Image courtesy flickr.com /photos/ footloosiety/

Power System Technology – A Systems and Research Perspective

ElecTEC10

11th June 2010

electricity research centre

Electricity Research Centre (ERC)

- Integration of renewables & distributed energy resources
- Flexible demand
- Portfolio analysis
- Energy economics and policy

Prof Mark O'Malley, director

Research group of 25

Funding:

http://erc.ucd.ie

ERC Industry Members

CER Commission for Energy Regulation
An Coimisiún um Rialáil Fuinnimh

SWS Energy

Gaelectric POWER FROM NATURE

EPRI ELECTRIC POWER RESEARCH INSTITUTE

ESB Energy International

BORD GÁIS

SSE Renewables

EIRGRID

erc electricity research centre

VIRIDIAN

ESB Energy Solutions

CYLON

SIEMENS

BORD NA MÓNA PLC

ESB Networks

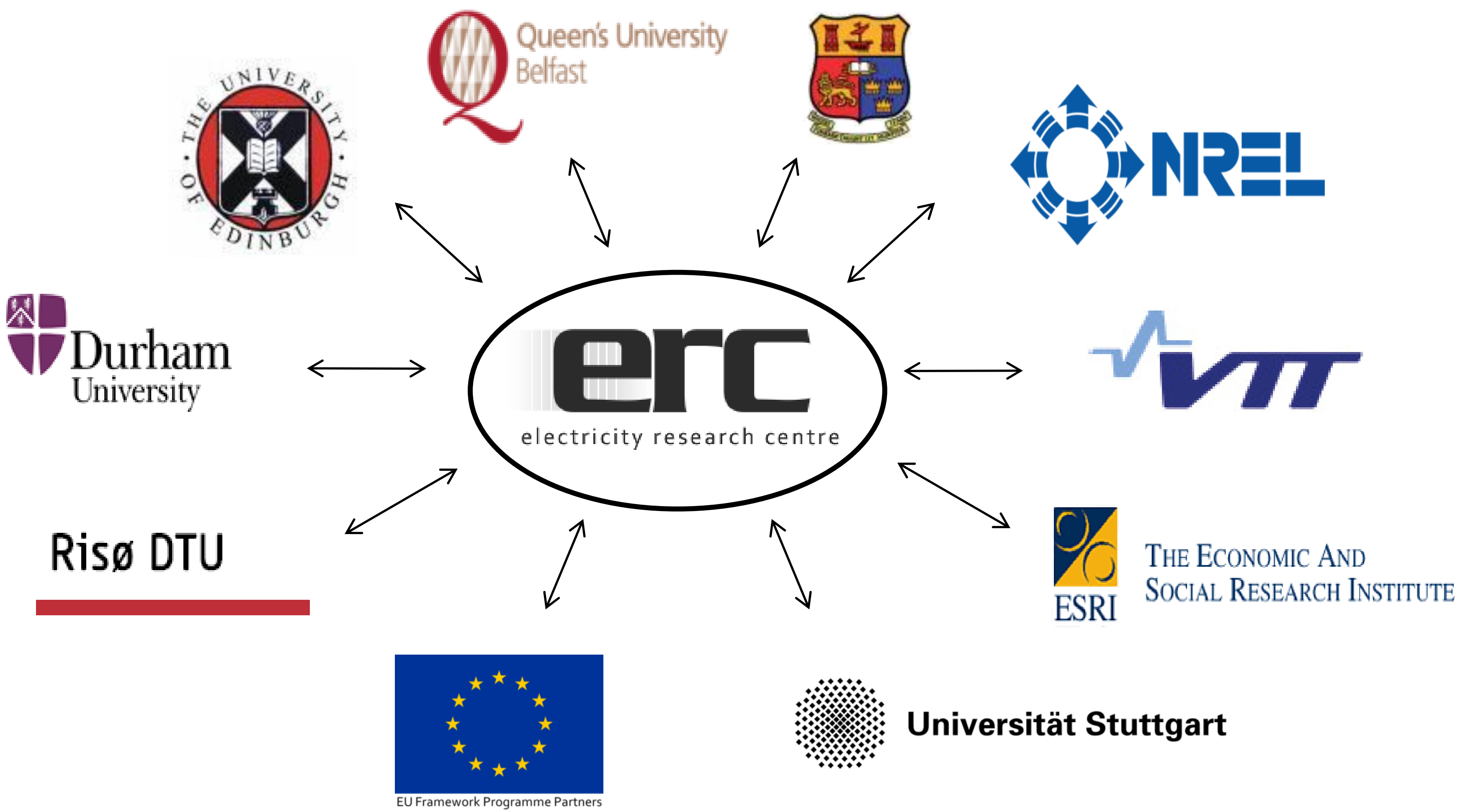
Other stakeholders on the ERC board:

Department of Communications, Energy and Natural Resources

ESRI The Economic And Social Research Institute

seai Sustainable Energy Authority of Ireland

ERC collaborations



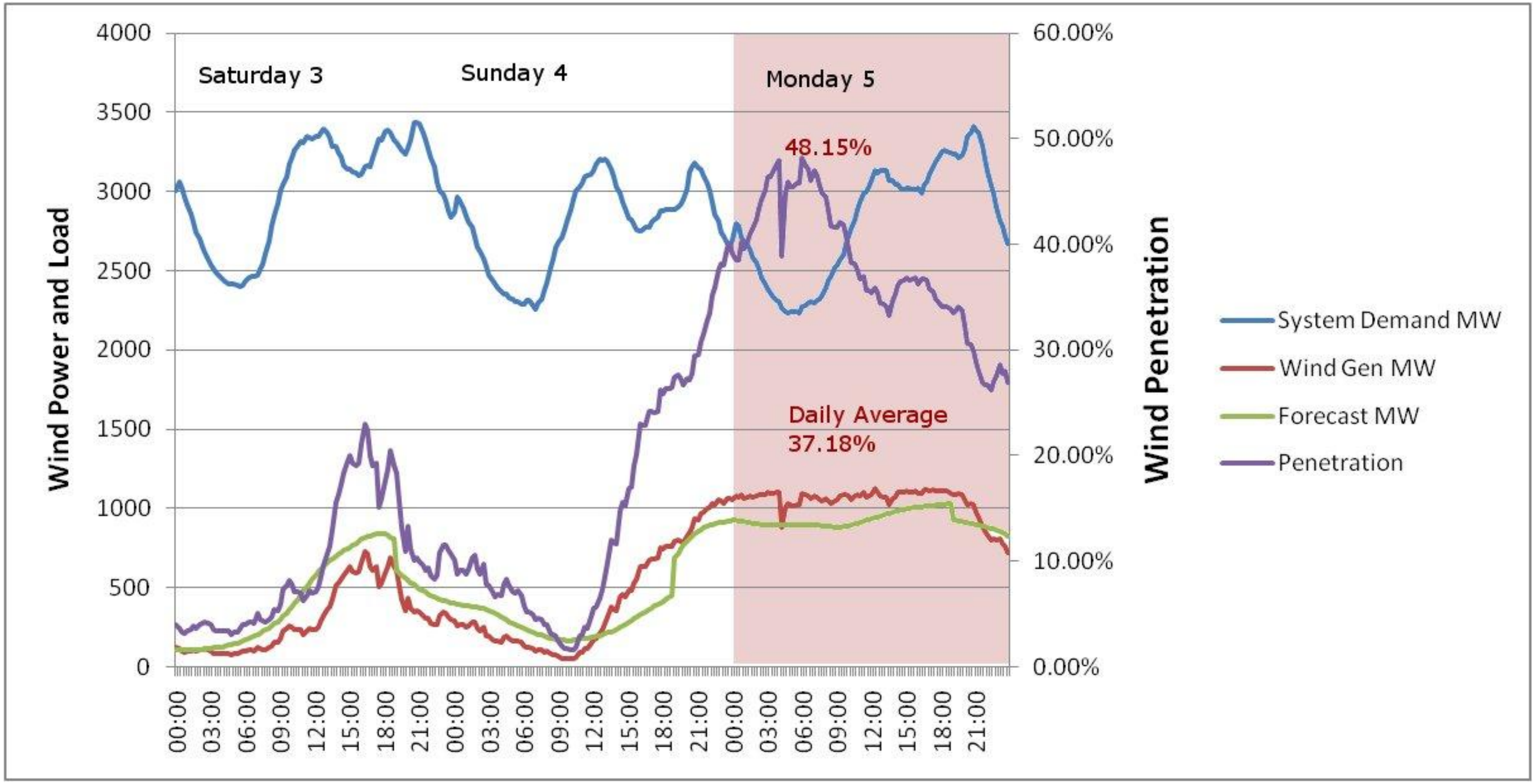
Examining Systems to identify technology needs

