

8th June 2017

South West Scotland Forum

Agenda

- Introduction – Pearse Murray
- System Design – Diyar Kadar
- Programme Update – Bob McGuire, Colin Brown
- Group Discussion – Cornel Brozio
- Questions – Pearse Murray

8th June 2017

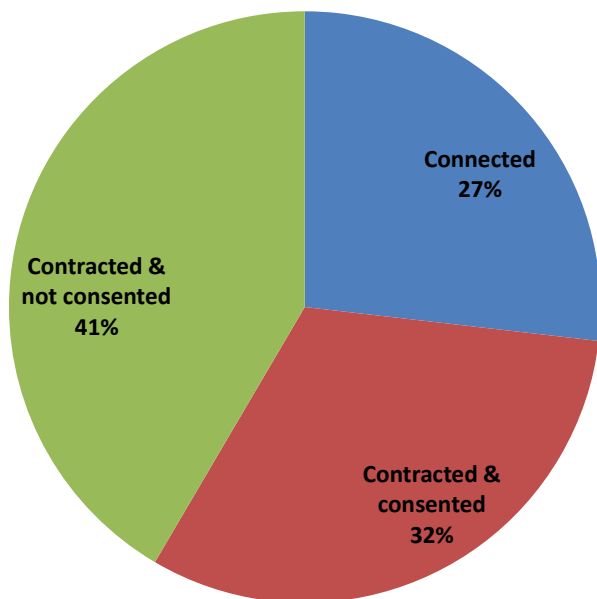
SWS Developer Forum

SPT System Design

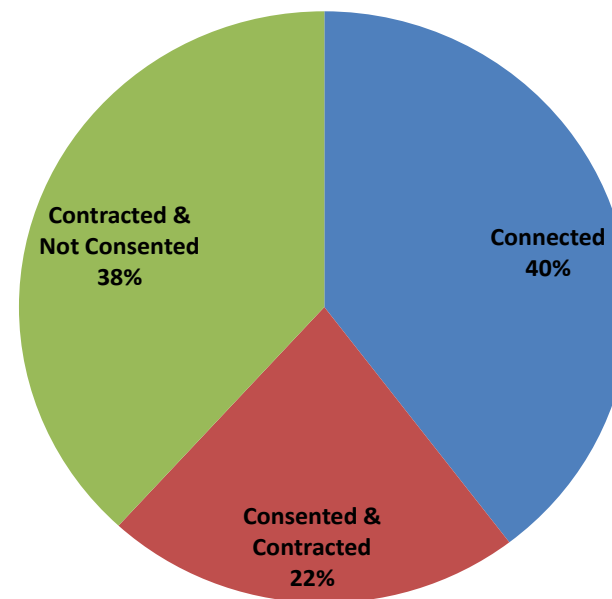
Diyar Kadar

Generation Background – Change from last forum

Generation Status in SWS - October 2016



Generation Status in SWS - June 2017



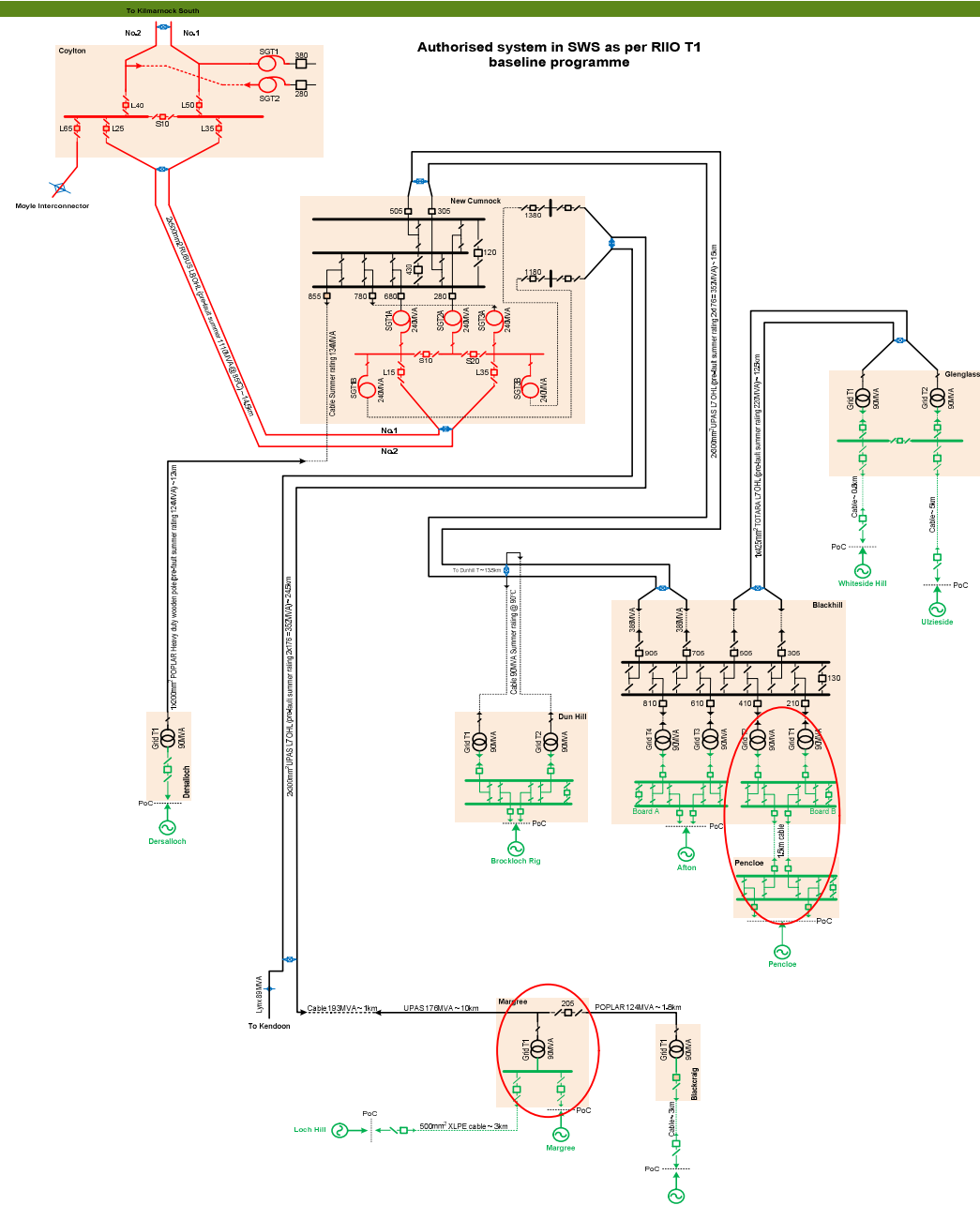
Four new wind farms connected to the system (Kilgallioch, Glen App, Airies, Ewe Hill and other smaller embedded generation)

Total generation (Connected and Contracted) in the whole of South West Scotland is around 2900MW

Not a significant change in the consented position and in excess of 1GW remains unconsented

Baseline system in SWS

No change in the baseline system design (Stages 1 to 4).



