Solutions to Enable and Improve Access for Small-Scale Generation

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All Energy, Aberdeen, May 2010

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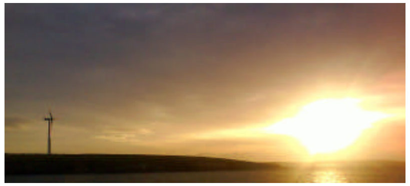

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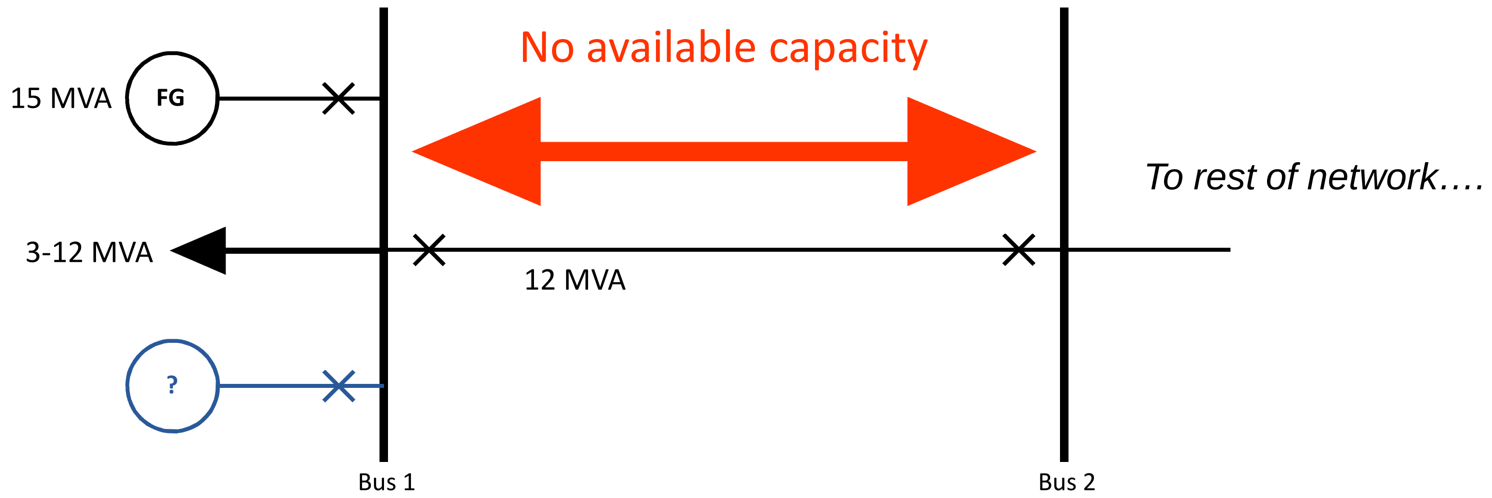
Smarter Grid Solutions Ltd

- Established Summer 2008
- 15 staff plus supplementary resources
- Develop Active Network Management solutions to overcome grid constraints
- Power System Analysis Consultancy
- Implement hardware and software solutions:
  - Power flow management
  - Voltage management
  - Real-time ratings
  - Smart Grid Interfaces, e.g. energy storage
- "Best New Business" and "Best Renewable Innovation" awards at the Scottish Green Energy Awards, 2009
- www.smartergridsolutions.com

Active Network Management

Network perspective – today:

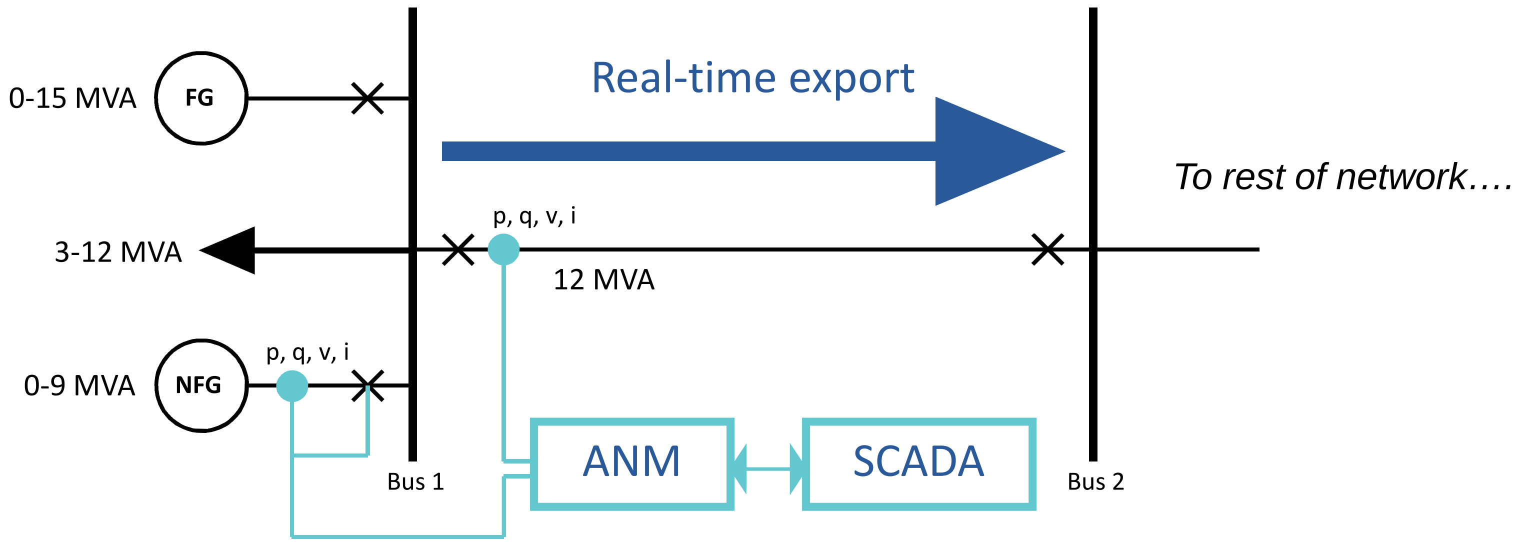
- Multiple generator applications but no capacity available due to network constraints
- Some diversity assumptions made regarding renewables
- Network operator focuses on conventional connection solutions
- Lengthy timescales for network reinforcement



Active Network Management

Network perspective – tomorrow:

- ANM system measures real-time network export
- Pre-emptive action to stay within limits (regulate NFG MW in real-time)
- Takes corrective action if necessary (disconnect NFG)
- Voltage at bus 1 and bus 2 must be within statutory limits in all scenarios



How to connect renewable energy sources to constrained networks?

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- Uncertainty regarding grid connections is a problem
    - For both the developer and network operator
- Existing planning standards do not consider smart alternatives
- Cost and time associated with reinforcements
- Network operators have limited internal resources
- Existing skill-sets driven by regulatory environment
- Some smart grid technologies offer an alternative to reinforcement
- Cost-benefit of smart grid technologies is an issue
- How to manage risks associated with new technology adoption?

How to Connect Renewables Quickly and Economically to Constrained Networks?

