

Possible role of Norwegian hydropower in the future European energy system

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Statkraft
PURE ENERGY

No. **1** WITHIN RENEWABLES
IN EUROPE

89% RENEWABLE
ENERGY

277 POWER AND DISTRICT
HEATING PLANTS

33% OF NORWAY'S
POWER
GENERATION

3200 EMPLOYEES..
20 COUNTRIES



OUR STRATEGY



Flexible generation and market operations

- Hydropower and gas-fired power in North West Europe (incl. France), and small-scale hydro in Norway
- Energy management and market operations



International hydropower

- Hydropower development in Turkey and Albania
- SN Power in South America and Asia



Wind power

- Onshore wind power in Norway and Sweden, consolidate UK portfolio
- Offshore wind power in UK, incl. Dogger Bank to concession



District heating

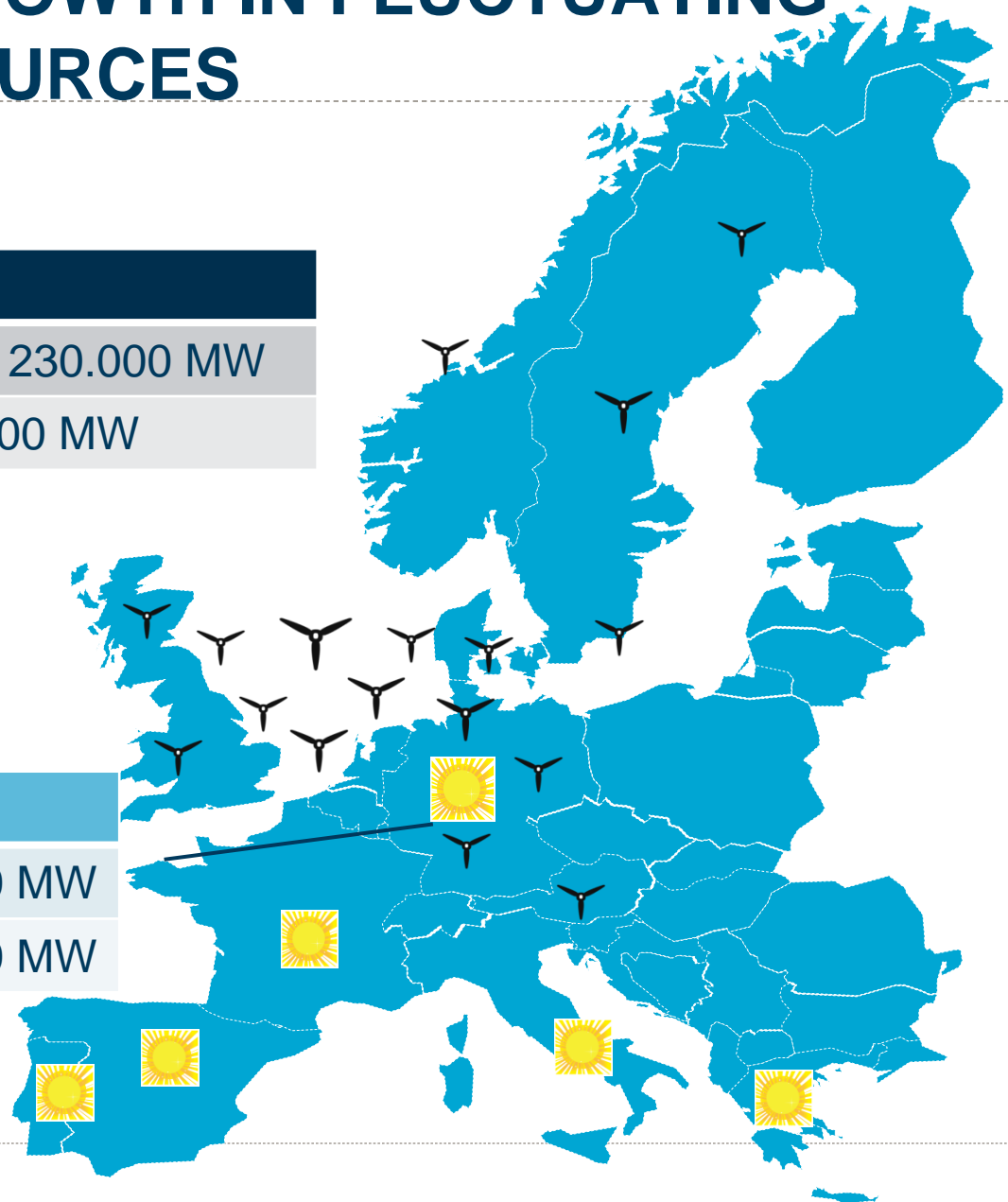


Regional companies

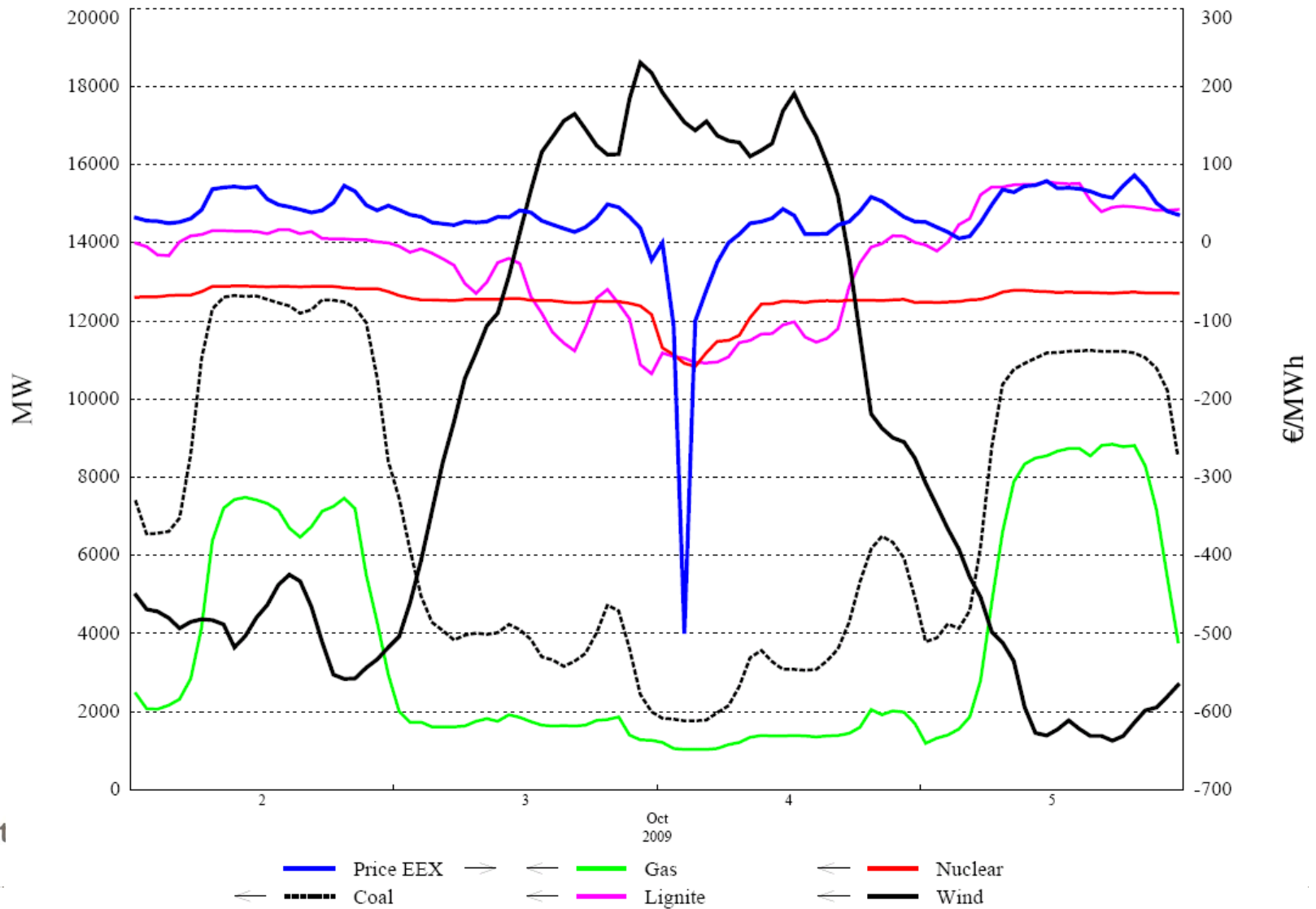
STRONG GROWTH IN FLUCTUATING ENERGY SOURCES

