The need for flexibility and Energy Storage

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Hydropower and its future role
ITU, Istanbul 21-22 Jan 2016
Conclusions Renewable Energy (RE) potential

IPCC SRREN

“The global technical potential of RE sources will not limit continued growth in the use of RE

A wide range of estimates are provided in the literature, but studies have consistently found that the total global technical potential for RE is substantially higher than global energy demand
SRREN: RE integration into the future energy system

Few, if any, fundamental technical limits exist to the integration of a majority share of RE, but advancements in several areas are needed:

- Transmission and distribution infrastructure
- Energy storage technologies
- Demand side management
- Improved forecasting of resource availability
Three Important deadlines in EU Energy/Climate policy

2020

The RES Directive
Share of RES 20%
Policy in effect

2030

2030 Framework
Share of RES > 27%
Finally decided Oct 2014

2050

Energy roadmap 2014
Near 100% Renewable?
REN will increase from 632 TWh (2010) to 1152 TWh (2020)
Largest absolute increase in Wind (ca 120 GW and 305 TWh)
Strong relative increase for solar PV (ca 65 GW and 82 TWh)
→ Largest increase for non-dispatchable sources (wind, solar, small hydro, ..)
RE integration need to consider:

- Variability in demand and supply, in time and space
- Dispatchability Predictability
- Capacity Factor
- Capacity Credit
- Active power, frequency control
- Voltage, reactive power control

Variable renewables (VREN) like Wind and Solar PV are more difficult (and expensive) to integrate
Integration costs increases with increasing share of VREN

Solar: System LCOE (profile costs only)

Integration costs

Generation costs

System LCOE (profile costs only)
LCOE
Overproduction costs
FLH reduction costs
Backup costs
Generation costs

Final electricity share of Solar PV (%)

€/MWh
RES challenges - Germany
High Photovoltaic production
Summer

Significant reduction of peak load due to solar power production at noon

RES challenges
High Wind power production
Winter

Nearly no residual load left to conventional power plants

But back-up capacity necessary

RES challenges
No production from RES
Winter

Peak load and nearly whole demand during the week completely covered by conventional power plants

Norwegian hydro and Danish wind

Norwegian hydro exporting

Danish wind cover underproduction

18 Oct  20 Oct  22 Oct  24 Oct

Norwegian hydro exporting

Danish wind cover underproduction

MWh

20 000
15 000
10 000

Export

Import

Generation in Norway
Load in Norway

CEDREN
Centre for Environmental Design of Renewable Energy
Simulated wind production in the North Sea area in 2030 – 95 000 MW installed capacity

80 000 MW

one year
Wind Power North-Sea Region - Jan – March

One week balancing means
Ca 30 000 MW in 168h ➔ 5 000 GWh energy storage

Same as 1000 typical PSH

Can Hydropower in Norway supply this storage?

(Wind data 2001)
Hydropower in Norway – Resource base

Water, high head

Large natural reservoirs
Norwegian hydropower

- Hundreds of large reservoirs
- 20 reservoirs with more than 100 Mm$^3$ both up- and downstream
Goldistal, Germany
8 GWh
Indirect storage

Blåsjø
7.8TWh reservoir
(1000 times Goldistal)
Hydropower – Supporting other Renewables
Environmental impacts
Hydropower supporting grid operation

- Flexibility (with storage)
- Very fast response (seconds)
- Large Storage is possible
- Frequency control
- Grid stability
- «Black start» capability
- Balancing variable generation & load
- ...
Tesla PowerWall© - 10kWh units for homes

- Balancing solar energy
- Energy security
- Off-grid solutions
The Great Wall

Cover with Tesla PowerWall©
1,23 TWh = 15 % of Blåsjø
Centre for environmental design of renewable energy - CEDREN

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