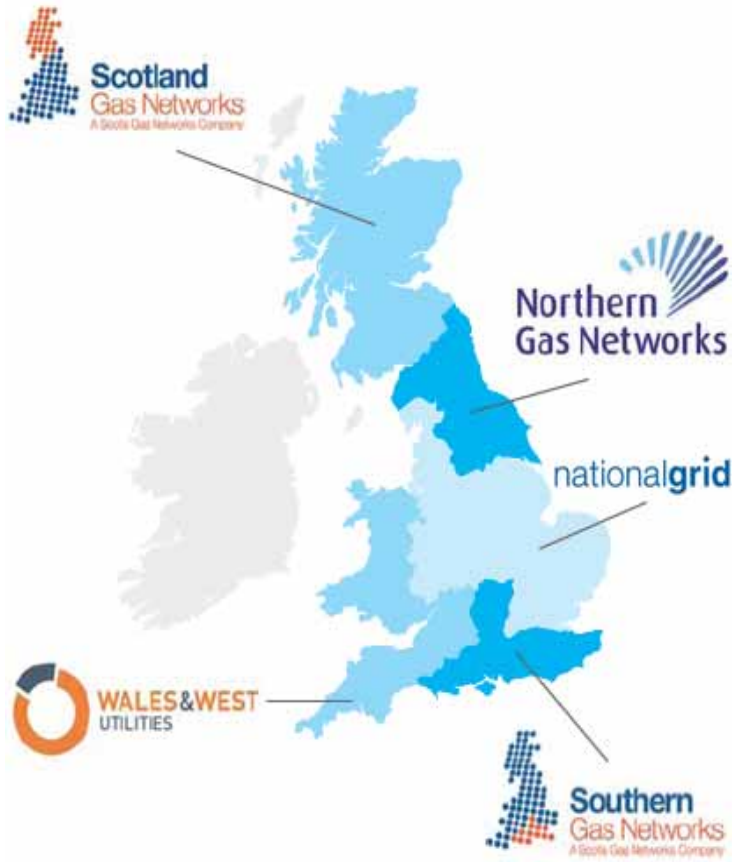
Shaping for the Future – *Scenarios for Transformation*

energynetworks association

DR DRAGANA POPOVIC

ENA Member Companies



Overview

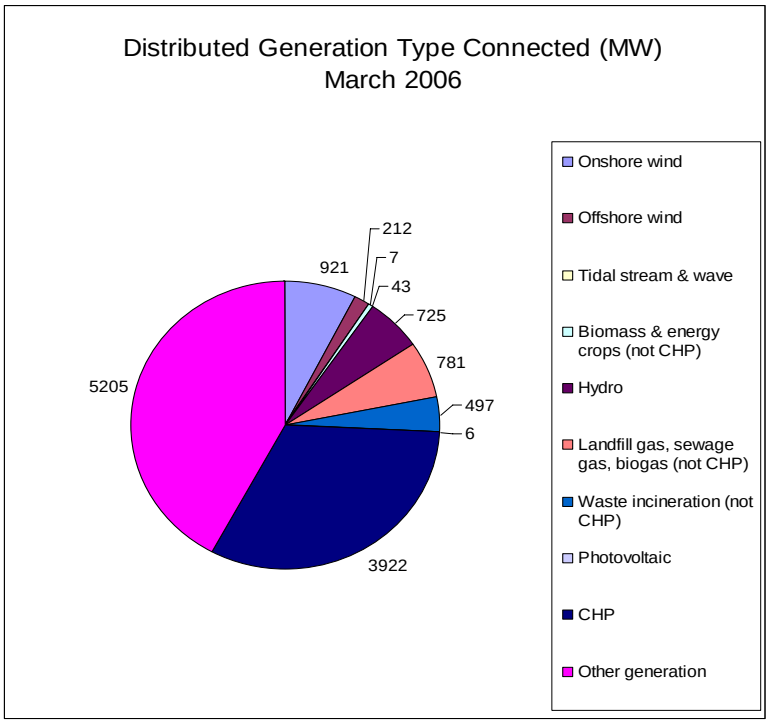
- Energy Review – Implications for Electricity Networks
- Integration of Renewables and DG
- Aging Infrastructure
- Evolutionary Path Forward

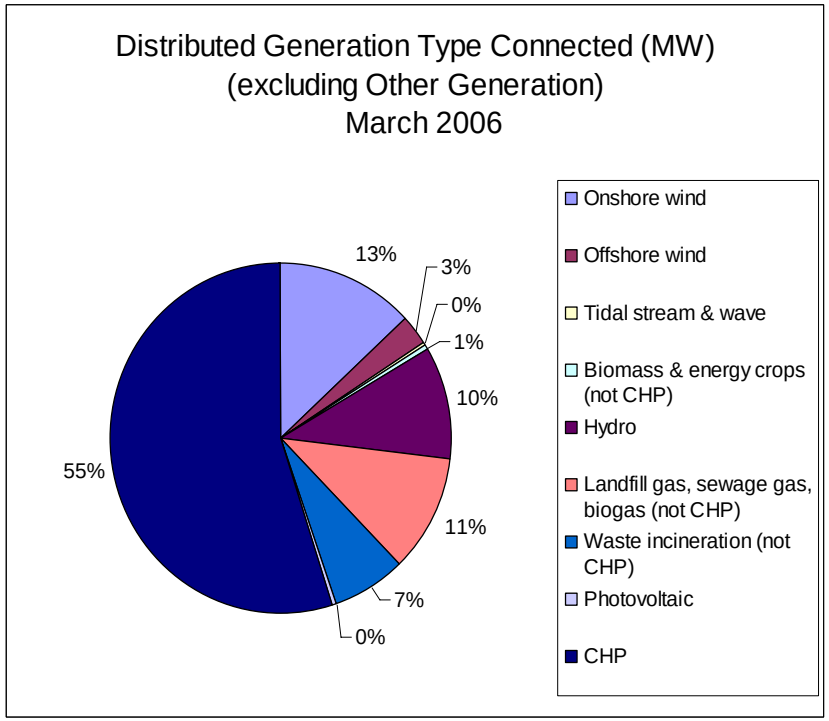
Energy Review – Implications for Electricity Networks

- **Distributed Generation (incl. renewables and low carbon cogeneration), as an alternative and/or large-scale supplement to centralised generation**
  - Review of barriers and incentives (2007)
  - Role of innovation
  - Community/regional carbon neutral developments
  - Foresight project - technological & economic opportunities (2008)
- **Network development and network investment**
  - Transmission reinforcements and timely investment to support large scale renewables
  - Integrating infrastructure renewal to support security of supply and low carbon economy
  - Improving planning process for all energy infrastructure
  - Scenarios for long-term development of the networks

