27th February 2009

Simon Bartlett
Chairperson, E S Cornwall Scholarship Advisory Committee

Dear Mr Bartlett,

Re: ES Cornwall Scholarship – Fourth Quarterly Report

Please find enclosed my fourth quarterly report during my tenure of the E S Cornwall Memorial Scholarship, as required by the scholarship rules.

During the fourth quarter of 2009, I have been working for National Grid in the United Kingdom. My primary responsibility has been to assist in the preparation of the inaugural Offshore Development Information Statement (ODIS), which was published in late December. This report therefore focuses on the intention behind the ODIS, issues encountered in its preparation, its content and the industry's reaction to it.

Working on the ODIS afforded interaction with a range of people in various commercial teams and government departments and has provided some insight into the broader response to climate change issues and how this is likely to impact on the power industry. This is briefly covered as a secondary topic.

I welcome any feedback or questions from the committee or other interested parties on anything I have discussed in my report and my aspirations for the next quarter.

Yours faithfully,

Jonathan Dennis

Enclosures:

- E S Cornwall Scholarship 2008-2010 – Jonathan Dennis – Fourth Quarterly Report

Fourth Quarterly Report

Introduction

I am using my tenure of the E S Cornwall Memorial Scholarship principally to gain experience in the measures being applied internationally by transmission companies to manage three significant deficiencies of large centralised renewable generation, being:

- variability of renewable power generation over time,
- low inertia, poor fault ride through capability, and
- remote location necessitating long distance radial connections.

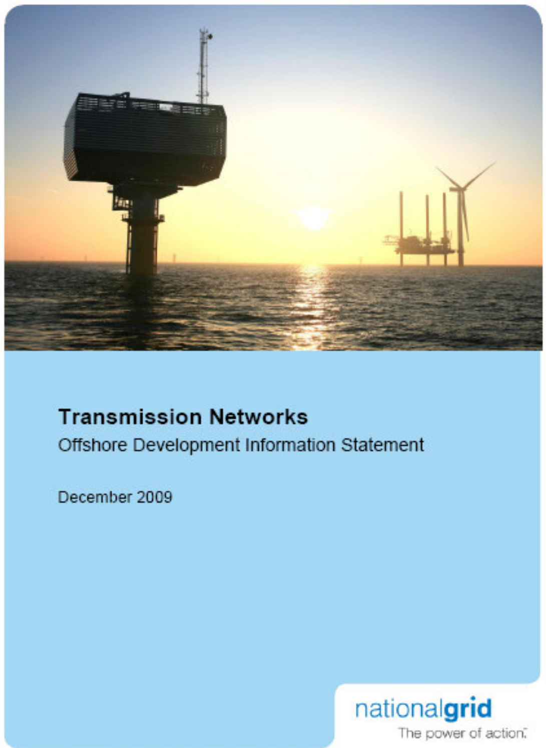
As previously indicated, my overwhelming impression since commencing the scholarship is that the obstacles to the increased use of renewable generation are multi-faceted, and the technical difficulties listed above must be considered alongside the political, regulatory, and commercial challenges. I have therefore sought to investigate and report on all of the transmission related obstacles to increased use of renewable generation.

This is the fourth of six quarterly reports required by the scholarship guidelines. It covers the fourth quarter of 2009. During this time I have been employed by National Grid, within their UK electrical network investment strategy development team. National Grid owns the electricity transmission network in England and Wales, and operates Great Britain's electrical power system. National Grid also owns and operates the UK's gas transmission network, as well as owning several gas distribution networks in the UK and several electricity and gas transmission and distribution networks in the USA. National Grid also owns several subsidiary companies involved in activities including metering, and developing interconnectors and offshore transmission networks.

My main responsibility to date has been assisting with the compilation of a report describing how the UK's onshore and offshore transmission networks can be developed together in a coordinated and economical fashion.

Offshore Development Information Statement (ODIS)

In mid-2009, a new licence condition was placed on National Grid to publish an annual statement to assist the coordinated development of offshore transmission networks in the UK. The first issue of this statement was published in late December, 2009, and is available on National Grid's website[1].



Background & Intention

The UK government has set ambitious targets for the development of renewable generation, and is looking for much of this to come from wind, wave and tidal generation situated in the offshore waters surrounding Great Britain. Locating renewable generation offshore reduces its impact on visual amenity, and in the case of wind generation, provides access to a stronger and more consistent wind resource. However, locating large volumes of generation offshore necessitates the development of offshore transmission infrastructure. The UK transmission regulator Ofgem has decided to allocate licences to develop and operate offshore transmission infrastructure to multiple companies in tranches using a competitive tendering process. This enforces a separation of generation, offshore transmission and onshore transmission businesses, which Ofgem hopes will encourage competition and minimise the cost of developing and operating this infrastructure. Under this arrangement, different parties are prohibited from communicating with each other until the competitive bidding process for each piece of infrastructure is complete (i.e. Ofgem has granted an offshore transmission licence and set the company's allowed revenue). To address concerns that the lack of coordination between these different parties would lead to inefficiencies in the design of this

[1] Available online at: http://www.nationalgrid.com/uk/Electricity/ODIS/

infrastructure, Ofgem placed a requirement on National Grid's UK Onshore Electricity Transmission business (NGET), as a centrally involved but impartial party, to produce a public document that would provide a basis for coordination. NGET is required to re-publish the ODIS annually to take account of ongoing changes in the industry.