Future Developments - SWS

Creating Board C at New Cumnock including two new 275/132kV 240 MVA transformer SGT1C & SGT2C
(TORI 158)

Creating Board B at New Cumnock including one new 275/132kV 240 MVA transformer SGT2B
(TORI 213)

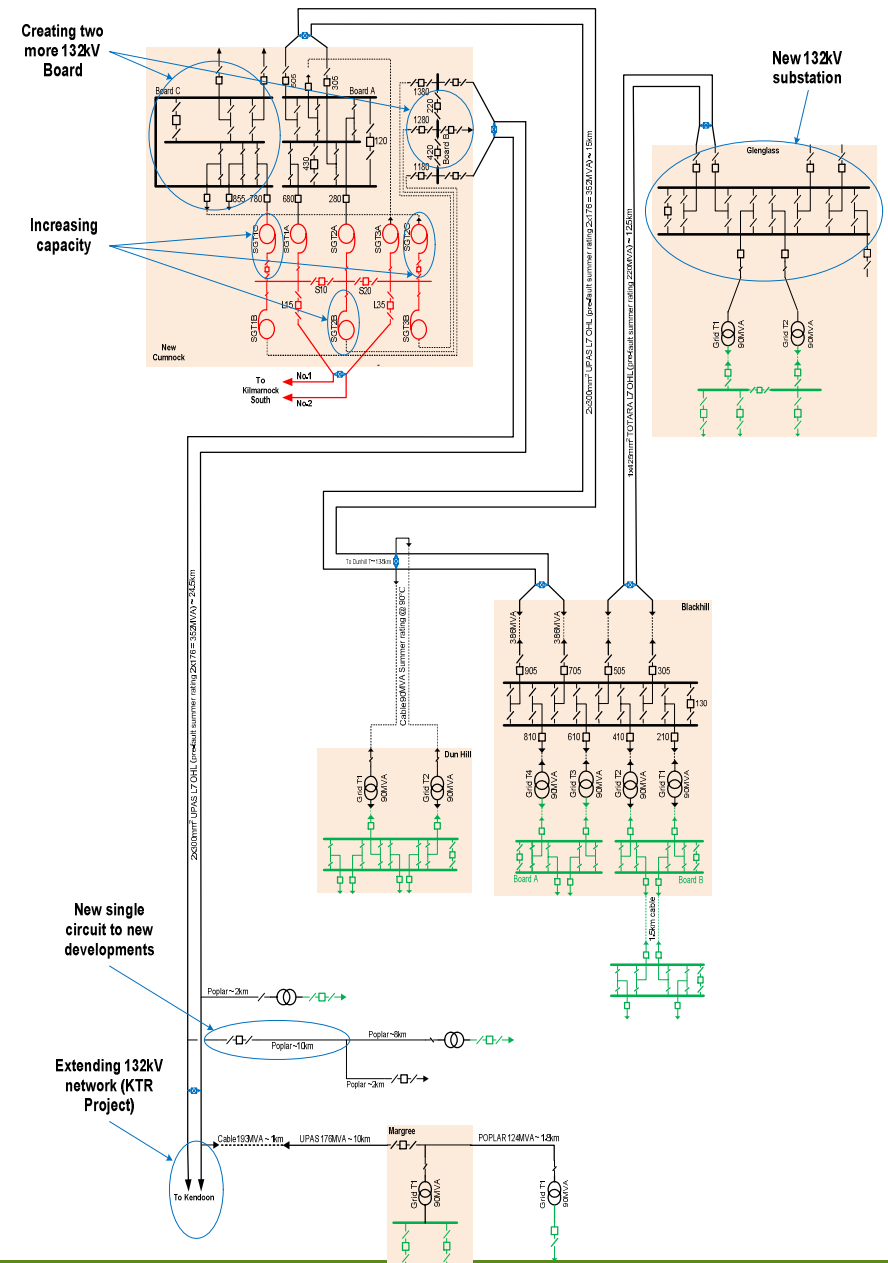
Creating a new 132kV GIS substation at Glenglass
(TORI 173)

Various Load Management Schemes to maximise utilisation of the system
(TORI 148, TORI 149, TORI 176, TORI 177, TORI 186, ..)

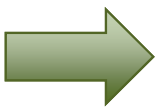
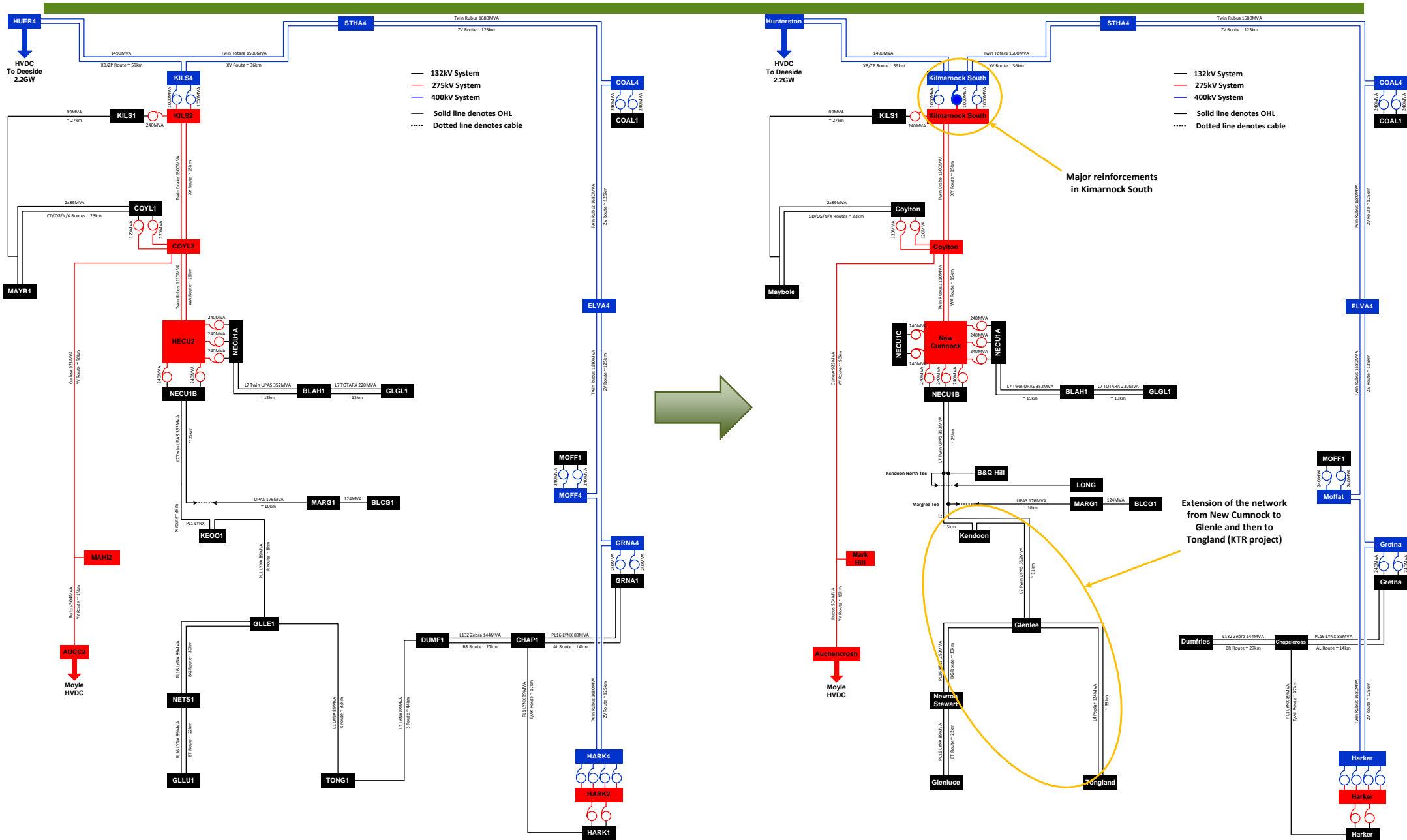
Creating a new circuit North of Kendoon
(TORI 211)