Distributed Generation

Connected to the UK distribution:

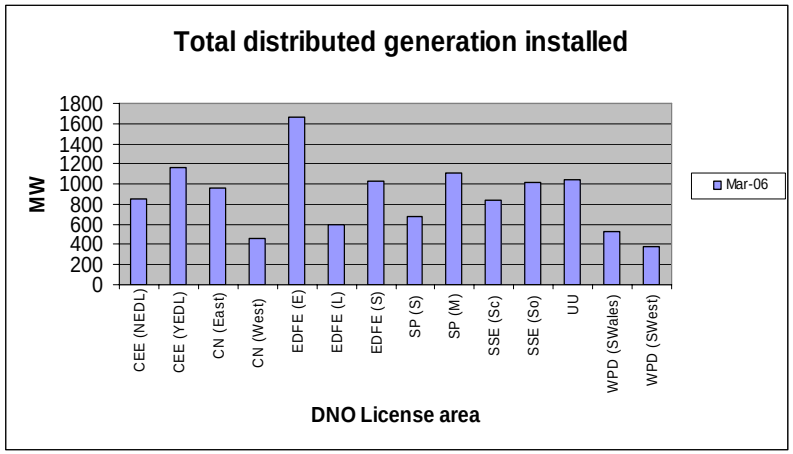




http://www.energynetworks.org/spring/engineering/distributedgeneration02.asp

Distributed Generation

- Clustering problem
  - main growth areas: Scotland, East Anglia and the SE
  - the growth as much as 7% between Jan'05 and Jan'06



- How the UK DG `mix' is likely to develop? - hard to say precisely
  - Most likely: the growth in DG is likely to continue
  - Notably in areas with larger amounts of wind resources (which is an issue for DNOs as these tend to be in rural areas with weak local networks)
  - Clustering will become more marked
  - Microgeneration in ``every'' house – LV networks to become even more important

(New) Generation and Transmission

- Clustering of new generation projects:
  - Offshore wind
  - CCGT
  - New nuclear
  - Interconnectors
- Significant reinforcements in certain areas

Cluster	No. of applications	GW
1	163	13
2	6	2.5
3	8	8.0
4	4	5.0
5	5	4.0

Source: National Grid ER consultation response 2006

Large-Scale Renewables

``The strategic role of renewables in the energy system'' (ER, 2006)

- **Technologies:**
  - Wind power – the principal commercially available and scaleable renewable energy technology
  - Wave and tidal generation technologies - under development

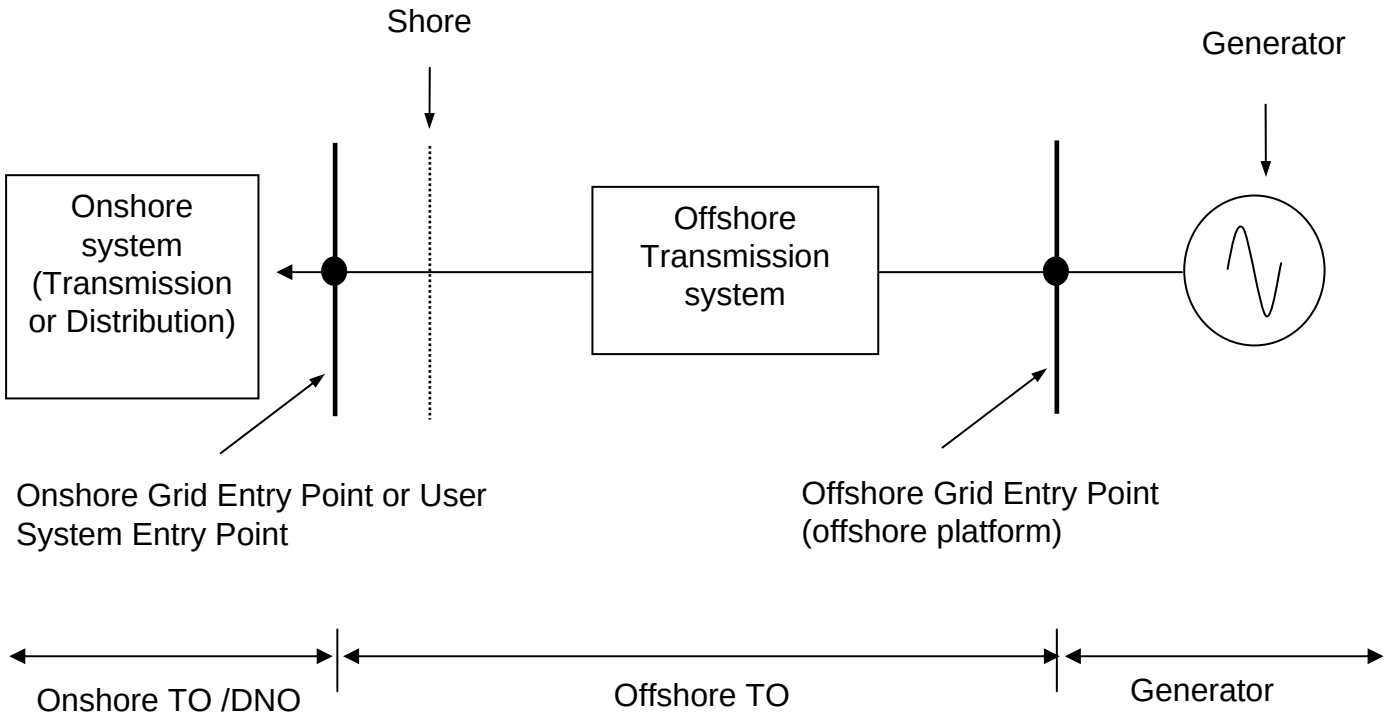
- **The key technical challenges related to renewables integration:**
  - Developing ways to deal with the specific characteristics of renewable generation technologies in order to assess the requirements of the transmission (and indirectly, distribution) infrastructure including offshore transmission infrastructure
  - The consequences which increasing levels of renewable energy with intermittent or variable output have on the overall stability and security of supply
  - The technical requirements and standards which might apply to the connection of large offshore wind farms (and marine renewables)

- **Interplay between (relatively inflexible) new nuclear and variable wind** - balancing issues; need for storage and DSM

