Grid and Market Impacts of 10 GW Norwegian Offshore Wind

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INTRODUCTION

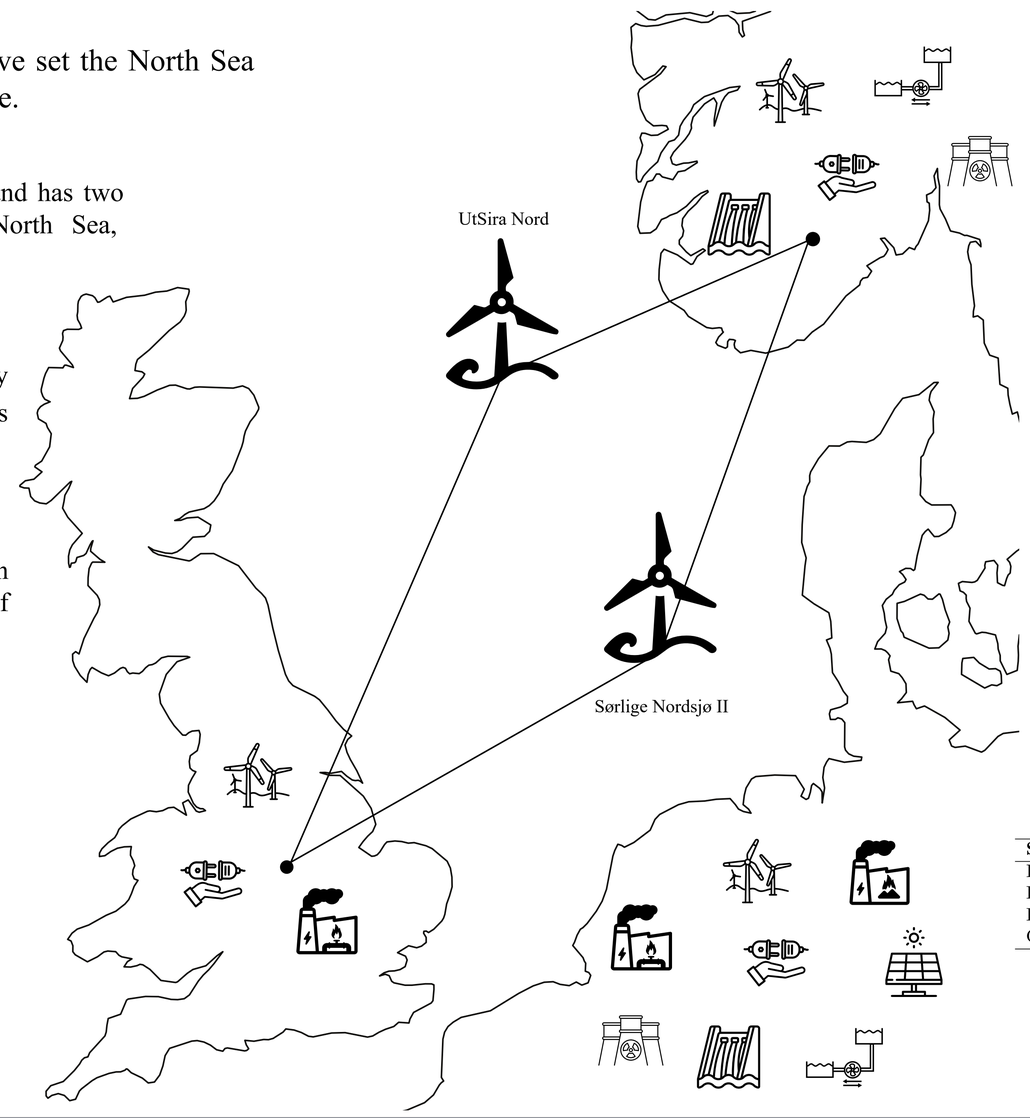
Growth in electricity demand and climate goals have set the North Sea at the center of the future European energy landscape.

Norway has a goal of 30GW of offshore wind by 2040 and has two projects in the advanced stage of planning in the North Sea, Sørlige Nordsjø II and Utsira Nord.