Extending the 132kV network from Margree Tee to Glenlee and Tongland (KTR Project)

Despite all these reinforcements the system is at full capacity against contracted position



Future Developments – Wider system



Future System – Challenges

System uncertainties are still significant and the contracted position continuously changing

The proposed future system does not provide sufficient transmission capacity for the contracted generation

The proposed future system is not compliant with the NETS-SQSS against the contracted position

Derogation against non-compliant parts of the network will be sought from Ofgem

Non-build solutions, such as LMS/ANM systems, will be progressed to allow maximum utilisation of the system

NGET with the support of SPT will ensure developers are not commercially disadvantaged

In Summary

Baseline system developments in SWS are progressing as originally designed and as per our RIIO T1 plans.

Further reinforcements are planned at New Cumnock, Glenglass, Kilmarnock South and Dumfries and Galloway to provide further transmission capacity

Against a contracted position the system is non-compliant and derogations will be requested

Reinforcement options will continuously be assessed to ensure the system is developed in a coordinated manner

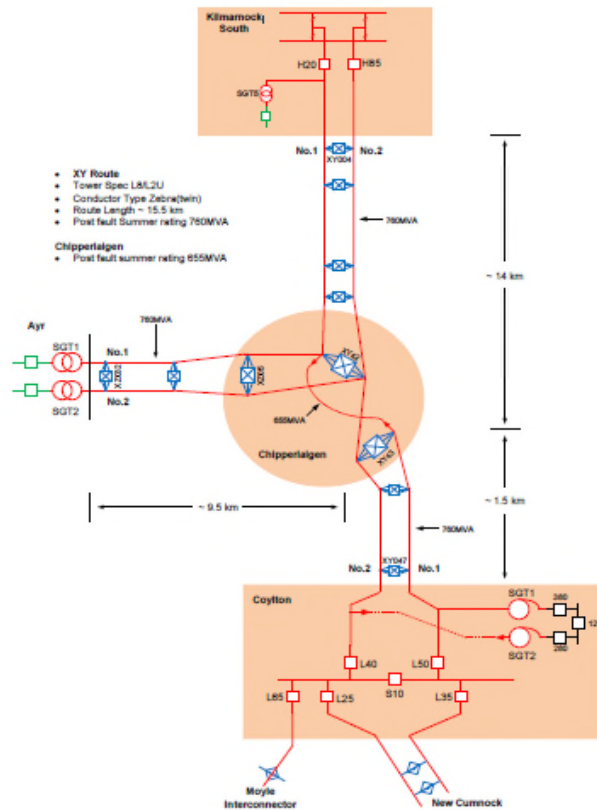
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SWS Developer Forum

Delivery Update

Bob McGuire

SP-RI-142 Kilmarnock South – Coylton 275kV (XY Route) Uprating



XY Route between Coylton and Kilmarnock South

- *Uprating of Coylton to Kilmarnock South Circuits*
- Current rating 600MVA
- New rating 1500MVA
- New twin Drake ACCR Conductor
- Selected OHL tower foundation upgrades
- New GIB compound at Chipperlagan
- Works Complete

SP-RI-142 Kilmarnock South – Coylton 275kV (XY Route) Uprating



SWS Project Progress (Stages 2 – 4)

Stage 2 New Cumnock – Blackhill

Stage 3 Blackhill - Glenglass

Progress since Nov 2016 SWS Developer Forum

Land Agreements: Previously secured.

Wayleaves / Servitude: Previously secured.

Consent Discharge: Previously secured.

SWS Project Progress (Stages 2 – 4)

Stage 4 New Cumnock - Margree

Progress since Nov 2016 SWS Developer Forum

Land Agreements: Previously secured.

Wayleaves / Servitude: Target indicated at for last forum was completion by Nov 2016 of remaining agreement for 7 towers.

Actual: 1 x servitude concluded in April for 7 towers .

Consent Discharge: Previously completed.

Actual: ECU / D&G consent agreed to construct OHL bypass through Margree due to revision of connection dates and revised programme for Margree substation.

Rights for additional land at Dalshangan cable compound to be secured.

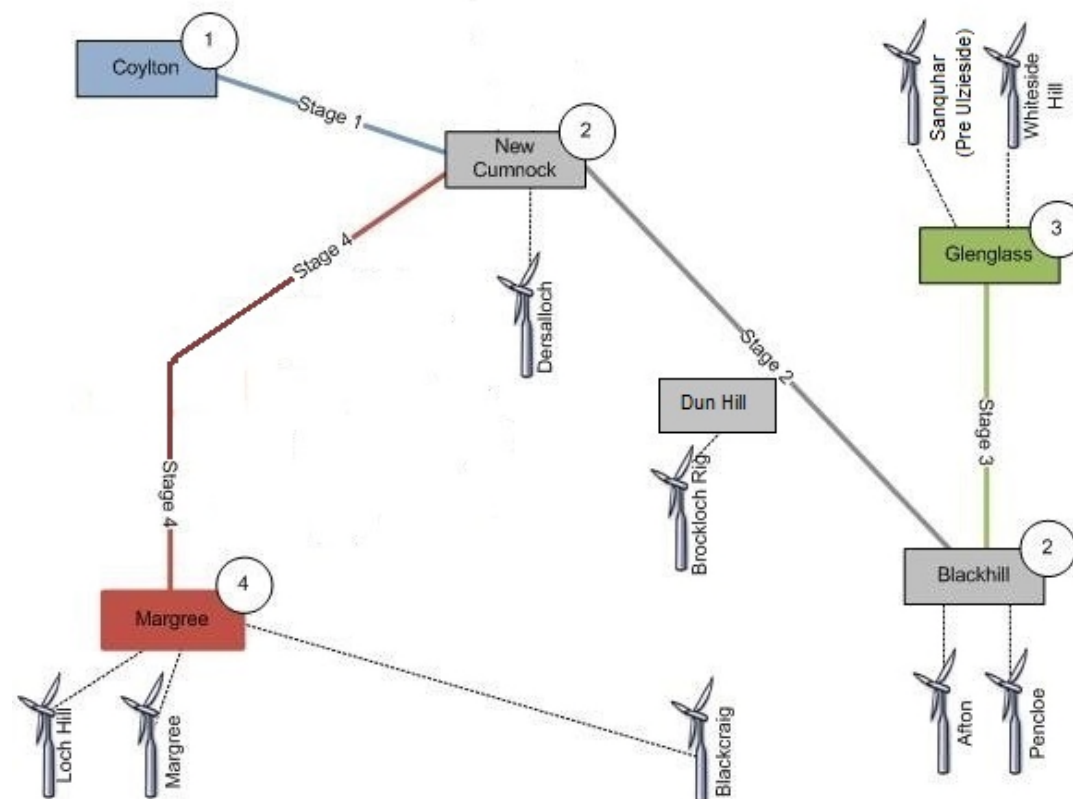
SWS Project Progress (Stages 2 – 4)