- A systems perspective is needed to ensure the correct technology is developed and deployed to increase grid efficiency.

- ERC examines system operation through analysis, modelling and simulation studies; technology is then needed to ensure outcome

- Economic aspect also important.

Need for flexibility

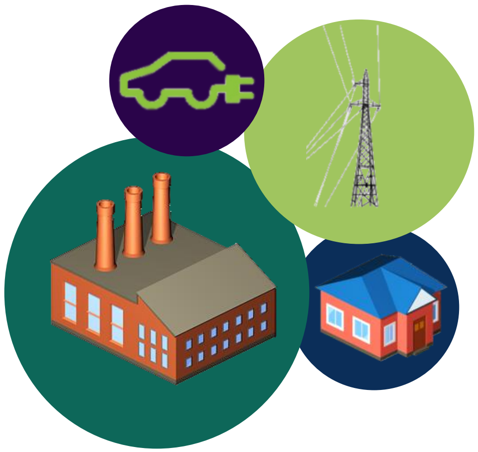


~1GW change in 18 hours (2% to 48% penetration)
– 1247MW installed – 5.5GW planned

Data from www.eirgrid.com

Power System Flexibility

- To enable larger shares of wind, increased grid flexibility is needed
  - Flexible generation (both RE and conventional)
  - Storage and Interconnection
  - Flexible consumption
  - ‘Smart Grid’ - State-of-the-art transmission system



Flexible conventional generation

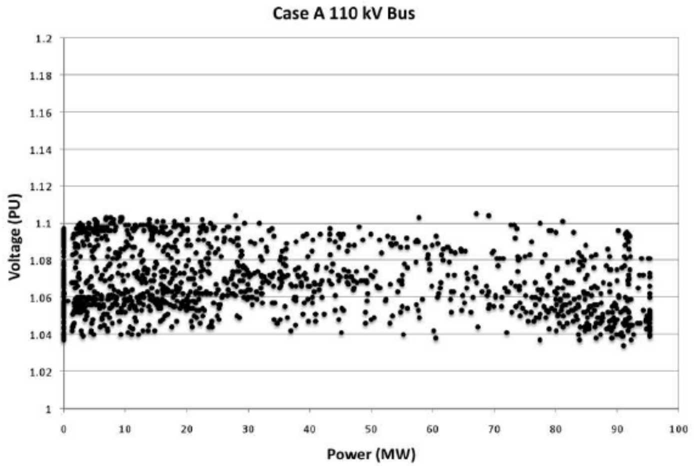
- Currently main source of flexibility: Respond to changes in demand and generation
  - Not just very flexible plant such as OCGT or hydro, but also other technology, i.e. CCGT or coal (longer acting but can still respond to changes)
    - MW/min is main measure
    - Start-up times, Minimum up and down times
    - Minimum stable level increasingly important – keep baseload units on at lower level
  - More cycling in conventional plant will have to be considered

