Renewables Grid Initiative

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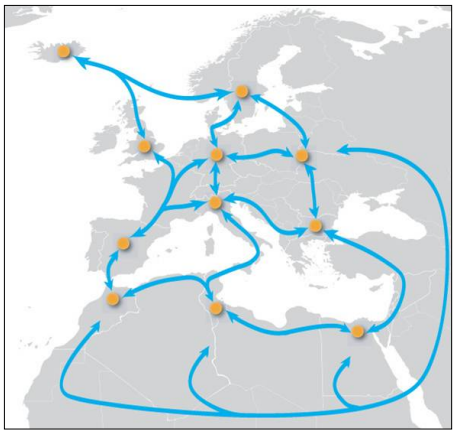


Applications and benefits of storage, Montreux, Switzerland 27/01/2011

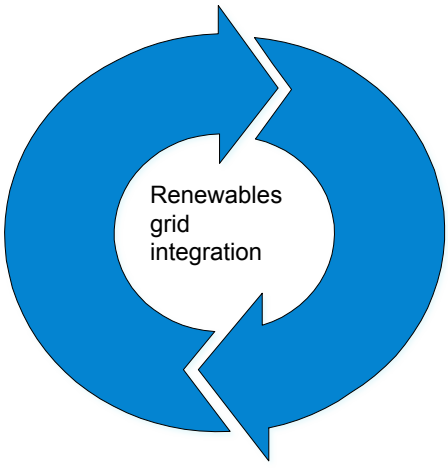
Towards a decarbonised power system alliance

Renewables Grid Initiative

Renewables grid integration

Grid expansion

- Within regions/ countries
- Between regions



Storage

- System-focused
- Dedicated to a renewables source

Renewables Grid Initiative

Storage characteristics

- Rating
  - energy
  - power
  - discharge
- Response
  - start-up
  - deployment
- Efficiency
  - round-trip
  - retention losses
- Energy and power density
- Charging costs
- Portability
- Operating costs (labor, plant/ equipment maintenance)
- Lifetime
- Reliability
- Power conditioning
- Environmental impact

Potential applications (1/6)

Balancing

- Classified according to different timeframes
  - primary (within seconds)
  - secondary (within minutes)
  - tertiary (several minutes)
- Current situation: mainly hydro and part-load power plants
- Not feasible in the future power mix
  - inefficient
  - limited available conventional capacity
  - increasing need for balancing capacity due to renewables growth (intra-day and/or seasonal variations)

Potential applications (2/6)

Balancing

- Storage technologies can adapt to the different timeframes required
  - immediate response for frequency regulation
  - reserve for secondary and tertiary response
- Key characteristics
  - deployment time
  - discharge time
  - efficiency
  - discharge cycle frequency
  - electricity prices

Potential applications (3/6)

Capacity displacement/deferral

- Need for additional capacity due to:
  - insufficient generation capacity
  - insufficient/congested transmission capacity
- Current situation: need for additional capacity is modest and is related to demand growth
- Future power mix
  - renewables can not displace completely conventional generation
  - renewables require more transmission capacity compared to other sources

Potential applications (4/6)

Capacity displacement/deferral

- Dedicated storage for a renewable source
  - smooth and predictable generation output able to adapt to market opportunities
  - reduce economic risk of forecast errors
  - able to operate as baseload, mid-merit or peak plant
- Key characteristics
  - reliability
  - dependent on renewable source profile and operational strategy

Potential applications (5/6)

Arbitrage

- Need for electricity time-shift to optimize profits
  - "Buy low/sell high"
- Storage as an enabling solution for arbitrage
- Key characteristics
  - operating costs
  - electricity prices
  - efficiency

Potential applications (6/6)

Arbitrage

- Arbitrage more important in the future power mix
  - day/night renewables (wind) variation
  - avoid curtailment due to peak generation, low demand and/or transmission congestion
- Other applications
  - voltage support
  - improved power quality
  - decentralized storage

Next up

- Pumped hydroelectric and alternative approaches to storage
- Challenges
  - political
  - technical
  - market