	2009	2020
Wind	76.000 MW	180 – 230.000 MW
PV	16.000 MW	150.000 MW

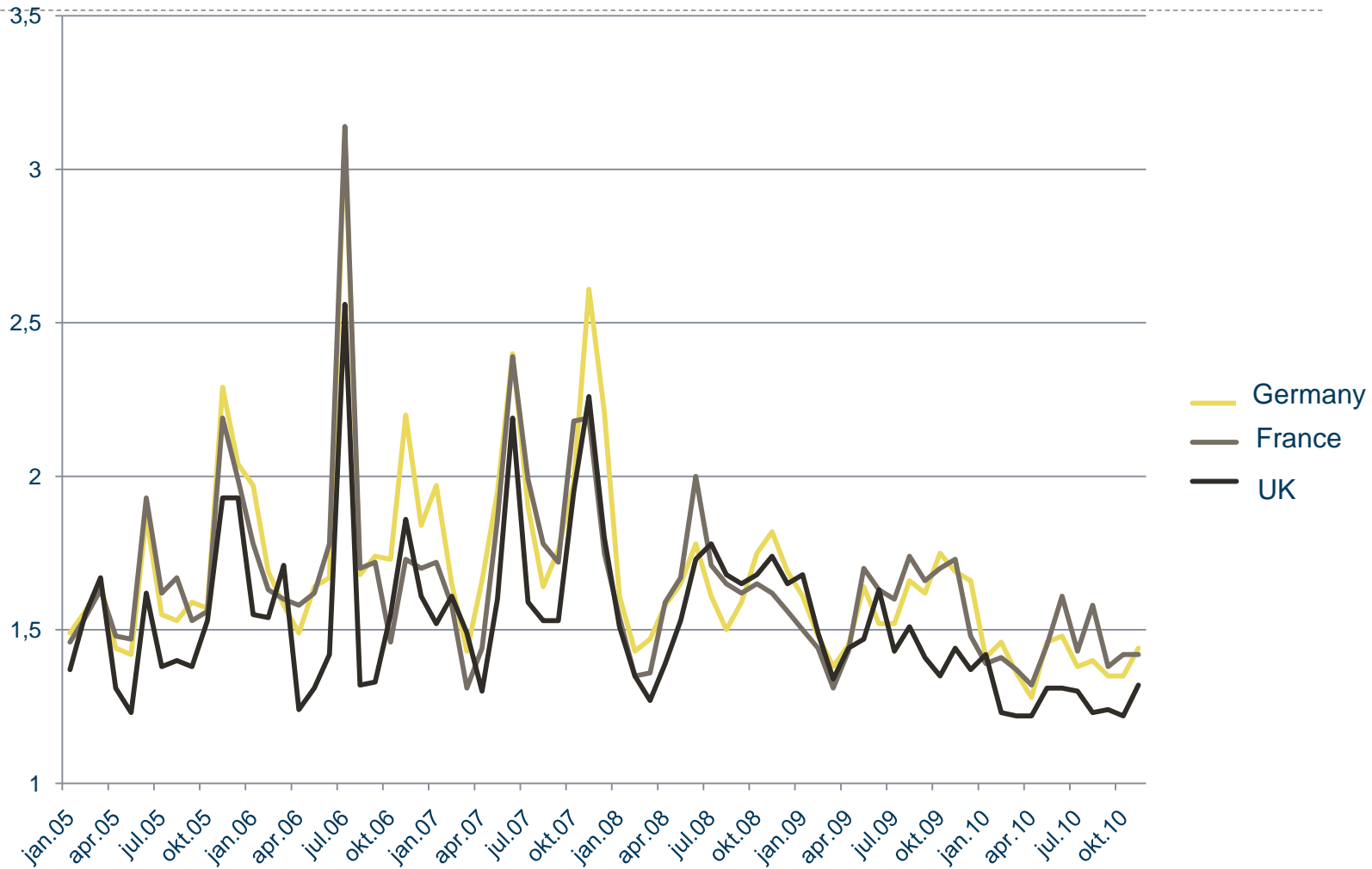
Germany	2009	2020
Wind	26.000 MW	46.000 MW
PV	10.000 MW	52.000 MW



A NEED FOR FLEXIBILITY..