Content

The ODIS report is broken down into multiple sections:

- Firstly, there is a review of the policies in the UK relating to the development of offshore generation and offshore transmission infrastructure.
- Secondly, the present development status and stated intentions of all existing offshore generation projects that have secured a lease of the seabed from the Crown Estate is documented.
- Thirdly, the composition of the different scenarios of how offshore generation may evolve in the future is explained. These scenarios are then used as the basis for analysis in subsequent sections in the report.
- Fourthly, indicative designs for suitable offshore transmission networks and local onshore infrastructure are presented for each region in Great Brittan.
- Finally, the adequacy of the onshore transmission network to support the connection of offshore generation is assessed, and the implications for proposed reinforcements are identified.
- An appendix is also included which explains the methodology used to design the offshore transmission infrastructure and includes an extensive review of offshore transmission technologies, including capabilities, costs, availabilities and operational experience.

Development

The development of the ODIS commenced in September with myself and another engineer, and progressively gathered momentum and resource, with around ten people working full time on the project by mid-October (within National Grid and an external consulting company) and several more people providing regular input.

I was involved in most aspects of development of the document which provided a good insight into the range of technical, political and organisational challenges we encountered. I will focus on four aspects of the document's development which were particularly interesting:

1. Document Form

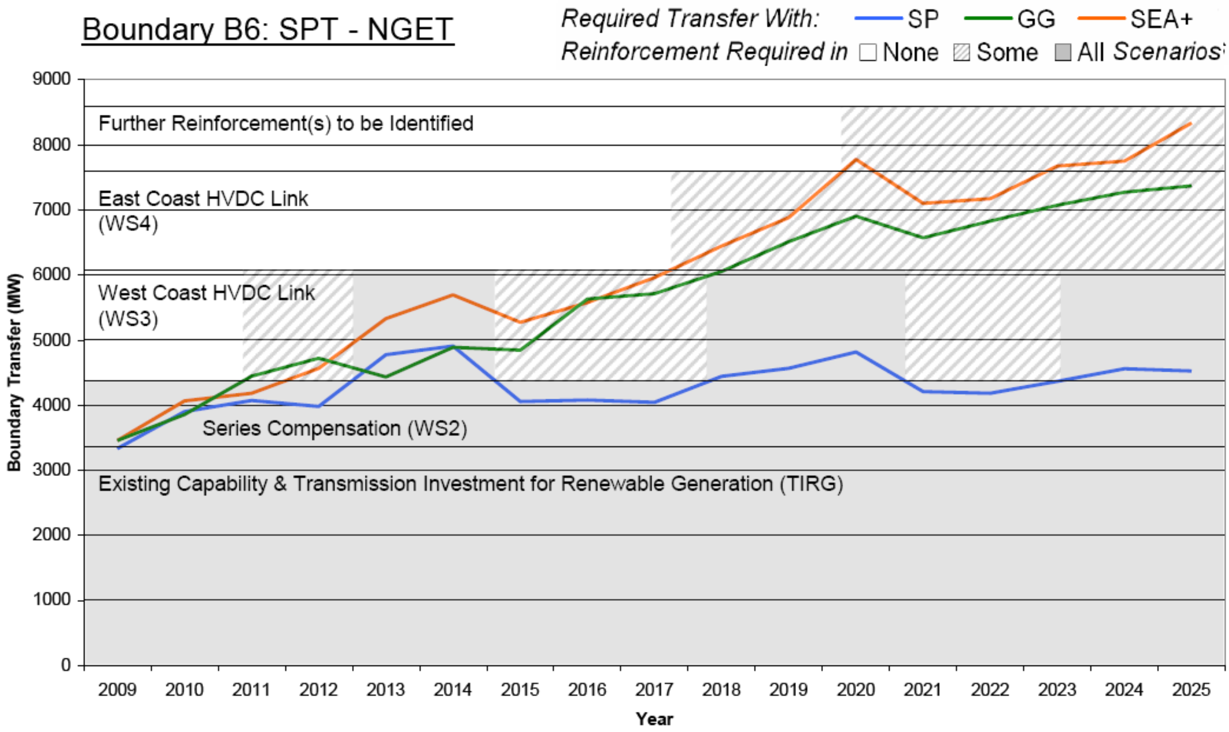
The initial problem we faced was deciding how the report should be structured. The licence condition described the intent and expected outcome of the report, but did not state how this should be achieved.

