Wellington, 14th April 2016

new zealand wind energy association

NZWEA Workshop:

The electricity sector in 2035

A perspective from the UK

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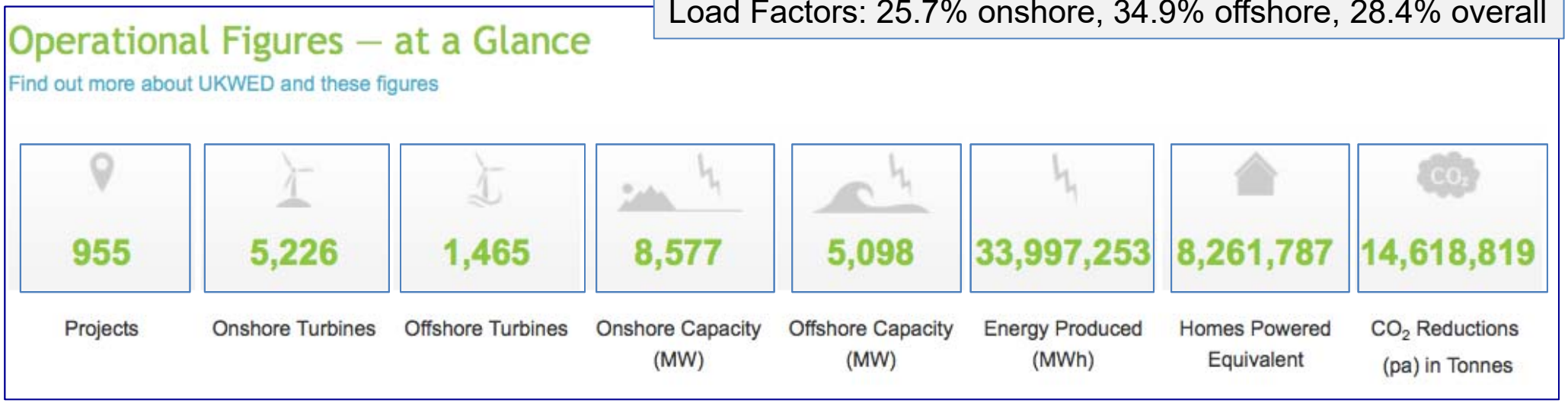
UK's Wind Energy at a glance

Load Factors: 25.7% onshore, 34.9% offshore, 28.4% overall



- UK has some of the best wind resources in Europe
- Offshore developments have benefitted from having both the continental shelf topography and knowledge from the North Sea oil & gas industry
- Government has provided various incentives to kick start development but is now withdrawing financial support for onshore developments
- Wider system issues are starting to attract attention: "the hidden costs…?"

http://www.renewableuk.com/en/renewable-energy/wind-energy/uk-wind-energy-database/index.cfm
https://en.wikipedia.org/wiki/Wind_power_in_the_United_Kingdom

GB's focus on 'Whole-System' concerns

Some of the core issues:

- National Grid now publishes an annual "System Operability Framework" (SOF) that reveals serious operational challenges
- These concern the security and supply quality of the GB system – they're evident *Now* and will grow in the future
- After 50 years, what's changing so radically?
  - Generation from renewables, with power electronic interfaces
  - Distributed rather than centralised generation (and storage)
  - New load types, such as Electric Vehicles & Heat Pumps
  - Active customers, automation, community energy, smart cities…
- It's a massive change in complexity and whole-system interactions. By the 2030s, our traditional G/T/D/C silos will no longer apply.

