Department of Communications, Marine and Natural Resources
Roinn Cumarsaids, Mara agus Acmhainni Nadura

Renewable Electricity to 2010

SUSTAINABLE ENERGY IRELAND

Final Report on Policy Consideration for Renewable Electricity to 2010

November 2004

Report Prepared for the Renewable Energy Development Group (REDG) By the Short Term Analysis Group (STAG)

Executive Summary

Introduction and Context

The Department of Communications, Marine and Natural Resources (DCMNR) established a Renewable Energy Development Group (REDG) to contribute to deliberations on future national policy options to increase the contribution of renewable energy technologies to Ireland's energy requirement.

The REDG concluded, at an early stage, that in order to maximise the contribution from renewable energy technologies in the longer term and comply with an extant requirement to deliver a short term EU target it would be necessary to identify -

a) short term solutions to deliver on the EU target as a minimum, and

b) strategies to maximise the contribution from renewable energy technologies in a logical and coherent manner into the longer term.

The EU target is an obligation addressed to Ireland in *Directive 2001/77/EC on the promotion of renewable energy sources in the internal electricity market* to put in place a programme to increase the consumption of electricity from renewable energy sources from approximately 4% in year 2002 to 13.2% by 2010.

The REDG established a working group, the Short Term Analysis Group, or "STAG", as a multi-stakeholder group to identify and report on options to overcome or eliminate the barriers to greater deployment of renewable energy technologies. STAG deliberated on these matters in the period August - October 2004. The modus adopted was a co-operative consensual approach to address the short term impediments. However the report cannot be interpreted as representing the wider held views or priorities of any individual STAG participant.

The quantitative information set out in this report on renewable energy powered electricity generation is based on information available on 20th October 2004. The primary purpose of this report is to propose actions to increase the consumption of electricity from renewable energy sources from approximately 4% in year 2002 to 13.2% by 2010.

The Preliminary Issues Identified

The renewable energy industry in Ireland faces serious challenges that must be addressed if the EU target is to be delivered under reasonable assumptions including *inter alia*:

- difficulties arising from the AER instrument including its "stop-go" nature which impedes forward planning and financing by developers;
- access to grid connections including direct access, costs of connections and delivery forecasts for connections;
- operational issues from the grid code for wind energy generators in particular;
- Planning timelines for renewable energy projects
- uncertainty about the future structure of the Irish electricity market and
- availability and cost of finance for RE projects in Ireland arising from these uncertainties.

These challenges if left unresolved would impede the attainment of the 13.2% target by 2010. A series of well thought out measures are required to tackle these impediments in the near term if the 13.2% target is to be delivered under realistic assumptions in the short term. Failure to address these challenges could also delay the deployment of renewable energy technologies RE in Ireland in the longer term.

Preliminary Actions Required

There were a wide variety of perspectives discussed within STAG. This section identifies key preliminary challenges and outlines recommendations for a way forward. Chief among the recommendations are that:

- Alignment between the grid connection application process, any support mechanisms put in place by DCMNR and wider RE policy should be maximised;
- The financial implications of RE deployment for developers and consumers should be carefully considered and fully costed;
- All relevant State bodies should must work in a co-ordinated and concerted manner to identify and implement solutions to overcome the barriers to the greater deployment of renewable energy technologies;
- Industry participants and representatives should be proactive in addressing the challenges including *inter alia* imparting relevant operational and market information t o decision makers to maximise the penetration of renewable energy technologies in Ireland, and
- Future policy must address the complexities inherent in the current situation, and the requirement to deliver the short-term (2010) target in a manner compatible with longer term objectives.

Additional challenges to RE Deployment

A number of technical, regulatory, and financial challenges were identified and discussed by STAG at four topical meetings, *viz.*: (i) grid code and modelling, (ii) constraints[1], (iii) connections process and (iv) support mechanisms. These items were identified as embodying significant challenges to deployment and are discussed further in the body of this report. . Options proposed by STAG as a sequence to optimise construction in the short term include:

- prioritised delivery of connection offers to renewable energy projects which can be connected without compromising system security or investor confidence;

- design and incorporate a support selection criterion to prioritise projects with connection offers

- viable projects selected in a national support programme could be prioritised for progression through the grid connection construction process.

Additional steps or ongoing actions proposed by STAG include:

- the grid connection application process could develop as a two-tiered approach to ensure a group processing approach if adopted does not exclude projects which could be constructed in a shorter time-frame in the absence of grouped projects;

- ongoing monitoring of grid code compliance issues for renewable energy technologies (including modelling);

- a contestability option at the distribution level similar to the contestable option available for transmission level connections;

- optimal planning of the electricity infrastructure in the short term in order to facilitate the achievement of longer-term renewable energy targets;

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[1] Constraining the electrical output of generating plant. Both technical and process (legal, financial and policy) issues were examined.

- duration of full planning permissions should be aligned with the typical subsequent planning permission requirement for a connection particularly where significant delays are encountered that are entirely beyond the control of developers;

- the level of actual or potential constraint to be applied to wind energy projects should be quantified and bounded with confidence so as to maximise investor confidence;

- the future operation and the portfolio of dispatchable plants on the power system should be studies and aligned in the short term to facilitate increasing renewable energy targets beyond 2010; .

- progress should be accelerated on forecasting of wind power levels in a 0 - 48 hour time window prior to electricity production;

- consideration should be given to the scale of financial commitment required from RE project developers at the different stages of the connection process to ensure high percentage uptake and use of grid connection offers[2], and

- ongoing monitoring of technical, regulatory, and financial conditions necessary to obtain financing should operate.

Quantifying the 2010 RES-E Target

This report concludes in the body of the report that Ireland will need to have approximately 1,432 MW of renewable energy powered electricity generating plant operational installed by the end of 2009 to achieve the 13.2 % target addressed to Ireland in the "RES-E Directive". The 2010 target is dependent on actual customer demand in 2010. The 1432 estimate in this report is based on the highest of three 2010 demand scenarios identified by ESBNG[3,4] in its forecast "General Adequacy Report. The 1432 figure is cumulative including (i) existing plants, (ii) plants under construction and (iii) additional plants not yet selected. STAG considered a number of scenarios and concluded that a figure of 1432 is representative of the total capacity required assuming approximately 1,100 MW of wind energy, 239 MW of hydro[5], 92 MW of bioenergy and 1 MW of ocean energy installed by the end of 2009. These figures and the gaps to target compliance are summarised in Table 1.

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[2] CER has already put in place application fees and bonds, which are now requirements of the wind connection application process to filter access to a scarce resource to those who are committed. It is also noted that for many cases of distribution connections, the cost of the connection is so small in relation to the project cost that it would be difficult to make the financial commitment large enough to exclude projects with limited likelihood of proceeding.

[3] Constraining off (curtailment) has not been accounted for in determining installed capacity required to meet the RES-E energy target.

[4] There was not complete consensus among STAG participants that the high demand scenario should be selected as the basis for determining the 2010 RE target. Some participants argued that its use would result in an excessively high target and that instead the target should be based on the ESBNG's median demand scenario. The high demand scenario was selected as a conservative assumption.

[5] Most of the hydro capacity that will contribute to the target has already been commissioned.

Table 1: Capacity Gap to Meeting 2010 RES-E Target

	Onshore Wind	Offshore Wind	Bioenergy	Hydro	Ocean	Total
Currently Generating (Nov 2004)	208 MW	25 MW	26 MW	238 MW	0 MW	497 MW
Installed Capacity Required by end 2009 to meet 13.2% RES-E Target	965 MW	135 MW	92 MW	239 MW	1 MW	1,432 MW
Capacity Gap Required to Meet 2010 Target	757 MW	110 MW	66 MW	<1 MW	1 MW	935 MW

Support Mechanism(s) to Deliver the Targets post-AER VI

The preceding table quantifies the gap between projects constructed and the target required to reach 1432 MW by 2010. However it can be noted this gap includes projects which may yet construct under the AER V or VI support programmes. The body of this report comments on a variety of support measures to deliver the ultimate gap between projects constructed under existing support programmes and the 1432 target and concludes by estimating the cost of a feed-in type support mechanism to deliver the additional capacity required.

It is noted by STAG that prior to publication of this final report the Minister has already notified to the market the proposed detailed terms and conditions of a new support programme which addresses some issues raised in this report viz.:-

- projects must have secured both planning permission and a connection offer
- a PPA can be executed with any supplier
- the support is a feed-in type support and
- the capacity supported will be at least 400 MW.

The Future

The primary focus of STAG was on the short term 2010 target. However short term and long term issues are so interlinked that it would be remiss not to summarise issues identified which can contribute constructively to progress on the longer terms issues.

The STAG concluded that future progress will be achieved in incremental phases dictated by technical developments and knowledge gains particularly in the case of intermittent wind power resources and also progress on wind forecasting. Other issues will include historical rises in BNE in conventional technologies flowing from likely upward pressure on gas/oil/coal prices and downward pressure on renewable energy technologies from technical development which will deliver a changing fertile backdrop for the implementation of RE policy in Ireland. STAG recommends that these issues should therefore continue to be monitored on an ongoing basis. These monitoring tasks work could be commenced or developed within the all-island studies in order to add additional benefit arising from economies of scale.

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1. Introduction

In late 2003 the Department of Communications Marine and Natural Resources (DCMNR) published "***Options for future renewable energy policy, targets and programmes***" to commence a public consultation on future targets and support mechanisms for renewable energy technologies in the electricity market.

In May 2004 DCMNR established the Renewable Energy Group (REDG) to advise on the same matters and the responses received. The REDG concluded, at an early stage, in its deliberations that in order to maximise the contribution from renewable energy technologies in the longer term and comply with an extant requirement to deliver a short term EU target it would be necessary to identify -

a) short term solutions to deliver on the EU target as a minimum, and

b) strategies to maximise the contribution from renewable energy technologies in a logical and coherent manner into the longer term.

The REDG established a short-term analysis group (STAG) for the purposes of investigating the challenges and opportunities facing renewable energy (RE) in Ireland up to 2010, and reporting back to the REDG. The responses to the consultation document were carefully considered throughout STAG's deliberations.

STAG was charged with identifying a way to meet Ireland's RE target of 13.2% of gross electricity consumption by 2010 as set out in *Directive 2001/77/EC on the promotion of renewable energy sourced electricity in the internal electricity market*. (It should be noted that in order to meet this 2010 energy-based target, RE plant must be operating by the end of 2009.)

