

The need and value of flexibility in North European power system 2050

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A high amount of variable generation (VG) increases the need of flexibility in energy systems. This study compares the impacts of the share of VG and different flexibility options on production and ramping of generation technologies as well as electricity prices. North European power system in 2050 is simulated with large share of wind power and solar PV.

Scenarios – Traditional, Windy and Sunny

All scenarios are simulated with different flexibility options. New transmission links are allowed in all cases.

- 'Base' cases do not include any special flexibility options.
- 'HeatFlex' cases include flexibilities in district heating.
- 'All' and 'All+EV' cases include heat flexibilities, demand response, lower minimum load of thermal power plants, batteries and more hydro power.
- 'All+EV' cases also include EVs (60 % of passenger cars, 18 % increase in electricity consumption).

Input	2020	2050					
		Trad.	Windy	Sunny			
CO ₂ (€/t)	17	12 49					
Nat. gas (€/GJ)	8	10					
Coal (€/GJ)	2.7	not available					
Wind (€/ kW)	1600	1600	1310	1340			
PV (€/kW)	1394	550	520	270			
VG target share (%)	25	40	60	60			

Ramping

Net load ramps increase with increasing share of PV. Ramping of consumption side increases with increasing share of VG. EVs reduce the ramping of hydro. Increasing share of VG, especially PV, increases the average ramping up/down of thermal power plants. However, it can decrease the amount of hours that thermal power plants, especially CHP, are ramping.



Annual electricity production

pad to

2020

Transition from base load to



Gas engines Gas engines Gas turbines Gas turbines Combined cycle Combined cycle 6000 0% 10% 20% 30% 40% 50% 60% 4000 8000 2000 Hours when ramping (h) Average ramping up (%/h) Sunny2050_All+EV Windy2050_All+EV Sunny2050 All+EV ■ Windy2050_All+EV ■ Traditional2050 All+EV Sunny2050_HeatFlex ■ Traditional2050 All+EV Sunny2050_HeatFlex Windy2050_HeatFlex Traditional2050_HeatFlex Windy2050_HeatFlex Traditional2050_HeatFlex

Electricity prices

Electricity prices from an example price region. Increased flexibility changes the relative share of VG, intermediate power plants and peak load power plants, which can both increase and decrease electricity prices.



System benefit

Large system benefit can be achieved with flexibilities in district heating when the share of VG is high. The system benefit can be doubled when additional flexibility Traditional2050_All Traditional2050_HeatFlex Traditional2050_Base

Electricity production

Impact of flexibility options on electricity production. Heat flexibilities increase the share of wind power and EVs increase the share of PV.



Coal is assumed to be not available for electricity production in 2050.

Windy2	2050_All			51%	<mark>10%</mark>		
Windy2050_H	leatFlex			51%	1 <mark>0%</mark>		
Windy205	0_Base			44%	<mark>9%</mark>		
-50	00 00 Y	0 early ele	500 ectricity	100 v produ)0 ction (⁻	1500 FWh)	2000
■ Coal & p	peat •	Gas &	oil	N	uclear		
Municipa	al waste	Bioma	SS	■ H	ydro		
Wind		Solar		■ O	ther		





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