Offshore electricity transmission

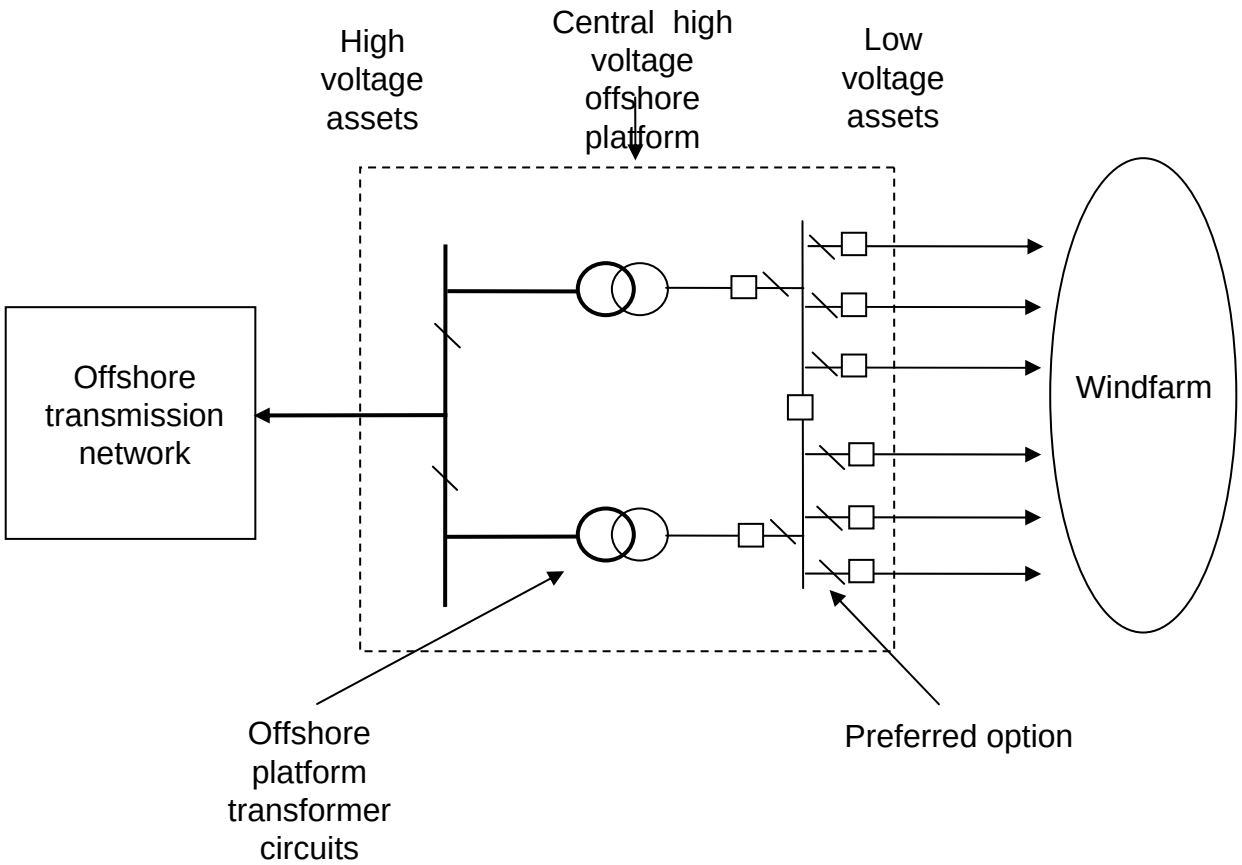
- Offshore transmission networks are to be subject to price controls (March 2006)
- Build on onshore regime where possible
- Work on the details of the regulatory arrangements is underway (through OTEG) to include
  - **GBSQSS work on offshore transmission standards**
  - Offshore transmission connecting to DNOs
  - **Regulatory options (Geographical scope / licensing)**
  - Price controls design (form, scope, duration of price control)
  - Adoption issues
- Consultation document in late Oct / early Nov
- A new regulatory regime in place in 2008

Scope of offshore transmission



Source: OTEG's GBSQSS, Sep 2006

Scope of offshore transmission

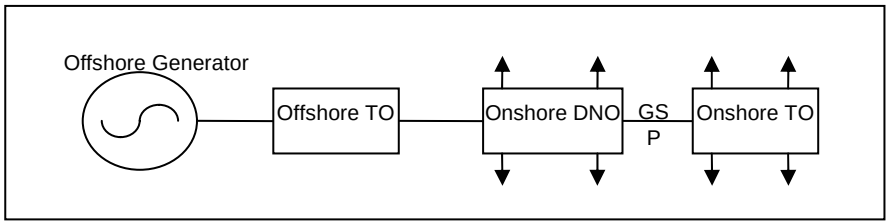


Source: OTEG's GBSQSS, Sep 2006

GBSQSS for offshore transmission

- GBSQSS subgroup is set up to review existing SQSS and test relevance to offshore transmission networks
- Initial recommendations are based on the cost benefit analysis (in line with existing GBSQSS and ER P2/6) applied to
  - Single and shared AC or DC connections
  - Wind farms up to 1500 MW and 25-100km offshore
- Possible options to take account of transmission voltage requirements at both the offshore platform and at the (cable) connection of offshore network to onshore network
- Further work needed in relation to access rights, compensation arrangements for loss of transmission system access, and offshore transmission charging arrangements

Offshore transmission connecting to DNOs



- DNO needs to be integrated into the process
- Similar to large power stations connecting to DNOs
- But with some key differences
  - Offshore TO exists between offshore gens (Users) and DNO
  - Contract between User and GBSO
  - Potentially, no contractual relationship between User and DNO

- Issues:
  - Who determines onshore connection design?
  - How are DNOs integrated into existing processes?
  - How does DNO make investment decisions?
  - How does DNO treat offshore TO connection?
  - Who contracts for DNO capacity?
  - Compensation if capacity is not available?
  - How is interface between DNO and offshore TO managed?

