Drumnakelly – Tamnamore 110 kV restring

Needs Report

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SONI

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Summary

With the increasing connection of renewable generation in the north and west of Northern Ireland, a number of 110 kV circuits have been identified as potentially at risk of overload. The existing Drumnakelly – Tamnamore 110 kV circuits are included, with overloads expected to occur for significant periods throughout the year during times of high renewable generation output. Northern Ireland has set a new renewable generation target of 80% renewables target through the Climate Change Act 2022.

Analysis from SONI's Tomorrow's Energy Scenarios NI (TESNI) and Shaping Our Electricity Future (SOEF) publications[1] has been used to determine this case of need using the 2030 cases. These cases represent a more onerous, challenging system than today with additional generation following the 80% renewable energy target as set by the Climate Change Act 2022.

Wind farm constraint modelling was carried out using these cases to assess the level of constraint on the existing Drumnakelly – Tamnamore 110 kV circuits. Using the forecast figure of £76.21/MWh[2] for the average market value of electricity in NI in 2030 it was possible to quantify this constraint financially. It has been determined that without reinforcement of the existing circuits this will result in potential overloads and a resulting high cost to constrain wind generation - £10.2m by 2030 annually based on the constraints study for 80% renewables.

This report sets out the case of need for reinforcing the 110 kV network between Drumnakelly and Tamnamore substations.

[1] The need to uprate both of the existing Drumnakelly – Tamnamore 110 kV circuits was identified in Shaping Our Electricity Future Version 1.0 as a candidate reinforcement for 2030 - Shaping_Our_Electricity_Future_Roadmap.pdf (soni.ltd.uk). In Version 1.1 this work was identified as a base case reinforcement - Shaping Our Electricity Future Roadmap: Version 1.1 (soni.ltd.uk).

[2] Based on the Average compensation rate of €88.62/MWh – Page 104, Shaping Our Electricity Version 1.1, published July 2023 and a euro to sterling conversion of £76.21/MWh

Introduction

The development of renewables in Northern Ireland to comply with targets set out in the Strategic Energy Framework and supported by the Renewable Obligation Certificates (ROCs) has led to the connection of approximately 1,600 MW of renewable generation in Northern Ireland (including small scale generation). SONI currently operates with 49% of electricity demand coming from renewable energy sources[3].

During times of high renewable generation output there is a risk of congestion on the transmission system. This has led to a number of circuits being at risk of overload for certain contingencies. The risk of overload is managed by restricting renewable generation output at peak times. However, this establishes points of congestion on the transmission system. The more generation that connects, the greater the requirement for constraints at peak times. This reduces the economic viability of this generation and reduces the NI consumer's access to very low marginal cost and low/zero carbon electricity.

These potential overloads and the associated congestion have been identified in SONI's Tomorrow's Energy Scenarios, NI (TESNI) and Shaping Our Electricity Future (SOEF) versions 1.0 and 1.1 analysis and provision has been made within the SONI Transmission Development Plan for Northern Ireland (TDPNI) 2021[4] to address these issues.

The existing circuits between Drumnakelly and Tamnamore are heavily congested. This is currently managed by constraining wind farms and other renewable generation in Constraint Group 2[5] using the Wind Dispatch Tool, although this in turn leads to congestion on the 110 kV system, between Omagh and Tamnamore. Upon real time warnings in the control room this measure is carried out first to reduce the risk of overload on the Drumnakelly – Tamnamore circuits. The control room then implement an operational mitigation measure which involves switching out of service the Drumnakelly - Tamnamore 110 kV circuits, allowing the generation to flow through the interbus transformers at Tamnamore and onto the 275 kV system. However, this measure reduces the strength and integrity of the transmission system and can causes further issues if an unexpected outage of an interbus transformer at Tamnamore occurs, causing the other interbus transformer to overload.

As electricity demand continues to increase through the electrification of heating and transport, and with the connection of onshore renewable generation to meet the 2030 target the level of constraint and system risk will continue to increase for these circuits. It is recognised that other significant reinforcements will be required to address the level of renewables expected for the 2030 target (as determined in the Accelerated Ambition (AA) – 80% renewables scenario - particularly in the mid Tyrone and northwest of NI areas on the 110 kV system. Additional projects are described in the SONI Transmission Development Plan, NI (TDPNI).

