integrating targeted RES-E levels on the future development of system infrastructure, plant portfolio and system operation practices. Some of the issues associated with this topic are discussed in Annex A4.
5. The integration of RES-E into future electricity market structure(s). Some of the issues associated with this topic are discussed in Annex A4.
6. The development of a comprehensive cost benefit analysis of the impact of accommodating increased penetration of renewables on the electricity system. This analysis should include a specific assessment of the impact of intermittent generation on the system.
7. Examination of policy options for RES-E electricity, including primary & secondary support options for appropriate technologies.
8. Harmonisation of RES-E policy with other related and relevant policy areas including: climate change, environmental, security of supply, fuel poverty and rural & agricultural diversification.

A proposed work programme is set out in Figure 10 overleaf.

Consider:

Q19. What work streams should be included in a work programme to facilitate RES-E goals?

²⁷ It is not a short-term exercise. Member States across the EU, and the Commission itself, are at the early stages of formulating approaches in the 2020 timeframe.

7.0 CONCLUSION

Ministers request interested stakeholders and associated entities to **submit comments to the subject matter of the consultation document by 30/09/2005 (FRI)** to either:

- Peter Hughes, DETI, NI: Peter.Hughes@detini.gov.uk or
- Brian McSharry, DCMNR, RoI: Brian.McSharry@dcmnr.gov.ie

The questions posed throughout this document and repeated below should be alluded to in the responses. Again, this is the beginning of a policy formation process for RES-E on an all-island basis. Wide stakeholder participation will be critical in identifying a robust way forward.

There are a very large number of assumptions, statements and proposals in this consultation document. The public is invited to submit comments, proposals and recommendations in response to any aspect of the document or related issues.

Submissions arising from the Consultation process will be aggregated and form the basis for an all-island discussion of the subject. Responses should follow the template included.

Summary of Key Consultation Questions for Consideration:**Sustainable Energy Policy**

- Q1. What are the drivers for RES-E policy, and can they be prioritised?
- Q2. How should RES-E policy interact with other government policies (waste, agriculture, environment, etc.)?

Regional Energy Markets

- Q3. Do the opportunities or obstacles facing RES-E differ between the two jurisdictions?
- Q4. Are there areas of RES-E policy should not be considered on an all-island basis, and why?
- Q5. To what degree are RES-E policies currently aligned – North & South?
- Q6. How should all-island RES-E policy inform and be informed by EU and UK RES-E Policy?
- Q7. What effects will interconnection (North-South & East-West) have on RES-E, and how should it be operated and regulated?

RES-E Resource

- Q8. What could the level of penetration of RES-E electricity be in 2020 on the island of Ireland? (Please include any analysis that supports your response.)

'2020 Vision'

- Q9. How should suggested levels of penetration be decided?
- Q10. Should NI and RoI be seeking to lead in any technologies?
- Q11. What type of plant (RES-E) should be promoted through appropriate financial, regulatory and / or planning policies?
- Q12. What primary policy mechanisms should be put in place to meet the suggested penetration level and how should it be applied? What prices are required? (Please include any analysis that supports your response.)
- Q13. What supporting policies are appropriate, and for what technologies?

Challenges to be Addressed

- Q14. What are the principal obstacles for RES-E penetration to 2020? How can they be addressed?
- Q15. What are the impacts of increased RES-E on the power system and operation? How can they be addressed?
- Q16. What are the implications for future policy of different scales of RES-E (e.g. distributed generation vs. large scale wind)?
- Q17. How should the costs and benefits of RES-E electricity be measured and quantified?
- Q18. What are the costs and benefits of increased RES-E penetration on the island of Ireland?

Future Work Programme

- Q19. What work streams should be included in a work programme to facilitate RES-E goals?

ANNEX A1 – ABBREVIATIONS

AER	Alternative Energy Requirement	NIAER	Northern Ireland Authority for Energy Regulation
BNE	Best New Entrant	PPA	Power Purchase Agreement
CER	Commission for Energy Regulation	PR	Progress Ratio
CHP	Combined Heat & Power	PSO	Public Service Obligation
CCGT	Combined Cycle Gas Turbine	PV	Photovoltaic
CCL	Climate Change Levy	REDG	Renewable Energy Development Group
DARD	Department of Agriculture & Rural Development (NI)	RES-E	Renewable Energy Supply - Electricity
DETI	Department of Enterprise Trade & Investment (NI)	ROC	Renewable Obligation Certificate
DNC	Declared Net Capacity	ROF	Renewables Output Factor
DoCMNR	Department of Communications, Marine and Natural Resources (RoI)	RoI	Republic of Ireland
EC	European Commission	SEI	Sustainable Energy Ireland
ESBNG	Electricity Supply Board National Grid	SEM	Single Electricity Market
ESBCS	Electricity Supply Board Customer Supply	SEWG	Sustainable Energy Working Group
EU	European Union	SONI	Systems Operator for Northern Ireland
GWh	Gigawatt Hour	STAG	Short Term Analysis Group
JPT	Joint Project Team	TPER	Total Primary Energy Requirement
LEC	Levy Exemption Certificate	UK	United Kingdom
MW	Megawatt		
MSW	Municipal Solid Waste		
NFFO	Non-Fossil Fuels Obligation		
NI	Northern Ireland		
NIE	Northern Ireland Electricity		
NIRO	Northern Ireland Renewables Obligation		

