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Historic Strategic Options Report - Update (2016)

National Grid (North Wales Connection Project)

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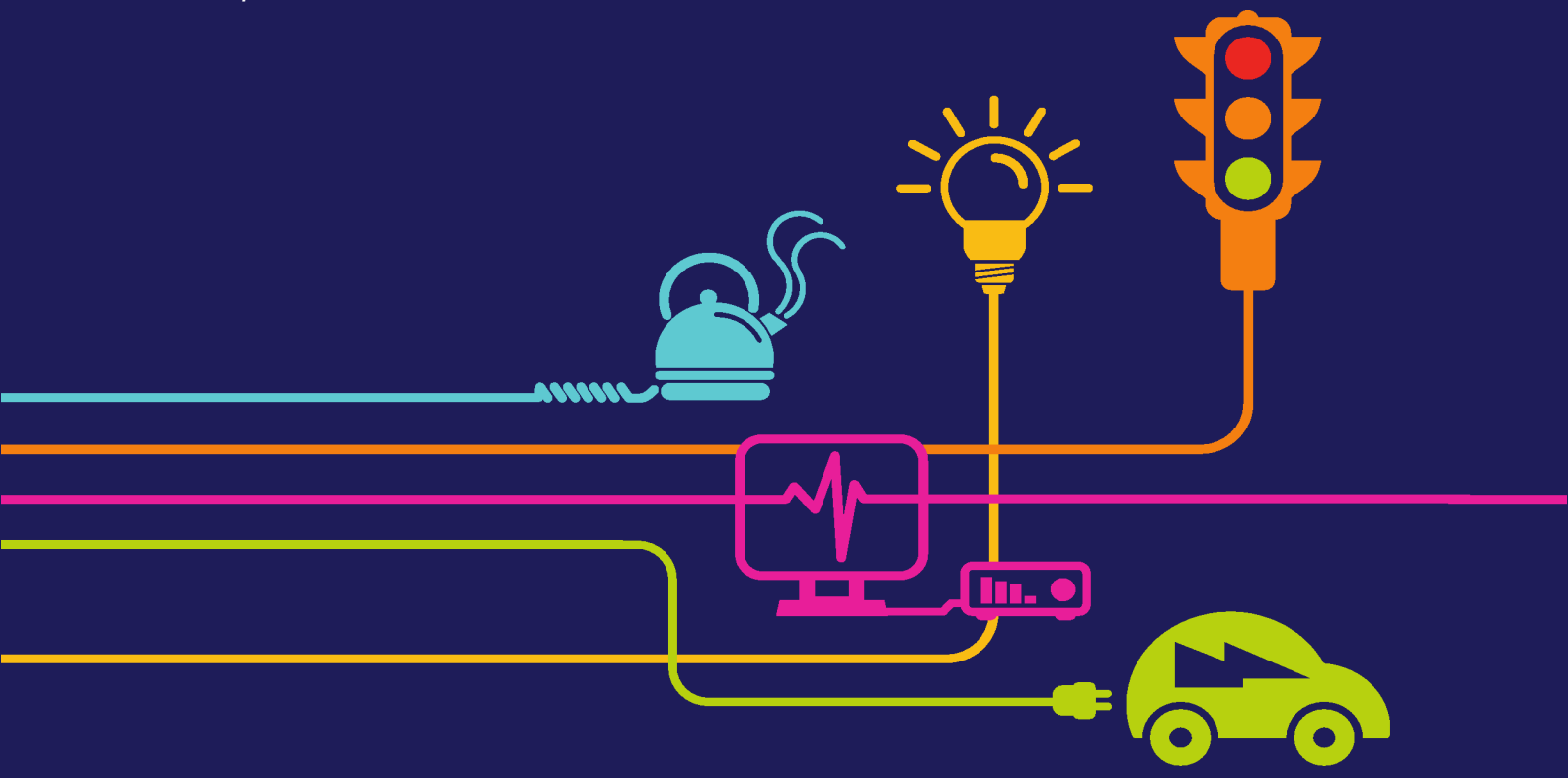

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North Wales Connections

2016 Strategic Options Update Report

National Grid

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October 2016

Contents

1. Introduction

1.1 This report provides an update on the developments related to the North Wales Connection project that have taken place since the publication of the Project Need Case and Strategic Options Report (SOR) on 9 January 2015[1].