STAG was chaired by Morgan Bazilian of SEI and Mark O'Malley of UCD. Membership consisted of representatives from CER, ESBNG[6], ESBCS, ESRI, SEI, academia as well as the RE industry, including the IWEA and a network of other RE industry associations. Liam Ó Cléirigh acted as secretary to the group throughout its deliberations. The full list of STAG participants is set out in Annex A2.

STAG's focus concentrated on the following important topics:

1. The RE capacity required to meet the 2010 target;

2. The current status of RE project deployment;

3. The challenges facing the implementation and options for overcoming them;

4. The financial support mechanism to be employed to meet the targets post AER VI;

5. Consideration of possible next steps.

Other invitees, including Airtricity and Goodbody Stockbrokers, also delivered short presentations to the STAG to enhance the group's level of understanding of certain specific topics and to ensure a high degree of inclusiveness among various stakeholders. The timeframe allocated to STAG was concentrated. There was good engagement of the topics and co-operation between the organisations represented. Two general meetings and four topical meeting were convened. Many of the discussions and outputs focused on wind energy due to its predominance (or likely predominance) in the Irish RE sector in the years to 2010. This report is the outcome of the deliberations of STAG. Options for a way forward to meet the 2010 target are outlined for

[6] ESB Networks were also consulted during STAG process.

consideration by the REDG. It is envisaged that a different, more rigorous process will be undertaken to inform longer term policy, i.e. to 2020.

2. 2010 Target

There is an implicit assumption in most European countries that there is a need to support increased penetration of renewable energy (RE) technologies in electricity generation. RE policy in this field is most desirably formed within the wider context of energy policy. The main benefits from supporting RE in electricity production to one level or another have been:

- Climate change mitigation;
- Air (and water) pollutant mitigation (SO_2, NOx, Hg, particulates, etc.);
- Fuel diversity (a subset of security of supply);
- Hedging against fossil fuel price volatility;
- Indigenous industry (and associated job creation);
- Consumer demand;
- Rural development;
- Dispersed (distributed) energy generation.

2.1 RES-E Directive

EU Directive 2001/77/EC[7] (the RES-E Directive) 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 target for Ireland is 13.2% of gross national electricity consumption, which is defined as, "national electricity production, including auto-production, plus imports, minus exports".

This target is referred to as the 2010 RES-E target in this report. Large scale hydro capacity contributes to this target, but the electricity output from pumped storage plants, such as Turlough Hill, cannot.

2.2 2003 Consultation Document

The DCMNR's consultation document on RE Policy of December 2003 (ConDoc) identified three RES-E capacity options to achieve illustrative target penetrations of 13.2%, 15% and 20% for 2010 to prompt debate. The ConDoc used ESBNG's *Generation Adequacy Report 03-09* (ESBNG GAR) medium forecast for electricity demand to 2009 and an ESRI determined growth rate for 2009-10 to arrive at the 33,187 GWh total of gross consumption in 2010. The ConDoc considered the medium or 'benchmark' demand forecast only.

2.3 Updated 2010 Target

The energy and capacity levels required to meet the 13.2% 2010 RES-E Directive target presented in the ConDoc have been updated by STAG to account for:

- More recent electricity demand forecasts available from the ESBNG GAR 04-10. These forecasts show large variance between low, medium and high forecasts for 2010;

- Changes to the assumptions underlying the generation plant load factors included in the analysis.

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[7] 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

2.3.1 Electricity Demand Forecast

The electricity demand forecasts were updated from the ESBNG's *Generation Adequacy Report 04-10*[8]. 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 Ireland including an allowance for transmission and distribution losses.

In order to arrive at the EU Directive definition of gross national electricity consumption, upon which the 13.2% RES-E target is based, the TER values were modified to account for generation plant 'house load'[9]. Gross national electricity consumption forecasts based on the ESBNG's high, medium and low demand forecasts are 34,123 GWh, 33,158 GWh and 30,898 GWh respectively.

2.3.2 RE Capacity Requirements to Meet 13.2% 2010 RES-E Target

The RE capacity levels calculated to meet the 2010 RES-E target and presented here are based on the ESBNG high demand forecast. The shared majority view within STAG was that the high demand scenario should be selected as the basis for determining the 2010 RE target. An alternative view was that instead the target should be based on the ESBNG's median demand scenario. The high demand scenario was selected when determining the 2010 target set out in this report as a conservative assumption. It was considered an appropriate conservative assumption to ensure meeting the target with some certainty.

Using the updated demand forecast and revised load factors (see Annex A3) for different generation plant, STAG considered how the 2010 RES-E target could be met by different combinations of RE technologies[10]. In the context of the renewable resources available in Ireland and the current status of different technologies, their supply chains, and identified market interest it is to be expected that wind will remain dominant to 2010 followed by bioenergy and a lesser amount of small hydro-power.

STAG[11] concluded that one potential scenario of RE deployment to meet the high electricity demand scenario would be approximately 239 MW of hydro, 92 MW of bioenergy and 1 MW of ocean energy installed by the end of 2009. The balance of the RE would be made up by wind energy (approximately 1,100 MW),. These capacity figures correspond to a conservative view of the level of energy output required to meet the 13.2% target set out in the Directive based on various assumptions and inputs from the DCMNR's Bioenergy Strategy Group[12] (BSG).

The proposed RE capacity levels for each technology required to meet the 2010 RES-E target based on the high electricity demand scenarios are summarised in Table 2.

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[8] Published in November 2003. This seven-year forecast of generation adequacy is produced annually by the ESBNG in conjunction with the ESRI. ESBNG has indicated that the next GAR medium demand forecast, GAR 05-11 due in November 2004, is not anticipated to differ significantly from the current one.

[9] ESBNG estimates a weighted average of 3.5% for house loads.

[10] The curtailment of intermittent RE generation was not accounted for in determining the capacity requirements to meet the target.

[11] Various RE industry parties have suggested alternative RE targets for 2010 and beyond.

[12] The BSG was established by the DCMNR in December 2003. Its primary objective is to consider the policy options and support mechanisms available to Government to stimulate increased use of biomass for energy conversion, and to make specific recommendations for action to increase the penetration of biomass energy in Ireland. The group is due to report by the end of 2004.

Table 2: RE Capacity Required to Meet 2010 RES-E Target (High Demand Forecast)

	Onshore Wind	Offshore Wind[13]	Bioenergy	Hydro	Ocean	Total
Energy	2,959 GWh	461 GWh	546 GWh	820 GWh	3 GWh	4,789 GWh
Load factors (see Annex A3)	35.0%%	39.0%	57.0% - 77.5%	38.8% - 43.7%	36.9%	-
Installed Capacity Required by end 2009 to meet 13.2% RES-E Target	965 MW	135 MW	92 MW	239 MW	1 MW	1,432 MW

As STAG was specifically tasked with addressing the 2010 target, much of the discussion recorded in this report refers specifically to wind energy because it will be the major contributor to meeting this target and because there are specific barriers currently constraining the deployment of wind energy in Ireland. However, some of these challenges are relevant to other RE technologies and the options discussed in this report could also facilitate their deployment.

3. Current Status of RE Deployment in Ireland

3.1 Gap to Meeting the 2010 Target

Table 3 following sets out the capacity gaps between the capacities of each technology currently generating in Ireland and the capacities required to meet the 2010 RES-E target under the high demand scenario.

Table 3: RE Capacity Gaps to Meeting 2010 RES-E Target

	Onshore Wind	Offshore Wind	Bioenergy	Hydro	Ocean	Total
Currently Generating (Nov 2004)	208 MW	25 MW	26 MW	238 MW	0 MW	497 MW
Installed Capacity Required by end 2009 to meet 13.2% RES-E Target	965 MW	135 MW	92 MW	239 MW	1 MW	1,432 MW
Capacity Gap (minimum)	757 MW	110 MW	66 MW	<1 MW	1 MW	935 MW

3.2 RE Project Matrix

3.2.1 Requirement for Data

STAG identified a requirement to develop and maintain an up-to-date matrix of relevant project details for all RE projects in Ireland – both current and proposed. It was intended that this list would be a useful tool for informing the deliberations of STAG and of future policy making group(s) by:

- Monitoring the progress in meeting RE targets;

[13] There is greater uncertainty associated with the deployment of this offshore wind capacity than with the onshore wind capacity due to the specific challenges facing offshore wind energy projects.

- Identifying the circumstances currently hindering the deployment of RE;
- Identifying obstacles that could potentially hinder RE deployment;
- Quantifying the potential impacts of these obstacles in terms of capacity and numbers of projects;
- Quantifying the likely level of RE deployment achievable under current support mechanisms;
- Quantifying the level of RE deployment that could be required under a new bridging support mechanism in order to meet the 2010 target.

3.2.2 Progress

An exercise was undertaken to create and populate this matrix by identifying the current and proposed RE projects in Ireland and collating relevant data for each with respect to (i) current operational status; (ii) grid connection status; (iii) PPA status (AER or Merchant); and, (iv) planning status. There was good cooperation from CER, ESBNG, DCMNR as well as industry parties in providing relevant inputs and clarifying important issues. Good progress was made on populating the matrix, particularly in identifying overlap between projects that have both grid connections and PPAs. However, the matrix could not be completed and additional data is required for many projects to fully evaluate the data.

Some of the aggregate outputs from the matrix are presented in Table 4 overleaf. These outputs represent the current RE project information contained in the matrix, which, in most cases has not been validated by direct discussions with project developers. However, in aggregate format, these outputs provide a useful insight into both the current status and likely future deployment of RE in the short term.

3.2.3 Options

This matrix updated regularly could collate useful data for ongoing planning and performance monitoring within the sector.

On 16th November 2004, DCMNR issued a letter[14] to IWEA and Meitheal na Gaoithe asking these organisations to request their members to submit information to the Department on their proposed RE projects. This information should be incorporated into the RE Project Matrix to provide a better snapshot of proposed RE project deployment and will be critical for informing any policy decisions required to facilitate this deployment.

It is therefore essential that RE project developers fully engage in this process and provide the relevant information as requested in a timely manner.

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[14] Open letter to all holders of planning permission for the construction of electricity generation stations harnessing wind power, 16th November 2004.

