Active Distribution Management Demonstrations in the UK

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CIRED 2009, Prague

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- Conclusions

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Smarter Grid Solutions Ltd

- Helping generators connect and DNOs meet their obligations quicker and cheaper
- Leading edge provider of products, services and consultancy
- An innovative solution provider developing active network management solutions to overcome grid constraints
- World-leading control solutions to release and maximise latent network capacity

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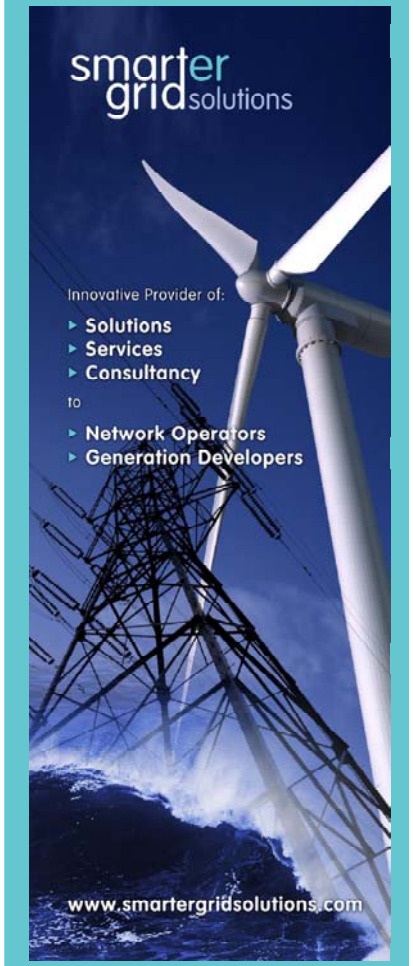


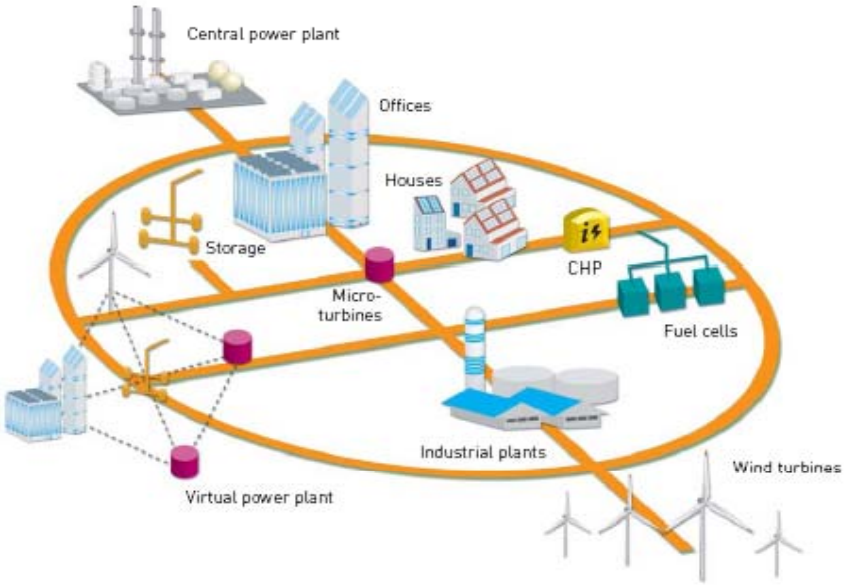
Scottish Enterprise

Scottish and Southern Energy plc

University of Strathclyde Glasgow

What is a Smart Grid?

- A highly inter-connected electricity network where the boundaries between generation, transmission and distribution are blurred?
- An electricity network that takes advantage of technological innovations to increase performance?
- An energy delivery platform to support reduced carbon emissions?
- An electricity network where advanced metering, monitoring and control takes place?



Source: European SmartGrids Technology Platform 2006, a report by the European Commission

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What is a SmartGrid?

- A SmartGrid is an electricity network that can intelligently integrate the actions of all users connected to it - generators, consumers and those that do both – in order to efficiently deliver sustainable, economic and secure electricity supplies.

- A SmartGrid employs innovative products and services together with intelligent monitoring, control, communication, and self-healing technologies to:

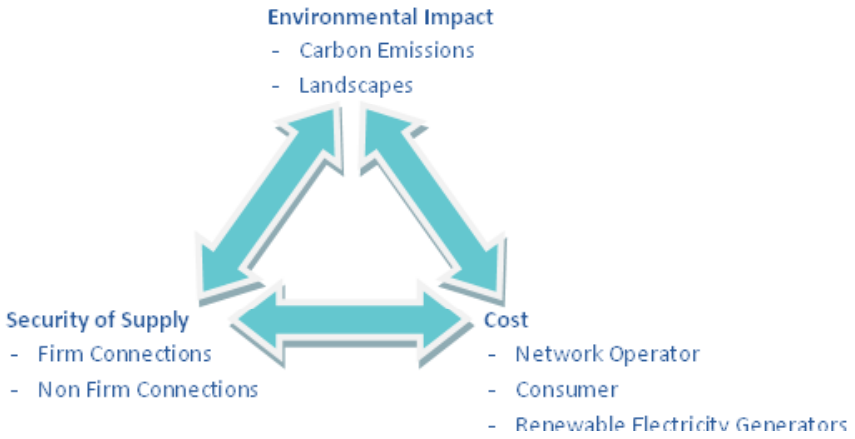
  - better facilitate the connection and operation of generators of all sizes and technologies;
  - allow consumers to play a part in optimising the operation of the system;
  - provide consumers with greater information and choice of supply;
  - significantly reduce the environmental impact of the whole electricity supply system;
  - deliver enhanced levels of reliability and security of supply.

Source: European SmartGrids Technology Platform 2006, Strategic Deployment Document

SmartGrid Challenges

- **Strengthening the grid -** ensuring that there is sufficient transmission capacity to interconnect energy resources, especially renewable resources;
- **Moving offshore -** developing the most efficient connections for offshore generation;
- **Developing decentralized architectures –** enabling smaller scale electricity supply systems to operate harmoniously with the total system;
- **Communications –** delivering the communications infrastructure to allow potentially millions of parties to operate and trade in the single market;
- **Active demand side –** enabling all consumers, with or without their own generation, to play an active role in the operation of the system;
- **Integrating intermittent generation –** finding the best ways of integrating intermittent generation;
- **Enhanced intelligence** of generation, demand and most notably in the grid;
- **Capturing the benefits of DG and storage**;
- **Preparing for electric vehicles**

How to perceive the costs the consumer will be exposed to?



