TOP25 Lookback

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TOP25 Overview

The following slides are intended to give an overview of our TOP25 performance, focusing on the following:

- Percentage of works included in the TOP25 baseline that were complete, and reasons for the works that were incomplete.
- A review of slides presented on this topic back in December 2024 and July 2025, detailing which works proceeded as planned or not.
- A look at additional works completed throughout the year.

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TOP25 Performance Overview

- TOP25 baseline programme included 789 outage weeks.
- 62% of the works in the TOP25 baseline programme were completed.
- When additional works were added (i.e. those utilising outage slots for works in TOP25 baseline programme that did not proceed) this increases to 75%.
- Where reasons for non-completion of works that are outside the control of EirGrid and ESBN are removed, the completion rate increases to 94%
- Our initial analysis shows the following, high-level reasons for incompletion:
    - Outage/plant availability (including transmission and generator FOs)
    - Project scoping changes / challenges
    - On-site delays / resources (some originating from storm response)
    - Material delays / equipment issues
    - Land access
    - Customer programme

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New Connections – Renewable South

- CP1062 Drombeg 110 kV Station – Substantially complete
- CP1260 Dennistown 110 kV Station – Enabling works complete
- CP1269 Crory 110 kV Station – Connection deferred to TOP26
- CP1351 Ballynadrideen 110 kV Station – Connection deferred to TOP26
- CP1353 Bendinstown 110 kV Station – Connection deferred to TOP26

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New Connections – Renewable Central

- CP1272 Derryiron Busbar Uprate (Enabling Project) – Complete
- CP1217 Philipstown 110 kV Station – Complete
- CP1231 Knockdrin 110 kV Station - Complete
- CP1234 Laurencetown 110 kV Station – Complete
- CP1158 Rattin 110 kV Station – Complete
- CP1059 Raghra 220 kV Station – Complete

New Connections – Renewable North & West

- CP1352 Gortatleva 110 kV Station : Ballymoneen Solar Farm 80 MW – Connection deferred to TOP26
- CP1342 Drumcamill 110 kV Station : Monvallet Solar Farm 50 MW – Connection deferred to TOP26

New Connections – Conventional

- CP1255 Castlelost 220 kV Station – Substantial works complete, connection extending into TOP26
- CP1256 Barnakyle 110 kV Station – Connection deferred to TOP26
- CP1259 Athlone 110 kV Station – Connection deferred to TOP26

Line Uprates/refurbs

- CP0817 Flagford Sliabh Bawn 110 kV Circuit (Old rating: 99/110/121 MVA; New rating: 178/194/209 MVA) – Complete
- CP0905 Louth Ratrussan 110 kV Circuit (Old rating: 104/113/122 MVA; New rating: 178/194/209 MVA) – Complete
- CP1155 Glenree Moy 110 kV Circuit (Old rating: 104/113/122 MVA; New rating: 178/194/209 MVA) – Complete
- CP1172 Crane Wexford 110 kV Circuit (Old rating: 135/137/137 MVA (no overload); New rating: 178/194/209 MVA) – Complete
- CP1167 Drybridge Oldbridge 110 kV Circuit & Oldbridge Platin 110 kV Circuit – (Old rating: 104/113/122 MVA; New rating: 178/194/209 MVA) – Complete
- CP1235 Louth Woodland 220 kV Circuit (Partial) (Old rating: 434/473/476 MVA; New rating: 786/807/823 MVA) – Planned works in 2025 complete, will require work in multiple outage seasons
- MC0383 Corduff Finglas 1 & 2 220 kV Bay Conductor Uprate (Old rating: 350/393/436 MVA (no overload); New rating: 434/473/513 MVA) – Deferred to TOP26 due to project delays
- CP1156 Sligo Srananagh 1 ONE Bay Conductor Uprate (Old rating: 99/110/120 MVA (no overload); New rating: 104/113/122 MVA) - Complete
- CP0857 Kilbarry Marina 1 & 2 Double Circuit refurbishment – Complete

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Reinforcements/Reconfigurations

- CP0624 Killonan GIS – Some enabling works complete, remainder deferred to TOP26
- CP0984 Belcamp Shellybanks Phase 2 – FO of North Wall – Poolbeg 220kV cable resulting in work deferred until TOP26
- CP0646 Finglas 110 kV GIS Transfers T2104 – T2103 transfer complete instead, only T2104 remains
- CP0585 Laois Kilkenny (Coolnabacky) – Planned enabling works complete, 110 kV connection 2026, 400kV connection 2027
- CP0644 Bracklone 110 kV Station – Planned enabling works complete, 110kV connection 2026
- CP0799 Louth 220 kV Station Refurbishment – Not all planned works completed due to project delays. Works remain for multiple outage seasons

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Reinforcements/Reconfigurations

- MC0398 Aghada Knockraha Additional Tower - Deferred to TOP26 due to project delays
- CP0973 Knockraha Short Circuit Rating Mitigation – Largely complete, some works remain
- CP1113 Corduff Deep Reinforcement – Complete
- CP0808 Maynooth Station Redevelopment – TOP25 planned works complete (multi-year project, substantial work remaining)
- CP1277 Maynooth-Ryebrook & Dunfirth-Ryebrook line diversion - Complete

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Protection Upgrades

- CP1114 : Platin T105 – Deferred due to storm

- CP1152 : Ratrussan Shankill 110 kV Circuit – Complete

- CP1163 : Butlerstown Killoteran 110 kV Circuit – Complete
- CP1163 : Killoteran Waterford 110 kV Circuit – Complete
- MC0356 : Killoteran Waterford 110 kV Circuit – Complete

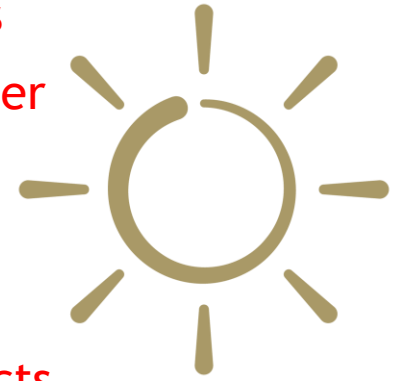
- CP1109 : Navan T142 – Complete
- CP1109 : Gorman Meath Hill 110 kV Circuit - Complete
- CP1109 : Louth Meath Hill 110 kV Circuit – Deferred to TOP26 due to project delays
- CP1109 : Gorman T2101 - Deferred due to project delays

Protection Upgrades

- CP1164 : Clashavoon 110 kV K1-2 Coupler - Complete
- CP1164 : Carrigadrohid 110 kV Full Station - Deferred due to issues on site
- CP1164 : Carrigadrohid Macroom 110 kV Circuit - Complete
- CP1164 : Dunmanway Macroom 110 kV Circuit - Deferred to TOP26 due to FO

- CP1228 : Shannonbridge T2101 – Complete

- CP1115 : Drybridge Gorman 110 kV Circuit - Deferred due to delays with other projects
- CP1137 : Carlow Kellis 1 ONE 110 kV Circuit - Deferred to TOP26 due to delays with other projects



- CP1111 : Cahir 110 kV K1-2 Coupler - Complete
- CP1111 : Cahir Doon 110 kV Circuit – Deferred to TOP26 due to delays with other projects

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Protection Upgrades

- CP1140 : Athy Portlaoise 110 kV Circuit - Complete
- CP1140 : Athy 110 kV A2 Busbar - Complete

- CP1139 : Sligo Srananagh 1 ONE 110 kV Circuit - Complete

- CP1153 : Cashla Tynagh 220kV Circuit – Deferred due to change in generator outage

- CP1227 : Cashla Prospect 110kV Circuit – Complete
- CP1227 : Cashla Ennis 110kV Circuit - Complete

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Projects with Limited System Impact

- CP1201 New CT/VT in Bogtown on Mt.Lucas Bay - Complete
- CP1287 Ringsend Station Cable Diversion – Complete
- CP1215 Civil works for Celtic transformers - Complete
- CP1412 New Knockraha T2104 - Ongoing

Substantial works completed additional to baseline

The below works were not included in the TOP25 baseline, however, due to cancellation of other works outage slots became available to get the works done:

CP No.	Title / Description	Duration (WDs)
n/a	Dunstown – Moneypoint 400kV Line Maintenance	50
CP1136	(Remainder of) Loop in of Deenes to Baltrasna - Drybridge	45
CP1217	(Remainder of) Loop in of Philipstown to Cushaling - Portlaoise	140
CP1236	Loop in of Timoney station to Ikerrin – Shannonbridge	150
CP1277	Maynooth-Ryebrook & Dunfirth-Ryebrook line diversion	25
CP1322	DLR installation on Cathaleens Fall - Corraclassy	5
CP1162	Protection upgrade on Poolbeg - Shellybanks	30

*Not an exhaustive list

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January 2026

TOP26
Industry Overview

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Guidance for customer projects in relation to TOP26 outages

- The Customer is made aware that the Company's scheduled commissioning and outage windows to connect new customer stations to the Transmission System can be impacted by prevailing system conditions, forced outages and/or delays to other conflicting Transmission outages and, as such, the Company cannot guarantee that it will be able to provide the Customer with an outage on a scheduled date in order to meet the Scheduled Operational Date.

- The Customer's programme shall be as accurate as possible in order to meet the Company's planned commissioning and outage windows and to ensure planned energisation dates are met. Failure by the Customer to meet the Company's planned commissioning and outage windows may result in postponement of these works thereby resulting in the Connection of the Facility being delayed to a subsequent outage season.

Agenda

- New Connections
- Line Uprates
- Line Refurbishments
- Network Reconfiguration
- Protection Upgrades

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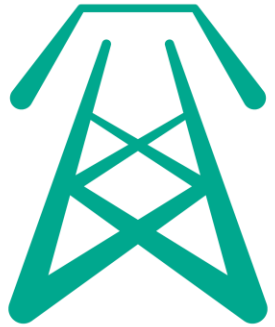
New Connection Projects South

- CP1069 Ballinknockane 110 kV Station
- CP1173 Glencloosagh Phase 1
- CP1245 Castletreasure 110 kV Station
- CP1260 Dennistown 110 kV Station
- CP1269 Lodgewood 110 kV & Crory 110 kV Station
- CP1347 Dunbrody 110 kV Station
- CP1351 Ballynadrideen 110 kV Station
- CP1353 Bendinstown 110 kV Station
- CP1424 Tarbert 220 kV station



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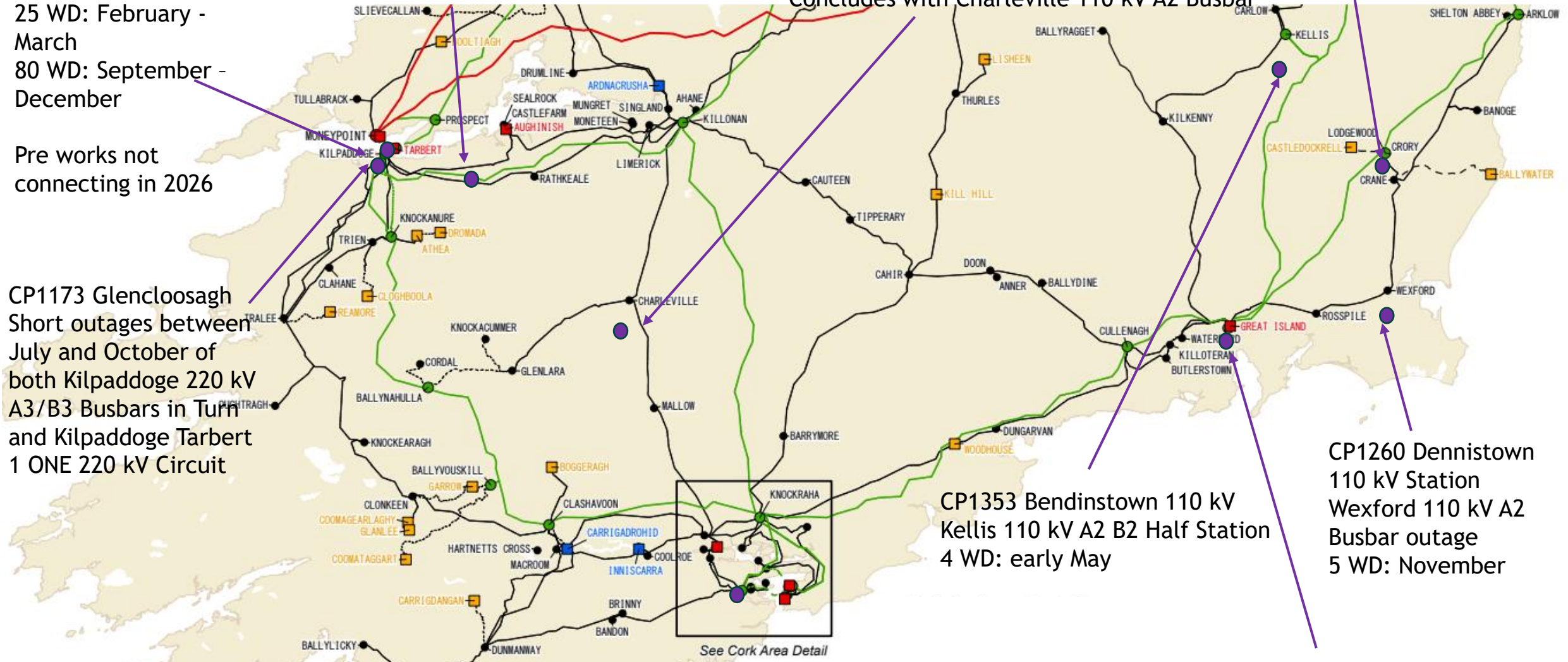
CP1424 Tarbert
Tarbert A1/B1 Busbars
In Turn
25 WD: February - March
80 WD: September – December

Pre works not connecting in 2026

CP1069 Ballinknockane 110 kV Station
Aughinish Kilpaddoge 110 kV Circuit
80 WD: August – November

CP1351 Ballynadrideen 110 kV Station
Charleville Mallow 110 kV Circuit
25 WD: September – October
Concludes with Charleville 110 kV A2 Busbar

CP1269 Crory 110 kV Station
Lodgewood 110 k A2
Short outage in March



CP1173 Glencloosagh
Short outages between July and October of both Kilpaddoge 220 kV A3/B3 Busbars in Turn and Kilpaddoge Tarbert 1 ONE 220 kV Circuit

CP1353 Bendinstown 110 kV
Kellis 110 kV A2 B2 Half Station
4 WD: early May

CP1260 Dennistown
110 kV Station
Wexford 110 kV A2
Busbar outage
5 WD: November

CP1245 Castletreasure
Short outages in Raffeen station
Between October and December

CP1347 Dunbrody 110 kV Station
Great Island 110 kV A2 B2 In Turn
40 WD: October - November

New Connection Projects Dublin

CP1230 Darndale 110 kV Station Phase 2
Transformer energisation

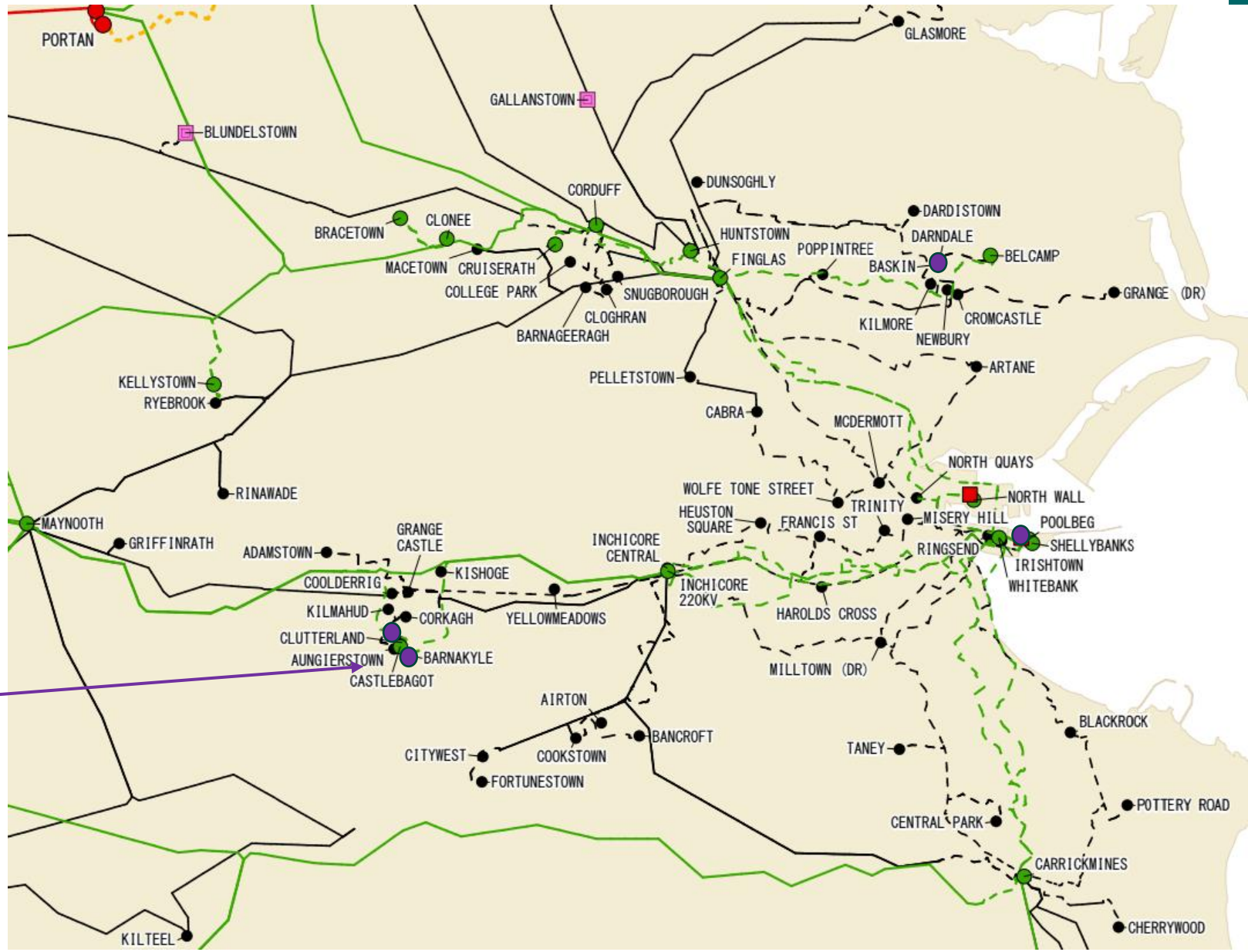
CP1452 Poolbeg 220 kV station
Proximity outages for Busbars and Inchicore and Carrickmines bays
February to October

CP1256 Barnakyle 110 kV station
Barnakyle A2 110 kV Busbar
12 WD: January

CP1456 Clutterland 110 kV Station
Transformer energisation

CP1188 Kilcarbery 110 kV Station
Barnakyle Castlebagot 1 ONE 110 kV
80 WD: April - August

CP1296 Rinawade GIS

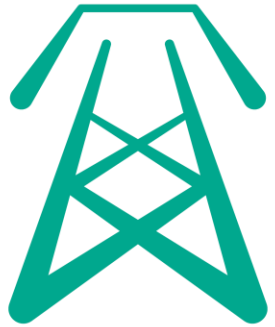


New Connections Dublin/Midlands

CP1296 Rinawade GIS
CP1390 Maynooth Rinawade Line Uprate
45 WD : August to November
Maynooth Rinawade 110 kV
Maynooth Ryebrook 110 kV
Dunfirth Tee Rinawade 110 kV

