

OPERATING THE ORKNEY SMART GRID: PRACTICAL EXPERIENCE

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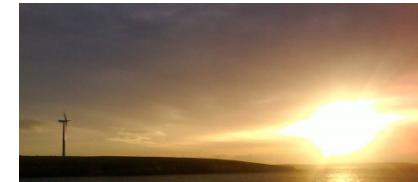
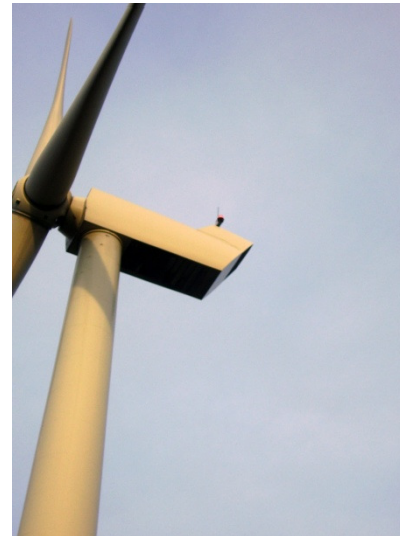




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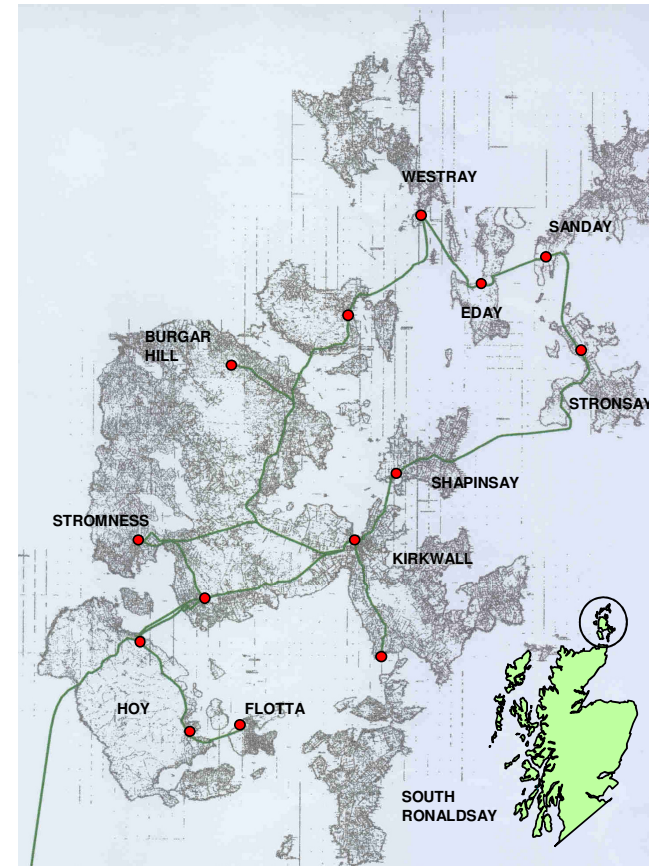
Summary

- ▣ Background
- ▣ 2009
- ▣ 2010
- ▣ 2011
- ▣ Future work
- ▣ References



Background: ANM on Orkney – I

- ❑ 2x20 MVA connection to the mainland
- ❑ 8-32 MW Load
- ❑ 47 MW Installed Generation
- ❑ Higher than average renewable resources
- ❑ New applications for wind projects





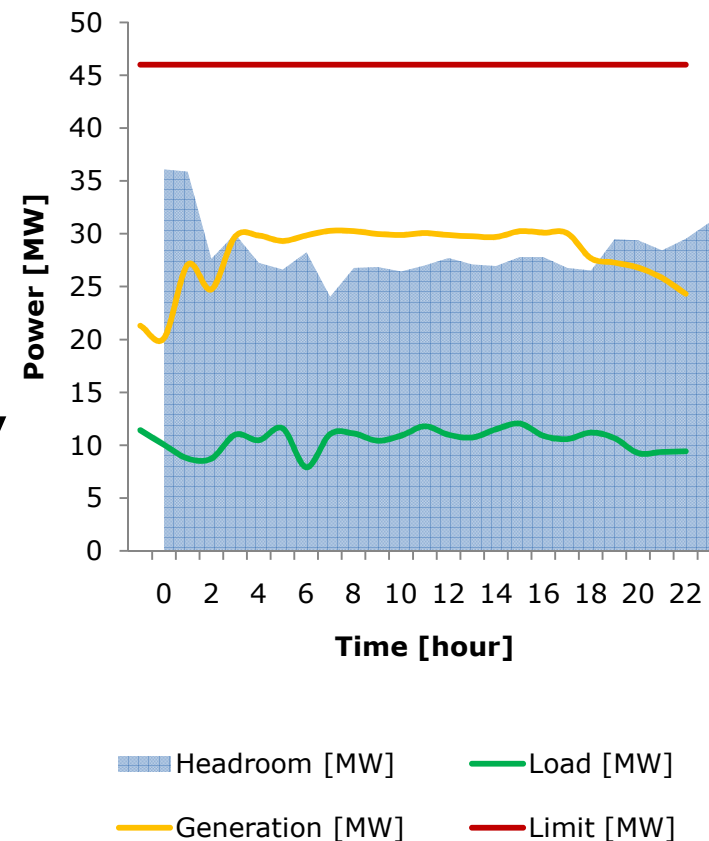
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Background: ANM on Orkney – II

