Preliminary Results of the FarmConners Market Showcases

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EERA DeepWind 2022

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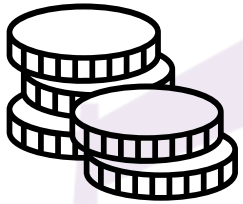
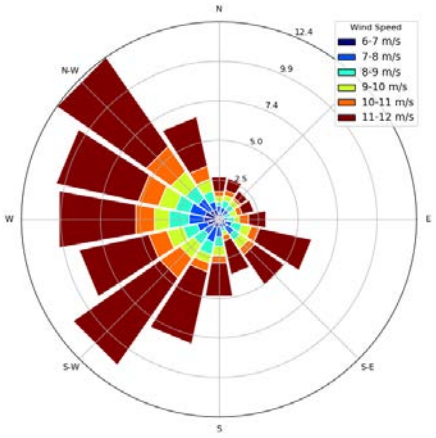
What are the FarmConners Market Showcases?

- Datasets

  of electricity prices and wind inflow (wind speed and direction)





- As input to wind farm flow control
- For a reference wind farm

Kölle, K., et al. FarmConners Market Showcases for Wind Farm Flow Control, Wind Integration Workshop 2020. https://farmconners-market-showcase.readthedocs.io/en/latest/

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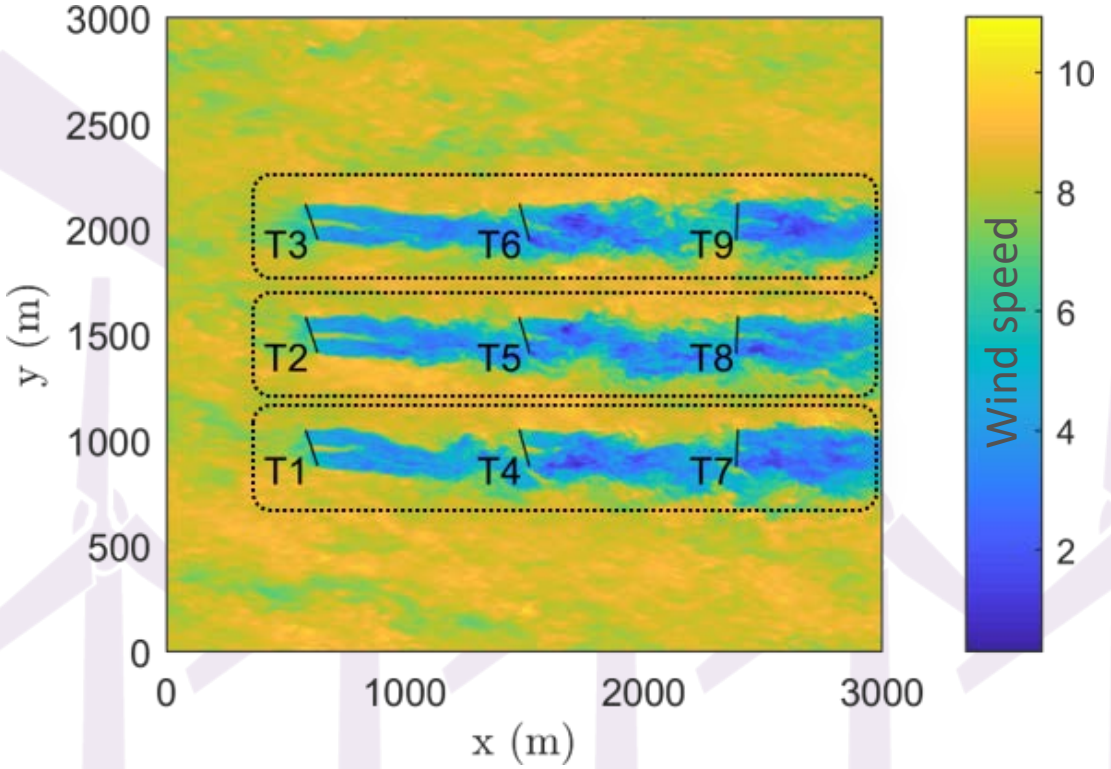
Wind farm flow control

Coordination of turbines in a farm

with the purpose of **improving inter-turbine aerodynamic interaction**

to better the overall farm power production

and/or reduce or distribute the structural loading among wind turbines



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Motivation

Present

- Wind farms are operated with the objective of power maximization
- Wind farm flow control (WFFC) does not consider market integration