New Connection Projects Midlands

- CP1268 Dunfirth
- CP1430 Lanesboro 110 kV Station
- CP1442 Fosterstown 110 kV Station



CP1430 Lanesboro 110 kV

Cloon Lanesboro 110 kV outage

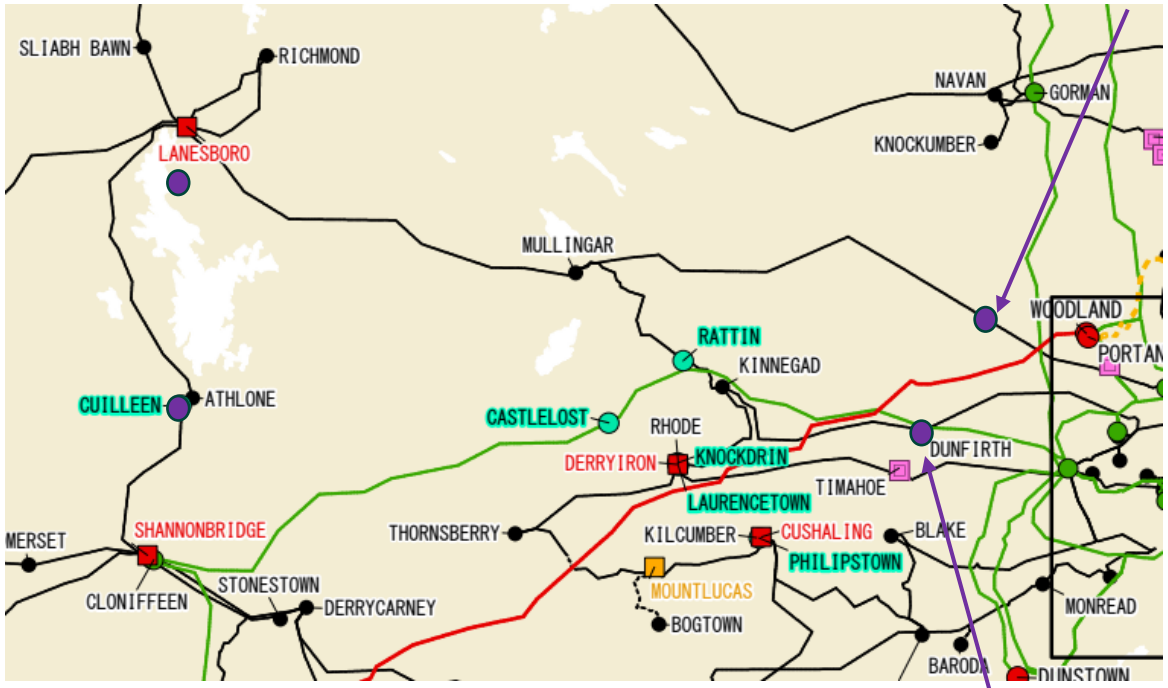
Lanesboro 110 kV A2 Busbar outages

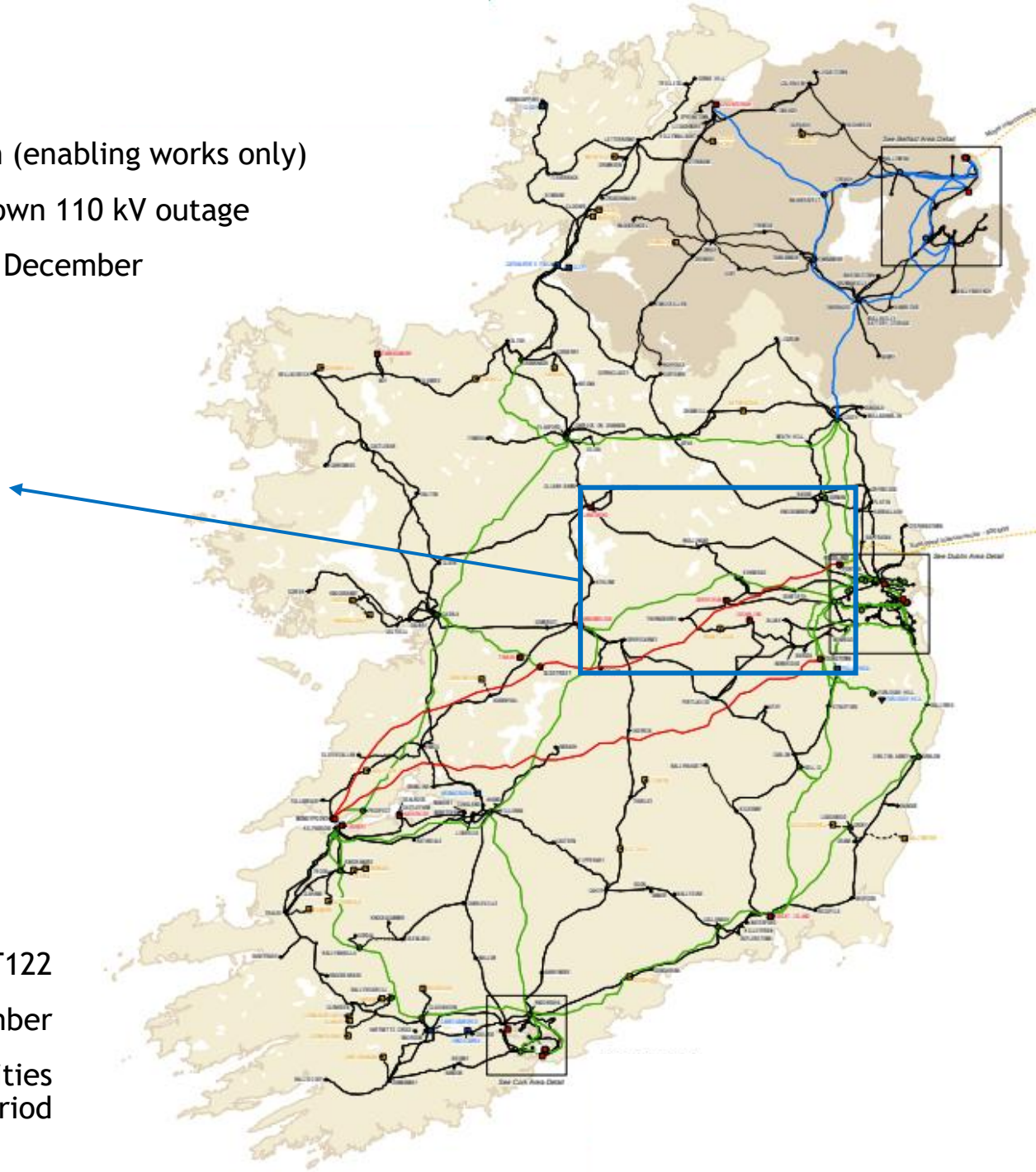
10 WD: July

CP1442 Fosterstown (enabling works only)

Mullingar Blundelstown 110 kV outage

20 WD: November – December





CP1259 Athlone 110 kV Station :

Athlone 110 kV A2

5 WD: March - April

Multiple outages 10–15-day outages in Athlone Station during the period May to September for protection upgrade works

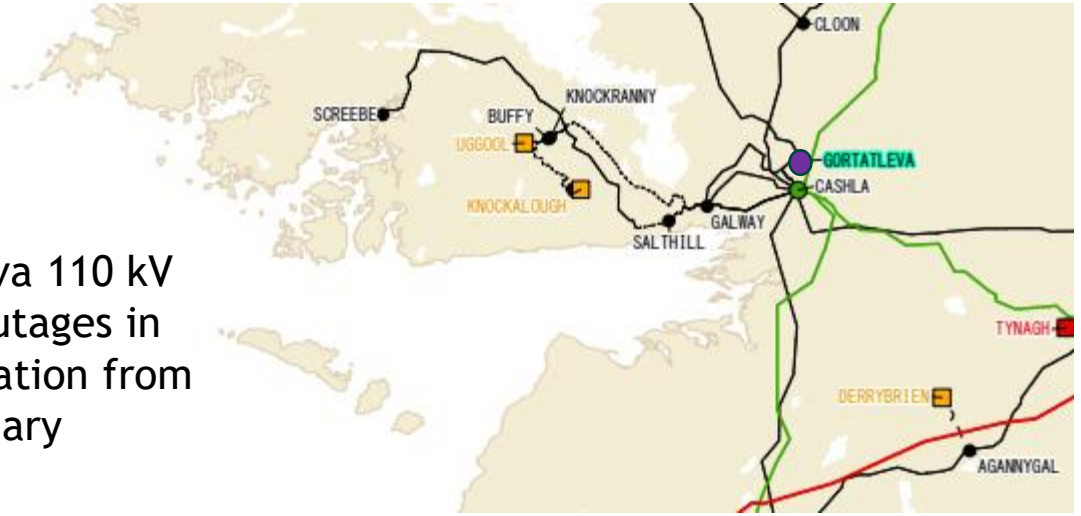
CP1268 Dunfirth T122

28 WD: September – November

Also short circuit proximities within this period

New Connection Projects North

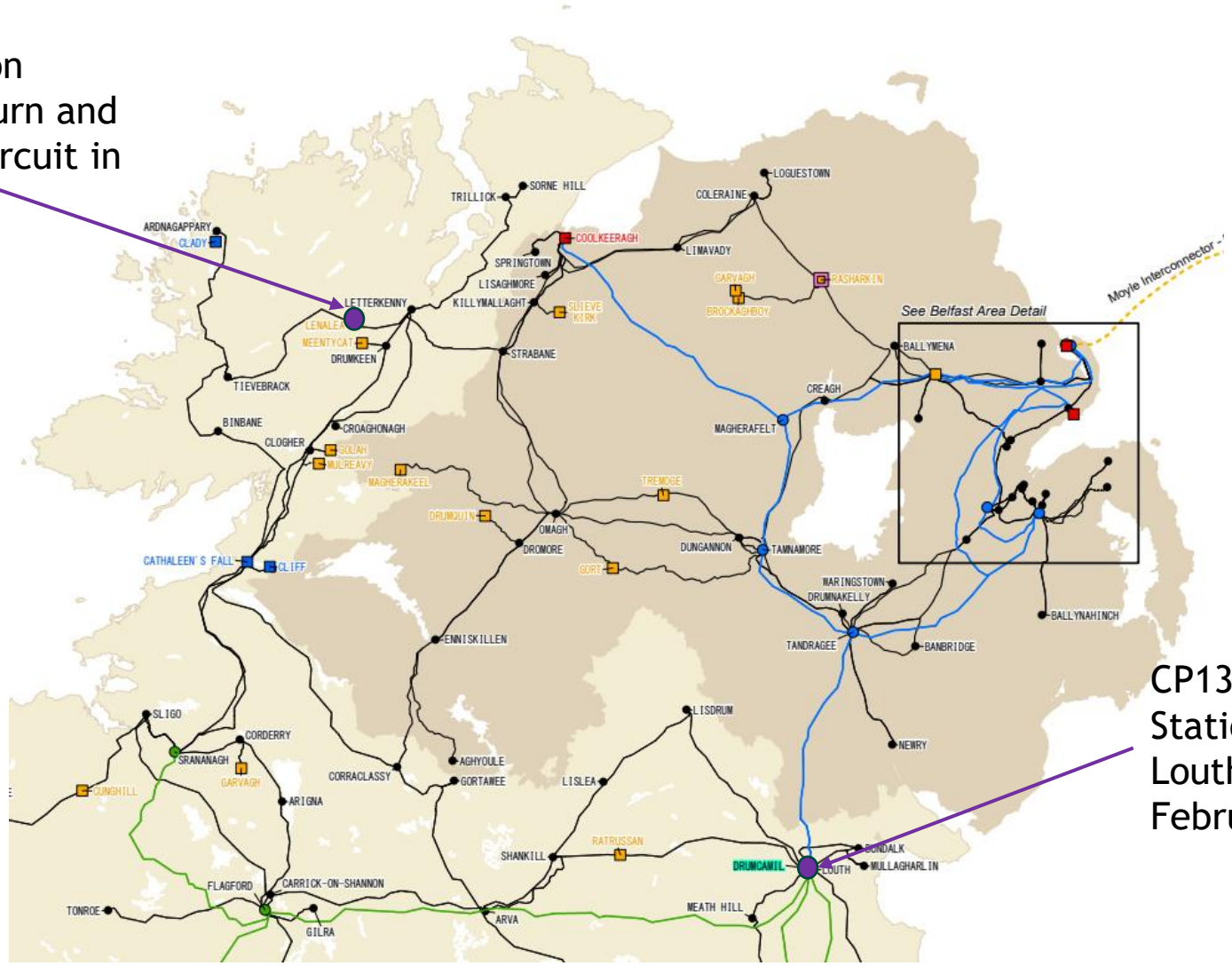
- CP1359 Lenalea 110 kV Station
- CP1342 Drumcamill 110 kV Station
- CP1352 Gortatleva 110 kV Station



CP1352 Gortatleva 110 kV Station – short outages in Cashla 110 kV Station from January to February

New Connection Projects North

CP1359 Lenalea 110 kV Station
Short outages of Busbars in turn and Lenalea Tievebrack 110 kV Circuit in period June - November



CP1342 Drumcamill 110 kV Station – short outages in Louth 110 kV Station from February to June

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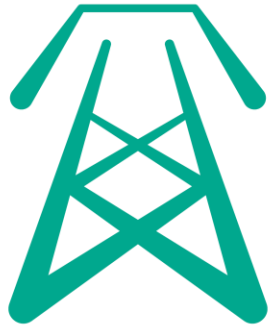
Line Uprates / Refurbishments North

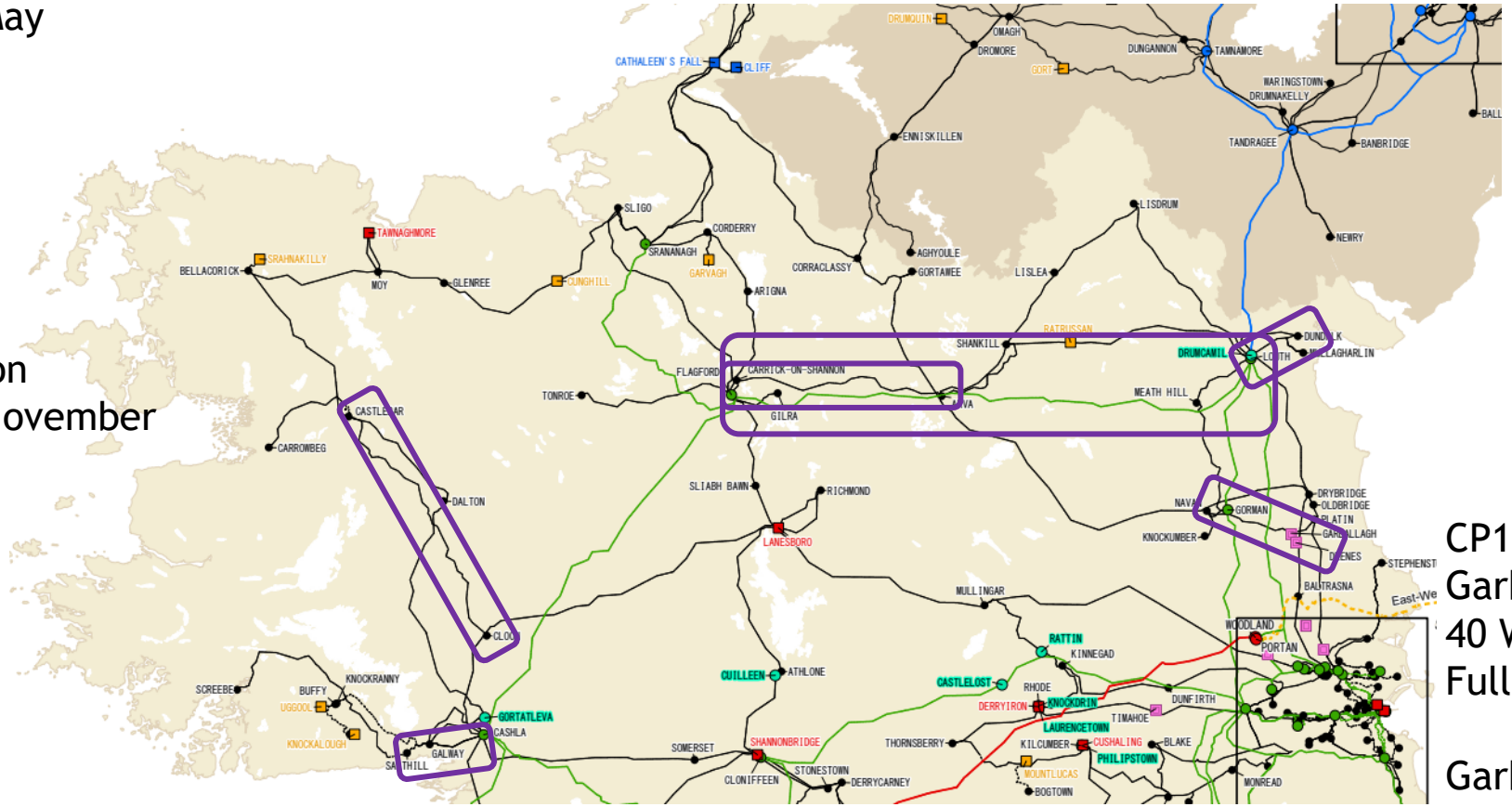


- CP0841 Arva Carrick-on-Shannon 110 kV Line Uprate
  - Old rating: 104/113/122 MVA; New rating: 178/194/209 MVA (Full uprate not planned for completion in 2026)
- CP0848 Castlebar Cloon 110 kV Line Refurb
  - Old rating: 99/110/121 MVA; New rating: 178/194/209 MVA (Full uprate not planned for completion in 2026)
- CP0867 Flagford Louth 220 kV Line Refurb (align with CP0799)
- CP1166 Gorman-Garballagh-Platin 110 kV Line Uprate
  - Old rating: 104/113/122 MVA; New rating: 178/194/209 MVA
- CP1168 Cashla Salthill 110 kV Thermal Uprate
  - Rating will remain 97/97/97 MVA. This circuit has both overhead line and cable sections. The overhead line section will be uprated to 178/194/209 MVA. Given that the cable section has a considerable overload capability, the uprate of the overhead line section will unlock this
- CP1301 Dundalk Louth 110 kV Line Uprate (Full)
  - Old rating: 99/110/121 MVA; New rating: 178/194/209 MVA (Uprate will not be realised until future Dundalk busbar uprate project is complete)

Line Uprates / Refurbishments North

CP0867 Flagford Louth Refurb
20 WD: February – March
30 WD: June – July

CP0841 Arva Carrick-on-Shannon
53 WD: March - May
Partial Uprate



CP1301 Dundalk Louth Uprate
80 WD: April - August
Full Uprate

CP0848 Castlebar Cloon
40 WD: September – November
Partial Uprate

CP1166
Garballagh Platin Uprate
40 WD: Feb – April
Full Uprate

Garballagh Gorman Uprate
50 WD: October - December
Full Uprate

CP1168 Cashla Salthill Line Uprate
55 WD: July – October
Complete uprate dependent on decision regarding CP1191