Table 4: RE Project Matrix

Current Status		Onshore Wind [MW]	Offshore Wind [MW]	Bioenergy [MW]	Hydro [MW]	Ocean [MW]	Total [MW]
Currently Generating	As of November 2004	208	25	26	238	0	497
2010 RES-E Target	Total Capacity Required	965	135	92	239	1	1,432
	Current Capacity Gap (Nov 2004	757	110	66	< 1	1	935
Under Construction (Nov 2004)	AER PPA, Signed Connection Agreement	145	0	0		0	145
	Merchant Plant / AER VI Reserve List, Signed Connection Agreement	107	0	0		0	107
Not Yet Under Construction	AER PPA, Signed Connection Agreement	60	0			0	60
	AER PPA, Live Grid Offer	42	0			0	42
	AER PPA, Connection Application in Queue	≤ 176	≤ 50	≤ 27		0	≤ 253
	No AER PPA, Signed Connection Agreement	240	50			0	290
	No AER PPA, Connection Application in Queue	≤ 1,688[15]				0	≤ 1,688

Additional outputs from the RE Projects Matrix are presented in Sections 3.3.1, 4.2.1 & 4.2.2.

[15] As of 20th October 2004 there were 126 applications representing 1,914 MW of wind capacity in the connection process. This is the latest information provided by ESBNG to STAG. All relevant figures presented in this report are calculated based on this total value. It is acknowledged however that this figure may have changed since this date as applications for connection offers are received by TSO & DSO on an ongoing basis.

3.3 AER V & VI

3.3.1 Current Status of Projects

Table 5 summarises the known status of AER V / VI projects. Table 6 shows a detailed breakdown of the status of AER V / VI wind energy capacity.

Table 5: Status of AER V & AER VI Projects (All Technologies)

Status	AER V [MW][16]	AER VI [MW][24]	Totals [MW][24]
Generating	37	17	53
Signed agreement	27	179	206
Live grid connection offers	14	28	42
Grid connection application complete (in the queue)	≤ 21	≤ 233	≤ 253
Totals	98	456	554

Table 6: Status of AER V & AER VI Wind Energy Projects

Status	AER V [MW][24]	AER VI [MW][24]	Totals [MW][24]
Generating	37	9	46
Under construction	19	125	145
Signed agreement but not under construction	8	52	60
Live grid connection offers	14	28	42
Grid connection application complete (in the queue)	≤ 20	≤ 206	≤ 226
Totals	97	421	518

The implications for AER projects in the grid connection queue are discussed in Section 4.2.2.

3.3.2 Timing

Under the terms of both the AER V and AER VI competitions, all projects, other than offshore wind and biomass-CHP projects, should be commissioned by 31st December 2004. In considering the implications of the moratorium (see Section 4.1) on the provision of grid connections and ultimately on the delivery of projects by end 2004, the Department issued a notification dated 30th June 2004 providing for extensions to this time deadlines in both the AER V and AER VI competitions to 31st December 2005 provided that that projects were compliant with the terms and conditions of the relevant competition and other aspects of project implementation were progressed.

It should be noted that the 15-year PPAs offered under AER V & VI will not extend beyond the end of 2018 and 2019 respectively[17]. Therefore, AER V projects that come online after the beginning of 2005 will not be able to avail of the full term of the 15-year AER PPA.

[16] In some cases these project capacities are less than those applied for under AER due to grid connection constraints.

3.3.3 Additional 140 MW of AER VI Capacity

The Green Paper on Sustainable Energy (1999) established a target to add 500 MW of new renewable energy based electricity generating plant to the electricity network by 2005. In the previous AER competitions additional capacity was offered to the market to make provision for some project failures. Similarly in AER VI the market was notified of proposals to allocate support for a further 140 MW of AER projects generally. This is additional to the 50 MW and 28 MW for offshore wind energy and biomass CHP projects respectively.

The 500 MW target had prior EU state aids clearance. The necessary state aids clearance for the additional capacities was received in September 2004 and the allocations, by category and applicants were competed thereafter.

3.3.4 Implications of AER Deployment for ESBCS

As more AER V and VI capacity is commissioned, there will be significant additional non-dispatchable renewable generation contracted to ESBCS on long term contracts. At the same time it is expected that ESBCS's share of the market will reduce as competition among suppliers develops. The intermittent nature and increased scale of this contracted generation will result in potential over-contracting and under-contracting issues for ESBCS to address and manage. These will have cost implications associated with them (over and above the existing PSO costs associated with the difference between AER bid prices and wholesale market value). ESBCS estimates that if 600 MW of wind are contracted to it by 2010 these additional costs would be of the order of €15 million per year under a bilateral market and of the order of €25 million per year under a pool trading regime.

ESBCS are conducting analysis to aid in the quantification of these additional costs under both the current bilateral trading arrangements and a pool type trading arrangement[18].

Other licensed electricity suppliers may have an appetite for contracting RE generation capacity through the AER system, through any future support mechanism or on a purely merchant basis.

3.3.5 Transition to an Alternative Support Mechanism

If a new support mechanism is needed and is put in place in Ireland, it may be necessary to develop and implement a transitional arrangement to accommodate AER contracted capacity. Some of the potential considerations for such an arrangement are set out in Section 5.4.

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[17] Except for offshore wind PPAs which are of 15-year duration and will not extend beyond 2021 and biomass CHP PPAs which are of 10-year duration and will not extend beyond 2016.

[18] ESBCS & SEI are considering the merits of jointly funding external consultants to model the effects of wind output on pool prices. It is hoped that this will build on the *Study on Renewable Energy in the New Irish Electricity Market* that was commissioned by SEI and undertaken by Henwood Associates / Brattle Group.

4. Challenges Facing RE Deployment

4.1 Overview

A variety of challenges that are either currently impinging on RE deployment in Ireland or have the potential to do so before 2010 were identified and discussed by STAG. Several of these challenges incorporate complex interactions between technical, regulatory and financial elements that combine to threaten the viability of RE projects. It is crucial to consider the role that a coherent policy can play in aligning and solving what may be considered technical challenges. This policy should be linked to technical solutions based on scientifically credible analysis in order to maximise the benefits of renewable generation to Ireland.

It was primarily technical issues, including a variety of stability and reliability concerns outlined by the system grid operator (ESBNG) that led to the announcement of the moratorium on new grid connection offers in late 2003. The moratorium was succeeded by a requirement within the Distribution Code, for wind energy being approved and the dynamic modelling requirements being met by applicants. The Distribution Code was approved on 6th October 2004 and new connection offers are expected to recommence shortly.

These technical issues are in need of further attention as wind penetration levels rise. In the short term, a need for continuous updating and refinements of the solutions remains. The introduction of significant amounts of generation of a distributed nature, with an intermittent primary energy source that employs non-standard generation technology on a relatively small, synchronized electricity system is bound to raise legitimate technical challenges. These issues need in the first instance to be understood before solutions are proposed, developed and deployed.

All of the technical challenges identified to date are manageable; however in the interest of meeting RE targets they need to be resolved in a timely manner. Notwithstanding this, short cuts need to be avoided as they will ultimately increase the cost of operating the system and will limit the long term penetration of RE generation. For example, allowing the connection of large amounts of renewable generation that does not meet the fault ride through requirement of the grid code would undermine the security of the electricity system and would result in a system that would be costly to operate and ultimately impose limits on the amount of wind that could be connected.

Perspectives on a number of these challenges are discussed in Sections 4.2 to 4.6.

4.2 Grid Connection Process

4.2.1 Grid Connection Status of Projects

A number of requirements must be met before a wind energy project can be built and commissioned. In this respect, three significant milestones are planning permission, grid connection agreement and a power purchase agreement (PPA). The latter may be secured either through the AER process or from a licensed electricity supplier other than ESB. In 2000, a mismatch existed between projects that had secured planning permission and those that had secured an AER PPA. This was addressed by imposing planning permission as a pre-requisite for entry in subsequent AER competitions.

Securing grid connections is a particular challenge currently facing wind energy projects in Ireland. The connection application process remained open during the moratorium on grid connection agreements. This led to a considerable backlog of grid connection applications 'in the queue'. Table 7 overleaf summarises the known grid connection status of proposed wind capacity in Ireland.

Following a workshop held on 1st November 2004, the CER together with the DSO and TSO, have been working towards progressing a workable solution to enable more intermittent plant to receive connection offers. A proposed direction to system operators on this solution was published on 15th November 2004[19]. Under this direction, the CER expects "*that the outcome should be that offers totalling 330 MW will have issued by early April 2005 with the risk of interaction completely removed and all recipients bound to accept or forego offers within 30 business days of issue*." The publication of this proposed direction was after the deadline for receipt of submissions for inclusion in this report and was not considered by STAG. It is acknowledged, however, that the subject matter is of great relevance to the grid connection issues discussed in this report.

Table 7: Grid Connection Status of Wind Energy Projects (Including Offshore)

Grid Connection Status	AER I & III / Valoren / Thermie [MW]	AER V [MW]	AER VI [MW]	AER VI Reserve [MW]	Merch-ant [MW]	Unknown PPA Status [MW]	Total [MW]
Connected	104	37	9	0	83	0	233
Signed Agreement	0	27	178	381		15	601
Live Offer	0	14	28	0	0	0	42
Application Complete[20]	0	≤ 20	≤ 206	>> 15		≤ 1,673	1,914
Totals	104	97	421	>> 396	>83	≤ 1,648	2,789

As of 20th October 2004[21], there were 126 complete applications representing 1,914 MW of wind energy capacity in the connection queue. It is anticipated that ESB Networks will offer two more connections by mid-December 2004 and ESBNG will offer one more connection within the next few months[22].

Table 7 highlights that a mismatch exists between the grid connection offers and PPA status of projects:

- In addition to the 233 MW currently installed, there are 472 MW with an AER PPA (61 MW AER V and 411 MW AER VI). However, only 205 MW of these currently have grid connection agreements. The balance, 267 MW, do not.

- There are a further 396 MW that have grid connection agreements in place but do not have an AER PPA. Of these, 381 MW are on the AER VI reserve list. In order to obtain appropriate finance, these projects typically must await an AER VI PPA offer via the reserve list, secure a third party PPA or await a new Government support mechanism.

- STAG is aware of 252 MW currently under construction, of which 147 MW have AER PPAs. The remaining 107 MW are on the AER VI reserve list, but are envisaged to be built as merchant plant.