Future

- Higher share of variable renewable energy in power systems
- Wind farms participate to a larger extent in wholeseale electricity markets
- More pronounced incentives to include additional objectives in WFFC

FarmConners Market Showcases

- Allow researchers to quantify the benefit of their WFFC
- Demonstrate value of WFFC in present and future market scenarios

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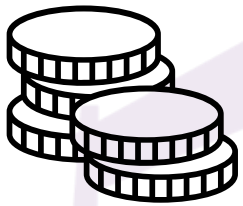

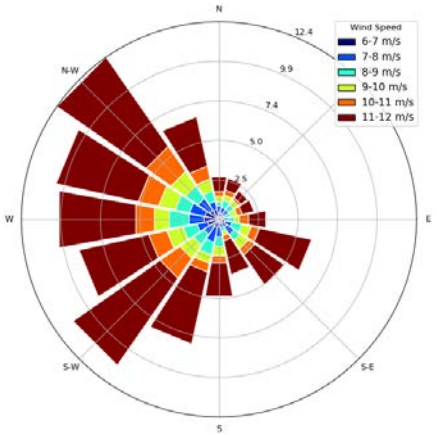

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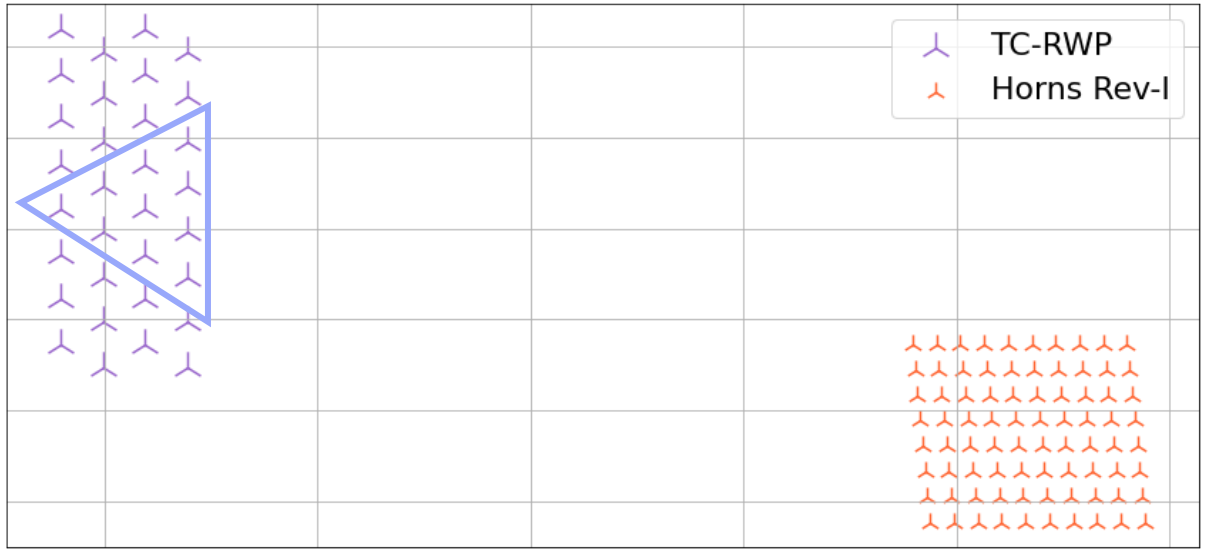
Reference wind farm



[TotalControl Reference Wind Power Plant (TC-RWP)]

- 32 turbines
- DTU 10 MW

[Subset of TC-RWP]

- 10 turbines
  for computational limitations
- DTU 10 MW

[FarmConners Market Showcases]

- 20 km west of Horns Rev I
- Connected to Danish power system (DK1, west)

Andersen, S., et al. Reference Wind Power Plant. TotalControl Deliverable D1.3, 2018.

