APPLICATION PAPER FOR THE APPROVAL OF ADDITIONAL CAPEX IN RP4

MEDIUM TERM plan : PART 1

APPLICATION TO PROCEED WITH THE CONSTRUCTION STAGE OF FOUR PROJECTS

1. TAMNAMORE 275/110KV SUBSTATION - PHASE 2
2. UPRATING THE DUNGANNON TO OMAGH A&B 110KV LINES - PHASE 2
3. UPRATING THE KELLS TO COLERAINE 110KV LINE - PHASE 1
4. CHANGE OF TRANSFORMERS AT OMAGH MAIN SUBSTATION

23 NOVEMBER 2011
Summary

The electricity network operating at 33kV and above in Northern Ireland is nearing saturation with respect to the connection of wind farms. To increase the capacity of the network to accommodate the connection of additional wind generation, short, medium and long term investment plans have been developed. These plans have been presented at summary level to the Utility Regulator.

In this paper, NIE is seeking the Utility Regulator’s approval to proceed with Part 1 of the Medium Term Plan comprising the following projects:

1. Tamnamore 275/110kV substation - Phase 2
2. Uprating the existing Dungannon to Omagh A&B 110kV lines - Phase 2
3. Uprating the existing Kells to Coleraine 110kV line - Phase 1
4. Change of transformers at Omagh Main substation

These projects are expected to be completed over the four year period from 2010/11 to 2013/14. Individual project approval papers have already been submitted by NIE for the first two projects on the above list (on 7 December 2009 and 17 June 2010 respectively). The approval papers for projects 3 and 4 will be submitted to the Utility Regulator shortly.

Three of the projects have been subject to detailed design and cost estimation by NIE and approval is sought for the financial sums indicated in the papers. The Tamnamore substation project is currently in the detailed design phase so could be subject to variation in the final estimated cost. On completion of the detailed design and estimation for Tamnamore an approval paper will be submitted for the final estimated cost.

The short and medium terms plans will identify and deliver a transmission infrastructure that will facilitate the connection of renewable generation. The method of connecting the generation to the grid is set out in NIE’s ‘clustering’ plan. The cluster plan was developed in early 2010 and has identified groups of wind farms that will connect into the transmission network using shared infrastructure and outlying wind farms that will be individually connected.

The four projects proposed in this document are required to connect wind farms that already hold connections offers or whose applications are under consideration. There is currently 340MW of onshore wind already connected to the network and a total of 353MW has obtained planning approval and is certain to connect.

Completion of the four projects will enable the connection of 550 to 600MW of wind generation to the network. This will allow 14% of the electricity consumed in NI to be delivered from renewable sources. The Government’s target is for 40% of electrical energy to be delivered from renewable sources by 2020.
The four projects have been discussed and agreed with SONI, the transmission system operator.

Cost

The total estimated additional investment required is £34.9m spread over four years. £25.3m of this expenditure is required for Phase 2 of the Tamnamore substation project. As no investment for the projects was included in the agreed capital budget for RP4, NIE is seeking approval to recover the outturn cost of the four projects through the RAB, based on a 40 year kinked depreciation profile at the allowed transmission rate of return.

The electricity network in Northern Ireland is facing an unprecedented demand for the connection of new sources of power generation. The primary driver for this demand, which arises almost exclusively in relation to wind powered generation, has been the strong economic incentive for renewable energy production underpinned by the Northern Ireland Renewables Obligation (NIRO). Renewable support mechanisms are a key enabler for the delivery of Government energy policy targets for increasing the development and application of renewable energy sources in Northern Ireland.

During 2005 the Governments of NI and the RoI initiated a joint study on the impact of increased levels of renewable energy sources on the economic and technical aspects of electricity generation and transmission on the island of Ireland. The study was conducted in four phases by a range of consultants (UCD, RISO, TNEI and Ecofys). This ‘All Island Grid Study’ was completed in 2008 and showed that significant investment would be required in the electricity network. The study indicated that it is possible and economic for 42% of electrical energy needs on the island to be delivered from renewable energy sources (mostly wind). The result of this study informed the NI and RoI Government’s respective energy policies.

The latest Government targets are set out in DETI’s Strategic Energy Framework (SEF) published in September 2010. The SEF requires increased levels of renewable power generation and associated new infrastructure to improve security and diversity of energy supply in Northern Ireland. In addition, it sets challenging renewables targets to guide market participants, recognising that there will be cost implications in moving Northern Ireland into this new energy future and the need to plan carefully to help manage and minimise the cost impact on consumers.