Stage 2 New Cumnock – Blackhill

Stage 3 Blackhill - Glenglass

Stage 4 New Cumnock - Margree

- £138m expenditure to date (£23m since Jan 17)
- Increase in 2017 expenditure total circa £47m
- Steel tower overhead line main construction in progress:
 - 69% accesses complete
 - 49% foundations complete
 - 36% tower erection complete
 - 26% conductoring complete
- Tree cutting works in progress 95% route corridors cleared / 732 Hectares felled / mulched
- Dunhill substation works complete
- Blackhill and Glenglass Substation electrical installation works substantially complete



Network Overview Diagram

SWS Project Progress (Stages 2 – 3) New Cumnock - Blackhill - Glenglass

- Route B completion to Dunhill in June
- Substation electrical installation phases substantially complete
- Cabling construction contracts in progress for New Cumnock / Blackhill and Glenglass substations
- Q2 2017 for completion of SPT-RI-114 / 145 infrastructure to Dunhill
- Q3 2017 for completion of SPT-RI-115 / 116 infrastructure to Blackhill substation
- Q3 2017 for completion of SPT-RI-022 infrastructure to Glenglass substations
- Energisation of customer connections Q3/4 2017 Blackhill / Glenglass Substations in line with current contract dates



SWS Project Progress (Stage 4) New Cumnock - Margree - Blackcraig

- Transformers deliveries re-scheduled for New Cumnock in June (Route D)
- Substation electrical installation phase substantially complete.
- Site construction works commenced on Heavy Duty Wood Pole (Route D).
- Tendering completed for Route D cabling works civil works contract awarded / cable supply contract award in progress.
- Q3 2017 for completion of SPT-RI-111 infrastructure
- SPT-RI-034 Margree collector substation now likely 2019/20 build overhead line through construction being progressed
- Energisation of customer connections Q3 beyond Margree in line with current contract dates

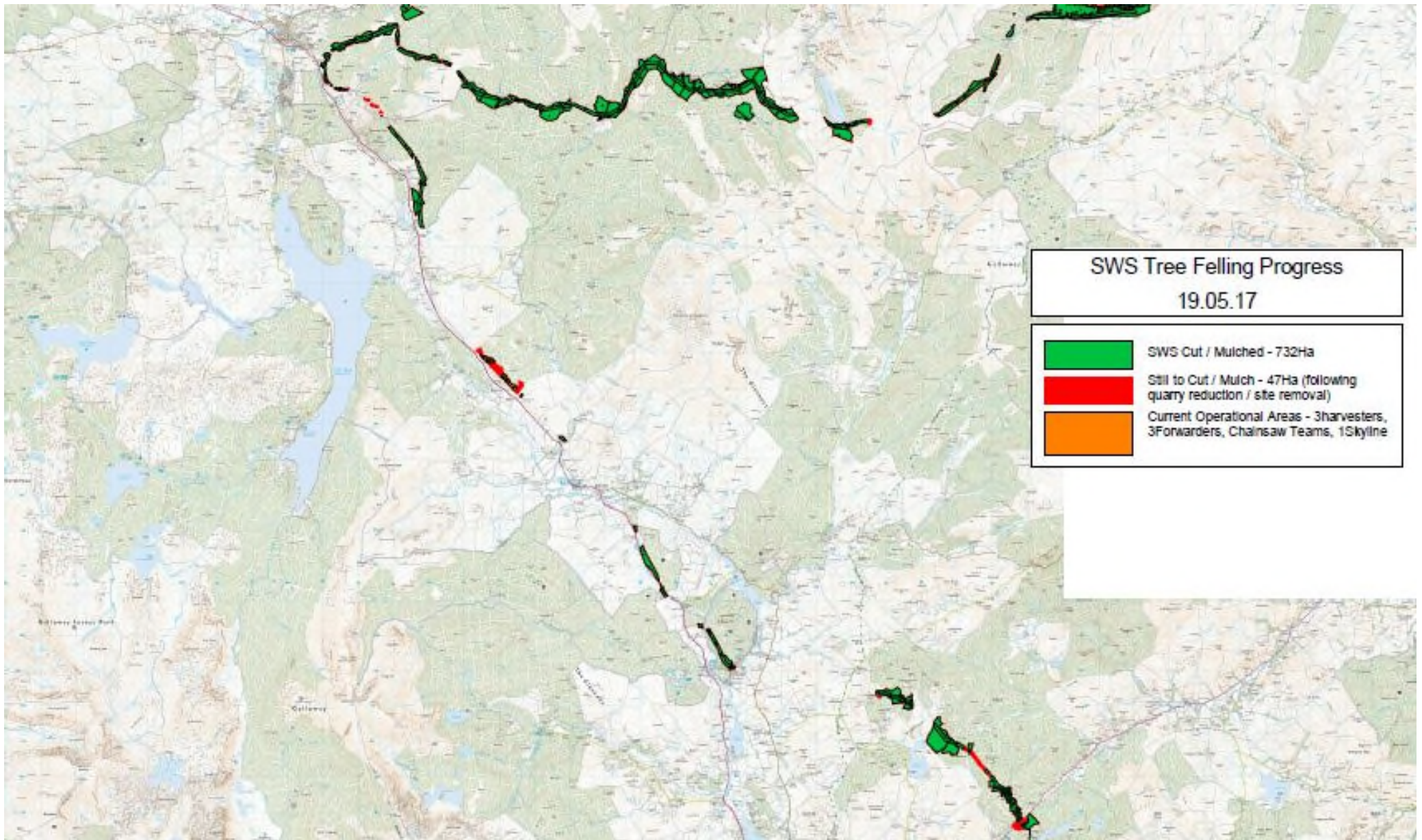


SWS Project (Stages 2 – 4) Key Risks Remaining

- Construction activities through Afton Reservoir water catchment area.
- Contractor health and safety / rate of progress performance.
- Environmental performance / compliance across all works
- Network Outage availability to facilitate final connections.
- Resolution of remaining private water supply issues.
- Resolution of remaining land agreement changes.