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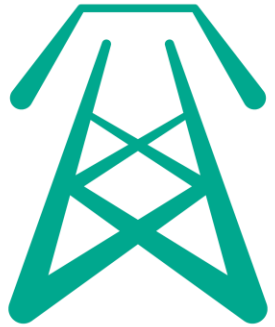
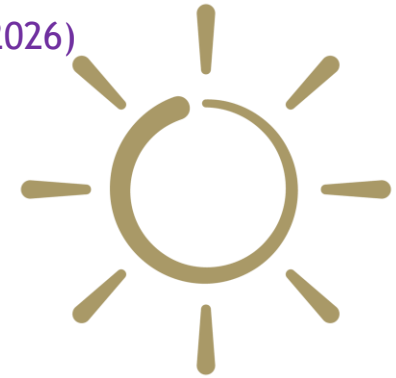
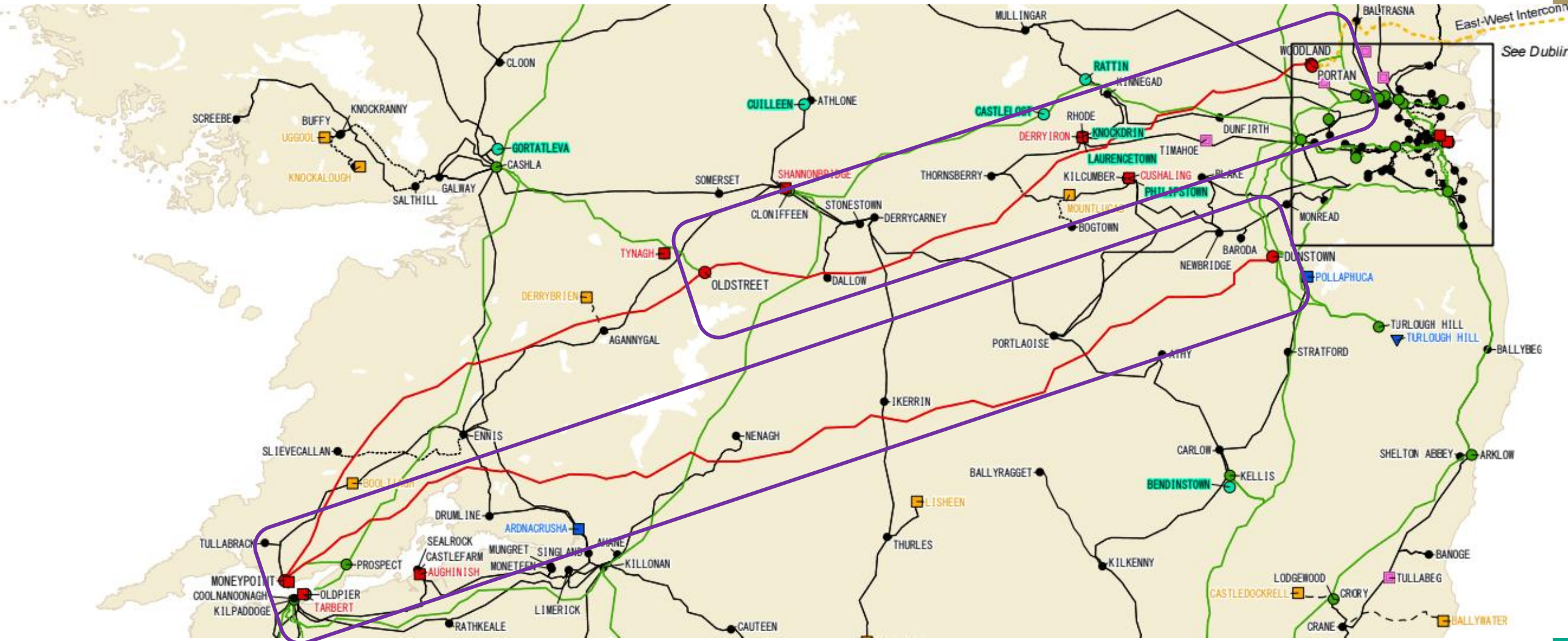
Line Uprates / Refurbishments Central



- CP0873 Dunstown Moneypoint 400 kV Line Refurb
- CP1170 Newbridge Portlaoise (aligns with Bracklone)
  - Old rating: 104/113/122 MVA; New rating: 178/194/209 MVA
- CP0835 Coolnabacky Portlaoise 110 kV Circuit (aligns with Coolnabacky)
  - Old rating: 99/110/121 MVA; New rating: 178/194/209 MVA
- CP1199 Derryiron Thornsberry 110 kV Line Uprate (Partial)
  - Old rating: 99/110/121 MVA; New rating: 178/194/209 MVA (Full uprate not planned for completion in 2026)
- CP1390 Maynooth Rinawade 110 kV Line Uprate
  - Old rating: 80/92/103 MVA; New rating: 178/194/209 MVA (Full uprate not planned for completion in 2026)
- CP1426 Oldstreet Woodland 400 kV Circuit – conductor sampling



CP1426
Oldstreet Woodland 400 kV Circuit
15 WD: October
Conductor Sampling



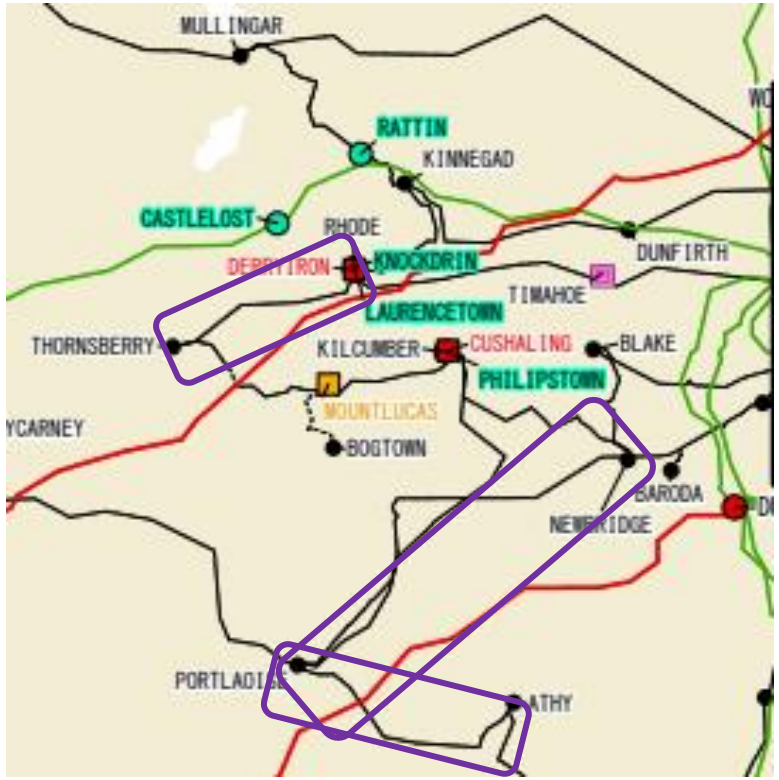
CP0873 Dunstown Moneypoint
46 WD: July – September
Line Refurbishment Works

CP1199 Derryiron Thornsberry 110 kV Circuit

60 WD: April – July

Partial Line Uprate

15 WD: May – June proximity of Derryiron Timahoe



CP1170 Newbridge-Bracklone-Portlaoise

60 WD: January – April

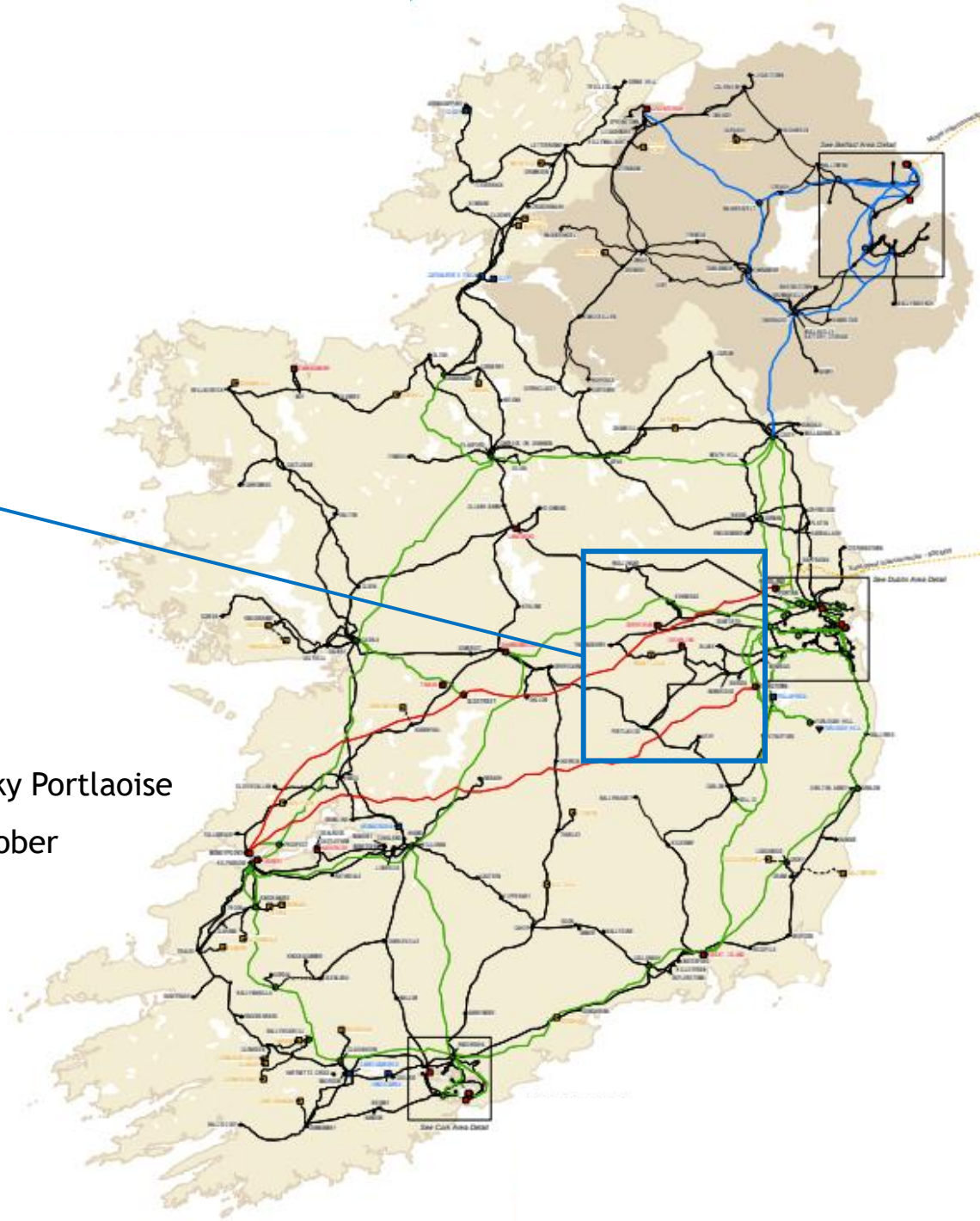
Bracklone Newbridge 110 kV Circuit

40 WD: October – December

Partial Uprate

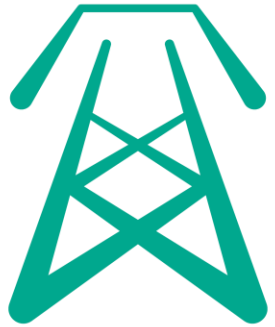
CP0835 Coolnabacky Portlaoise

110 WD: May – October



Line Uprates / Refurbishments South

- CP0868 Knockraha Raffeen Line Refurb
- CP1212 Bandon Raffeen 110 kV Line Uprate (Partial)
    - Old rating: 99/110/121 MVA; New rating: 178/194/209 MVA (Uprate will not be realised until CP1223 Bandon busbar uprate is complete)
- MC0398 Aghada Knockraha 1 & 2 220 kV Circuits New Tower

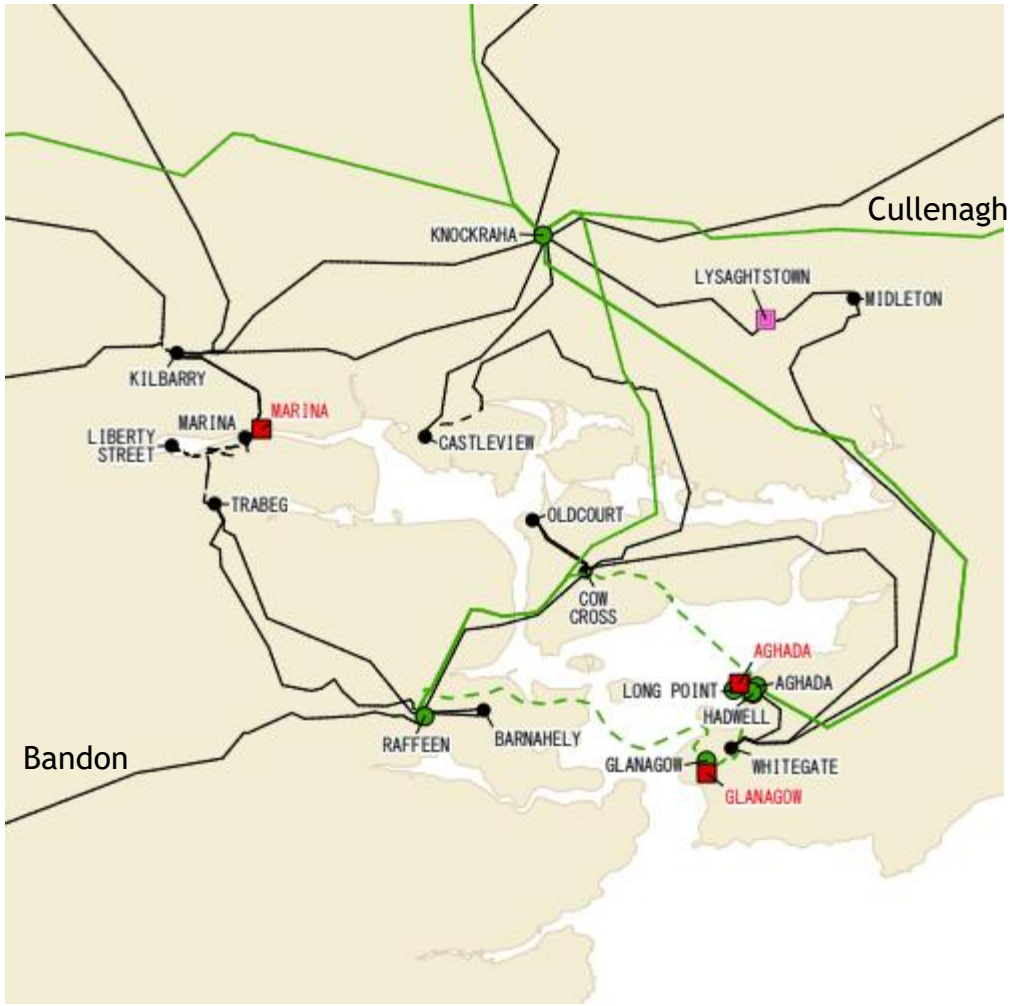


CP0868
Knockraha Raffeen 220 kV &
Aghada Raffeen 220 kV
5 WD : April

Knockraha Raffeen 220 kV &
Cullenagh Knockraha 220kV
10 WD : September – October

CP1212
Bandon Raffeen 110 kV
81 WD : March -July

Knockraha Raffeen 220 kV &
Aghada Raffeen 220 kV
10 WD: April – May



MC0398
Aghada Knockraha 1 & 2 220 kV
Double Circuit Outage
15WD : October

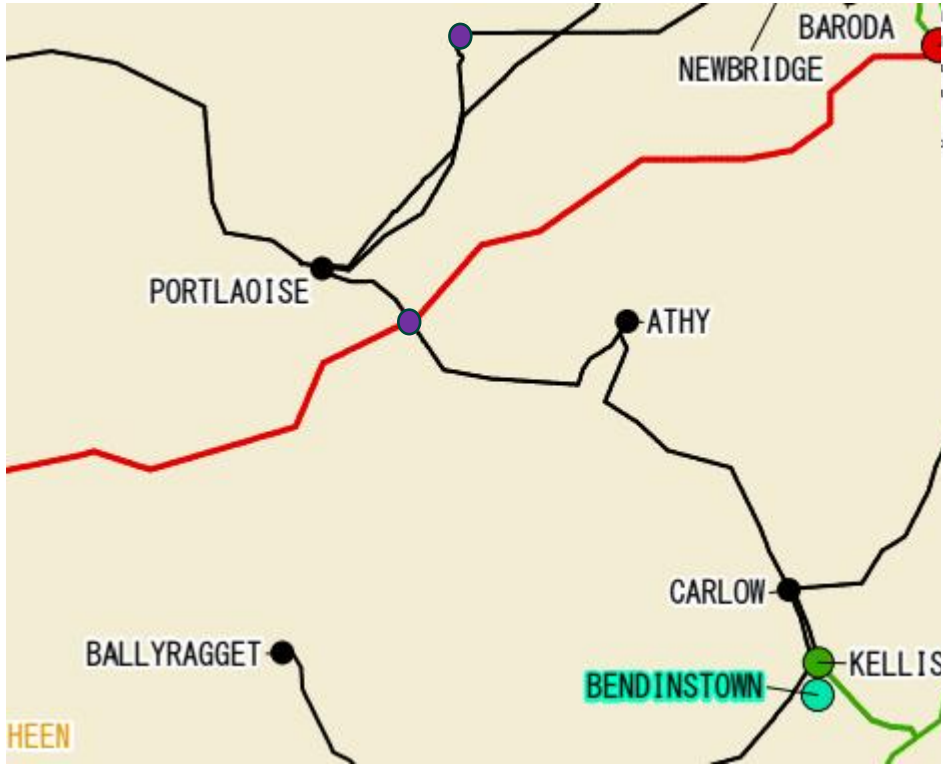
Outage to install additional tower to resolve ground clearance issue