The SEF establishes a target for 40% of Northern Ireland’s electricity consumption to be met from renewable sources by the year 2020. This is a significant increase from the previous target of 12% as set in 2004. The current level of renewable generation within Northern Ireland is closer to 8%, and already there are difficulties in accommodating it on the existing network. The 40% DETI target presents a major challenge for the development and expansion of NIE’s network infrastructure in order to facilitate increasingly high levels of renewable power generation over the next decade and beyond.

NIE’s response to this challenge has been to develop a coordinated network development plan incorporating short, medium and longer term measures designed to increase the capacity of the network to accommodate wind power over the coming years. The shorter term measures are focused on increasing the capabilities of the existing network, medium term measures will require a

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1 http://www.dcenr.gov.ie/NR/rdonlyres/1B7ED484-456E-4718-A728-97B82D15A92F/0/AllIslandGridStudyStudyOverviewJan08.pdf
phased series of 110kV network reinforcements to increase capacity and to remove “bottlenecks”. The longer term plans will require substantial expansion of the 275kV transmission grid system. Many of the shorter term measures are already complete or underway.

This paper is concerned with the first stage in the “Medium Term Plan”, which involves reinforcement and extension of the 110kV network. Development and planning for the more substantive 275kV works to be included in the long term plan proceeds in parallel. This approach provides additional connection capacity and evens the flow of work over the development period.

The paper describes four separate developments within the 110kV network. All four are critical to the managed expansion of NIE’s network capability as part of the overall plan to facilitate Government renewable targets as quickly as possible.

2. Funding Network Development for Renewables in the current Regulatory Framework - RP4

At the time when NIE and the Utility Regulator agreed the current regulatory price control (RP4) in 2006/07 it was understood that the impact of future renewable generation was not sufficiently certain to allow either party to have confidence in a development plan or the timing of expenditure. It was clear, however, that significant transmission network development would be required. The parties agreed that the arrangements would be dealt with when the Government’s policy became better known and NIE had developed a network plan and work programme. Hence investment to support renewable generation was not included in the capital budget agreed with the Utility Regulator for RP4 (2007/08 – 2011/2012), and all development work in this area within the RP4 period has therefore been subject to specific incremental approvals.

This paper therefore requests specific regulatory approval for funding of works associated with the four 110kV network infrastructure projects described herein as part of the Medium Term Plan.

3. Progress to Date against Targets and Network Limits

Currently there are three fossil fuelled power stations located in Northern Ireland. They are Ballylumford PS close to Larne, Kilroot PS at Carrickfergus and Coolkeeragh PS in the North West. Historically most of Northern Ireland’s electric power has come from these stations together with a power station in Belfast which has closed down.

The current level of renewable generation connected to the NIE network is mainly provided by onshore wind farms. The table in Figure 1 below summarises the level of existing and projected future onshore wind farm generation:
### Wind Farm Connection Stage Summary (01 November 2010)

<table>
<thead>
<tr>
<th>Wind Farm Connection Stage</th>
<th>Capacity (MW)</th>
<th>Firm Capacity (MW)</th>
<th>Non Firm Capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connected</td>
<td>340</td>
<td>241</td>
<td>99</td>
</tr>
<tr>
<td>Committed (Offers accepted)</td>
<td>176</td>
<td>56</td>
<td>120</td>
</tr>
<tr>
<td>Applications under consideration</td>
<td>177</td>
<td>13</td>
<td>164</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>693</strong></td>
<td><strong>310</strong></td>
<td><strong>383</strong></td>
</tr>
<tr>
<td>Awaiting planning approval/under appeal</td>
<td>762</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Figure 1  Wind farm capacity summary (01 November 2010)**

The 340MW of existing generation accounts for 8% of electricity usage in NI. 275MW of this generation is located in the West of the province with the remainder in the North East. Additional wind farms with a capacity of 353MW have been approved by Planning Service and are at various stages in the connection process. Again this generation is largely located in the West.

The existing transmission network was assessed as being able to cater for the first 250MW of renewable generation in the West. Connection of additional generation in the West above 250MW causes the transmission network to become overloaded under certain network conditions (as more fully described in Section 6 below). Since mid 2009 connection offers for wind farms in this area have therefore been subject to constraints on their outputs.

As an “interim target” within its energy plan, DETI has challenged NIE to carry out sufficient network development to enable 1,000MW of renewable generation (representing circa 20-24% of energy demand) to be connected by 2015. DETI expects most of this to be provided by onshore wind. NIE has separately forecast that a total of around 780MW of onshore wind generation will be connected by 2015. This figure includes the existing 340MW of commissioned onshore wind, 353MW currently in the connections process and wind farms that are expected to obtain planning approval in time to connect by 2015. Discussions with wind farm developers and the Planning Service have helped NIE form a view on the rate at which generation will come forward for connection.