Source: European SmartGrids Technology Platform 2006, Strategic Deployment Document

SmartGrid Deployment Priorities?

- Deployment Priority #1: Optimizing Grid Operation and Use
- Deployment Priority #2: Optimizing Grid Infrastructure
- Deployment Priority #3: Integrating Large Scale Intermittent Generation
- Deployment Priority #4: Information & Communication Technology
- Deployment Priority #5: Active Distribution Networks
- Deployment Priority #6: New Market Places, Users & Energy Efficiency

From EU SmartGrids Strategic Deployment Document

What is a Smarter Grid?

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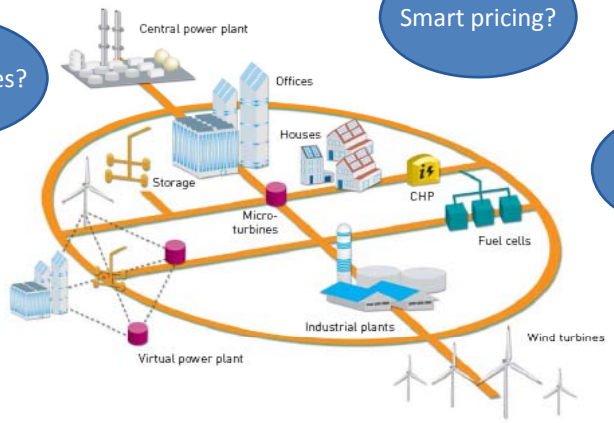
Smart pricing?

Smart homes?

Autonomy?

Smart asset management?



Source: European SmartGrids Technology Platform 2006, a report by the European Commission

2030

Becoming smarter?

Now

Multi-cell solutions

Supporting development of single cell solutions towards managing multiple constraints

Implications of adoption for wider network control and SCADA

Single cell solution

Multiple schemes

Commercial issues

Control room interaction

Single cell solutions

Getting more out of the existing grid

Improving reliability and information

Adopting single cell solutions as business as usual

Power flow management

Voltage control

Distribution Automation

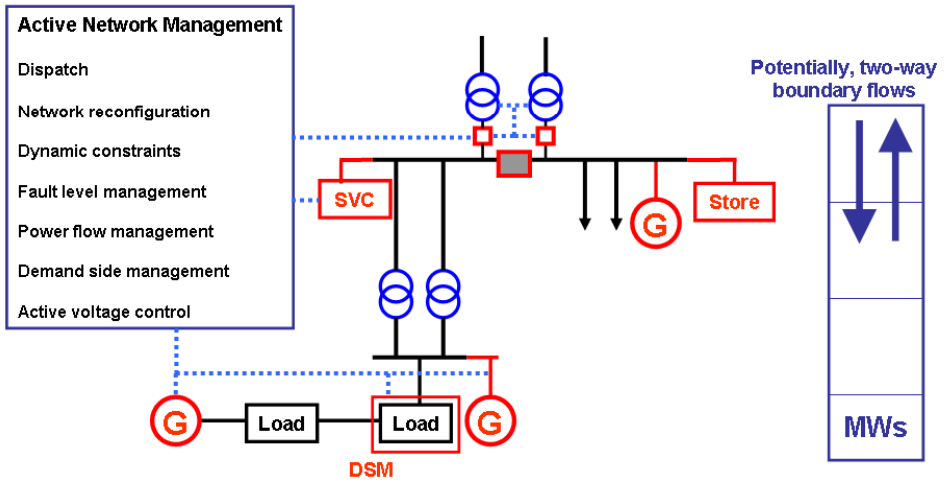
Dynamic line ratings

Energy storage systems

Smart Meters

Active Network Management

- No generally accepted definition
- Most in agreement as to characteristics of an active network…..
  - *DG, renewables, monitoring, comms and control, preventive and corrective actions, flexible, adaptable, autonomous? Intelligent?*
- Aspects of ANM in many international programmes (SmartGrids, Intelligrid…etc)

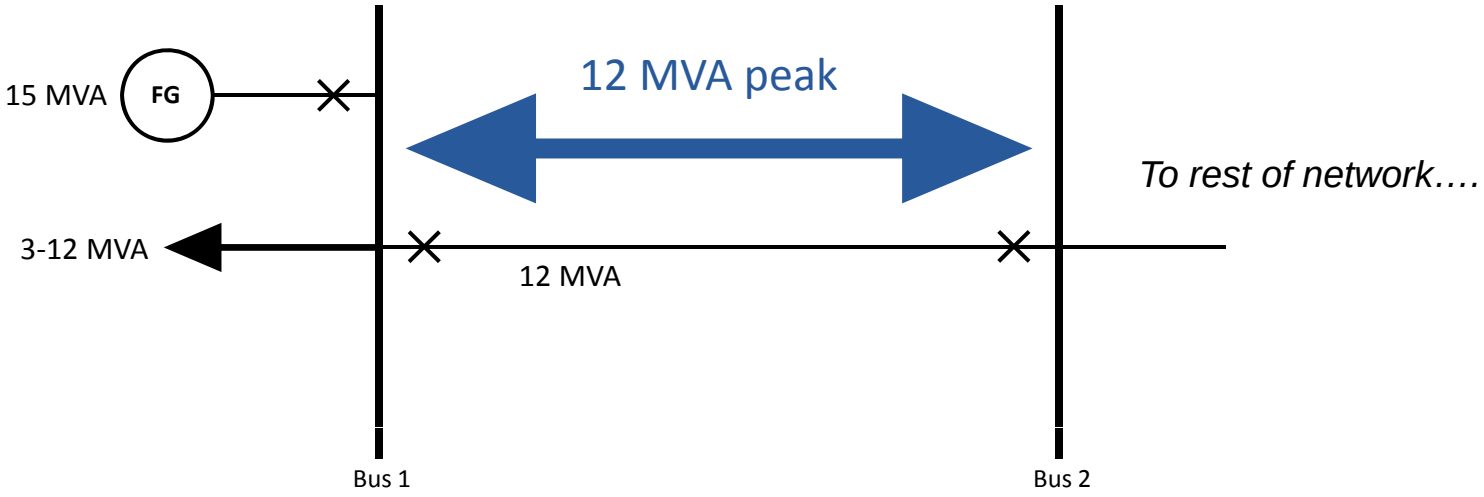


Source: Ofgem

Active Network Management

Traditional distribution network perspective – yesterday:

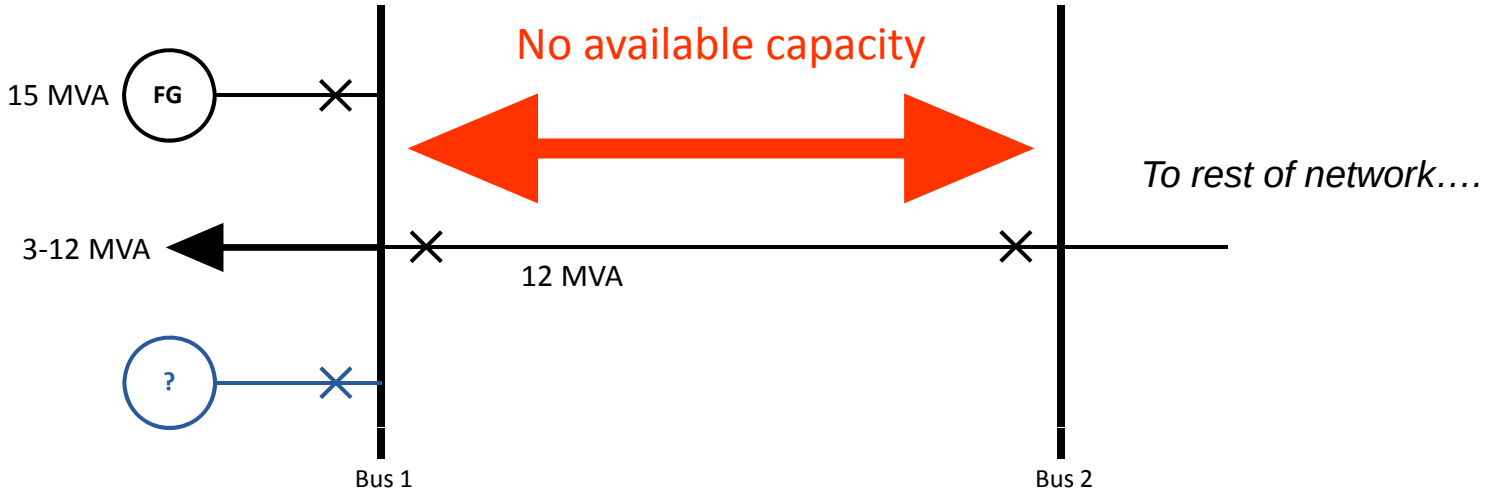
- Firm Generation (FG) capacity allocated (some diversity considered)
- Passive system operation preserved
- Worst case scenario for network – Min Load Max Gen
- Voltage at bus 1 and bus 2 are within statutory limits in all scenarios



Active Network Management

Distribution network perspective – today:

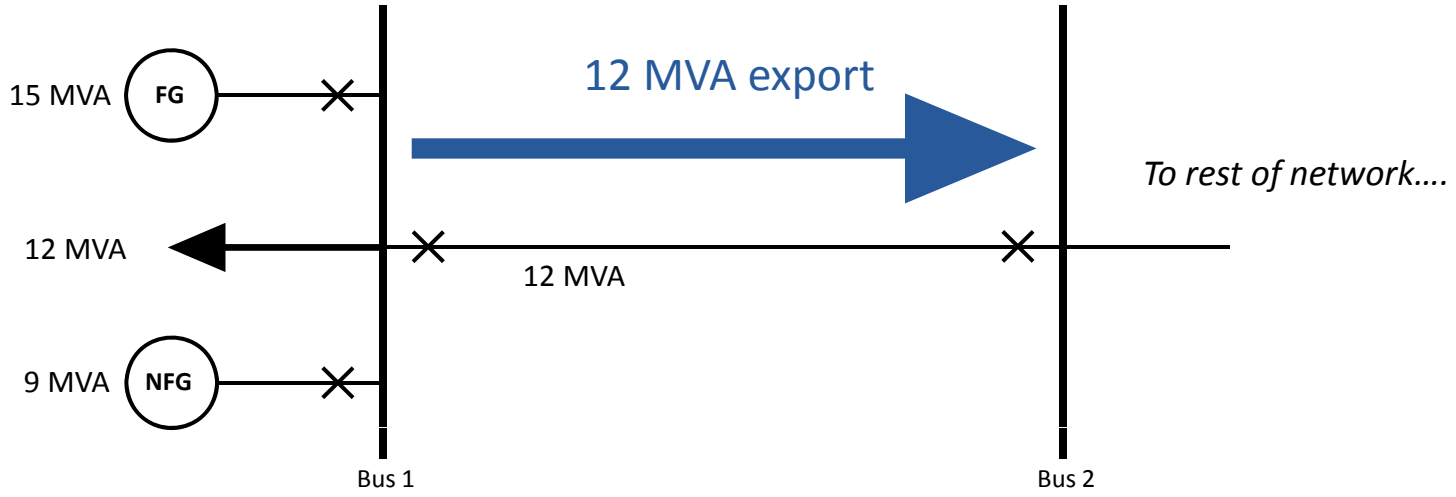
- Multiple applications for connection to existing network
- No capacity available due to network constraints
- No means for network operator to consider other connection solutions
- Lengthy timescales for network reinforcement



Active Network Management

Distribution network perspective – tomorrow (Summer 2009):