Source: OTEG's GBSQSS, Sep 2006

Aging Infrastructure

- **Aging asset base**
- **Changes in demand and generation patterns**
- **Drive for lower environmental impact** (renewables, DG incl microgeneration, more efficient use of heat energy) **and increasing generation investment** (25 GW of new generation over the next 20 years)
- **New network technologies** (automation, ANM, DSM & smart metering, FACTS …)

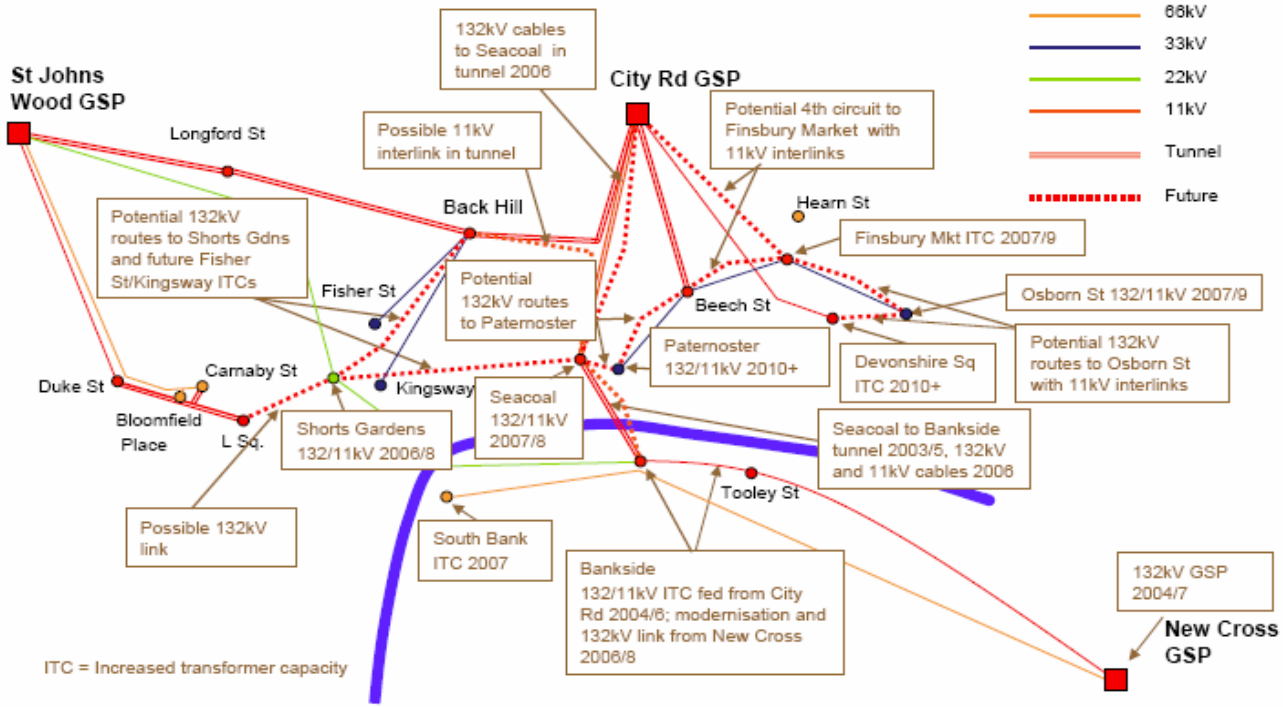
Synergetic development across the spectrum of opportunity

The Asset Challenge

- **Replace / reinforce *or* a more strategic approach?**
  - `Design–in' for greater network capability and functionality so as to allow for managing uncertainties and future changes
  - New and different (low carbon) designs as apposed to conventional network designs?
- **Managing risks and ensuring return on investment**
  - Good "knowledge" of the natural life cycles of networks and their existing components
  - The life-expectancies of future installed / refurbished assets – and the functional performance expectations (e.g. reliability, security, availability, accessibility, flexibility, adaptability, safety, environmental /aesthetic impact, operational impact, efficiency, and whole-life cost) from asset installation to disposal

Synergies with Network Renewal

(Planned Central London EHV Network Reinforcement 2003 – 2012)