NIE’s Medium Term Plan, described in summary below, is based on the maximum connection capacity that can be delivered without dependence on the major 275kV transmission grid reinforcements provided by the Long Term Plan. It is believed that the Medium Term Plan can deliver the network reinforcements required to permit the connection of 750 to 800MW of wind powered generation to the network by 2015, albeit with roughly the same level of system availability as that applicable to current connections, that is with 100-150MW of the capacity being “non-firm” (and therefore subject to constraint or curtailment under certain network conditions).
The 275kV Long Term Plan (together with the proposed 400kV North–South Interconnector) will remove these constraints and will enable the full 40% target, or around 1,700MW of renewable generation, to be connected to the network. At an overview level the scope of the Long Term Plan is illustrated in Figure 2 below. The plan is still subject to detailed studies, but will entail significant lengths of additional 275kV circuits. Given the present planning context in Northern Ireland, it is unlikely that the Long Term Plan will begin to deliver significant infrastructure until 2017 or beyond.

NIE will continue to explore ways of closing the gap to achieve DETI’s 1,000MW interim target without dependence on the Long Term Plan. One area for investigation is whether the recent development of dynamic line ratings\(^2\) can be used to extend capacity. NIE will investigate and report on this at a later stage.

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\(^2\) Dynamic line rating is a recent project where the electrical rating of the Dungannon to Omagh 110kV circuits were enhanced by taking the ambient temperature and cooling effect of the wind into account. Ambient temperatures and wind speeds are continually measured at various points along the route of the lines and a real time electrical rating is calculated. This rating is used by the Transmission System Operator to manage power flows in the circuits.
4. Compatibility of Plans

NIE recognises the need to ensure consistency and compatibility between the various elements of medium and long term planning. The following key tests will be applied:

- Utilise existing transmission circuits to the maximum extent before seeking to build new circuits. (NIE has developed and installed active monitoring devices to give dynamic ratings on congested circuits). This has given significant additional capacity via more intensive use of the most congested parts of the transmission network. NIE has also carried out small scale re-conductoring or structural modifications where they support significant rating increases. Part of the Medium Term Plan seeks further re-conductoring of existing circuits.
- Utilise existing transmission line routes where possible to develop higher capacity circuits.
- Ensure that the Medium Term Plan is compatible with the Long Term Plan. Expenditure on developments which would be nugatory after the Long Term Plan is delivered will be minimised. However this would not preclude expenditure on the 110kV network that provides an economic benefit in delaying 275kV reinforcement.

Details of how the four projects detailed in Part 1 of the Medium Term Plan with the remainder of the Medium Term Plan and the Long Term Plan is described in Appendix 2.

5. The Medium Term Plan

For the reasons set out above, the Medium Term Plan (MTP) is critical to the near term expansion of renewable generation capacity in Northern Ireland and is therefore an important focus at this juncture.

The network infrastructure projects that NIE currently intends to consider as part of the complete MTP are shown in Appendix 1. NIE estimates that the completion of the work detailed in Appendix 2 will allow 750 to 800MW of renewable generation to be connected by 2015/16. This equates to 18% of energy consumption from renewable sources.

Projects within the plan are at various stages in their development, and details on design and costs vary between the projects.

The four projects specifically described in this paper comprise the first part of the MTP. Together, they will provide for an increase in network capacity sufficient to allow the connection of 550 to 600MW of renewable generation by 2013/14.
The completion of the remainder of the projects in the MTP (to be brought forward for later approval) will allow the connection of 750 to 800MW of renewable generation by 2015/16.

Following discussions with the Utility Regulator a two stage regulatory approval process has been agreed as follows for application to medium term renewable projects initiated within the RP4 period:

1. **Need.** NIE sets out the “case of need” for the project together with a request for the approval of defined pre-construction costs associated with development and design of an appropriate solution.

2. **Capital Approval.** NIE submits a request for capital approval for the estimated construction cost as defined following the pre-construction work.

In general, the “Case of Need” applicable to the MTP is as follows:

- The Government’s firm commitment to a 40% renewable target for 2020 has been confirmed with the publication of the SEF. It is also clear that until other technologies demonstrate commercial viability that the majority will be provided by onshore wind farms.

