RAP Energy solutions for a changing world

RGI workshop: Storage Needs, Options and Challenges

Storage vs. transmission and demand management

Stephen Benians

Thursday, January 27, 2011

December 27, 2010 **The Regulatory Assistance Project** 48 Rue de Stassart Building C, BE-1050 Brussels, Belgium Phone: +32 2-894-9300 web: www.raponline.org

Storage vs. transmission and demand management

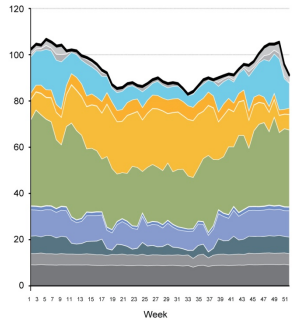
Contents

- The future context determines our approach to storage today
- Role of transmission
- Role of Storage: solutions and limits
- Role of DSM and distributed storage
- …enabled by smart grids (and smart policies)
- Conclusions

Storage vs. transmission and demand management

The Future:

- 80% GHG reduction by 2050 means 95-100% decarbonisation of power sector, buildings, transport.



80% RES
10% CCS
10% nuclear

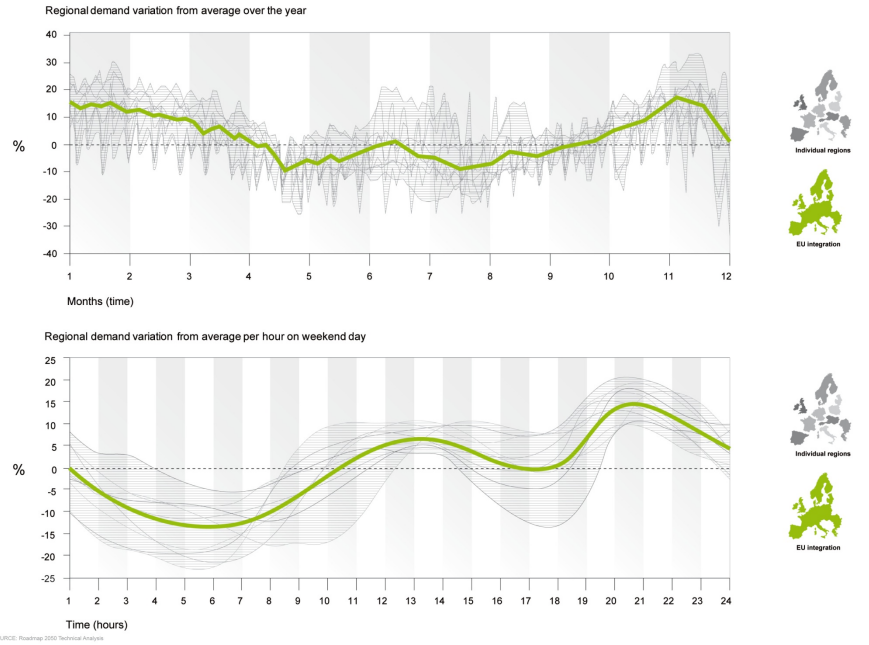
HI RES Future determines our approach to storage today

- Hi RES penetration – 80% (more non dispatchable low carbon generation); decarbonised power sector; in a single competitive wholesale power market
- Storage - and transmission and Demand response – must be seen in context of this future. More RES means more Intermittency and non-dispatchable –this makes demand management, storage and interconnections all valuable.
- Hi RES future will shape their qualitative combination in regions…if Market designs incentivise power sector decarbonisation, *including investments in transmission and demand storage technology necessary for a reliable and affordable '2050' system*

2050 High RES future: transmission role

Transmission: Inter regional demand and supply sharing is key

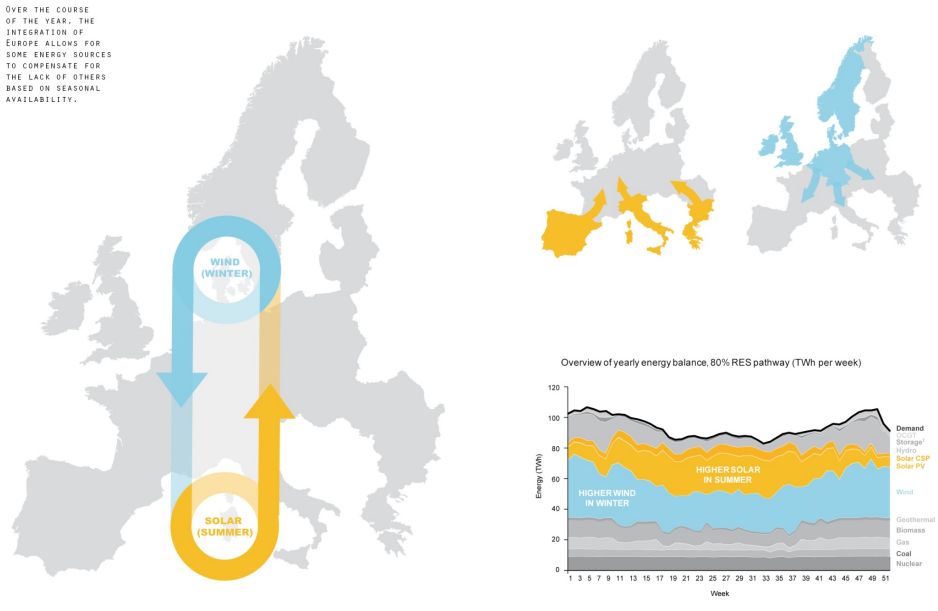
- Transmission reduces impact of demand and supply variability over system – and leverages negative correlation between solar and wind. daily and seasonal demand differences across regions = lower aggregated demand variability.
  - Ratio of peak demand to minimum demand is reduced