- ❑ Active Network Management (ANM) scheme installed in 2009
- ❑ Modular and scalable
- ❑ New generators
 - Are associated with constraints
 - Have a connection priority (LIFO approach)
 - Are constrained when power flow exceeds constraint limits
 - Given an estimate of annual curtailment

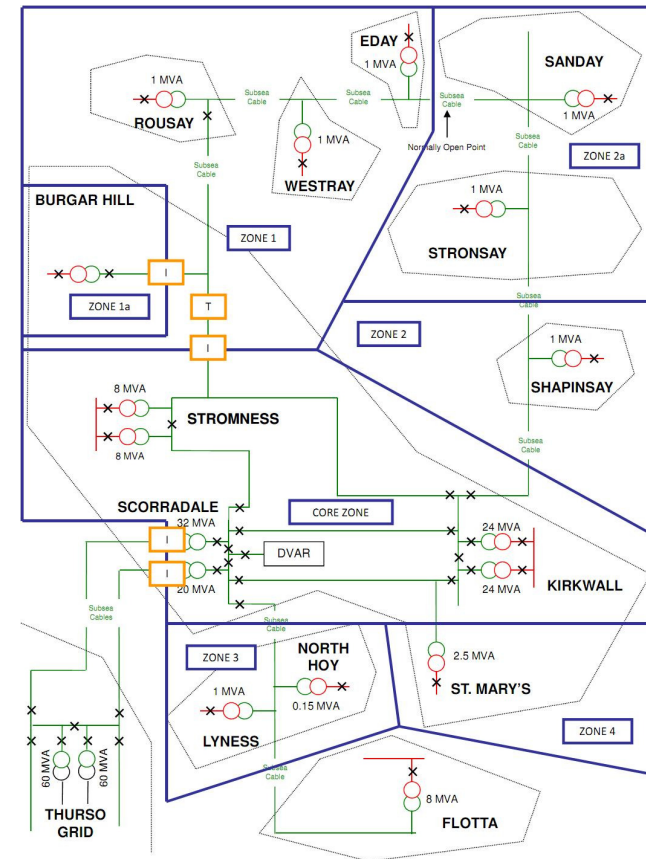
Orkney Smart grid in 2009 – I

- Work undertaken by:
 - SHEPD
 - Strathclyde University
 - SGS
- Exploit diversity in:
 - Generator output (gas, wind, tidal, wave...)
 - Demand
- Release latent real time network capacity for “Interruptible” generators



Orkney Smart grid in 2009 – II

- ❑ Zonal Structure
- ❑ Potential for 15 MW
- ❑ Avoid/delay up to £30M in network reinforcements
- ❑ Two generators connected in 2009 (3.2 MW)
 - Generators
 - Central ANM controller
 - Report to SHEPD SCADA