- To deliver the Government’s target approximately 1700MW of renewable generation will be required. Information provided by Planning Service, DETI and developers has shown that onshore wind will account for around 1400MW. Most of this wind generation is located in the North and West.

- Electrical studies have shown that the existing transmission network does not have sufficient capacity to enable the connection of the required level of renewable generation. The present transmission network can cater for only 250MW total generation in the West and North.

- The ‘All Ireland Grid Study’ and Renewable Integration Development Project have both reported that new major transmission infrastructure is required to allow the connection of renewable generation to meet the Government’s target.

- The development of the transmission network needs to be delivered so that it keeps pace with the demand to connect renewable generation. The MTP is a critical step toward that overall objective.

- Failure to deliver increased capacity on the transmission network will:
  - make future wind farms in the North and West non-viable due to the low level of availability that can be provided;
  - possibly prevent NIE from being able to issue connection offers for future wind farms in the North or West;
  - lead to difficulties in the day to day operation of the transmission network due to the high level of non-firm connections; and
  - increase the level of constraint payments due to developers where a wind farm has proceeded with a low level of availability.
6. **Background to the Proposed Projects**

As the amount of wind powered generation connected to the network increases, initially there are three parts of the transmission network that will experience thermal overloads, these are detailed below and shown in Figure 3.

(i) **Dungannon to Omagh**  
The first part of the transmission network that will experience overloads are the two 110kV circuits between Dungannon and Omagh. Two separate network outages give rise to overloads:  
• the loss of the Coolkeeragh to Magherafelt 275kV double circuit tower line, during periods of high North West generation and low load in the area, causes excessive power flow from Omagh to Dungannon; and  
• the loss of either of the two 110kV Dungannon to Omagh circuits can overload the other.

(ii) **Kells to Coleraine**  
The next circuit to experience overloads is the 110kV from Kells to Coleraine. This circuit can experience overload, under certain outage/load conditions, without wind power, but the renewable generation driver for thermal enhancement is:  
• the loss of the Coolkeeragh to Magherafelt 275kV double circuit tower line during periods of high North West generation and low load in the area will result in excessive power flow from Coleraine to Kells.

(iii) **Drumnakelly to Dungannon**  
The third area of difficulty is that the two Drumnakelly to Dungannon 110kV circuits can become overloaded under the following two conditions:  
• the loss of the Coolkeeragh to Magherafelt 275kV double circuit tower line during periods of high North West generation; and  
• the loss of either of the two 110kV Drumnakelly to Dungannon circuits can overload the other.
Figure 3  Transmission network with critical outage

In addition, the Omagh to Enniskillen 110kV circuits could become overloaded due to the increasing level of wind generation in Fermanagh.

Studies have also shown that the need for further transmission capacity will become more apparent as greater levels of generation are connected. For example the 110kV lines between Coleraine and Coolkeeragh and the Coolkeeragh to Strabane to Omagh lines will also become overloaded.
7. Projects for Approval

NIE is seeking approval for the capital funding of four projects that make up Part 1 of the MTP. Individual approval papers for Projects 1 and 2 have already been submitted to the Utility Regulator, approval papers for Projects 3 and 4 are submitted along with this document. The individual papers provide a greater level of detail for each of the projects.

7.1 Project 1 - Tamnamore Substation Phase 2 Development - £25.3m

Tamnamore is a townland about 6km from Dungannon. A new grid supply substation was established at Tamnamore in 2009, initially with one 275/110kV transformer. The primary purpose was to reinforce the network in the West in response to load growth by assisting to maintain voltage within statutory limits.

Within the original RP4 approval the work was expected to be augmented by a Phase 2 project which would add a further transformer and divert nearby 110kV circuits into the new substation. This work was to be completed within RP5. The present proposal is to advance this work into the final years of RP4 and complete the work by 2013/14.

The existing high level of wind generation in the West creates reverse power flows on the 110kV network at lightly loaded times. As further generation is connected in the West the reverse flow levels will increase. The reason for the advancement of this project is that the flows will cause an overload of the 110kV lines between Dungannon and Tandragee. Opening the 110kV circuits from Tamnamore towards Tandragee will eliminate the overload. However, with one transformer installed at Tamnamore the substation is not sufficiently secure to allow the two 110kV circuits to be operated in the normally open position.

By reconfiguring the substation and by adding an additional transformer now, rather than during RP5, the substation will be made secure. The circuits linking to Tandragee can then be operated in the normally open position. The existing and proposed networks are shown in Figure 4 below.

The project is critical to achieving already contracted wind farm connections and 2015 renewable targets. The need for the project was peer reviewed and the results provided to the Utility Regulator.