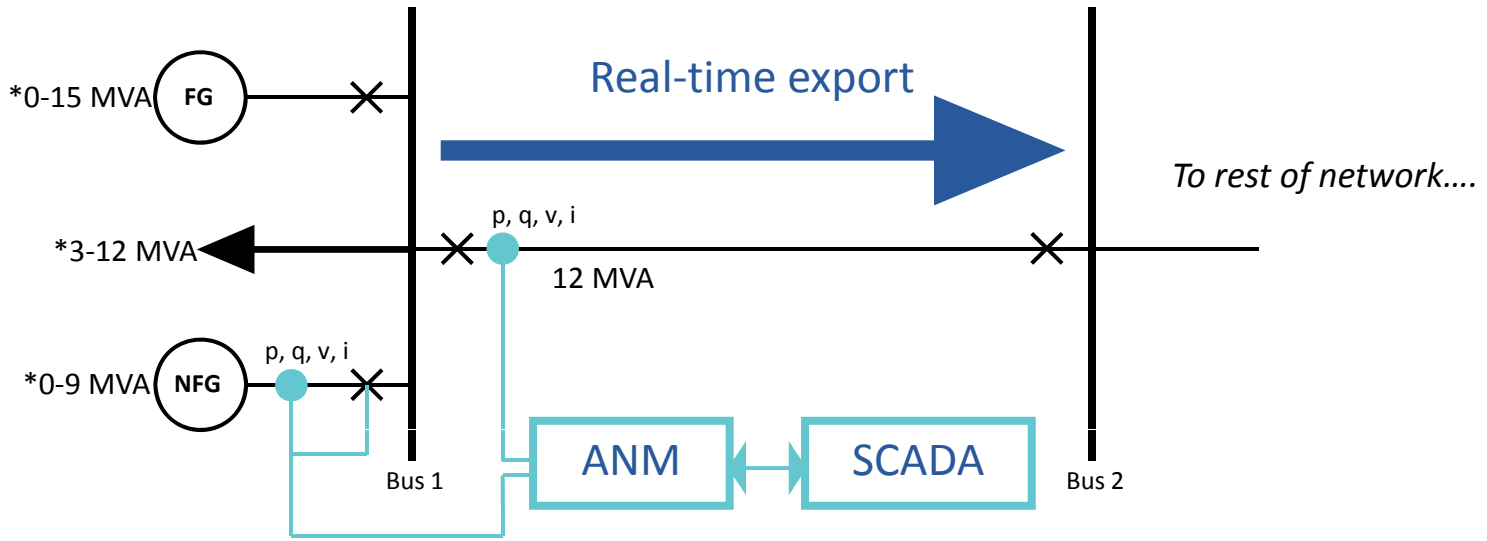
- Consider peak demand scenario (12 MVA)
- Non-Firm Generation (NFG) capacity of 9 MVA (theoretical) exists
- NFG must be controlled in real-time based on 12 MVA circuit constraints
- Voltage at bus 1 and bus 2 must be within statutory limits in all scenarios



Active Network Management

Distribution network perspective – tomorrow (Summer 2009):

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



ANM Deployment Register

1st ANM Review (2006) focusing on Research, Development and Demonstration:

- Supported by the Distribution Working Group 'Active Network Management' project
- Funded by Department of Trade and Industry

2nd Review (2008) focusing on Deployment:

- Update on 1st review in research, development and demonstration activities
- Supported by the Distribution Working Group 'Active Network Management' project
- Funded by E.On Central Networks (project budget < £10k)

3rd Review (2009) focusing on Deployment:

- Update on 2nd review in research, development and demonstration activities
- Available soon….

Technical Areas in ANM Register

- Active Management Planning
- Communications and Control
- Demand Side Management
- Fault Level Management
- Future Technologies
- Modelling and Analysis
- Power Flow Management
- Power Quality
- Protection Systems
- Storage
- Voltage Control

ANM Deployment Register

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Project ID	Project Title	Lead Organisation	Partner Organisations	Funding Source	Activity Type	Activity Status	Start and completion dates	Country	Classification of technical focus	Summary of Technology/ Activity	Deployment Summary	Impact of Technology/ Activity	Contact details	Report Link (URL)
001	"Embedded Controller" for Active Management of LV Distribution Networks	Econnect ltd	University of Northumbria at Newcastle, VA Tech and T&D UK Ltd and YEDL	DTI Technology Programme: New and Renewable Energy. Contract number: K/EL/00334	Research & Development	Completed	2004 - 2007	UK	Voltage Control, Fault Level Management, Power Flow Management	Modelled and simulated the effect of the connection of small-scale embedded generation to LV Distribution Networks through a range of scenarios. Simulation data used to develop design specifications for "Embedded Controller", leading to the building and testing of a prototype. Project successful in defining design specifications for effective prototype "Embedded Controller", proven through simulation and testing of a lab-based prototype.	-	Has provided design specifications for development of a production prototype Embedded Controller, development of the controllers is outside scope of project.	http://www.econnect.co.uk/	http://www.berr.gov.uk/files/file389 94.pdf
002	Voltage Control Policy Assessment Tool	EATL	Central Networks, EDF Energy, Central Electric, Scottish Power, United Utilities	EATL STP Project	Research & Development	Completed	2004	UK	Voltage Control	Develop effective policies for applying voltage control technologies for enabling increasing connections of small generators. This project is developing a tool for DNOs to assess new approaches and find the best that allows maximum connections at the lowest cost for the developer, customer and DNO.	-	-	http://www.eatechnology.com/	http://www.eatechnology.com/STP_Home.asp
003	Enhancing protection and control systems to maximise benefits	EATL	Central Networks, EDF Energy, Central Electric, Scottish Power, United Utilities	EATL STP Project	Research	Completed	2004	UK	Protection Systems, Communications & Control	Defining best practice management of protection and control systems to enhance future network performance, and provide the ability to manage the risks associated with the connection of DG.	-	-	http://www.eatechnology.com/	http://www.eatechnology.com/STP_Home.asp