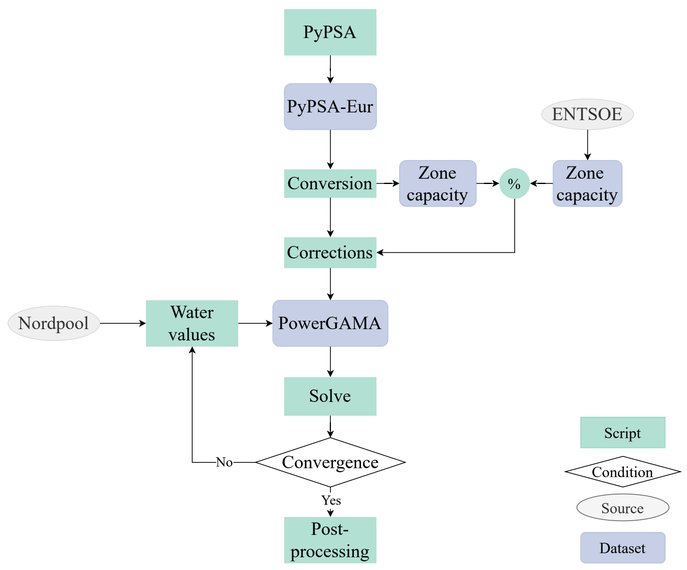
Previous research have focused on Net Transfer Capacity analysis to study the economic benefits of those wind farms in the countries of connection.

We conduct a power flow analysis at the European transmission level to analyze the integration potential of those wind farms and their grid and market impacts under different connection configurations.

Additional information



METHOD



Scenario	New Wind Farms [GW]	Link to NO [GW]	Link to GB [GW]
RAD	5	5	-
HYB	5	2.5	2.5
HYB$^+$	5	5	2.5
CON	-	2.5	2.5

Table 1: Names and capacities of the different scenarios

RESULTS

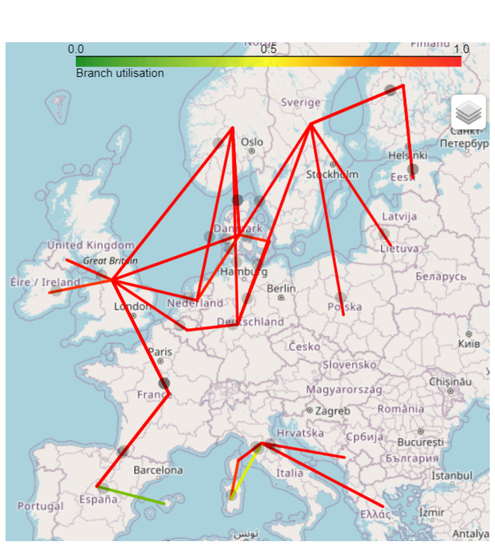


Figure 2. Annual DC lines utilization

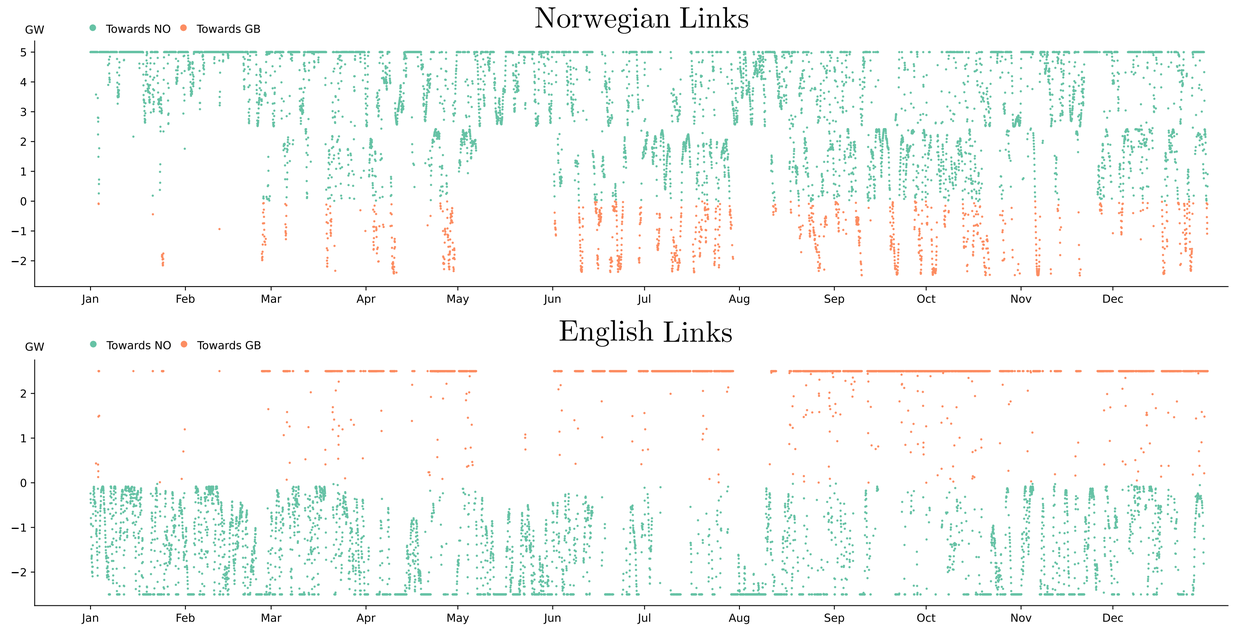


Figure 1. Dynamic utilization of links connecting the wind farms to Norway and Great-Britain