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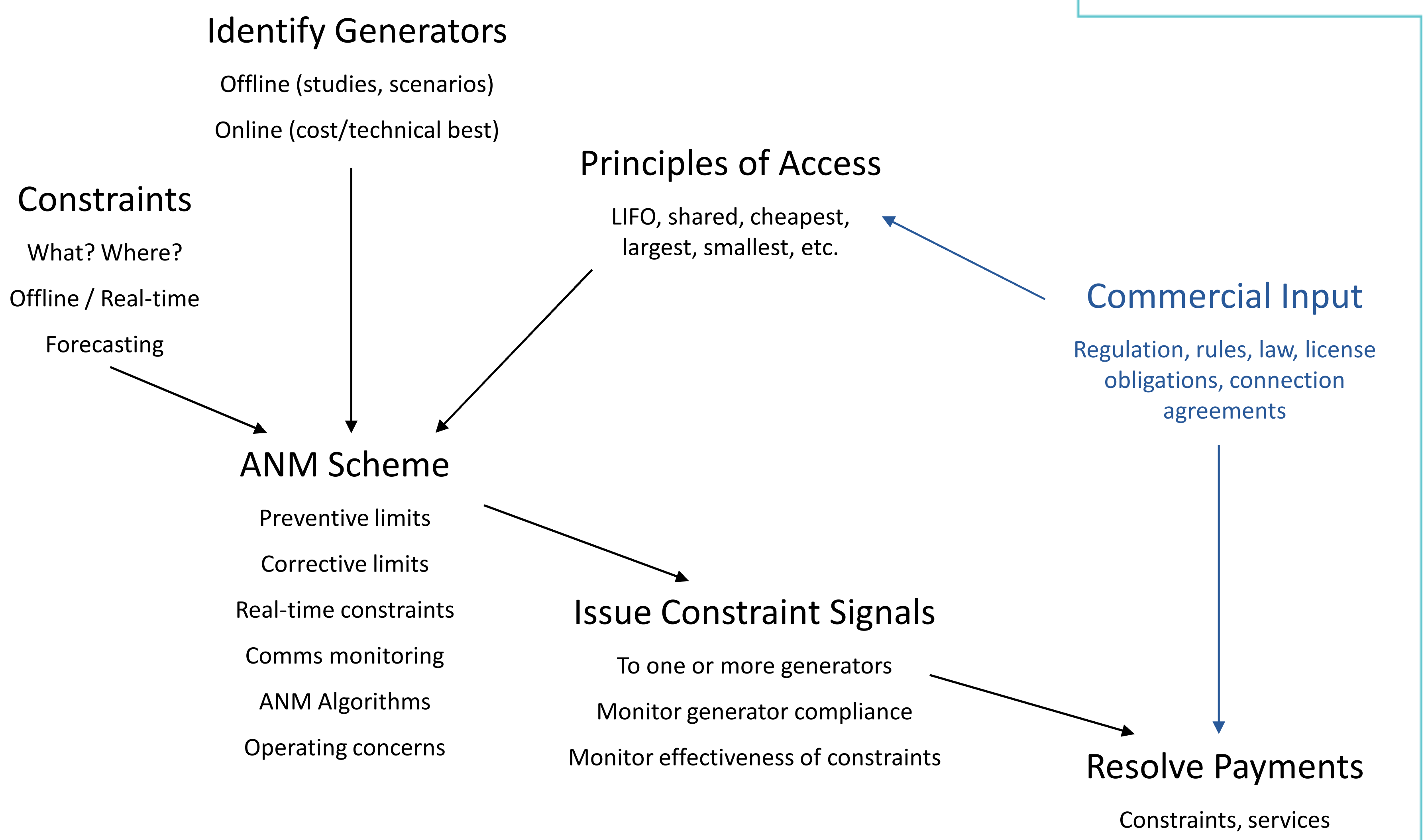
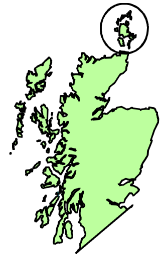
- Need to reinforce **or** implement constraint management?
- Impacts on planning and operation
- Cost-benefit studies?
- Security standards?
- No real-time automatic constraint management systems available off-the-shelf?
- What about the commercial arrangements?
    - Recent developments in the UK - ‘Connect and Manage’
- Active Network Management (ANM) can be deployed
- ANM forms one component of future smart grids

