



# Brief Overview of Smart Grid Research at Strathclyde



## Core disciplines

### Institute Capacity

- 24 +6 Academic Staff
- 40 Research Staff
- 140 Research Students
- 18 Tech/Admin Staff
  
- Currently recruiting 6 new academics in Smart Grid and Wind Energy areas
  
- Research portfolio: £40m



- Power System Analysis
- Power System Simulation
- Power System Economics
- Energy Markets
- Active Network Management
- Machines & Power Electronics
- Control, Protection & Monitoring
- Wind Energy Systems
- Renewables
- Dielectric Materials/Pulsed Power
- HV Technology/UHF Diagnostics
- Energy System Modelling





# Smart Grid/Network Projects

- We have the largest number of EPSRC Supergen Programmes in the UK:
  - Supergen I – Future Network Technologies (financial hub)
  - Supergen III – Highly Distributed Power Systems (management hub)
  - Supergen III – Energy Storage (management hub)
  - Supergen V – Wind Energy Technologies (management hub)
  - Supergen V – AMPerES - Condition Monitoring (partner)
  - Supergen I Renewal – FlexNet (financial hub)
  - Supergen III Renewal – HiDEF (management & financial hub)
  - Supergen III Renewal - Energy Storage
  - Supergen V Renewal - Wind Energy Technologies
  - **Supergen Energy Networks Hub – Strathclyde is leading Smart Grid activities for the UK**
  - **Supergen Energy Networks Grand Challenge – The Autonomic Power System** (lead)
  - **Supergen Energy Networks Grand Challenge – Transformation of the Top and Tail of Energy Networks**

*Programmes worth ~£39M of which ~£10M to Strathclyde*

- Power Network Demonstration Centre - 11kV physical system for advanced network management and novel device demonstration - £12.5M+
- NINES – Northern Isles New Energy System – SSE

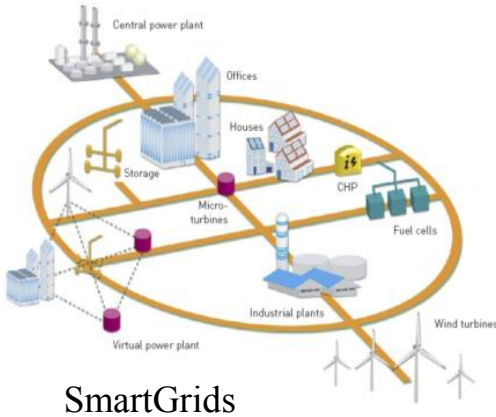


## Smart Grid/Network Activities (selected examples)

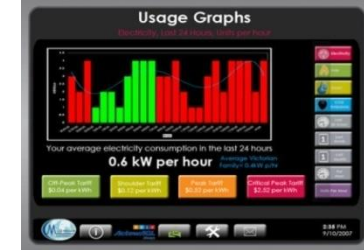
- Several other EPSRC programmes including
  - E.ON/EPSRC Transitions Consortium (partner)
- Renewable and distributed generation integration (constraint management, optimisation – EPSRC FlexNet & HiDEF projects and Rolls-Royce University Technology Centre)
- Electric Vehicles (vehicle technology, G2V and V2G - E.On projects)
- Energy Storage (technology, system integration, DER facilitation – Scottish & Southern Energy Shetland project)
- Physical demonstration (laboratory to field – Orkney RPZ project and Power Network Demonstration Centre)
- Demand side and Smart metering (ScottishPower-EDR project, Home Automation, DSM laboratory)
- HVDC and offshore grids (EU FP7 Downvind, EU FP7 Twenties, Energy Technologies Institute)



# Power Network Demonstration Centre



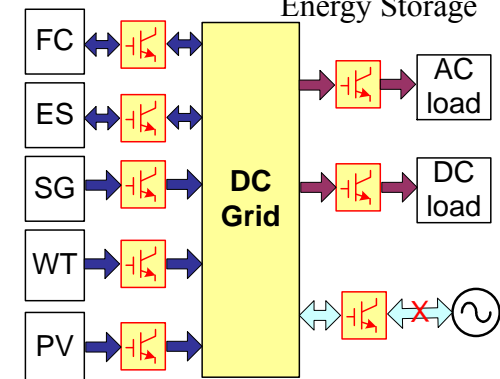
## Smart Meters & DSM



## Distributed Generation



## Fuel Cells & Energy Storage



Public/private collaboration of £12.5M+

- Building of around 1300m<sup>2</sup> including control room and working areas for project teams
- Typical network components laid out to represent actual network topographies
- Gen-set to provide ability to run 'off-grid'
- Capacity for connection of equipment on test
- Network simulator to assess complex systems and act as a proving ground for ANM
- Innovative Tier 1 / Tier 2 industrial membership
- Accelerated integrated systems testing supporting faster deployment