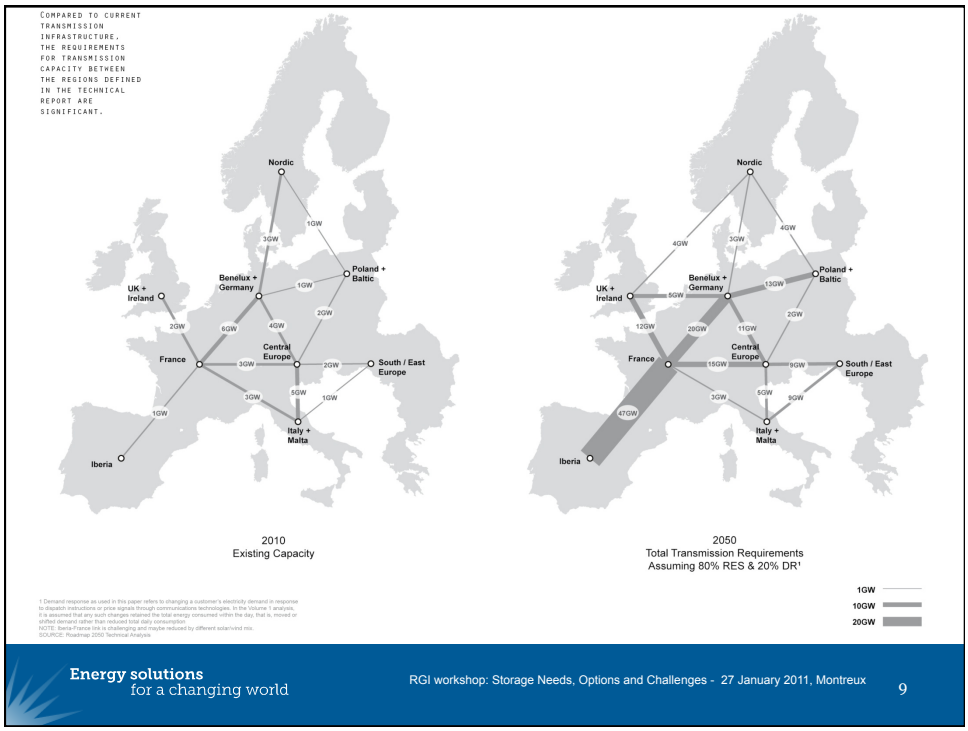


2050 High RES future: transmission role

Transmission: Inter regional demand and supply sharing is key

- Supply level: wide aggregation disperses volatility of otherwise locally volatile wind output.
  - Less backup gen needed if connect regions with sufficiently non correlated resource profiles.





High RES future: transmission vs storage

Transmission between regions lowers need for excessive backup gen capacity and balancing costs allowing the sharing of system resources and reserves.

- Compete (to a point): storage capacity can displace/defer need for additional transmission capacity (and/or generation)
- Complement: transmission cannot solve all variable generation - extreme conditions, day/night variations. Storage supports it:
  - More intraday variations with RES – storage can help balance
  - Smooth output from large scale intermittent Gen – like a conventional baseload plant - so RES more attractive to market
  - start up power (likely centralised large scale storage – PSH)
  - In hi RES future storage and Transmission synergy depends on market structure at both ends (long term capacity contracts don't lend themselves well to short term balancing needs). Till then…storage

Storage solves different challenges, but not always

- RES value enhancement. storage strategies match supply with demand to balance a predicted output; reduce fees for forecasting errors over the hour. System & dedicated storage offer great trades & reduce variability!
- Storage type depends on time over which you charge and discharge it, and how (in)frequently you plan to cycle it.
  - **second by second:** fluctuations managed by key Regulation Service; **minute by minute**: flexi resources increase/decrease output.
    - **System storage** on RES gen site for balancing
  - **Hour by hour**:
    - Dedicated storage capacity displacement and arbitrage; reduced variability; imitates conventional baseload. Suits large scale & remote RES gen
    - centralised point storage: Pumped storage hydro only real commercial scale option as yet. Onsite for wind forecast management
  - **energy shortages beyond a few hours**… conventional centralised storage is not efficient to deal with it