http://cimphony.org/anm

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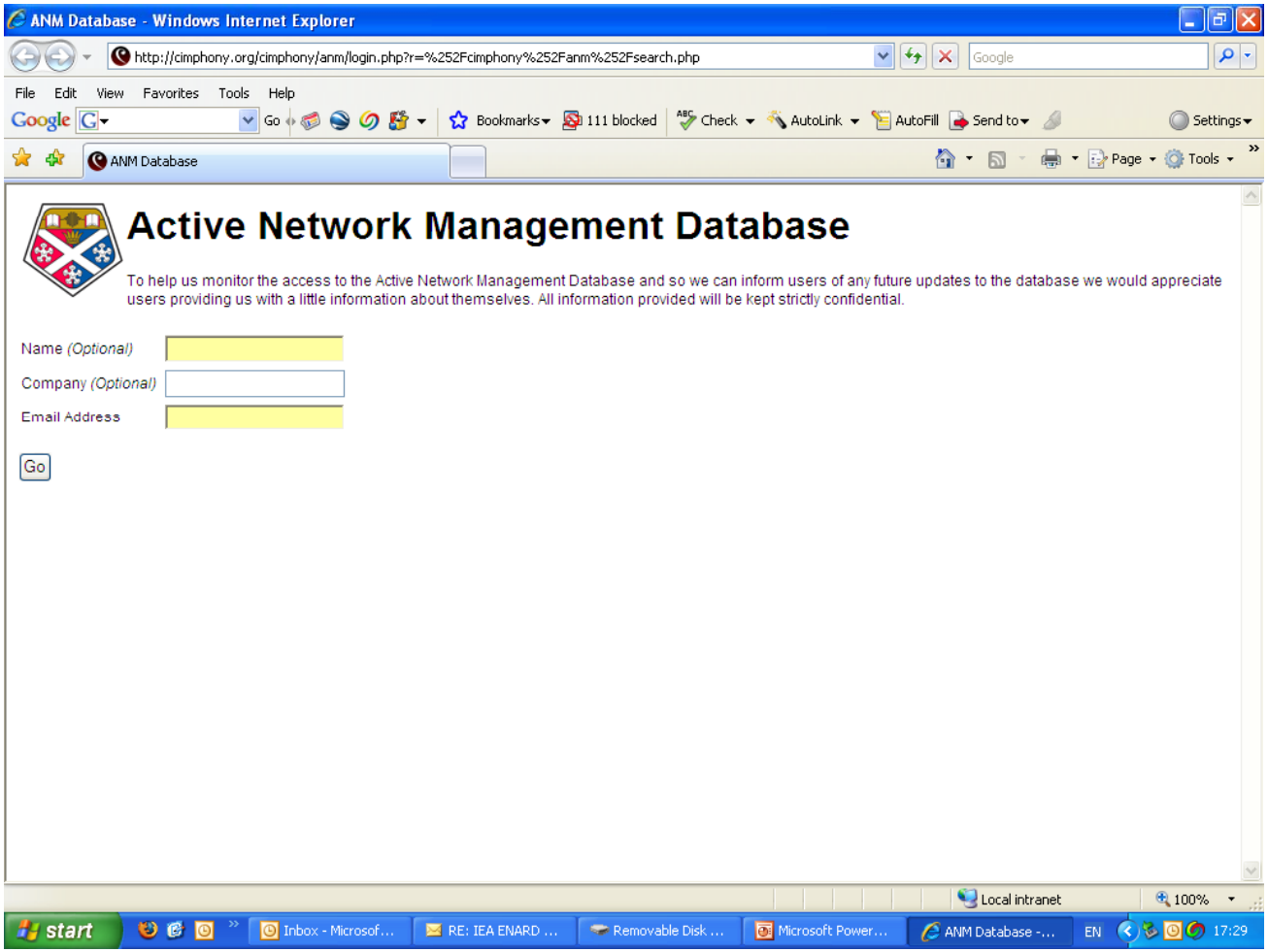

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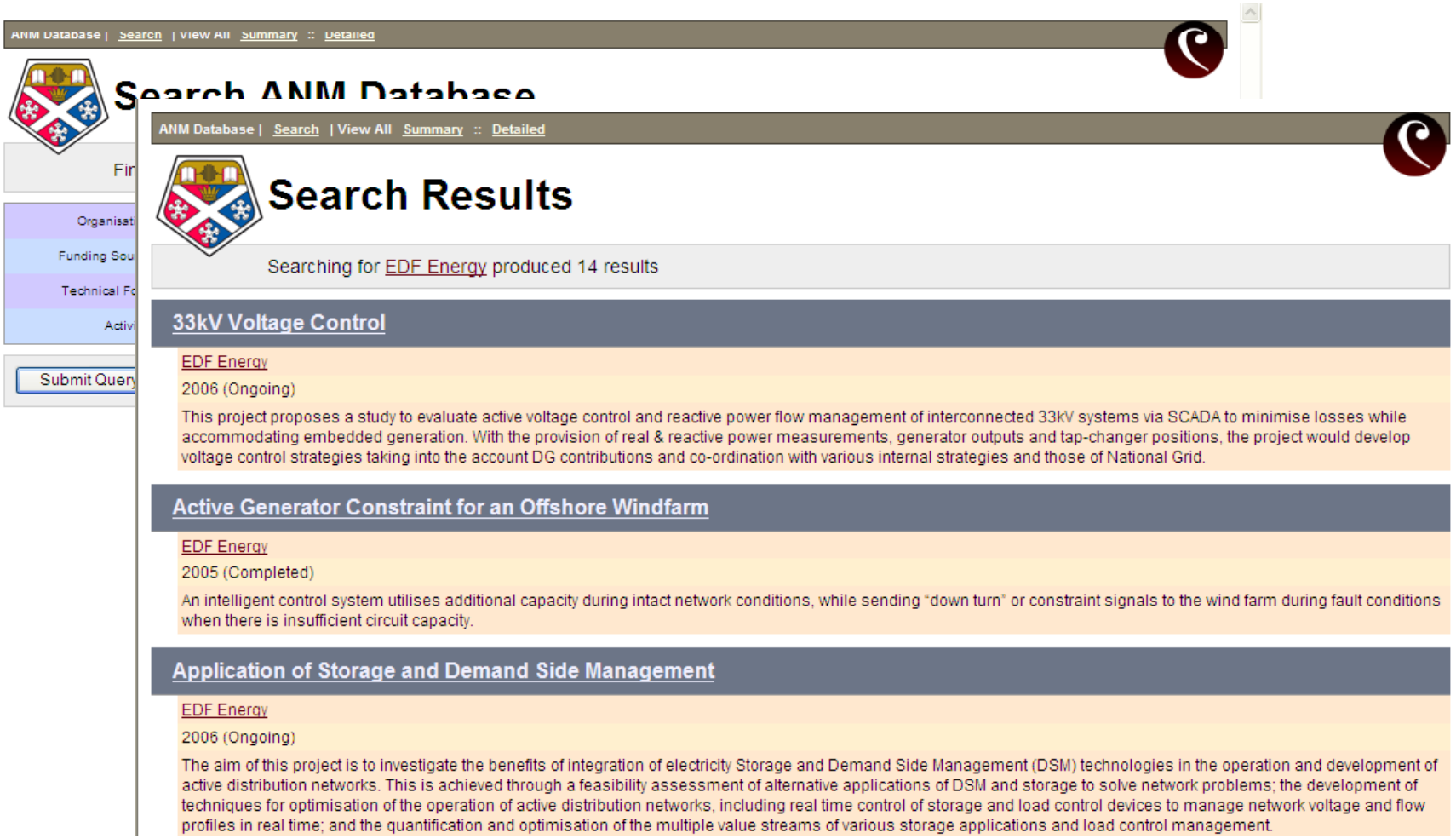

Demonstrated SmartGrid concepts: Voltage Control

- GenAVC and other real-time voltage control techniques successfully demonstrated and deployed
- In-line voltage regulation (LV/MV) technologies successfully demonstrated
- Reactive power management through power electronics technologies (D-VAR and D-Statcom) now emerging in network operators in GB and elsewhere
- Voltage control devices being tested in Japan