[3] https://www.economy-ni.gov.uk/news/electricity-consumption-and-renewable-generation-northern-ireland-year-ending-march-2023
[4] https://www.soni.ltd.uk/media/documents/Transmission-Development-Plan-Northern-Ireland-2021-2030.pdf
[5] Wind-Dispatch-Tool-Constraint-Group-Overview.pdf (eirgridgroup.com)

Description of the network

The transmission network, see Figure 1 below, is based on a strongly meshed 275 kV ring around Lough Neagh with a double circuit spur to Coolkeeragh. There is also an underlying 110 kV network which establishes a meshed ring around the north and west from the 275 kV backbone substations at Kells and Tamnamore.

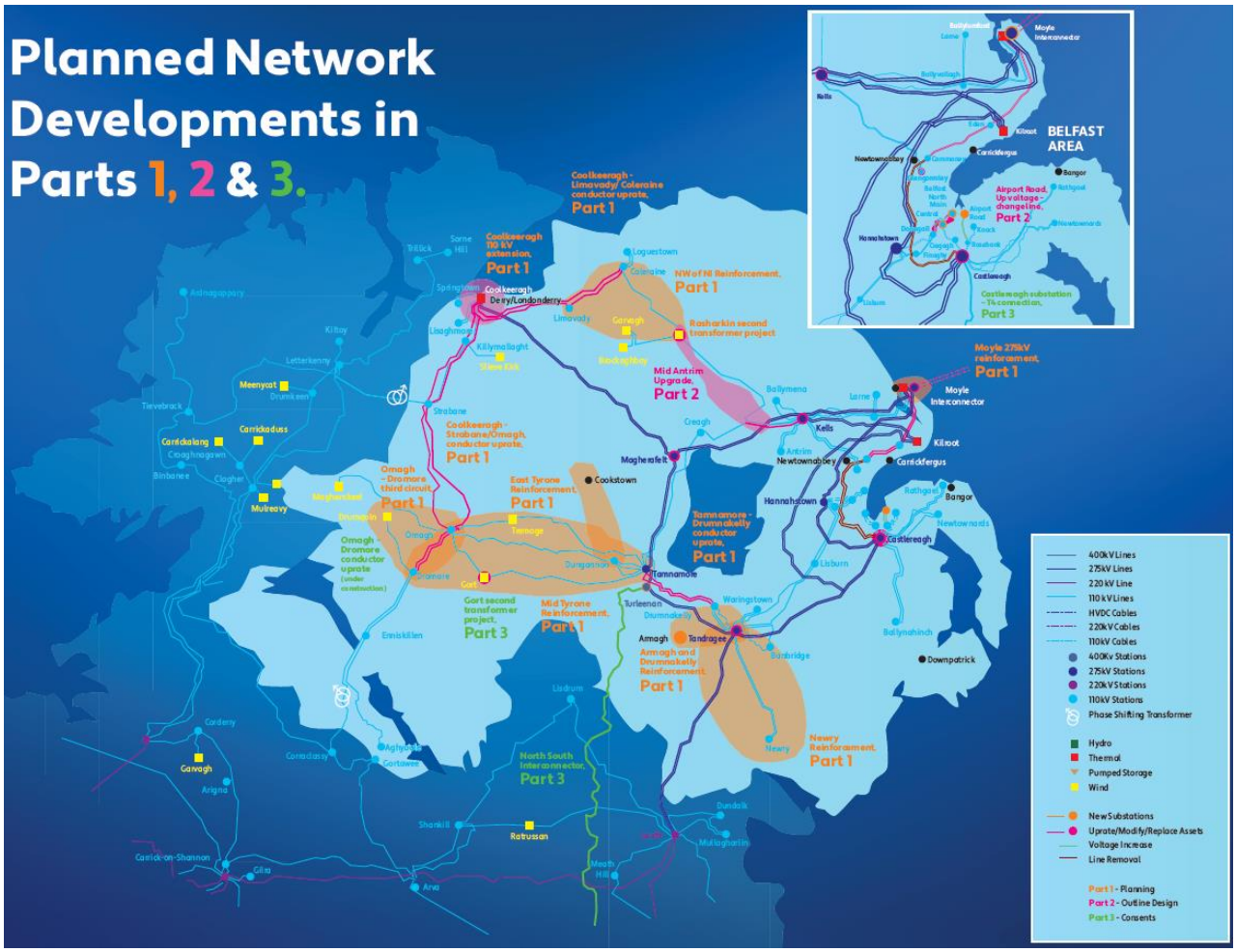

Figure 1 - Transmission System in Northern Ireland

The majority of renewable generation, to date, has been connected in the north and west of Northern Ireland. This is passed onto the 110 kV system at bulk supply points and cluster substations and onto the 275 kV system at grid supply points. Currently there is 1600 MW of generation from Renewable Energy Sources (RES), large scale and small scale, installed in Northern Ireland and SONI operates with 49% of electricity demand coming from renewable energy sources.

The existing 110 kV circuits between Drumnakelly and Tamnamore substation are comprised as follows;

- Double circuit towerline ('A' and 'B' circuits) from Drumnakelly to Bond's Bridge (5km south-east of Tamnamore substation) – 16.2 km;
- 'A' circuit;
    - Portal (twin wood pole) arrangement through Killyman village (Laghey Corner) – 3.94 km;
    - AP1 (single wood pole) arrangement north of the M1 – 1.37 km;

- Underground cable section and connection into Tamnamore 110 KV substation – 1.18 km;

- ‘B’ circuit;
  - Portal (twin wood pole) arrangement terminating near Killyman St Mary’s GAC (less than 1 km from Tamnamore substation) – 4.05 km; and
  - Underground cable section and connection into Tamnamore 110 KV substation – 1.4 km.

Figure 2 below shows these arrangements. The circuits were constructed in the 1950’s when the circuits previously connected between Dungannon and Drumnakelly substations. These circuits will be due for refurbishment and asset replacement sometime in the near future given their asset age, however SONI has not been informed of any concerns on the assets’ condition to date from NIE Networks. When Tamnamore 275/110 kV substation was constructed these circuits were diverted into the new substation arrangement and new connections were made between Dungannon and Tamnamore substations.

The circuits are currently rated to 109/119/124 MVA using ACSR Lynx conductor (with a 75° Design Operating Temperature (DOT)). The underground cable sections for both circuits are rated to 200 MVA using 2000mm^2 Aluminium XLPE.