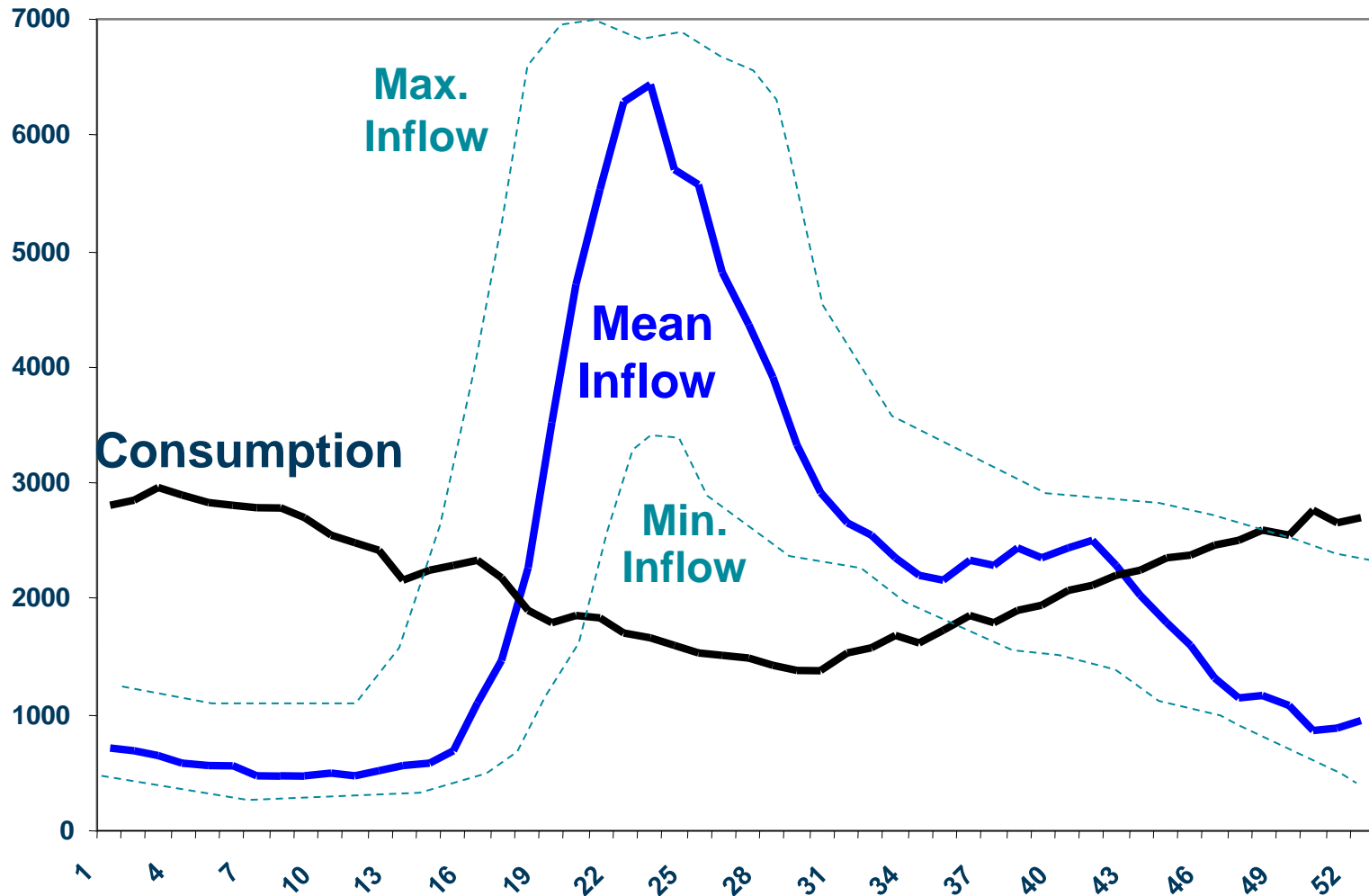
..OR MAYBE NOT



Reservoir management

- the basic challenge in hydro optimization

GWh/week

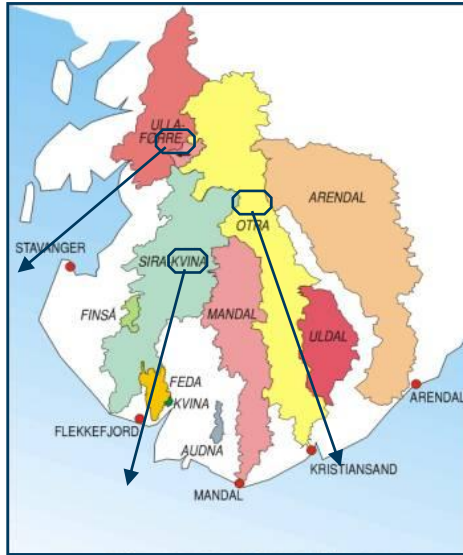


Data for Norway

Week



NORWEGIAN POSSIBILITIES



--> Close to 50 % of the total hydro reservoirs in Europe – 84 TWh

--> Three alternatives:

1. Change the operation pattern in existing plants
2. Increase installed capacity
3. Build pumped hydro storage in connection with existing reservoirs



Both increased capacity and pumped storage is possible where the distance to the Continent is the shortest

TECHNICAL POTENTIAL - SOUTHERN NORWAY

Pump Storage Plants (PSP) possibilities depend on limitations in the change of water level in upper and lower reservoirs and duration for pumping / generation.

Change in waterlevel	PSP Capacity (MW) duration pumping mode			Increased capacity existing plants (MW)
	24 hours	7 days	60 days	
				7500
0,5 m/hour	85000	30000	2600	
0,1 m/hour	30000	16000	2600	
0,01 m/hour	3200	3200	1500	



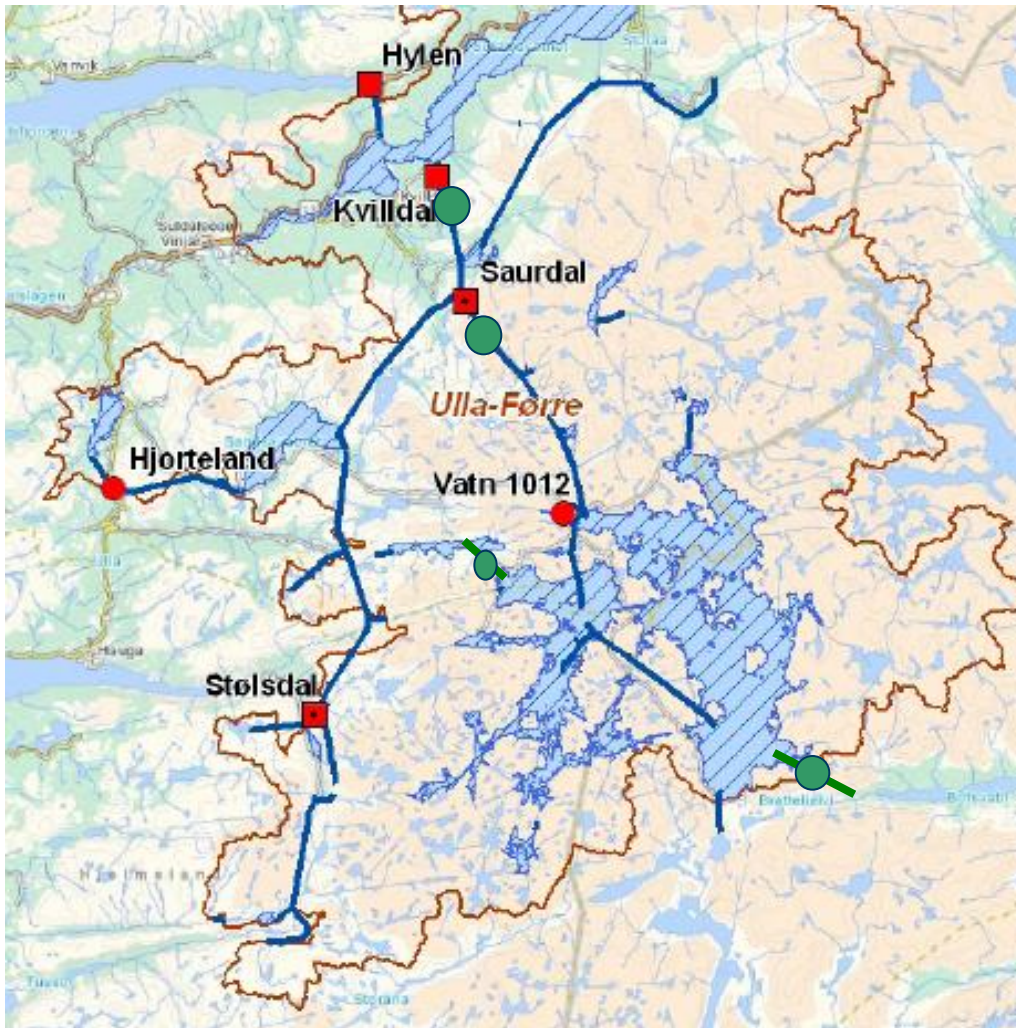
The reservoir capacity of Lake Blåsjø is 7.8 TWh