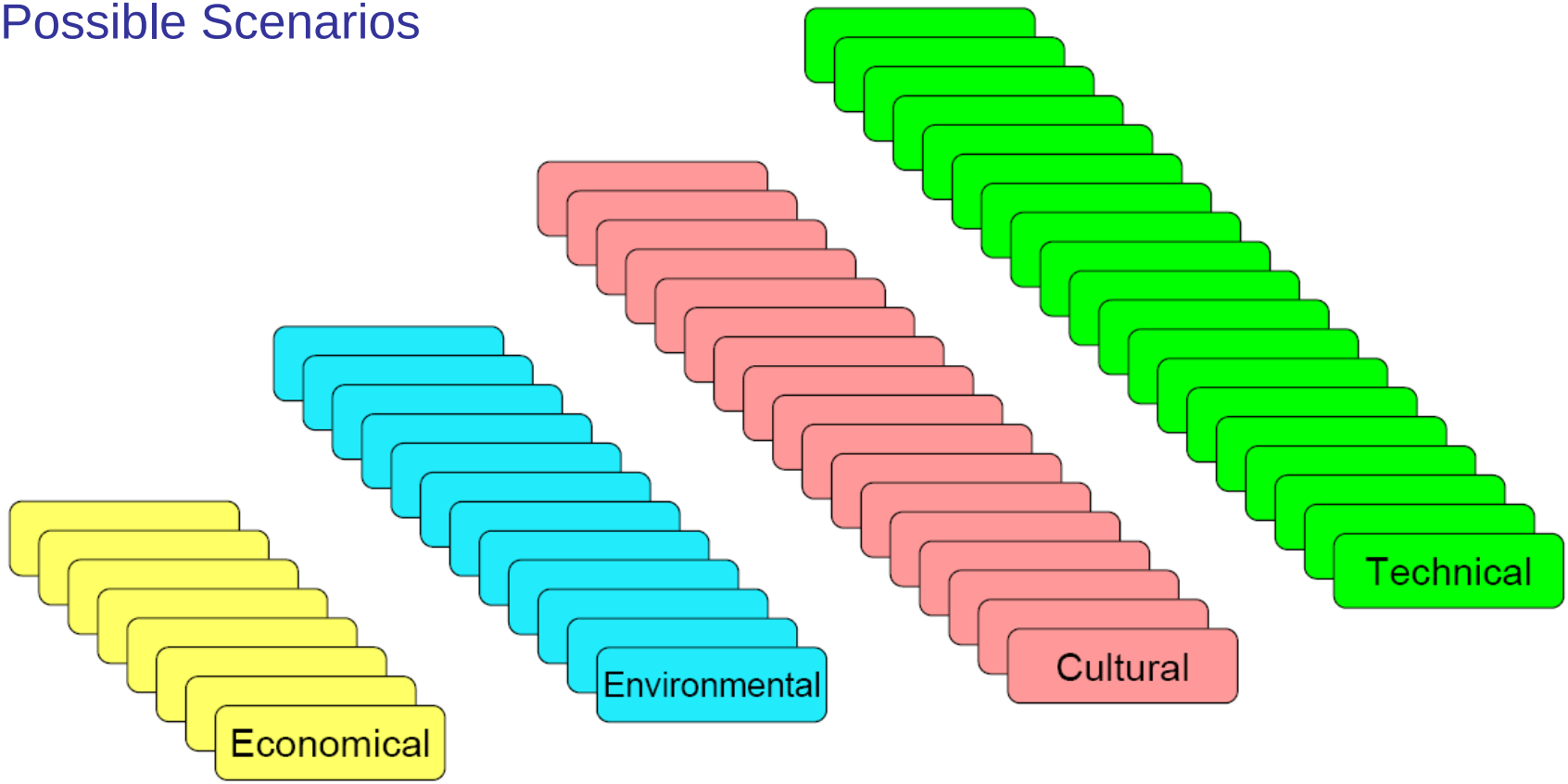
Source EDF

Evolutionary Path Forward

- A range of paths for delivering secure supplies and 2050 carbon goals depending on fossil fuel prices, carbon prices, technological developments, customer requirements, economic growth, institutions etc
- These uncertainties, along with the asset challenge, have implications for
  - Future network topology and architecture
  - Future need for and/or use of innovation
  - (Long-term) investment needs
- **A need for**
  - Longer-term strategic planning - *Examining potential long-term generation scenarios and corresponding network architecture options*
  - Setting the market and regulatory frameworks to respond to the possible technical and commercial solutions and provide the incentive for efficient network investment

Longer term strategic planning

Possible Scenarios

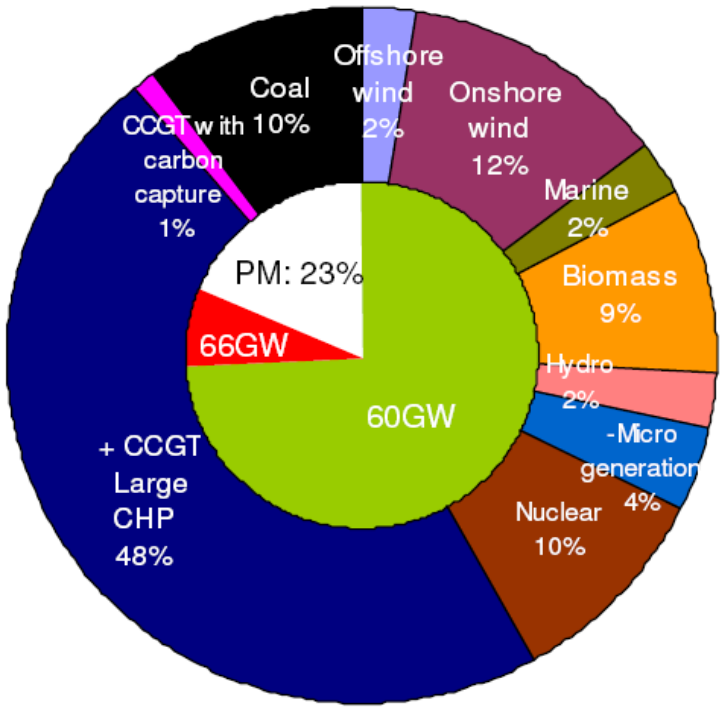


2020 and beyond

Source ABB

Continuing Prosperity Scenario

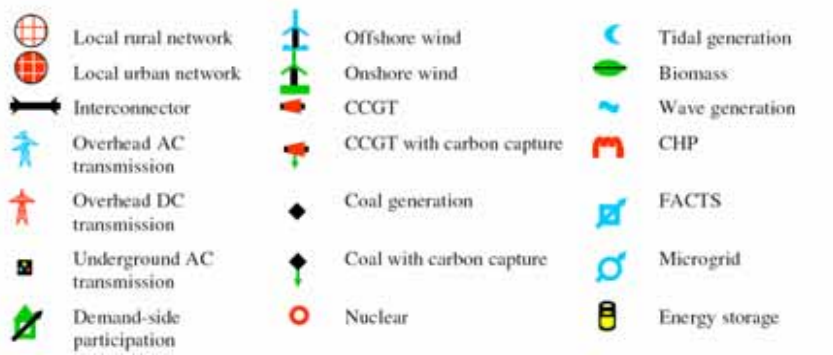
- Wind as a dominant renewable technology – 10GW onshore plus 2GW offshore
- Biomass – 7GW
- Wave and Tidal – 2GW
- Hydro – 2GW
- CCGT is a dominant non-renewable
- Micro-CHP - 3GW
- Coal and nuclear plants are life-extended and /or under construction

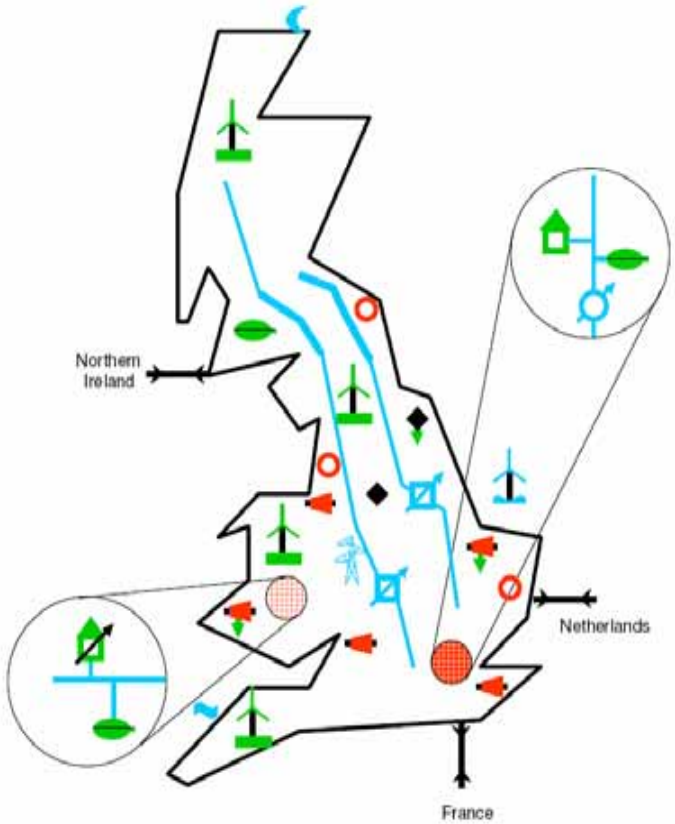


Source: Supergen, "Electricity Network Scenarios for 2020''

Generation and network technologies in `Continuing Prosperity' scenario

- Strain on T & D networks
- DSM on distribution side so as to avoid network reinforcements
- Smart Metering to underpin DSM and support microgeneration
- Use of power flow control devices and power electronic compensation
- New interconnector to Netherlands

