



6th December 2017

South West Scotland Forum

Agenda

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



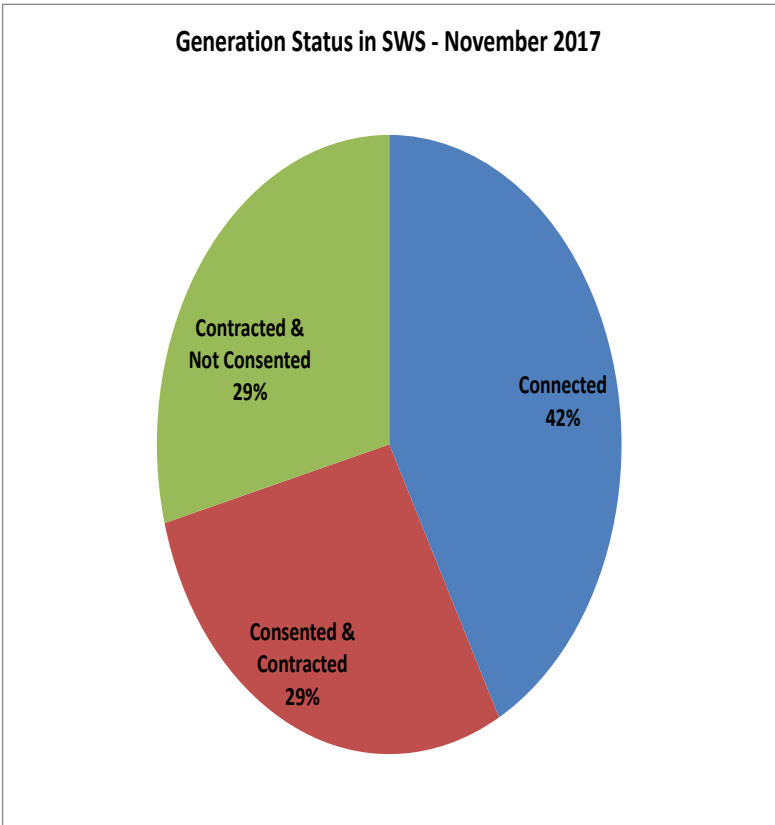
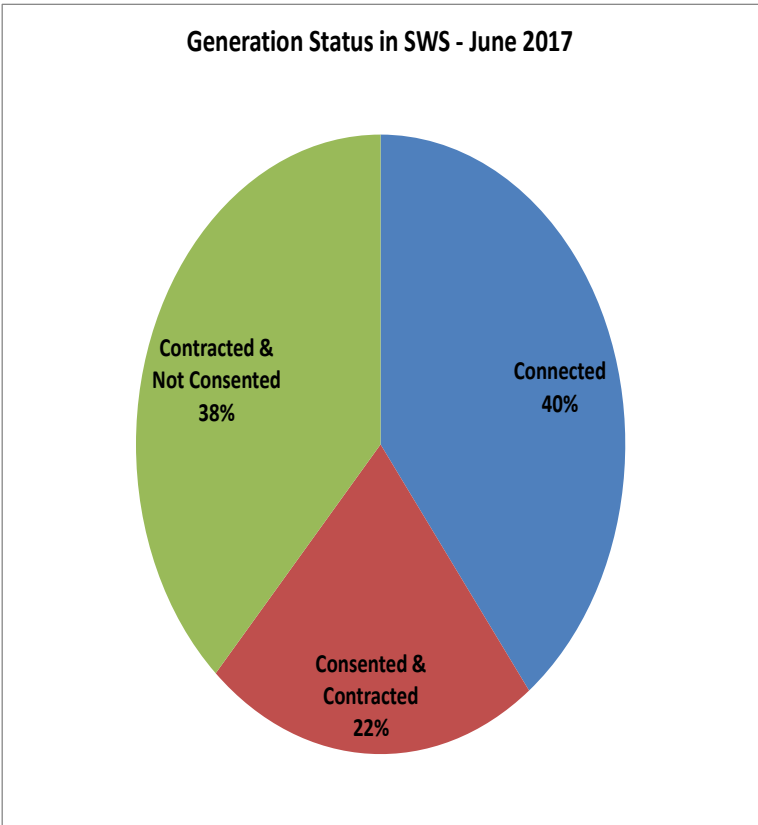
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SWS Developer Forum

SPT System Design

Diyar Kadar

Generation Background – Change from last forum



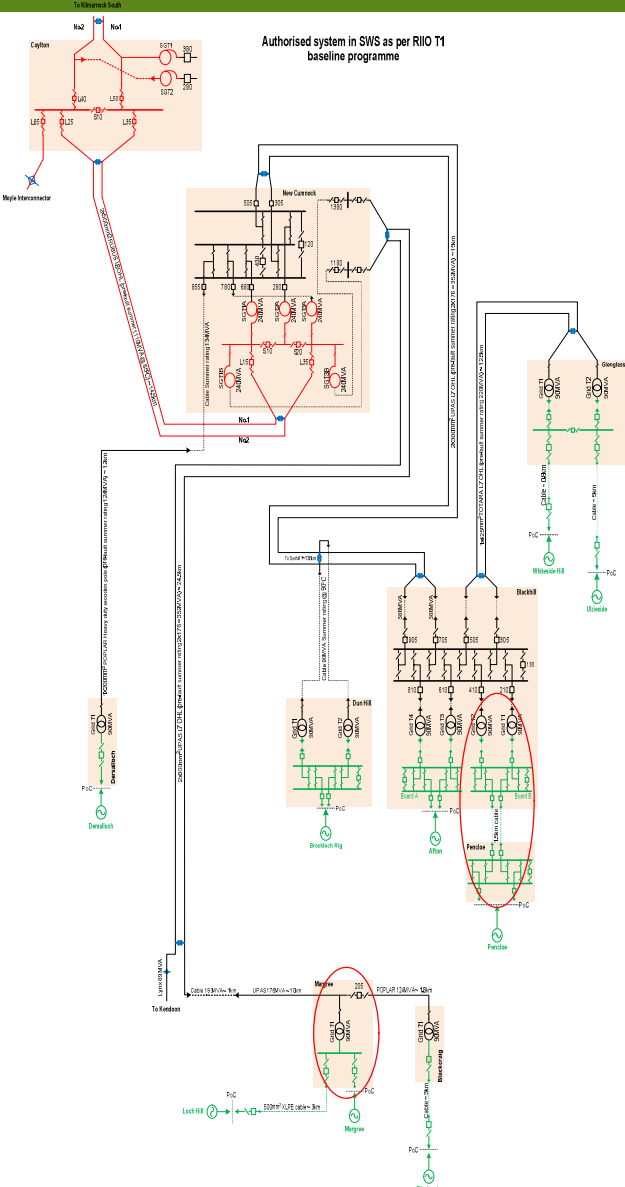
One new wind farm connected to the system (Brockloch Rig Wind farm)