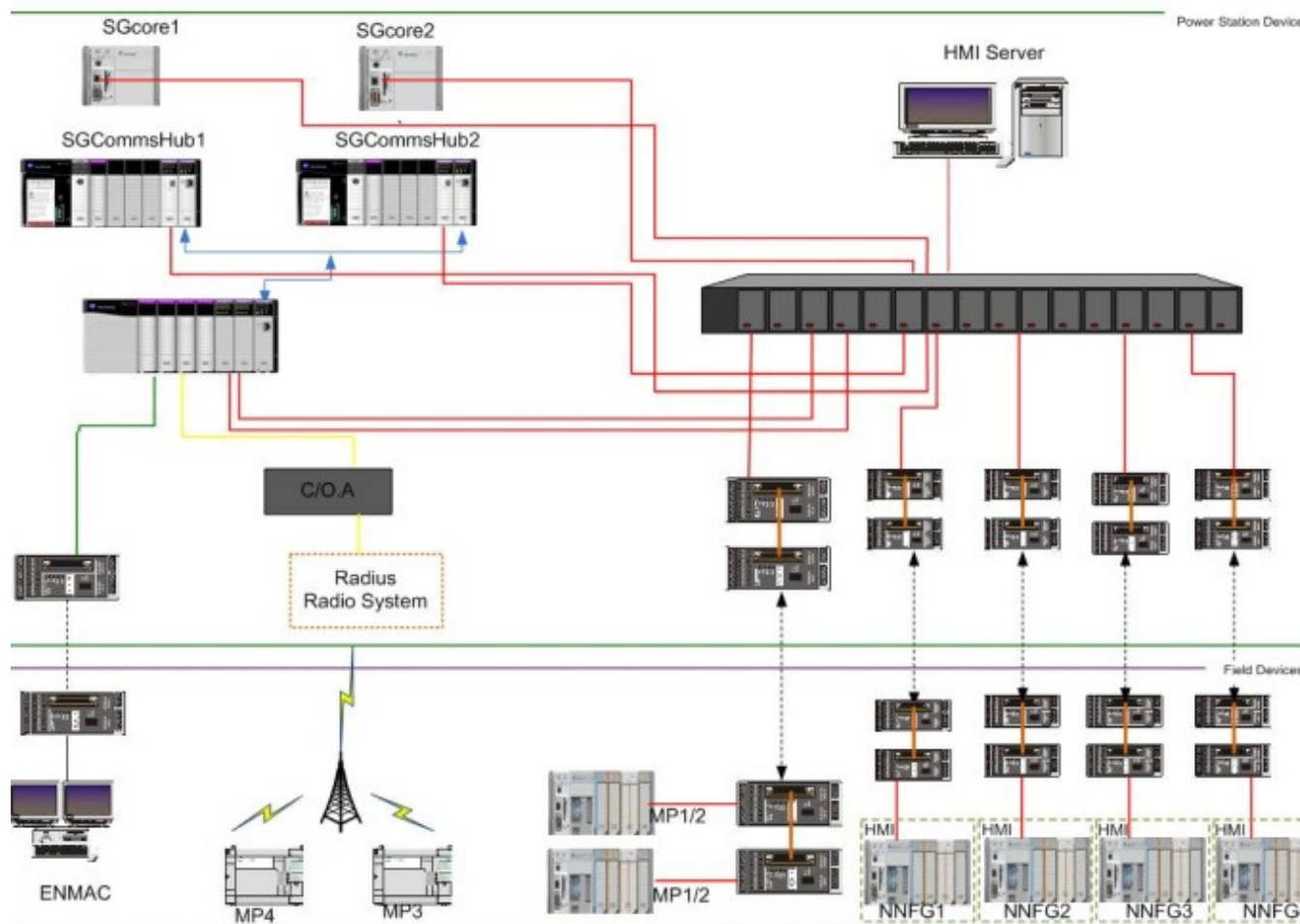
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Orkney Smart grid in 2010

- ❑ SGcore – enhanced control system
 - Structured Text format
 - Support for future functionality
- ❑ Increased redundancy
- ❑ CommsHUB
 - Universal communications interface
 - Developed and Deployed
- ❑ 3rd NNFG unit (4.5 MW)



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Deployed ANM Architecture at the end of 2010

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Orkney Smart grid in 2011

- ❑ Expected 4th NNFG (0.9 MW)
- ❑ Dynamic Line Rating
 - USi PowerDonut2™
 - On the most congested section of the network
 - Release up to 4 MW
- ❑ Real Time Rating
 - Measures weather conditions
 - Ratings for multiple circuits
 - Developed, open loop test



Future developments – I

- Performance review
 - Calculate CO₂ savings
 - Revise curtailment assessments
 - Expected 5375 tonnes of CO₂
 - Review operational data
- SHEPD reviewing supporting communications
 - Considering upgrading existing links

Considering:

9880 MWh

0.544 kgCO₂/kWh

Produced in 2010

UK electricity carbon footprint

Future developments – II

- ❑ 2009, SGi: Current limit constraints
- ❑ 2011, DLR: Temperature limit constraints
- ❑ In progress:
 - SGv: Voltage limit constraint management
 - ❑ Manage NNFG output, Regulate transformer tap changers, Manage reactive compensation devices
 - DSE: Distribution State Estimation
 - ❑ Enhanced Orkney network visibility
 - ESS: Energy Storage System
- ❑ Similar ANM schemes considered by DNOs and TSOs



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References

R Currie, D MacLeman, G McLorn, R Sims "Operating the Orkney Smart Grid: Practical Experience"

Also in Cired 2011:

R Currie, et al., "Commercial Arrangements to Facilitate Active Network Management";
W Kong, et al., "Improving state estimation accuracy for active network management using advanced modelling techniques"

A Michiorri, et al., "Dynamic Line Ratings Deployment on the Orkney Smart Grid"

C Marantes, et al., "Low Carbon London: A Learning Journey"



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Thank you for your attention

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