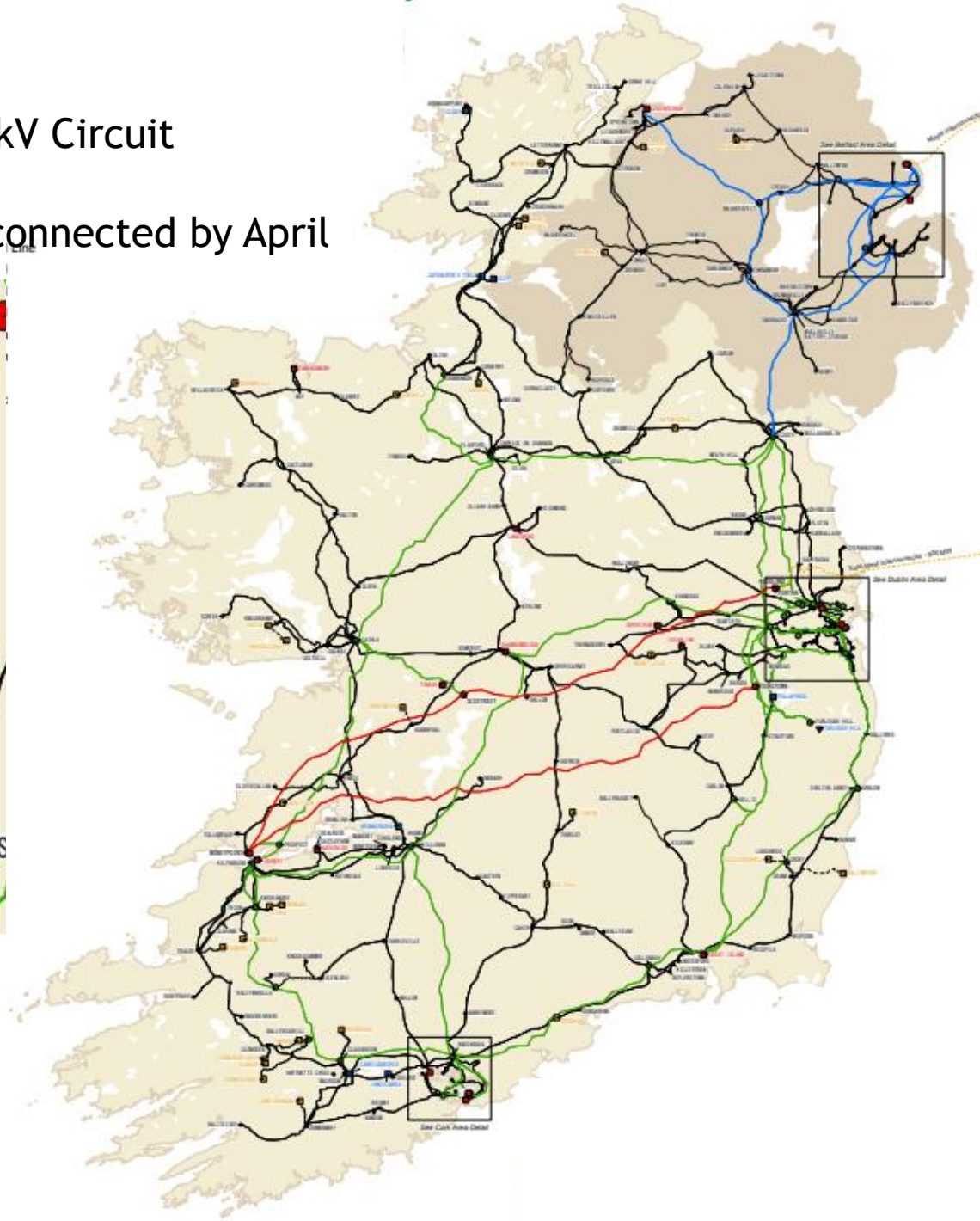
Network Projects

- CP0585 Coolnabacky
- CP0624 Killonan
- CP0644 Bracklone
- CP0692 Inchicore
- CP0799 Louth
- CP1032 Cashla S&S
- CP1084 Lisdrum Sectionalising Cubicle
- CP1194 Woodland 400 kV Station Redevelopment
- CP1449 Midleton 110 kV Transformer

Network Projects

CP0644 Bracklone
Newbridge Portlaoise 110 kV Circuit
60 WD: January – April
Bracklone 110 kV Station connected by April





CP0585 Coolnabacky
Athy Portlaoise 110 kV Circuit
110 WD: May – October

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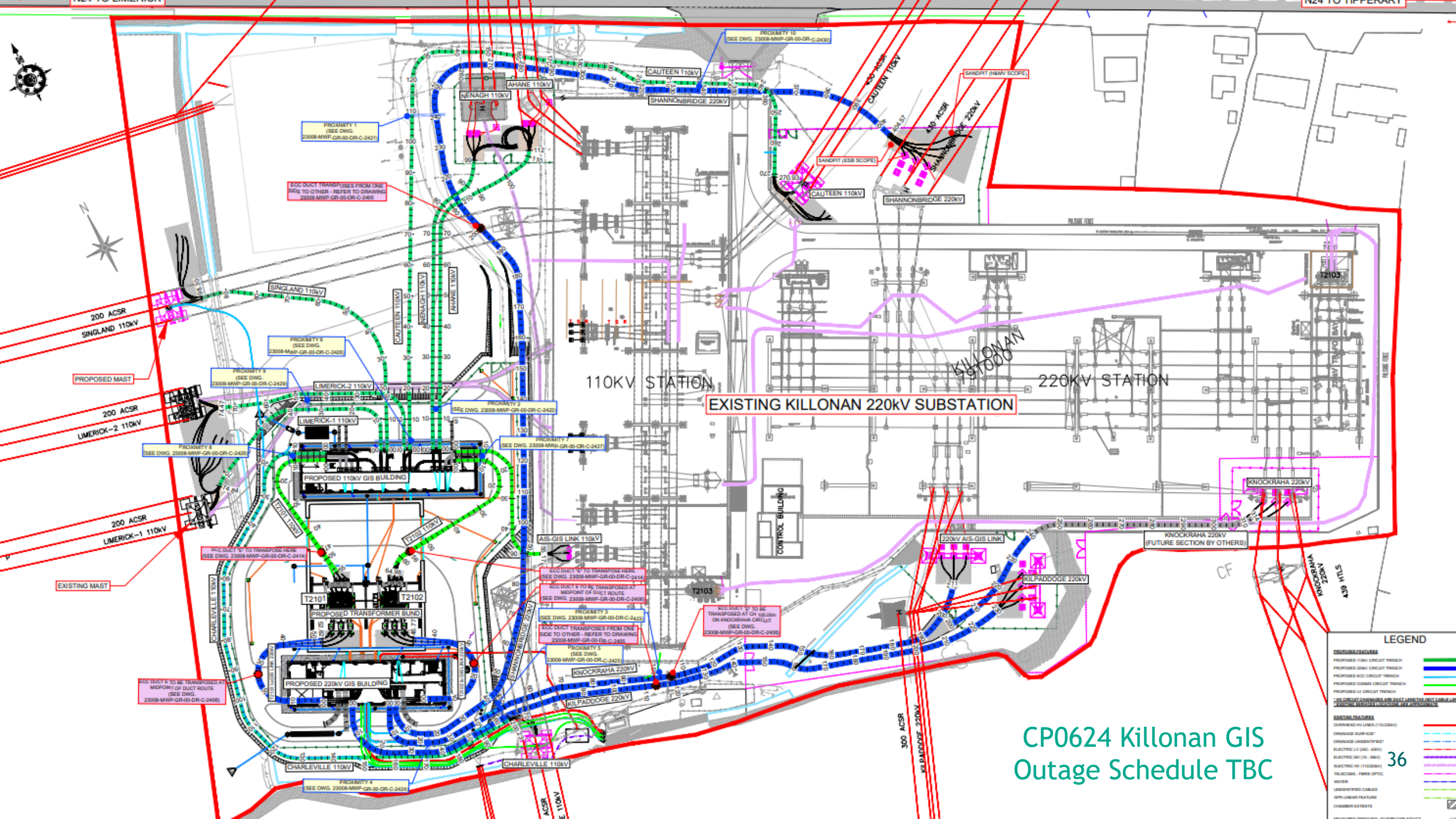
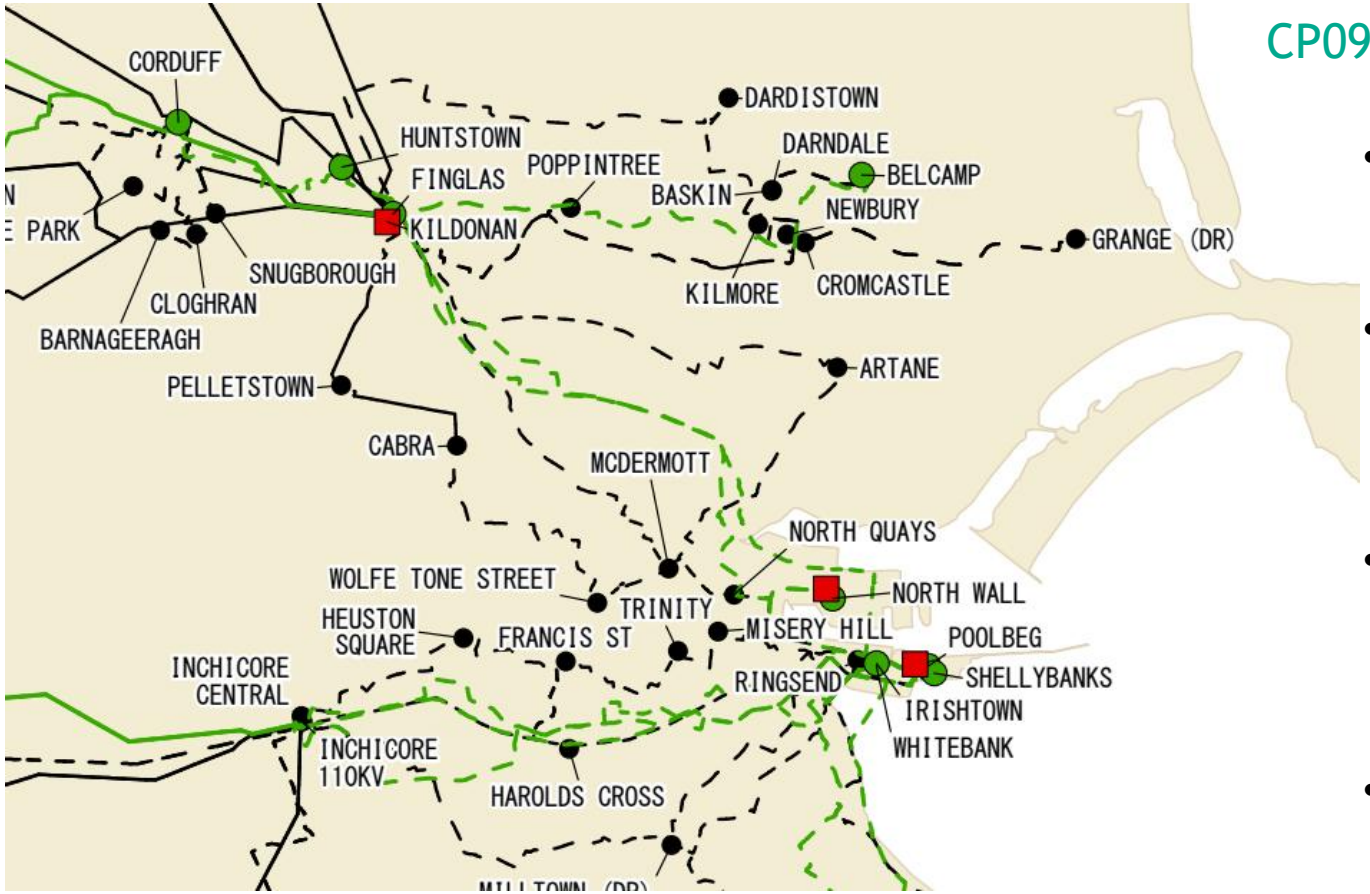

EXISTING KILLONAN 220kV SUBSTATION
110KV STATION
220KV STATION
KILLONAN 191000
PROPOSED 110kV GIS BUILDING
PROPOSED TRANSFORMER BUND
PROPOSED 220kV GIS BUILDING
CONTROL BUILDING
T2101
T2102
T2103
CAUTEEN 110kV
AHANE 110kV
NENAGH 110kV
SHANNONBRIDGE 220kV
SINGLAND 110kV
LIMERICK-2 110kV
LIMERICK-1 110kV
CHARLEVILLE 110kV
KNOCKRAHA 220kV
KILPADDOGE 220kV
SANDPIT (ESB SCOPE)
SANDPIT (M&MV SCOPE)
AIS-GIS LINK 110kV
220kV AIS-GIS LINK
PROPOSED MAST
EXISTING MAST
200 ACSR
300 ACSR
450 ACSR
LEGEND
CP0624 Killonan GIS
Outage Schedule TBC
36

Network Reconfigurations



CP0984 Belcamp Shellybanks Phase 2

- Looping Belcamp 220 kV Station into Finglas Shellybanks 220 kV Circuit
- Loop in works: commencing June 50 day outage of Finglas Shellybanks 220 kV Circuit at conclusion Belcamp will be tailed from Shellybanks
- Finglas Belcamp 220 kV Circuit outage for 30 days outage Belcamp tailed to Shellybanks for this period (August – September)
- Returns as Finglas – Belcamp – Shellybanks in September

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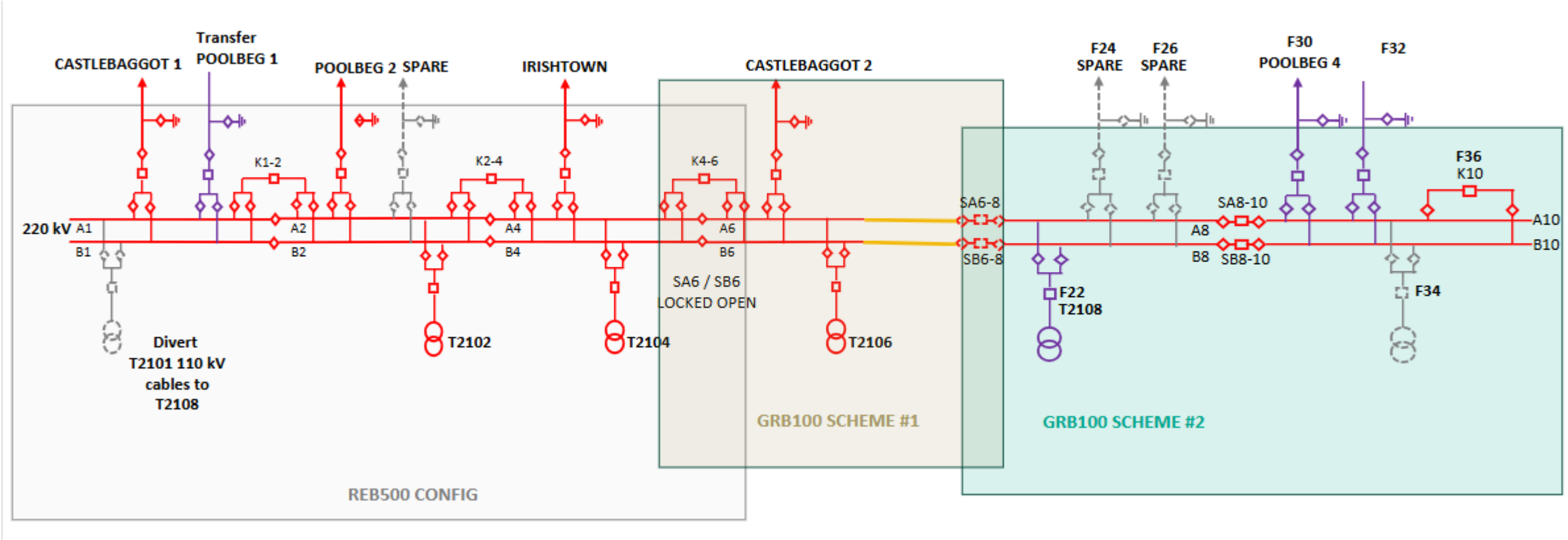
Network Projects

CP0624 Inchicore GIS



Inchicore A6/B6 outage: 32 WD : March to April – joining new GIS to old GIS
Inchicore A6/B6 outage: 40 WD : April to June – overlapping REB500 and new GRB100
Inchicore Poolbeg 1 ONE : 84 WD June – October - transfer become Poolbeg 4 FOUR
Inchicore T2101 : 51 WD : June – September - transfer to Inchicore T2108