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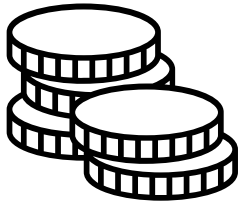

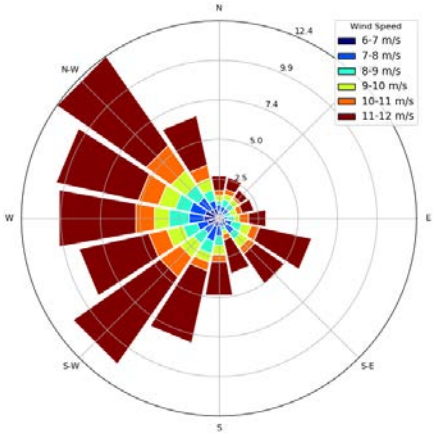

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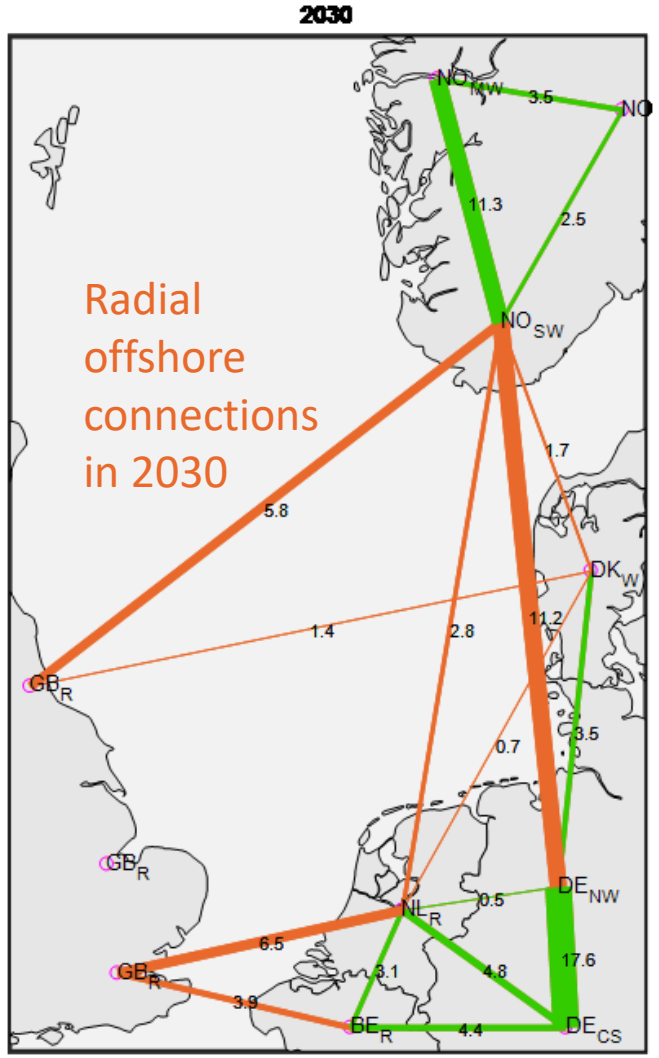
Energy scenarios

- Electricity price signal for West Denmark (DK1)
- Hourly time series of day-ahead market price for 2020 and 2030
- Based on investment optimization for generation and transmission capacity using the DTU Balancing Tool Chain



Eguinoa, I., et al. Wind farm flow control oriented to electricity markets and grid integration: initial perspective analysis, 2021. https://doi.org/10.1002/adc2.80