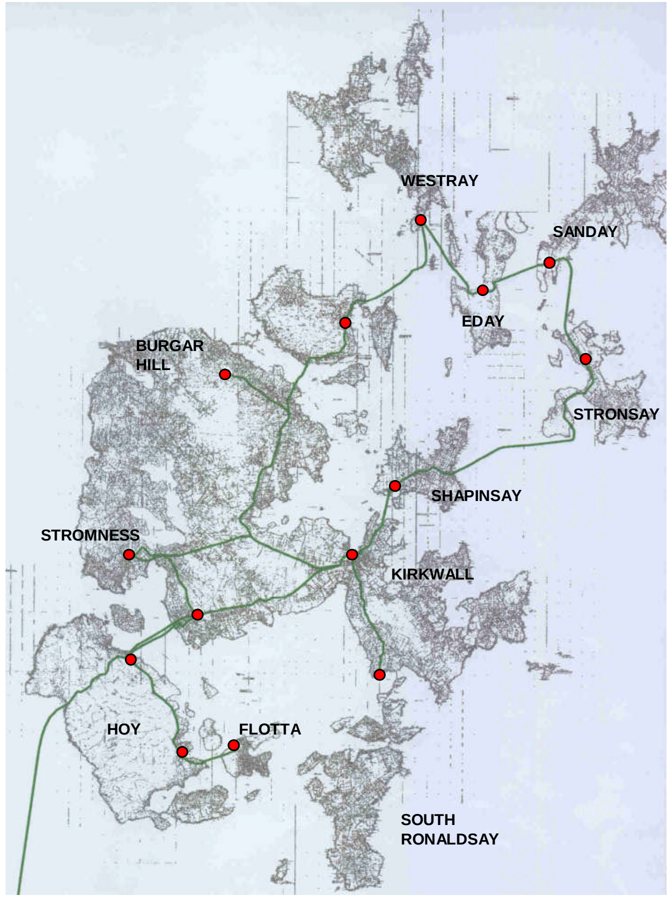
High-Level Constraint Management



The Orkney Situation



- 6 miles off North-Scotland
- 11,500 customers
- Min/Max demand: 8/31MW
- 33kV submarine cables: 2 x 20MW import/export
- Gas, wave, wind and tidal generator capacity allocated
- No capacity exists for further generator connections, according to established practice
- Long lead times for new capacity
- Multiple applications for grid connection from renewable developers