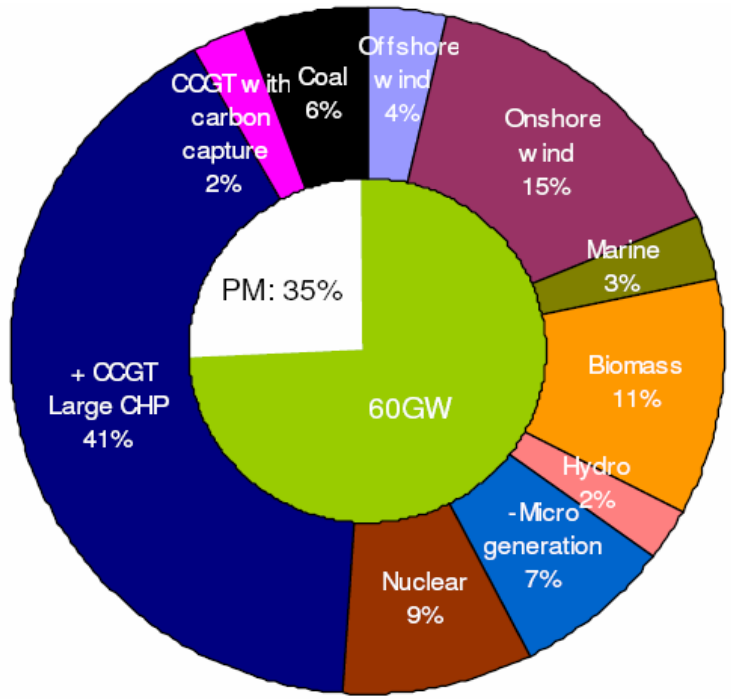




Source: Supergen, "Electricity Network Scenarios for 2020''

Environmental Awakening Scenario

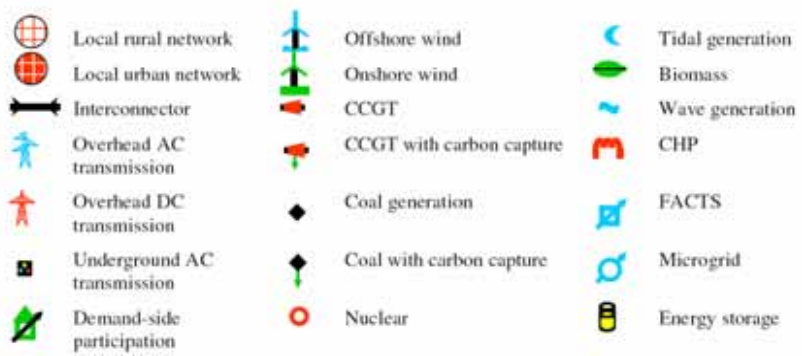
- Wind as a dominant renewable technology – 12GW onshore (but smaller community-scale schemes) plus 3GW offshore and growing
- Biomass – 10GW
- Wave and Tidal – 2.5GW
- Hydro – 2GW
- CCGT and gas fired CHPs
- Microgeneration - 6GW
- Existing nuclear plants are life-extended with no new constructions

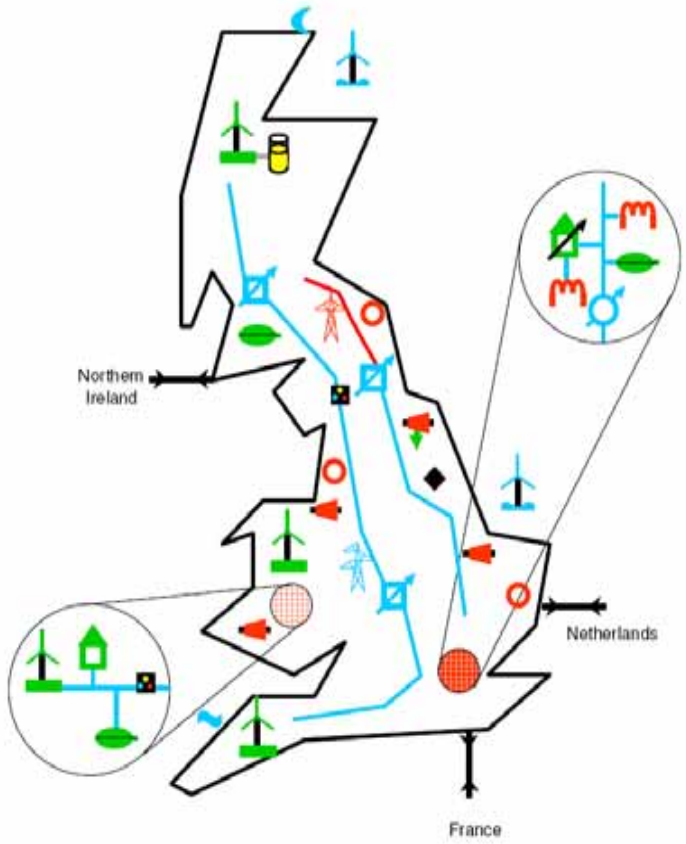


Source: Supergen, "Electricity Network Scenarios for 2020''

Generation and network technologies in `Environmental Awakening' scenario

- Some extension of T network in remote areas only
- HVDC on one of the interconnector routes between Scotland and E&W
- Extensive use of power electronic based flow management
- Use of prototype bulk energy storage
- Wide take-up of DSM/smart metering
- Active distribution networks