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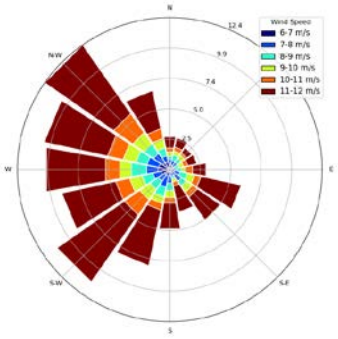
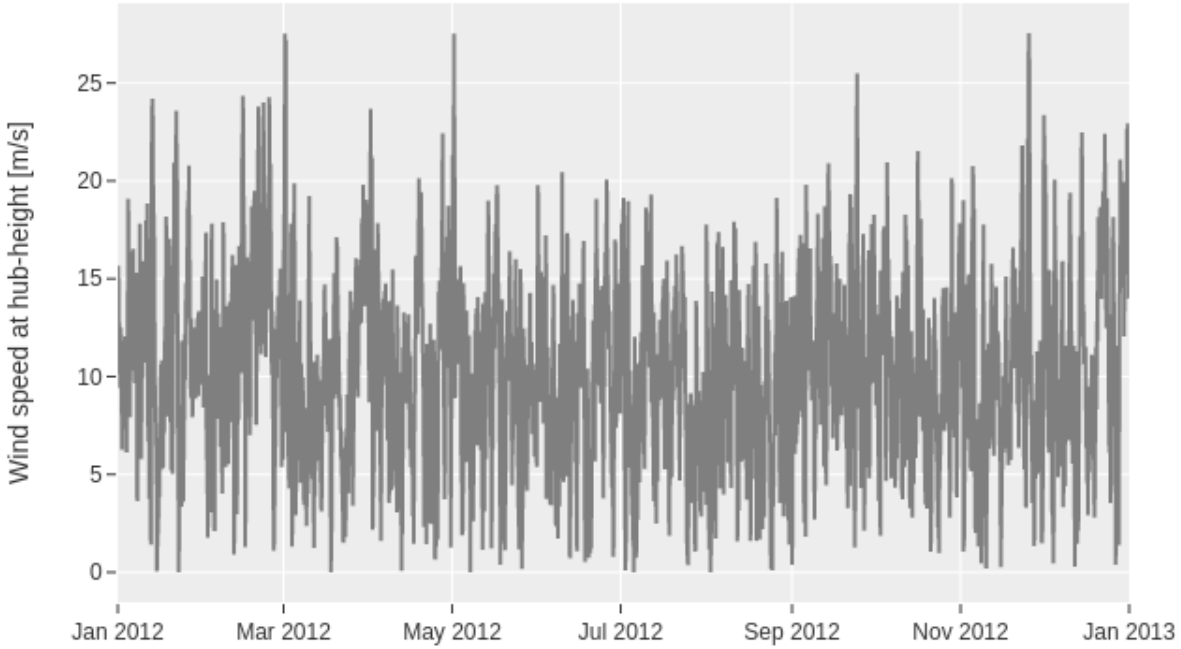
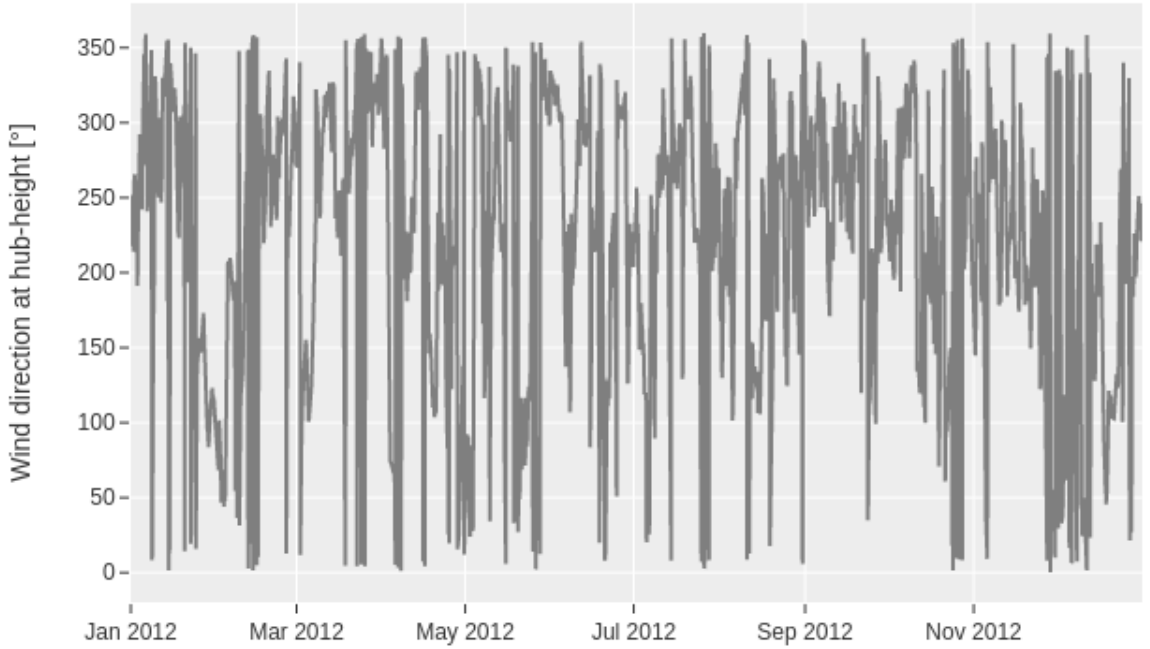
Wind speed and direction at location of reference wind farm