Total generation (Connected and Contracted) in the whole of South West Scotland is around 3050MW (an increase of 150MW from June 2017)

Significant change in the consented position and around 887MW 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 transformers(TORI 158)

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

Creating a new 132kV GIS substation at Glenglass is no longer required for the wind farm connections (TORI 173)

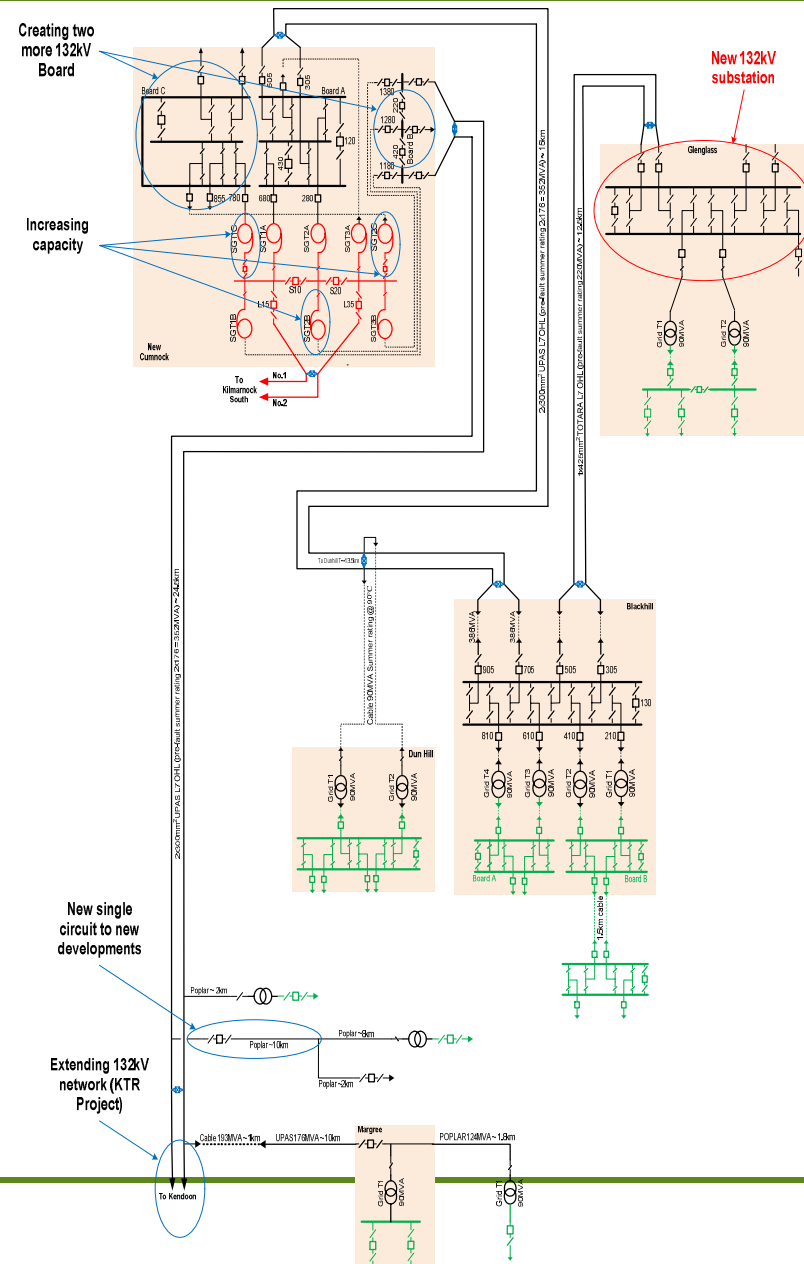
Various Load Management Schemes to maximise utilisation (TORI 148, TORI 149, TORI 176, TORI 177, TORI 186)

Creating a new circuit North of Kendoon (TORI 211)