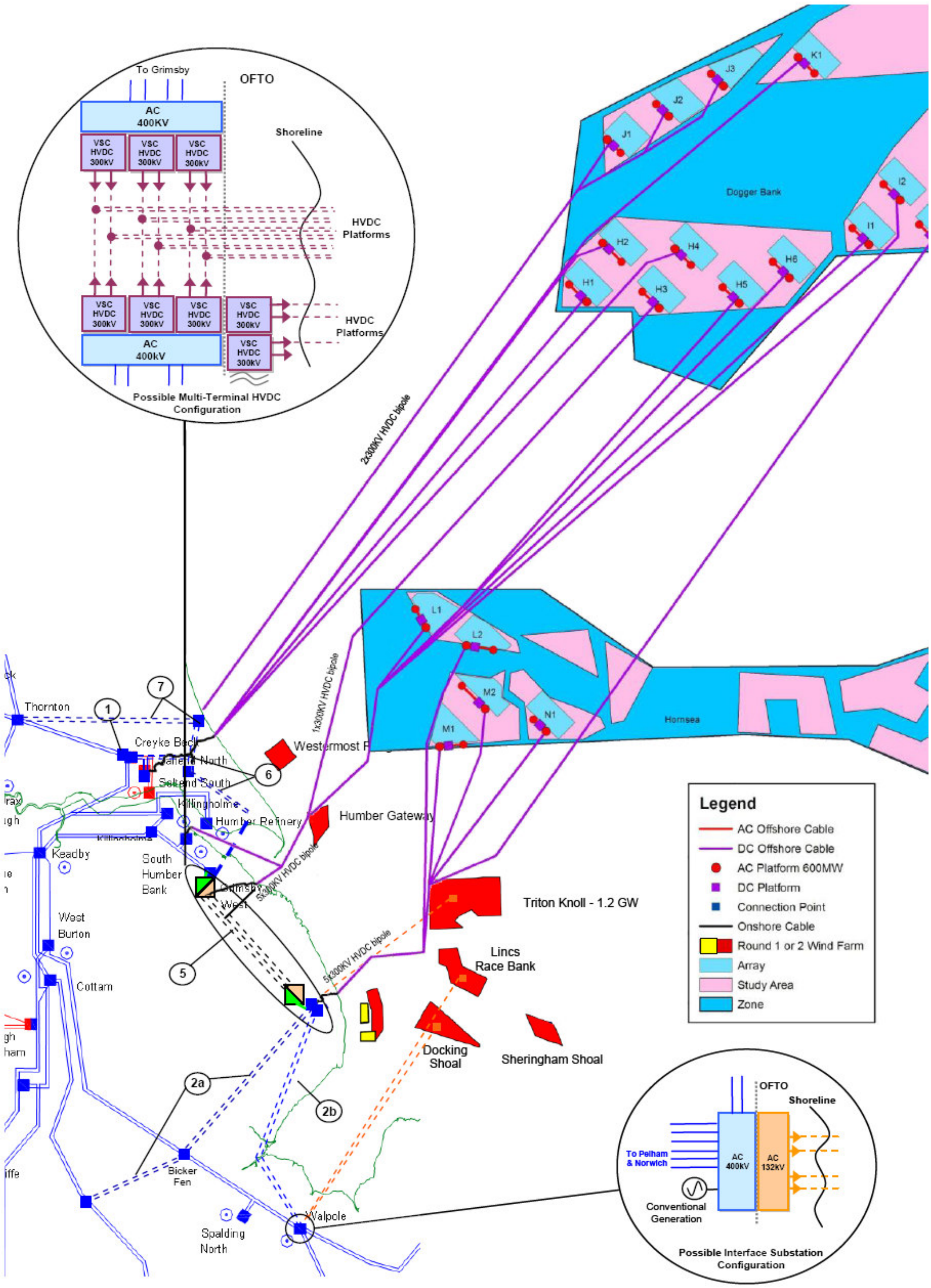
Initially we favoured an approach that studied the interaction between different regional design options and sought to identify the combination of options that minimised the cost to UK plc (i.e. to the nation as a whole). However, in mid October it became clear that:

- Completing the analysis within the obligated timeframe would be practically impossible.
- There was unlikely to be a single straightforward answer, but rather a vast range of solutions with different costs and degrees of confidence. Presenting these results in a straightforward fashion way would be very difficult.
- The results would be highly influenced by the input assumptions, and uncertainty surrounding the volume, location and timing of offshore generation development would therefore lead to a low level of confidence in the results.

Therefore, a decision was taken to analyse each region individually, and to present the implications for the onshore transmission network in a more generalised fashion. Given the amount of effort that was required to complete the document and the industry's positive reaction to the document, in retrospect I believe that this was the right decision.

An example of a regional design, and the implications for a major network boundary (cutset) is shown in the two plots below.