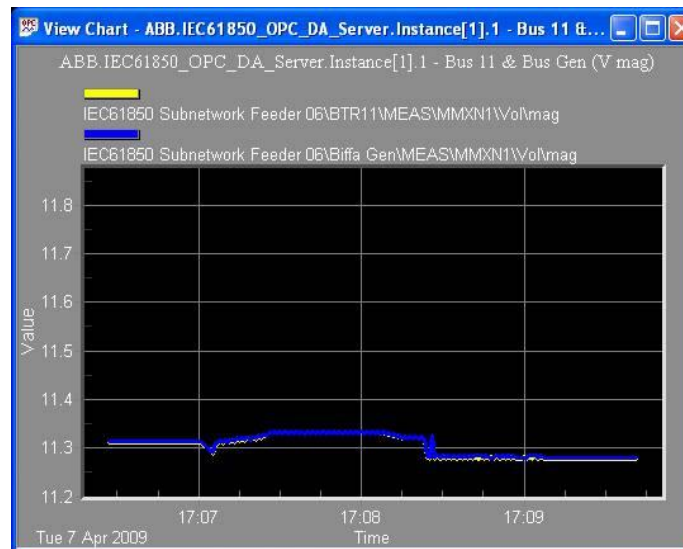
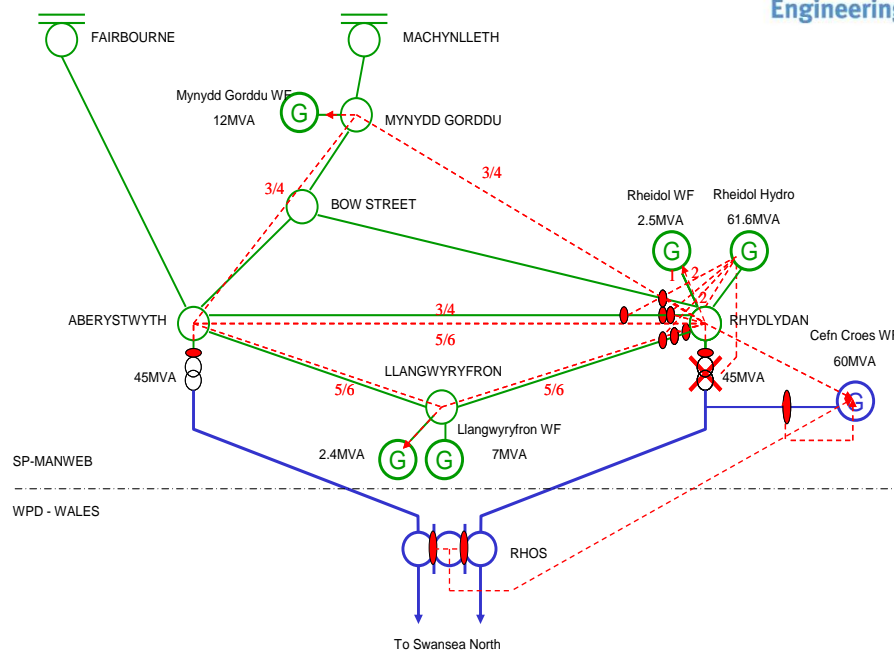
# Aura-NMS project

Autonomous Regional Active Network Management System (Aura-NMS) project with ABB, Scottish Power, EdF-Energy – moving towards demonstration

Novel network management approaches being deployed on ABB COM600 computer – lab concept demonstration in 2008