1.2 In order to connect to the electricity system a power station must have a contractual agreement with National Grid or with a distribution network owner. Only generation projects that have contracted connection agreement are considered as part of National Grid's need case. We refer to these contracted future connections (along with the existing power stations in North Wales) as the "contracted generation background". The changes to the contracted generation background in North Wales that have occurred since January 2015 and how these changes affect the previously identified Strategic Options are described.

1.3 This report also describes the results of the continued development work around the preferred option (Strategic Option 3 – with overhead line). This update focuses on the proposed new overhead line double circuit route connecting between Wylfa and Pentir substations as this element of the preferred Strategic Option has been the focus of the most recent development work.

1.4 This development work has provided greater certainty around specific elements of the preferred option such as the overhead line route length, any mitigation that is required, and the nature of this mitigation. The impact this latest information has upon the cost of the preferred option is also presented in this report.

1.5 This report clarifies the scope of the proposed development that National Grid currently intends to include within the planned 2017 Development Consent Order application, subject to the outcomes of the statutory consultation commencing in October 2016.

1.6 A "back-check" comparison of the current preferred Strategic Option against the alternatives that were previously identified will also be presented in this

[1] The 2015 versions of the Project Need Case and Strategic Options Report can be found on the project website http://www.northwalesconnection.com

report, as referred to in paragraph 1.11 of the January 2015 SOR. This comparison will reflect any changes including in project cost and scope that have been driven by matters such as the changes to the contracted generation background in North Wales and by the mitigation measures identified for the preferred option through the ongoing development work.

1.7 Finally, this report will advise whether or not Strategic Option 3 – with overhead line remains the preferred connection option at this stage of the evolution of the proposed project.

1.8 Following consideration of all the latest information available to the project team it was concluded that Strategic Option 3 – with overhead line does remain the preferred option

2. Contracted Generation Background in North Wales

2.1 Four changes have occurred in the North Wales contracted generation background since January 2015. These are:

- The existing Wylfa nuclear power station formally reduced its generation capacity to 0 MW
- Greenwire has revised its connection date from 2018 to 2020
- Codling Park has revised its connection date from 2018 to 2021
- A new 299 MW biomass power station, named Orthios Power, applied to connect at Penhros substation in 2019.

2.2 The following table shows the changes in contracted generation in North Wales since 2015 (changes from the 2015 background are highlighted in yellow)

	2015 Contracted Background		2016 Contracted Background	
Generator Name	Connection Date	Capacity (MW)	Connection Date	Capacity (MW)
Wylfa	Existing	450	Decommissioning	0
Dinorwig	Existing	1,644	Existing	1,644
Ffestiniog	Existing	360	Existing	360
Dolgarrog	Existing	39	Existing	39
Maentwrog	Existing	30	Existing	30
Cwm Dyli	Existing	10	Existing	10
Gwynt y Môr	Existing	565	Existing	565
Burbo bank Extension	2016	254	2016	254
Greenwire Wind Farm	2018	1,000	2020	1,000
Codling Park Wind Farm	2018	1,000	2021	1,000
Wylfa Newydd	2024-2025	2,800	2024-2025	2,800
Orthios Power	-	-	2019-2020	299
		8,152		**8,001**

Table 1 – Changes in North Wales Contracted Generation Background

2.3 The change in connection dates for Greenwire and Codling Park have no impact of the need case for reinforcement in North Wales or on the parameters of the previously identified Strategic Options. This is because the capacity of these projects has not changed and projects still intend to connect

at the same location in the North Wales network, Pentir.