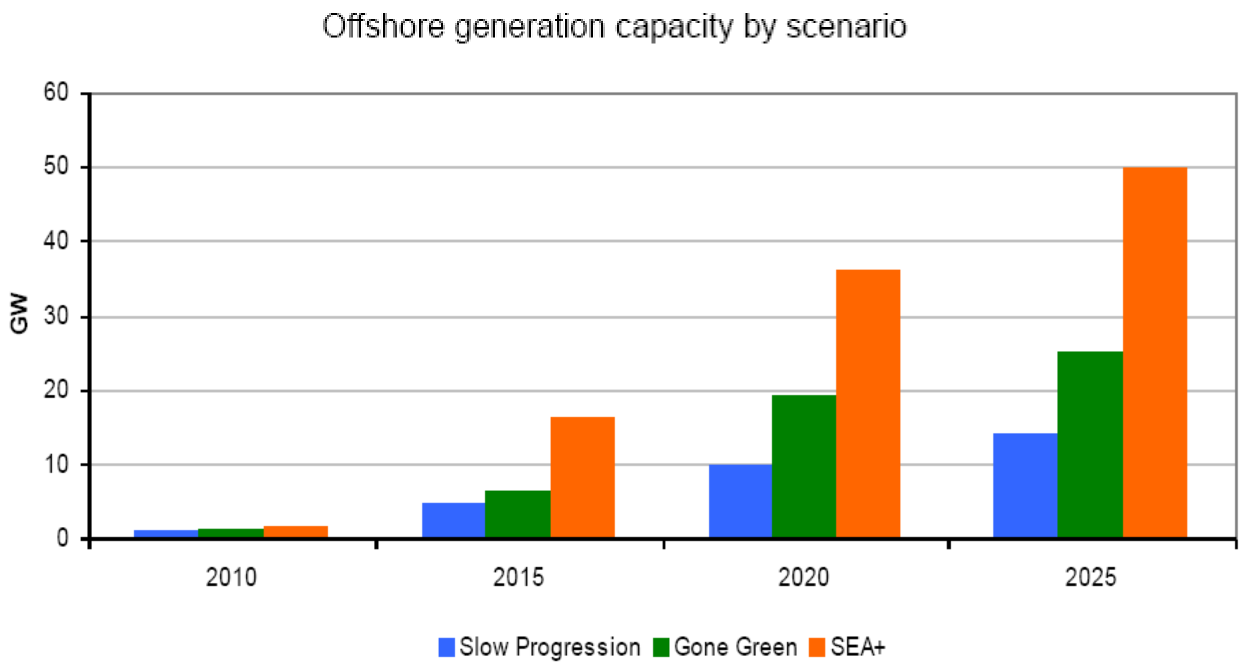



To Grimsby
OFTO
AC 400KV
VSC HVDC 300kV
Shoreline
HVDC Platforms
AC 400kV
Possible Multi-Terminal HVDC Configuration
Dogger Bank
J1
J2
J3
K1
I1
I2
H1
H2
H3
H4
H5
H6
2x300KV HVDC bipole
1x300KV HVDC bipole
5x300KV HVDC bipole
L1
L2
M1
M2
N1
Hornsea
Thornton
Creyke Beck
Saltend North
Saltend South
Killingholme
Humber Refinery
Westermost Rough
Humber Gateway
Keadby
South Humber Bank
Grimsby West
West Burton
Cottam
Triton Knoll - 1.2 GW
Lincs Race Bank
Docking Shoal
Sheringham Shoal
Bicker Fen
Spalding North
Walpole
1
2a
2b
5
6
7
Legend
AC Offshore Cable
DC Offshore Cable
AC Platform 600MW
DC Platform
Connection Point
Onshore Cable
Round 1 or 2 Wind Farm
Array
Study Area
Zone
To Pelham & Norwich
AC 400kV
AC 132kV
Conventional Generation
Possible Interface Substation Configuration

2. Scenario Development

The most controversial aspect of the development process was establishing the scenarios that would be used as basis for analysis in the report. This required us to liaise with the Crown Estate and a variety of UK governments and government organisations and try to reach a consensus position. Initially one month was allocated to this task, but in reality the scenarios continued to change until late November. The discussion in every teleconference that I participated in focused only on the headline figures, which I found surprising since the geographical distribution of generation can be even more influential on the results than the overall volume of generation. The controversy was due to concerns about the implicit message that the different scenarios would send to the industry, and the range of views held by the different parties. Some parties were keen to ensure that the report contributed further momentum to the offshore generation industry, while other parties were concerned that the report should be able to be considered to be credible.

The headline figures of the three scenarios used in the report are shown in the figure below. For reference, the peak demand in the UK is approximately 60GW. Each scenario does in fact contain details regarding the specific timing and location and merit order of new generation, based on the view of National Grid's energy forecasting team, but these details are not published due to their commercial sensitivity. However, each scenario is further broken down in the ODIS with plots and commentary explaining how the generation varies over time by fuel-type and region.



The Gone Green scenario reflects the situation where the UK marginally complies with its emission reduction targets. The UK fails to meet its targets under the Slow Progression scenario and significantly exceeds them under the SEA+ scenario. Most of the debate related to whether the Slow Progression scenario should be included in the report. Interestingly, most of the feedback was have received from industry since publishing the report also relates to the decision to include the Slow Progression scenario.

Initially a fourth scenario was suggested which contained even greater volumes of offshore generation than the SEA+ plus scenario, but it was later agreed to only use this in the regional section of the ODIS to assess the maximum extent to which each region could be developed.

National Grid is required to consult publicly on the development of scenarios to be used in the 2010 ODIS, with consultation to commence in March. Although I won't be involved in this work, it will be very interesting to see how it progresses.

3. Offshore Technologies Review and Network Design

The main aspect of the ODIS is the design of offshore networks to cater for the offshore generation included in the various scenarios. Because of the short timeframe in which the work needed to be completed and several competing demands for resource within National Grid, the decision was taken (without any influence from myself) to engage the consulting firm Senergy Econnect. Econnect was the host of my previous scholarship placement and it was very interesting to work with Econnect again, this time as the client. I believe that my recent experience working for them helped me to better manage the relationship and maximise the value of the work for both parties.

The offshore generation industry is undergoing rapid change. Therefore, National Grid initially asked Senergy to conduct a review of the present capabilities and costs of relevant offshore technologies. This aligned well with some other work that Econnect was conducting for the European Union, and Econnect were quite successful at obtaining meaningful input from equipment and service providers. NGET periodically reviewed the work that Econnect had done and provided guidance for further investigation. The overall findings of this work are summarised in Appendix 4 of the ODIS (appendix document, pages 14-53). I believe the summary is a genuinely helpful and up-to-date overview of offshore transmission technologies and construction techniques, and the inclusion of aggregated cost information is very uncommon in the public domain. The ODIS' sponsors and industry participants have been particularly complementary about this section of the ODIS.