## Different algorithms tested:

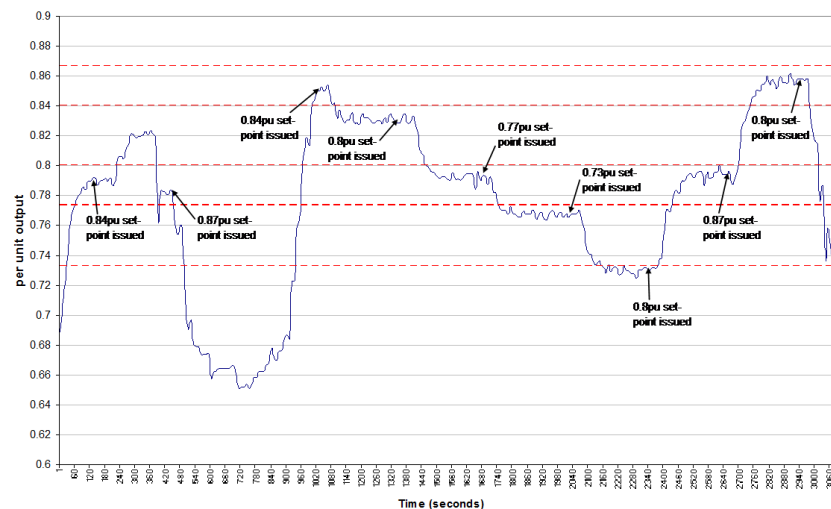
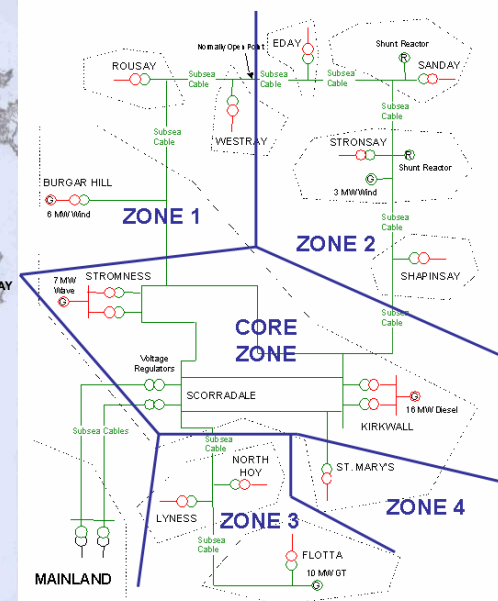
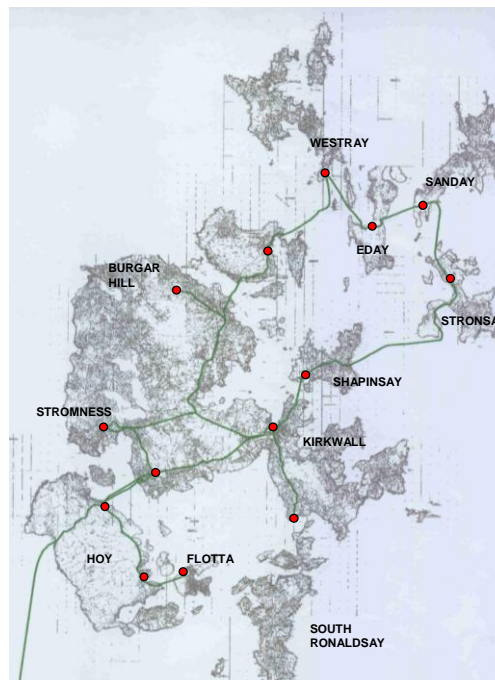
- Constraint satisfaction for thermal and voltage constraint management
- OPF for thermal constraint management
- Current tracing for thermal constraint management





# Orkney ANM project

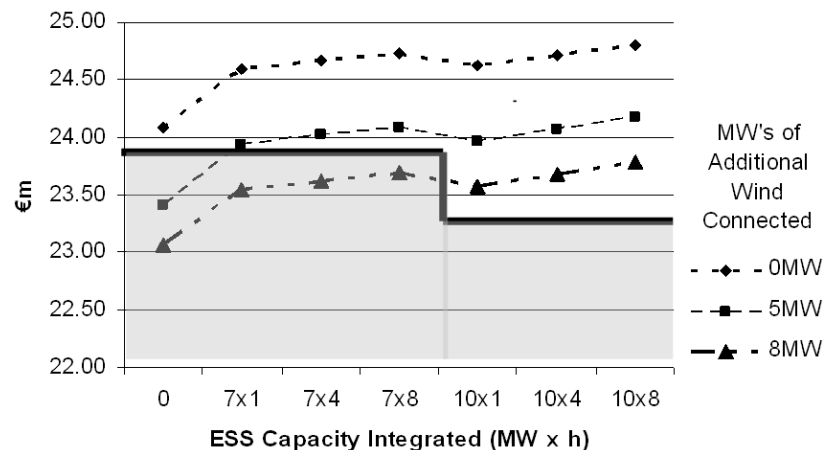
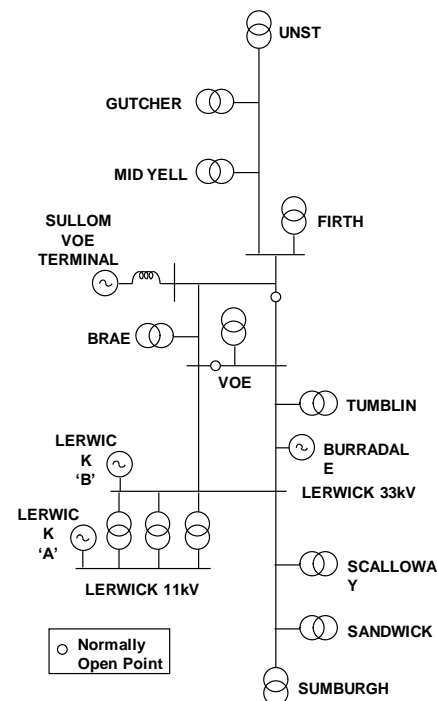
- Zonal approach to Active Power Flow management
- Each zone has a thermal limitation on generation output at any given time
- Whole system has a further thermal limit on generation output
- Real time control of wind and marine generating units based on measurements and control logic
- Technology being taken forward by university spin-out company:





# Shetland Energy Storage project

- Different energy storage roles considered:
  - Wind energy capture
  - Voltage support
  - Reserve/response
- Mix of generation technologies:
  - Wind power
  - Gas turbines
  - Diesel engines
- VRB and NaS battery technologies considered to support system and enhance wind connection potential

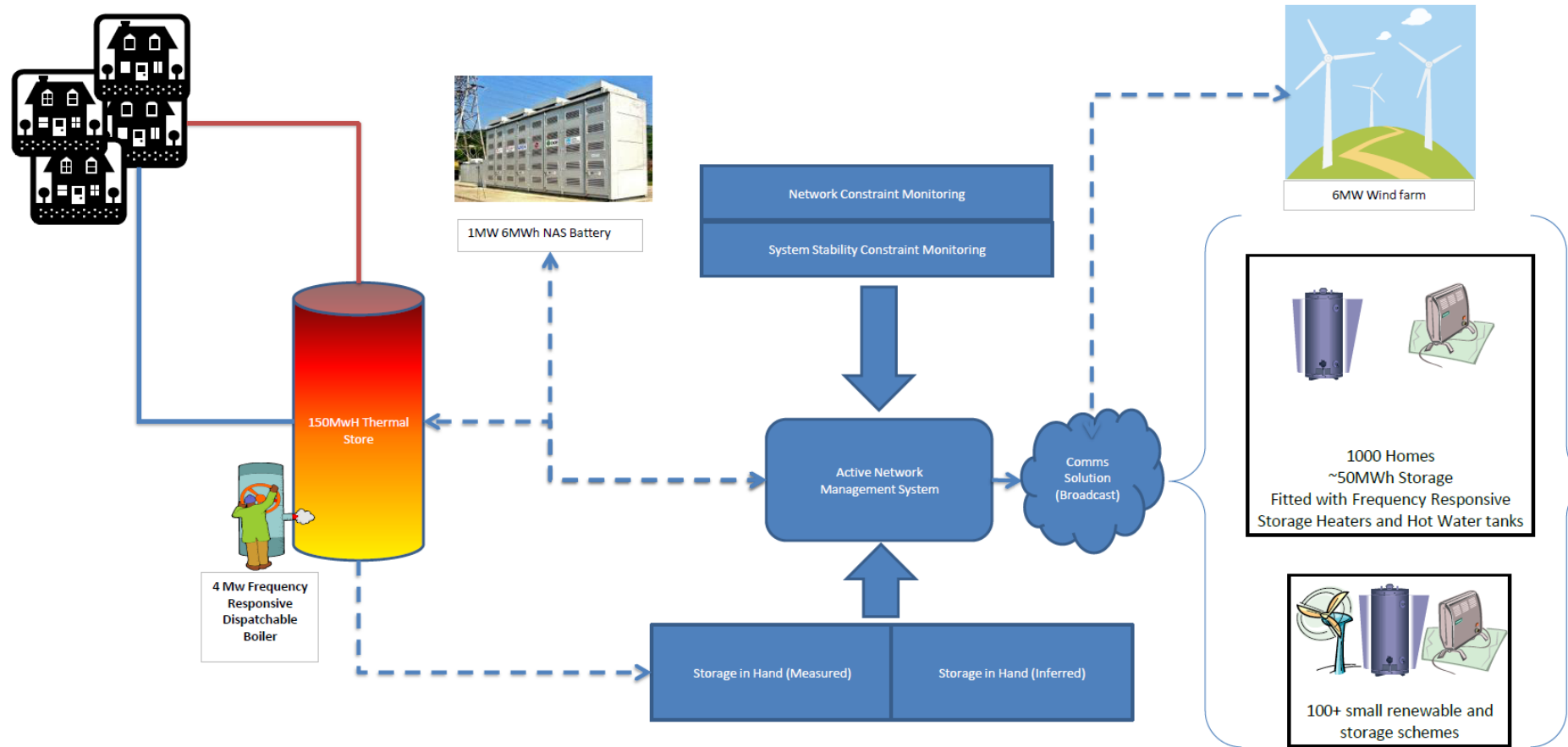






# NINES project

## NINES Project Simplified architecture



# Electric Vehicles Grid Integration

- Statistical model of domestic car use has been constructed
- Privately owned cars are utilised only **5.2%** of time of transportation, thus they are available up to **94.8%** of time as responsive load or provide secondary function, V2G or G2V
- Statistical model of electric vehicle use now possible
- Integration with network management schemes