SWS Tree Cutting Progress



SWS Project New Cumnock



SWS Project New Cumnock



SWS Project New Cumnock



SWS Project Dunhill Substation



SWS Project Dunhill Substation



SWS Project Dunhill Substation



SWS Project Dunhill Substation



SWS Project Route B



SWS Project Route B



SWS Project Blackhill



SWS Project Blackhill



SWS Project Blackhill



SWS Project Blackhill



SWS Project Blackhill



SWS Project Route C



SWS Project Glenglass / Route C



SWS Project Glenglass



SWS Project Glenglass



SWS Project Route D



SWS Project Route D



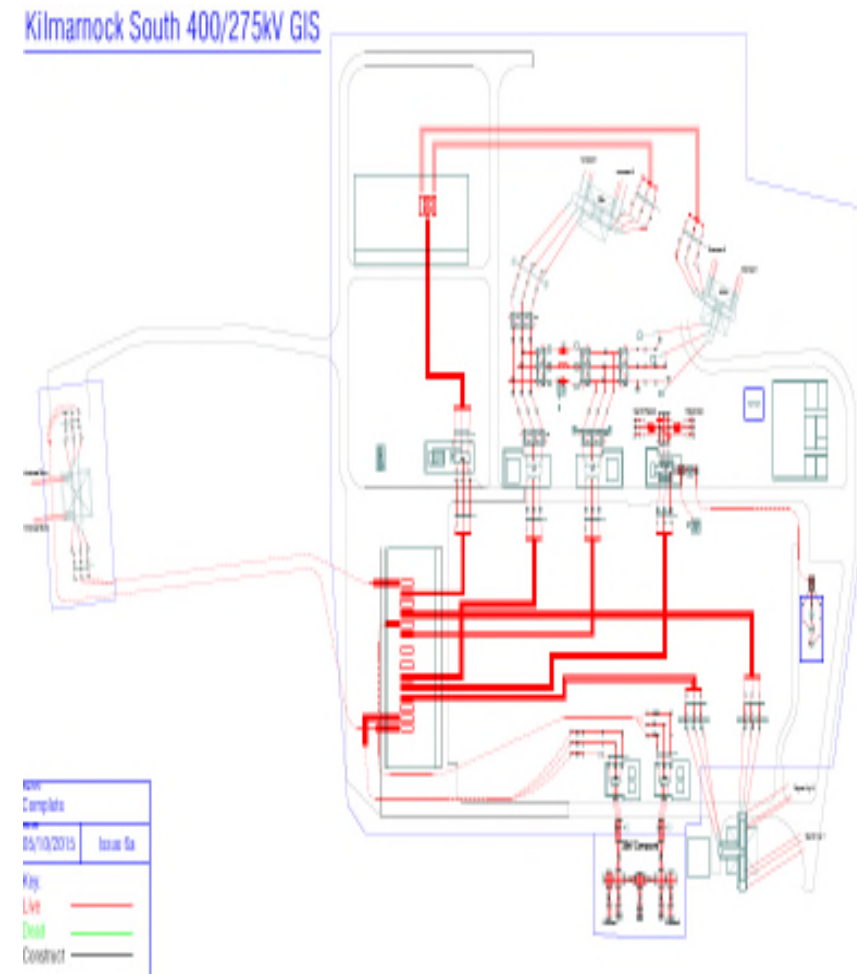
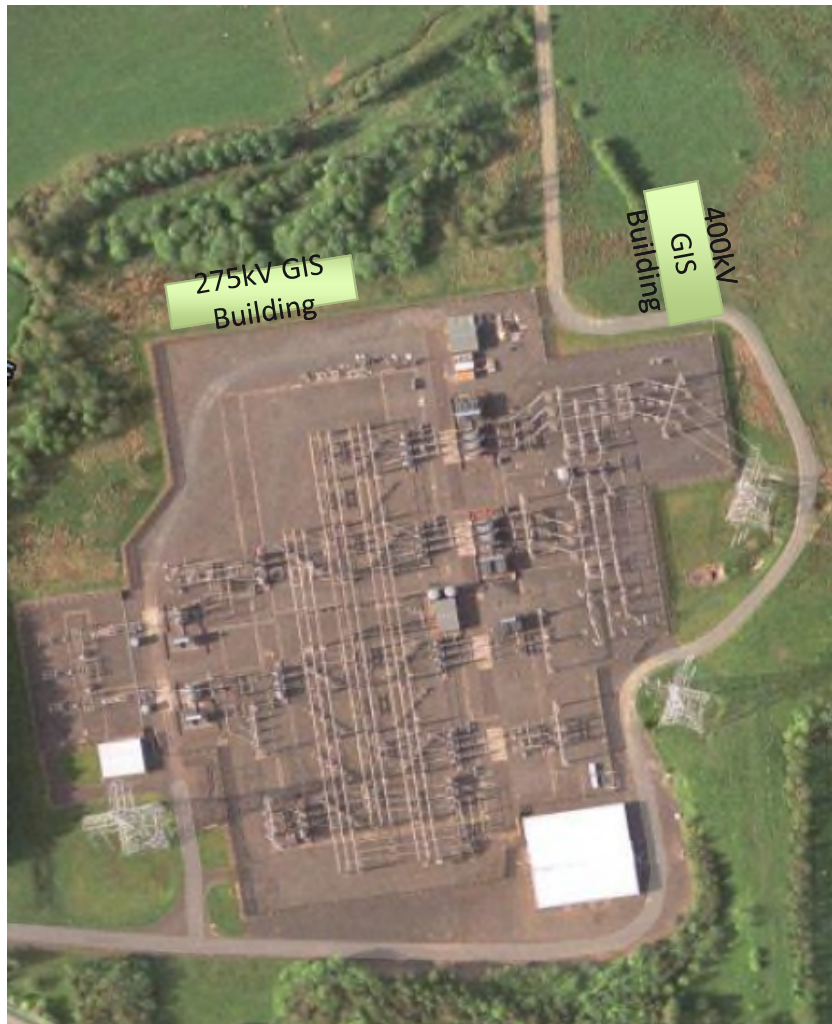
SWS Project Route D



TORI 143 – Kilmarnock South Uprating

Construct new 275kV and 400kV GIS Substation and Installation of a third 1000MVA 400/275kV auto wind transformer

- Construct new 275kV and 400kV GIS Substation and Installation of a third 1000MVA 400/275kV auto wind transformer
- Planned Completion Date November 2019



TORI 143 – Kilmarnock South Upgrading Project Progress

Construct new 275kV and 400kV GIS Substation and Installation of a third 1000MVA 400/275kV auto wind transformer

- Civil enabling works substantially complete – platform available for construction of GIS buildings
 - 80,000m³ of excavation
 - 58,000m³ of disposal
 - At peak 320 wagon movements per day (160 return journeys)
 - 1.3kM of palisade fence
- GIS building contract works commenced early 2017 – good progress being made
- Balance of Plant and 275kV cable contracts in closing stages of tender process
- Civil works commenced – SGT6 area
- OHL contractor on site to suit outage works
- Target to get 275kV & 400kV GIS Buildings substantially complete for November 2017
- Overall programme on track for completion in 2019

TORI 143 – Kilmarnock South Uprating



TORI 143 – Kilmarnock South Uprating



TORI 143 – Kilmarnock South Uprating



TORI 143 – Kilmarnock South Uprating





Transmission Programmes

8th June 2017

South West Scotland Forum

SPT Development

Colin Brown

Kilmarnock South
Uprating now in
delivery

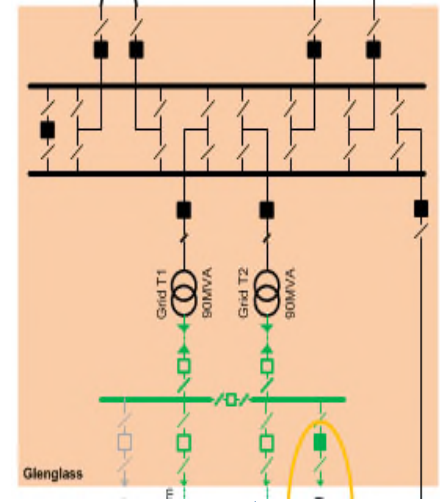
Kilmarnock South to
Coylton 3rd Circuit –
No Longer Required