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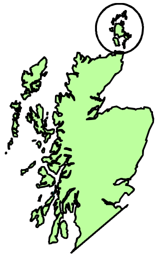
Renewable Energy on Orkney



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Wind Farm at Burgar Hill, Orkney

Tidal device test facility at the Fall of Warness, Orkney

Wave Device test facility at Billia Croo, Orkney

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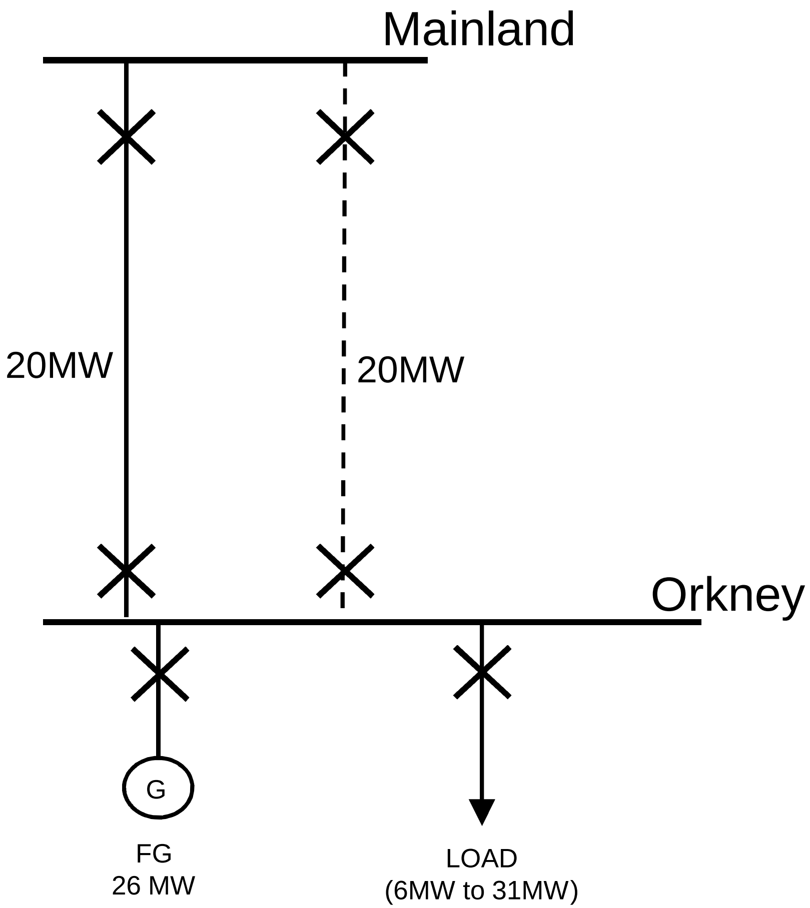
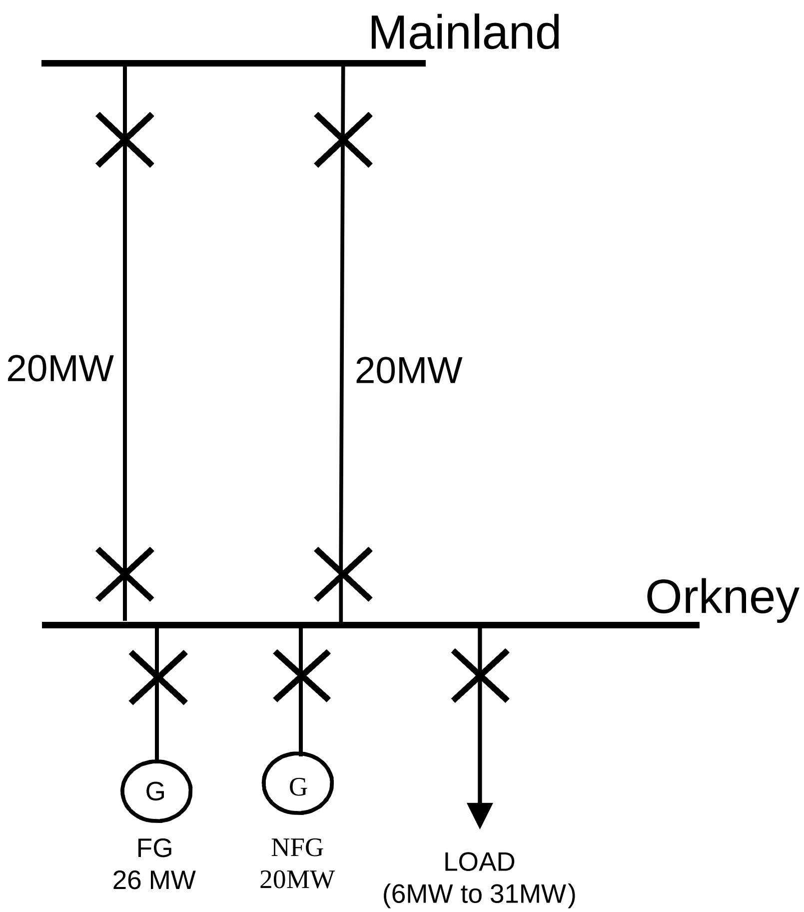
Existing Generator Capacity on Orkney