ANNEX A2 – KEY SUPPORTING STUDIES

Table of Completed Supporting Studies														
Study Title	Field of Study						Technology					Jurisdiction		
	Resource Assessment Methodology	Short-Term Resource Potential / Targets	Longer Term Resource Potential / Targets (2020)	Support Options	Integration into Wider Electricity System	Energy Markets	Economic Assessment	Onshore Wind	Offshore Wind	Biomass	Other RES-E	RoI	NI	All Island
<i>Wind Atlas 2003</i> , SEI (2003)			✓					✓	✓			✓		
<i>Renewable Energy Resources in Ireland for 2010 and 2020 – A Methodology</i> , SEI (Nov 2004)	✓		✓					✓		✓		✓		
<i>Co-firing with Biomass</i> , SEI			✓				✓			✓		✓		
<i>An Assessment of the Renewable Energy Resource Potential of Dry Agricultural Residues in Ireland</i> , SEI			✓				✓			✓		✓		
<i>A Resource Study on Recovered Vegetable Oil and Animal Fats</i> , SEI (2003)			✓				✓			✓		✓		
<i>The Costs and Benefits of Embedded Generation in Ireland</i> , SEI (2004)					✓		✓					✓		
<i>Offshore Wind Energy and Industrial Development in the Republic of Ireland</i> , SEI (2004)			✓	✓			✓		✓			✓		
<i>Operating Reserve Requirements as Wind Power Penetration Increases in the Irish Electricity System</i> , SEI (2004)					✓			✓	✓			✓		

Table of Completed Supporting Studies														
Study Title	Field of Study						Technology					Jurisdiction		
	Resource Assessment Methodology	Short-Term Resource Potential / Targets	Longer Term Resource Potential / Targets (2020)	Support Options	Integration into Wider Electricity System	Energy Markets	Economic Assessment	Onshore Wind	Offshore Wind	Biomass	Other RES-E	RoI	NI	All Island
<i>Economic Analysis of RES-E Support Mechanisms, SEI (2004)</i>				✓				✓	✓	✓	✓	✓		
<i>Options for Future Renewable Energy Policy, Targets and Programme, DoCMNR (2003)</i>			✓	✓			✓	✓	✓	✓	✓	✓		
<i>Bioenergy in Ireland – A Strategy for Action, DoCMNR Bioenergy Strategy Group (2004)</i>			✓	✓	✓					✓		✓		
<i>Wind Atlas for Ireland, SEI (2003)</i>	✓		✓					✓	✓			✓	✓	
<i>A Study on Renewable Energy in the New Irish Electricity Market, SEI (2004)</i>				✓		✓	✓	✓	✓			✓		
<i>A Study into the Economic Renewable Energy Resource in Northern Ireland and the ability of the electricity network to accommodate renewable generation up to 2010, DETI/NIE (2003)</i>	✓	✓			✓		✓	✓		✓	✓		✓	
<i>A Study into the Renewable Energy Resource in the Six Counties of Northern Ireland – Generic Resource Report, Action Renewables (2004)</i>	✓	✓						✓	✓	✓	✓		✓	
<i>The Potential for the Use of Marine Current Energy in Northern Ireland, DTI/DETI/NIE (2003)</i>											✓		✓	

Table of Completed Supporting Studies														
Study Title	Field of Study						Technology				Jurisdiction			
	Resource Assessment Methodology	Short-Term Resource Potential / Targets	Longer Term Resource Potential / Targets (2020)	Support Options	Integration into Wider Electricity System	Energy Markets	Economic Assessment	Onshore Wind	Offshore Wind	Biomass	Other RES-E	RoI	NI	All Island
<i>Recommendations for a Renewable Energy Policy, DARD (2005)</i>		✓								✓			✓	
<i>Northern Ireland Vision Study, Carbon Trust (2005)</i>			✓ ¹										✓	
<i>Best Practicable Environmental Option for Waste Management in Northern Ireland, DOE (2005)</i>			✓							✓			✓	
<u>Notes</u> 1. This study extends to 2050.														