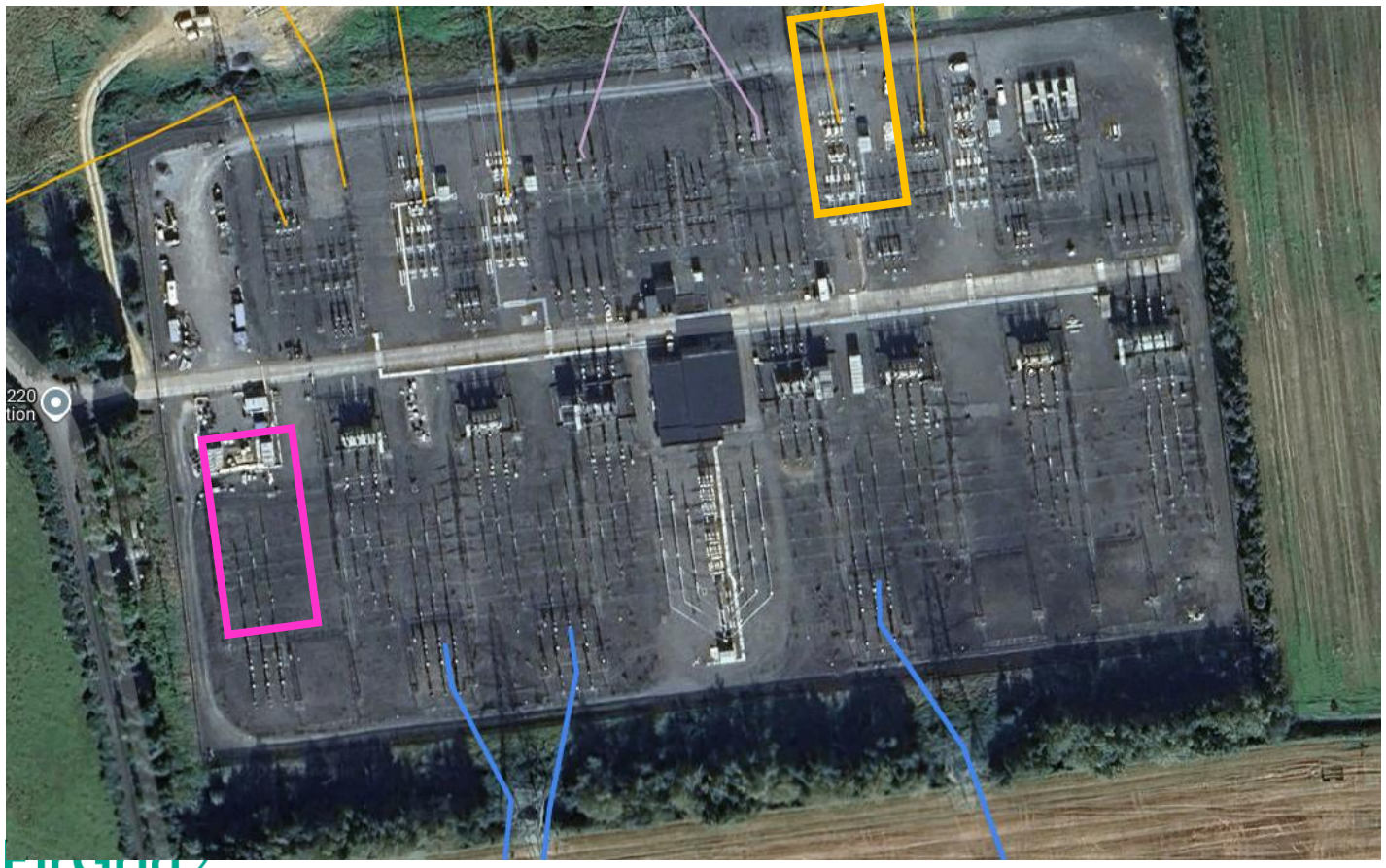
EirGrid

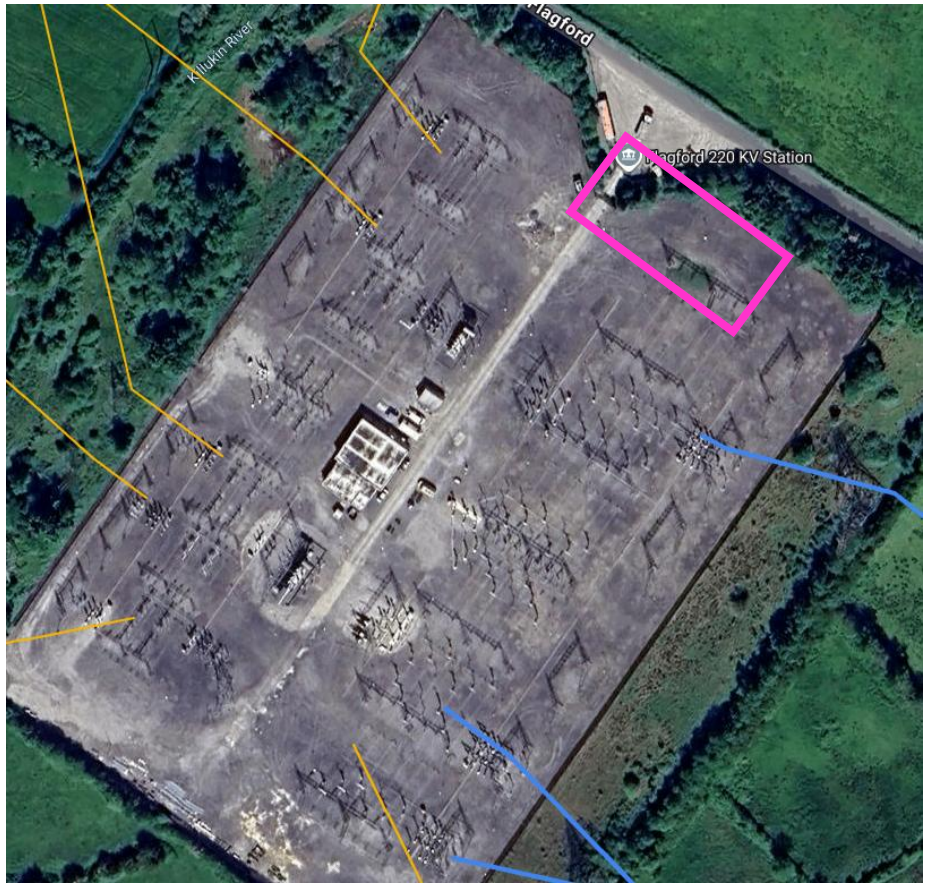
Network Projects

CP0799 Louth 220 kV Station

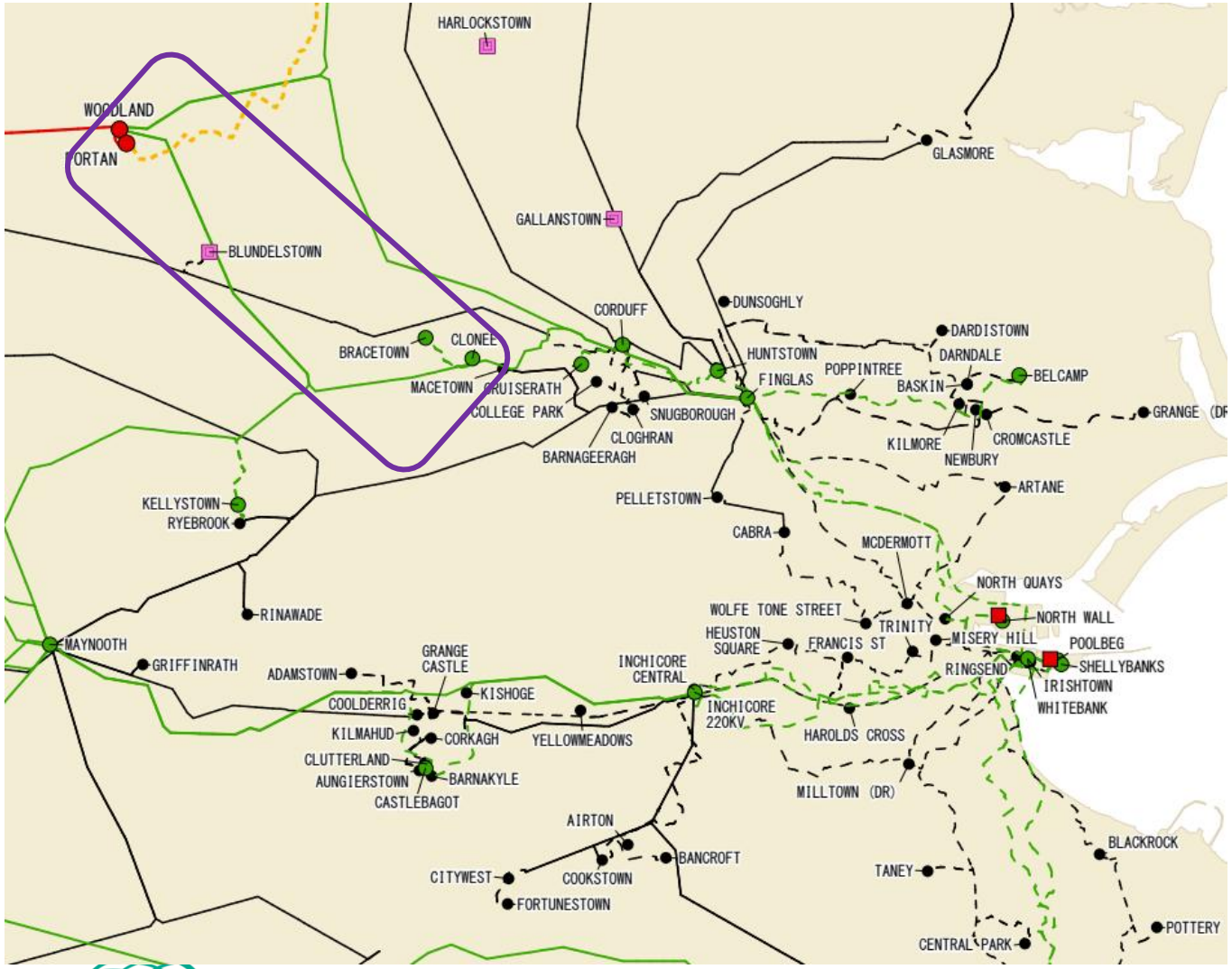
CP0799 Louth 220 kV Station Refurb
Flagford Louth
20 WD: February – March
30 WD: June – July

Drybridge 110 kV Bay Refurbishment
100 WD: July – November





Network Reconfigurations



CP1194 Woodland Station Redevelopment

- Clonee Woodland 220 kV
- Bay upgrade in Woodland Station
- 55 WD: March - May

- Woodland 220 kV K1-2
- Circuit Breaker Replacement
- 33 WD: August – October

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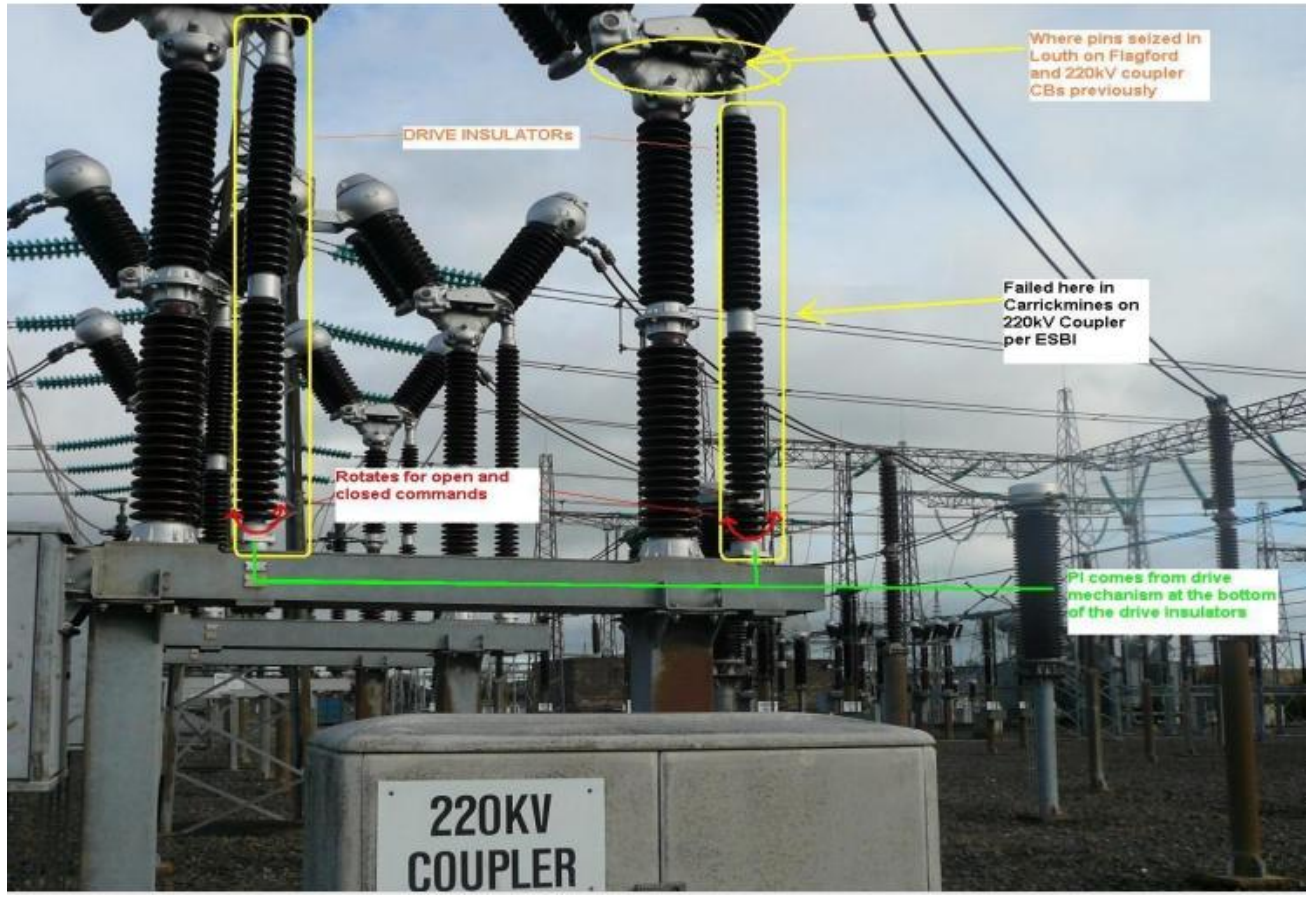
Network Reconfigurations



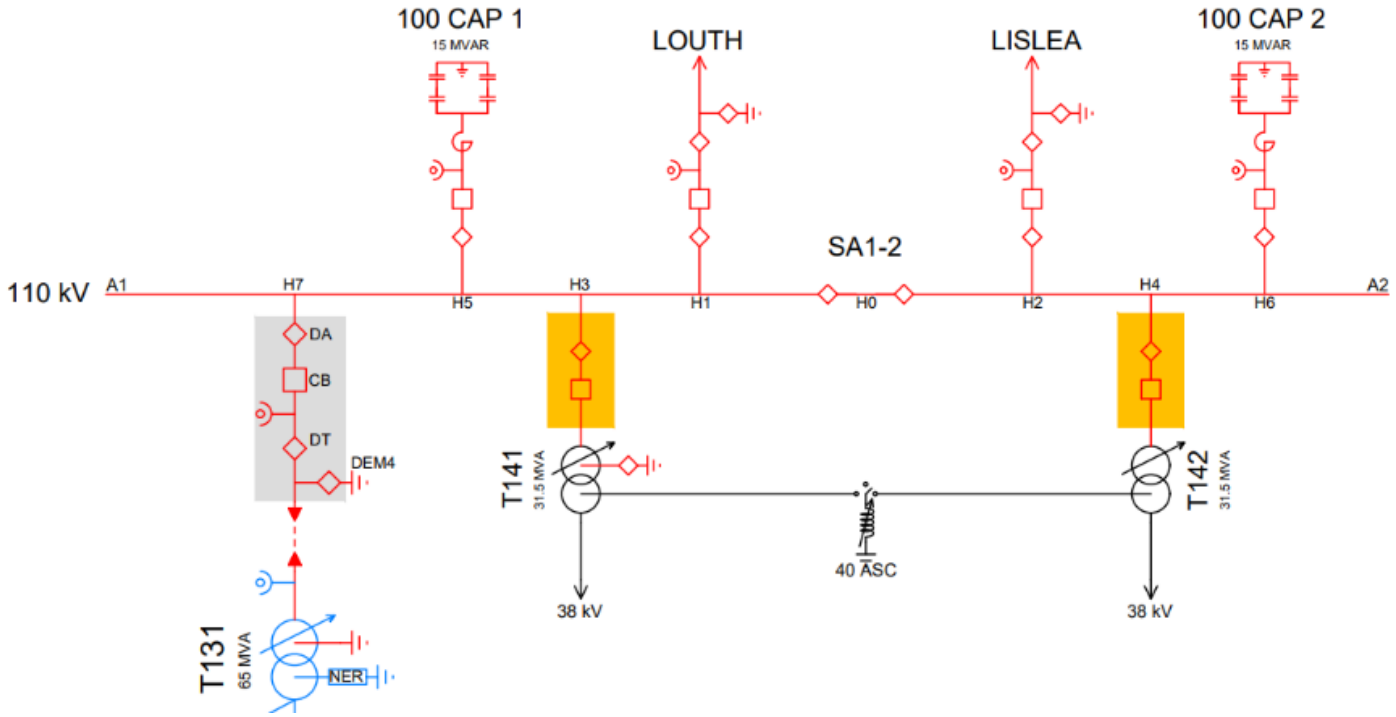
CP1032 Cashla Sprecher & Schuh

- Cashla Cloon 110 kV Circuit
  - 40 WD: April – June
- Cashla K1-2 110 kV Coupler
  - 40 WD: June – July

Network Reconfigurations

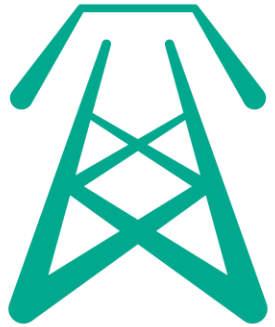
CP1084 Lisdrum

- New Sectionalising Cubicle in Lisdrum (SA1-2)
- Multiple half station outages
- 59 WD August - November



Protection Upgrades

- CP1109 Gorman and Connected Stations (Half Bars in Meath Hill)
- CP1111 Ballydine Cahir 110 kV Protection
- CP1114 Platin
- CP1137 Carlow Kellis 1& 2
- CP1139 Srananagh 110 kV K1-2
- CP1140 Athy BZP Integration
- CP1141 Kellis 110 kV Coupler
- CP1161 Cathaleen's Fall 110 kV K1-2
- CP1162 Poolbeg Shellybanks and Connected Stations Protection Upgrade (Irishtown T2001)
- CP1164 West Cork – Dunmanway Macroom 110 kV – 20 WD
- CP1227 Cashla and Connected Stations
- CP1228 Shannonbridge and Connected Station



Questions

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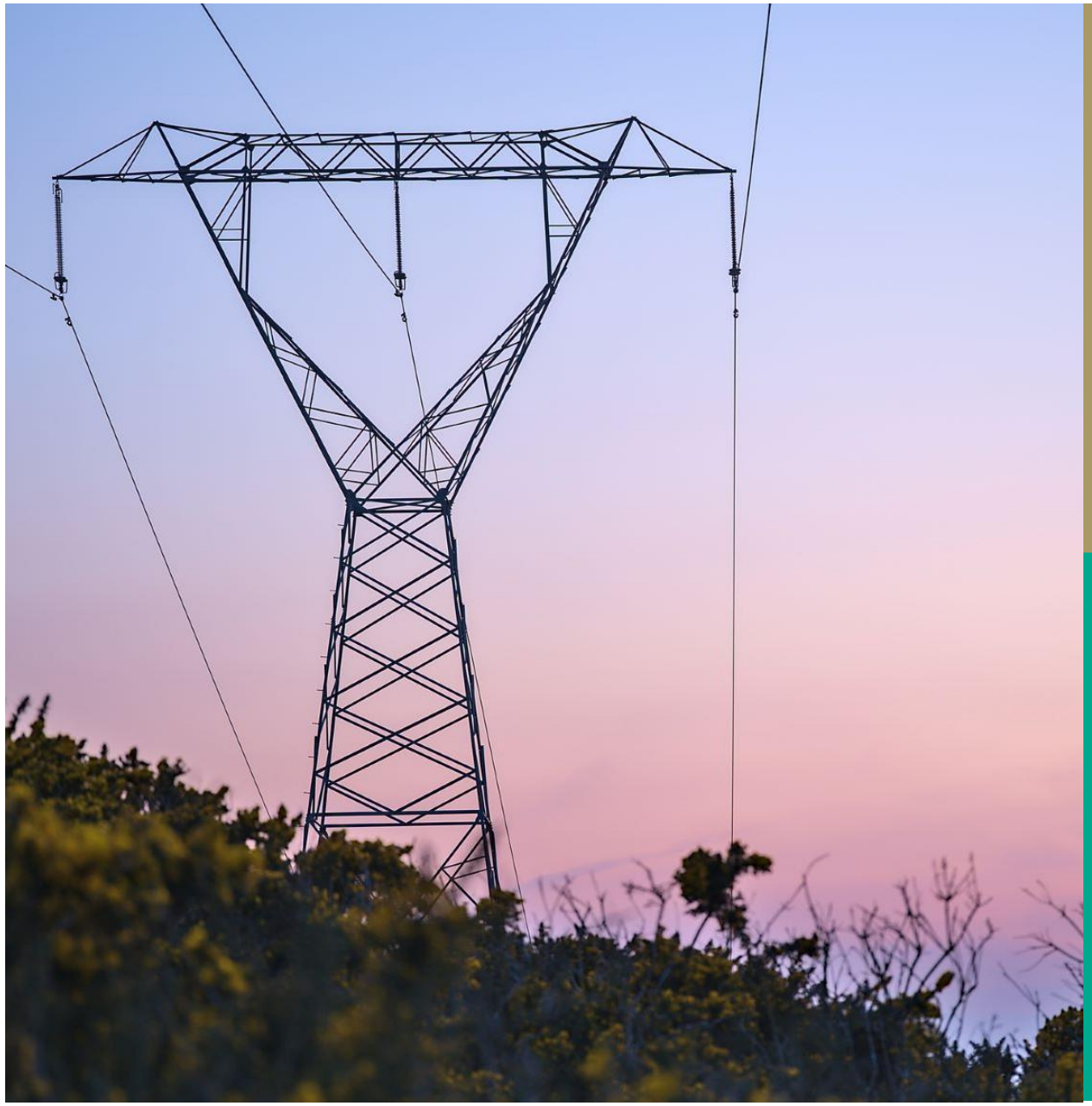
13 January 2026

Dynamic Line Rating (DLR)

How does it work, experience to date, and future installation plans



Aidan Geoghegan

EirGrid

Dynamic Line Rating - The Fundamentals

Installing DLR on an overhead line -

- Does not alter the line in any way.
- Does not uprate the overhead line.
- Does not change the rating of the overhead line.

So, what does it do –

- It allows us to make better use of the existing rating.
- It enhances the safe operation of line.
- It provides valuable data on how the line is operating which in turn allows network planners, outage planners, controllers, and asset managers make better informed decisions.