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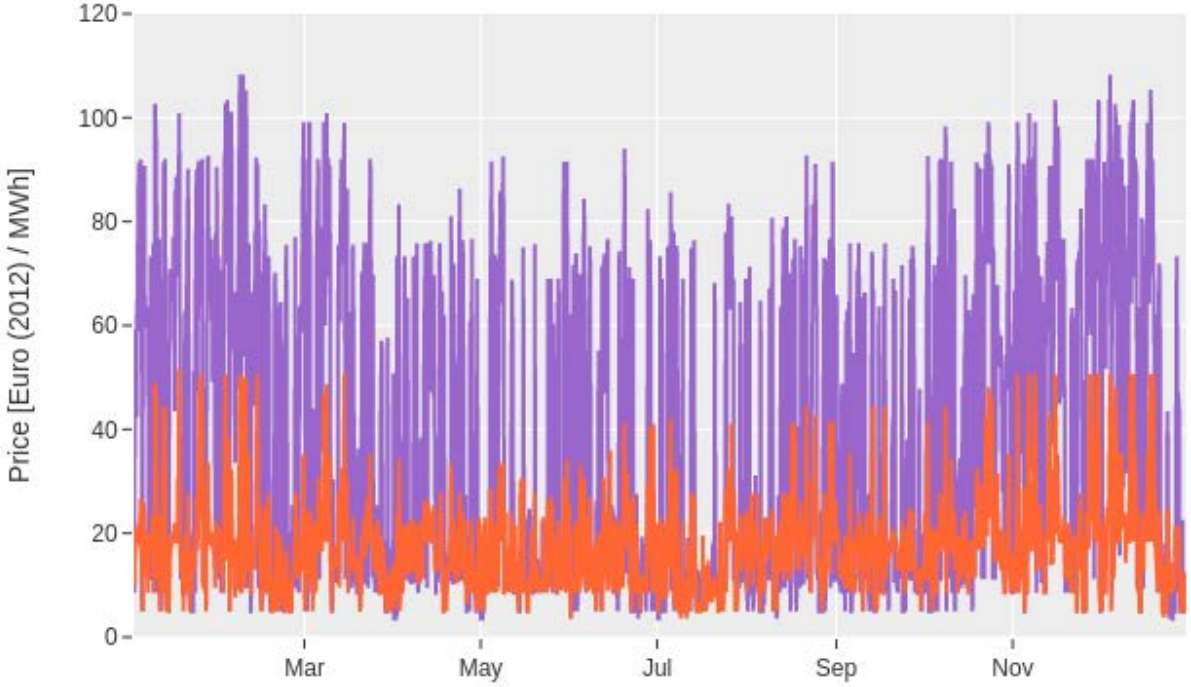
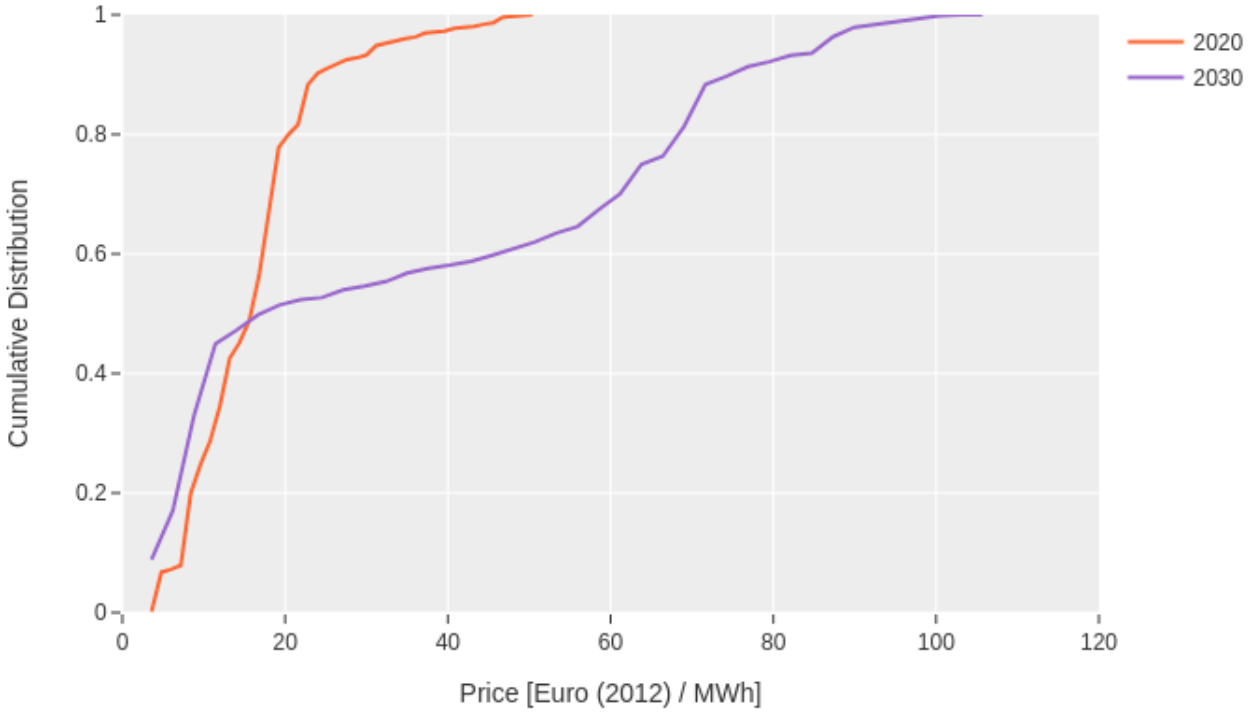
Day-ahead (DA) prices