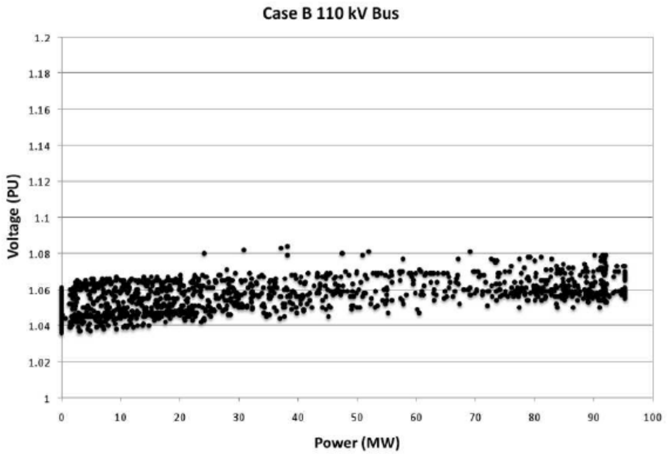
Wind Generation

- As wind penetrations increases:
  - Ability to control distribution connected wind
    - Controllability of small wind farms
    - Enhanced power factors
  - Transmission connected wind must utilize reactive power resources efficiently
    - Strengthen the rural networks
    - Provide support for conventional generation
    - Increase system stability

Wind for Flexibility

- Reactive power support can increase stability margin of the system





- Utilizing the wind efficiently and how it interacts with conventional generation will be critical

Wind For Flexibility

- Moving forward:
  - Wind farms will need control to curtail and ramp generation
  - Inertial emulation from wind
  - SCADA control of wind will be critical for system operators
- These advances will allow for larger interconnection of wind while keeping stability of the system in mind

Interconnection

- More important as variability increases
- Increased sharing of balancing services
- Need for fast acting interconnection
- HVDC Networks / HVDC Light has a key role to play
- Supergrid / Desertec require long, high capacity connections
- Reliability an issue in these large projects

