



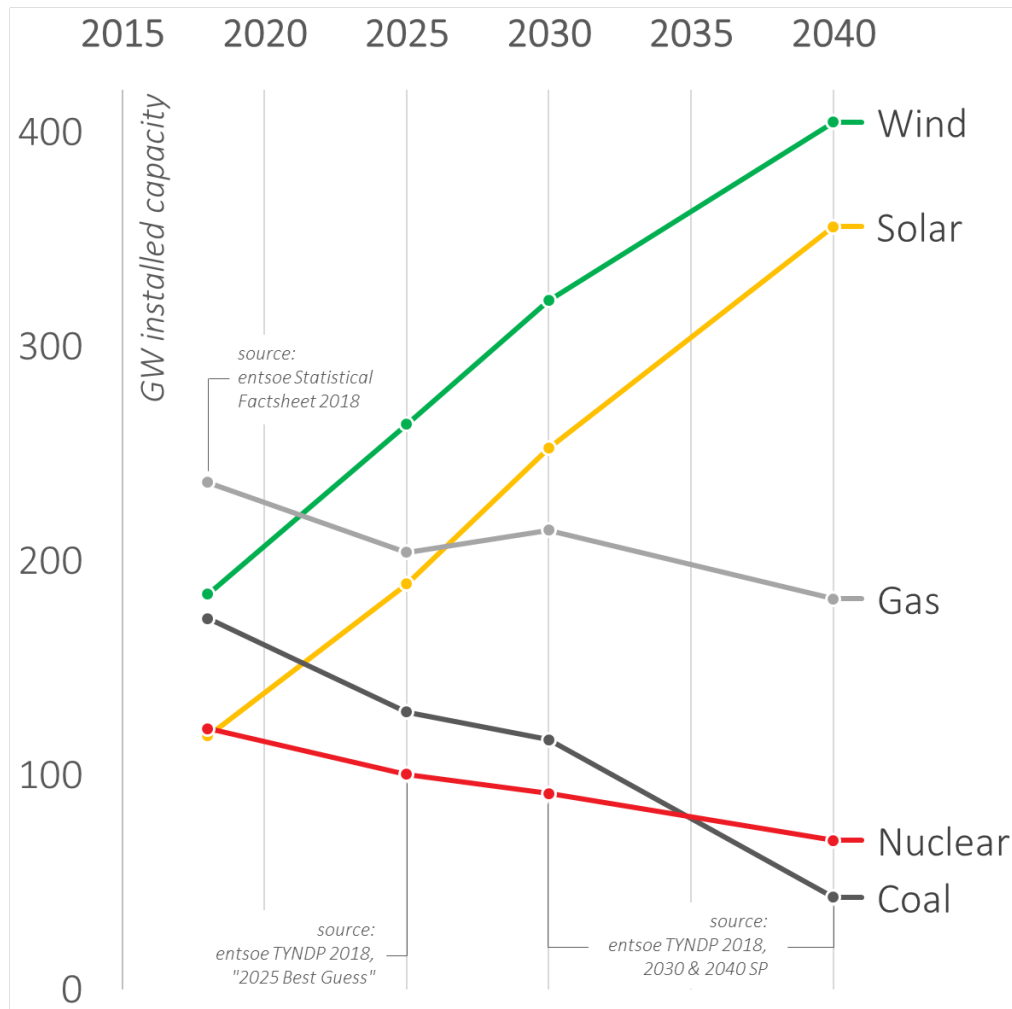
Hydropower in the green European power system,
and the need for R&D

Photo: Statnett

Håkon Borgen, ENTSO-E Chair -Research Development and Innovation Committee (RDIC)