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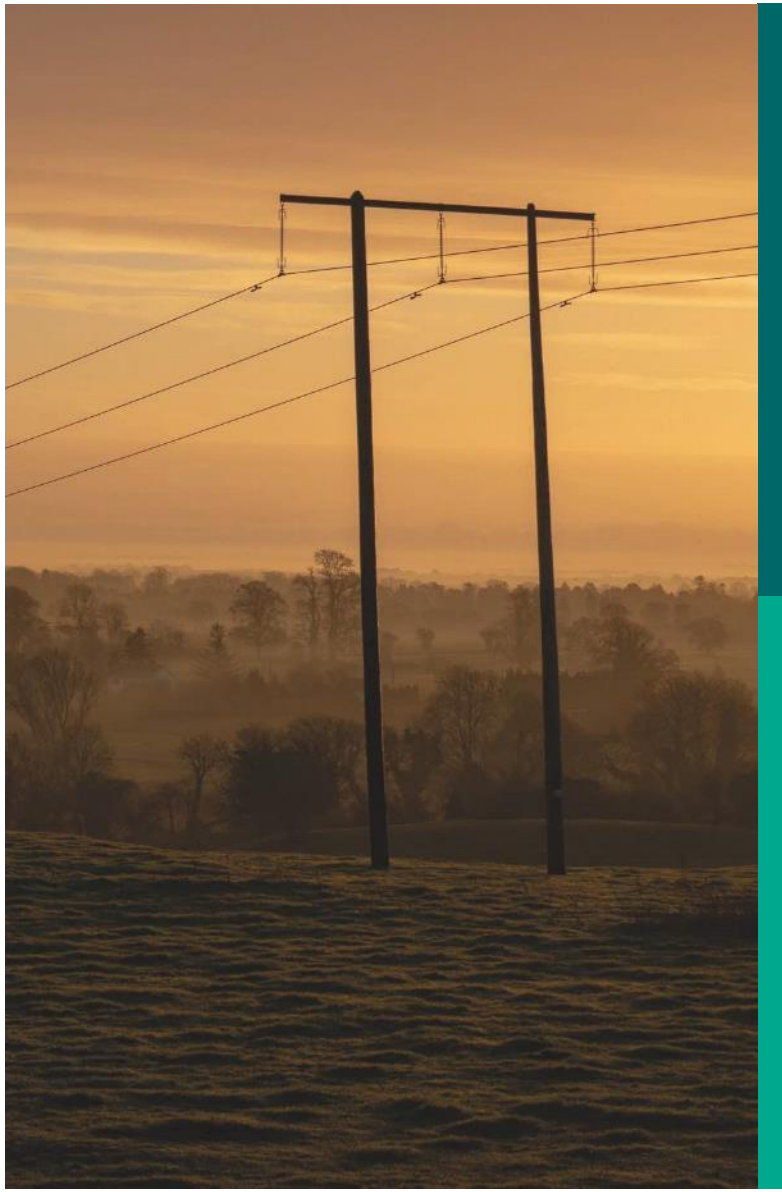
Dynamic Line Rating – The Fundamentals

The true rating of an overhead line is its **maximum operating temperature**.

The TAO specifies the rating of overhead lines to the TSO in the format shown in these two examples - 200 ACSR @ 60°C and 200 ACSR @ 80°C.

Where -

- The '200' represents the cross-sectional area of the conductor in mm^2.
- 'ACSR' is the conductor type – Aluminium Conductor Steel Reinforced.
- The '60°C' and '80°C' are the respective max operating temperatures for the particular line.



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Dynamic Line Rating - The Fundamentals

- The **maximum operating temperature** is rarely a limitation of the conductor.
- Taking the two previous examples - 200 ACSR @ 60 °C and 200 ACSR @ 80 °C – the size and type of conductor are the same but the max operating temperature is different.

What determines the maximum operating temperature of an overhead line conductor?

- The **max operating temp** is a function of the overhead line design; a function of the overhead line as a system comprising of support structures and conductors.
- The metals that form the conductors are subject to thermal expansion, when they heat up, they expand, when they cool down, they contract.

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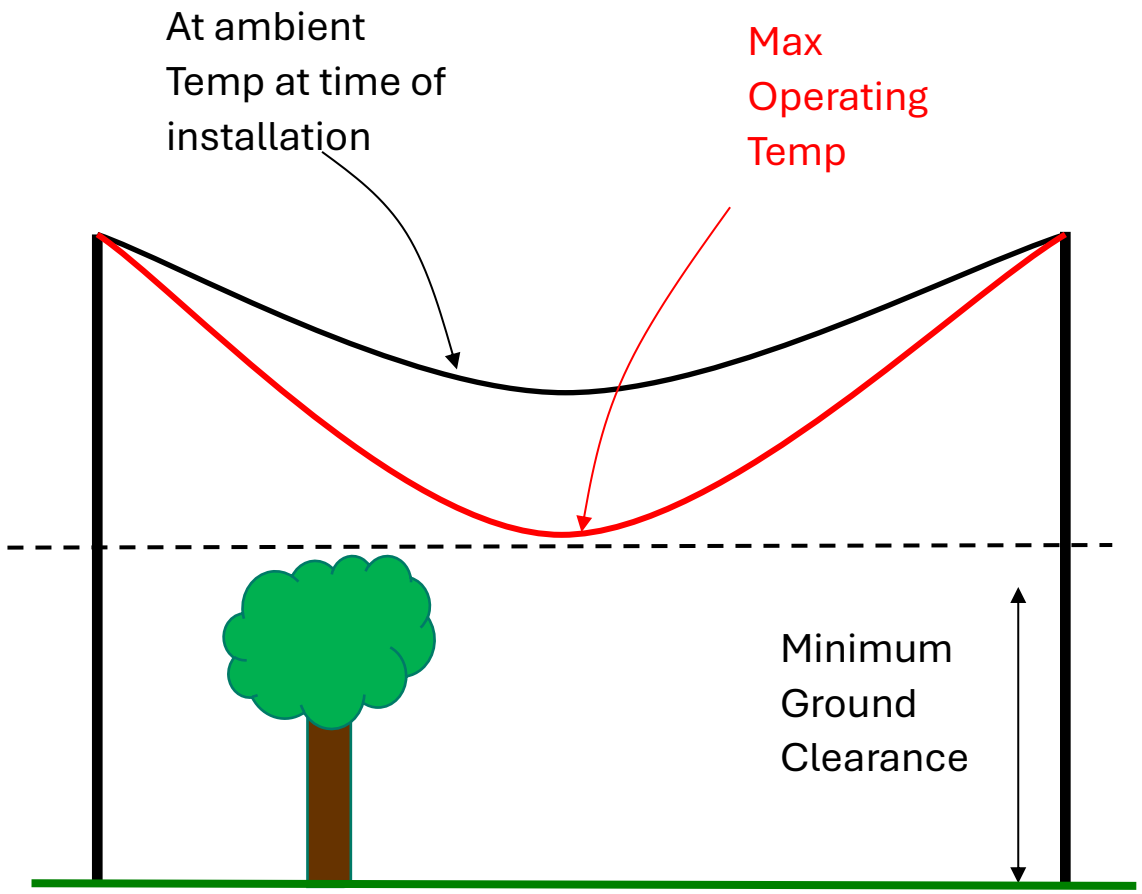
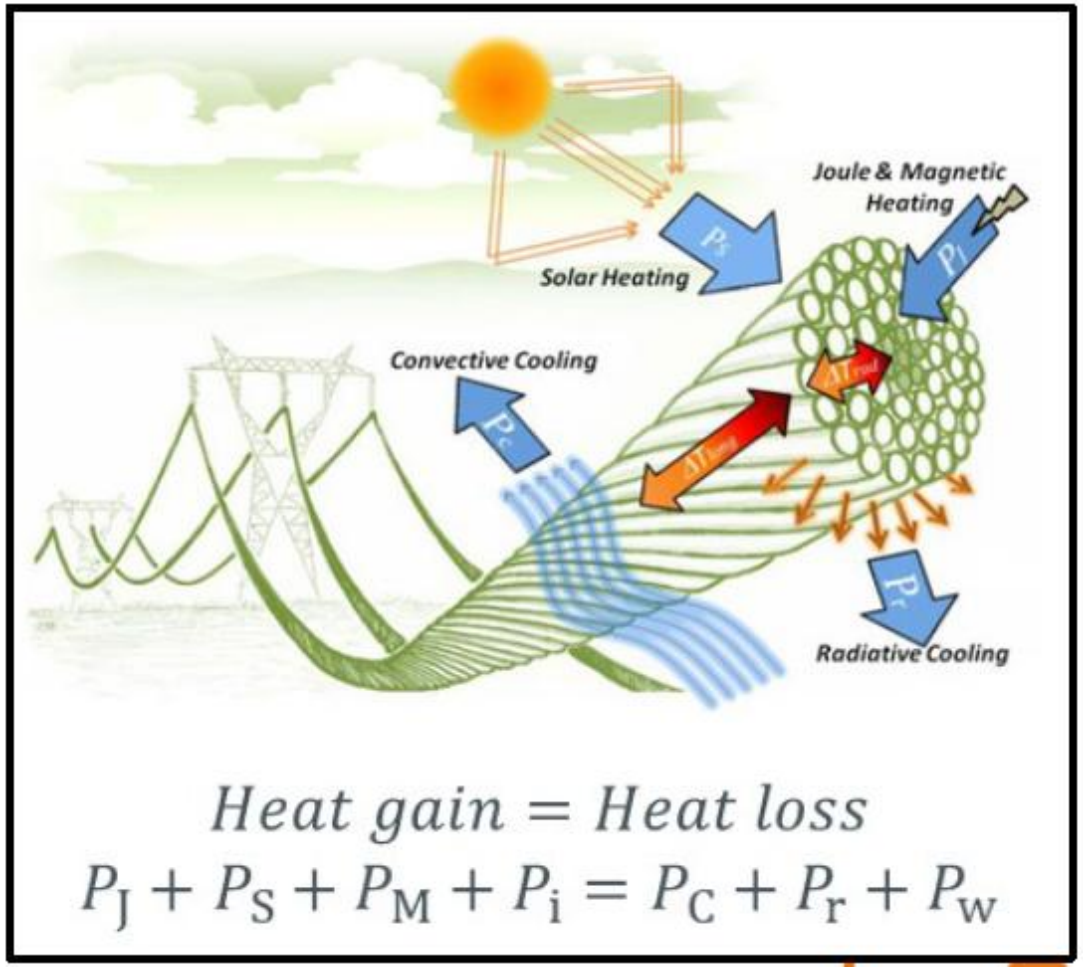
Dynamic Line Rating – The Fundamentals

- Current flowing in the conductor will cause it to heat up which will result in increase in sag.
- Minimum ground clearances have been specified 7m for 110 kV, 8m for 220 kV, and 9m for 400 kV.
- There will be spans on the overhead line where these clearances will be infringed if the conductor temp exceeds the Maximum Operating Temperature.
- That is a safety hazard and it must be avoided.



Dynamic Line Rating - The Fundamentals

- But the problem is we have no visibility of the conductor temperature.
- We know passing current through a conductor will cause it to heat up.
- But that is not the only factor impacting the temperature of an overhead line conductor.
- Environmental factors also play a part and some of these can result in heat gain while others result in heat loss.



$$Heat\ gain = Heat\ loss$$

$$P_J + P_S + P_M + P_i = P_C + P_r + P_w$$

Dynamic Line Rating – The Fundamentals

- All of the factors in the heat balance equation are subject to continuous change.
- The controllers in the NCC do not have visibility of any of these except the current in amps.
- So, in the interest of practicality, we need to provide the NCC with the quantity of amps that equates to the **maximum operating temperature**.
- This is known as the **AMPACITY** of the overhead line conductor.
- We do this by fixing all the variables, except the amps, and then calculating the quantity of amps that equates to the **maximum operating temperature.**

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Dynamic Line Rating - The Fundamentals

- The variables that are fixed are fixed on a seasonal basis.
- The more significant of these are shown in the table below.

Season	Wind strength	Solar radiation	Ambient Temperature
Winter	0.6 m/s	551 W/m^2	11 °C
Spring/Autumn	0.6 m/s	862 W/m^2	17 °C
Summer	0.6 m/s	938 W/m^2	25 °C

- The direction of the wind relative to the direction of the overhead line is also an important factor.
- For theses calculations it is assumed that the wind is at 90º to the overhead line.
- 90º is the optimum angle of attack for the wind to cool the conductors.

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Dynamic Line Rating - The Fundamentals

Voltage and Conductor Type	Air Temp	Design Temp	1988 Ratings [9]		2018 Ratings (NEW)			Maximum Short-Term (30 min) emergency loading	
			[A]	[MVA]	A	MVA	% +/-	A	MVA
110 kV 200mm^2 WOLF	11°C	80°C	660	126	643	123	-2.6%	707	135
	17°C	80°C	610	116	598	114	-2.0%	658	125
	25°C	80°C	560	107	550	105	-1.8%	605	115

Table 4.1: Thermal Ratings, 110 kV 200 mm^2 ACSR WOLF at 80°C

Voltage and Conductor Type	Air Temp	Design Temp	1988 Ratings [9]		2018 Ratings (NEW)			Maximum Short-Term (30 min) emergency loading	
			[A]	[MVA]	A	MVA	% +/-	A	MVA
110 kV 200mm^2 WOLF	11°C	60°C	580	111	544	104	-6.2%	598	114
	17°C	60°C	520	99	486	93	-6.5%	535	102
	25°C	60°C	450	86	421	80	-6.4%	463	88

Table 4.3: Thermal Ratings, 110 kV 200 mm^2 ACSR WOLF at 60°C

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Dynamic Line Rating - The Fundamentals

- These ampacity ratings are known as **Seasonal Line Ratings** (SLR).
- Because the weather-related variables are fixed based on conservative assumptions the resulting SLR values are conservative.

Season	Wind strength	Solar radiation	Ambient Temperature
Winter	0.6 m/s	551 W/m^2	11 °C
Spring/Autumn	0.6 m/s	862 W/m^2	17 °C
Summer	0.6 m/s	938 W/m^2	25 °C

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Dynamic Line Rating - The Fundamentals

- DLR schemes on the other hand get the relevant data for the ampacity calculation in real time direct from the overhead line and/or direct from the locality.
- This reduces the reliance on assumptions - giving a more accurate calculation - that is updated dynamically.
- So instead of having to work with a fixed ampacity for an entire season we are now given an updated ampacity every five minutes and it is this that allows us to **make better use of the existing rating**.
- There are several suppliers of DLR systems on the market today and they don't all use the same methodology for capturing the relevant data in real time.

Dynamic Line Rating - The Fundamentals

- Some DLR schemes require that sensors are installed in direct contact with the overhead line conductor, this is called the ‘direct’ method.
- Some require that sensors are installed on the support structures, this is called the ‘indirect’ method.
- Others don’t install sensors on the line at all and instead only capture local weather data. These types are know as ‘virtual’ DLR schemes.
- To date we have only installed DLR schemes that use the direct method.

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Dynamic Line Rating - How does it Work

- For our schemes sensors are installed at selected locations onto the conductors and in direct contact with the conductor.
- The supplier has named their sensor the ‘Neuron’. The Neurons are really sensor platforms in that they have multiple different sensors on board.
- They have sensors that measure current, and conductor temperature, vibration and angle of inclination.
- There is a sim card in the Neuron that enables the captured data to be uploaded to the supplier’s server via the internet.

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Dynamic Line Rating - How does it Work

- The weather data for the locality is obtained separately from a third-party commercial weather service.
- The data captured by the Neurons and the weather data is then processed on the supplier's server and a Dynamic Line Rating is calculated.
- The processed data along with the calculated DLR and the calculated conductor ground clearance is then uploaded to the supplier's cloud-based application.

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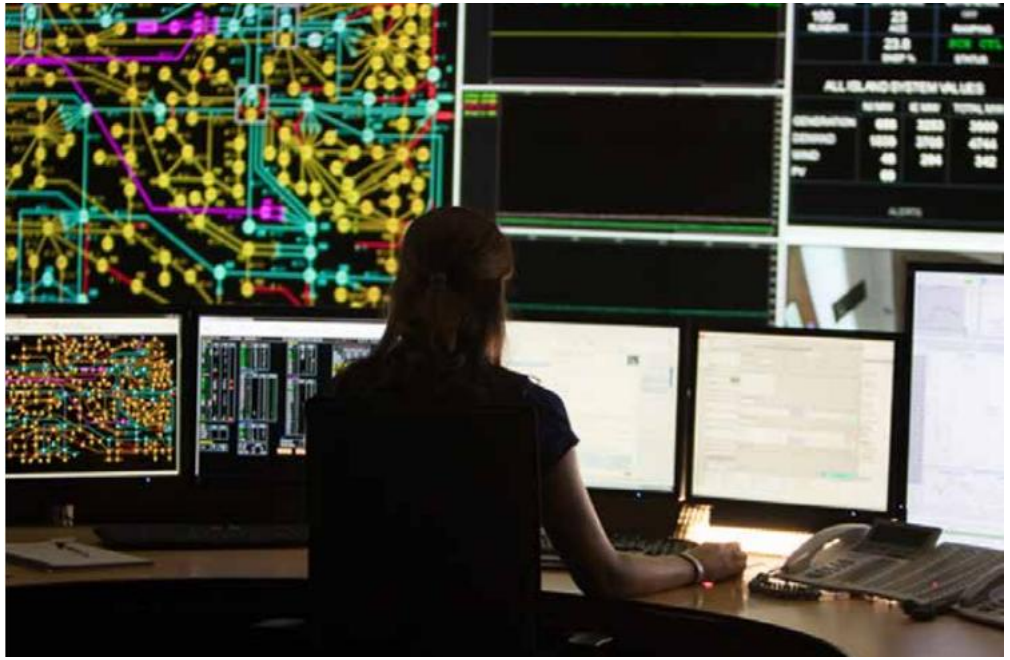
Dynamic Line Rating - How does it Work

- The dynamic rating is downloaded from the cloud to the SCADA/EMS in the NCC at five minute intervals where it overwrites the SLR.
- If the DLR system fails for any reason the EMS will automatically revert to the latest SLR.
- This all takes place in the background and the controllers on duty in the NCC have no awareness of it; and don't need to have.