2.4 Due to the reduction of the existing Wylfa power station capacity to 0 MW it appears that the overall generation capacity in North Wales has reduced by 151 MW. However, as this power station was always scheduled to commence decommissioning before the connection of any of the new generation in North Wales it was not considered as part of the need case and did not influence the scope of the proposed Strategic Options presented in 2015. All previous descriptions of the project need case and Strategic Options assumed that the existing Wylfa nuclear power station would close prior to the connection of new generation in North Wales.

2.5 Therefore the reduction in contracted generation capacity at the existing Wylfa power station has no impact on the need case for reinforcement in North Wales or on the specific rating requirements for the previously identified Strategic Options.

2.6 When the 450 MW capacity of the existing Wylfa power station is removed from the calculations it can be seen that the total contracted generation background in North Wales has increased from 7,702 MW (8,152 MW minus 450 MW) to 8,001 MW. An increase of 299 MW resulting from the additional connection of Orthios Power.

2.7 As the Orthios connection does cause an increase in the North Wales generation capacity it was necessary for National Grid to reassess the rating requirements of the previously identified Strategic Options.

2.8 The results of that analysis concluded that the increase of 299 MW of generation capacity in North Wales does not alter the parameters of the Strategic Options, i.e. all the previously identified Strategic Options could accommodate the additional 299 MW of North Wales generation without the need for higher rated assets being used. No new Strategic Options have been identified as a result of the changes to the contracted generation background.

2.9 As there is no change to the parameters of the Strategic Options in terms of generation capacity or need, there is therefore no change in the associated estimated costs for the Strategic Options. In addition, there have been no material changes, including in respect of National Grid's understanding of

technology costs that would result in changes to the estimated Strategic Option costs.

2.10 In conclusion, the changes to the contracted generation background in North Wales since January 2015 result in no material change to the project need case and results in no changes at all to the parameters or estimated costs of the Strategic Options as presented in table 17.1 of the 2015 SOR. Those options are presented again in table 2 below.

	Description	Total Capital Cost by Technology Type			
		OHL	AC Cable	HVDC	GIL
SO1	2x HVDC Wylfa - Deeside	**N/A**	**N/A**	**£1,134m**	**N/A**
SO2	1x HVDC Wylfa – Deeside 1x HVDC Wylfa - Pembroke	**N/A**	**N/A**	**£1,378m**	**N/A**
SO3	Wylfa to Pentir Onshore	£164m	£585m	£776m	£798m
	Mainland Common Works*	£355m	£355m	£355m	£355m
	Strategic Option 3 Total	**£519m**	**£940m**	**£1,131m**	**£1,153m**
SO4	Wylfa to Pentir Offshore (E)	N/A	£900m	£866m	N/A
	Mainland Common Works*	N/A	£355m	£355m	N/A
	Strategic Option 4 Total	**N/A**	**£1,255m**	**£1,221m**	**N/A**
SO5	Wylfa to Pentir Offshore (W)	N/A	£1,113m	£927m	N/A
	Mainland Common Works*	N/A	£355m	£355m	N/A
	Strategic Option 5 Total	**N/A**	**£1,468m**	**£1,282m**	**N/A**
SO6	Wylfa to Pentir Hybrid	£560m	£836m	£876m	£973m
	Mainland Common Works*	£355m	£355m	£355m	£355m
	Strategic Option 6 Total	**£915m**	**£1,191m**	**£1,231m**	**£1,328m**

* Assumes AC underground cable is used for the Wern to Y Garth Connection

Table 2 – Strategic Options and Estimated Costs as Presented in 2015 SOR

3. Continued Assessment of Alternative Strategic Options

3.1 Alongside development of the preferred Strategic Option, National Grid continues to assess any new information that may have an impact on the assessment of alternative Strategic Options that were not previously taken forward.

3.2 As described in section 2, the changes to the contracted generation background in North Wales resulted in no changes to the range, scope, or cost of the previously identified Strategic Options and hence the information presented in the 2015 SOR remains valid.