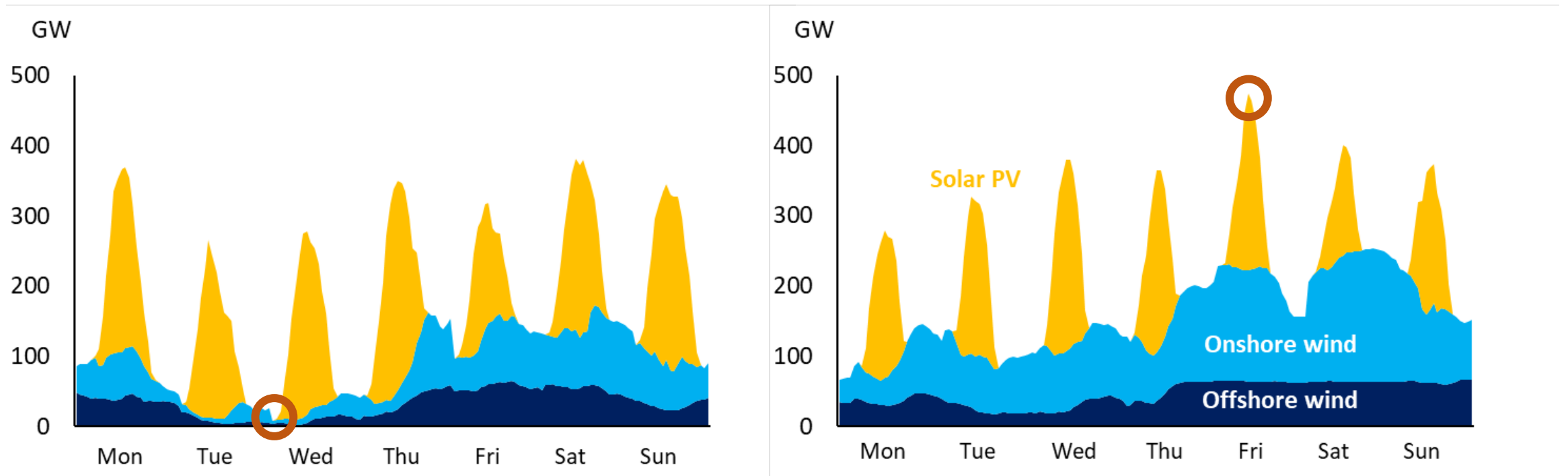
EERA JP HYDROPOWER, BRUSSEL 9 SEPTEMBER 2019

We are headed for a green European Power system



Installed capacity per power source,
ENTSO-E data 2018

Main challenge – huge variations in RES generation

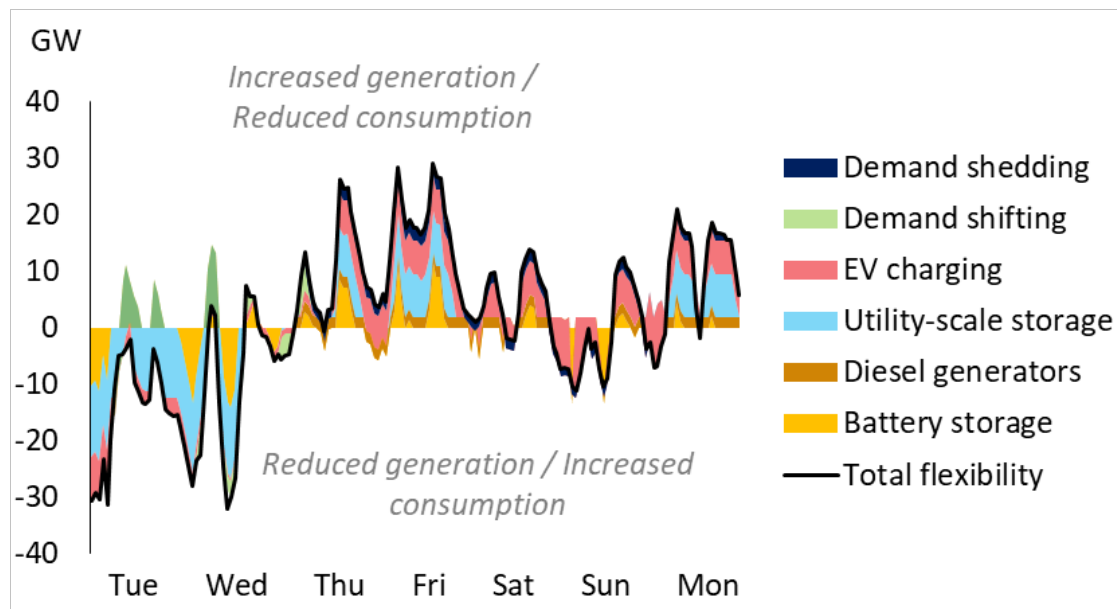


Data from Statnett analyses (LMA 2018)