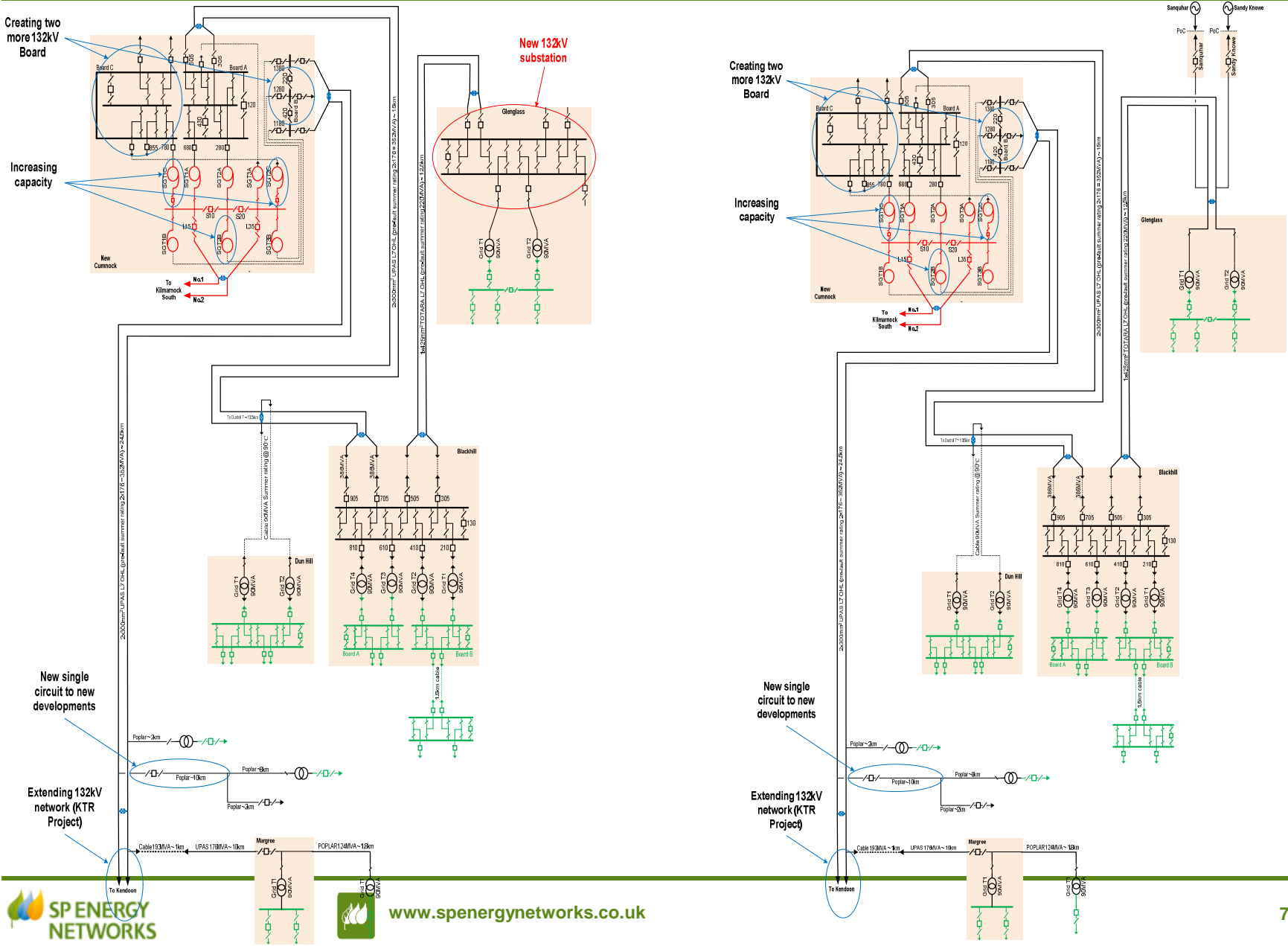
Extending the 132kV network from Margree Tee to Glenlee and Tongland (KTR Project)

Uprate Kilmarnock South to increase its capacity by 1000MVA (TORI 143)

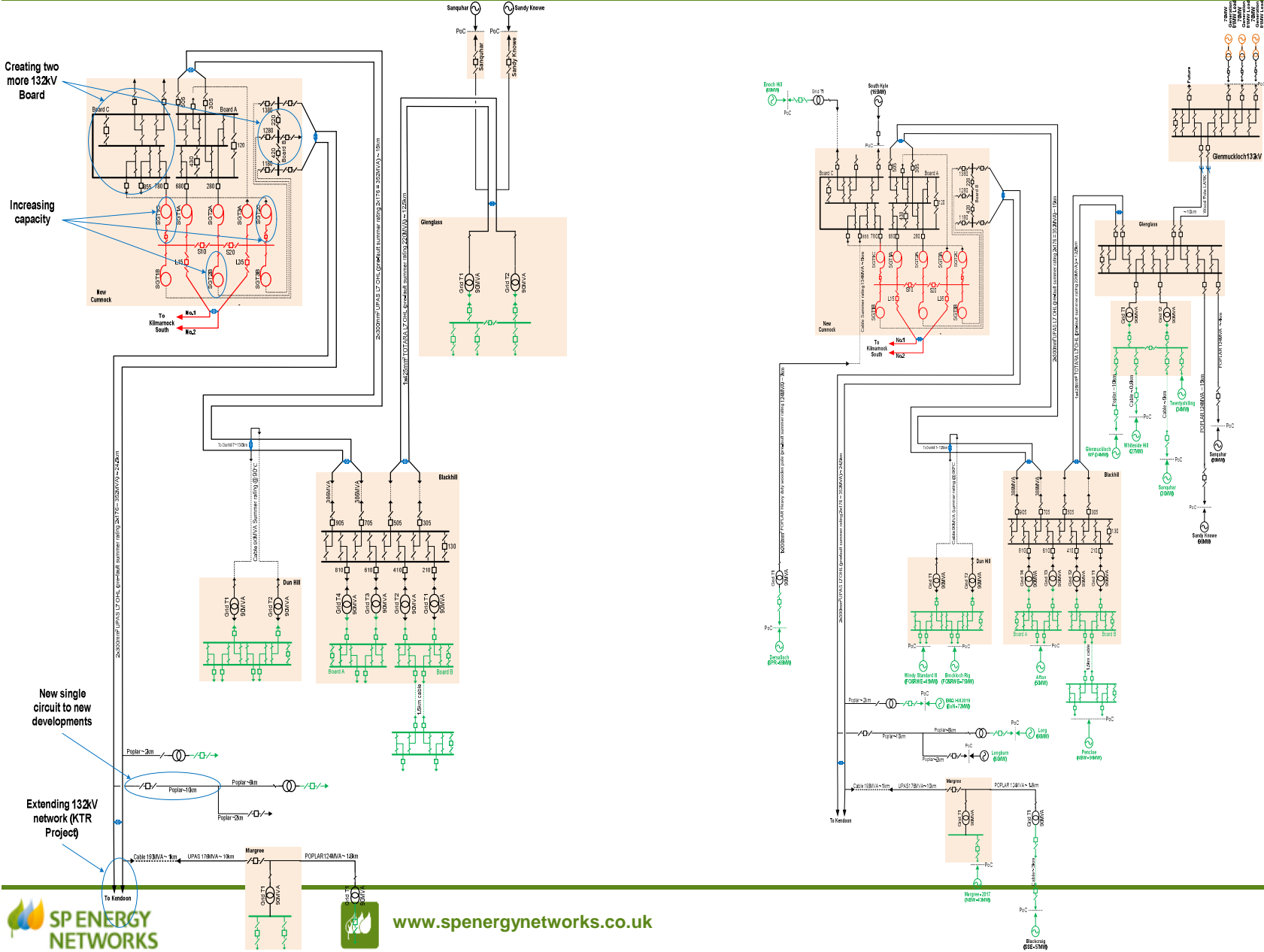
Despite all these reinforcements the system is at full capacity against contracted position