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[19] CER/04/354, *Resuming Connection Offers to Wind Generators*

[20] The capacity shown as 'Application Complete' is currently in the connection queue awaiting processing.

[21] This is the latest information provided by ESBNG to STAG. All relevant figures presented in this report are calculated based on this total value. It is acknowledged however that this figure may have changed since this date as applications for connection offers are received by TSO & DSO on an ongoing basis.

[22] CER Grid Connections Workshop, 1st November 2004

- There are 60 MW that have AER PPA offers and grid connection agreements but are not yet under construction.

4.2.2 Proposed Group Processing Approach

Overview

A long-term approach is currently being decided on by CER as to how the applications in the queue may be efficiently and effectively processed in a manner that develops the network infrastructure in a more optimal manner. The outcome should be clear indications of timeframes for connection of proposed RE capacity to the network, which should inform the timing of market support delivery.

Following a workshop held by ESBNG on 20th August 2004, ESBNG and ESB Networks published a joint proposal[23] to CER for a new processing approach for RE projects on 30th September 2004. Stakeholders in the sector have prepared submissions on this proposal to CER. CER also hosted a useful workshop on this topic on 1st November 2004.

Outline of Proposed Approach Methodology

The basis of the proposed approach is that grid connection applications would be processed by grouping projects together into groups and sub-groups. Each group would consist of one or more sub-groups and each sub-group would consist of one or more projects. Each sub-group may share connection assets. Groups would be based on projects with 'major interactions' and which would have a common requirement for deep reinforcement.

The criteria by which projects would be selected for inclusion in sub-groups / groups and the criteria by which groups would be prioritised for processing have not been finalised.

Timelines

Given that these important parameters have not yet been finalised, it is likely that it will be several months before the proposed approach could begin to process groups. Table 8 sets out indicative best case timelines for the proposed approach from the commencement of group processing, i.e. from when the grouping parameters are finally agreed.

Table 8: Indicative Best Case Timelines for Group Processing Approach

Step	Indicative Duration
Processing of application for group	3 – 12 months[24]
Planning process for connection assets[25]	12 – 18 months (minimum)
Construction of connection infrastructure	6 – 12 months

Based on these indicative timelines, it is likely that it would take at least 36 months from the commencement of the proposed group processing approach until RE projects could be commissioned. This represents the best case for projects that require planning permission for the connection assets; for some projects this could run to 5 years.

[23] *Group Processing Approach for Renewable Generator Connection Applications*, CER/04/317.

[24] ESBNG estimate

[25] Not all connections require planning permission.

If the group processing approach is implemented by early 2005, this would mean that very little RE capacity currently in the 'grid connection queue' would be exporting power by the beginning of 2008. This would likely result in a significant interruption in the deployment of RE capacity in Ireland between now and 2010 with little RE capacity being brought online until 2008 – 2009 apart from up to 643 MW[26] that currently has signed agreements or live offers.

While capacity commissioned in 2008 – 2009 would help to meet the 2010 target, the indicative timeframes for group processing could have serious repercussions for projects with AER offers as follows:

- The timing deadlines for the AER V / VI competitions are outlined in Section 3.3.2. Even if extensions could be granted to specific projects so that they could commence exporting power under AER V / VI in 2008, the effective durations of the PPAs would be constrained by the 2018 / 2019 PPA termination deadlines set out in the AER V / VI terms & conditions. Projects originally competitively bid into the AER competitions based on the expectation of 15-year PPAs would then be limited to 12 / 13-year PPAs (maximum). In these circumstances, the financial viability of these projects could be threatened.

- Planning permissions typically are valid for 5 year periods only. Most RE project developers obtain planning permission before obtaining a PPA (such as under AER) and then making an application for connection. Therefore, for the connection timeframes discussed above:

    - Original planning permissions granted to projects offered AER V PPAs could have lapsed by the time grid connections are complete.

    - Original planning permissions granted to projects entered into AER V and subsequently offered AER VI PPAs could have lapsed by the time grid connections are complete.

    - Original planning permissions granted to projects entered into AER VI only would most likely have lapsed by the time grid connections are complete in some cases at least.

Therefore, it is likely that all of the planning permissions granted for the outstanding AER V / VI onshore wind capacity currently in the grid connection queue (176 MW) could have lapsed before grid connections could be commissioned.

A summary assessment of the wind energy capacity in the grid connection process is presented in Table 9 below.

Table 9: Summary of Wind Energy Capacity (Including Offshore)

Grid Connection Status	**Total [MW]**	**Summary Assessment**
Connected	233	Generating now

[26] Only 246 MW of this capacity has AER PPA offers – see Section 4.2.1

Signed Agreement (as of 20th October 2004)	601	252 MW currently under construction including 145 MW via AER & 107 MW merchant – online by end 2005 60 MW have AER PPA offers but not currently under construction – could proceed to construction in 2005 290 MW on AER VI Reserve (50 MW offshore) – awaiting *inter alia* AER VI offer or third party PPA before proceeding to construction
Live Offer (as of 20th October 2004)	42	42 MW have AER V / VI PPA offers – could proceed to construction in 2005
Application Complete (as of 20th October 2004)	1,914	Unlikely to generate until 2008 at the earliest 176 MW (onshore) have AER V / VI offers – planning permissions likely to lapse before grid connections are commissioned

Lack of Uptake of Grid Connection Offers

In addition to the 176 MW of onshore wind energy capacity in the grid connection queue with AER PPA offers, there are other projects that should be able to arrange PPAs with other third parties and proceed on a merchant basis.

However, it is likely that some of the capacity in the queue will not proceed to construction in the absence of some form of Government-backed support mechanism. If there are sufficient of these latter projects in a particular group or sub-group, the level of uptake of offers within these groups / sub-groups could be low enough to force a redesign of the proposed connection method, which could lead to further delays for the projects with PPAs.

Contestability of Shared Connection Assets

It is proposed in the joint ESBNG / ESB Networks connection offer processing paper that both the detailed design and the construction of the shared connection assets[27] for sub-group connections would be contestable. The functional design of the assets would not be contestable. Under current arrangements, ESBNG undertake this design on a least cost technically acceptable basis.

Notwithstanding this, several parties in the RE sector believe that the non-contestability of the functional design can lead to designs for connection assets that do not represent least cost technically acceptable solutions, thereby significantly escalating the cost of connections.

4.2.3 Options

Integration of Grid Connection with Market Support

There is a clear need to integrate the processes providing projects with market support and with an offer of grid connection. This situation is not dissimilar to that in 2000, where the mismatch then was between projects with market support and those with planning permission. The recommendation made then by RESG for planning can be applied here for grid connection; market support would not

[27] The detailed design and construction of transmission-level connection assets are currently contestable. This is not currently the case for distribution level connection assets (38 kV and below). However, CER is in favour of contestability for distribution connections for non-shared assets.

be forthcoming for a project (whatever shape that support may take) without having first secured both planning permission and a grid connection agreement[28].

One option to achieve this would be to explore the possibilities of withdrawing AER PPA offers from projects that do not have grid connection agreements (up to 226 MW of wind energy capacity) and offer these PPAs to AER VI reserve list projects that do have grid connection agreements.

Two-Tier Processing of Grid Applications

A two-tier processing approach has been discussed[29] whereby some projects already in the grid connection application process would be prioritised for processing.

It is recognised that this will stretch resources within the TSO and DSO compared with a single approach but it should provide added probability of meeting the 13.2% target. In a two-tier approach, projects that meet a number of clear criteria could be filtered out of the 1,914 MW for processing while the longer term approach is being decided upon. These criteria could include planning permission, land lease, CER license to generate, CER authorisation to construct and a PPA with a licensed electricity supplier.

Using the latter as selection criteria for two-tier processing would help to achieve the required integration of providing projects with market support and grid connection. Of the 1,914 MW, there is up to 226 MW of wind energy capacity (up to 176 MW onshore) with AER V / VI offers although it is uncertain how many have PPAs with licensed suppliers outside of the AER process.

In selecting projects based on any of these alternate criteria, due regard must also be given to the optimal development of the system.

Extensions to Planning Permissions

The possibility of revisiting the Department of Environment, Heritage & Local Government's *Planning Guidelines for Windfarm Developments* on the extension of time issue should be further explored

The requirement for 'substantial works' to be carried out before the planning period can be extended under current rules should be reconsidered where the delay is attributable to the delay in obtaining a grid connection for the wind farm. For distribution connected projects, which are not contestable, all works must be carried out by ESB so this is totally outside the control of the developer. Substantial works normally require the bank's project finance to be completed and this cannot be done where there is any risk that the planning permission will not be extended so only large companies using balance sheet finance who are prepared to take the risk are in a position to meet the cost of carrying out substantial works before grid connections are complete.

Grid Upgrade Development Programme

The Grid Upgrade Development Programme (GUDP) was instituted on the foot of recommendations of the RESG Report Strategy for Intensifying Wind Energy Deployment of 2000.

The GUDP was based on studies that took place in early 2002 and a significant amount of generation (both wind and thermal) has accepted connection agreements since then. In effect, two large scale

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[28] If a grid connection agreement is to be a pre-condition for market support, then the design of the process for applying for and obtaining market support should take account of the burden that this requirement could impose on the TSO and DSO in terms of dealing with a large number of connection applications in a limited time.

[29] CER Grid Connections Workshop, 1st November 2004

onshore wind energy projects have replaced two of the proposed clusters and Corderry proceeded as a cluster.

The GUDP should be carefully reviewed after a decision is issued on the new connection application processing proposals. Consideration must given as to whether the GUDP can continue, or whether it will have any function to fulfil. The following could be considered in reviewing the GUDP:

- Strategic grid upgrades – these were anticipated in the RESG report, there are now strong indications from the planning, AER and connection application process as to the location of concentrations of renewable energy projects. Strategic upgrades might provide the network capacity for projects to be connected as they arise rather than being delayed awaiting the provision of network.

- Offsetting new Grid Code costs – neighbouring wind farms smaller than 5 MW may be defined as having a "contiguous" capacity exceeding 5 MW and have to comply with new Grid Code for wind requirements. The cost associated with this may form a disincentive to clustered connections. Also, compliance with the new grid code may entail significant extra costs for all wind farms. Means by which some of these costs could be offset using GUDP funding might be considered. (This proposal is not supported by ESBNG[30].)