SOF – some of the big issues ahead

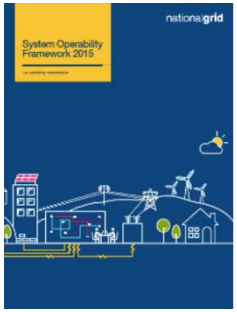


Figure 13
Minimum System Inertia Excluding Contribution from Embedded Generation

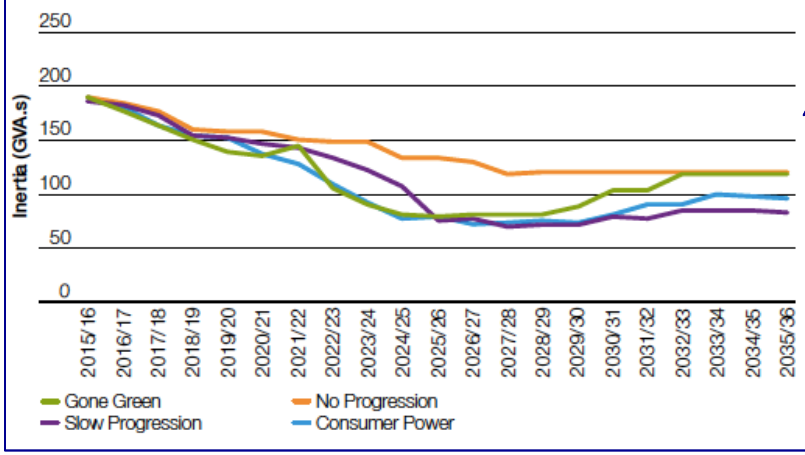
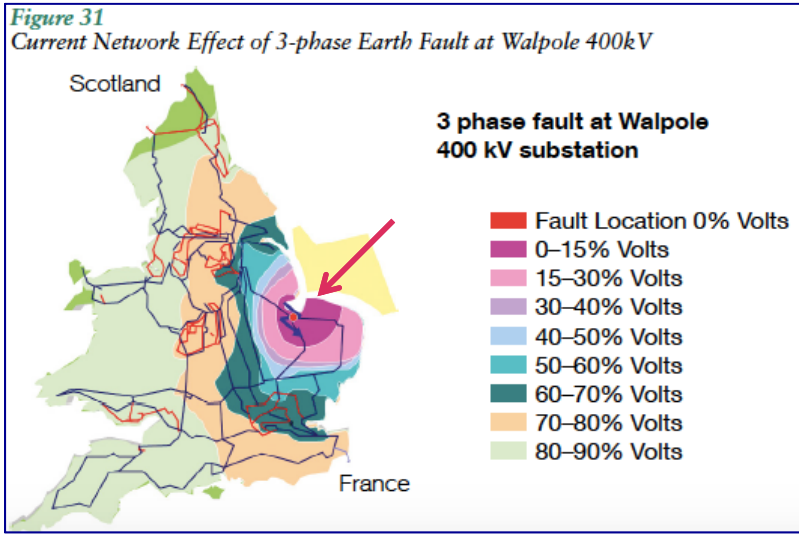


Figure 31
Current Network Effect of 3-phase Earth Fault at Walpole 400kV



- **System Inertia is falling** and set to halve by 2030
- This is due to power electronic interfaces in wind and PV gens and the closure of conventional synchronous generation

- **System 'Strength' is reducing** as short circuit infeeds reduce (again a result of the changes in gen types)
- One of the consequences is far greater spread of voltage depressions under fault conditions (that risks tripping generation)

- **Frequency keeping and stability** need new solutions

http://www2.nationalgrid.com/UK/Industry-information/Future-of-Energy/System-Operability-Framework/

SOF's Three Strategic Themes

- **Services and Capabilities**
  It is essential that new system services are developed to access existing enhanced capabilities from generation (particularly windfarm, solar and interconnector technologies) whilst facilitating the provision of new capabilities

- **Whole System Solutions**
  Transmission and distribution companies must continue to look at the whole-system impact of new technologies and greater access to services from demand side. In this context, the viability of accessing multiple services through different operator models across the whole system and layering of services should be considered from both technical and commercial perspectives

- **Increased Flexibility**
  The value of system services, in particular flexibility, should be considered by the manufacturers and developers of new plant, and form the basis of revenue streams which ensure new developments incorporate the system needs in their design. For example, the more flexible operation of new nuclear, gas and other synchronous plant is likely to be of much greater value going forwards.

- **New 'Flexibility' Services** that will have $$ value in ancillary services and aggregation markets
- **Initially for short-term operating reserve**, frequency keeping support
- **But in due course** also for voltage control, inertia support, Black Start?
- Also **partnering** with local storage, may be other energy vectors, or community energy?