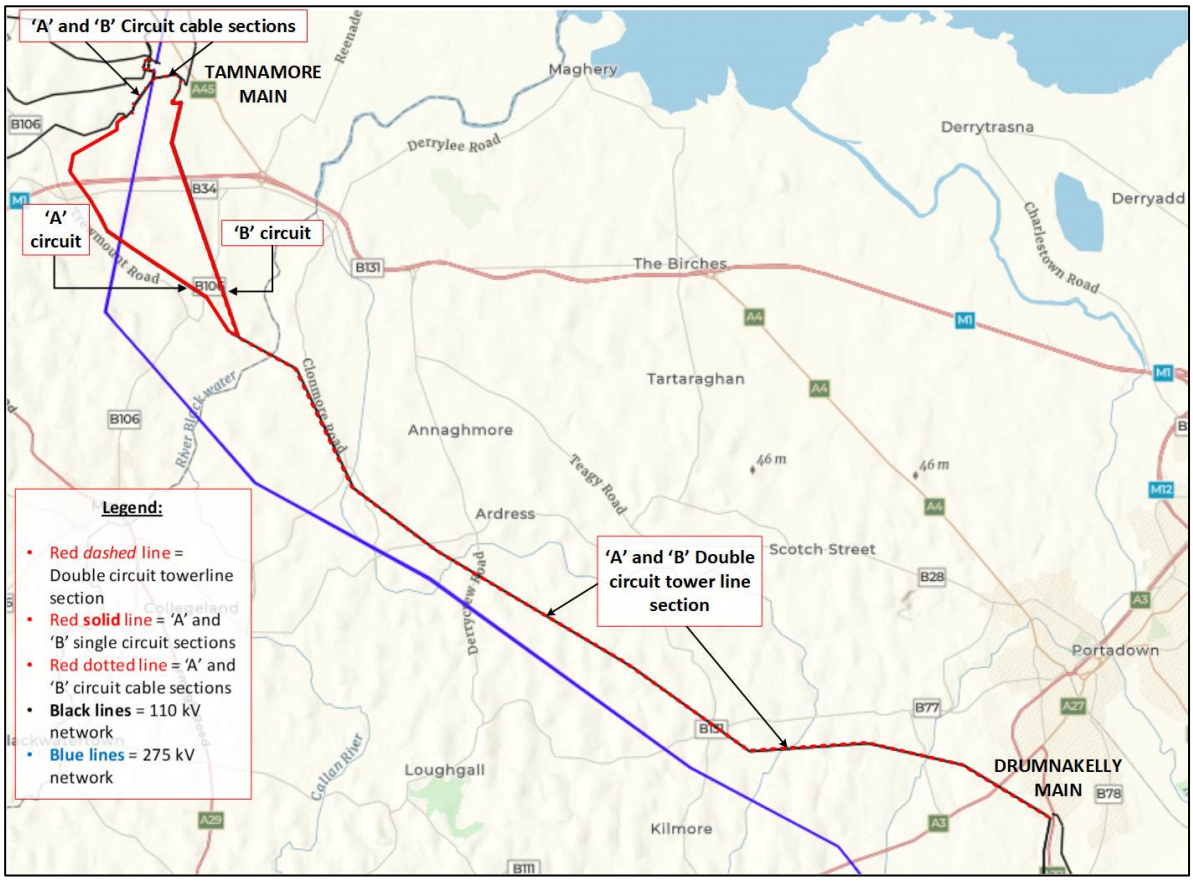

Figure 2 - Drumnakelly - Tamnamore 'A' and ‘B’ circuit arrangements

General network issues at present

The most onerous contingency affecting the power flow in Northern Ireland is the loss of the Coolkeeragh – Magherafelt 275 kV double circuit. When this contingency occurs the remaining generation at Coolkeeragh Power Station and that connected to the 110 kV system in the north and west of Northern Ireland is transferred onto the 110 kV network. This power then flows through Omagh to Tamnamore and through Limavady, Coleraine, Rasharkin and onto Kells. This combination of conventional generation and renewable generation at Omagh, Drumquin, Magherakeel, Tremoge and Gort leads to the potential for overloads on the existing Drumnakelly – Tamnamore 110 kV circuits.

The Drumnakelly – Tamnamore 110 kV circuits have the potential to be overloaded by approximately 200% of their seasonal rating (max rating of 124 MVA in Winter). This is shown in figures 3 and 4 below for the 'A' circuit, as highlighted in the Tomorrow's Energy Scenario, NI System Needs Assessment[6]. This was tested against the outage of the Coolkeeragh – Magherafelt 275 kV double circuit (N-DCT) and operation of the Coolkeeragh run back scheme, alongside other local contingencies such as the loss of one of the existing Drumnakelly – Tamnamore circuits (N-1).