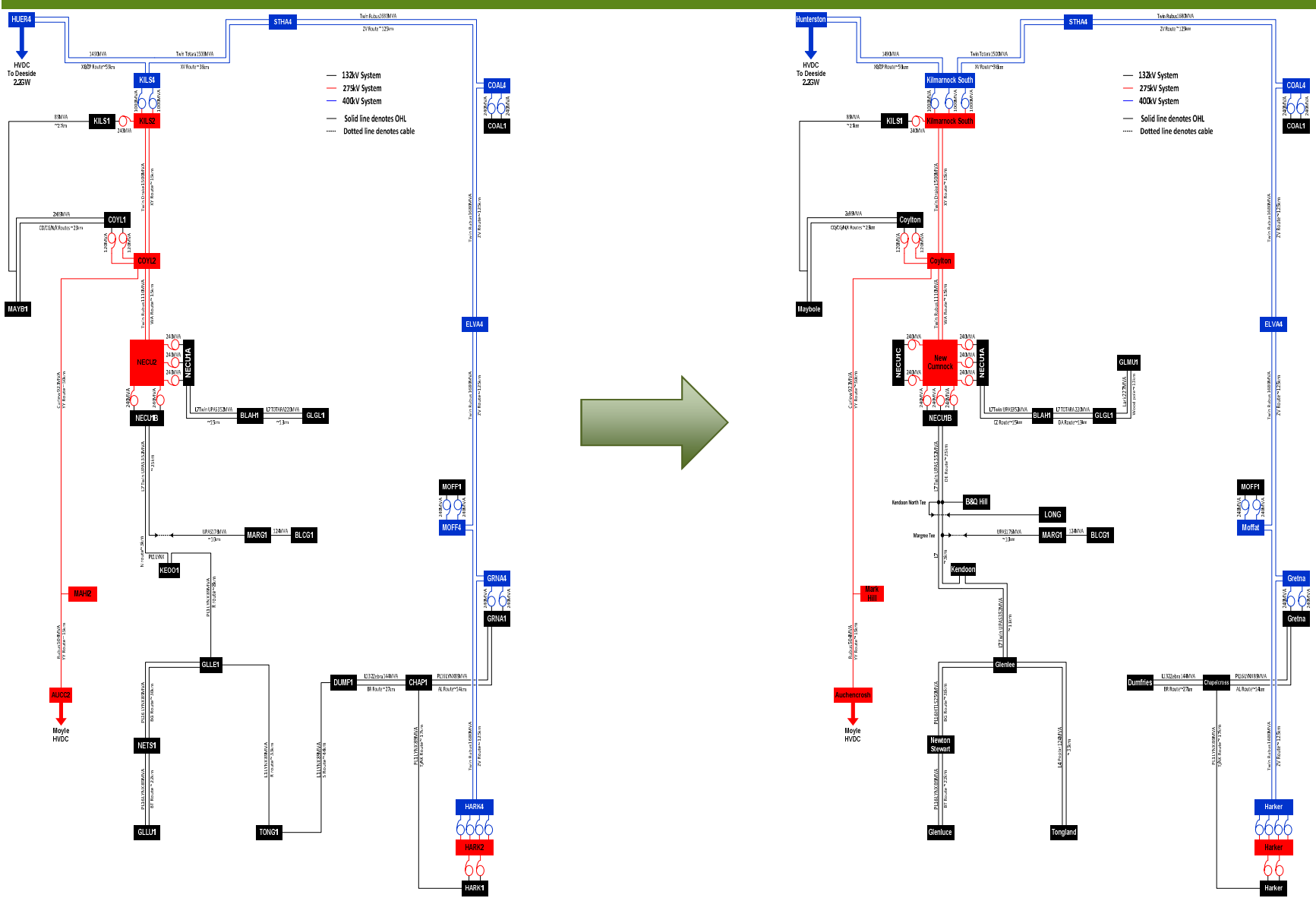
Future Developments – SWS – (2022)



Future Developments – SWS – (post Glenmuckloch pump storage)



Future Developments – Wider system



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 Kilmarnock South, New Cumnock and Dumfries and Galloway to provide further transmission capacity

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

Significant change to the contracted background in the Glenglass area

Against a contracted background the system in non-compliant and new offers will be contingent on further reinforcements

Reinforcement options are being assessed to ensure the system is developed in a coordinated manner



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SWS Developer Forum

Delivery Update

Bob McGuire

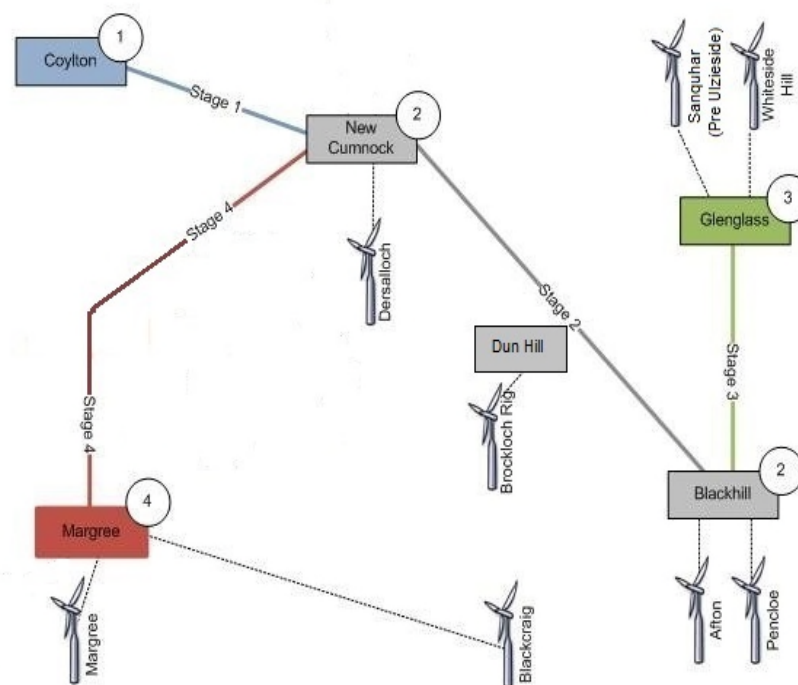
SWS Project Progress (Stages 2 – 4)