- Priority deployment of GUDP - roll-out of the GUDP is currently constrained by the fact that it has no priority over the normal connection process, i.e. any offer taken up by an individual interacting applicant invalidates the load-flow analyses carried out for any interacting applicants, including GUDP clusters. Future implementation of the GUDP might seek to avoid this restriction through strategic upgrades. However, any such mechanism should be well aligned with whatever grid connection application process is implemented.

- Compatibility with group connection process – an altered GUDP process must be compatible with and indeed complementary to, the new group connection process, if that process is implemented.

- Funding time limit – any alternative mechanism must disburse funding within the National Development Plan time limits.

Facilitating Embedded Generation

Embedded generation is small-scale generation connected to distribution network (generally up to 38 kV in Ireland). According to the type of connection embedded generator size in Ireland is typically limited to around 25 MW. There are indications from the connection application process that 50% of wind generating capacity in Ireland will be embedded in the distribution system. Other RE technologies that will also require embedded connection capacity are small-scale hydro, bioenergy, ocean energy and solar.

It is to be expected that, in order to meet national RE targets, additional embedded generator connections will be required by 2010. In addition to recent developments in the field[31], there is a

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[30] ESBNG believe that it is up to the industry to find cost-effective ways of complying with the Codes. All generation and all directly connected customers incur costs in complying with the Grid and Distribution Codes. This is part of the cost of doing business.

[31] Including CER's *2004 Distribution System Tariff Review,* SEI's *Costs and Benefits of Embedded Generation*, SEI's tender for study *Metering Solutions for Small-Scale Generation in Ireland* and UCD's Electricity Research Centre research on optimal network utilisation by embedded generation.

requirement for additional work to help facilitate the deployment of embedded generation including the introduction of new procedures, codes, tariffs and regulatory arrangements for new classes of generator.

4.3 Compliance with Grid Code

4.3.1 Overview

The Grid Code[32] as originally developed was intended to address all types of generation. Wind generators connecting to the transmission system found it necessary to seek a large number of derogations from the Grid Code. Furthermore, there were no appropriate provisions governing the connection of large amounts of wind generation to the distribution system. It was therefore decided to develop appropriate Grid Code and Distribution Code provisions for wind generation.

4.3.2 Grid Code Consultation Group

To facilitate the development of Grid Code provisions for wind generation that would meet the requirements of the power system whilst taking account of the technological capabilities of wind turbine generators and the reasonable concerns of developers, a consultation group was established. The consultation group included representatives from wind developers, wind turbine generator mmanufacturers, conventional generators, SEI, System Operator Northern Ireland, DSO and CER. The topics addressed in the Grid Code and Distribution Code and considered by the consultation group were:

- Fault ride through capability;
    - Frequency;
    - Voltage;
    - Signals, communications and control;
    - Minimum size.

4.3.3 Code Approval and Implementation

The Grid Code and Distribution Code provisions for wind generation were approved by CER in July 2004 and October 2004 respectively. These codes place modest technological requirements, with relatively low cost implications, on wind farms provided they are planned for at an early stage of the project. This is a high priority technical issue as aall wind farms connecting to the transmission system must comply with new Grid Code for wind and all wind farms over 5 MW connecting to the distribution system must comply with the Distribution Code provisions. All connecting parties have the option of applying to CER for derogations from the relevant code. However CER is unlikely to grant derogations unless there are exceptional circumstances.

Full compliance with the codes will increase the ability of the system to integrate high levels of wind penetration. However, a high level of grid code compliance monitoring will be necessary initially and the codes will need to be continually analysed and studied so that they can be updated and refined for the overall benefit of the system.

[32] The Grid Code is a technical document setting out the rules, responsibilities and procedures governing the operation, maintenance, & development of the transmission system. Its purpose is to ensure the reliability and security of the system for the benefit of all system users. It does not address commercial issues such as payments and charges or aspects related to market operation.

Wind farms already connected to the system will be required to comply with the new codes or obtain derogations from those clauses where there is non-compliance. It is reasonable to expect that these installations will need to apply for the latter. CER intend to grant derogations only under exceptional circumstances. Previously granted derogations will still stand.

STAG anticipate the requirement for existing wind farms to comply with the new code should not significantly impact on their ability to continue generating.

4.4 Dynamic Modelling

4.4.1 Assessing System Stability – the Need for Models

In order to ensure reliability of electricity supply, the essential requirement, ESBNG as TSO needs to predict the performance of the system under a wide range of conditions, to identify any problems and scope measures needed for reliability. Among the key assessments required is the assessment of system stability.

In assessing system dynamic performance, ESBNG checks for two phenomena – transient stability and voltage stability. Transient stability relates to the risk of one or more synchronous generators losing synchronism with the rest of the system during a disturbance. Although wind generators are not themselves synchronised to the system, the changing pattern of power flows in the system will affect the stability of synchronous generators. Furthermore, the acceleration of wind generators during disturbances will affect the performance of the synchronous generators.

Voltage stability relates to the ability of system voltage to recover following a disturbance, and is affected by the reactive power balance at every point in the system during and after a disturbance. The reactive power demand of wind generators during and after a disturbance is therefore critical. The main objectives of ESBNG's dynamic studies are to identify any potential transient or voltage stability problems as wind penetration increases and to scope and assess solution options.

To carry out these studies, models to represent the behaviour of wind turbine generators must be included in ESBNG's power system model. ESBNG uses the PSS/E (Power System Simulator for Engineering) package[33]. It is important to note that there are no standard models for wind turbine generators available for PSS/E. Ireland is the first place where the supply of 'appropriate' dynamic models, capable of modelling the performance of wind generators performance during a system fault has been deemed a pre-condition for receipt of a grid connection offer. ESBNG therefore requires wind energy developers, and through them the wind turbine manufacturers, to provide the necessary models. This requirement is consistent with the general requirement for connecting parties to provide full details of the plant that they propose to connect.

4.4.2 Progress

The provision of appropriate dynamic wind turbine models was a difficult challenge to overcome and was made more difficult by the presence of intellectual property issues and competitive pressures on each of the manufacturers to maintain an advantage over competitors. In addition there were some unavoidable delays associated with the proprietary software vendor.

However, wind turbine manufacturers have been working closely with ESBNG to resolve this issue and significant progress has been made during 2004. Models and data for use with the PSS/E program have now been received for all wind turbine generators cited in connection applications.

[33] Developed by Shaw Power Technologies Inc. of Schenectady, New York, USA

There are issues outstanding with a number of these models and ESBNG is pursuing these with the relevant manufacturers.

In the expectation that the outstanding issues will be resolved, ESBNG is now building the cases to study the impact of dynamic performance of wind generation, and will be carrying out the studies in the coming months.

It is anticipated that within 12 months time there will be appropriate[34] models in place for the majority of wind turbine types in the Irish market. Appropriate models for some turbine types should be in place well before this.

Table 10 summarises the modelling requirements for wind energy projects of different status.

Table 10: Summary of Modelling Requirements for Wind Energy Projects

Status	**Modelling Requirements**
Connection offer and fully commissioned by 9th July 2004	Actual generator data (all plant sizes) upon reasonable request from TSO / DSO
'Live' / signed connection offer and not commissioned 9th July 2004	No less than 120 days prior to advised date of commencement of commissioning (only generic data for plant < 5 MW)
Awaiting connection offer	Within 20 business days of letter from ESBNG to applicants to retain place in queue. (Only generic data for wind plant < 5 MW) Most, but not all applicants complied by the September deadline.
Future applicants	Yes (only generic data for plants < 5MW)

In order for the results of the studies and any conclusions drawn from them to be valid, the models underlying the studies must be validated; i.e. it must be demonstrated that the performance predicted by the models corresponds to the performance of the real machine under equivalent conditions. ESBNG is currently in dialogue with manufacturers with a view to establishing plans to validate the models used – currently mmodel validation is largely unresolved. New technologies are continually being developed and proper validation requires high quality data gathering in the field[35], i.e. a wind turbine generator connected to the grid and experiencing system faults.

4.4.3 Options

It is essential that delays in offering grid connection offers to wind energy projects specifically attributable to the requirement for 'appropriate' dynamic models for wind turbine generators are minimised as soon as possible.

[34] ESBNG differentiate between models deemed 'satisfactory' to remain within the connection offer process and those deemed 'appropriate' (i.e. models that have been validated and are suitable for full system modelling studies). A number of turbines fulfil the 'satisfactory' criteria but none to date have been successfully deemed to be 'appropriate'.

[35] It may be possible to undertake some of the validation process by laboratory testing.

The validation process could by its nature[36] take a significant period of time but it would be unreasonable to delay connection offers until validation is fully completed. In addition there is a large range of different technologies being deployed by a significant number of manufacturers and this adds to the dimension of the problem. A systematic process of model validation, requiring a substantial high resolution data gathering exercise and prompt testing and possible updating of models may allow connection of wind farms prior to full validation. This 'learning by doing' approach will require strict oversight and strict application of the rules to minimise any of the inherent risks involved.

4.5 System Operations

4.5.1 Overview

As the level of penetration of intermittent generation sources increases the operation of the system will need to adapt to account for the changing nature of the system. The detailed technical issues surrounding system operations formed part of the concerns behind the actions of the system operator. As the debate has evolved over the past year and as progress is made in fault ride through and wind turbine modelling it has become apparent that system operational issues such as constraining-off are now becoming the next potential stumbling block to the deployment of renewable generation.

Wind farms currently have priority dispatch[37] and the grid generally accepts whatever they produce. CER in conjunction with its Northern Ireland counterpart Ofreg commissioned a study titled *The Impacts of Increased Levels of Wind Penetration on the Electricity Systems of the Republic of Ireland and Northern Ireland*. This report identified the electricity network limits on wind penetration in Ireland both with and without measures being taken to facilitate it and identified constraining-off (or 'curtailment') of wind farms as a measure that would be necessary with high wind penetration.

Constraining-off represents a significant challenge to wind energy deployment in Ireland because:

- The associated reductions in energy exported from wind farms have potentially serious impacts on project revenues. For instance, it may be reasonably assumed that project developers bid into the AER competitions on the basis of zero / very low constraint.

- It increases the risk associated with developing wind farms because of the uncertainty with regard to the level of constraint that can be expected at different levels of wind energy deployment.

- There is currently uncertainty with regard to regulatory rules dealing with constraining-off which impacts directly on investor confidence.