NGET then asked Econnect to use the findings of this review to develop offshore network designs to cater for the offshore generation scenarios. For speed and transparency, rather than custom-designing the network for each individual windfarm, NGET asked Econnect to develop three optimised 'standard' design arrangements. These arrangements have been developed so that they comply with relevant grid codes and planning criteria, use presently (or soon to be) available equipment, and minimise the cost of transmission for different capacity wind farms and different distances from shore. The three 'standards' consist of:

- a 600MW 220kV$_{AC}$ single-platform two-cable design,
- a 900MW 220kV$_{AC}$ two-platform three-cable design, and
- a 1000MW +/- 300kV$_{DC}$ bipole three-platform design.

Finally, NGET asked Econnect to apply these standard designs to the offshore generation scenarios and identity suitable cable routes to a list of possible connection points provided by NGET. Meanwhile, NGET engineers worked to identify the local onshore network establishment/reinforcement required to accommodate these connections.

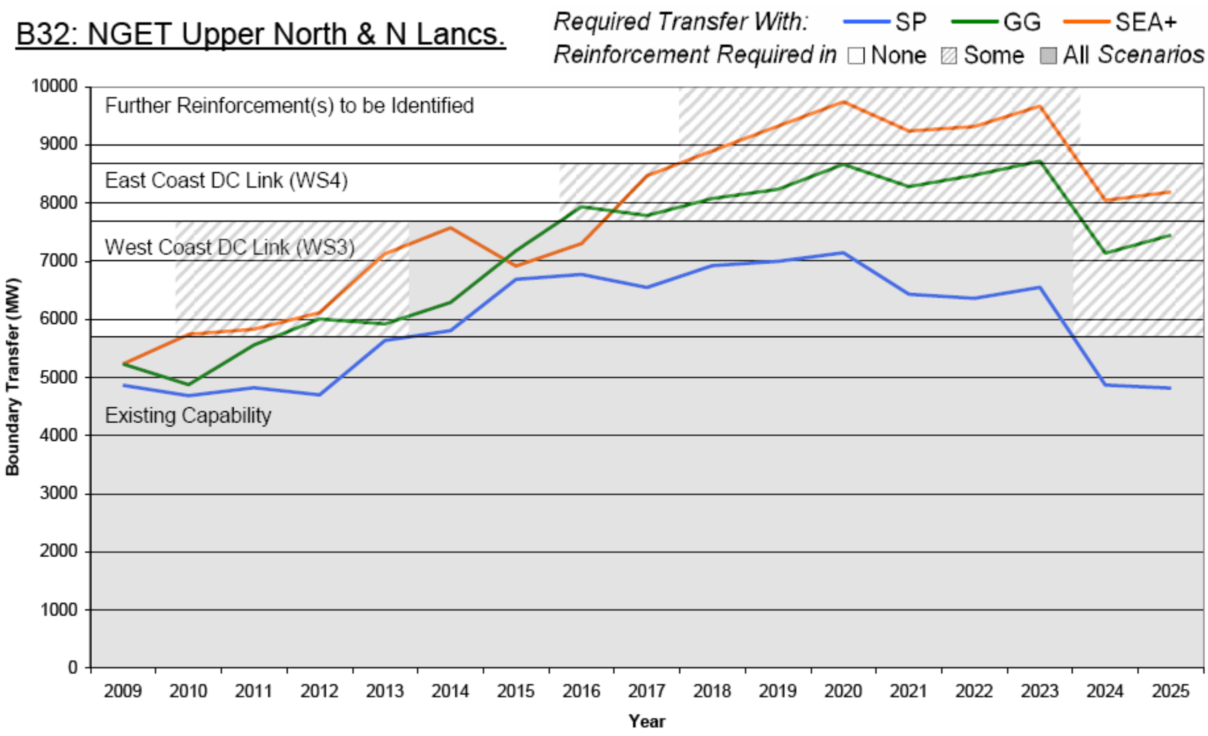
Whilst these standard designs incorporate some sharing of connections between multiple platforms, I consider there to be much more scope for the interconnection of multiple connections. The use of interconnection in the ODIS was limited both because of the very short time available in which to perform the work, and the requirements of the planning criteria for offshore networks, which are optimised for windfarms under 1500MW of size and within 100km of the coastline. By contrast, the largest proposed windfarm in the ODIS has a capacity of 12.8GW and is located several hundred kilometres offshore (almost half way to Norway). Such large windfarms will require multiple platforms and multiple transmission links back to the shore. In these cases, the cost of interconnecting multiple platforms would be relatively slight (as a proportion of the total project cost), and interconnection would provide valuable redundancy should one of the relatively long and vulnerable shore-links cables fail. These issues are being investigated as part of a fundamental review of GB's transmission planning criteria, with a view to developing a second set of criteria optimised for larger windfarms located far from shore, potentially with connections to more than one country. However, under the competitive offshore transmission regime it is possible that each platform and shore-link could be developed by a different Offshore Transmission Operator, and so it is presently unclear how such interconnection would be developed.

4. Onshore Transmission System Implications

Having established generation scenarios and identified where the offshore generation will come ashore, NGET was keen to highlight the implications for the onshore transmission network. This was done by using the process defined in Great Britain's transmission planning criteria to determine the required transfer capability for system boundaries. This process consists of three steps:

1. Using a merit order and capacity cutoff threshold to determine the generation to be considered online.
2. Scaling the output of the generation considered online so that it matches the peak demand to produce the 'planned transfer' condition, and measuring the resulting flow across system boundaries.
3. Adding a defined additional allowance to the planned transfer for each boundary, to provide flexibility to accommodate variations in the generation online at peak demand.

Following this process, the required transfer capability can be seen to change over time in response to new (mostly renewable) generation coming online, and older (mostly thermal) generation subsequently being pushed 'out of rank'.