Stage 2 New Cumnock – Blackhill

Stage 3 Blackhill - Glenglass

Stage 4 New Cumnock - Margree

- £165m expenditure to date (£50m since Jan 17)
- Increase in 2017 expenditure total circa £53m
- Steel tower overhead line main construction in progress:
 - 97% accesses complete (+28%)
 - 87% foundations complete (+38%)
 - 72% tower erection complete (+36%)
 - 52% conductoring complete (+26%)
- Tree cutting now complete on route corridors
- Dunhill substation works complete
- New Cumnock / Blackhill and Glenglass Substation electrical installation works complete and pre-commissioning complete



Network Overview Diagram

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

- Route B Dunhill first circuit energised 19th June 2017
- Dec 2017 for completion of SP-RI-114 / 145 infrastructure to Dunhill
- Dec 2017 for completion of SP-RI-115 / 116 infrastructure to Blackhill substation
- Energisation of customer connections from Blackhill Dec 2017
- Jan 2018 for completion of SP-RI-022 infrastructure to Glenglass substation
- Energisation of customer connections from Glenglass Substations Jan 2018



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

- New Cumnock / Blackcraig electrical installation works complete and pre-commissioning complete
- Site construction works commenced on Heavy Duty Wood Pole (Route D).
 - 56% structure erection complete (+56%)
 - Wiring to commence W/C 4th Dec
- Dalshangan cable compound substantially complete and cable jointing in progress.
- Dec 2017 for completion of SP-R1-111 infrastructure
- SPT-RI-034 Margree collector substation now likely 2019/20 build overhead line through construction being progressed
- Energisation of customer connections Dec 2017 beyond Margree in line with current contract dates



SWS Project (Stages 2 – 4) Key Risks Remaining

- Construction activities through Afton Reservoir and Euchar water catchment areas.
- Contractor health and safety / rate of progress performance.
- Environmental performance / compliance across all works.
- Network Outage availability to facilitate final connections.
- Winter working / Weather impacts.



SWS Project (Stages 2 – 4)

- Interim reviews undertaken to capture key construction lessons learned and incorporate into future works.
- Targeting completion of key contract reviews in Q1 2018.



SWS Project Route C Terminal Tower



SWS Project Route B Terminal Tower



SWS Project New Cumnock Substation



SWS Project HDWP

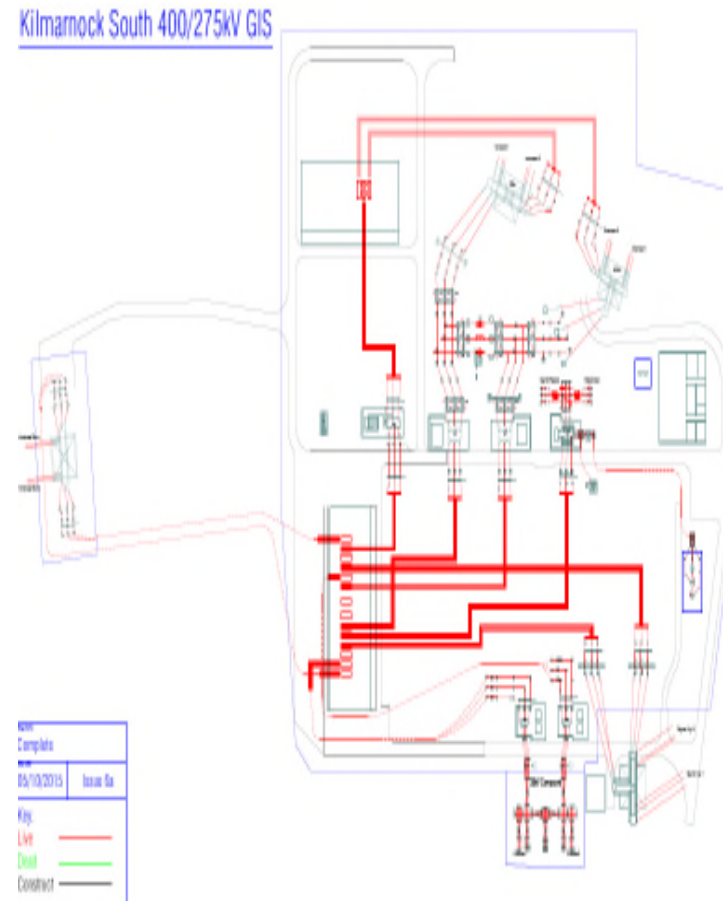
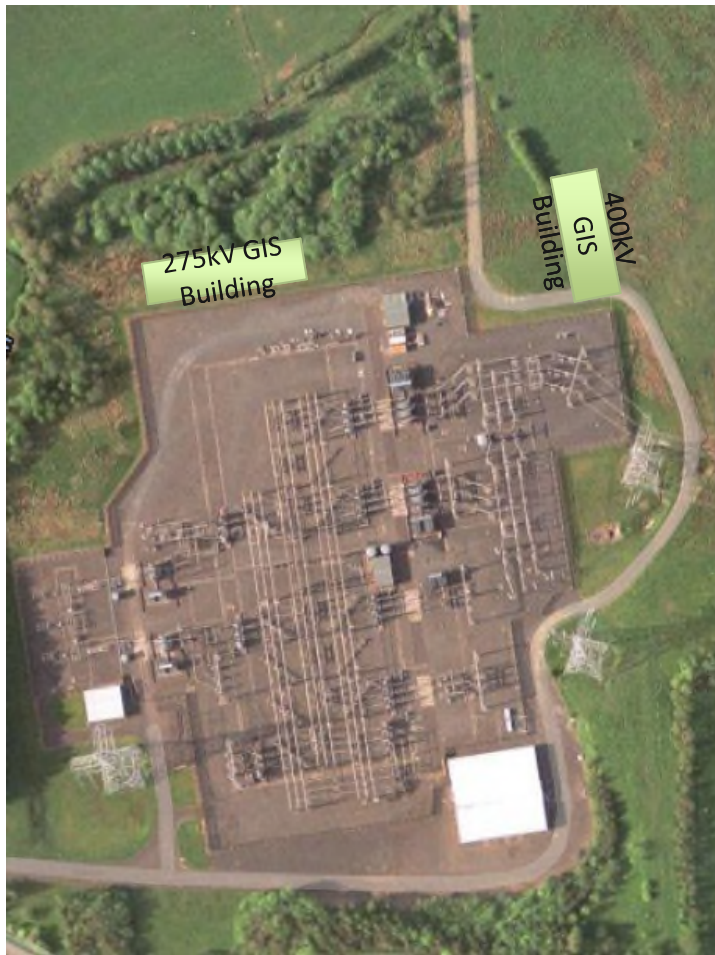