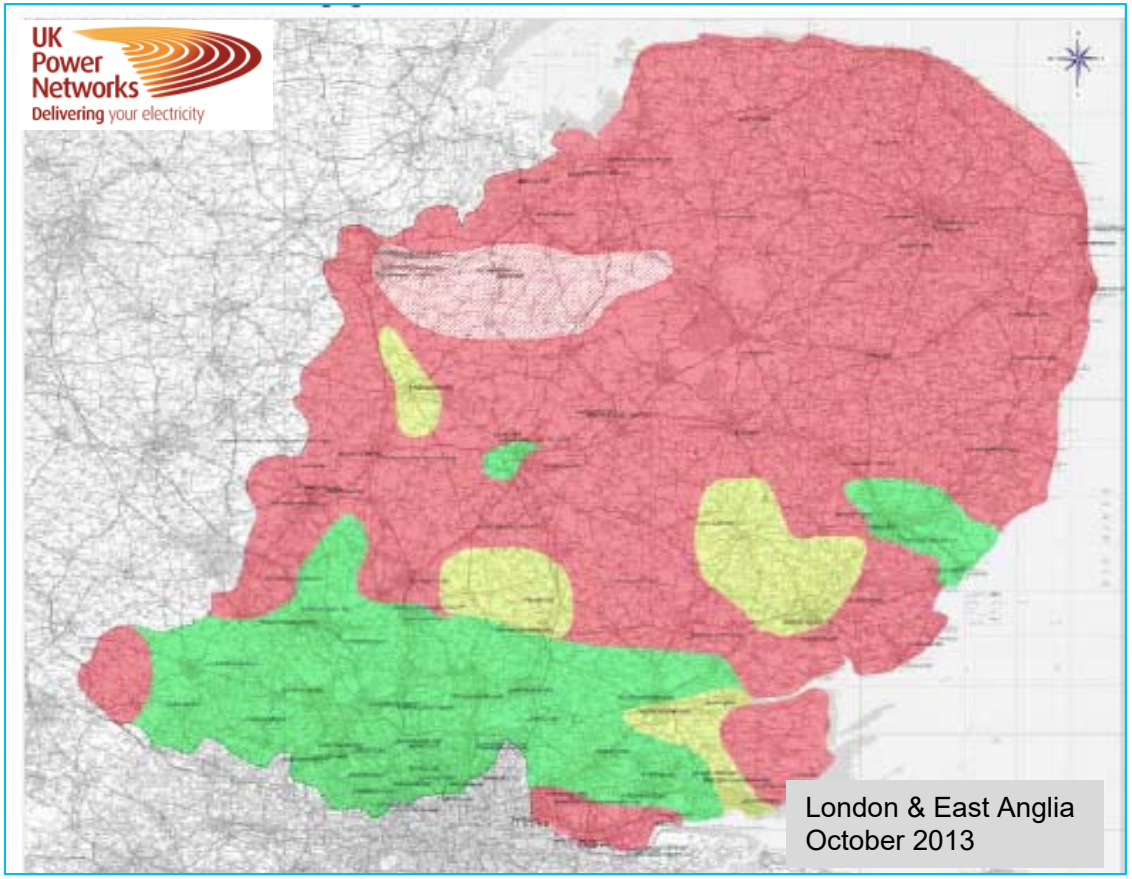
In GB the networks are ‘getting full’

Resulting in delays and high costs for new connections

- **Smart networks technologies** are starting to bring real practical benefits
- One of the successful large scale trials has been the deployment of **ANM: Active Network Management**
- UK’s ENA has published a good practice guide (see link). It describes ANM as: “Using flexible network customers autonomously and in real-time to increase the utilisation of network assets without breaching operational limits, thereby reducing the need for reinforcement, speeding up connections and reducing costs.”
- ANM monitors the network pinch points and, if conditions exceed asset limits, automatically instructs generation output to be trimmed
- To respond rapidly, ANM monitors the state of the network in real-time; in decentralised schemes remote devices *act autonomously*; intelligent algorithms ensure fully automated, fail-safe operation
- **Moving towards 2030, techniques like this will become the norm.**

http://www.energynetworks.org/news/press-releases/2015/july/new-active-network-management-guide-will-help-deliver-a-more-efficient-energy-system.html
http://www.smartergridsolutions.com/markets/generation-developers/
(Declaration of Interest: John Scott is a Non Exec Director at Smarter Grid Solutions)

A real case from UK Power Networks plc



Flexible Plug & Play project

- The ‘heat map’ shows most of the East Anglia network as ‘Highly Utilised’, so new connections here would traditionally require capital reinforcement works
- The table below shows some 80% saving in connection costs, where the wind farms participated in an Active Network Management scheme (ANM)
- ANM curtails generator output in real time if network limits are reached; as this is infrequent the loss of production is acceptable in business terms, being offset by much lower connection costs.

Project	Capacity	Technology	Business As Usual connection offer	Flexible Plug and Play offer	Savings	Status
Generator C	10 MW	Wind	£4.8m	£590k	87.8%	**Accepted**
Generator D	8 MW	Wind	£3.5m	£881k	74.9%	**Accepted**