This procedure has been used since the 1940s and is largely considered to have been very effective at striking an appropriate balance between ensuring security of supply and minimising the cost of transmission infrastructure. However, the process was designed for situations where the total generation capacity is ~110-130% of the peak demand. With the large amount of intermittent renewable generation connecting to the network, the future generation capacity in some scenarios exceeds 200% of the peak demand in later years. We subsequently encountered a number of difficulties in using this process for the ODIS.

The first problem was when we found that in some of the more optimistic scenarios, wind-generation was going 'out of rank' in later years. This was because generators have historically been ranked according to their recent behaviour (or in the case of a new generator, the behaviour of similar generators), and using this technique, most intermittent forms of generation were ranked below base-load nuclear, coal and some gas-fired generation. After some discussion we decided that the recent operation of generation is not necessarily indicative of what its operation in 2020-2025 will be like and opted to re-rank the generation based on fuel type. This was adequate to ensure that renewable generation was not pushed out of rank. The practical implication of this is that conventional forms of generation (including base-load nuclear and coal) will need to become more flexible in coming years. This requirement is apparently being factored into the design of the next generation of nuclear power stations soon to be developed in the UK. These generators are likely to support a mode where they can operate stably at a very low level of output (around 20% of rated power), that they can quickly enter and come out of. Whilst in this state, they are unlikely to be able to provide ancillary services (FCAS, voltage regulation etc.), but will still contribute inertia to the system.

The second difficulty we encountered using the technique was finding that in some cases the calculated required transfer was less than what would be necessary to accommodate some reasonably anticipated operating conditions. This was due to the manner with which intermittent generation is handled by the process and the large scaling factors needing to be applied to match the generation to the demand. This issue was most notable in somewhat radial areas of the network with a small number of large generators. We reasoned that given the changing background there was inadequate generation diversity in certain regions for the problematic boundaries to be considered part of the 'main interconnected transmission system', for which the procedure is valid. These boundaries were therefore excluded from the 'onshore transmission implications' chapter and were instead implicitly considered in the 'offshore and local onshore transmission' chapter. However, the validity of the procedure is presently being assessed as part of a wider 'fundamental review' of Great Britain's transmission planning criteria, and it will be interesting to see how the required boundary capabilities may vary in the future with changes to the technique. Given the relatively high cost of generation (renewable and conventional) compared with transmission infrastructure in the UK and the greater variability in network flows that will occur, I expect the required boundary capabilities to increase.

Future

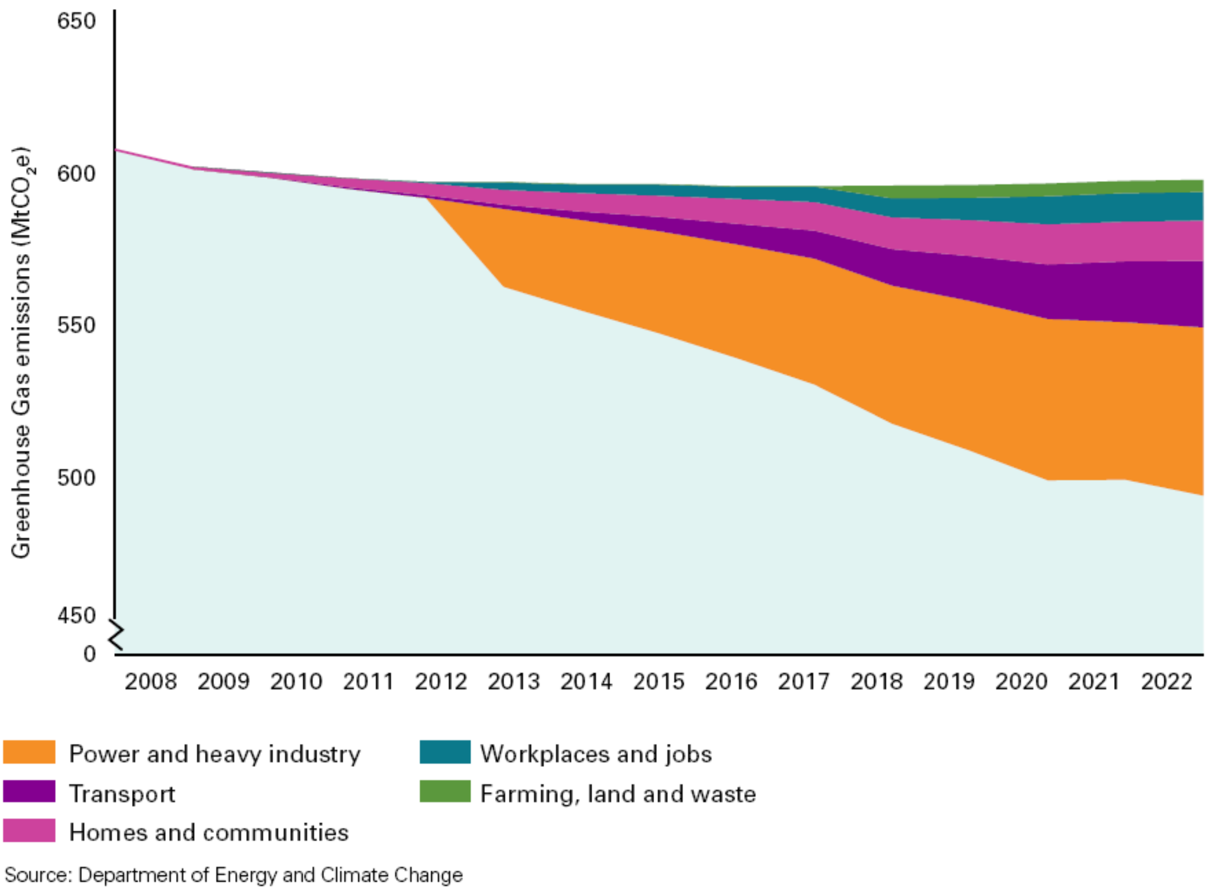
The ODIS is intended to be a living document and NGET is required to re-publish it each year. However, it remains to be seen how effective it is at facilitating co-ordination between multiple prospective Offshore Transmission Operators (OFTOs) when they are not allowed to communicate with each other or with NGET until the bidding process is complete and the OFTOs have been appointed and had their revenue set. NGET has firmly maintained that since it will not own the assets, it will not perform detailed design work for the assets, and so the document will always contain indicative results, based on speculative high-level analysis. Therefore, I find it difficult to understand how the ODIS can accomplish its purpose and am concerned that the cost efficiencies gained by a competitive offshore transmission network operator appointment process may be outweighed by the efficiencies that are missed through a lack of communication. This is a hotly discussed topic amongst my colleagues, and within NGET there is obviously a strong preference for NGET to undertake all of the work. Some political parties have indicated that, should they win the upcoming federal election, they would dissolve the competitive offshore transmission regime and adopt a more straightforward approach.