SWS Project HDWP



TORI 143 – Kilmarnock South Uprating

- 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

- Enabling works fully complete
- GIS buildings substantially complete – 275kV and 400kV installation ongoing
- Balance of Plant and 275kV cable contracts awarded – BOP contractor mobilised on site
- Civil works ongoing
- 1000MVA SGT6 delivered to site – installation underway
- OHL contractor on site to suit outage works
- Overall programme on track for completion in 2019
- Approx. 100 workers on site at any one time

TORI 143 – Kilmarnock South Uprating

400kV GIS Equipment



275kV GIS under construction





Transmission Programmes

6th December 2017

South West Scotland Forum

SPT Development

Colin Brown

Development update on TORIs in SWS area

- Transmission Owner Reinforcement Instructions (TORIs)
- SPT provide quarterly updates
- Feedback from last forum
- Updates based on current position
 - We need to continue to work together through regular engagement to ensure that we are bringing the right investments forward at the right time



TORI 146 – Coylton to Maybole Circuit Uprating

Scope

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



MW

Around 118MW of generation is connected or will connect before these works are completed
A further 53MW is contingent on this TORI
An additional 200MW of non-firm capacity will be available upon completion

Programme

Target completion **October 2022**
Around 30MW of generation would have to terminate for scope review & further engagement with affected parties



Sealing end tower south of Coylton substation

TORI 224 Coylton SGT1(2) Reinforcement

Scope

Decommissioning and removal of the existing Coylton SGT1(2) 275/132kV 120MVA transformers

Installation of two 275/132kV 240MVA transformers SGT1(2)



MWs

Around 200MW of generation is connected or will connect before these works are completed

A further 53MW is contingent on this TORI

An additional 220MW of non-firm capacity will be available upon completion

Programme

Target completion **September 2022**

Around 50MW of generation to terminate before scope review & further engagement with affected parties



TORI 221 Kendoon to Glenlee Reinforcement

Scope

Construction of 11km of new double circuit 132kV OHLs between Polquhanity & Glenlee
Substation works at Glenlee and Kendoon



MWs

Around 245MW of generation is connected or will connect before these works are completed
A further 84MW is contingent on this TORI
An additional 96MW of non-firm capacity will be available upon completion

Programme

Target completion **October 2023**
Modernisation element which will progress with a significant amount of generation to terminate before scope review & further engagement with affected parties



TORI 222 Glenlee to Tongland Modernisation

Scope

Construction of 33km of new double circuit 132kV OHLs between Glenlee and Tongland
Substation works at Glenlee and Tongland



MWs

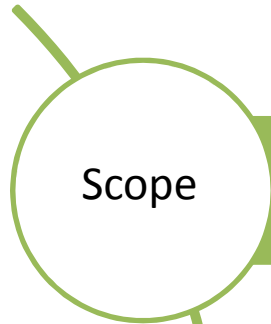
Around 35MW of generation is connected or will connect before these works are completed
A further 51MW is contingent on this TORI
An additional 160MW of non-firm capacity will be available upon completion

Programme

Target completion **October 2023**
Modernisation which will progress regardless of generation background



TORI 223 Glenlee to Newton Stewart Reconductoring



Reconductor 30km of double circuit 132kV overhead line between Glenlee and Newton Stewart



Around 136MW of generation is connected or will connect before these works are completed
A further 56MW is contingent on this TORI
An additional 191MW of non-firm capacity will be available upon completion



Target completion **October 2023**
Around 50MW of generation to terminate before scope review & further engagement with affected parties

TORI 213 – SGT2B New Cumnock

Scope

Install a new 275/132kV 240MVA transformer
Cabling work to connect to 132kV Board B and install three new 132kV circuit breakers to tee in the new transformer.



MW's

Around 245MW of generation is connected or will connect before these works are completed
A further 293MW is contingent on this TORI
No remaining non-firm capacity will be available upon completion

Programme

Target completion date **October 2022**
Around 250MW of generation to terminate before scope review & further engagement with affected parties



TORI 158 - New Cumnock Substation Extension

Scope

Extend double bus bar to create Board C and install 2 new 275/132kV 240MVA units (SGT1C and SGT2C)



MWs

Around 651MW of generation is connected or will connect before these works are completed
A further 530MW is contingent on this TORI
An additional 230MW of non-firm capacity will be available upon completion

Programme

Target completion date **August 2022**
If over 500MW of generation terminates then the scope will be reviewed & further engagement with affected parties



TORI 154 - Glenluce to Newton Stewart 132kV OHL reconductoring

Scope

Reconductor the existing No. 1 & 2 circuits between Glenluce and Newton Stewart. Uprate 22km to provide summer pre-fault rating of 156MVA from existing 89MVA



MWs

Around 100MW of generation is connected or will connect before these works are completed
A further 40MW is contingent on this TORI
An additional 147MW of non-firm capacity will be available upon completion

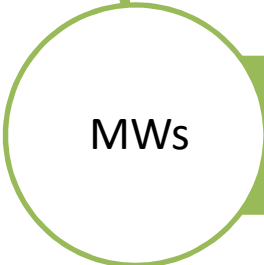
Programme

Target completion date **October 2023**
Around 35MW of generation to terminate before scope review & further engagement with affected parties

TORI 173 - Glenglass Double Busbar Substation



At the proposed Glenglass 132kV Substation, install a new 132kV GIS double busbar substation with eight bays.