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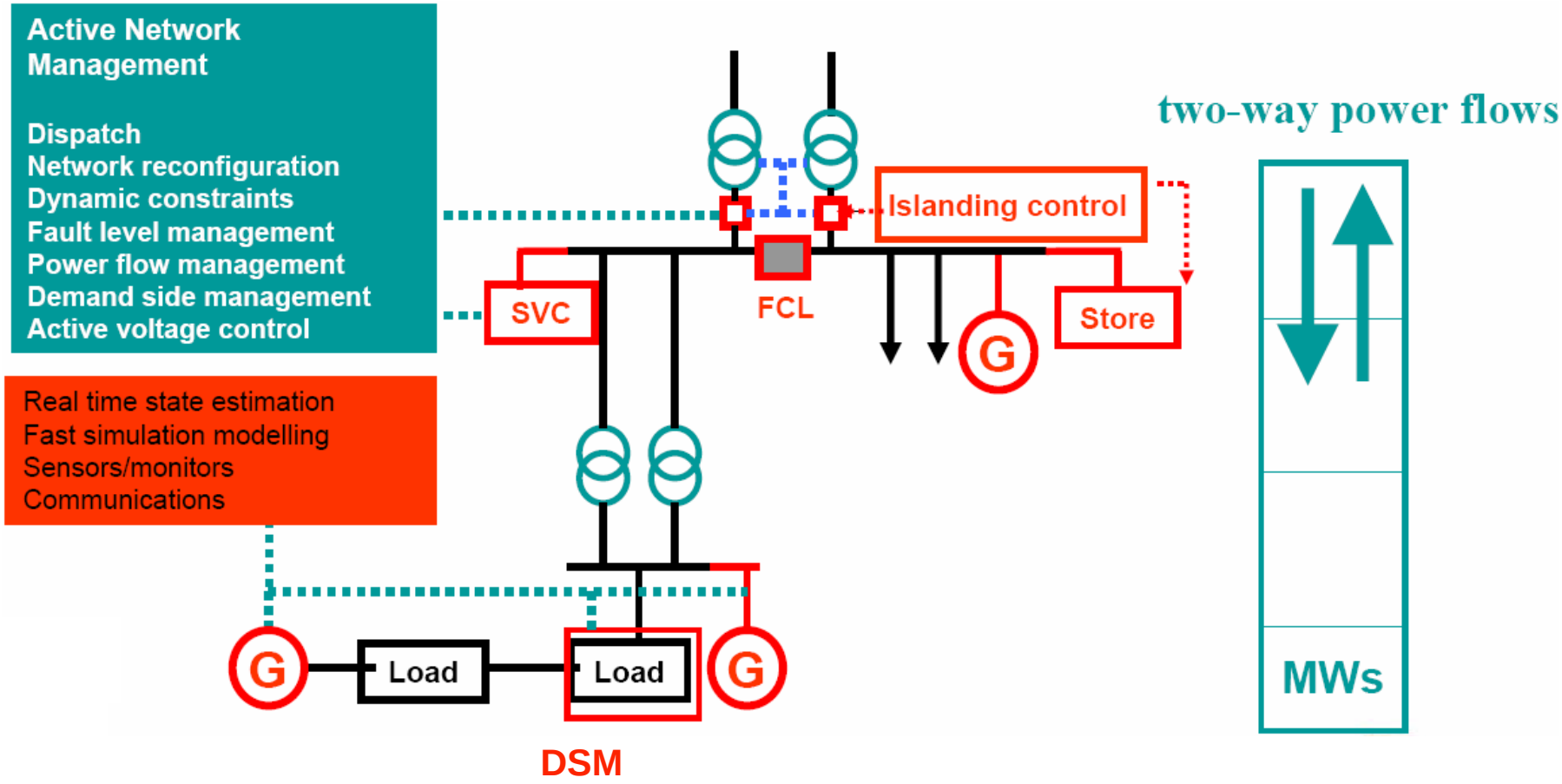
Active Network Management



AURA - NMS

Source Scottish Power

Availability

Reliability

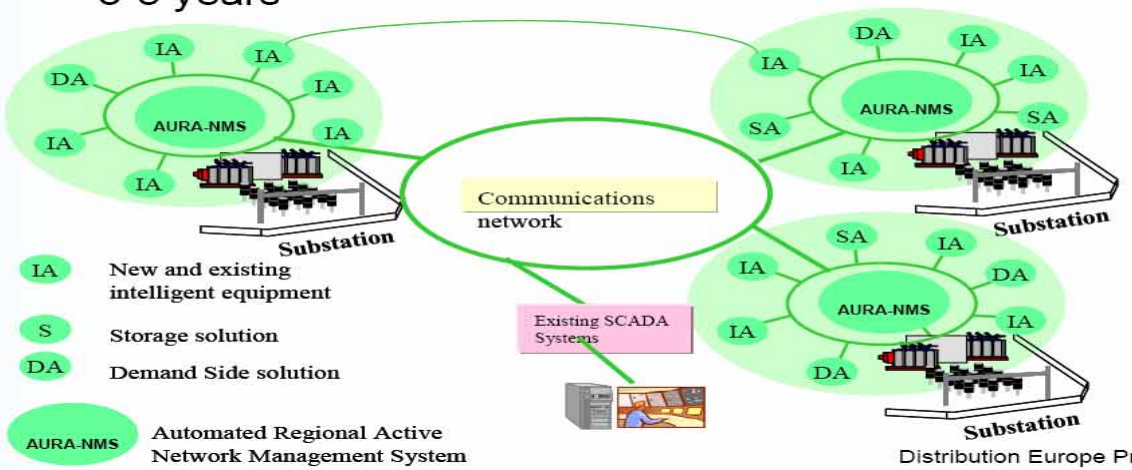
Quality

Economical

Safety

Environmental

- AUtomated Regional Active Network Management System
  - Regional control rather than centralised
  - Embedded Intelligence
- Applications
  - Automated solutions to complex, multiple generation sites
  - Active Network Management for Dist. Networks
- Timescale to adoption
  - 3-5 years



Distribution Europe Presentation – May 06

Single Phase LV Voltage Regulators

Source Scottish Power

Availability

Reliability

Quality

Economical

Safety

Environmental

- Series connected power electronics devices
  - Capable of fast response voltage regulation for over or under voltages
- Applications
  - Increase voltage at the end of long LV lines
  - Decrease voltage for customers close to transformers
  - Potential solutions to increase/decrease voltage due to generation
- Timescale to adoption
  - 12months following trial

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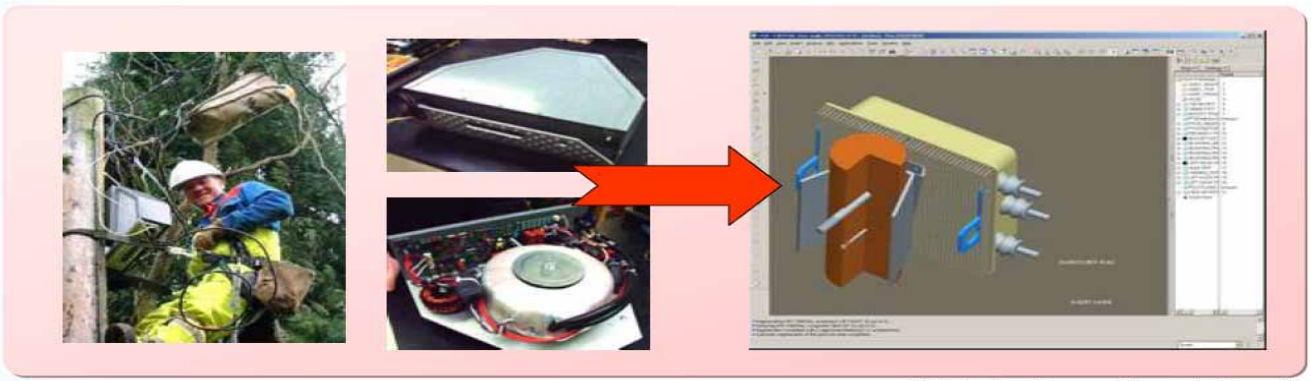