This requires massive volumes of flexibility

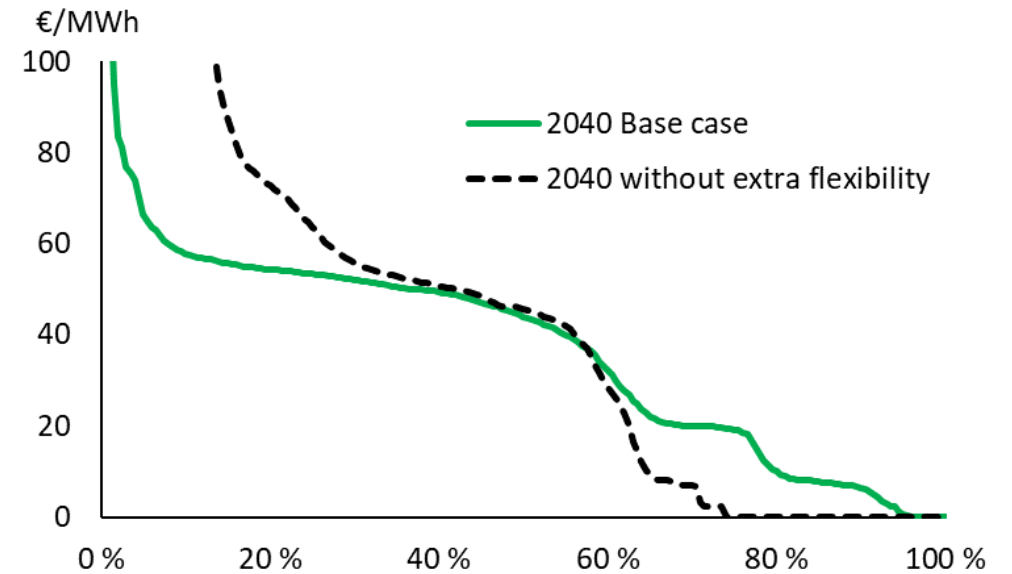
- In order to maintain a stable and safe system operation
- And to keep a necessary usage and profit of new RES

Example peak week, Germany 2040



Results from market model simulations

German price with and without flexibility



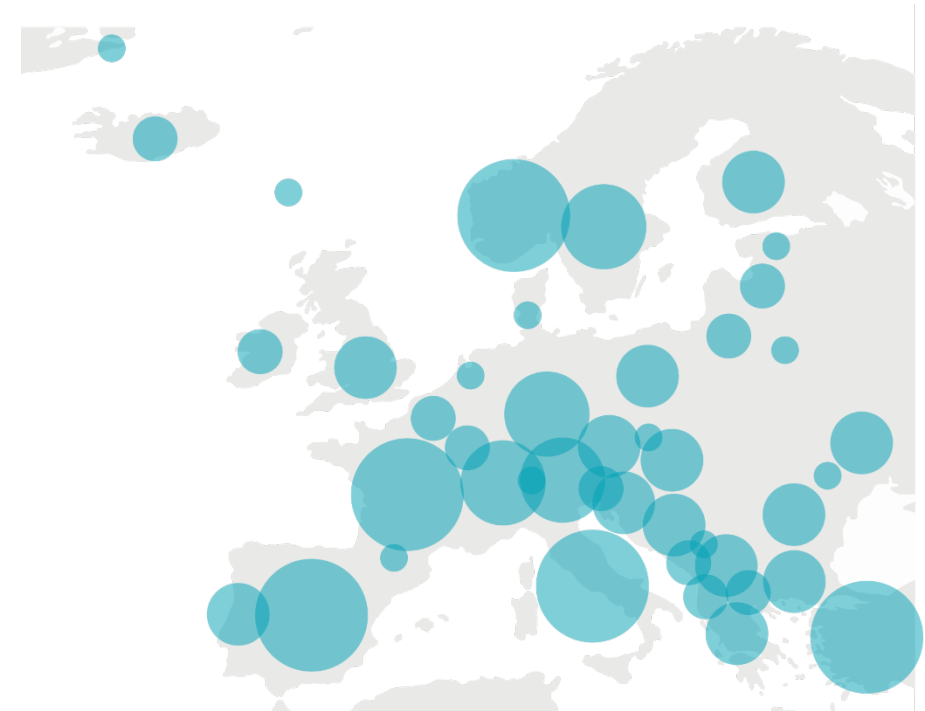
Flexible hydro power is part of the solution

- Hydropower accounts for 615 out of 3660 TWh global generation by ENTSO-E members (17%)
- Increasing importance
 - Nuclear and coal decommissioning
 - Replaced by intermittent sources (wind and solar)
 - Inertia, regulating power and storage capacity
- Hydropower can provide flexibility in
 - Short term (seconds, hours)
 - Medium term (days, week)
 - Long term (seasonal, annual)
- Interaction with other sources of flexibility

Hydro power capacity by country in Europe

Source: International Hydropower Association (IHA)