FG = (N-1 circuit capacity) + (local minimum load)

FG = 20+6 = 26MW

Post-Fault Intertrip to connect more DG

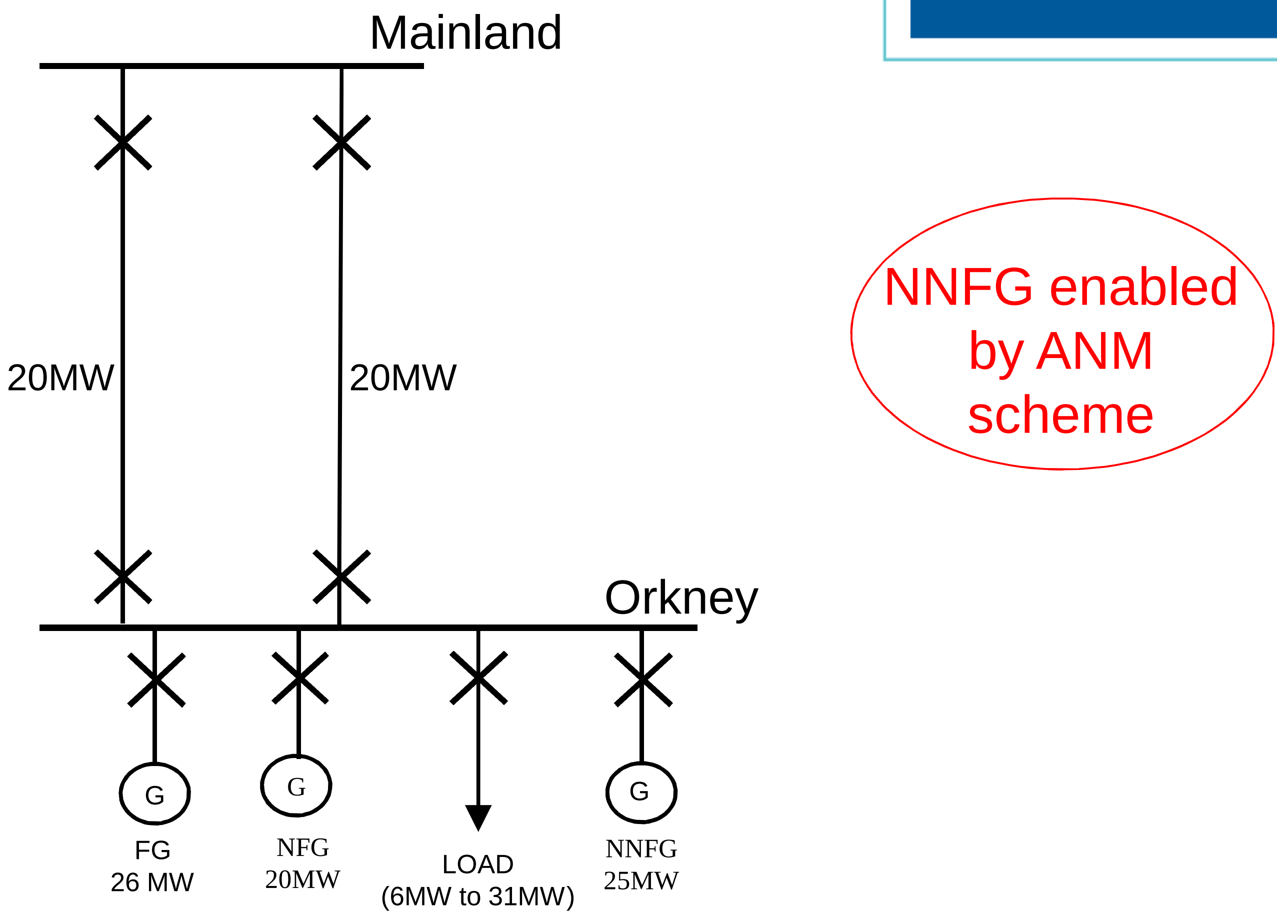


Intertrip NFG for N-1 contingency

NFG = Capacity of circuits + local minimum load - FG

NFG = 20+20+6–26 = 20MW

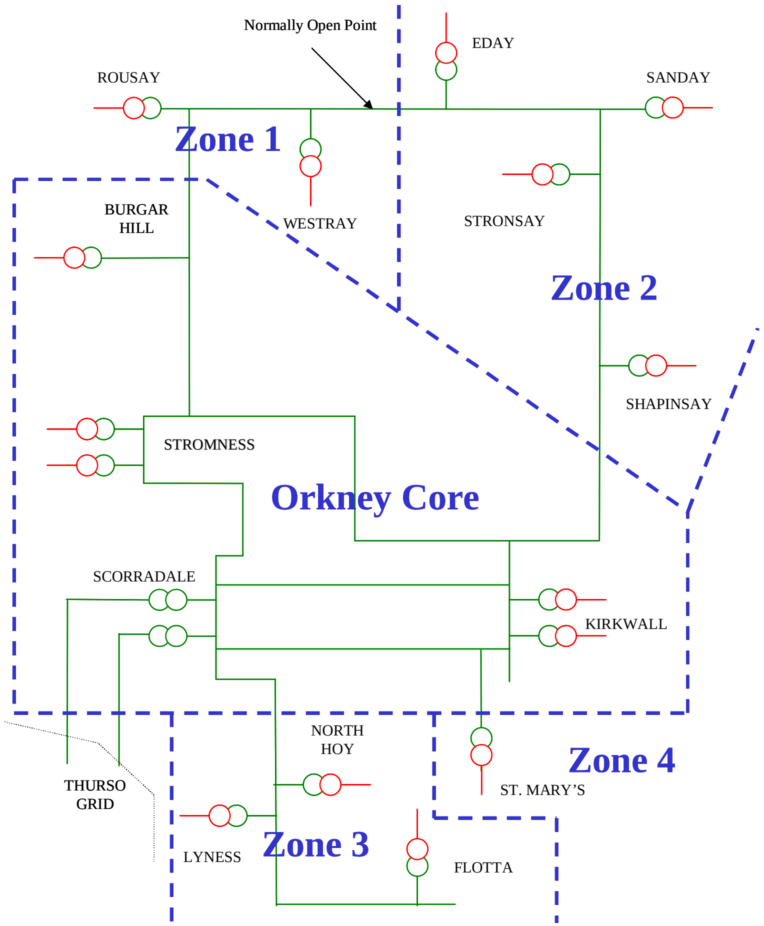
Real-time Control to Enable Further DG



NNFG = Capacity of circuits + local maximum load – FG – NFG

NNFG = 20+20+31-26-20 = 25MW

The Orkney ANM Deployment



Picture Courtesy of SSEPD/University of Strathclyde

- Collaboration between University of Strathclyde and SSE
- SSE Planners and Control Room involved from beginning
- **NEW** connections only
- Multiple generators and constraints
- Real time ANM
- Nested control zones
- Existing connections unaffected
- Last In First Out (LIFO) approach
- Alternative to reinforcement