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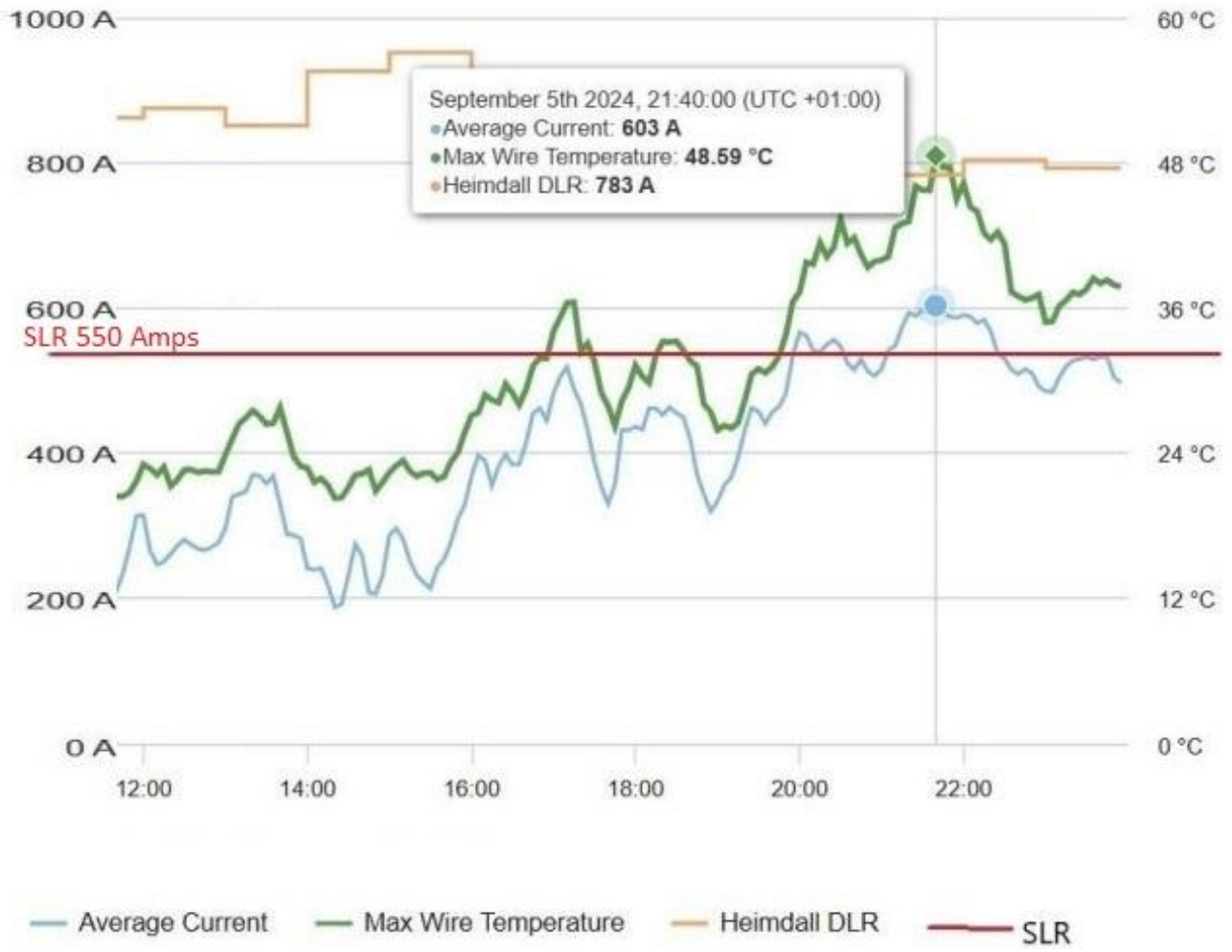
Dynamic Line Rating - How does it Work

- As the DLR data is cloud based it is available to asset managers for analysis at any time, and from anywhere.

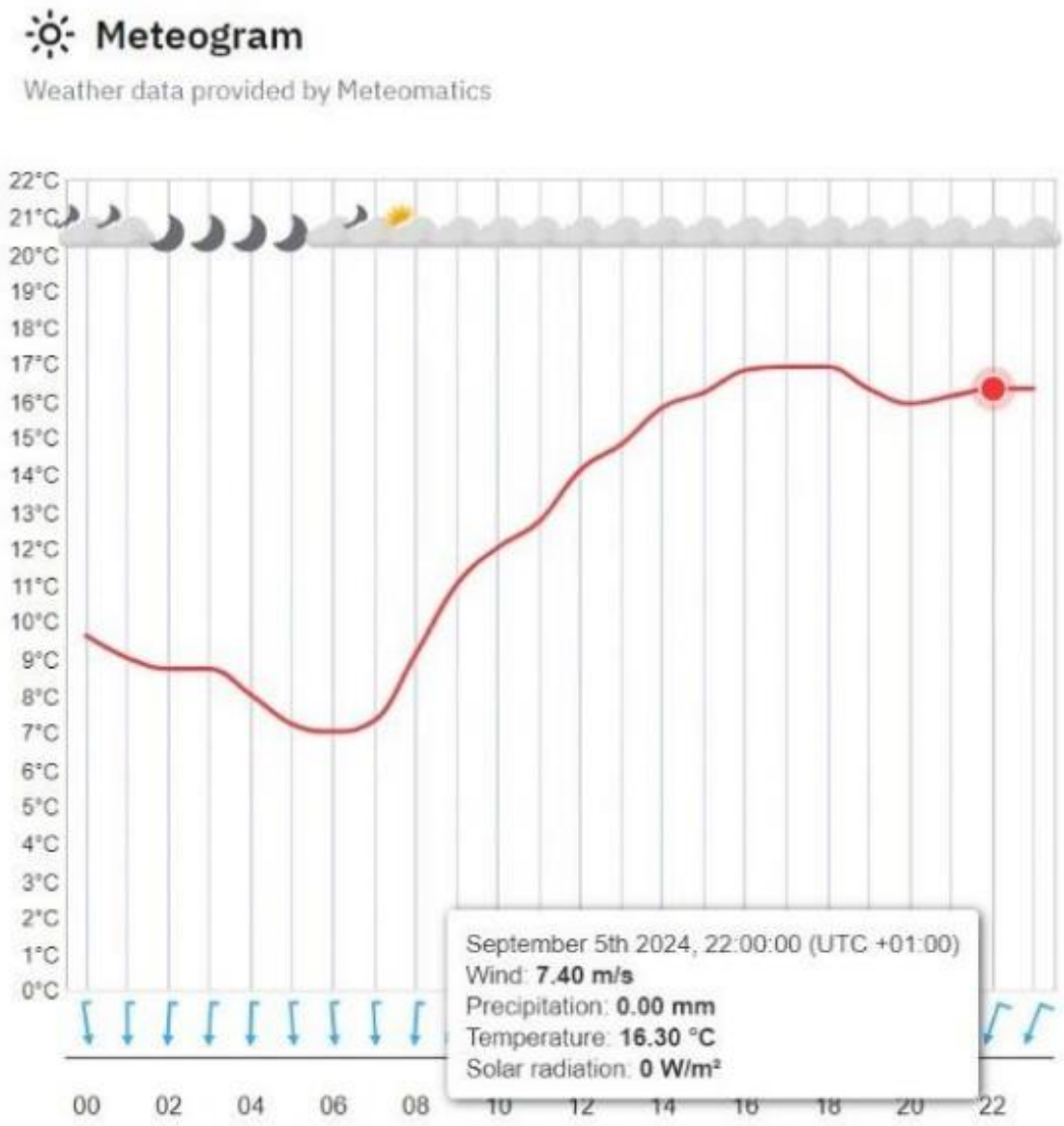
Here is an example of the kind of analysis that we can do.

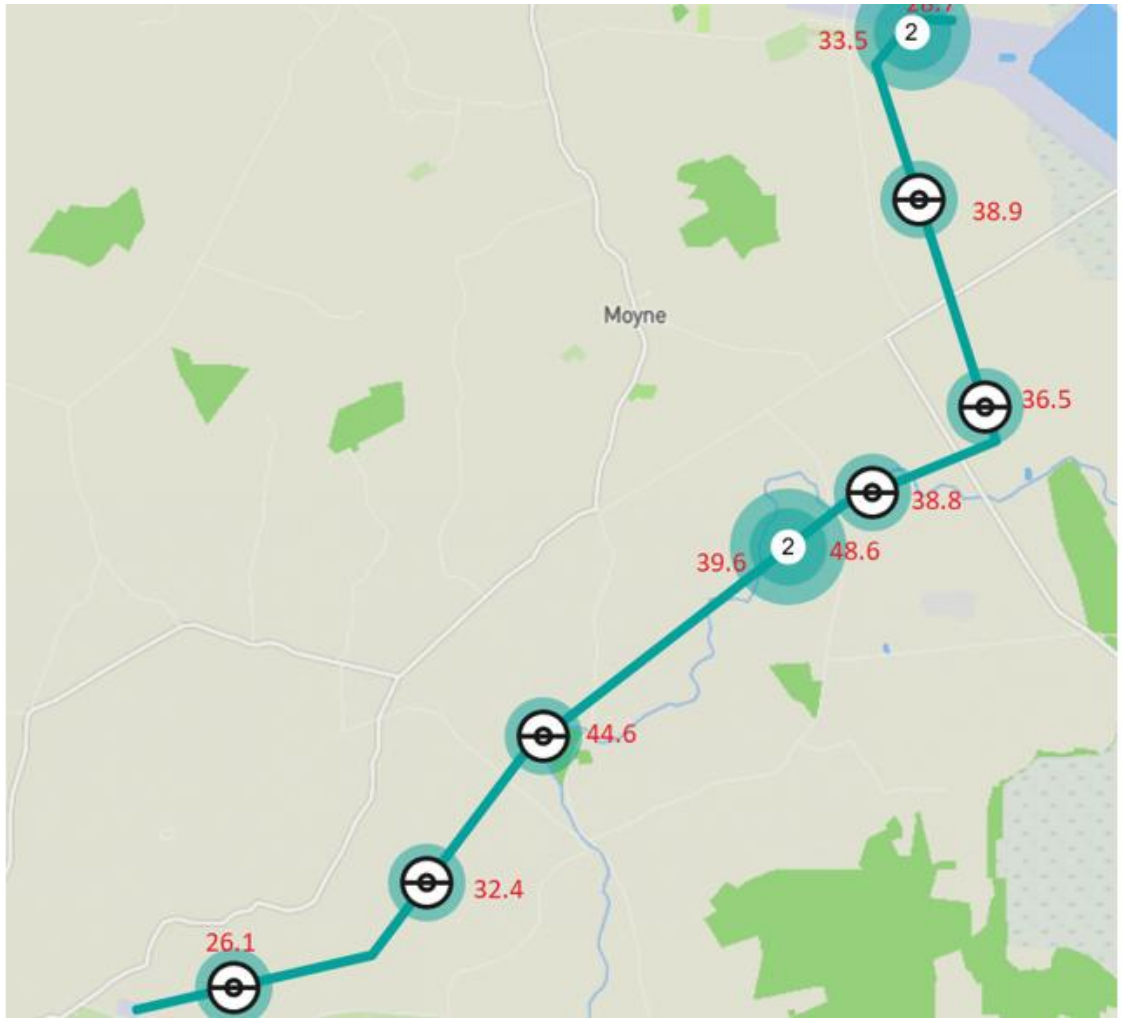
- We want to know what was the highest conductor temperature recorded on the Lisheen-Thurles 110 kV line in the past two years and what were the conditions at the time.
- The line has a Maximum Operating Temperature of 80°C and we found the highest temperature was 48.6°C and was recorded on 05 Sept. 2024.



Dynamic Line Rating - How does it Work

- Compare the weather conditions at the time with the weather conditions that are assumed for the calculation of the seasonal line rating –
- September 05 is still in our Summer Season.
- The weather conditions that are applied for the summer SLR calculation are –
  - Wind Speed: 0.6 m/s
  - Wind direction: 90º
  - Ambient Temp.: 25ºC
  - Solar Radiation: 938 W/m2




33.5
2
38.9
Moyne
36.5
38.8
39.6
2
48.6
44.6
32.4
26.1


38.8
Castletown Castle
48.6
39.6

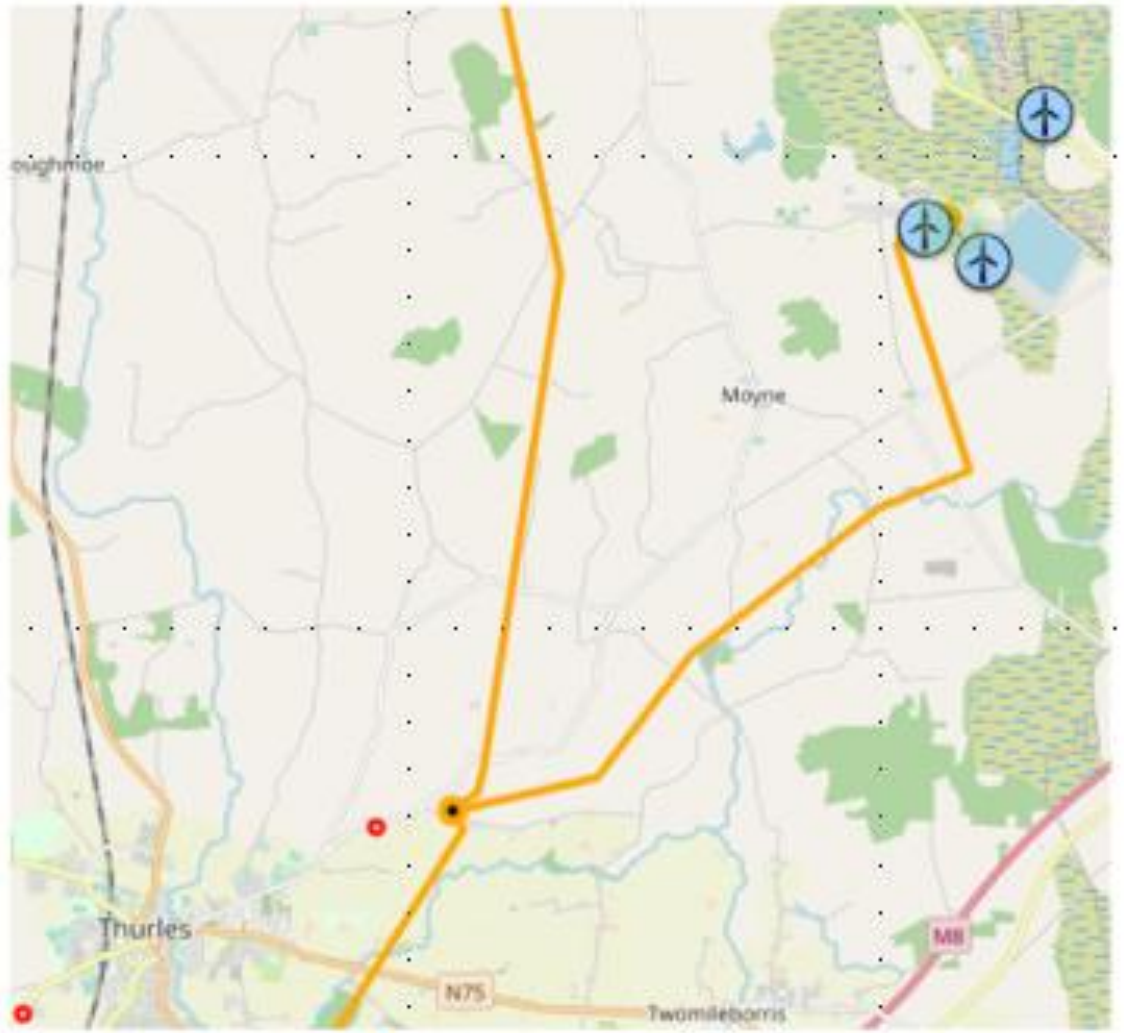
EirGrid

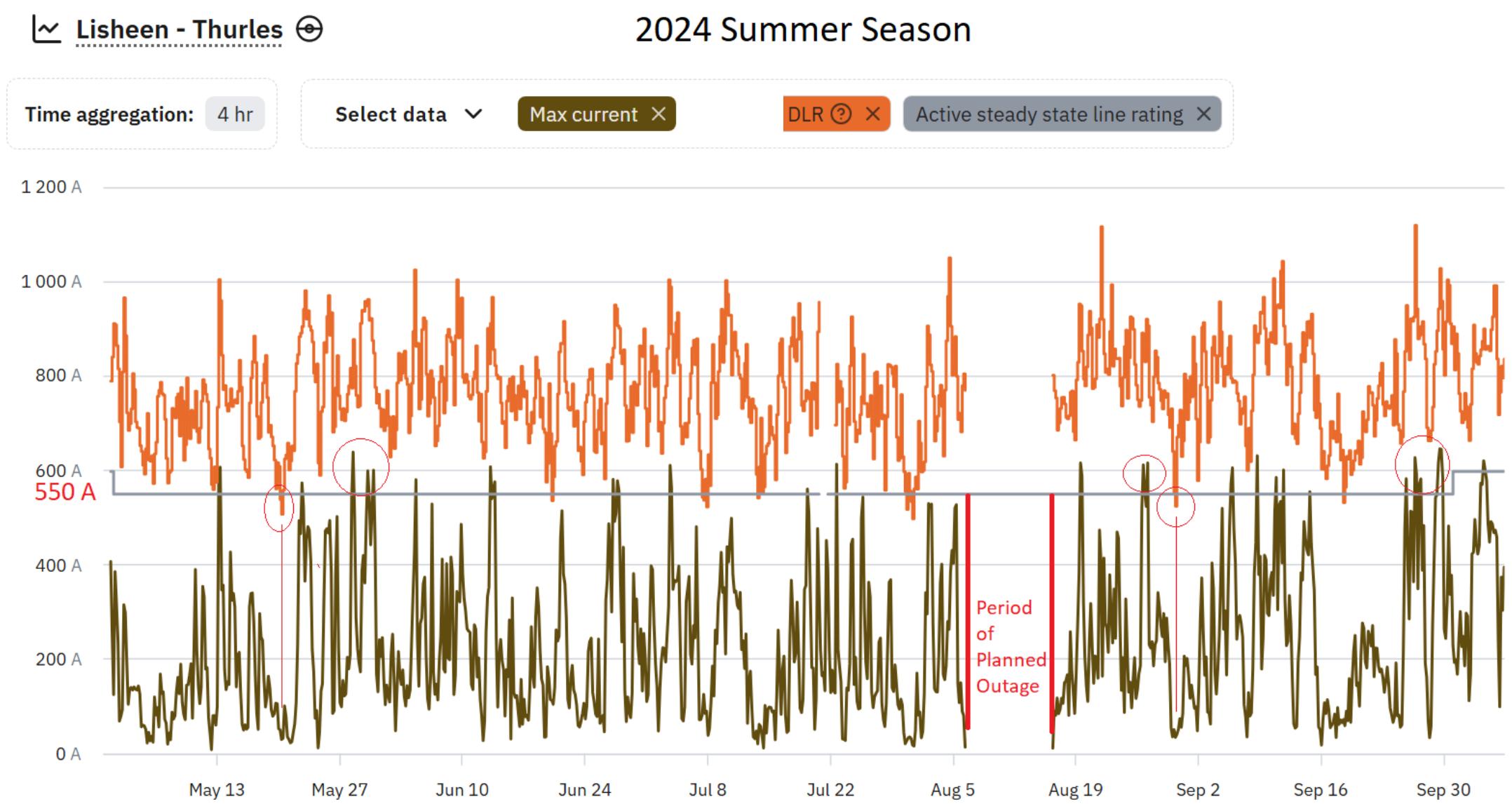
Dynamic Line Rating - How does it Work

- Here we can see the calculated height of the conductors above ground at the time the highest temperature was recorded and at the span where that temperature was recorded.
- This is a 110 kV line, so the minimum ground clearance is 7 m.
- If the conductor temperature was 80ºC we could expect to see close to 7 m here.
- The actual conductor temperature was 48.6ºC giving a ground clearance of 9.9 m, so no problem.

Lisheen - Thurles 110 kV Line
Our First DLR installation

- 10km radial circuit with a summer SLR of 550 amps (104 MW).
- Only load on the line is wind generation.
- Maximum output was 99 MW.
- Want to connect a new 28 MW windfarm
- Options - uprate the line or install DLR
- DLR was installed and it has been a great success.