Area 80 km², elevation :1055m

Today, capacity:

- 320 MW Pumps
- 2050 MW Generation
- 5 TWh/a Mean annual production

ULLA FØRRE – AN EXAMPLE



Legend

- Existing tunnels
- Existing powerplants
- Existing pumping turbines
- New tunnels
- New reversible pumping turbines

Today

PSP 0,3 GW

Generation 2 GW

Future

PSP 4 GW

Generation 6 GW



TECHNOLOGY COMPETITION

Rough assessment for 2020-2030 time frame

	Technology	Long term flexibility	Short term flexibility	Real time flexibility
Demand side flexibility	Smart grid		X	X
	DSM		X	
	Electric cars		X	
	Flexible heating	X	X	
Supply side flexibility	Nuclear, lignite, coal	X	X	(X)
	Gas	X	X	X
	Hydro	X	X	X
	Battery		X	X
	Compressed air		X	(X)
	Grid integration	X	X	X

MAIN CHALLENGES

--> Political and regulatory issues

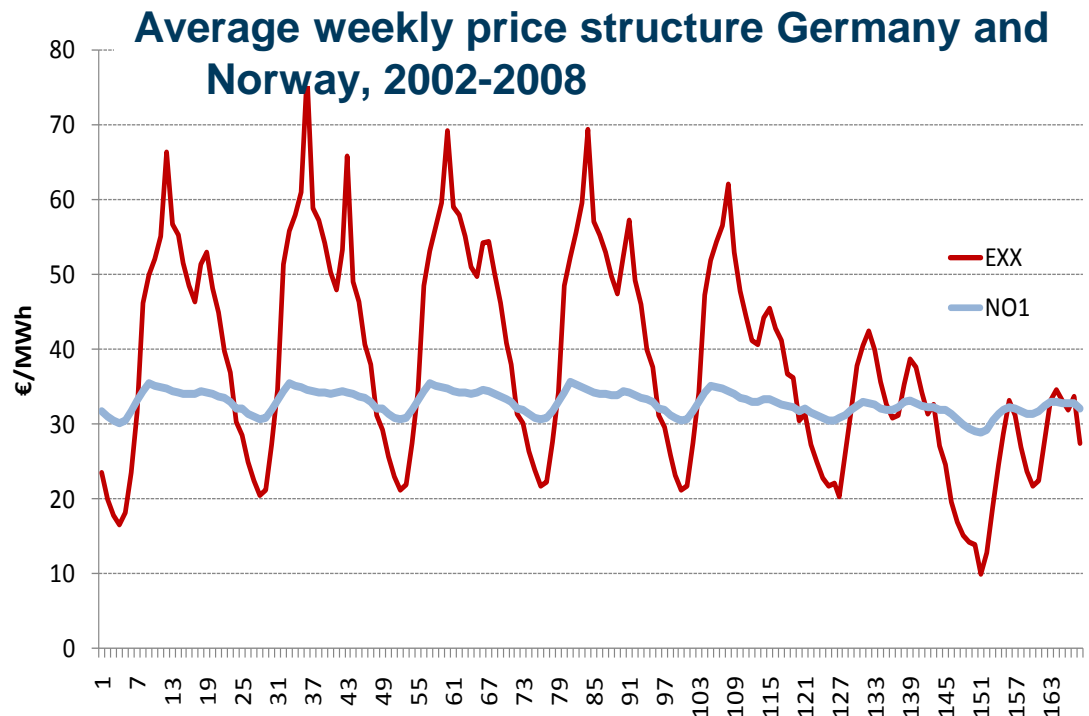
- National and EU regulations
- Transmission capacity and regulation

--> Norwegian issues

- Environmental aspects
- Security of supply
- Public acceptance

--> Commercial models

- Security for long term investments
- Market design issues



SUMMING UP

- ❑ **Balancing large scale integration of fluctuating wind and solar power is likely to be a major challenge in Europe**
- ❑ **Further development of flexible hydropower could be a part of the solution**
- ❑ **To succeed, public acceptance in Norway and development of business models are crucial..**
- ❑ **..and sufficient development of interconnections must be facilitated**

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Our internet site:

www.statkraft.com

www.statkraft.de

Pump storage plant video:

www.statkraft.com/energy-sources/hydropower/pumped-storage-hydropower/

