Infrastructure and Market Implications of Energy Storage For Electricity Markets in Europe and Asia

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By

Magdalena AK Muir
Researcher, Arctic Institute of North America
Associate Professor, Aarhus University, and
Adjunct Professor, Johns Hopkins University
Presentation Outline

European Energy Storage:
- UK Leighton Buzzard Substation Case Study

Asian Energy Storage:
- Japan
- Korea
- Australia

Observations on infrastructure and market implications
Key role in enabling the EU to develop a low-carbon electricity system by providing more flexibility and balancing to the grid, as well as back-up to renewable energy.

Locally, to improve distribution network management, reduce costs & improve efficiency.

The paper stated that energy storage can
- Ease market introduction of renewables,
- Accelerate de-carbonisation of the grid,
- Improve security and efficiency of transmission and distribution,
- Stabilise market prices for electricity, and
- Ensure higher security of energy supply
Limited storage in the EU energy system (around 5% of total installed capacity) almost exclusively from pumped hydro-storage, mainly in mountainous areas.

Other forms of energy storage – batteries, electric cars, flywheels, hydrogen, chemical storage - have limited market penetration or at an early stage of development. Necessary to consider
importance of eu energy storage

decisions to invest in the development and deployment of adequate storage capacity will depend on the evolution of the energy system. closely linked to developments like:

(a) electricity super-highways with large-scale renewable energy systems in north sea and north africa combined with distributed and regional solutions;
(b) penetration of electric vehicles; and
(c) improvements in demand response, demand side management and smart grids.
Economic Challenge for EU Storage

Economics is main challenge, and varies depending on where the storage is needed (generation, transmission, distribution or at customers level). Economic benefits to owners and users will depend on storage location. Uncertainty around value due to compensation, innovative business models, and storage ownership.
EU Grid Integration Challenge

Storage is not a stand-alone technology and must be considered with grid infrastructure. Storage will complement other ways of improving grid flexibility. Integrated measures are needed

- Large centralised storage,
- Small decentralised storage,
- Flexible generation systems, and
- Back-up capacity.
UK Leighton Buzzard Substation

6 MW/10 MWh Smarter Network Storage Battery Technology Project involves S&C Electric Europe, Samsung SDI and Younicos on UK Power Networks substation.

Project has technical and commercial aspects:
- Deploy large-scale distribution-based storage
- Implementation of smart optimisation & control system to manage & optimise storage flexibility
- Innovative commercial arrangements to support the shared use of energy storage in providing wider system benefits (standby reserve and frequency)
- Assessment & validation of value of storage.
UK Leighton Buzzard Substation Implementation
UK Leighton Buzzard Substation Cost Analysis

Funding of £13.2 Million ($22C Million) by Ofgem, under The Low Carbon Networks Fund scheme for the period of Jan 2013 to Dec 2016. Income forecast for project from short term operating reserve and frequency response, and displacement of generation capacity.

Anticipated future UK energy storage benefits: Research from Imperial College, identifies savings from energy storage of £3bn a year by the 2020s, based on 2GW of energy storage. The value increases with increasing renewable generation, with savings of £10bn a year identified towards 2050, based on 25GW of energy storage.
Japanese Ministry of Economy, Trade and Industry announced large-scale storage batteries for electricity grid substations. Tohoku Electric Power will install large-scale Storage batteries (lithium-ion batteries) at Nishi-Sendai substation. Hokkaido Electric Power and Sumitomo Electric Industries will install storage batteries (redox flow batteries) in Minami Hayakita substation. The companies will cooperate to increase renewable energy in the Hokkaido area.
Map of Japan Electricity Distribution Network with Different Regional Systems

日本の電力網と電力会社の管轄
Electricity grid and companies in Japan

北海道電力 Hokkaido
東北電力 Tōhoku
東京電力 Tōkyō
北陸電力 Hokuriku
中部電力 Chūbu
関西電力 Kansai
中国電力 Chūgoku
四国電力 Shikoku
九州電力 Kyūshū
沖縄電力 Okinawa

60Hz / 50Hz

500kV 交流(AC)
275 – 187kV 交流(AC)
250kV 直流(DC)
250kV 直流(DC)

周波数変換所 Frequency Converter
交直変換所 AC / DC Converter
Japanese Electricity Market Implications

Japan plans to unbundle transmission and distribution, as 10 regional power companies own more than 70 percent of generation and control transmission and distribution networks. Smaller companies such as Marubeni and Softbank will be more willing to invest in renewable energy under new framework. Residential solar customers also have option of storing energy from solar systems to use to offset time-of-use electricity rates.
South Korea government is considering mandatory use of energy storage and management systems by companies and public offices that consume electricity. Private companies will store energy in off-peak times when supply and prices are low, and sell excess power back to the market. Government will revise current electricity rates, widening the gap between highest and lowest amounts paid, to allow higher uptake when demand is low. His approach will encourage greater renewable generation.
South Korea Electricity Generation

South Korea's net electricity generation by type, 2001-2011

billion kilowatthours

Source: U.S. Energy Information Administration
Energy Storage in Australia

Energy storage study by Clean Energy Council considers energy storage to support existing networks, facilitate the efficient operation of electricity markets, improve the stability of our grid, and meet needs of remote communities and customers.

Commercial storage options considered are: Supporting Fringe and Remote Electricity Systems, Network Support, Market Participation, Grid Stability, Residential Storage, and Business Storage.
Australia Electricity Market

Historical Pool Prices & Futures Forward Prices (as at 6 July 2012)
Observations on Infrastructure and Market Implications of Energy Storage

Use, value and location of energy storage depends on electricity transmission and market design. Electricity markets & infrastructure may change for energy storage. Economic challenges of storage may equal to technological challenges. Replicable models of public-private partnership for pilot energy storage projects from Europe, UK, and Asia.
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Further information on energy storage available at:
http://www.arctic.ucalgary.ca/research/sustainable_energy_development