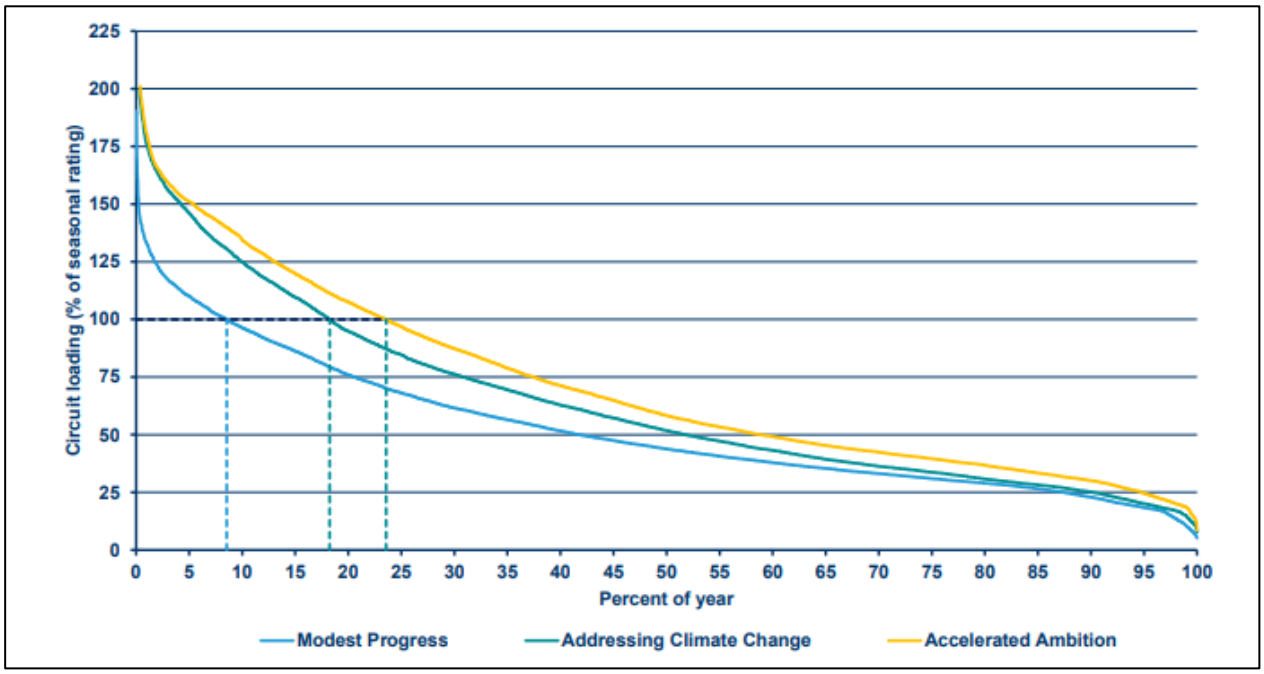

Figure 3 - N-1 loading for the Drumnakelly - Tamnamore circuits in 2025

[6] TESNI-SNA-2020.pdf (soni.ltd.uk)

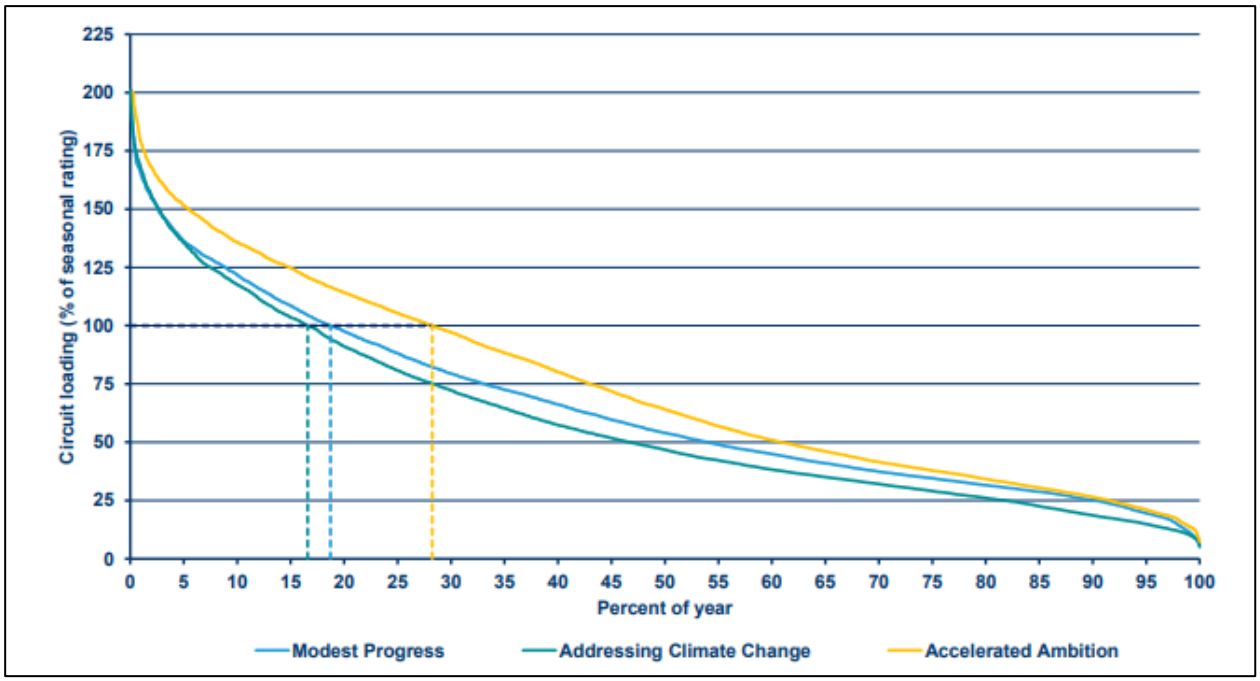

Figure 4 - N-1 loading for the Drumnakelly - Tamnamore circuits in 2030

This analysis confirms that these circuits will be overloaded for 25% of the year in the event of the loss of the Coolkeeragh – Magherafelt double circuit (N-DCT) or loss of either existing Drumnakelly – Tamnamore circuit (N-1), for the Accelerated Ambition scenario (80% renewables) in 2025, and 30% of the year for this scenario in 2030.