Reduced
Kendoon
North
132kV
Substation -
No Longer
Required

Coylton
Transformers
Uprating

Coylton to
Maybole OHL
Uprating

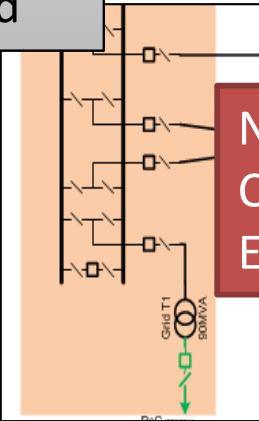
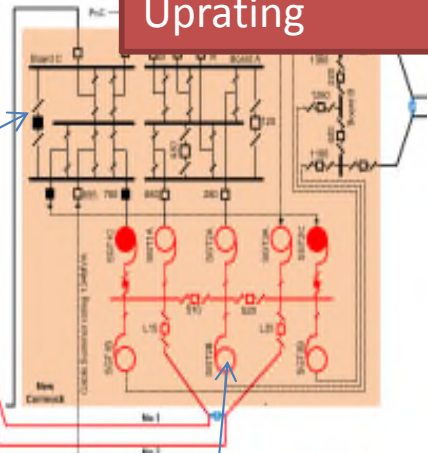
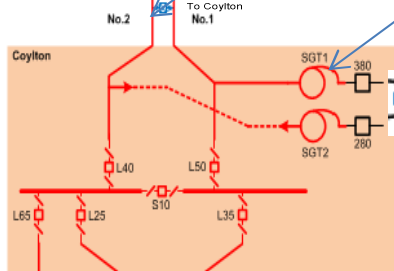
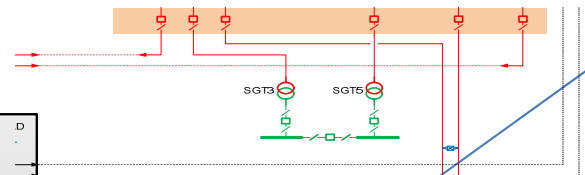
New
Cumnock
Extension



Glenglass Double
Bus Substation

Coylton to New
Cumnock WA route
Uprating – No
Longer Required

SGT2B New
Cumnock



TORI 213 – SGT2B New Cumnock

At New Cumnock 275kV substation

- Install a new 275/132kV 240MVA transformer
- Cabling work to connect to New Cumnock 132kV Board B

At New Cumnock 132kV Board B

- Install three new 132kV circuit breakers to tee in the new transformer.

Contracted generation 297MW with 59.5MW consented. This will be progressed as non secured works as part of the Kendoon to Tongland (KTR) project.

Target completion date Q4 2022



Current layout of New Cumnock Substation with TORI 213 works highlighted

TORI 158 - New Cumnock Substation Extension



- Extend double bus bar to create Board C and install 2 new 275/132kV 240MVA units (SGT1C and SGT2C)
- Contracted generation of 372MW with 51MW consented
- Following changes to the contracted background target completion date is now Q4 2021

TORI 146 – Coylton to Maybole Circuit Upgrading

- Following changes to contracted background, technical solution has been updated
- Re-conductor 23km of existing 132kV double circuit overhead tower line
- Replace existing sections of 132kV cable to increase the rating and match the new overhead line conductor
- Contracted generation is 85.9MW with 30MW consented
- Target completion Q3 2022



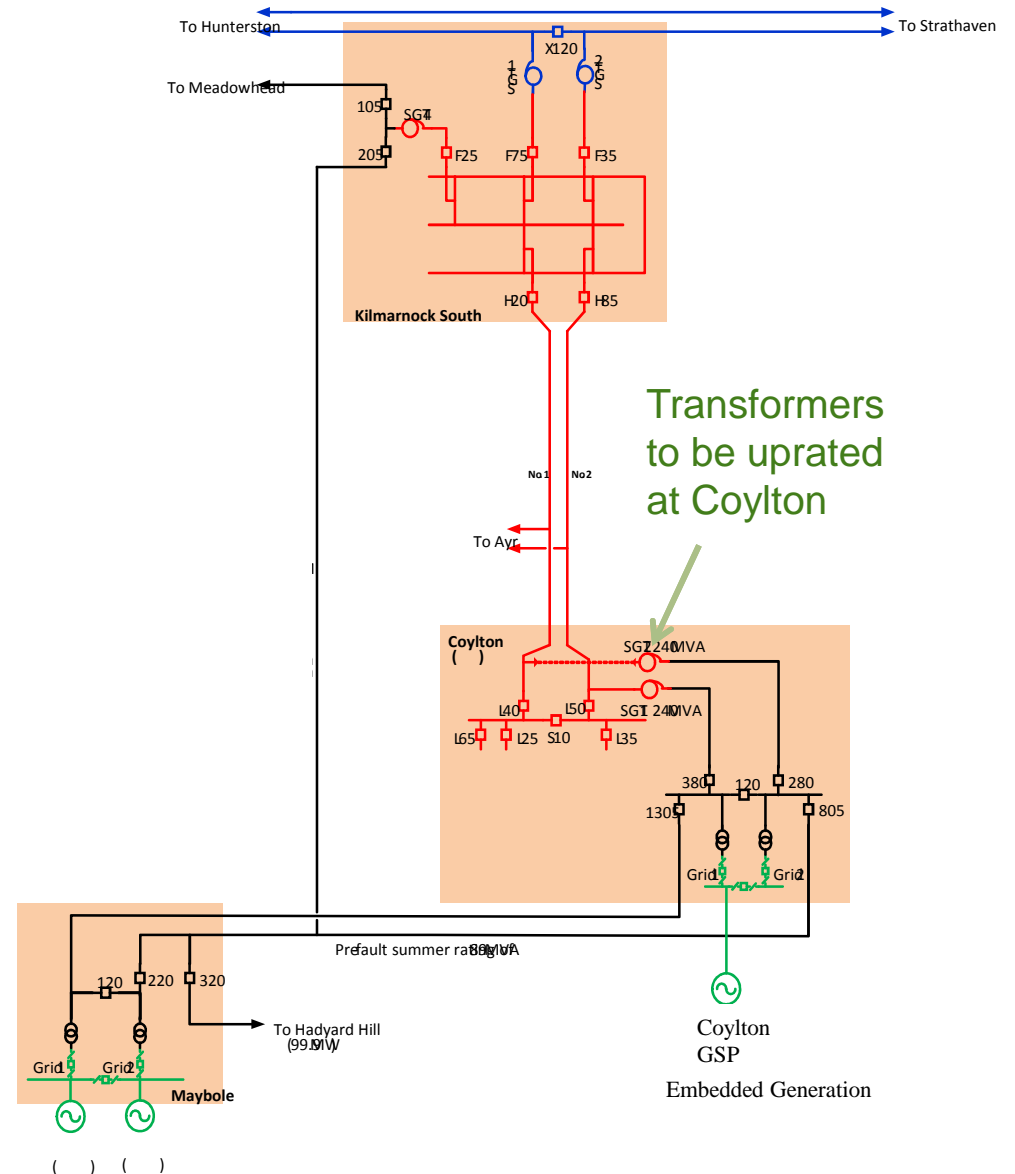
Sealing end tower south of Coylton substation

TORI 224 Coylton SGT1(2) Reinforcement

The diagram below shows the Coylton 240MVA SGT1(2) units installed, along with the wider transmission network associated with Maybole and Coylton GSPs. (N.B. This is shown post the removal of the Kendoon to Maybole T 132kV circuit, scheduled to be completed as part of SPT-RI-111 in October 2017).