Distribution Europe Presentation – May 06

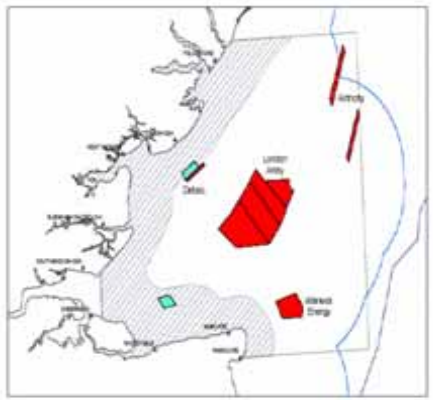
Low Carbon London's Developments

Olympic Village

60MW peak demand
District Heating
Energy Efficiency
Self-sufficient in energy production
100% back up from Grid
Private network managed by ESCo

Corporation of London

- Target: 665GWh of clean electricity and 280GWh heat by 2010
- Could be 40000 schemes
  - 6 large wind turbines
  - 500 mini-wind
  - 7000 domestic PV
  - 250 commercial PV
  - 25000 solar water heaters



London Array

1GW or 25% of London's peak demand

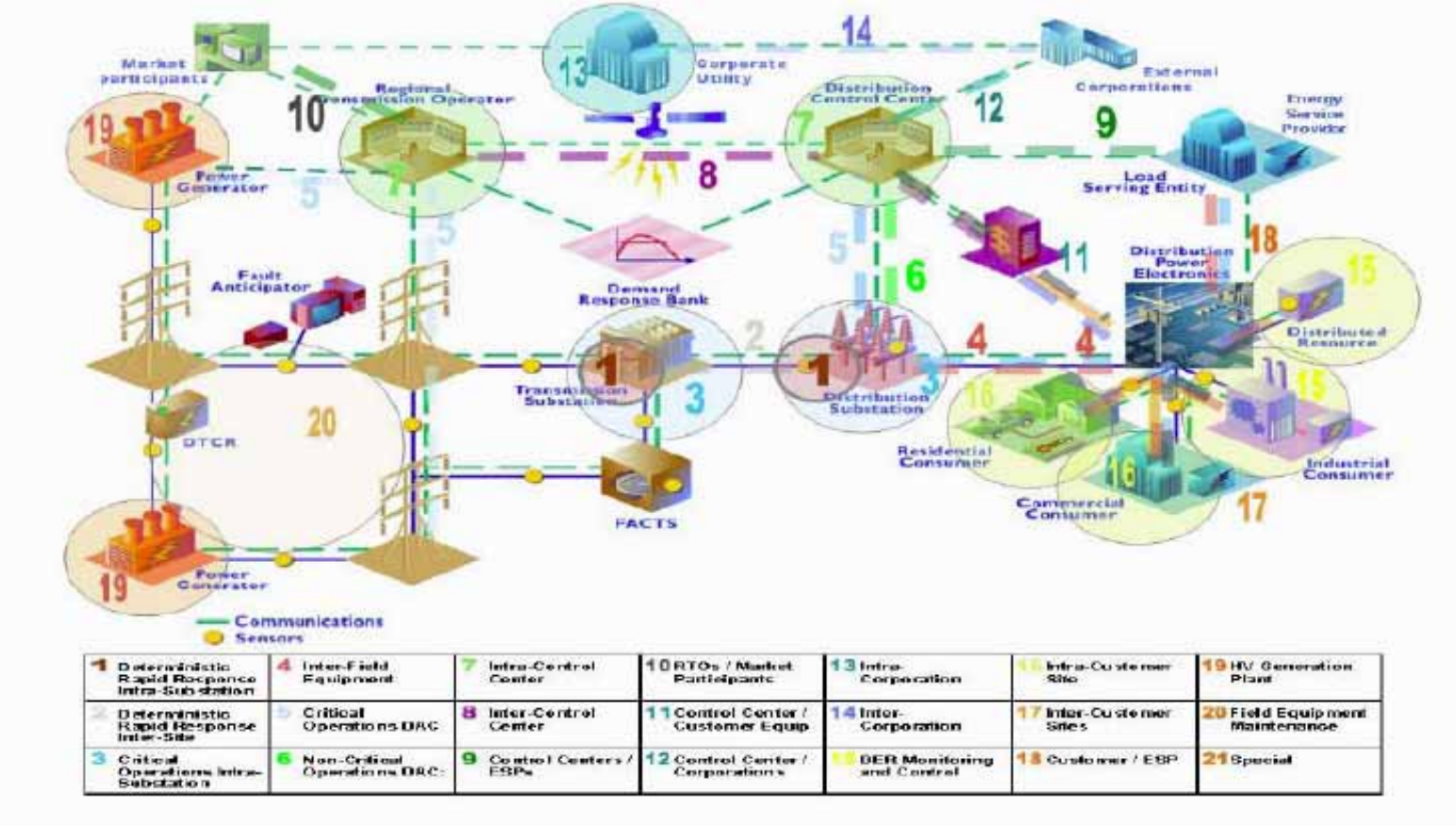
Source EDF

Urban energy network

Towards SmartGrid?

EU Technology Platform SmartGrids

Or an Intelligrid?



Source EPRI

Challenges for Regulation

- **An effective regulatory treatment**
  - **Arrangements that take account of the true scale of the overall investment needed in the transmission system**
  - **A more holistic DG incentive framework**
    - To promote DG connections as an integral part of the way DNOs develop their networks
    - To fund the deep reinforcement required in resource rich, infrastructure sparse areas (i.e. not just a localised infrastructure)
    - To allow for more optimal development of networks rather than just accommodating DG on a scheme by scheme basis
  - **A longer-term regulatory framework** which allows to create and develop flexible, extendible and economic networks of tomorrow
- **A new business framework and organisational models for total energy solutions?**

Conclusions

- Transmission and Distribution networks are vital for:
  - Enabling current deployment and future development of renewables and DG
  - Exploiting the diversity and synergies of different sources
- With an increase in the uptake of DG technologies, it is essential to:
  - Fully understand the impact of these technologies, and micro-generation technologies in particular, on electricity networks
  - Examine the current and potential further clustering of DG projects esp in terms of upgrades that might be needed in areas with weak local networks
- The importance of adequate and timely networks infrastructure *and* hence the focus on ongoing and more strategic investment
- Clear Government policy and stable regulatory framework compatible with this policy –to allow development of secure, efficient and sustainable low carbon networks for a low carbon economy