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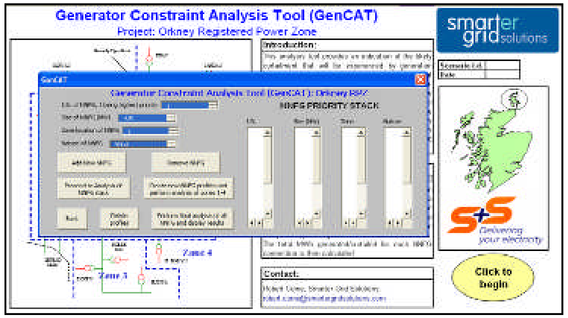
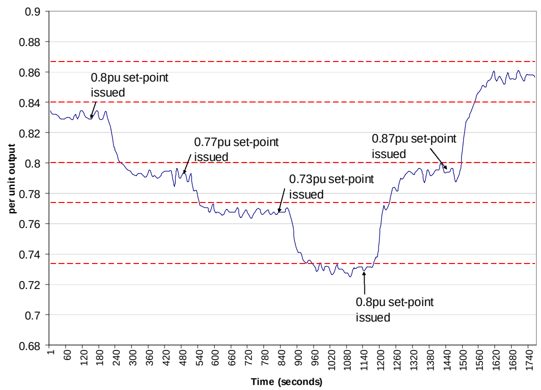
Case Study - Orkney

- Around 15 MW of new capacity, made up of >10 generators
- Operational November 2009
- ‘Curtailment Assessments’ issued
- New commercial arrangements implemented
- Solution tailored to meet host DNO requirements
- SCADA interface
- Simulator, manuals and training seminars
- Flexible/Interoperable/Scalable





Case Study – Orkney

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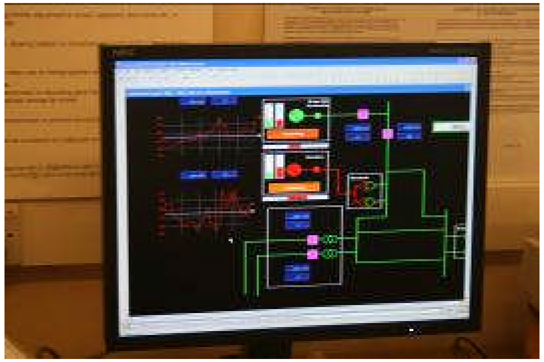
- 2 wind generators connected late 2009
- Around 10 further generator connections in 2010 and beyond
- Radio and private wire communications implemented
- New and existing monitoring
- Platform for further smart grid developments
  - Real-time ratings
  - Energy storage systems
  - Restoration & reconfiguration
  - Voltage management