Substation design work is on-going under a pre-construction fund (of £250k) agreed with the Utility Regulator. The estimated cost when the approval paper was initially submitted to the Utility Regulator was £25.3m. The Utility Regulator will be provided with an updated approval paper on completion of the pre-construction design activity. The updated cost is expected to be within 20% of the original estimated value (typical engineering contingency).
Figure 4 Existing and proposed arrangements at Tamnamore substation
7.2 Project 2 - Dungannon to Omagh A&B 110kV circuits - £4.7m

The Dungannon to Omagh A and B circuits are the first to become overloaded during periods of high wind in the West. Both circuits had a summer rating of 109MVA and have already been partially up-rated. This has been achieved by surveying the circuits to determine which parts are well cooled by wind, accurately determining the clearance between the conductors and the ground and using instrumentation to determine the electrical rating of the line in real time. The circuits are shown below in Figure 5.

![Figure 5 Existing transmission network](image_url)

The conductor rating varies throughout each day, but it is estimated that an average increase of about 20MVA has been achieved. This rating increase is per circuit, but a critical condition is when one circuit is out of service. The increased rating has facilitated offers for connection of 20MW of additional wind generation.

Approximately one third of each circuit is not well cooled by prevailing winds. This happens because the prevailing wind blows along rather than across the line, or because the line is in a place sheltered by terrain, vegetation or the built environment. The one third of line length which is not well cooled has been re-conducted to a 200MVA rating using a high temperature conductor. This work was included in Phase 1 of the up-rating of the Dungannon to Omagh A&B circuits and was completed in mid 2010.

Project 2 includes re-conductoring the remaining two-thirds of the A&B circuits. This work must be carried out by the time Project 1, Tamnamore Phase 2, is completed if the benefits of both projects are to be realised without delay. Delivery of Projects 1 and 2 will provide a transfer capacity of 200MVA between Dungannon and Omagh with one circuit out of service. The project is shown in Figure 6 below.
It is also proposed to build a third 200MVA circuit between Dungannon (Tamnamore) and Omagh. It is intended to bring this project forward later in 2010 for approval under Part 2 of the MTP. The third circuit will raise the capacity of the corridor from two circuits at 109MW (109MW firm i.e. with one circuit out of service) to three circuits at 200MW (i.e. 400MW with one circuit out of service). This is shown in Figure 7 below.

When the third circuit is established, together with Project 1 and Project 2 above, the 110kV network will allow the firm connection of an additional 290MW of generation in the West\(^3\). This is a total increase in firm capacity of around 290MW (or 270MW when compared with the Phase 1 developments).

\(^3\) The original capacity between Dungannon and Omagh was 109MVA. Following completion of Phase 1 the capacity is 129MVA. On completion of Phase 2 the capacity will be 200MVA. On completion of third circuit the capacity will be 400MVA. The total increase in capacity will be 291MVA, 400MVA minus 109MVA.
In summary, Phase 1 has already increased the capacity between Omagh and Dungannon from 109 to 129MW. Completion of Projects 1 and 2 included in Part 1 of the MTP will increase the capacity of the corridor to 200MVA. Construction of a third 110kV circuit between Tamnamore and Omagh will further increase the capacity to 400MW, this project will be included in Part 2 of the MTP.

On completion of Projects 1 and 2 similar conductor will then have been used on all parts of the A and B circuits which will have maintenance benefits.

The need for Project 2 and the method of achievement have been technically peer reviewed and the report provided to the Utility Regulator.

NIE has carried out a full survey of the 110kV line to determine the work content and has considered the costs. The estimated cost of £4.7m is based on current NIE and contractor labour rates, the time taken to perform the same tasks under Phase 1 and the unit costs of materials used on Phase 1, with a year on year uplift applied.

7.3 Project 3 – Kells to Coleraine 110kV line - £2.4m

The existing Kells to Coleraine 110kV circuit is at present essentially in two sections. The section from Kells to Terrygowan (a townland about 13km to the east of Kells) utilizes All Aluminium Alloy Conductor (AAAC) on a steel tower line with a summer rating of 144MVA. The remainder of the circuit, until it is close to entering the substation at Coleraine, is of Aluminium Conductor Steel Reinforced (ACSR) which limits the summer rating of the circuit to 109MVA.

The plan to uprate the Kells to Coleraine 110kV line has been divided into three phases; Project 3 is the first phase. The three phases are described below and shown in Figure 8.