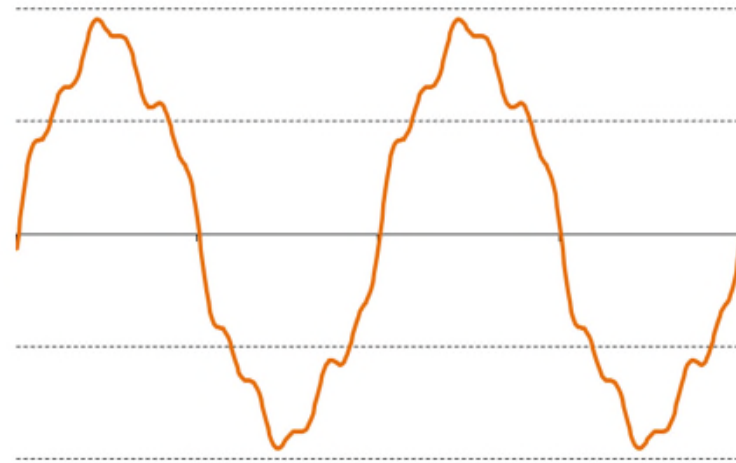
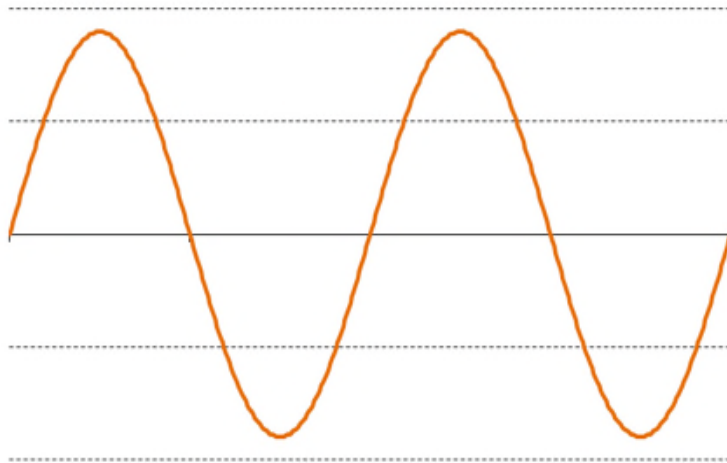
Recent changes to contracted background have affected the completion date



Target completion date of **October 2021**



Harmonic Voltage Distortion

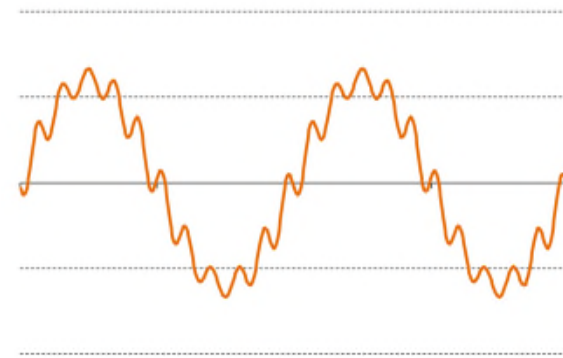


Harmonic Voltage Distortion in SWS

Introduction

- In this presentation we'll look at:
 - A quick review of harmonic voltage distortion
 - Existing compliance approach
 - Issues with the existing approach
 - Solution for SWS and funding

Harmonic compliance is an increasing problem for Users and TO's

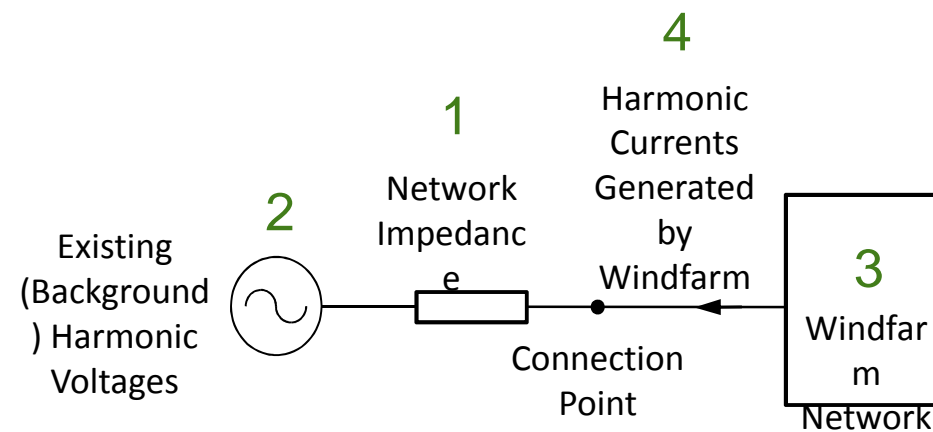


Harmonic Voltage Distortion in Networks

What affects the harmonics at the Connection Point?

1. Transmission network
2. Background harmonics
3. Windfarm network
4. Windfarm harmonics

These change constantly



More issues as renewables increase

Harmonic Voltage Distortion in Networks

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



Harmonic Compliance

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 – no background measurements
- Final network design uncertain
- Windfarm design and harmonic emissions not known
- Engineering Recommendation G5/4 sequential process
- How to apportion headroom fairly?
- Inefficient mitigation
- Filter redundancy
- Mitigation costs may not be distributed equitably between Users
- Late identification of problems

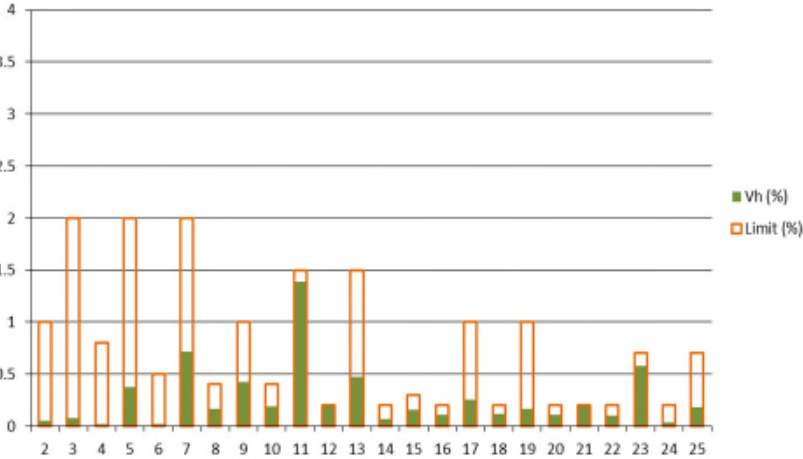
Harmonic Compliance

Issues with Existing Approach 2

Who is responsible in case of a network resonance?