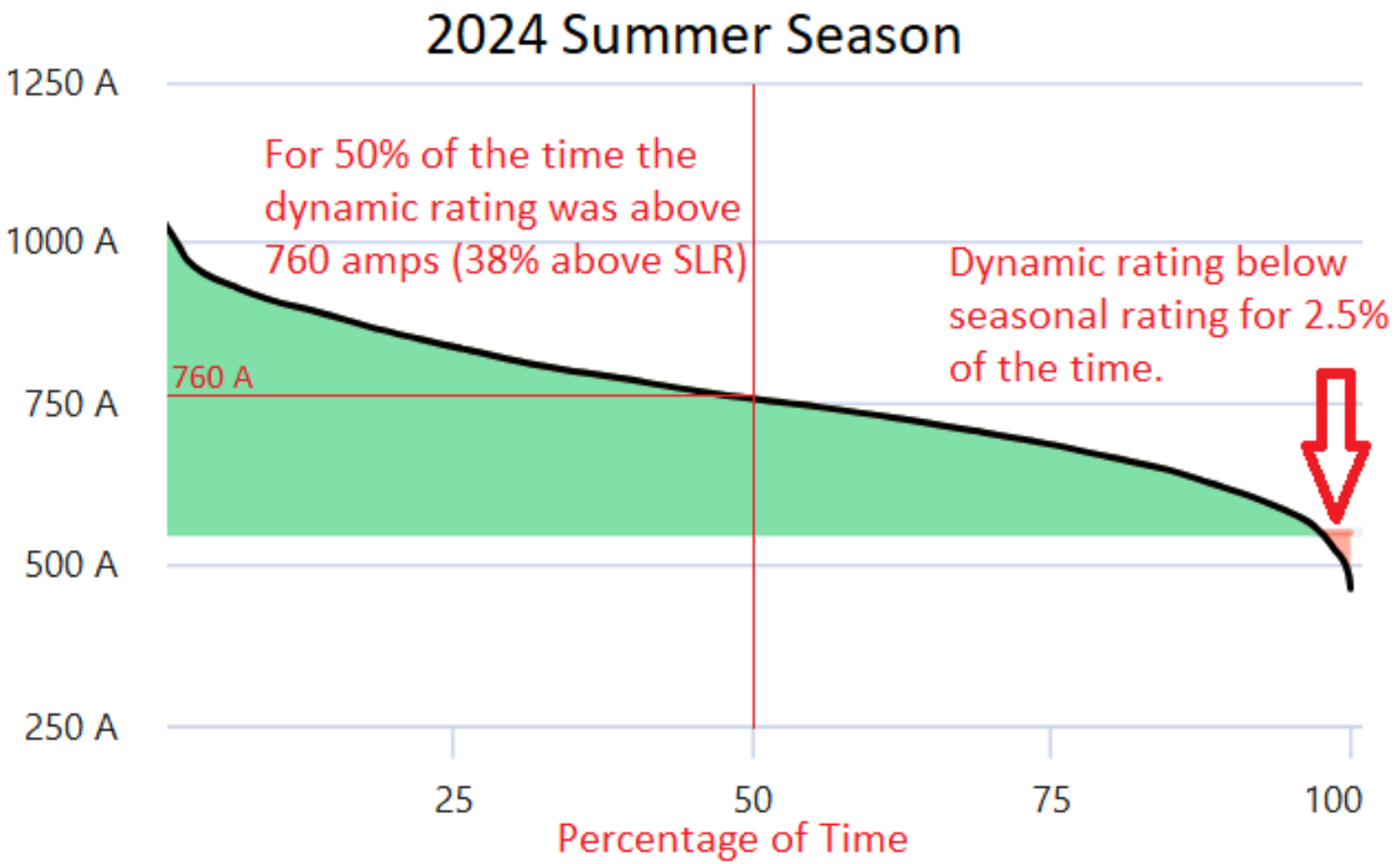



Lisheen - Thurles
2024 Summer Season
Time aggregation: 4 hr
Select data
Max current
DLR
Active steady state line rating
1 200 A
1 000 A
800 A
600 A
550 A
400 A
200 A
0 A
Period of Planned Outage
May 13
May 27
Jun 10
Jun 24
Jul 8
Jul 22
Aug 5
Aug 19
Sep 2
Sep 16
Sep 30

Line DLR

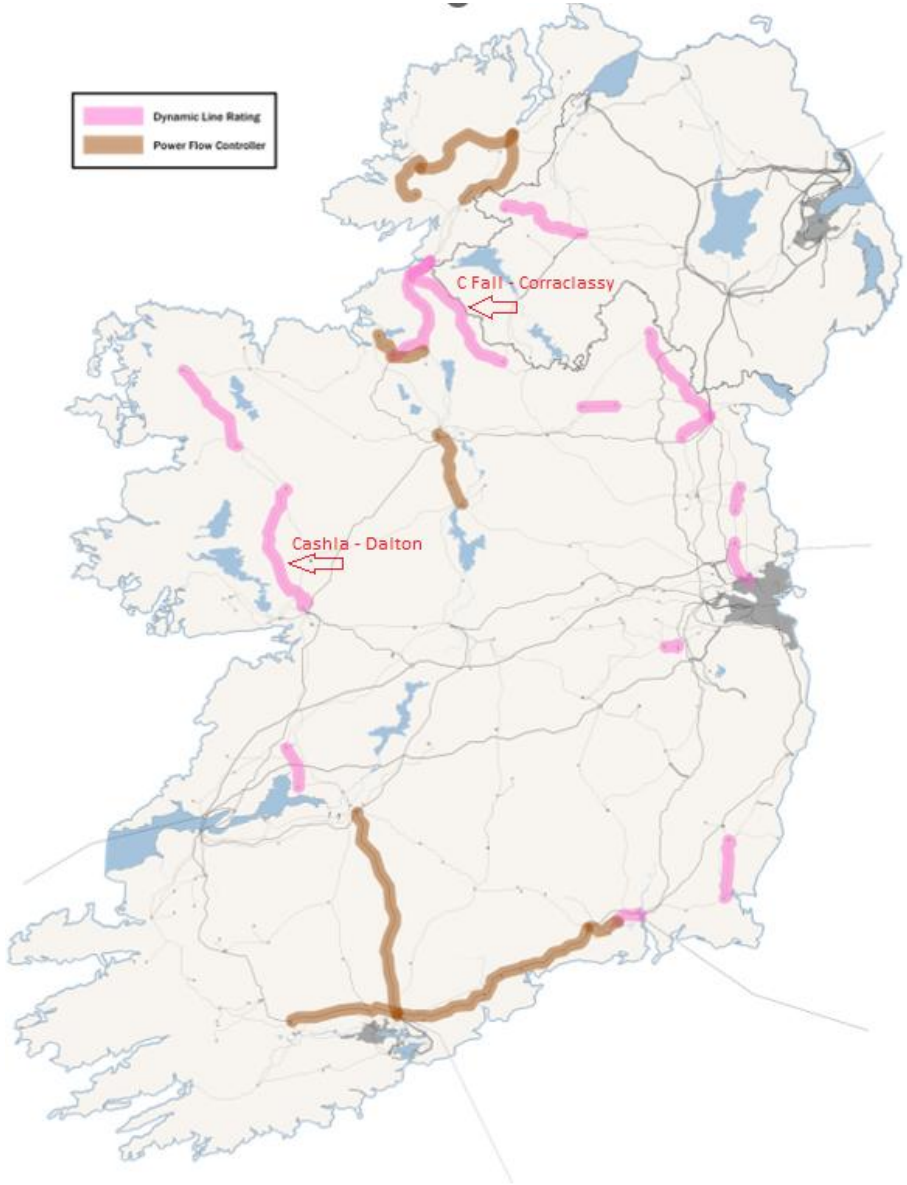
Duration curve

Lisheen- Thurles 110 kV Line



Planned Roll-Out of DLR Schemes Across the Network

- Thirteen 110 kV circuits have been identified as candidates for DLR in the Shaping Our Electricity Future Strategy.
- Of these two have already been installed: Cashla – Dalton and Cathaleen's Fall - Corraclassy.
- Lisheen –Thurles did not emerge from SOEF, it was driven by a customer connection.
- DLR has also been installed on the 110 kV busbar in Dalton Station.
- Even more schemes than those that were identified in SOEF are now proposed.

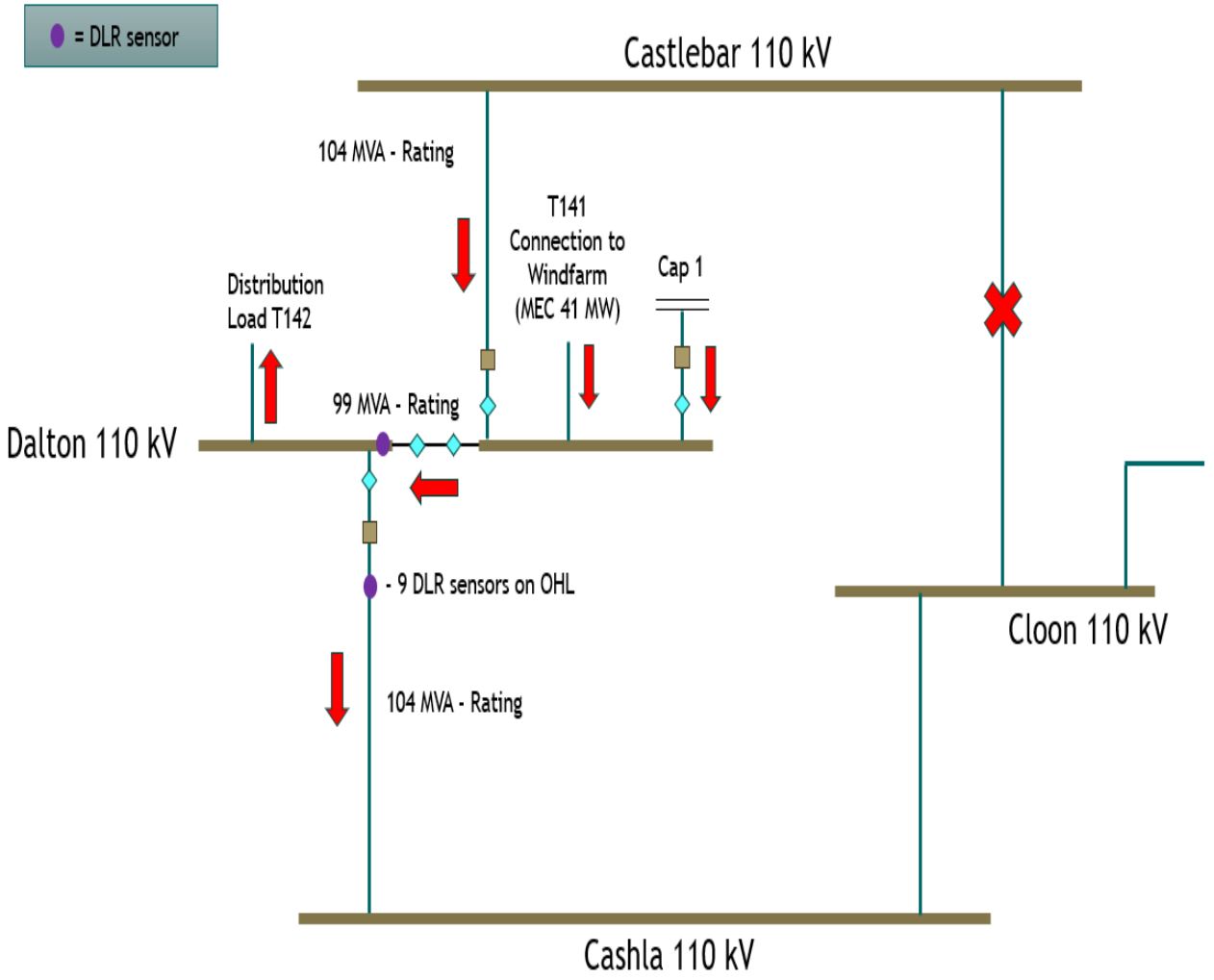


DLR on Busbar in Dalton Station

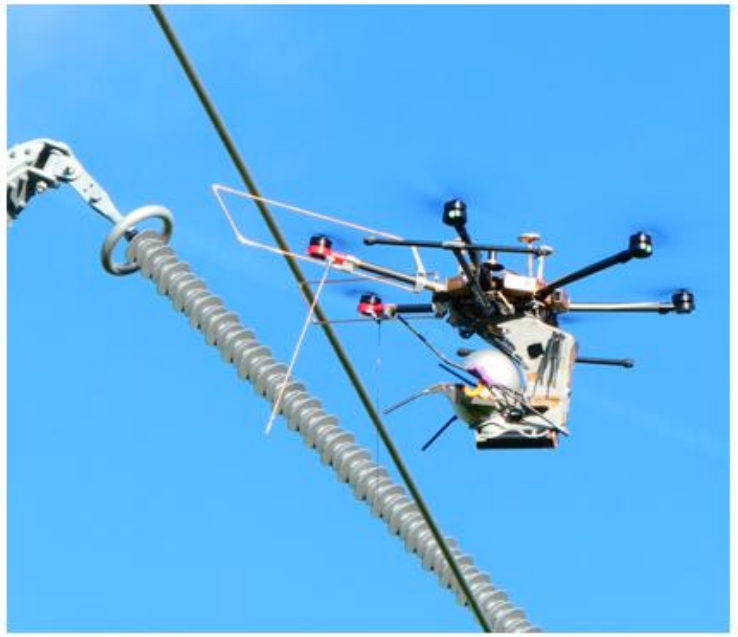
- This is a novel application of DLR – not aware that any other utility has done this.
- The busbar in Dalton has a very low rating.
- It is a bottle neck for the export of wind generation out of County Mayo.
- There is a plan in place to uprate the busbar but getting the outages to do this is proving very difficult.
- It is hoped that the installation of the DLR will provide a solution in the interim.
- Results to date are very promising.

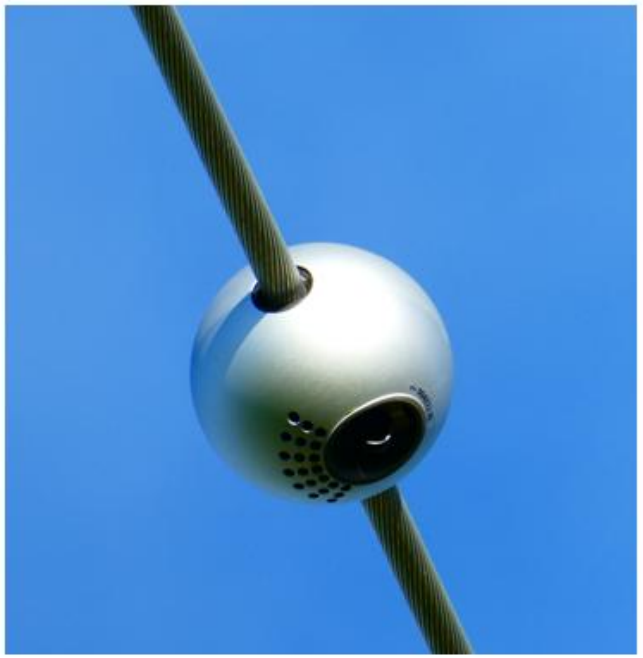
DLR on Circuits Forming Part of the Meshed Network.

- When DLR was installed on the Lisheen – Thurles line the benefits were apparent almost immediately.
- This is because Lisheen – Thurles is a radial circuit carrying only wind generation.
- Whenever the wind blows the benefits are there to see, the same cannot be said when DLR is installed on the meshed network
- This because the benefits will only be apparent during n-1 situations.
- This can be explained by considering the network diagram here.



Latest Development
Installation of Neurons on Live Lines using a Drone





Questions

EirGrid

Questions (1 of 7)

Q: If EirGrid/ESB provided detailed project connection programmes that they would share with the customer it would help to reduce issues with the customer programme. The only programme that the customer gets from EirGrid/ESB is the level 1 programme that is in the grid connection agreement which is very high level. Can these be provided?

A: EirGrid are currently running a pilot with Industry and ESBN to develop a single programme for each project. This will help us in developing a standard and integrated template.

Q: At the end of a reinforcement project that runs over a number of years is there a way of presenting the total length of the outages?

A: We will provide this information at future fora.

Questions (2 of 7)

Q: Can EirGrid provide the existing and new ratings of circuits being uprated?

A: These have now been included in slides 27, 29 and 32.

Q: When do rating changes between the seasons occur?

A:

Season	Start of Season	Seasonal Ratings
Winter	Last week in November	Winter
Spring	First week in March	Spring/Autumn
Summer	First week in May	Summer
Autumn	Last week in September	Spring/Autumn

Questions (3 of 7)

Q: How will DLRs be modelled and how will this feed into future EirGrid constraint reports/firm access studies?

A: Dynamic line rating (DLR) projects are included in our constraint forecast modelling for Enduring Connection Policy (ECP) provided the DLR project is included in the Network Delivery Portfolio (NDP) or was included in Shaping or Electricity Future 1.1 and provided the project has not since been lapsed or been discontinued. The projects included in each ECP iteration are correct as of the data freeze date for that ECP. Any changes post the data freeze date will be picked up in the next ECP iteration. For a list of all DLR projects included in the latest ECP, please see the assumption document on the ECP webpage on the EirGrid website[1].

In constraint forecast modelling for ECP, DLR is modelled with respect to the wind availability within the area that the DLR will be potentially installed. DLR is modelled dynamically meaning a new rating is calculated for the circuit for each timeslot in the forecast horizon.

[1] https://www.eirgrid.ie/industry/customer-information/ecp-constraint-forecast-reports

EirGrid

Questions (4 of 7)

For ECP 2.2 and 2.3 a conservative approach that allowed the rating of the line to increase up to a maximum of 10% was selected. In the constraint forecast modelling for ECP 2.4 and ECP 2.5 methodology, the DLR can increase a line rating by up to a maximum of 30%. There are multiple references quoting different ratings achieved by DLR projects[2]. The current methodology of applying a maximum rating increase of 30% for DLR projects will be reviewed in future iterations.

In constraint forecast modelling for ECP, the amount that DLR can increase a line rating by is dependent on the hourly wind capacity factor, the seasonal rating of the circuit element where DLR is installed, and the rating of the lowest rated element of the circuit that isn't affected by the installation of DLR.

[2] https://www.entsoe.eu/technopedia/techsheets/dynamic-line-rating-dlr/

EirGrid

Questions (5 of 7)

The formula for calculating the circuit rating with DLR for any time slot is:

$$Circuit\ Rating = MIN(CLE_{non-DLR}, 0.3 * CF_{Wind} * Rating_{pre-DLR})$$

Where:

(i) Circuit Rating is the rating of the entire circuit post installation of DLR for a specific timeslot in the model horizon.

(ii) $CLE_{non-DLR}$ is the rating of the lowest rated element on the circuit that isn't affected by the installation of DLR.

(iii) CF_{Wind} is the wind capacity factor applied to the area that the DLR is installed at the specified timeslot in the model horizon.

(iv) $Rating_{pre-DLR}$ is the seasonal rating of the element of the circuit where DLR is being installed, pre DLR installation.

Questions (6 of 7)

Further information on the constraints forecast for ECP modelling methodology and DLR assumptions can be found on the ECP section of the EirGrid website. The assumptions and methodology are subject to change and updates will be posted to the above webpage.

Example:

DLR is installed on a line in Area A where the overhead line is the circuit limiting element with a rated capacity of 200 MW pre-DLR install. The next limiting element on the circuit is rated 270 MW. Wind Capacity Factor in Area A at Timeslot 1 is 0.9.

$CLE_{non-DLR}$ = 270 MW

CF_{Wind} = 0.9

$Rating_{pre-DLR}$ = 200 MW

$$Circuit\ Rating\ at\ timeslot\ 1 = MIN(270\ MW,\ 0.3 * 0.9 * 200\ MW)$$

$$Circuit\ Rating\ at\ timeslot\ 1 = MIN(270\ MW,\ 254\ MW) = 254\ MW\ \square$$

Questions (7 of 7)

Regarding firm access studies, DLR is not currently included in the model. We are reviewing how this can be incorporated into the process and will engage directly as part of our dedicated firm access engagement sessions.