At Coylton 275/132kV substation:

- Decommissioning and removal of the existing Coylton SGT1(2) 275/132kV 120MVA transformers
- Installation of two 275/132kV 240MVA transformers SGT1(2)
- 85.6MW currently contracted with 30MW consented
- Target completion date September 2022

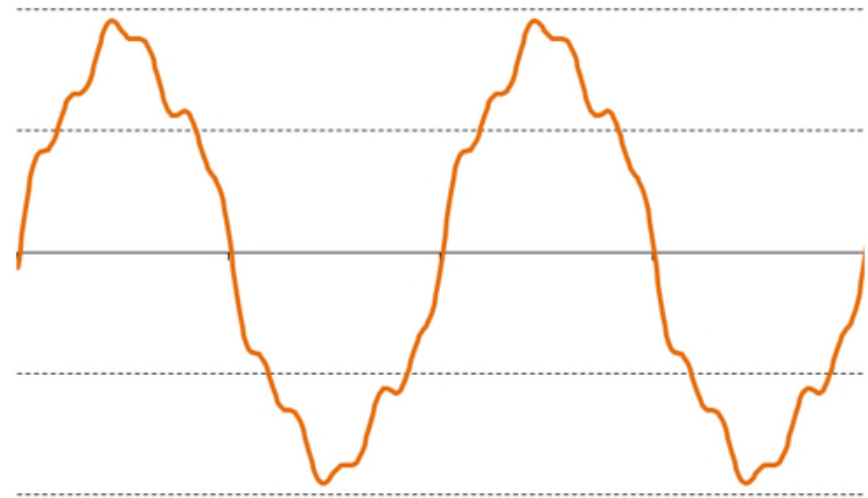
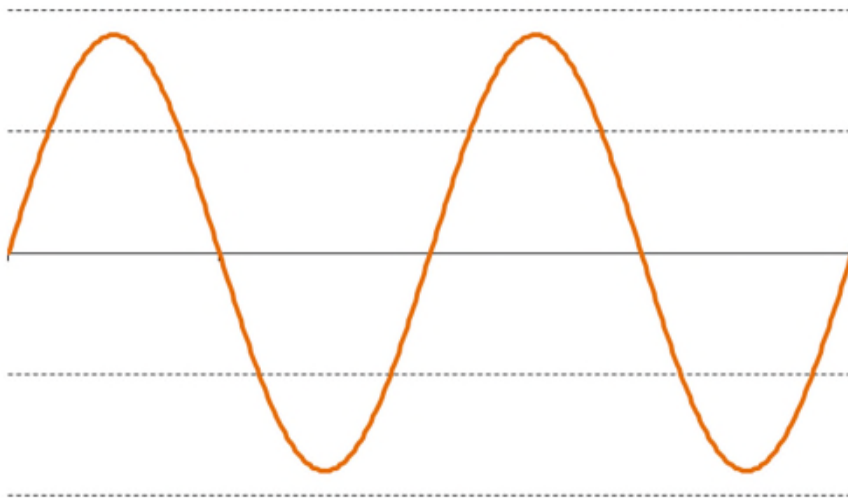


Project Progress (Stage 5 and Beyond)

TORI 173 - Glenglass Double Busbar Substation

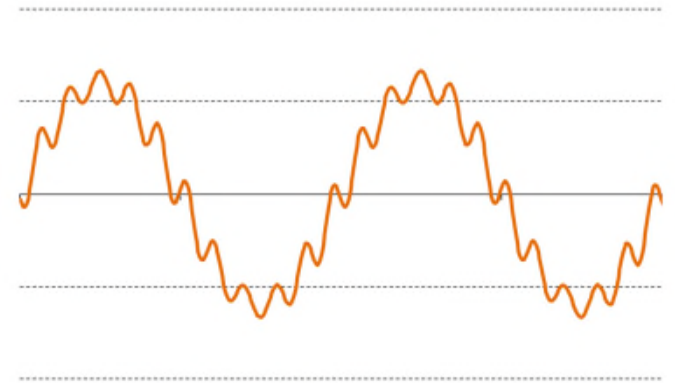
- At the proposed Glenglass 132kV Substation, install a new 132kV GIS double busbar substation with eight bays.
- Continually reviewing design requirements based the contracted background
- Contracted capacity of 277.4MW contracted with 51MW consented
- Original completion date of October 2020 however, based on contracted background changes, new target completion date of October 2021

Harmonic Voltage Distortion



Introduction

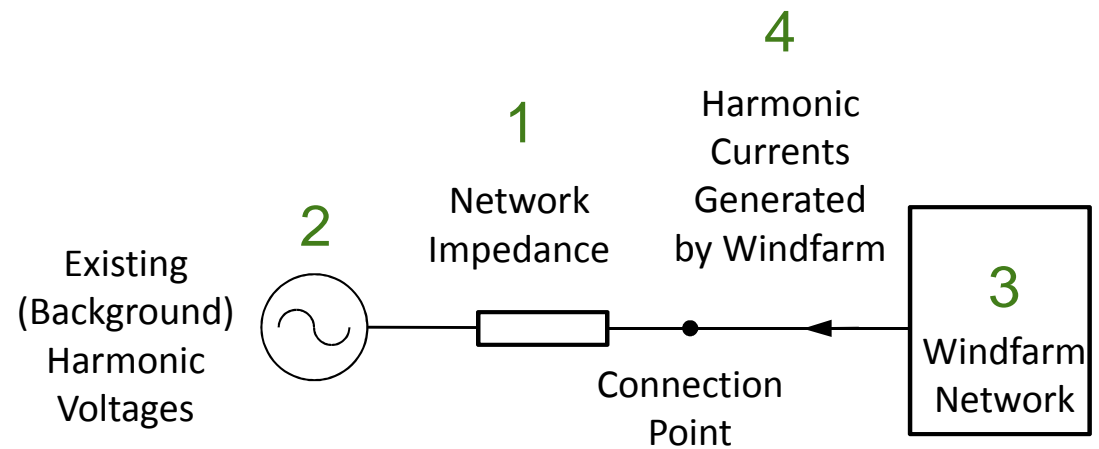
- Harmonic compliance can be a problem for Users and TO's
- In this presentation we'll look at:
 - Harmonic voltage distortion in networks and SWS
 - Resonance
 - Why are harmonics a problem?
 - Existing compliance approach
 - Issues with existing approach
 - Possible alternative for SWS



Harmonic Voltage Distortion in Networks

What affects the harmonics at the Connection Point?