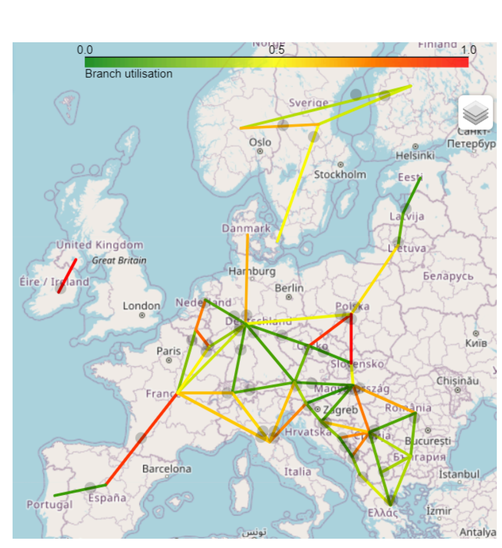


Figure 3. Annual AC lines utilization

	Objective	Fuel	Hydro	User
REF	72.92	61.10	11.81	161.74
RAD	69.99	59.38	10.60	159.67
HYB	70.21	59.34	10.88	160.04
HYB$^+$	69.96	59.42	10.54	159.66
CON	72.42	61.43	10.99	160.53
Savings Δ_{abs}				
RAD	2.93	1.72	1.21	2.07
HYB	2.70	1.77	0.94	1.71
HYB$^+$	2.96	1.68	1.28	2.08
CON	0.50	-0.33	0.82	1.21

Table 2.
Results, reduction in operational & user electricity costs in billions of euros.

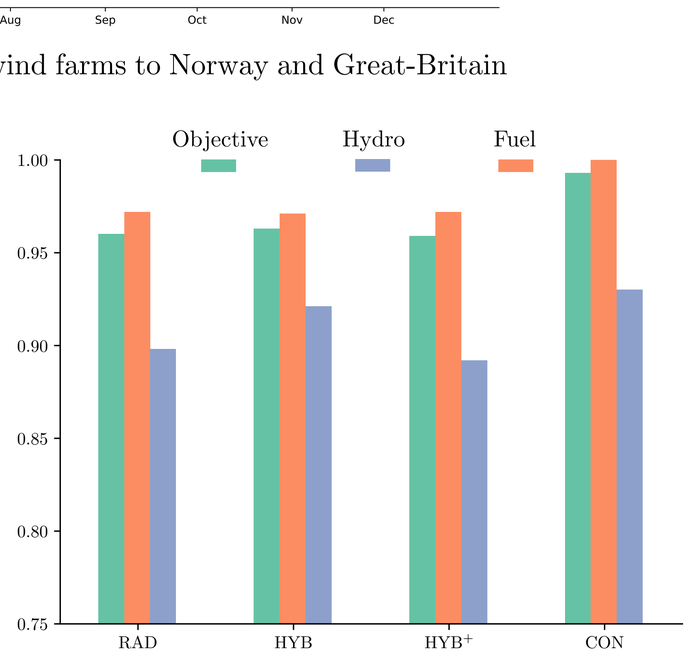


Figure 2.
Economic benefits of the different scenarios in Per Unit

TAKE AWAY

INTERCONNECTORS

Decrease hydro operating costs.
Increase price convergence & PHS utilization.
Increase English exports through Norway.
Cause a redispatch of Danish exports to Europe.

WIND FARMS

Decrease imports in the country of connection by consuming & storing their production.
Decrease fuel costs by replacing thermal units.
Production flows towards mainland Europe.

COSTS & BENEFITS

Costs and benefits aren't localized in the same zones.
Some benefits are observed far from the North Sea.
Risk of blocking expansion candidates.
Reallocation mechanisms are needed.

NORWAY

Hybrid links with maximum capacity to Norway bring the most operational costs savings to the system and position Norway as a near-exclusive exporter of electricity.