3.3 National Grid previously considered the use of HVDC links to provide an offshore connection as part of the alternative Strategic Options. While it was acknowledged that HVDC could, in theory, be used to provide a direct connection for a nuclear power station such as Wylfa Newydd, National Grid highlighted the fact that this technology had not been used in this manner before and that a connection of this type would represent a world first both in terms of the size of HVDC link required and connection of a nuclear power station.

3.4 Therefore, in addition to the fact that HVDC options have a far higher capital cost than alternatives we also believed that an HVDC option would carry far greater risk in terms of technical performance, potential cost increases, and delays to delivery programme. Horizon Nuclear Power (the developers of Wylfa Newydd) also provided a supporting statement recording their concerns regarding an HVDC connection:

"Horizon is not aware of any precedent for a nuclear power station grid connection being achieved using HVDC technology, either in part or solely connected using that technology. We therefore see such a connection design as introducing significant additional technical risk for both normal and abnormal grid operating scenarios and we would anticipate the need for National Grid to carry out a range of studies to fully understand the nature and extent of those risks. For its part, Horizon would also wish to carry out its own independent studies to assess the technical implications of employing a connection achieved partly using HVDC technology and it is likely that a significant programme of work would need to be undertaken to enable Horizon

to make such a judgement."

3.5 In response from stakeholder feedback requesting that National Grid further investigate the possibility of an HVDC option a report by an independent technical consultant (WSP – Parsons Brinkerhoff) was commissioned to assess the viability of an HVDC options. This report confirmed National Grid's view that using HVDC technology in this way is unprecedented and that a significant amount of technical development work would be needed before an HVDC connection could be considered viable.

3.6 As a result of this confirmation and the fact that the capital cost of HVDC equipment has not materially changed, it has been concluded that the appraisal of the HVDC options presented in the 2015 SOR remains valid.

3.7 In conclusion, having regard to the new information that has become available, no changes to project scope have occurred that would require a re-appraisal of the Strategic Options previously presented in the 2015 SOR.

4. Scope of National Grid's Planned Development Consent Order Submission

4.1 National Grid has previously described, for all identified Strategic Options, the full scope of works required to connect all contracted generation developments in North Wales.

4.2 National Grid's planned Development Consent Order application (scheduled for submission in late 2017) will be seeking to obtain consent for the works between Wylfa and Pentir. Therefore the scope of work for which development consent will be applied is:

- Modification of the existing 400 kV substation at Wylfa;
- modification of the existing 400 kV substation at Pentir;
- and installation of an AC overhead line double circuit between Wylfa and Pentir (with an underground cable section crossing the Menai Strait).

4.3 In terms of the other works forming part of Strategic Option 3, other relevant planning applications will be made in due course to the appropriate planning authorities.

4.4 This consenting strategy has no impact on the appraisal of the Strategic Options and all works identified in the 2015 SOR are still required to connect the contracted generation in North Wales.

5. Development of a Preferred Strategic Option

5.1 The 2015 SOR identified Strategic Option 3 – with overhead line as being the preferred Strategic Option that would be taken forward for further development.

5.2 Strategic Option 3 comprised of two distinct elements: new circuits connecting between existing substations at Wylfa and Pentir, and mainland works to upgrade the existing transmission network in North Wales.

5.3 The works connecting between Wylfa and Pentir, as described as part of Strategic Option 3 – with overhead line in the 2015 SOR, consist of:

- Modification of the existing 400 kV substation at Wylfa;
- modification of the existing 400 kV substation at Pentir;
- and installation of an AC overhead line double circuit between Wylfa and Pentir, a distance of 40 km.

