Renewable Energy Systems

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High Penetration of Renewables into the Japan Grid

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Renewable Journey

1982

2014

1982-91 Research into wind technology

1992 Our **FIRST wind farm**, Carland Cross, UK

2001 King Mountain, wind farm in Texas, is then the **largest wind farm in the world**

2003 RES moves into **award-winning low carbon** head office, Beaufort Court

2005 RES supplies onsite renewables – **biomass and solar**

2006 Wind projects reach **1GW**

2008 Large-scale PV and biomass projects begin development

2009 RES manages the **engineering and construction** of Centrica's **194MW offshore wind farm**

2010 First **solar park** in France

2010 RES' wind installations reach **5GW**

2012 Offshore wind joint ventures - **developing 500MW** off Brittany and **400MW** in the Irish sea

2013 RES' energy projects exceed **8GW**

2013 US-Canada **Transmission line** completed

2014 RES completes it's first **Battery Energy Storage project**

High Penetration of Renewables

- Technical challenges can and are being overcome
- High penetration of renewable energy is already working in some markets today
- The lights are “staying on”!
    - Norway – 100% renewables and recent diversity from hydro
    - Iceland – 100% from renewables with significant geothermal
    - Portugal – around 35% on average from renewables
    - Denmark – 45% from renewables in 2012
    - Germany – growing to over 20% in 2012
    - Japan – 9% renewables

Australian Market Example

- AEMO concludes that 100% renewable is possible

- 100% renewable is not without its challenges:
  - geographic & technology diversity of the generation portfolio
  - strong network infrastructure (in particular strong regional interconnectors)
  - network power quality support infrastructure
  - accurate generation forecasts are all required to manage network

- Improvements in technology
  - Rapidly improving battery technology, leading the way for economic network support solutions
    - Frequency control
    - Voltage control
    - Ramp rate
    - Reactive power
  - e.g. RES' battery solutions for power quality support (frequency control) in the US/Canada

Source: AEMO: 100% Renewable Study July 2013

Energy Storage – RES's battery solution

RES' battery solutions for power quality support (frequency control)

Storage offers solutions:
- for power quality / availability
- Ramp rates
- allows integration of renewables
- commercial scale assets

RES has completed & operates two 4MW /2.6MWh frequency regulation projects in USA & Canada

50MW of projects in development.

RES can design, engineer, construct, own & operate energy storage projects

South Australia Case study

- South Australia is a good case study for a high renewable penetration region
- Renewables generation = 1,475MW wind + 533MW PV which is greater than SA's minimum demand (1,040MW)
- In July 2014, 43% of SA's total energy was supplied from wind
- At 4.15am on 28th Sept 2014, 109% of SA's demand was instantaneously supplied by wind (with the excess being fed in to Victoria via interconnectors)

Source: Renewable Energy Integration in South Australia, October 2014

South Australia Case study

- This makes SA one of the highest penetration regions in the world, and yet the system is running reliably and within the very strict grid rules applied in Australia (some of the most stringent in the world)

- Note that the report does highlight that under a combination of very unlikely events (the interconnectors and all of the frequency control and regulation services (e.g. gas plant) fail at the same time) then this could lead to a state wide power outage
  - They note that a solution to this could be to develop new ancillary services markets (e.g. for the provision of frequency control) within SA so that the network can be supported locally.
  - Again, energy storage could be an economic solution here and batteries in particular can provide very fast acting response

Source: Renewable Energy Integration in South Australia, October 2014

Situation in Japan

- The overheated FiT has led to a large amount of PV being pushed in (or potentially) to the distribution network:
  - exceeding the capacity constraints of the local networks and
  - potentially leading to power quality issues (PV in particular can have very high power ramp rates as clouds pass over)

- Good forecasting and storage could assist here but ultimately the distribution lines can only cope with so much before infrastructure upgrades are required. Improving interconnectivity will help

- Geographic and generation profile diversity i.e. wind + solar provide a flatter generation profile than each alone hence support for wind and other alternative renewables is now important

- Network strengthening and energy storage also important as is being promoted

Any Questions?