Management of potential overloads on Drumnakelly - Tamnamore circuits

The above potential overload risks are not permitted on the transmission system. This is currently managed by constraining wind farms and other renewable generation in Constraint Group 2, see figure 5 below, using the Wind Dispatch Tool, although this in turn leads to congestion on the 110 kV system, between Omagh and Tamnamore. Upon real time warnings in the control room this measure is carried out first to reduce the risk of overload on the Drumnakelly – Tamnamore circuits. The control room then implement an operational mitigation measure which involves switching out of service the Tamnamore – Drumnakelly 110 kV circuits, allowing the generation to flow through the interbus transformers at Tamnamore and onto the 275 kV system. However, this measure reduces the strength and integrity of the transmission system and can causes further issues if an unexpected outage of an interbus transformer at Tamnamore occurs, causing the other interbus transformer to overload.

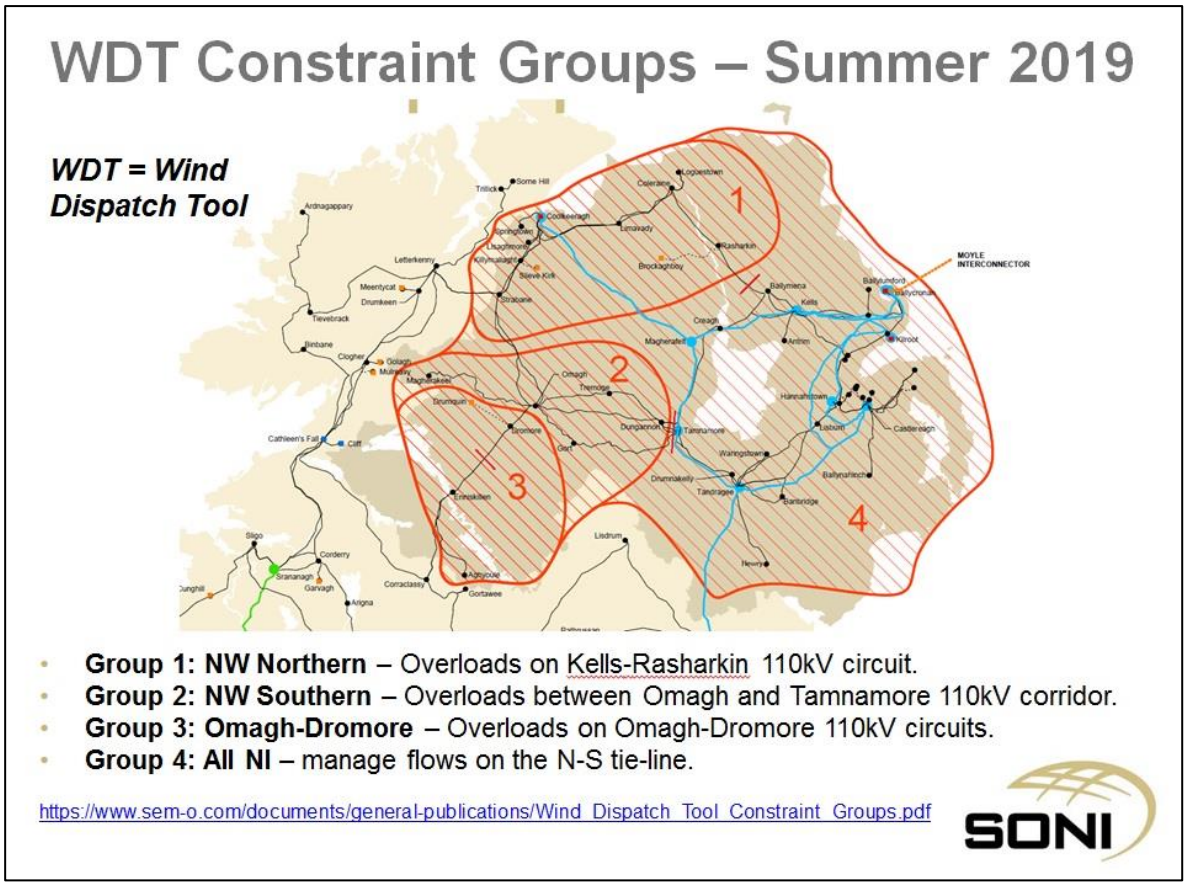

Figure 5: Wind Dispatch Tool Constraint Groups

Wind farm constraint modelling was undertaken to determine the cost to constrain renewable generation to prevent overloads on the Drumnakelly – Tamnamore circuits. Using the forecast figure of £76.21/MWh for the average market value of electricity in NI in 2030 it was possible to quantify this constraint financially. On the basis that this constraint would be compensated the costs are as presented in Table 1 below.

Renewables target/ Scenario	*Total MWhs constrained*	*Approx. Constraint costs (£76.21/MWh)*
Addressing Climate Change (ACC) – 70%	51,891	£3.96m
Accelerated Ambition (AA) – 80%	133,292	£10.2m

Table 1 - Cost of constraining renewables to manage congestion

The above constraint costs would accumulate to a net present cost over a 40-year period to £191m. Note that the above analysis would be assessed further in the justification of any reinforcement options. In addressing the reinforcement of the Drumnakelly – Tamnamore circuits it is expected that there will be other constraints. This will be considered in the appraisal of options.

The total energy consumed in Northern Ireland is approximately 7.47 TWh[7]. In order to reach a target of 80% renewables in Northern Ireland, approximately 6 TWh will be required to come from renewables. A 2030 constraint of 0.133 TWh is a constraint of approximately 2% of the required energy coming from renewable sources.

[7] "Between April 2022 and March 2023, some 7,471 Gigawatt hours (GWh) of total electricity was consumed in Northern Ireland" - https://www.economy-ni.gov.uk/news/electricity-consumption-and-renewable-generation-northern-ireland-year-ending-march-2023