Storage

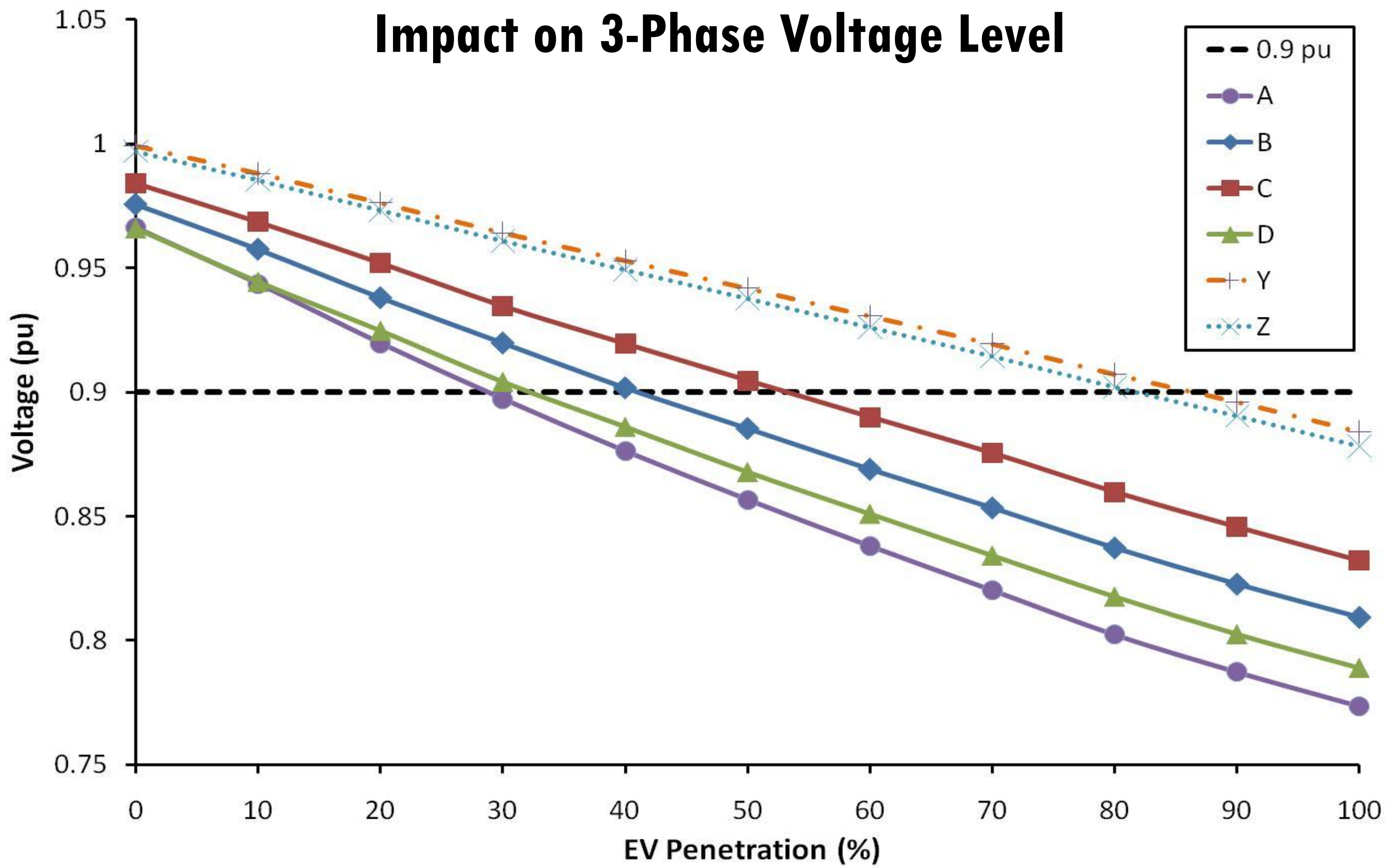
- Prevents curtailment of variable resources
- Development of centralised and distributed storage
- Capital expenditure a major issue
  - Caverns for CAES require specific geology
  - Civil works for large scale pumped storage
- Efficiency affects economic case
  - Round trip efficiencies need to improve to make storage more viable
- Fuel storage
  - Wind variability affects the flows in gas system.

Electric Vehicles

- Electric Vehicles (EVs) will introduce a new type of load to power systems
  - Large numbers of EV loads may present a new challenge to the existing distribution network
  - Active demand side management would help to accommodate such loads while minimising the need for costly network upgrades

Photo: www.esb.ie

Electric Vehicles



- High levels of EV charging can exceed distribution network operating limits

Electric Vehicles

- EVs as Flexible Load
  - Potential to act as large flexible loads if controlled in an aggregated manner
  - Achievable through a smart network solution

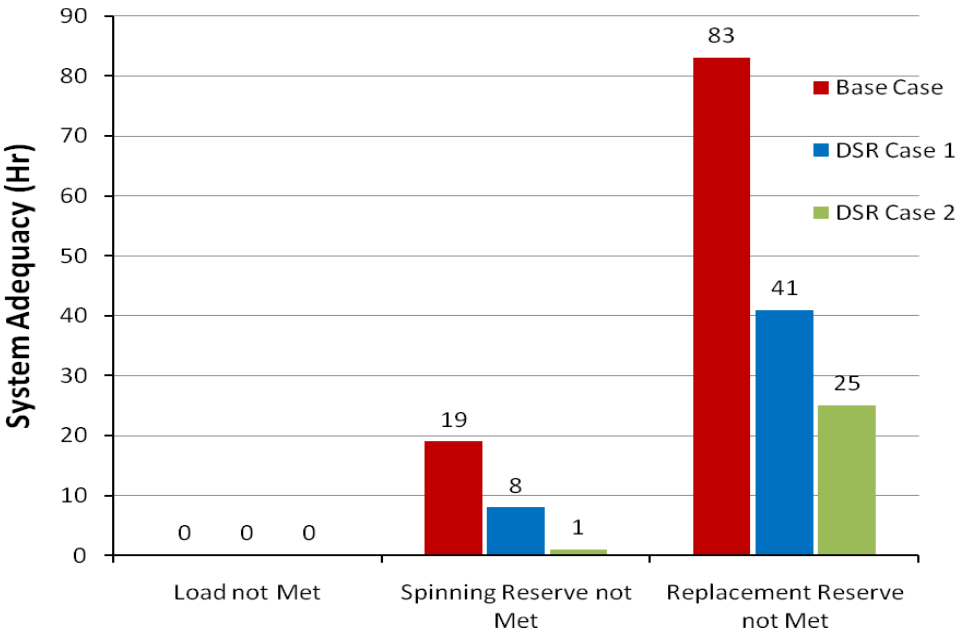
- Key Challenges
  - Distribution network characteristics may limit flexibility
  - Uncertainty in availability of EVs
  - Requires suitable IT Infrastructure and smart meter technology
  - Appropriate DSM schemes should be developed