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Data binning

Eguinoa, I., et al. Wind farm flow control oriented to electricity markets and grid integration: initial perspective analysis, 2021. https://doi.org/10.1002/adc2.80

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Showcases

High prices	Low prices	TSO-driven

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Showcases

High prices	Low prices	TSO-driven
Highest 25% of 2020 DA prices		
Highest 25% of 2030 DA prices		

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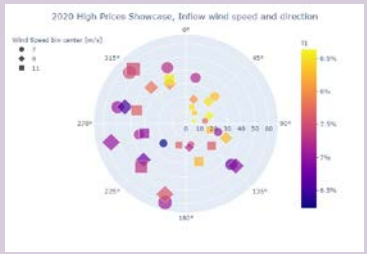
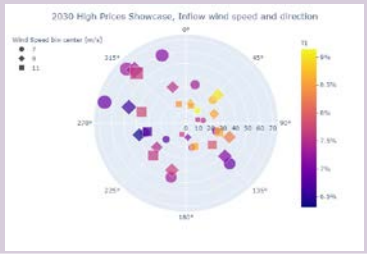
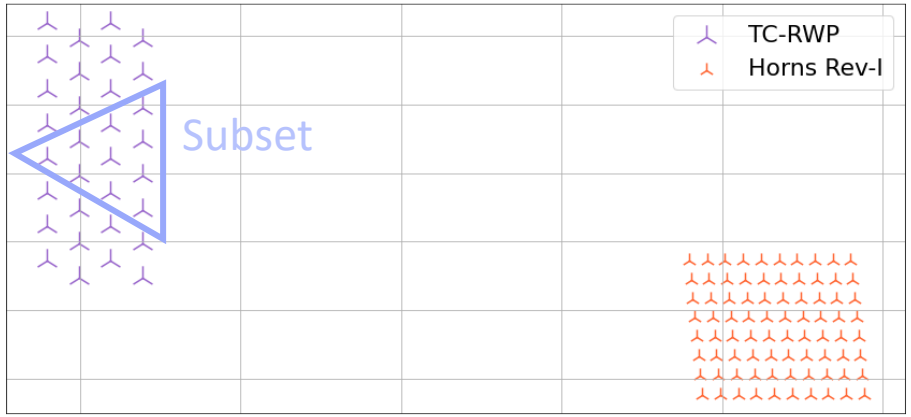
FarmConners Market Showcases

High DA prices	Low DA prices	TSO-driven
Highest 25% of 2020 DA prices + inflow 		
Highest 25% of 2030 DA prices + inflow 		

Expected participants

		P1	P2	P3	P4	P5	P6
Showcases	High DA prices	x	x	x	x	x	x
	Low DA prices	x			x	x	
	TSO-driven operation			x		x	
Wind farm layout	TC-RWP			x	x	x	x
	Subset of TC-RWP		x				
	Single wind turbine	x					