5.4 The works on the North Wales mainland to enhance the existing network in North Wales beyond Pentir (referred to as the "mainland common works") as described as part of Strategic Option 3 – with overhead line in the 2015 SOR, consist of:

- Addition of a second Pentir to Trawsfynydd circuit on the same pylons as the existing circuit (including reconductoring of existing circuit);
- modification of Pentir 400 kV substation to accommodate second Pentir – Trawsfynydd circuit;
- a new Grid Supply Point (GSP) in west Gwynedd;
- re-conductoring of existing circuits in North Wales;
- the installation of series compensation equipment;
- and installation of enhanced connections between Wern and Y Garth (near Porthmadog and the Glaslyn Estuary).

5.5 A full description of this Strategic Option, and all other identified Strategic Options can be found in the 2015 SOR, available on the project website[2].

5.6 National Grid has previously confirmed our intention to use underground cable

[2] http://www.northwalesconnection.com

technology in the most sensitive areas of the Wylfa to Pentir route, namely the Anglesey AONB and the Menai Strait. National Grid remains committed to this mitigation approach and the development work carried out since January 2015 has sought to clarify how this mitigation can be delivered.

5.7 National Grid has undertaken extensive geological and environmental surveys of the Menai Strait and the surrounding area. In addition we also sought the views of local stakeholders and the public at the end of 2015 regarding the potential options for crossing the Menai Strait.

5.8 After assessing all the available information the most appropriate means of achieving a crossing using AC cables is to house these cables in a tunnel that passes underneath the Menai Strait. In arriving at this solution National Grid assessed alternatives such as laying cables direct on the seabed or using horizontal directional drilling to install cables under the surface of the seabed. However it was decided that the construction of a tunnel represented both the best solution for maintaining the integrity of the Anglesey AONB and the Menai Strait as well as ensuring the most economic and efficient solution for the GB electricity consumer. Further information on our assessment of the options for crossing the Menai can be found in The Menai Crossing Report which is available on the project website[3].

5.9 Based on feedback from consultation and our further development work, National Grid has narrowed down the range of possible locations for the cable sealing end compounds (these are required to transfer the overhead line circuits to the underground cable sections). A number of options have now been ruled out leaving only options that lie outside of the Anglesey AONB. This decision means the underground cable section needed to cross the Menai Strait will be approximately 4km in length.

5.10 National Grid has also continued to develop our proposal for the new overhead line route on Anglesey. This work has examined detailed routing options. The results of this work, and the conclusion regarding the length of the underground section at the Menai Strait means that we now understand the total length of the route between Wylfa and Pentir to be ~35km in length (~31km overhead line and 4km underground cables) as opposed to the 40km that was assumed at the initial Strategic Options stage.

[3] http://www.northwalesconnection.com

5.11 This updated information regarding the proposed route length and the identified mitigation measures at the Menai Strait allow National Grid to prepare a more detailed cost estimate of the preferred option. This updated cost and a "back-check" against the previously identified alternative Strategic Options are described in section 6.

6. Developed Cost Assessment of the Preferred Strategic Option

6.1 The Strategic Options costs presented in the SOR are based on the best information available at this stage in the detailed design evolution. These are early stage indicative estimates of the capital costs and are prepared to allow a high level cost comparison of options. These are based on a high level scope of works defined for each Strategic Option in respect of each technology option that is considered to be feasible.

6.2 National Grid takes account of equivalent assumptions for each option. The capital cost estimates are based on generalised unit costs for the key elements of each option. They include costs for the transmission equipment and also for the installation of that equipment but do not include any project or site specific costs or requirements that may later be found to be applicable to a particular option.

6.3 At the time of the Strategic Options assessment, the unit cost information took account of recent contract values and/or budget estimates from equipment manufacturers/suppliers or specialist consultants and provided a consistent basis for preparing capital cost estimates. The unit cost information also takes account of the report 'Electricity Transmission Costing Study', an independent report endorsed by the Institution of Engineering & Technology and prepared by Parsons Brinckerhoff in association with Cable Consulting International.

6.4 Given the early stage in the project development process at which the identification of Strategic Options takes place, an estimate route length for new circuits is applied to all Strategic Options. These route lengths may change during project development as further information regarding specific routeing constraints becomes available. This initial assumption enables a direct comparison of technologies in order to rationalise Strategic Options to a pragmatic number of options to be taken forward for further consultation and assessment.