The uncertainties with regard to the extent of constraint and the associated commercial implications are perceived as significant barriers to securing finance for wind energy projects by both developers and financiers.

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[36] Faults are random events and it may take several years before the 'correct' set of faults occurs.

[37] Since wind farms have virtually zero marginal cost, they will normally have priority in dispatch. Furthermore, it is a duty of the CER under the *Electricity Regulation Act*, 1999 to require the System Operator to give priority to renewable sustainable or alternative energy sources. Therefore the TSO generally accepts whatever they can produce.

4.5.2 Quantification of Degree of Constraint

As stated above, there is currently great uncertainty as to the level of curtailment that could be experienced by wind energy generators as the installed capacity of wind energy increases on the system. A clear signal is required 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).

However, it is acknowledged that it very difficult to quantify the amount of probable constraining-off. ESBNG has indicated that curtailment will be in the region of 0 - 10% of annual wind farm energy output in 2010. ESBNG is currently performing analysis in this field in an attempt to refine its estimates and provide additional clarity in this area. It envisages reporting on this detailed analysis by the end of January 2005[38].

In the absence of compensation for constraining off, it is likely that 10% curtailment would have significant financial repercussions for existing and proposed wind energy projects in Ireland.

4.5.3 Options

ESBNG Studies on Constraining-Off

Wind powered plants will be constrained for two reasons, *viz.*: transmission reasons and 'wind reasons'. The latter reasons are due to the inherent variable and unpredictable nature of the wind. It is expected that the extent of curtailment for transmission reasons, under the current access regime, will be reasonably limited.

ESBNG has undertaken to carry out analysis of the effect of the wind on the system in isolation of transmission constraints. To this end, ESBNG has devised a work programme, which can be split into two main strands - an Initial Investigation and a Detailed Technical Analysis.

It is envisaged that Strand 1, the initial investigation phase, should take approximately 3 months, beginning November 2004. Strand 1 will firstly identify typical historical wind generation patterns. Then, scaling these wind generation patterns up to the capacity required to meet the 2010 RES-E target of installed wind capacity, and assuming fixed forecast error, operating strategies for conventional generation will be devised to facilitate these typical wind profiles given a set of typical system demand curves. This analysis will allow determination of the capabilities of conventional plant mix to accommodate increased wind penetration, and initially estimate the level of wind curtailment that may be operationally necessary, ignoring the economic aspects. The effect of intra-15 minute period fluctuations of wind will be examined in this phase.

Strand 2, a more detailed technical analysis phase, is provisionally estimated to take approximately 6 months and will commence in parallel with Strand 1. Strand 2 will develop on the initial analysis in Strand 1 by:

- Considering future wind profiles that take into account more diversification;
- Considering the impact of wind forecasting in more depth;
- Using a projected conventional plant portfolio for 2010.

The power system operating strategies developed in Strand 1 will be evaluated from both operational and economic perspectives. A report is programmed for completion by the end of April

[38] As per CER's direction to ESBNG of 9th July 2004.

2005. It is ESBNG's intention to publish the timetables for the work programme on the ESBNG website.

Capping the Risk of Constraint

Participants at the recent workshop[39] on the proposed grid connection grouping approach discussed the concept of capping the risk associated with constraint. It was suggested that RE generators could be 'made whole' up to the level required by the 2010 target if the actual level of curtailment exceeded a set level over a specific period, as determined by CER. In effect, the level of constraint that the wind energy developers would be exposed to would be capped at the agreed level.

This option is worthy of further consideration as it would help to reduce the perceived risk associated with the current uncertainty surrounding the quantification of constraint. However, constraint up to the agreed level would still directly and adversely affect the financial viability of proposed wind energy projects.

Market Rules

The recent proposals to introduce a new electricity market in Ireland highlighted many of the concerns surrounding renewable energy sources that have virtually a zero incremental cost and the concept of priority dispatch. Literal interpretation of priority dispatch without consideration of the physical constraints[40] that the system must operate under can result in sub optimal dispatches that can reduce the level of avoided CO_2 emissions and in certain circumstances result in an increase in NO_X emissions. Some study has been done in this area but with the start of an all-island market design process planned for early 2005 it would be prudent to engage in it at an early stage to optimise RE within the resulting market.

Wind Energy Forecasting

There are a number of approaches to addressing the issues relating to wind variability including use of energy storage technologies, development of an appropriate dispatching methodology, inclusion of more flexible plant (such as open cycle gas turbine technology) in the thermal plant mix, improving electricity system interconnection and many other possible strategies which will develop over a period beyond 2010.

Regardless of the strategy chosen, in order to mitigate against the negative impacts of wind energy variability effectively and efficiently, it is essential that accurate forecasts of wind power are available. This will provide key advance information to inform the detail of the strategy chosen. It will allow for sensible charging and discharging of storage technologies, appropriately informed dispatch scheduling, clear timing signals for the requirement of back up capacity, etc.

Wind forecasting does not in itself overcome the problems associated with wind intermittency. However, an accurate forecasting tool can facilitate transmission system operators to overcome these problems. In particular, there are certain days, when the profile of wind power output mismatches completely the electricity load profile.

Forecasting is also required in order to provide the system operators with advanced warning of potential events that may affect all wind farms simultaneously and thereby affect total wind power output over a short period of time, say 3 hours.

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[39] 1st November 2004, at CER

[40] Instantaneous constraints such as reserve and transmission and inter temporal constraints such as ramping limits and the use of storage devices such as Turlough Hill.

In order to further improve the accommodation of wind generated electricity, accurate forecasting of wind power output in a 0 – 48 hour time window is necessary, with particular value in the 3 - 36 hour ahead timescale.

Other Areas of System Operations

Additional work is required within the system operations arena including on reserve as well as the wider issue of optimal plant mix on the system. The type, specification, size, location and timing of new conventional plant additions to the system and the retirement of existing plant from the system will have significant impact on the ability of the system to accommodate large amounts of RE capacity.

In particular the potential use of Turlough Hill in any future electricity system should be extensively assessed[41].

4.6 Availability of Finance

It is acknowledged that the ability for RE projects to obtain financing is a critical issue to address and is directly related to overcoming the technical challenges set out above. This requires policy and regulatory certainty (to a degree) and was thus the basis for most of the discussions of STAG.

In addition to the challenges set out above, there is a clear need to address other uncertainties in the marketplace that affect directly the availability and cost of finance for RE projects. A number of these uncertainties grow as the number of applicants seeking connection agreements increases. These include the structure of the electricity market and how that will impact on the RE projects including the uncertainty regarding the causer pays principle applied to charging for reserves and the requirements for forecasting.

The magnitude of some of these risk factors could be mitigated by the introduction of an appropriate market support mechanism (see Section 5).

4.7 Challenges to Opportunities

It is worth noting that the technical challenges facing RE deployment in Ireland can also be viewed as opportunities. The understanding, insight and experienced 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.

[41] Turlough Hill is currently fully utilised for providing system services. However, with the advent of substantial amounts of wind energy capacity on the system, it would be prudent to examine the optimum use of this asset.

5. RE Support Mechanism post AER VI

5.1 Overview

Due to the short timeline for STAG and the lack of complete data on project deployment, the amount (if any) of capacity that would require support via a bridging mechanism to achieve the 2010 target is not clear.

Although there clearly is a mismatch between those with connection agreements and those with AER PPA offers, the present high level of the BNE, arising from high fossil fuel prices and the impact of the cost of Carbon arising under the Emissions Trading Scheme, means that the more advanced RE technologies including onshore wind may be in a position to compete on a level playing field with conventional sources of energy in the short-term if technical and regulatory issues are resolved. If BNE continues to rise the apparent cost to consumers of supporting wind energy may be zero (or negative). However, it is still useful and in many cases necessary to have long term PPAs in place in order to obtain financing in order to reassure investors so long as "constraining off" and impact son revenues remain concerns fro investors.

Indeed, 83 MW of the 233 MW of wind energy capacity currently generating is operating on a merchant basis. Furthermore, indications are that up to 107 MW of the 252 MW currently under construction may be developed on a merchant basis. Notwithstanding this project development activity on a merchant basis, it is uncertain if the 2010 target could be achieved in the absence of a support mechanism.

The concept of separate support mechanisms was discussed by STAG[42]:

- One longer term mechanism to promote the deployment of different RE technologies in Ireland well into the next decade, and;

- A second, shorter-term 'bridging' mechanism specifically designed to bridge the RE capacity gap between the 2010 target and the capacity that is currently commissioned plus the capacity that will be developed under AER V & VI and the capacity that will be developed on a merchant basis.

It is envisaged that due to a number of factors including the proposed timeframe for the development of a new electricity market structure in Ireland[43] (and an associated current lack of a clear wholesale spot price for electricity), the timeframe of any east-west interconnection , the timeframes for writing legislation and gaining state aids clearance, that a PPA financial support mechanism (a fixed feed-in tariff or competitive tender) would be the most likely instrument to be utilised to 2010 as a bridging mechanism.

[42] CER has raised concerns about the potential cost implications (to consumers) of a bridging mechanism given that the full impact of AER VI has yet to be reflected in final electricity prices.

[43] In August 2004, CER and the Northern Ireland Authority for Energy Regulation signed a Memorandum of Understanding (MOU). The MOU provides a set of agreed principles, which will underpin the development of a single wholesale electricity market on the island. A progress report on this project was published on 8th November 2004.