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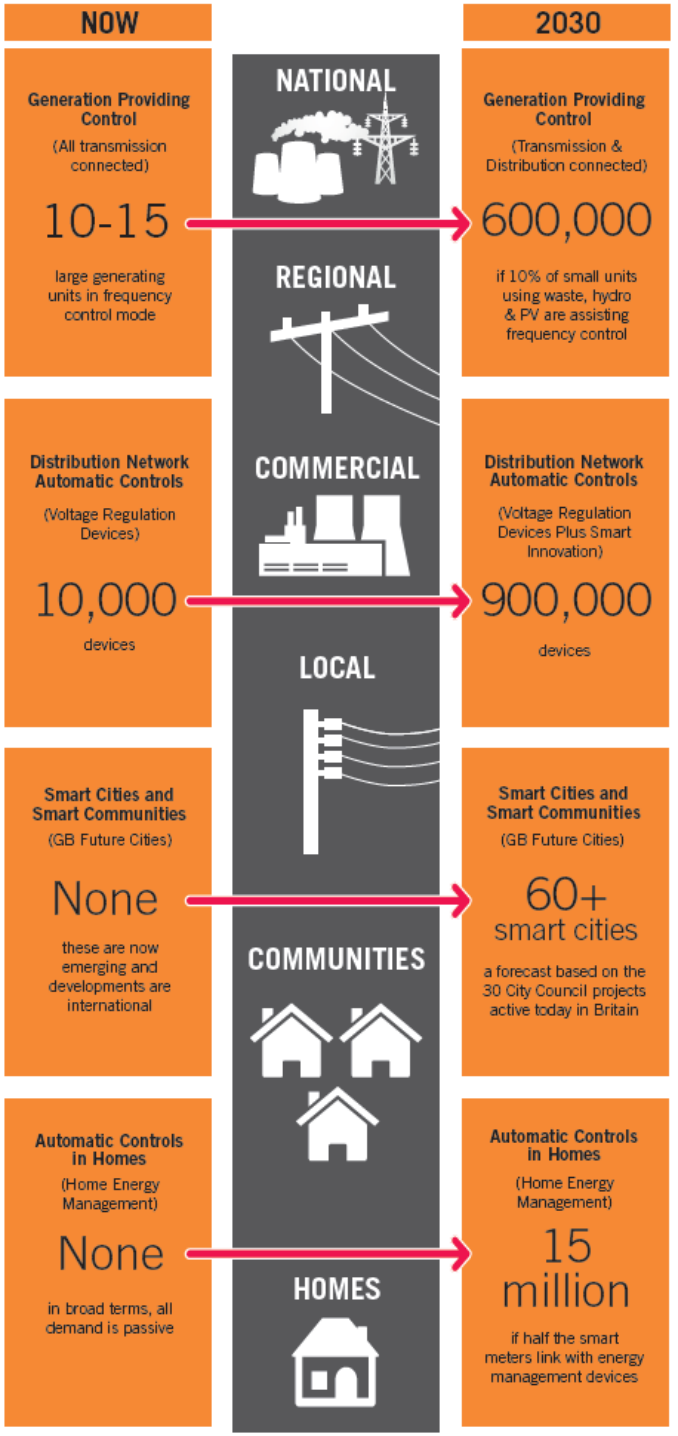
Case study information is at:
http://www.smartergridsolutions.com/consultancy/modelling-and-analysis/

What about the rising system complexity?

- **The IET has raised the debate on this through their Power Network Joint Vision work (PNJV).**
- **Significant changes**: more distributed and more complex devices & services, that are system-wide
- **There will be a massive increase in** sensors, data, communications, automation & intelligence
- **Secure & Interoperable operation** is essential – no interference or system crashes can be tolerated
- **In Britain no party is *accountable*** for 'whole-system' interoperability; is today's governance deficient as we move towards 2030?



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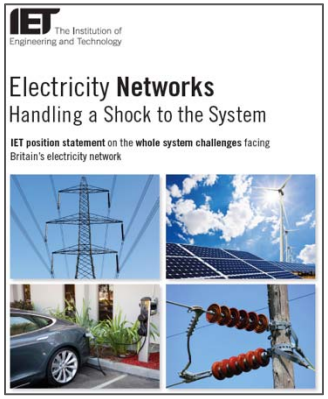
The Institution of Engineering and Technology

http://www.theiet.org/factfiles/energy/elec-shock-page.cfm

IET's expert group, PNJV
Current status



The IET has now obtained 'political sponsorship' for the debate. This has followed strong engagement in a House of Lords Select Committee and reference in their report.

FPSA: Future Power System Architecture project has commenced to examine the issues and establish evidence. This is funded by Government, via the Energy Systems Catapult, and is facilitated by The IET.

Following 6mths intensive work, the Final Report was recently submitted to government.

The FPSA report is not yet published but background is available at:
http://www.theiet.org/sectors/energy/newsletters/energy-autumn-2015.cfm?type=pdf

2030 ahead: concluding messages

No longer think of wind farms as 'connecting *to* the system', but rather as 'joining *with* the system'

- As *part of the system* there should be new ways for wind generation to contribute solutions and earn income
- This whole-system interaction may require new technical capabilities – and shaping the market /regulatory agendas
- New opportunities will appear as whole-systems thinking and regulatory/governance changes come into effect
- Where connections are problematic, *generators* could develop and propose 'Active Network Management' solutions to the network owners for faster, cheaper solutions

A perspective from the UK

Thank you for your attention

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