Conclusion

In conclusion there is a need to reinforce the existing Drumnakelly – Tamnamore 110 kV circuits in order to manage the level of wind generation in the west of Northern Ireland.

There is a need to address the existing and expected congestion on the 110 kV network with the increasing connection of renewable generation, to allow our statutory energy targets to be achievable in Northern Ireland. It is recognised that other significant reinforcements will be required to address the level of renewables expected for the 2030 target (as determined in the Accelerated Ambition (AA) – 80% renewables scenario - particularly in the mid Tyrone and northwest of NI areas on the 110 kV system. Additional projects are described in the SONI Transmission Development Plan, NI (TDPNI).

The Drumnakelly – Tamnamore 110 kV circuits have the potential to be overloaded by approximately 200% of their seasonal rating (max rating of 124 MVA in Winter). Analysis also confirms that these circuits will be overloaded for 25% of the year in the event of the loss of the Coolkeeragh – Magherafelt double circuit (N-DCT) or loss of either existing Drumnakelly – Tamnamore circuit (N-1), for the Accelerated Ambition scenario (80% renewables) in 2025, and 30% of the year for this scenario in 2030. This project is named as a key reinforcement in Shaping Our Electricity Future version 1.0 (and as a base case reinforcement in version 1.1).

This is currently managed by constraining wind farms and other renewable generation in Constraint Group 2 using the Wind Dispatch Tool, although this in turn leads to congestion on the 110 kV system, between Omagh and Tamnamore. It has been determined that without reinforcement of the existing circuits this will result in potential overloads and a resulting high cost to constrain wind generation - £10.2m by 2030 annually based on the constraints study for 80% renewables.

The loss of the double circuit between Coolkeeragh and Magherafelt will result in overloads on the local 110 kV network as power flows move from west to the east (in the direction of Tamnamore substation). This system reinforcement is needed now and in order to meet our 2030 targets. With increased onshore generation in the north and west beyond what already exists, this congestion will significantly increase. This will result in a significant level of wind generation constraint and cost to the consumer.

It is considered prudent that system reinforcement is required to support the existing network between Drumnakelly and Tamnamore.