Demonstrated ANM concepts: Power flow management

- Scottish & Southern Energy, EdF Energy and Scottish Power have post fault tripping schemes implemented
- Power Matcher technology for management of generation, storage and DSM tested in the Netherlands
- PoMS power management device from the EU DISPOWER project demonstrated at the community scale
- Commercial arrangements including interruptible contracts tested in Greece
- DG management schemes tested in the US
- Dynamic line (Central Networks for OHL and Belgium for UGC) rating schemes deployed

Demonstrated ANM concepts: Communication and control

- Several generation aggregation demonstration projects (e.g. VPP - Encorp, DENNIS – NREL)
- DMS systems from major vendors now being linked into real active network management schemes (e.g. AREVA e-terra on Crete)
- … and other trials under way in areas such as DSM and fault current limitation

Areas of Technical Focus 2008

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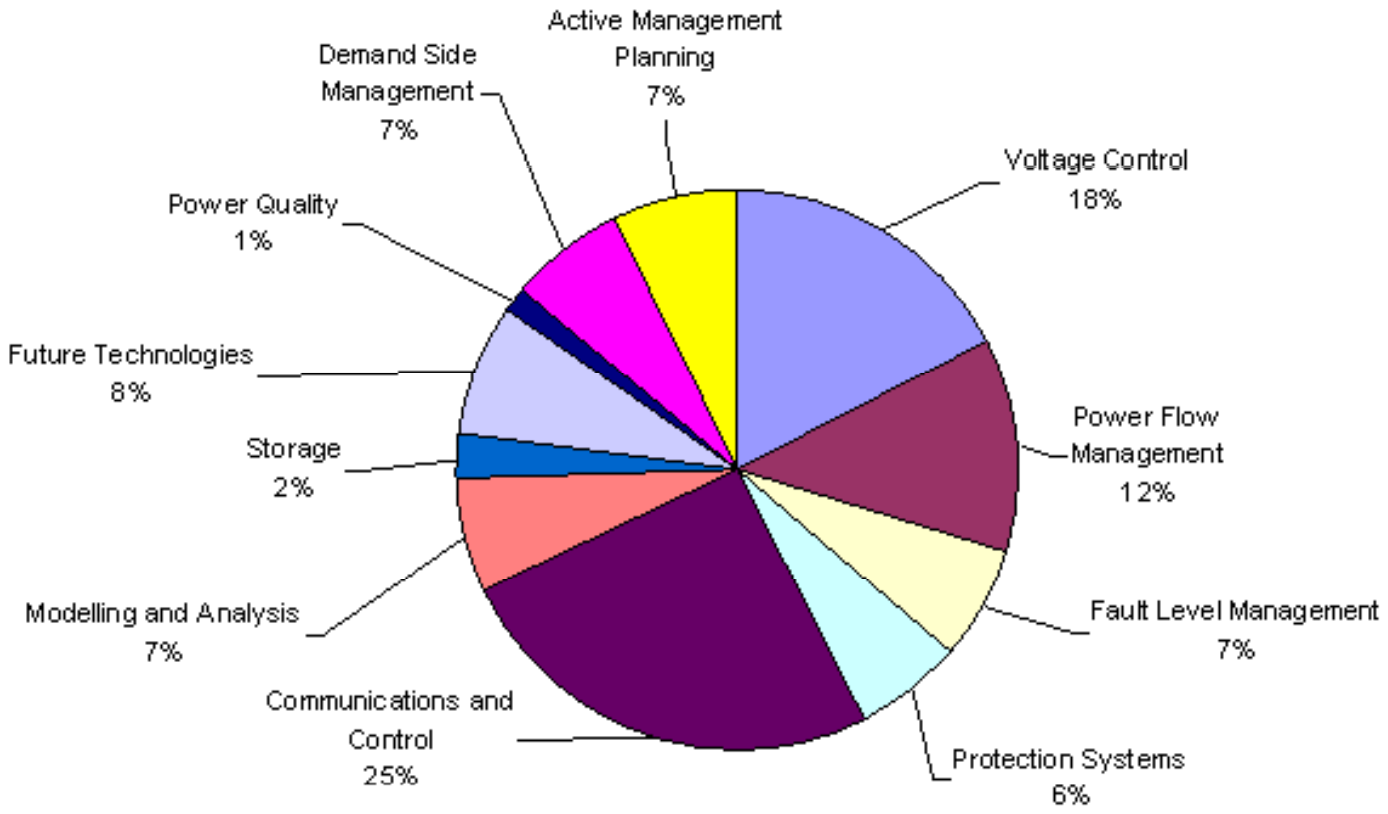


Developments in technology maturity (2006 – 2008)

Activity Type	Research	Development	Research & Development	Trial	Pilot	Full Deployment
2006 Register	65%	4%	9%	4%	4%	14%
2008 Register	41%	4%	24%	8%	8%	15%