6.5 The capital cost estimates prepared at this initial analysis stage are sufficiently detailed to allow an indicative comparison of capital costs across options but do not represent a forecast of actual final project cost.

6.6 As National Grid has continued to develop the preferred Strategic Option we have also developed a more detailed understanding of the actual forecast construction costs and have been able to factor in project specific requirements such as the mitigation proposals around the Menai Strait and the exact overhead line routing.

6.7 As a result of this continued development work, National Grid's latest forecast of cost for Strategic Option 3 – with overhead line including mitigation is £620m.

6.8 This forecast includes the current details of the proposed overhead line route between Wylfa and Pentir and also includes the mitigation required at Anglesey AONB and the Menai Strait. This cost estimate is based on our latest proposals that this mitigation will be delivered via underground cables housed in a tunnel.

6.9 This forecast cost is not solely based on the SOR methodology that was used to prepare the initial cost estimates for the identified Strategic Options. This is National Grid's current "best view" forecast of likely project costs and takes into account all project specific information that we have at this time and does not solely rely on generic assumptions around technology, routing, or mitigation cost.

6.10 The previously calculated SOR cost for Strategic Option 3 – with overhead line was £519m (see table 3 above).

6.11 Therefore, National Grid's current actual project cost estimate (£620m) represents an increase of £101m from the SOR estimate.

6.12 It is therefore necessary to compare this latest cost estimate against the alternative Strategic Options and technology options to confirm that Strategic Option 3 – with overhead line remains the preferred option now that the full mitigation requirements and detailed project cost forecast have been determined.

6.13 The following table shows the full range of alternative Strategic Option costs and includes the latest actual cost forecast for Strategic Option 3 – with overhead line.

	Description	Total Capital Cost by Technology Type			
		OHL	AC Cable	HVDC	GIL
SO1	2x HVDC Wylfa - Deeside	**N/A**	**N/A**	**£1,134m**	**N/A**
SO2	1x HVDC Wylfa – Deeside 1x HVDC Wylfa - Pembroke	**N/A**	**N/A**	**£1,378m**	**N/A**
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	Strategic Option 6 Total	**£915m**	**£1,191m**	**£1,231m**	**£1,328m**

* Assumes AC underground cable is used for the Wern to Y Garth Connection

Table 3 – Strategic Options and Estimated Costs (with latest forecast cost for Strategic Option 3 – with overhead line including mitigation)

6.14 It can be seen in table 3 that the forecast actual cost for Strategic Option 3 – with overhead line including mitigation remains £295m less expensive than the next cheapest Strategic Option cost (£915m for Strategic Option 6 - OHL).

6.15 If National Grid were to carry out further development of the alternative Strategic Options in order to prepare more detailed cost estimates (i.e. including mitigation) for these options it is expected that these estimates would at best remain unchanged or would most likely increase from the current SOR cost level.

6.16 Therefore it can be concluded that Strategic Option 3 – with overhead line

remains the lowest cost option even when the detailed mitigated project cost forecast is compared against the SOR cost estimates as at January 2015 for the alternative Strategic Options.

6.17 Strategic Options 1 and 2 are not subject to the identified mitigation requirements around the Menai Strait as these options are entirely offshore. However, these HVDC options remain significantly more expensive than other Strategic Options, even without mitigation considered. Therefore there is no basis to assume that further investigation of these options would result in a reduction in the capital cost for these options. Strategic Options 1 and 2 remain £514 and £758m respectively more expensive than Strategic Option 3 – with overhead line.

6.18 Strategic Option 3 – with overhead line remains between £320m and £533m less expensive than the alternative technology choices for this Strategic Option (AC cable, HVDC, or GIL). Were these alternative technology solutions to be developed further the cost estimates would be expected to rise as each of these options would still require a crossing of the Menai and the current SOR cost estimates do not include the costs for constructing the tunnel required for this crossing.