Demand Response

- Could be very significant, but currently close to zero (in sense of being flexible for wind):

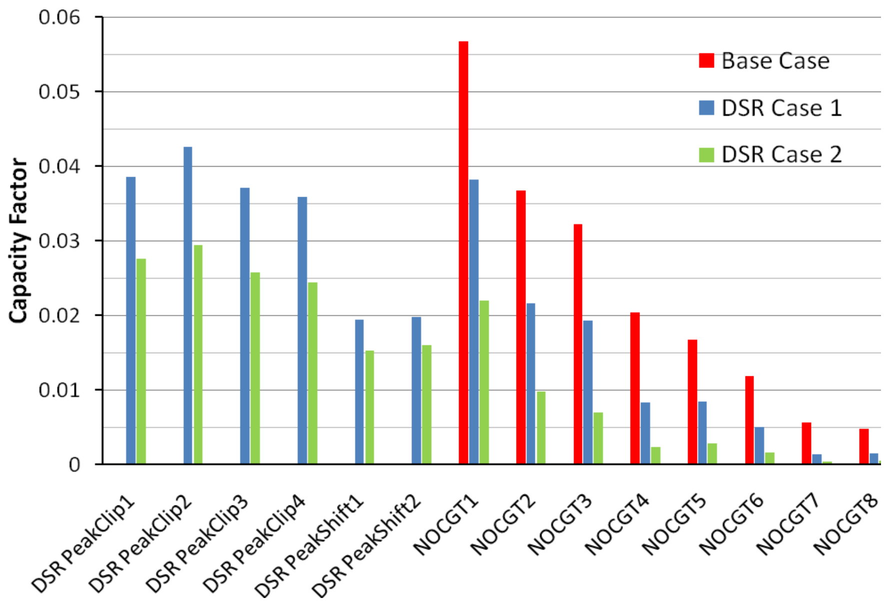
- Aggregated domestic/industrial loads can be scheduled off
  - 'Smart grid' components
  - Smart meters (and real time pricing or close)
  - Need to be well coordinated and optimised to ensure greatest utilisation

Demand Response



- System adequacy improvement
- Can replace conventional units in terms of energy
- Inertial and voltage support to the system may not be provided

"Demand Side Resource Model for Unit Commitment", Keane et al, 2010, in review



Communications and Control

- Vastly increased number of generators, many in remote locations
- Generator outputs are variable and are not always coherent with load requirements
- Load will be more variable and less predictable
- Many distribution networks will now be active rather than passive
- Hence, in order to operate the grid in a safe and secure manner, the number of control centre decisions and commands issued to generators and substations will multiply.

Communications and Control

- Smart grids are constructed around ICT
- Control and implicitly communications will be at the core of future power systems
- Delivery and maintenance of communications infrastructure will be critical
- For example, satellite communications is already used in Ireland to control remote substations. US company iDirect is now offering utilities dedicated satellite bandwidth for control of substations

Thank You

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