- Phase 1 will uprate the 25km section of single circuit line from Terrygowan to a proposed wind farm cluster substation in mid-Antrim.
- Phase 2 will uprate one side of the double circuit tower line from Kells substation to Terrygowan.
- Phase 3 will uprate the 13km section of single circuit from the proposed cluster substation to Coleraine.

Only Phase 1 of the project is required at this time. The speed with which further wind farms are developed in the mid-Antrim area will dictate when Phase 2 is required. NIE is not yet in a position to have confidence in the case of need for Phase 3.
Following a double circuit outage on the Magherafelt to Coolkeragh line the wind power in the North West together with Coolkeragh generation can cause the Kells to Coleraine circuit to overload. This is managed by automatically reducing the output of Coolkeragh power station and disconnecting a wind farm which is connected into Coleraine. Any further wind farms connected in the area would need to be constrained off during long periods in summer to avoid breaching system limits regarding how much generation can be shed in one operation. This may result in further wind farm developments becoming financially unviable.

NIE proposes to develop a new wind farm cluster substation in mid-Antrim close to Rasharkin village. This will connect into the Kells to Coleraine 110kV circuit approximately 13km from Coleraine. Uprating a 25km length of the single line from Terrygowan to the mid-Antrim cluster (Phase 1) will allow the new substation to be connected with sufficient capacity to connect the initial wind farms. The rating of the re-conducted line, using a high temperature conductor, would be 200MVA. However the rating of 13km section of AAAC between Kells and Terrygowan will restrict the circuit, for the time being, to a rating of 144MVA.

Phase 2 will therefore uprate the section of tower line between Kells and Terrygowan with a suitable conductor. This will increase the rating of the circuit from Kells to the cluster substation to 200MVA. In the meantime, it is intended to gain advantage by using an enhanced short term rating (about 20 minutes) for the section of the circuit from Kells to Terrygowan. This would allow the system operator to re-dispatch generation in an orderly manner and so relieve the overload on the circuit. The short term rating would be 158MVA.
Phase 3 of the work involves up-rating the 13km section of line from the mid-Antrim wind farm cluster to Coleraine. This would relieve some of the present constraints, but systems are already in place to manage this within the available network capacity. Phase 3 will be considered further at a later date.

As discussed earlier there are a number of options currently being considered in the RIDP long term plan. Some of the development options require the uprating of the complete Kells to Coleraine circuit while others require the circuit to be operated normally open. For this reason NIE is not yet in a position to demonstrate the need for Phase 3 as described above. It is unlikely that this can be resolved before the completion of RIDP Phase 3.

NIE has carried out a full survey of the 110kV line to determine the work content and has considered the costs. The estimated cost of £2.4m is based on current NIE and contractor labour rates, the time taken to perform the same tasks under Phase 1 of the uprating of the Dungannon to Omagh A and B lines and the unit costs of materials also used on Phase 1, with a year on year uplift applied.

7.4 Project 4 - Omagh Main Transformers - £2.5 million

There are currently two 40MVA 110/33kV transformers located at Omagh Main substation. They each have an enhanced rating of 60MVA when operated with their cooling fans running. This gives a substation firm capacity (i.e. maximum capacity available when one transformer is unavailable) of 60MVA.

The level of wind generation connected into Omagh Main has now reached 128MVA. The minimum summer night load at Omagh Main is 15MVA. This combination has the potential to create a power flow through the transformers of up to 113MVA. Measured data from a recent windy summer night (in July 2010) has shown a flow of 78MVA through the transformers, in addition, during this period a recently connected 20MW wind farm was out of service.

Reconfiguration of the 33kV network to transfer load on to Omagh Main can provide an additional 5MVA load at minimum periods. Potentially the substation’s power flow could still exceed 100MVA.

Recorded data has shown that the substation is operating beyond its 60MVA firm capacity for significant periods of time. When the power flow is over 60MVA, the loss of either transformer will result in an overload and protection operation on the other transformer. This would result in the loss of supply to over 19,000 customers.

Also, as a result of the high level of wind generation connected into Omagh Main the existing voltage control schemes may struggle to remain stable. The existing control schemes are designed to operate with power flowing in the conventional direction. NIE has already experienced some instability in the...
voltage at Omagh Main. A suitable voltage control scheme must operate successfully during periods of high generation and low load through to no generation with a high load.

There were three options considered to provide increased capacity at Omagh Main substation.

1. Installing a third 110/33kV transformer
2. Replacing the two existing transformers with larger units on their existing plinths
3. Replacing the two existing transformers with larger units, one of which would be located in a new position

The cost of the work and the associated constraint payments were estimated for each of the options. The outage period and timescale for each option were also considered.