6.19 The lowest estimated SOR costs for Strategic Options 4 and 5 remain £601m and £662m respectively more expensive than the latest forecast cost for Strategic Option 3 – with overhead line. If further development of these options were to be undertaken it could be reasonably assumed that these cost estimates would increase as the need for similar mitigation requirements to those proposed for Strategic Option 3 would be identified. Although Strategic Options 4 and 5 are primarily offshore options they are still based on a connection at Pentir. Therefore any offshore cables would have to negotiate some form of passage along or around the Menai Strait. Laying cables through the Menai Strait is not preferred due to potential effects on the SAC. Therefore, any further development of these options would likely include the use of tunnelling under the Menai Strait or an alternative onshore route around this area, both of these solutions, when mitigated, would increase costs above the SOR level.

6.20 Strategic Option 6 remains a minimum of £295m more expensive than Strategic Option 3 – with overhead line. National Grid has no new information

to indicate that the cost of subsea cables have reduced since the SOR cost estimate was prepared. Therefore it is not expected that further development of this option would result in a lower cost being determined. It is more likely that cost would increase as a result of further development. The initial SOR cost estimate assumes the most direct subsea routing in order minimise the length of the cables required. It could be reasonably expected that any detailed sea bed survey of this route would identify some areas that would require a diversion from the most direct route or some other form of mitigation measure. Either of these would increase the cost of sub-sea cable route.

6.21 In conclusion, National Grid has continued to develop the preferred option and as a result has developed a more detailed cost forecast of this option. This forecast shows an increase of £101m from the generic SOR cost estimate.

6.22 There is no evidence that the cost of any of the alternative technology types previously considered (e.g. HVDC) have reduced in any material way since the 2015 SOR cost estimates were prepared.

6.23 Therefore, National Grid has concluded that even with the additional mitigation requirements and other project specific costs taken into account, that Strategic Option 3 – with overhead line remains the lowest cost of the identified Strategic Options.

7. Overall Conclusion

7.1 This Update Report has presented the changes in contracted generation background in North Wales that have occurred since January 2015 and concluded that these do not have any material impact on the project need case or the scope, parameters, and cost of the previously identified Strategic Options.

7.2 National Grid has reviewed the alternative Strategic Options and has concluded that there are no material changes in circumstance, including in the scope or costs of these options that would necessitate a re-appraisal of the Strategic Options and hence the conclusions of the 2015 SOR remain valid.

7.3 The scope of works which National Grid intends to submit as part of the planned 2017 Development Consent Order application has been described in this report. At this time National Grid intend to seek that development consent for the works between Wylfa and Pentir that are needed to connect Wylfa Newydd. The impact this decision would have on the scope and cost of the previously identified Strategic Options has been presented in this report.

7.4 The ongoing development work of the preferred option (Strategic Option 3 – with overhead line) has determined that a tunnel will be required to achieve the crossing of the Menai Strait using underground AC cables.

7.5 As a result of this development work National Grid has developed a detailed cost forecast for the preferred Strategic Option. This forecast cost has been compared against the SOR level cost estimates for the alternative Strategic Options.

7.6 This comparison showed that the capital cost of Strategic Option 3 – with overhead line remains £295m lower than the next cheapest Strategic Option.

7.7 As described in the 2015 SOR, Strategic Option 3 also offers a degree of flexibility in terms of when National Grid has to progress with each element of the works. This flexibility allows National Grid to ensure that investments are only undertaken when required and allows us to plan delivery of required

works in a way that best aligns with generation developments.

7.8 In conclusion, following a review of changes of circumstance that could materially affect the analysis, including to the contracted generation background, a review of the alternative Strategic Options, and an assessment of the latest forecast costs, Strategic Option 3 – with overhead line remains the preferred option. Development of this option will continue with the aim of submitting a Development Consent Order application in 2017 for the works between Wylfa and Pentir.