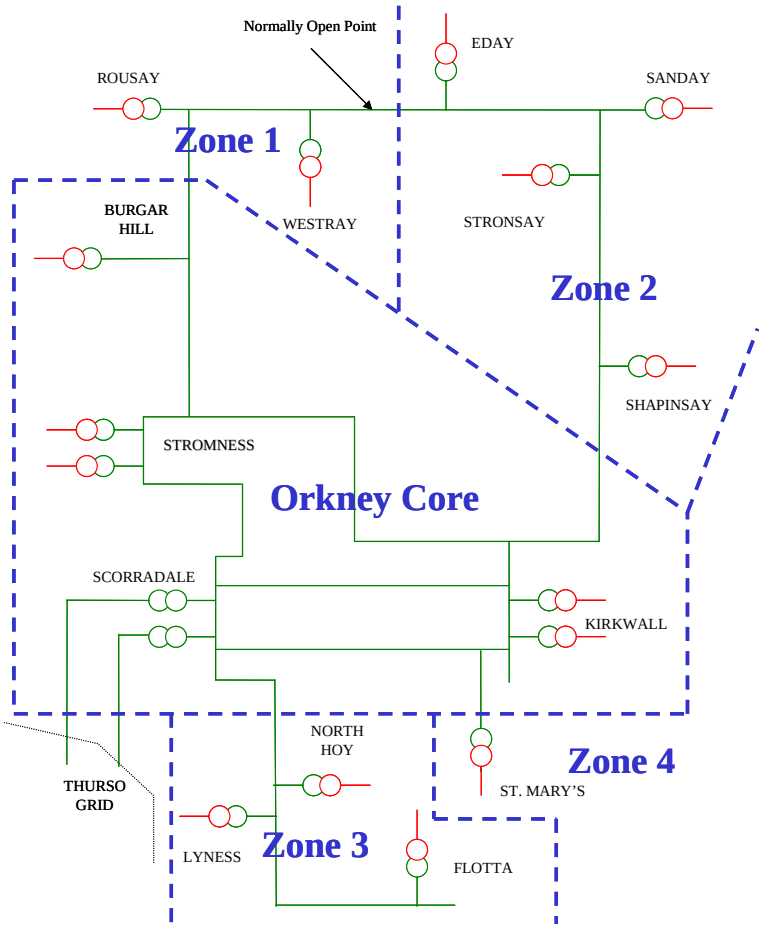
ANM Register Findings

- Good range of technologies at demonstration stage
- Individual solutions to many of the DNO network management issues at an advanced stage of development
- Government and regulators appear to be responding
- Barriers to active network management deployment still exist
- First RPZs really only coming on stream in 2008/9
- Higher profile and integrated demonstrations required to build acceptance across power sector
- Many research developments led by academia who also conduct industrially focused R&D

SmartGrid Demos in the UK

- Registered Power Zone Activities
  - Active Power Flow Management – SSE, Orkney RPZ
  - Dynamic Line Ratings – EON Central Networks, Skegness/Boston RPZ
  - Voltage Control – EDF Energy, Martham Primary RPZ and Steyning RPZ
- Trial of tap changer control products
  - SuperTAPP n+, GenAVC
- Anticipated trials
  - Aura-NMS, Dynamic Line Ratings
- Many companies trying to increase deployment and uptake of innovative solutions
- More projects in planning

SmartGrid Case Study – The Orkney RPZ

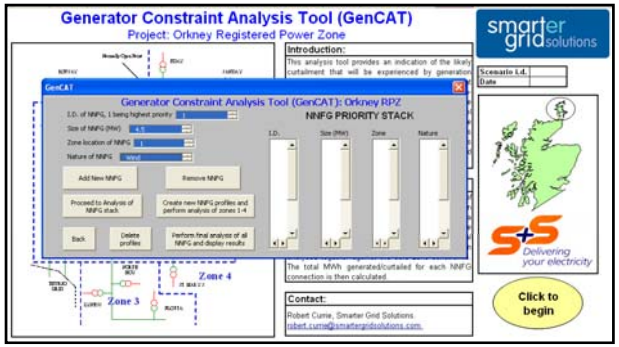


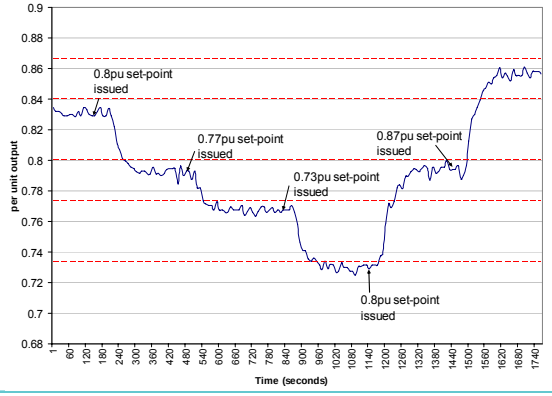
Picture Courtesy of SSEPD/University of Strathclyde

- Separate network into ANM control zones
- Zones may be nested within one another
- Each zone has a thermal limitation on generation output at any given time
- The submarine cables to the mainland place a further thermal limit on generation output
- Real time control of wind and marine generators based on real-time measurements and control logic
- Existing DG units unaffected by ANM implementation
- Last In First Out approach to DG connecting through ANM

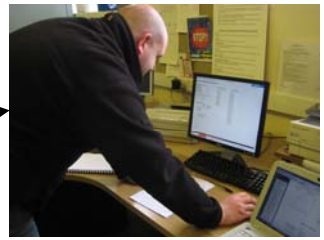
The Orkney RPZ Update

- 14.1 MW, 7 generators
- Base configuration witness tested
- Installation May 2009
- First connections summer 2009
- Curtailment Assessments issued (individual and multiple interactive generator connections)
- Solution tailored to meet host DNO requirements
- SCADA integrated
- Simulator, manuals and training seminars