Transmission Owner

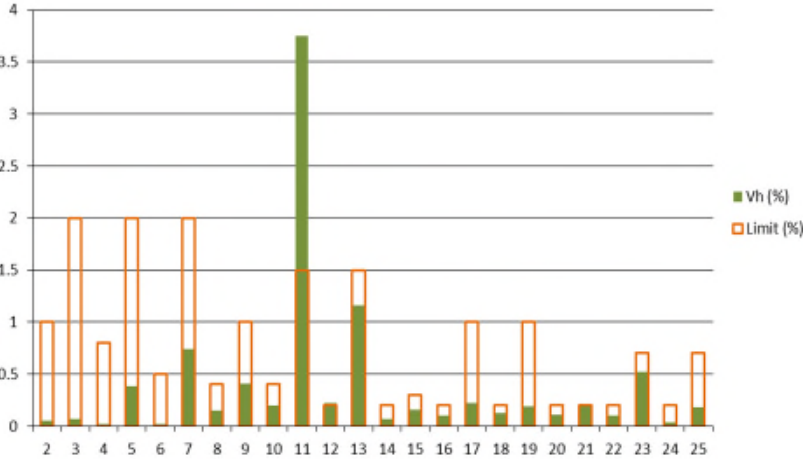
- Background not from new windfarm
 - Cable circuits
- Before connection



Windfarm

- Cables part of the resonant circuit

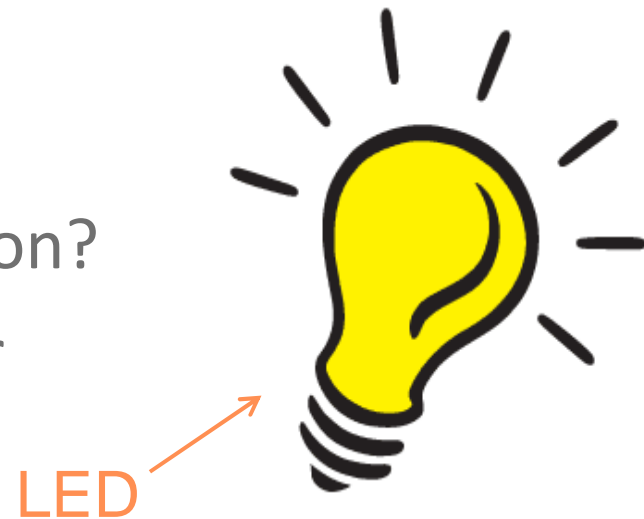
After connection



Harmonic Compliance Problems

We've had some ideas

- Project to consider a standard 33kV harmonic filter design
 - Successfully completed
 - Not the most efficient solution
- SWS and D&G harmonic study
 - Optimal, future-proof solution?
 - Simplify connection for User



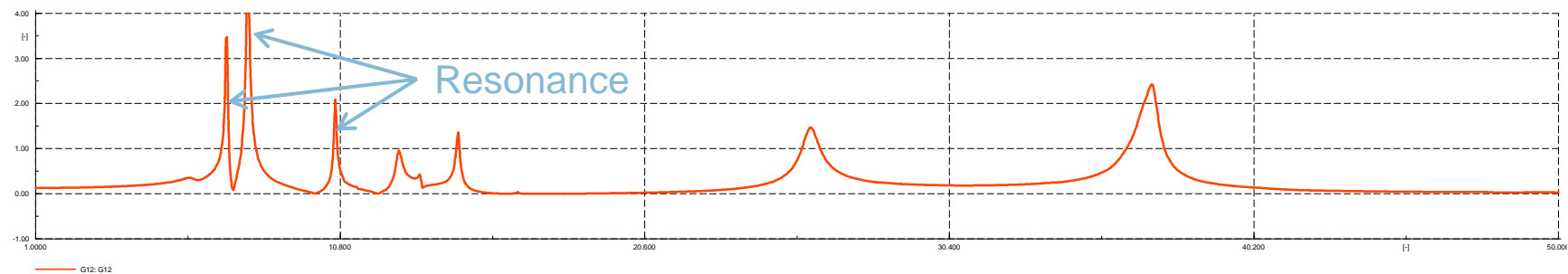
Harmonic Filter Solution for SWS

Innovation Project with EPRI as Partner



ELECTRIC POWER
RESEARCH INSTITUTE

- Design studies considered:
 - SWS and D&G network in 2020, 2022 and 2026
 - Preference for standardised filters
 - Network and generation outages
 - Filter unavailability
 - $\approx 40,000$ studies carried out



Harmonic Filter Solution for SWS

Project Findings

- Harmonic issues progressively worsen
- Optimal solution installs 4 x 20Mvar damped filters at 132kV:
 - New Cumnock
 - Blackhill
 - Glenlee
 - Margree
- Possibly up to 5 filters at 33kV
 - 5Mvar or 7.5Mvar



Project Cost and Funding Possibilities

- Minimises User harmonic compliance requirements
- Cost around £6m - £10m
- We're looking at options:
 - Developer funded
 - RIIO-T2 (2021 – 2029)
 - Innovation Roll-out Mechanism
 - Bid in May 2018
 - Would you be willing to contribute e.g. £1k - £3k/MW?

Harmonic Voltage Distortion in SWS

Nearly done...

- Next Steps
 - Finalise SWS studies and share results
 - Detailed engineering
 - Improve cost estimate
 - Commercial arrangements
 - Technical workshop?
- Any feedback or questions on harmonics?

Questions?