Although the offshore connection distances being considered in the UK are not long by Australian standards, the need to use cable makes offshore transmission similar, both electrically and economically, to long radial overhead-line generator connections. Therefore, in a lot of ways, the development of offshore generation in the UK is akin to the development of generation in Australia's interior. It will therefore be valuable for Australia to monitor developments in the UK in coming years and to learn from their experience.

General Impact of Climate Change Initiatives on UK Power Sector

The UK is in the midst of a significant shift in the way in which it generates and uses energy, as it attempts to reduce its greenhouse gas emissions. Working with different teams inside National Grid and interacting with representatives of various UK governments and government departments has provided some insight into the broad impacts of this shift on the UK as a whole and on National Grid as a company. I wanted to briefly record some of these insights as a secondary topic in this report.

In mid 2009 the UK Government released its Low Carbon Transition Plan[2], which outlines how the UK is planning to deliver emission cuts of 18% of 2008 levels by the year 2020. The plot below shows how this reduction is apportioned between different sectors of society.



The emission reductions will be delivered by a variety of different measures, which I have summarised in the table below. In this table, I have tried to differentiate between the measures that will directly provide the emission reductions and the mechanisms that the government will implement to support these measures. Initially it might seem as though only the reductions

[2] The UK Low Carbon Transition Plan, HM Government, 15 July 2009 Available online at: http://www.decc.gov.uk/en/content/cms/publications/lc_trans_plan/lc_trans_plan.aspx

associated with the ‘power and heavy industry’ section would impact upon the electricity industry. However, many of the measures being applied to other sectors will have a knock-on effect on the electricity sector, which I have attempted to describe in the third column.

<table>
<tr><th>Measure</th><th>Supporting Mechanism(s)</th><th>Impact on Electricity Sector</th></tr>
<tr><td>Obtaining 40% of UK’s electricity from low carbon sources and “around 30%” from renewable sources by 2020</td><td>Renewable obligation scheme (akin to Australia’s MRET scheme)</td><td>Significantly increased proportion of renewable generation, and a moderate increase in nuclear generation</td></tr>
<tr><td>Improve energy efficiencies in the heavy industry sector</td><td>EU emissions trading scheme</td><td>Reduced industrial demand</td></tr>
<tr><td>Increase use of carbon capture & storage</td><td>Funding up to four demonstrations of capturing and storing emissions from coal power stations.</td><td>Some coal and gas fired thermal generation likely to remain part of the fuel mix in future years</td></tr>
<tr><td>Facilitate the building of new nuclear power stations</td><td rowspan="2">New approval process for nationally significant infrastructure project, based around government-authored National Policy Statements and an independent Infrastructure Planning Commission to decide on specific projects. [3]</td><td>Baseload demand supplied by very large (up on 1800MW per unit) and operationally inflexible nuclear generation for the foreseeable future</td></tr>
<tr><td rowspan="2">A “bigger, smarter electricity grid” with:
- improved information for consumers
- improved demand management
- support for embedded generation
- improved information for operators
- increased use of energy storage
- optimised usage of the grid</td><td>Faster consenting time for infrastructure, but far more public transparency/scrutiny of design options</td></tr>
<tr><td>“Clarifying that Ofgem, in its job to protect consumers, both current and future, should help tackle climate change and ensure security of supply.”</td><td>Development of considerable transmission infrastructure.</td></tr>
</table>

[3] Draft National Policy Statements relating to electricity sector have been released for consultation. The statements are much more focussed on delivering infrastructure than the previous regime seems to have been, and the networks statement is quite sympathetic to the use of overhead lines. A copy of the draft NPS is available at: https://www.energynpsconsultation.decc.gov.uk/