Overview of Deployed Orkney Smart Grid Architecture

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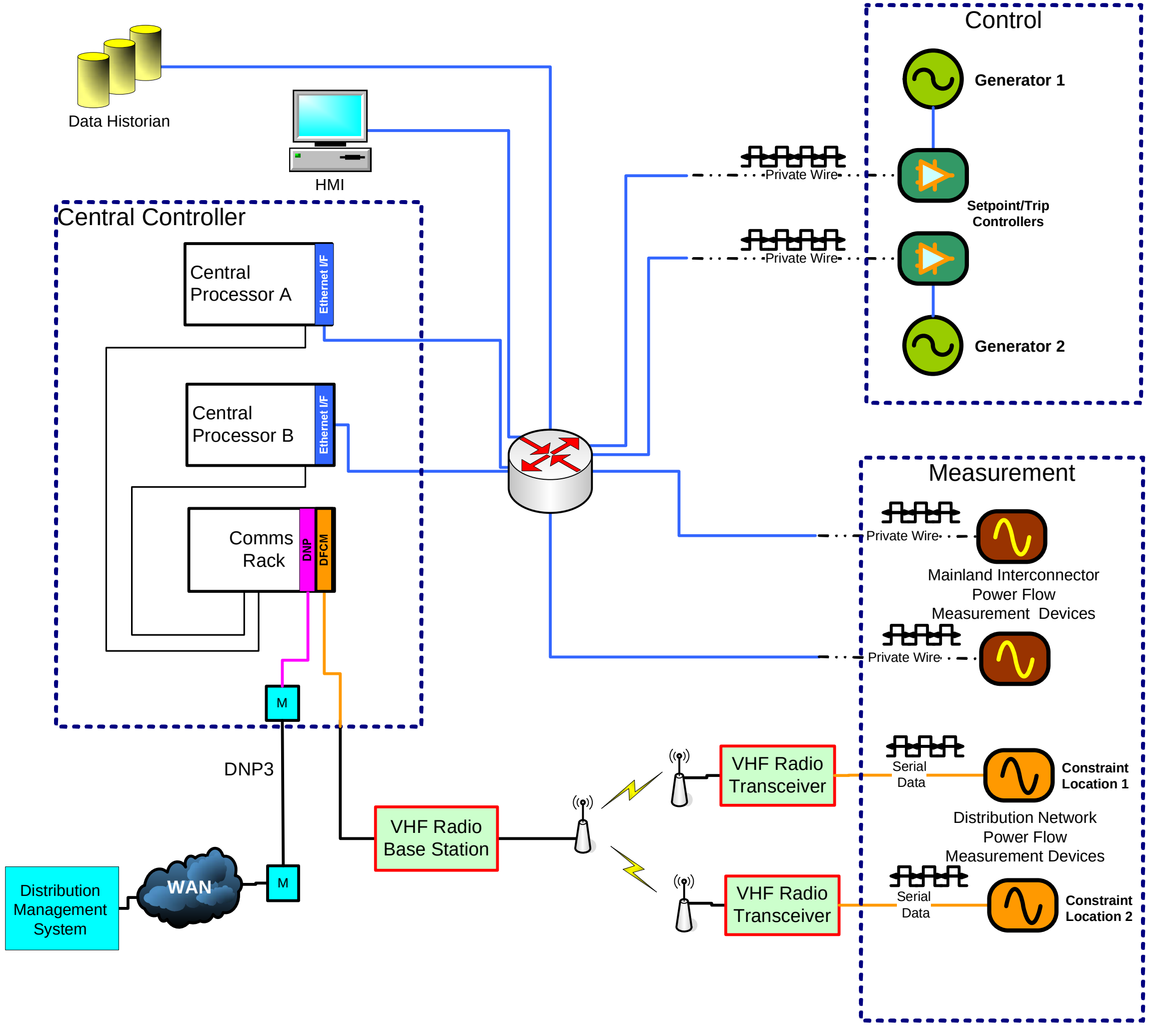

- **Central ANM Controller**

  Receives all measurements, performs calculations, manages communications and interfaces to SCADA

- **Measurement Controller**

  Collects current, power flow, circuit breaker status, etc and passes to the Central ANM Controller

- **Generator Controller**

  Receives generator set-points from the Central ANM Controller and passes them to the generator control system, monitors generator compliance and communications links

Summary

- There is a pressing need to connect renewable generators to congested networks
- Smart Grid technology can provide an alternative or intermediary solution to network reinforcement
- >10 new generator connections to the existing Orkney distribution network
- ANM applicable for different networks and voltage levels
- New commercial arrangements required
- Clear cost-benefit of ANM technology
- Evolving ANM to incorporate other technologies…

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University of Strathclyde Glasgow