ANNEX A3 – PRACTICAL LOAD FACTORS

RES-E Technology	Practical Load Factor
Onshore Wind	35.00%
Offshore Wind	39.00%
Biomass – Wood Residues	72.96%
Biomass – Agricultural Waste	77.52%
Biomass – Biogas AD	78.74%
Biomass – Landfill Gas	64.85%
Biomass – Waste to Energy MSW Combustion	72.96%
Biomass – Energy Crops	72.96%
Hydro (New)	43.66%
Wave	36.86%
Tidal	36.86%
Solar PV	14.00%

ANNEX A4 – SYSTEM INTEGRATION OF RES-E IN CONTEXT OF 2020 TARGETS

Introduction

Compared to other European networks the Irish electricity system is relatively small and isolated with very limited interconnection capacity. The issues concerning the electricity system integration of renewable energy might be divided into three broad categories. These are:

- Electricity Network Issues
- Electricity System Operation Issues
- Electricity Market Issues

There are areas in which these issues overlap, for example electricity system operation is highly dependent upon the state of network development and electricity market design must include an objective of delivering a stable and predictable environment for electricity system operation. It is, however, convenient to demarcate the issues along these lines for the purpose of analysing development requirements.

Electricity Networks

With increasing renewable generation penetration, electricity network operators will face the challenge of adapting these networks to incorporate increasing amounts of small, largely embedded, low capacity factor, variable, non-dispatchable, intermittent generation, connecting to the network in an uncoordinated fashion and often making use of induction generators or electronic power conversion. These generation connections will often be sought at unconventional parts of the network, remote from load but where the relevant primary energy resource is available. The characteristics listed above may not be present for all types of renewable generators but are a representative collection of the characteristics in which renewable generators may differ from large conventional generators and which may challenge current network planning, design, operation and maintenance practices. The NI and RoI electricity networks are both small isolated systems with only very limited interconnection to other networks.

If the rate of increase of uptake of renewable generation technologies in the countries leading this trend is to be replicated on the island of Ireland, then the network operators will experience an ever increasing demand for the provision of network connections for small-scale renewable generators. The generator connection-application administration process must be capable of dealing with these increased numbers. The process will have to become more akin to the administering of demand connection applications, with generator connection applications dealt with in a manner and on a timescale appropriate to their scale and nature and with standardised procedures and systems to support expeditious processing of applications. To arrive at this situation, however, codes and standards which allow the connection of the larger numbers of renewable generators without compromising network safety or security will have to be put in place. Progress has been made in developing appropriate codes and standards in other jurisdictions and at an EU level and it may be advantageous to adopt or modify these standards for use on the island of Ireland rather than undergoing the longer process of developing completely new standards. It would be desirable that, to facilitate the development of a uniform

single electricity market on the island, that any new codes and standards for renewable generators would be developed on an all-island basis.

The increasing numbers of small-scale generators will also require modification to network planning practices. Hitherto network planning, and in particular distribution network planning, has primarily been driven by demand growth and the associated methodologies primarily require statistics on demand growth as an input. Projections of embedded generation growth will become important for network planning and, if network infrastructure is to develop to keep pace with the rate of growth of embedded generation it must anticipate the demand for generator connections in advance of connection applications being made. This will require accurate spatial projections of future renewable generation deployment.

If renewable generation is to be optimally incorporated into the electricity networks, generators will have to be provided with appropriate economic signals and network information required to make a decision. Network tariffs and connection charges may have to be reviewed²⁸ and refined in order to give the incentive to generators to locate appropriate generation precisely where it is of most benefit to the electricity system. This will require provision of up-to-date network information to prospective generators, preferably on-line. Such provision of information is required if several EU directives are to be fully implemented.

Network design practices may have to be adapted to cope with the increasing penetration of renewable generation, new technologies may have to be adopted to allow safe and secure operation of the electricity networks incorporating this generation. Network operation may require an increasing amount of lower level intervention to optimise generation active and reactive power output or network configuration. Optimal techniques for network and generation management in this altered operational mode may have to be developed and may require considerable R&D effort and piloting trials. Network design may have to be adapted to take account of any increased demand in control systems for low level intervention.

Network maintenance practices may have to be adapted to take consideration of any changes to codes and standards. Particular consideration will have to be given to the safety issues regarding protection systems and network maintenance for a network with increased penetration of embedded generation at the lower voltage levels of the network. Network maintenance personnel and general electrical personnel will require training to implement any new codes and standards.

Electricity System Operation

Previous work²⁹ has indicated that, with current projected generation mix and system planning and operation standards, existing renewable energy targets for 2010 on the island of Ireland will bring the penetration of such generation within the electricity systems close to the limits of what it is feasible without compromising system security, increasing costs unreasonably or having a detrimental effect upon pollutant emissions. If there is to be a further increase in the penetration of renewable energy in the period from 2010 to 2020 measures will need to be taken to anticipate

²⁸ Network tariffs and connection charges – as well as the Grid codes – are under the legislative remit of the regulators.