Anti-cyclone over North Sea offshore wind scenario

- Transmission? Yes, but also…
- Coal plants to re-charge pumped storage hydro? No.
- Expanding conventional forms of storage? Not likely: to be profitable they must arbitrage intra/inter day differentials – recharging when energy is short makes this storage part of the problem!
  - current and forecasted storage options can't deal with rare events where system is short of energy for days or even weeks
- Demand response? Yes and No. OK to shift demand within day or over 2 days at most – beyond that, it's unserved demand, ie reduced reliability. Not a viable solution for such (rare) events,
  - "storage" at a very local level is embedded within demand response
- …Peaking combustion turbines? Yes. GHG impact is minimal for rare events

Most economic system combines transmission, CTs and demand response rather than invest in new storage systems

When supply exceeds demand, same principles apply: smart combination

The need to avoid curtailment can maximise investments in intermittent RES & storage:

- Dedicated Storage at generation site to 'take' the power from RES discharge at another (off peak/unwindy) moment
- Transmission takes it to the load centres. Not only answer…
- Demand response: Demand can be scheduled / automated in the course of the day or even longer to moderate less controllable fluctuations in supply

Clearly all three are needed – scenarios need planning for; markets need to make these solutions attractive *now* for *then!*

2050 High RES future: demand management

DSM toolbox:

- Reduce the demand peaks, especially when utilisation of power comes close to its limits of availability
- Shift the loads between times of day or even seasons
- Fill the demand valleys to better utilise existing power resources
- Reduce overall demand (strategic saving) in the context of delivering the required energy services by use of less energy (and not a reduction in services)
- Provide strategic growth especially to shift between one type of supply to another with more favourable characteristics, for example, in terms of the environment

➢ RM2050: DR max 20% of daily energy demand is shifted in 24hrs

➢ High RES future: DSM is key but storage has role in making maximising its potential…

Distributed Storage and demand response (1)

- Especially **Distributed energy storage** which complements both distributed and centralised generation.
- Technologies such as advanced batteries; thermal storage units associated with HVAC systems;
- Right time charging/discharging of EV can reduce peak demand; improve load factor, reliability and system flexibility by **smoothing ups and downs of variable generation.**
  - Customer incentive/automated response: “charge when wind blows!”

Smart grid enabled and demand response & distributed storage

- Smart grid: smart metre (just a tool), plus distributed intelligence in appliances, plus overlay of sensors, software, advanced controls, 2-way comms

Smart grid enabled and demand response & distributed storage

- Residential load is not usually considered in current context:
- Remote appliance control in a DSM context reduces system peaks
  - **Distributed intelligence in appliances**:
  - Scheduling UK's 10 million dishwashers to run at lowest demand time provides all Uk balancing needs
  - Ontario: reduced by 1 degree the AC – nobody noticed!
- Smart grid enables Demand response and distributed and embeded storage - combined with EE obligations - The potential **may well compete** with 'conventional' storage (though 'storage can be seen as embedded in DSM')
- Likely consequence: widely 'Distributed energy storage' complements distributed (and centralised) generation but must work in concert with DSM

Smart Grids need smart policies

- 'Smoothes' microgenration onto the grid to balance system
- Achieving consistenly high levels of peak load reduction via dynamic pricing requires automating customer's responses.
- Reducing peak loads via dynamic pricing and other **smart grid enabled demand response & distributed/embedded storage** offers huge operational savings checks generator and market prices. But…
- …Only if demand response shifts usage from less efficient peaking resources **to more efficient and low/no carbon resources.**

Conclusions 1

Transmission:

- storage makes it robust & profitable to a certain extent Storage:

Storage

- Centralised storage: less technological, geographical; financial scope for centralised Large scale storage. Not much greenfield hydro. Maybe add PSH to hydro.
- Decentralised: will play a more important role. Large scale centralised systems at the site of RES gen will serve in certain scenarios… but storage tech will adapt to need of specific context.

DSM strategies:

- reduces (not eliminates) need for costly centralised storage. DSM works in tandem with **distributed storage & smart grids. Most action here – and together with new markets, jobs, innovation: most commercial *and political* potential..**

Conclusions 2

- **current market structure favours large-scale point storage** solution, so integration challenge seems expensive, when in fact it can be quite affordable if we opt for the system wide solution.
- storage is always more valuable the closer it is to load: so **embedded &distributed options are economic on wider scale especially enabled by smart grid *and smart policies***
- centralised storage can be attractive (adding PSH to hydro) and plays its role but more remote/centralised storage will be less attractive commercially and have less of the market
- **New market and planning must decide the Transmission, Storage, DSM, CT combination most efficiently**:


Questions…
Energy solutions
for a changing world
RGI workshop: Storage Needs, Options and Challenges - 27 January 2011, Montreux
21