Option 1 was found to be the most expensive and could not be delivered in the timescale required. Option 3 was found to be more expensive than Option 2 and requires a 4 week outage to deliver the work. Option 2 requires a 12 week outage.

On balance Option 2 was selected as the preferred solution as it offered a saving of £0.25m compared to Option 3, including constraint payments. The 12 week outage period will be reduced to 8 weeks by utilising overtime working. The additional cost associated with the overtime will be easily covered by the savings in wind farm constraint payments. The risk to customers will also be minimised by soak testing the remaining transformer on full load for a period prior to the work commencing. Contingency plans will be in place for each stage of the work.

To increase the capacity at Omagh Main it is proposed to:

- Replace the two 110/33kV transformers in situ with two 60MVA units, each with an enhanced rating of 90MVA.
- Install a modern voltage control system on both transformers.

The firm capacity of the substation will be increased to 90MVA. On completion of the work either transformer can be removed from service with no risk to customer supplies. The new voltage control system is designed to operate successfully in an environment with constantly changing levels of generation and load and will ensure the voltage at Omagh Main remains stable.

It is proposed to transfer an existing 30MW wind farm at Slieve Divena from Omagh Main on to a new cluster substation located close to Ballygawley village. It is expected to establish this cluster substation in late 2013/early 2014. In the meantime there is a small risk of wind generation constraint even when the transformers are replaced.
The existing 40MVA transformers will be returned to stock for use on a future project. The cost of changing the transformers and installing modern voltage control at Omagh Main is estimated at £2.5 million. The cost is based on a site specific design, current NIE labour rates and previous 110/33kV transformer change projects.
8. Proposal

The Utility Regulator is requested to approve the four projects and the estimated costs associated with Part 1 of the MTP. The projects are as follows.

1. Tamnamore Phase 2 (advancement into RP4) £25.3m
2. Dungannon to Omagh A&B 110kV Phase 2 line re-conductoring £4.7m
3. Kells to Coleraine Phase 1 110kV line re-condutoring £2.4m
4. Change of the transformers at Omagh Main £2.5m

£34.9m

The cost provided for Project 1 is an initial estimate, this will updated on completion of the pre-construction design activity.

9. Expenditure Profile

If approval for the four projects in Part 1 of the MTP is achieved by February 2011 then the estimated expenditure profile is:

<table>
<thead>
<tr>
<th>Project</th>
<th>Direct Cost £m</th>
</tr>
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<tr>
<td>1 Tamnamore Phase 2</td>
<td>0.3 7.6 9.1 8.3 25.3</td>
</tr>
<tr>
<td>2 Dungannon to Omagh A&amp;B</td>
<td>2.4 2.3         4.7</td>
</tr>
<tr>
<td>3 Kells to Coleraine Phase 1</td>
<td>2.4 2.4         2.4</td>
</tr>
<tr>
<td>4 Omagh Transformers</td>
<td>2.5 2.5         2.5</td>
</tr>
</tbody>
</table>

<table>
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<th>2010/11</th>
<th>2011/12</th>
<th>2012/13</th>
<th>2013/14</th>
<th>Total</th>
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<td>1 Tamnamore Phase 2</td>
<td>0.3</td>
<td>7.6</td>
<td>9.1</td>
<td>8.3</td>
<td>25.3</td>
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<td>2.3</td>
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<td>4 Omagh Transformers</td>
<td>2.5</td>
<td></td>
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<td></td>
<td>2.5</td>
</tr>
</tbody>
</table>

|                  | 0.3     | 12.5    | 13.8    | 8.3     | 34.9  |

Figure 9 Expenditure profile for Part 1 of the Medium Term Plan

The above expenditure profile is provided for indicative purposes only. The actual profile will depend on a number of factors relating to the delivery of the projects. Detailed expenditure profiles will be generated on completion of the design activity for each project. This information will be made available to the Utility Regulator.