1. Transmission network
2. Background harmonics
3. Windfarm network
4. Harmonics generated by windfarm



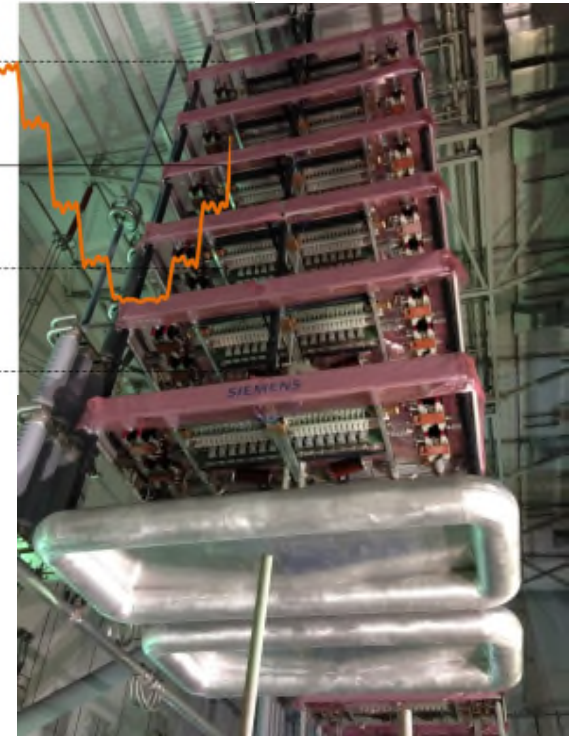
These change constantly

More issues as renewables increase

Where do harmonics come from?

Why are there background harmonics?

- Mainly power electronic converters and devices
 - HVDC converters
 - Mobile phone chargers
 - Windfarms
- Transformer magnetisation
- Also
 - Arc furnaces
 - Fluorescent lighting



Harmonic Resonance

- Cause of many compliance issues
- Transmission and windfarm networks work together
- Amplification of background harmonics
- More problems in networks that
 - are weaker
 - use more cable
- Studies show high resonance risk in SWS network



Why don't we just ignore harmonics?

- Increasing risk of interference or disturbance
 - Network and User equipment
- Heating (losses)
- Life Reduction
- Communication
- Zero-crossing detection
- Noise



Existing Approach

- The User is responsible for harmonic compliance
- Network studies
 - Network data
 - Background measurements from TO
 - Marginal non-compliance can be resolved by measurement
- Measurements to confirm compliance

Issues with Existing Approach 1

- Network does not exist – background measurements not available
- High level of uncertainty around final network design
- Windfarm design and harmonic emissions not known
- Data confidentiality
- Engineering Recommendation G5/4 sequential process
- How to apportion headroom fairly?

Issues with Existing Approach 2

- Windfarm non-compliance risk
- Potential impact on reactive power range
- Inefficient mitigation
- Filter redundancy
- Mitigation costs may not be distributed equitably between Users

Issues with Existing Approach 3

Who is responsible in case of a network resonance?

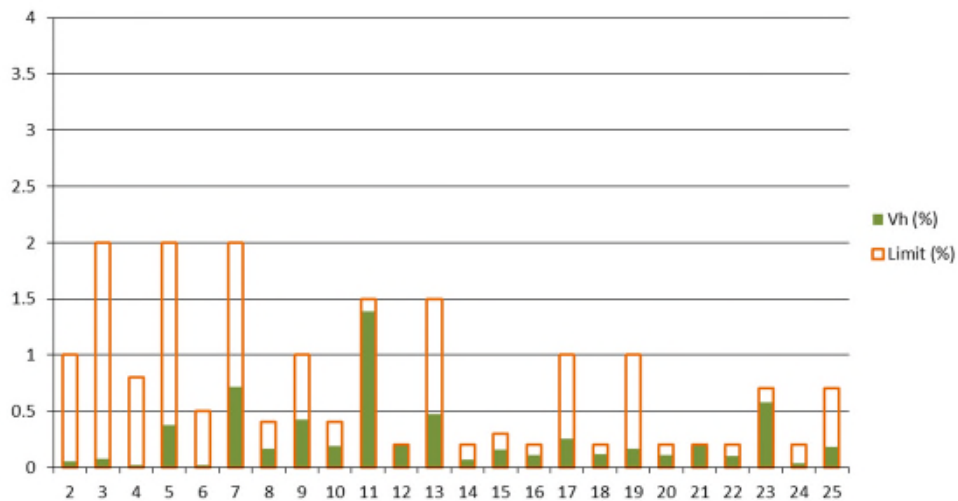
Transmission Owner

- Background not from new windfarm
- Cable circuits

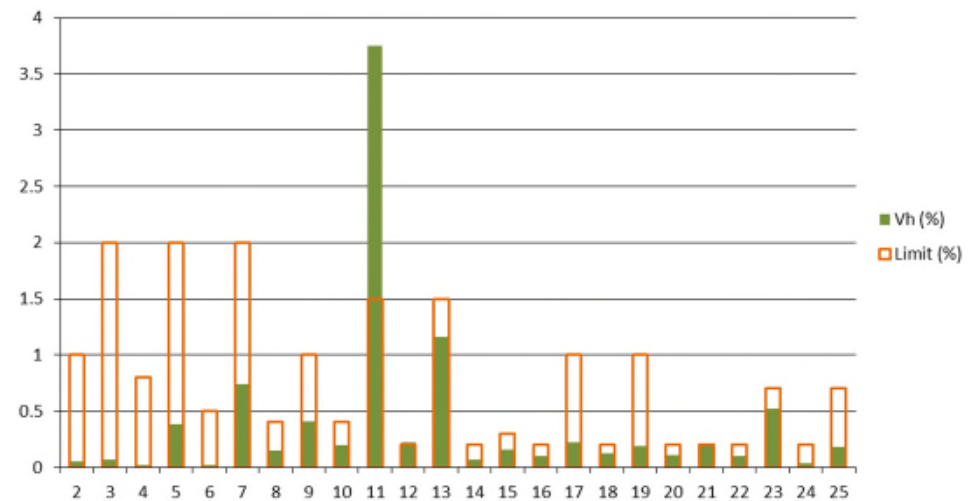
Windfarm

- Cables part of the resonant circuit

Before connection



After connection



Issues with Existing Approach 3

Who is responsible in case of a network resonance?



We've had some ideas

- NIA project to consider a standard 33kV harmonic filter design
 - Can be included in connection offer
 - Not the most efficient solution
 - Report and paper available
- SWS harmonic study is in progress
 - Economic and efficient solution for the whole area?
 - Considers uncertainties
 - Considers evolving network

Possible Alternative for SWS

- SPEN designs and installs harmonic mitigation
- Windfarms can connect without harmonic compliance requirements if
 - Harmonic currents are not unusually high
 - Total cable capacitance is within a certain range
- Commercial framework?
- Initial cost estimate
 - £6k – £9k/MW

Nearly done...

- Next Steps
 - Complete SWS studies and share results
 - Improve cost estimate
 - Commercial arrangements
- Your views on SPEN designing and installing harmonic filters in SWS?
- Any questions on harmonics?

Any Questions?