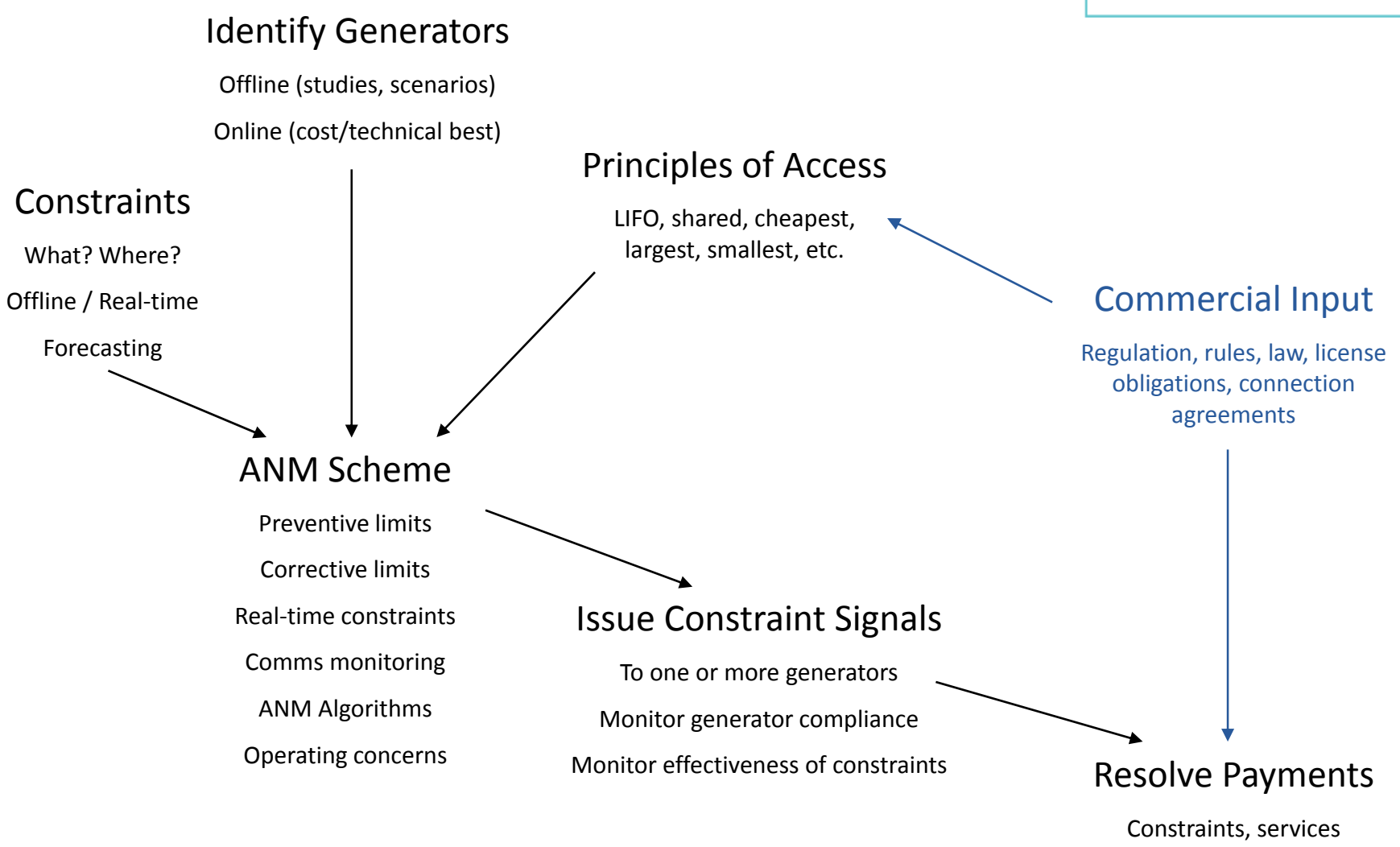


The Orkney RPZ Update



SCADA

Summary of DG Constraints and ANM



What does it take to deploy a Smarter Grid?

- It seems that several technologies are available
- ***BUT***, there has not been wide spread adoption of ANM
- Does this represent:
  - A lack of mature and proven solutions?
  - A lack of business drivers?
  - Too much risk for network operators?
  - Resistance to change?
- Bound to be plenty of factors…

What does it take to deploy a Smarter Grid?

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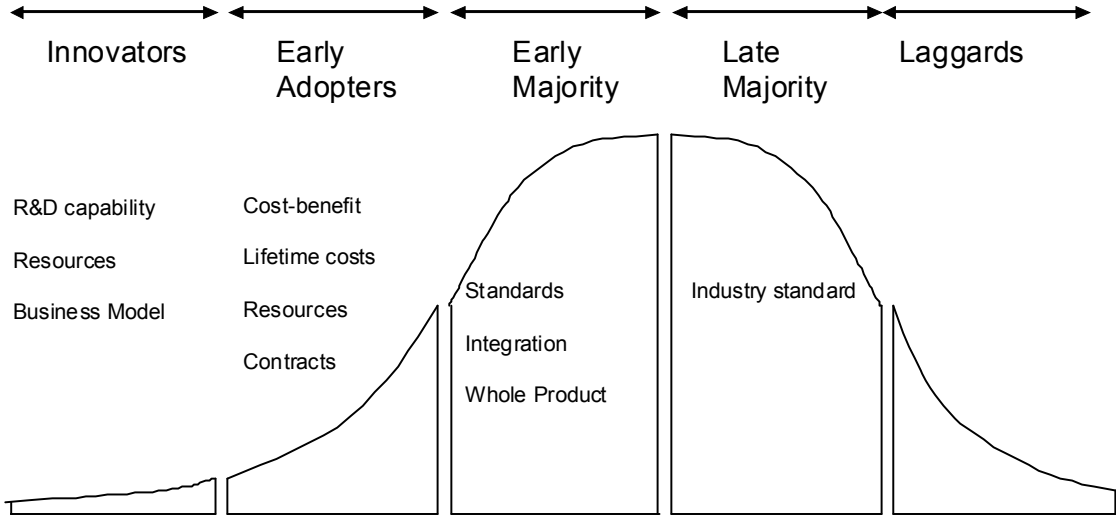
Differences from other technology development roadmaps:

- Nature of industry
- Cost recovery and incentive mechanisms
- Support and Warranty in the power sector
- Liabilities



What does it take to deploy a Smarter Grid? Lessons Learned from Orkney RPZ

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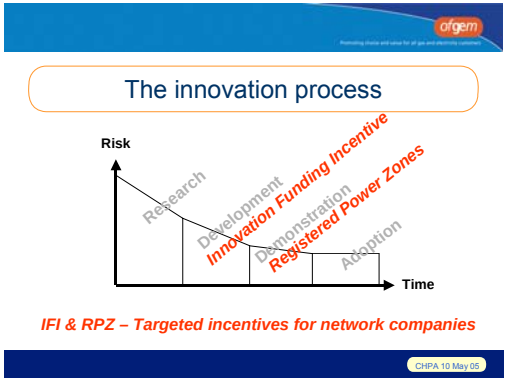
- Start simple and build
- Lots of simple things can become very complicated
- A lot can be done with existing technologies
- Network planning and operation need to be brought closer together
- Network operators need to know what “goes on” inside boxes
- Network planners need to understand long-term implications and evolution
- Commercial arrangements are complex
- Support and warranty are crucial
- Timescales vary (impacts on nature of solution)
- Generator developers are good at understanding and accommodating risk
- ANM service providers need to identify and demonstrate value

Ongoing work at SGS

- Deploy Orkney RPZ and multiple generator connections
- Exploring other deployment opportunities in UK and Ireland
- Modification of **SGi** to accept dynamic thermal line ratings
- Development of **SGv** (funded via SMART Award)
  - Voltage management
  - Multiple DG units and multiple constraints
  - Work in tandem with **SGi**
  - Prototype late 2009, trial in 2010 (seeking partners…)
- R&D programme
  - DSM, Energy Storage and Losses
- SGS Consulting
  - Power Systems Analysis
  - Generator connections



Summary

- ANM is one facet of the SmartGrid
- Several deployments have occurred in the UK
- ANM solutions providers are emerging
- Move towards business as usual – needs regulatory support
- Orkney RPZ first implementation of **SGi** and represents a living, breathing and evolving SmartGrid
- Commercial challenges are significant
- Need to bridge the “chasm” from early adopters and early majority
- The value proposition needs to be fully demonstrated
- Stay up to date! http://cimphony.org/anm

Thank you for listening

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