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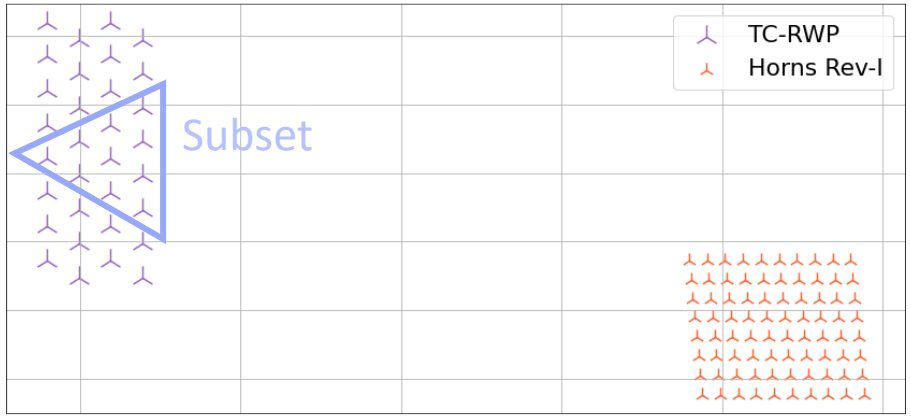
Preliminary results

		P1	P2	P3	P4	P5	P6
Showcases	High DA prices	x	x	x	x	x	x
	Low DA prices	x			x	x	
	TSO-driven operation			x		x	
Wind farm layout	TC-RWP			x	x	x	x
	Subset of TC-RWP		x				
	Single wind turbine	x					



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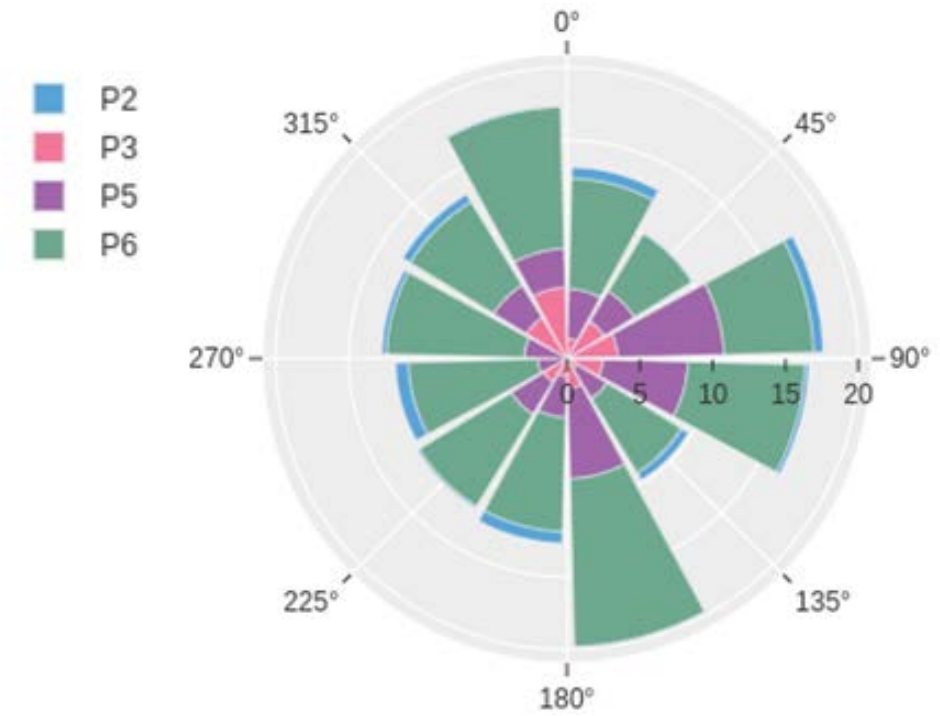
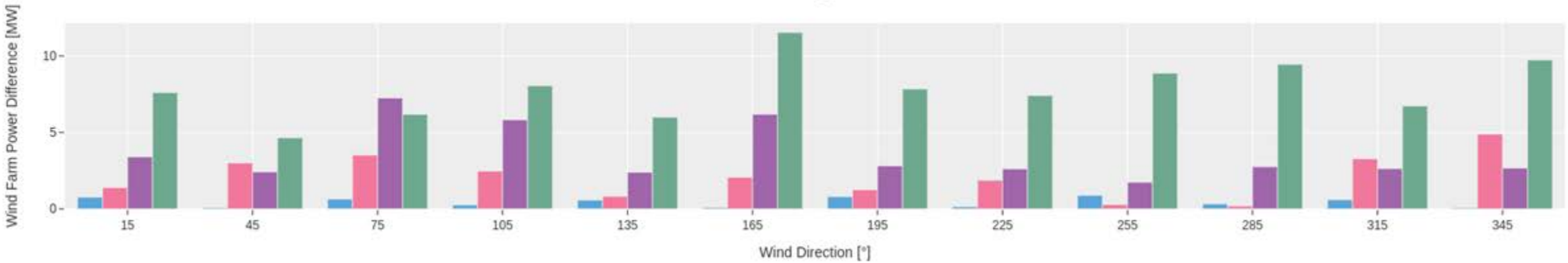
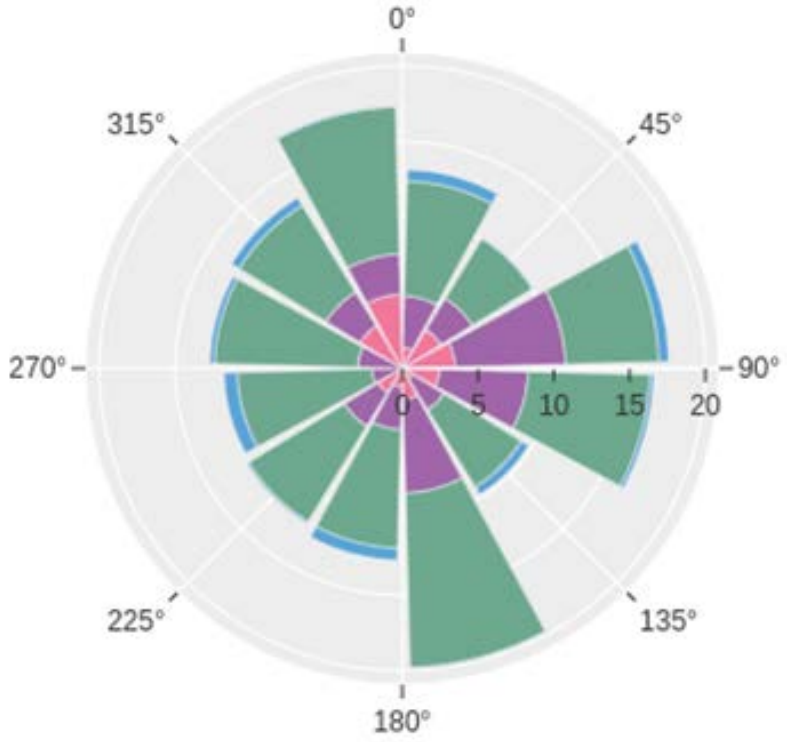
Power gain per wind direction