The design of the contracts and the method of funding the bridging PPA would be critical in ensuring its quick implementation. In forming a new support mechanism, an appropriate PPA price (to attract development) should consider the balance between the needs of project developers and the costs to consumers. This is not a simple task. The harmonisation of issuing the PPAs with other technical and regulatory considerations is also complex. Co-ordination is essential, as is facilitation by all relevant State bodies. In this regard some important items for consideration include:

- Identification and quantification of the requirement for a bridging support mechanism to meet the 2010 target.
- The design of detailed and robust rules for awarding PPAs to projects.
- The ability of RE investors to secure bank finance - long term PPAs are crucial for this.
- The timing of State Aids clearance for a bridging mechanism should be considered at an early stage.
- Any financial support mechanism designed to deliver compliance with the 2010 target should allow for more capacity to be allotted support than strictly defined by this report. There is historical precedence for some level of project failure for a variety of reasons throughout the development process.
- Any financial support mechanism start date and closure date should take account of the timelines for delivery of grid the connection in each case.
- The time required to propose new legislation necessary to launch a new mechanism could be a barrier to selecting a completely new financial mechanism in the shorter term.
- The merits and demerits of structuring a bridging mechanism so that it is available to holders of AER V and VI contracts who have not yet begun construction should be carefully examined. In this regard, a future mechanism should not undermine the AER process by demonstrating that developers who delay project implementation could obtain improved terms via a subsequent mechanism. Neither should such a mechanism unnecessarily impose increased costs on customers.
- Integration of compensation for constraining off into the construct of a financial support mechanism should be considered.
- Use of 10-year PPAs could be considered (in line with EU State Aids guidelines).
- There are issues around mandating ESBCS to take on future PPAs in this sector. ESBCS has indicated that it does not want to be a counter-party to further PPAs due to its future reduced projected market share. Consideration should be given to allow other suppliers to engage in contracting with RE generators under long term PPAs for any new additional supported RE with the same PSO conditions that apply to ESBCS

5.2 Summary of Support Options

Most of the submissions in response to the ConDoc favoured feed in tariffs or a renewable obligation system. The former has been successful in delivering large amounts of wind energy in Germany Spain and Denmark who collectively account for 25.8 GW of installed wind capacity (62% of global wind capacity). The latter is more compatible with the development of an all-Ireland framework based on the current plans to introduce an obligation system in Northern Ireland. While the AER system is very disfavoured, by many developers, the improvements brought with AER VI are significant in addressing a number of concerns and this is also an option. From the perspective of investment risk, the feed in tariff presents a number of clear benefits related to the guaranteed income stream (assuming in the case of wind energy that the wind resource study has correctly quantified the wind regime). The fixed price shelters generators from the electricity price variations associated with market dynamics. The obligation scheme on the other hand contains risks associated with electricity price volatility and separately with obligation certificate price volatility. In this scheme, generators are thus exposed to two separate market dynamics.

A compromise in risk terms is a fixed premium system employed in Spain, in which generators receive the half-hourly market price for electricity plus a fixed premium. This provides exposure to electricity market dynamics but also some revenue certainty (through the fixed premium)[44].

The timeframe for implementation will be a key aspect of the choice surrounding which mechanism to employ in the short term, given the urgency in meeting the 2010 target. This timeframe will depend not only on the choice but also the structure of the mechanism and whether State Aids approval is required for the system.

5.3 Cost of Support Mechanism to Deliver 2010 RES-E Target

SEI supported the STAG by undertaking an exercise to prepare indicative best estimate figures for the potential costs of funding a bridging support mechanism to meet the 2010 target. In order to determine the cost of providing support to deliver the 2010 RES-E target, a schedule of deployment between now and 2010 was considered. This schedule was determined by:

- Source assumptions: AER V, AER VI, merchant projects, post-AER VI;
- Timing assumptions: year of project completion and beginning of support payments.

Indicative ranges for support costs were calculated in terms of the cost to the consumer using the current Public Service Obligation (PSO) methodology, i.e. the difference between the financial support prices and the BNE. The cost ranges are presented as total present value figures[45]. As part of the detailed design process for any new support mechanism, more detailed discounted cash flow simulations with scenario and sensitivity analysis will be required.

Neither the indirect costs, including system costs associated with increases in intermittent plant and changes to the operation of conventional generation, nor the indirect benefits nor the benefits, such as fuel diversity or environmental impacts, were included in this analysis. These important issues could be addressed in a full cost benefit analysis of the impact of accommodating increased penetration of renewables, particularly intermittent RE generation on the system. Such an analysis would be valuable for informing ongoing policy decisions in this area.

5.3.1 Cost of AER V & VI

Using an AER V & VI project deployment scenario based on an analysis of the project status information set out earlier in this document, the current forward-looking costs for outstanding AER projects is estimated to be approximately €30 million. This is an indicative best estimate figure for the construction of an additional 375 MW of capacity under AER V & VI between now and 2006 and is

[44] A research project at UCC funded by EPA is currently exploring how this system might operate in Ireland and the initial findings will be available by December 2004.

[45] Annual figures will of course vary year to year and will be utilised in annual PSO calculations. In the interest of brevity they are not included here.

calculated using current knowledge and a number of important assumptions. Several of the critical assumptions have been agreed by STAG participants.

An important issue affecting forward-looking support costs is the potential for the recycling of AER V and VI projects into a post-AER VI programme or alternatively for these projects to abandon their PPAs and opt out of the AER programme entirely. Quantification of these possibilities was beyond the scope of STAG's analysis.

5.3.2 Cost of post AER VI Support Mechanism

SEI's costing exercise involved the quantification of the cost of future support for RES-E capacity post AER VI over the 2006 - 2009 period based on a feed in tariff (FIT) type mechanism[46,47,48] for the capacity gaps set out in Table 3. Different RE technologies could be supported through a banded FIT system. A range of feed-in tariffs were accounted for in this analysis for each technology based on the financial criteria of commercial developers and investors. The output from this quantification exercise was ranges of total net present value costs to consumer (utilising the currently accepted CER methodology for the calculation of the PSO).

The costs associated with funding the entire remaining RE capacity build-out to bridge the capacity gap identified in Table 3 under a hypothetical bridging mechanism (based on an FIT) would range from zero to €310 million. These values are based on 15 year PPAs and are highly sensitive to certain parameters discussed below, including the FIT price for each technology, the degree of indexation, the inflation rate and the BNE cost. The figures are the present value of the expected 15-year cost incurred in complying with a PSO. The large cost range underlines the need for more detailed analysis and agreement on important parameters and assumptions.

The BNE for the 2005-2010 period was assumed to be CER's 2005 BNE in constant 2005 money terms.

5.3.3 Sensitivity of Support Costs

The calculated range of financial support costs are dependent on, and are highly sensitive to, a variety of assumptions. Adjustments to these assumptions can alter the calculated support costs significantly. The figures presented here are 'best estimates' using the most accurate economic and technical information currently available to STAG.

The assumptions underlying the following elements affecting the forward-looking support costs are particularly important:

- Support costs under Competitive Tender system;
- Support costs under front loaded tariff;

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[46] This does not include analysis of a competitive tender tariff. This could be modelled as a discount on a feed-in tariff by using a historically derived figure for the average AER strike price below the cap.

47 CER is concerned with the potential cost impacts to consumers of a fixed feed in tariff mechanism.

[48] ESBCS believe that a feed-in tariff could be developed to facilitate the sharing of support costs among all electricity suppliers and that support costs could be recovered from customers via use of system charges.

- 5 MW of co-firing capacity;
- High / Low BNE future;
- Social discount rates;
- Indexation;
- Term of PPA.

Competitive Tender System

Feed-in tariffs are essentially PPAs offered without requiring projects to go through a competitive tender process as was the case for the AER schemes. It was assumed in this analysis that under a feed-in-tariff scheme developers would be offered PPAs on a first-come first-served basis until the 2010 RES-E target was met.

Experience in AER V and AER VI indicates that successful wind projects were bid in at approximately 90% of the cap price. A feed-in-tariff mechanism is expected to cost more than a competitive tender process because large amounts of onshore wind would be supported at a higher feed-in rate instead of at a lower competitive-tender adjusted rate.

Front Loaded Tariff

The use of a fixed feed-in tariff as opposed to a front-loaded tariff will indicate a higher tariff price *ceteris paribus*. It also appears to have a significant impact on the debt service cover ratio[49] (DSCR).

Co-firing Biomass

Co-firing has a relatively high levelised cost due primarily to high fuel costs and, as a secondary factor, low conversion efficiency. Consequently the premium over BNE is substantial. Adding 5 MW of co-firing capacity and subtracting wind energy[50] capacity with an equivalent annual energy output would drive overall support costs up considerably.

High / Low BNE Future

The future BNE price has a considerable impact on support costs. Higher BNE prices, potentially driven in part by high gas prices, could eliminate the requirement for a support mechanism for more mature technologies such as onshore wine. A feed-in tariff for onshore wind energy at prices below 6.0 €c/kWh with 25% indexation will provide a net benefit (i.e. negative PSO) over 15 years assuming the BNE price increases with inflation.

A 10% decrease in BNE could result in a 63% increase in the present value of the expected 15-year cost incurred in complying with a PSO.

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[49] This ratio is used by banks to evaluate the amount of funding they will provide to a project by considering the ratio of cash generated by a project annually to the annual debt payments required. A ratio minimum of 1.3 is typically required.

[50] Since co-firing replaces peat capacity rather than CCGT (BNE) capacity, it may be more appropriate to compare co-firing with the levelised cost of generating electricity from peat.

Discount Rates

The indicative cost figures presented here are based on a 15-year social discount rate of 1.85%. Using other rates would change the present value of the PSO costs. Higher rates would discount future costs more, while lower rates would discount future costs less

Indexation

Reduced indexation to CPI will require a higher price to achieve equivalent returns to those achieved under full indexation. Reducing indexation from 80% CPI to 25% CPI could reduce the total cost of funding the support mechanism for the bridging capacity by approximately 50%.

Term of PPA

The cost of a 10 year fixed feed-in tariff will require prices approximately 5% - 10% higher that 15 year feed-in tariff to achieve the same returns; however achieving a similar DSCR with a 10 year feed-in tariff will require a 50% higher feed-in tariff than the 15 year feed-in tariff.

5.4 AER Transition to New Support Mechanism

A transition arrangement may be required for existing or new AER contracts if:

- A new support mechanism is adopted which cannot admit the existing AER contracts into it without disadvantage to the generators, or;

- The new market arrangements or liberalisation processes are incompatible with AER.

It may, for example, be difficult to transfer existing contracts into a feed-in system and it is very unlikely that the contracts could be transferred into a ROC system. Suitable arrangements will therefore have to be put in place for handling the AER contracts in parallel with the construction of an interim and / or long-term replacement for AER. Primary and / or secondary legislation is likely to be required and, based on UK experience of transfer from the NFFO to Renewables Obligation system, this could take 2-3 years to accomplish.

Key considerations that would need to be taken into account in developing transition arrangements include:

- An announcement of the intention to implement transition arrangements (if required) at the same time as any announcement of new support measures.

- This announcement should include the explicit statement that the position of the AER contract holders will be protected. This is particularly important in respect of the key features of AER enabling developers to attract finance – price, term and security of revenue. This announcement should also state that AER contract holders will be expected to honour their obligations under their contracts.