Total capacity: 252 000 MW



Hydropower responds to variations in wind and solar

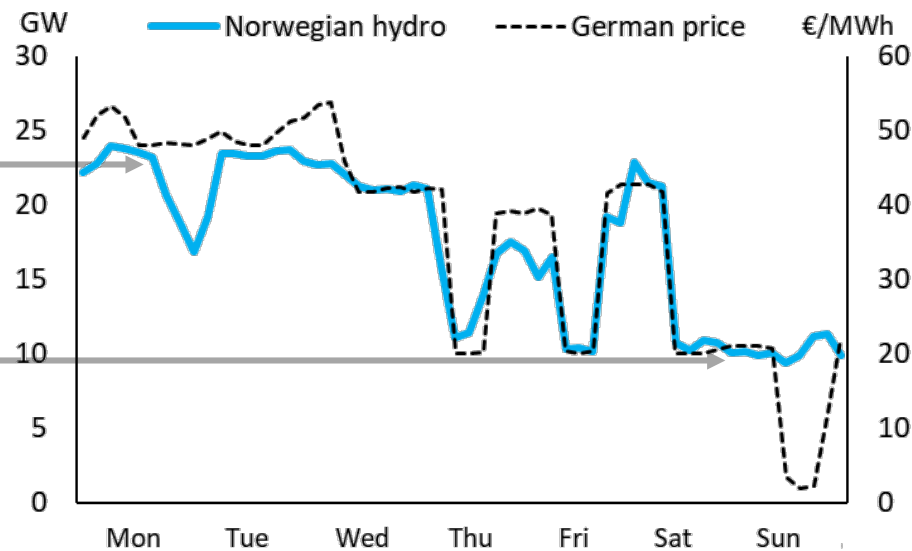
Medium term flexibility through exchange

Example week in 2040

Data from Statnett analyses (LMA 2018)

Norwegian hydropower supplies Europe during high price period (high load/low RES)

During low price period (high load/low RES), Norwegian hydro provides flexibility by shutting down



Short term flexibility with pumping

Hydro power during 2015 solar eclipse

Source: DNV GL, based on J. Weniger et al. (2014) p. 28

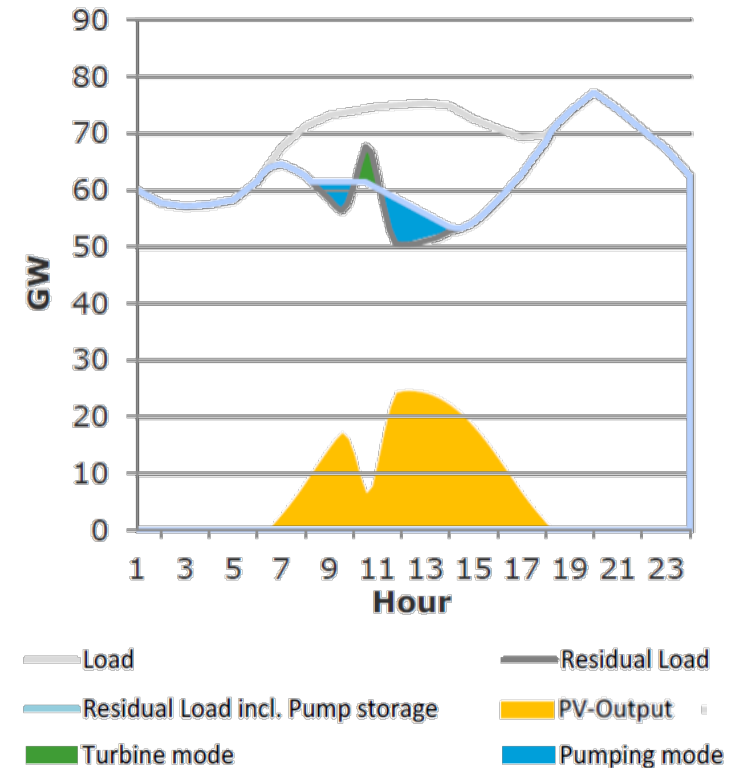




Photo: NVE

Topics for further research

- **Socio-economic benefit**
 - Increasing power system flexibility
 - Improvements on stability and balancing
 - Integrating more RES into the system
 - Flood and drought prevention
- **Costs and disadvantages**
 - Environmental impacts
 - High CAPEX for new capacity
- **Do we have the right tools and knowledge to evaluate costs and benefits?**

ENTSO-E RDI workstreams:

mandate, innovation hubs, European presence and cooperation

1 ENTSO-E task: Research Plans



2 Innovation hubs

- Assets & Technology
- Security & Operations of tomorrow
- Flexibility & Markets
- Future of Energy Systems
- Digital & Communication
- RDI Planning

3 European presence

- EC R&I funded projects
- ETIP SNET – vision, Roadmap