²⁹ *Renewable Energy Resources in Ireland for 2010 and 2020 – A Methodology*, SEI (2004); *Impact of Wind Power Generation In Ireland on the Operation of Conventional Plant and the Economic Implications*, ESBNG; *Operating Reserve Requirements as Wind Power Penetration Increases in the Irish Electricity System*, SEI (2004)

this growth. As for electricity networks, projections of the feasible penetrations of the different renewable generation technologies will have to be available for this period. These will have to be spatially accurate if the requirement for transmission network reinforcement and the effects upon system operation are to be predicted. Deep reinforcements of the electricity network are planned on the basis of system operational scenarios and these are therefore interdependent.

These renewable energy growth projections will be required to allow modelling of system operation to ensure that adequate operating and capacity reserves are available and that other system services can also be provided from within the projected generation plant mix. System modelling will be required to determine whether there are specific requirements for additions to the balance of conventional generating plant to allow the integration of the projected levels of renewable generation. This modelling may also provide indications of the generating system operational costs with projected increases in renewable generation. Such modelling should also consider whether changes to the operational modes of some conventional plant will be required and what the costs associated with such changes will be.

There is currently great uncertainty as to the level of curtailment – or ‘constraining-off’ that could be experienced by wind energy generators as the installed capacity of wind energy increases on the system over the next few years. It is important that information regarding the extent of wind farm curtailment for a range of penetration levels (under a number of scenarios relating to different forecasting error regimes, new additional non-wind plant deployment and dispatch strategies) is made available.

New system modelling and management tools may have to be developed to deal with an increased penetration of intermittent or non-dispatchable generation. Accurate forecast tools to predict the output from wind power and other variable renewable sources for timescales appropriate to system operation will be critical to enabling a high penetration of these renewable energy technologies in the generation system. Such tools are already being used for wind power forecasting by the system operators and there is an international co-operation to developing a next generation of these tools. There is wide scope for the further refinement of such tools to meet the specific requirements of system operators. Forecasting may also be assisted by the extension of the network of measurement sites. Other software tools will be required to predict the possible variations of renewable power output for projected spatial penetrations of renewable energy in the time horizons relevant to system operation. For wind power this will become easier with availability of data from an increasing number of geographically dispersed wind farms. Possible extreme scenarios due to extreme, unusual or unpredictable weather events will also have to be investigated. System operation and planning practices and assessment criteria may have to be modified to incorporate the use of such tools. Specific intermittency management software tools may need to be developed for use in system operation. The further development of wind forecasting techniques and tools will require co-operation between wind developers and the system operators.

Demand participation in providing system services may be the most economic manner in which to facilitate a higher renewable energy penetration. The feasible contribution of demand side participation should be investigated and its effects upon system operation costs quantified.

Electricity Market

The electricity market structure and detailed design will need to have regard to the projected levels of increased renewable electricity penetration. The size limits for market accession and central dispatch will have to be considered in relation to the nature and level of projected

renewable energy penetration. The market gate closure time will be a critical consideration for generators using an intermittent renewable energy source³⁰. A shorter gate closure time will increase the certainty of forecasts from such generators and allow more accurate prediction of actual plant dispatch. A long gate closure time may increase balancing costs and increase such generators' dependence on price support schemes and increase the time to their competitive participation in the market.

The system modelling detailed in the section on system operation above may be used to predict the dispatch of generating plant in scenarios with increased renewable energy penetration. The results of such modelling may be used in market models to determine prices within the market and whether conventional plant will earn the revenues required for them to remain in the market and provide the services required for system operation with the required level of system security

Demand participation may be the most economic manner to facilitate higher renewable energy penetration. Further economic modelling might be carried out on the results of the study detailed in the section on system operation to determine the costs and benefits of various penetrations of demand participation.

Since the SEM is not an energy-only market, it is likely that the system marginal price will be lower than it would otherwise have been. For this reason any capacity payment mechanism in the SEM should ensure that renewable generators receive a payment that is appropriate to the capacity value that they have on the system. The issue of capacity payments to renewable generators will need to be carefully considered during the design of the SEM.

Coherence will be required between the electricity market and network tariffs and operation. Some advance work may be required, on the aspects detailed in the section on networks, to allow the market arrangements to be finalised, particularly in relation to ancillary services. An exact understanding of how interconnectors will be operated, given the new market arrangements and any increased level of renewable electricity penetration, will be critical to facilitating this penetration and predicting prices within the market. The correct market incentives to operate interconnectors in a manner that supports system operation and complements the generating plant mix will be critical in this respect.

³⁰ *Renewable Electricity in the New Irish Electricity Market*, SEI (2004)