Faster grid connections	A new 'connect and mange regime' where generation is connected as soon as local connection works are complete, instead of waiting for backbone reinforcements to also be complete	Increased constraints on the power system, leading to increased constraint costs and greater pressure to deliver transmission reinforcements
Improving the energy efficiency of homes	Retailer led efficiency program (the effectiveness of which is being debated quite publically) 'Pay as you save' financing on home efficiency improvements. Higher standards applying to new homes and efficiency certificates for existing properties that are rented. Other community initiatives	Decrease in demand from residential homes. Changing magnitude and characteristic of loads, including its the sensitivity to various factors (such as weather) and its nature (e.g. the replacement of resistive heating more efficient heat pumps (reverse cycle air conditioning) will increase the demand for reactive power at winter peak)
Change the behaviour of energy consumers	Rolling out smart meters to every home Support measures for low income earners	Change in demand profile
Increased embedded renewable generation	Incentives to purchase renewable generation Feed in tariff	Increased volumes of embedded generation
Developing expertise in green technologies	Support for technology development for: - marine power generation - low carbon construction - ultra-low emission vehicles	Increased marine power generation and electric vehicles
Efficiency improvements in workplaces	Various advice, incentive and penalty schemes to encourage companies to save power and reduce emissions.	Reduction in commercial demand

Reducing average carbon dioxide emissions from new cars across the EU by 40%	Supporting the largest demonstration project in the world for electric cars Offsetting the cost of low-carbon vehicles	Significant new electric loads being connected throughout the distribution network
	Pushing for more stringent vehicle emission standards	Increased use of public transport, including electrically powered trains.
	Sourcing 10% of UK transport energy from sustainable renewable sources by 2020	
Capturing and converting farming waste into renewable power	Increasing landfill levy Greater capture of landfill emissions, to produce power Greater use of anaerobic digestion to produce power from manure and farming waste	More embedded generation in rural areas and at landfill sites
Creation of new woodland areas	Encouraging private funding for new woodland creation	N/A
Efficient farming	Encouraging efficient farming practices	N/A

In addition to these measures, a number of supporting mechanisms are being fundamentally reviewed/changed to ensure that they remain fit for purpose in the changing environment, including:

- the process Ofgem uses to regulate the UK's energy networks [4]
- Great Britian's transmission planning and operating standards [5]

This profound shift in energy generation, transport and usage is significantly increasing the demand for National Grid's existing services and providing new business opportunities, such as the transportation of captured carbon dioxide. As such, National Grid is highly supportive of the UK's carbon reduction aspirations, and is quite vocal about this within the media.

[4] For more information on Ofgem's review, see http://www.ofgem.gov.uk/Networks/rpix20/Pages/RPIX20.aspx

[5] For more information see http://www.nationalgrid.com/uk/Electricity/Codes/gbsqsscode/fundamental/

However, grappling so many changes at the same time is also leading to several complications for National Grid. Some commonly known examples include:

- The unprecedented national and international demand for technical employees is leading to difficulties resourcing National Grid's activities. The is only likely to worsen in coming years as several very large UK projects move from the conceptual planning stage to the detailed design and construction stages, further increasing demand.
- Ofgem recently announced that it will defer National Grid's next price control review (i.e. revenue reset) by one year to enable Ofgem to conclude its review of energy network regulation. This necessitates a 'mini' one-year price control review in 2010, followed by the normal five-year review in 2011. Past experience suggests that a disproportionate amount of effort is likely to be required for this 'mini' price control review.
- Significant transmission network planning, and increasingly project approval and implementation, is taking place before the fundamental review of planning criteria is complete. The government is rightly upset that Ofgem has approved funding to progress the development of several major projects before the review is complete, while Ofgem and National Grid rightly claim that the infrastructure won't be delivered in time if it isn't progressed immediately.
- A key driver for the transmission reinforcements being progressed (series compensation of existing circuits and an offshore HVDC link between England and Scotland) is the speed with which the projects can be developed. Had the need for reinforcement been recognised earlier and funding been made available, it is possible that more cost-effective onshore options could have been utilised.
- The new infrastructure approval process is presently untested and there is concern that the first few applications will be rejected as National Grid (and other companies) learn about the committee's expectations, and will subsequently need to be resubmitted adding an additional 1-year delay.

In retrospect, it would have been far preferable for many of the strategic reviews/changes/studies to have been progressed earlier so that their findings were in place before the wave of new generator connection applications hit. Of course, the need to make these changes has only become apparent in the past few years. I believe that this is a key area in which Australia can learn from the UK's lead. The more strategic thinking that can be done in advance, the more orderly, co-ordinated and efficient the transition to renewable generation will be.

Next Quarter

At the time of writing, my first quarter of 2010 has already been very interesting and varied, including:

- a visit to the Spanish transmission operator, Red Eléctrica de España to learn from their operational experience with over 18GW of wind generation
- power system studies to assess the effectiveness of reinforcements to facilitate wind generation on the west coast of Great Britain
- a visit to a key central London substation, including a 400kV GIS switchyard
- analysis of government developed 2050 generation scenarios to identify the implications for the transmission network
- attending the grid-code compliance testing of a new windfarm, the first in the UK to use full-converter turbines

The remainder of the quarter is likely to be taken up by involvement in the fundamental review of Britain's transmission planning and operational standards. I will write about all of these experiences in my next quarterly report.

Acknowledgements

I would like to gratefully acknowledge the assistance and patience of those NGET colleagues with whom I worked on the development of the ODIS: Richard Proctor, Paramjit Sihre, James Walley, Lilian MacLeod, Steve Thompson, Duncan Rimmer, Beehun Tan, and Andy Hiorns.

Soli Deo Gloria – to God alone be the glory.