- Existing AER contracts with ESB may need to be terminated.

- New contracts with a new a counter-party may be necessary.

- The new contracts might need to specify that any green benefits remain with the new counter-party if trading were introduced.

- A system which permits the output and green benefits from the AER contracts to be sold to competing buyers is likely to produce the best outcome if a trading system were introduced.

- Development of the transitional arrangements and legislation will require several months at least.

5.5 Secondary Support Mechanisms

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 been predicted in full. Thus, secondary support mechanisms have often proved essential in successful policies.

It is likely that the less mature renewable energy electricity generation technologies will need support in addition to a production based premium in order to achieve the higher levels of penetration required to meet more ambitious longer term targets at least cost.

SEI has commissioned a *Study on the Economic Analysis of the RE Support Mechanisms in the Electricity Generation Sector*, prepared by a consortium of consultants lead by the Energy Economics Group at Vienna University of Technology. While the report is not yet finalised, preliminary findings show that when specific support for less mature technologies is not made available early (through 2010 in this study), the cost of deploying these technologies in the future, when the resource available for the more mature technologies are exhausted, is significantly increased. Early support of a less mature technology will enable the development in the value chain necessary to facilitate commercial deployment of a new technology. For instance, local consultancies will gain experience in the environmental impacts involved with a particular technology, local engineering firms will develop expertise in construction and installation, local finance sources will gain an understanding of, and comfort in, the risks associated with a technology. It is noteworthy that the timing of such support can be as important as the structure and magnitude of the support.

A number of options are available for offering support to less mature technologies. Where a production price support system is banded for technologies, higher prices can be offered for less mature technologies. This has been the case with the AER system thus far in that higher cap prices have been offered for biomass applications, which have not been deployed thus far in Ireland, than are available for onshore wind. Where a competitive element is incorporated in the design of the support mechanism, it is not always possible or efficient to include technology bands. A production support 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 mechanisms that is designed primarily for more mature technologies. The following type of investment support schemes may be considered:

- Investment incentives through grant funding can be offered. Grant funding for pilot and initial commercial deployment of a new technology can overcome the unavailability of capital due to the high level of risk associated with unproven technologies. Grants may also be made available to support the uptake of a new technology that has already been proven but needs support in establishing a market presence.

- Tax incentives can be used to support renewable investments in much the same way that grants do. Tax credits can be given on personal income tax or on corporate income tax. Credits for investments in large-scale grid connected renewable technologies can be an effective means of stimulating equity investment in projects. Credits for small-scale investments in renewable energy appliance for domestic application can be an effective means of stimulating market demand.

- Accelerated tax depreciation for expenditure on renewable energy equipment is another tax mechanism that can be used to stimulate investment. Accelerated depreciation means the cost of the equipment purchased is written off against the project's revenue in the first few years of ownership as opposed to the statutory 8-year period for capital equipment.

- Low interest rate loans are a policy mechanism that provides funds to subsidise interest rates on loans available for funding renewable energy projects. Government can provide funds and administer a loan programme through an agency, or utilise existing private sector expertise by providing the interest subsidy directly to a bank that provides the loan to the project. This mechanism can help to expose banks to less mature technologies; however it carries more risk for project sponsors than tax incentives or grant schemes.

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. A robust RE policy must consider the impact of secondary support mechanisms on the long term policy goals. Appropriate integration of investment incentives with production price supports should be considered to ensure the long term efficiency of a renewable energy policy.

6. The Future

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 in the short term (2010) while taking account of potential RE policy out to 2020 and beyond.

The consensus attitude and positive interactions that were built up between all parties during STAG and REDG meetings is a necessary ingredient in any long term strategy to resolve the technical challenges. STAG discussed the concept of progressing a number of topical long-term issues (technical & policy) to further the formation of RE policy within an appropriate forum. The issues identified include the following:

- Reduction in policy and regulatory uncertainty;
- Evaluation of the requirement for and, as appropriate, development and implementation of, support mechanism(s) to further RE deployment rates, including a potential bridging mechanism, a longer term support mechanism and secondary supports;
- Methodologies and quantification of technical issues including constraint, wind turbine modelling, etc.;
- Transition to 2020 - targets & instruments to deliver them;
- The challenges facing embedded generators;
- The challenges to the deployment of non-wind RE, including bioenergy, ocean and PV;
- Inter-jurisdictional relationships with both Northern Ireland and Britain, including interconnection, common support mechanisms and the proposed all-island electricity market.

The development and implementation of a policy to achieve Ireland's 2010 RES-E target should be conducted in parallel with addressing the requirement to develop RE in Ireland beyond 2010. This should include facilitating the deployment of a range of different RE technologies in the heat and electricity sectors.

There is likely to be a requirement to seek legal advice and undertake risk assessments on a number of the issues outlined in this report. There is also a need to consider capacity building in Ireland, industrial development and resource (fiscal and human) allocations to areas that require further analysis. This is in addition to other issues not listed that may be identified. The proposed long-term groups could be the focal point for this work.

It is apparent that there are significant challenges facing the deployment of RE in Ireland, which, if not overcome could constrain Ireland's ability to meet the 2010 RES-E target. Close co-operation will be required between relevant bodies to critically assess options to overcome these challenges, including those set out in this report, with a view to implementing processes to facilitate the deployment of RE on a scale that will meet or exceed targets.

This will require a clear and transparent policy for RE. This policy will form a framework to help resolve technical impediments. It can also serve as a boundary in which to quantify effects.

Annex A1

Abbreviations

AER	Alternative Energy Requirement
BNE	Best New Entrant
BSG	Biomass Strategy Group
CER	Commission for Energy Regulation
CHP	Combined Heat & Power
DCF	Discounted Cash Flow
DCMNR	Department of Communications, Marine and Natural Resources
DSO	Distribution System Operator
EPA	Environmental Protection Agency
GAR	Generation Adequacy Report
ESBNG	ESB National Grid
ESBCS	ESB Customer Supply
ESRI	Economic & Social Research Institute
GUDP	Grid Upgrade Development Programme
GWh	Gigawatt Hour
IWEA	Irish Wind Energy Association
MW	Megawatt
MSW	Municipal Solid Waste
PPA	Power Purchase Agreement
PSO	Public Service Obligation
RE	Renewable Energy

REDG	Renewable Energy Development Group
RES-E	Renewable Energy Supply - Electricity
RESG	Renewable Energy Strategy Group
STAG	Short Term Analysis Group
SEI	Sustainable Energy Ireland
TER	Total Energy Requirement
TSO	Transmission System Operator
UCC	University College Cork
UCD	University College Dublin

Annex A2

List of STAG Participants

Participant	Organisation	STAG Meeting					
		6 Aug	31 Aug	21 Sep	27 Sep	11 Oct	26 Oct
Morgan Bazilian (Co-Chairperson)	SEI	✓	✓		✓	✓	✓
Mark O'Malley (Co-Chairperson)	UCD	✓	✓	✓	✓	✓	✓
Martin Finucane	DoCMNR				✓		
Bob Hanna	DoCMNR		✓				
Eugene Dillon	DoCMNR	✓	✓			✓	✓
Michael Purcell	DoCMNR	✓	✓			✓	✓
Pat Dowling	DoCMNR			✓			
Godfrey Bevan	SEI						✓
John McCann	SEI	✓		✓	✓	✓	✓
Katrina Polaski	SEI						✓
David Murphy	SEI	✓					✓
Sheenagh Rooney	CER	✓	✓	✓		✓	✓
Eugene Coughlan	CER		✓			✓	
Denis Cagney	CER			✓		✓	
David Naughton	CER				✓		
Clare Beausang	CER				✓	✓	✓
Anne Trotter	ESBNG	✓	✓		✓		✓
Paul Smith	ESBNG			✓	✓	✓	

Participant	Organisation	STAG Meeting					
		6 Aug	31 Aug	21 Sep	27 Sep	11 Oct	26 Oct
Emma Fagan	ESBNG			✓			
Michael Kelly	ESBNG					✓	
Andrew Cooke	ESBNG					✓	
Karl Leavy	ESBCS		✓	✓	✓	✓	✓
Niamh McCarthy	ESRI	✓					
Mary Keeney	ESRI		✓	✓		✓	✓
Brian Ó Gallachóir	UCC	✓	✓	✓	✓	✓	✓
Eleanor Denny	UCD		✓		✓		
Alan Mulane	UCD			✓			
Rónán Doherty	UCD					✓	
Adrian Denny*	Goodbody*		✓*				
Paddy O'Kane	Airtricity			✓			
Dermot O'Kane	Airtricity					✓	
Maureen dePietro	DP Energy				✓		
Aidan Sweeney	Eco Wind Power				✓	✓	✓
Guy Nicholson	Econnect / IWEA					✓	
Grattan Healy	Meitheal na Gaoithe						✓
Liam P. Ó Cléirigh (Secretary)	Byrne Ó Cléirigh	✓	✓	✓	✓	✓	✓

*Adrian Denny of Goodbody gave a presentation on financing wind energy projects at the meeting on 31st August. He did not attend the rest of the meeting.

Annex A3

Load Factors for Determining Capacity Requirements to Meet 2010 RES-E Target

Load factors take into account planned and forced outages. In the case of bioenergy CHP plant, which comprises most future bioenergy capacity, planned outage is assumed to be zero. (This is because CHP plants can perform maintenance during low demand periods). Offsetting this however, CHP plants are deemed to have slightly higher forced outage rates due to their complexity.

Generation Type	Load Factor	Generation Type	Load Factor
Co-firing Coal (max 10%)	79.6%	Agricultural waste CHP	66.5%
Co-firing Peat (30%)	79.2%	Wood industry residues CHP	66.5%
Hydro	38.8%	Forestry residues CHP	66.5%
New Hydro	43.7%	Energy Crops CHP	66.5%
Onshore Wind	35.0%	Biogas ADCHP	61.8%
Off-shore Wind	39.0%	LFG	64.9%
MSW Combustion	77.5%	Agricultural waste	77.5%
MSW Combustion CHP	57.0%	Wood industry residues	73.0%
Wave	36.9%	Forestry residues	73.0%
Tidal (current)[51]	36.9%	Energy Crops	73.0%
Solar	14.0%	Biogas AD	78.7%

[51] These are indicative factors for wave and tidal technologies. In practice they are unlikely to be identical.

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