In addition a number of projects will be brought forward to the Utility Regulator under Part 2 of the MTP. Some of the expenditure associated with Part 2 will be incurred in the period 2011/12 to 2103/14.
### Appendix 1
#### Overall Short and Medium Term Plans

<table>
<thead>
<tr>
<th>Project</th>
<th>Estimated Amount (£m)</th>
<th>Status</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dungannon - Omagh 110kV A &amp; B Phase 1</td>
<td>£3.2</td>
<td>Complete</td>
<td>Work complete July 2010</td>
</tr>
<tr>
<td>Tamnamore Phase 2 Development</td>
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<td>Approval process</td>
<td>Project 1 of Medium Term application Part 1</td>
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<tr>
<td>Dungannon - Omagh 110kV A &amp; B Phase 2</td>
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<td>Approval process</td>
<td>Project 2 of Medium Term application Part 1</td>
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<tr>
<td>Kells - Coleraine 110kV Up-rate Phase 1</td>
<td>£2.4</td>
<td>Approval process</td>
<td>Project 3 of Medium Term application Part 1</td>
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<tr>
<td>Omagh 110/33kV Transformer changes</td>
<td>£2.5</td>
<td>Approval process</td>
<td>Project 4 of Medium Term application Part 1</td>
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<tr>
<td>Tamnamore – Omagh (via Fallaghearn) 110kV</td>
<td>£15.0</td>
<td>Approval process</td>
<td>To be included in Medium Term application Part 2</td>
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<tr>
<td>Enniskillen - Omagh DC 110kV Up-rate</td>
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<tr>
<td>Kells - Coleraine 110kV Up-rate Phase 2</td>
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<td>Kells - Coleraine 110kV Up-rate Phase 3</td>
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<td>Studies</td>
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</tr>
<tr>
<td>CPS - Coleraine 110kV Up-rate</td>
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<td>Studies</td>
<td></td>
</tr>
<tr>
<td>CPS - Limavady 110kV Up-rate</td>
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<td>Studies</td>
<td></td>
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<tr>
<td>Coleraine – Limavady Up-rate 110kV</td>
<td>£1.8</td>
<td>Studies</td>
<td></td>
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<tr>
<td>Strabane - Omagh B Up-rate 110kV</td>
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<td>Studies</td>
<td></td>
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<tr>
<td>Limavady Substation</td>
<td>£12.0</td>
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<td></td>
</tr>
<tr>
<td>Install 150MVAR Reactive Support</td>
<td>£102.0</td>
<td>Studies</td>
<td></td>
</tr>
</tbody>
</table>

4 Initial estimate, cost to be updated on completion of pre-construction design activity
Appendix 2
The Demand for Renewable Generation and Future Network Capacity

The four projects in Part 1 of the MTP will provide for an increase in network capacity sufficient to allow the connection of approximately 550 to 600MW of renewable generation by 2013/14.

The completion of the remainder of the projects in the MTP (to be brought forward for later approval) will allow the connection of approximately 750 to 800MW of renewable generation by 2015/16.

The graph shown in Figure 10 illustrates:
- The cumulative amount of onshore wind generation that NIE predicts will be ready to connect, up to 2020.
- The predicted level of firm capacity available under current plans.

The firm capacity available on the network will continue to lag behind the connected generation capacity. Some of the shortfall will be met by offering wind farms non-firm capacity. The maximum difference between these two quantities is a matter for determination by SONI, but is likely to be limited at the current level of 150 to 200MW in aggregate.

Figure 10  Predicted onshore wind generation and firm capacity
If the Government is to meet its renewable energy targets (1000MW by 2015 and 40% of energy consumed by 2020) then additional renewable projects must come forward to fill the gap between the capacity that can be realistically delivered by onshore wind and the overall target level. These may include projects such as those known to be under consideration for large scale biomass located at the existing power stations, offshore wind on the North coast and in the Irish Sea and a tidal scheme close to Rathin Island.

There are a number of points to note on the illustration shown above:

1. The third 110kV circuit between Dungannon and Omagh (to be included in Part 2 of the MTP) will need to be constructed to enable the connection of up to 1000MW.

2. The Long Term Plan must be delivered, at least in part, to enable the network capacity to increase above 1000MW.

3. Figure 10 assumes that the proposed 400kV North - South Interconnector is commissioned by 2015. Without the interconnector in place the system operator will be forced to curtail renewable generation. The impact that this may have on the development of renewable energy projects is a complex function dependent on the decisions taken by individual developers. However, the overall impact of any extended delay in delivery of the Interconnector will create a likely limitation in a region between 700 – 900MW of connected capacity as illustrated below.
Figure 11 Predicted onshore wind generation and firm network capacity with no additional interconnection

The Government’s renewable energy targets cannot be met if the 400kV North – South interconnector is not constructed.

The Long Term Plan forms a significant part of the work that will be needed to allow the integration of renewable generation in NI. Additional projects will provide capacity to connect generation located in the South and East.

The Long Term Plan will involve a substantial extension of the transmission network and it is extremely unlikely that it will be completed by 2020. A more realistic timeframe for overall completion of the works required will extend to 2025 and beyond.