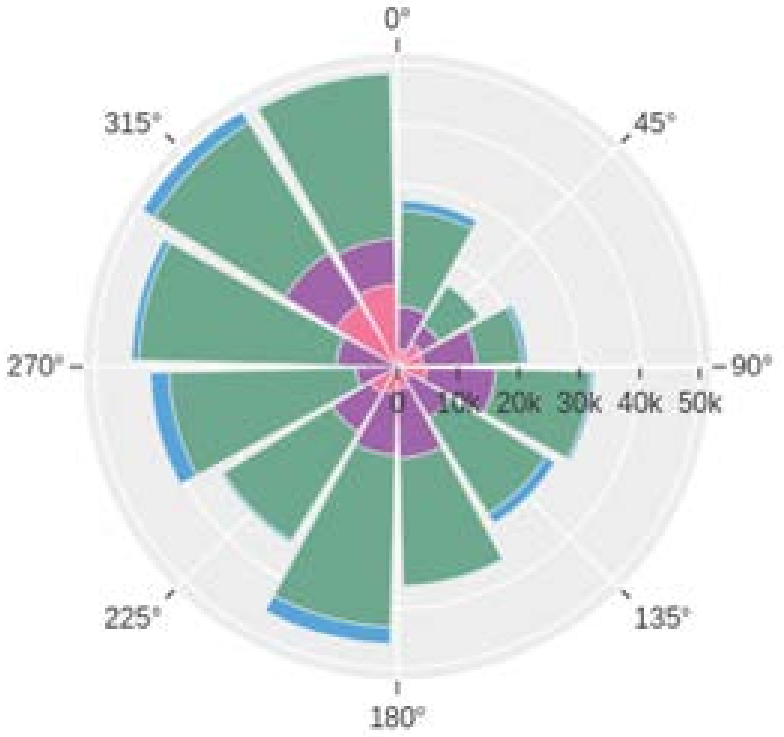
- High Prices 2020
- Power gain
  = power output with WFFC
  – power ouput without control
- Weighted average per bin
- Stacked from all participants



Power vs. income gain



Power gain



Income gain

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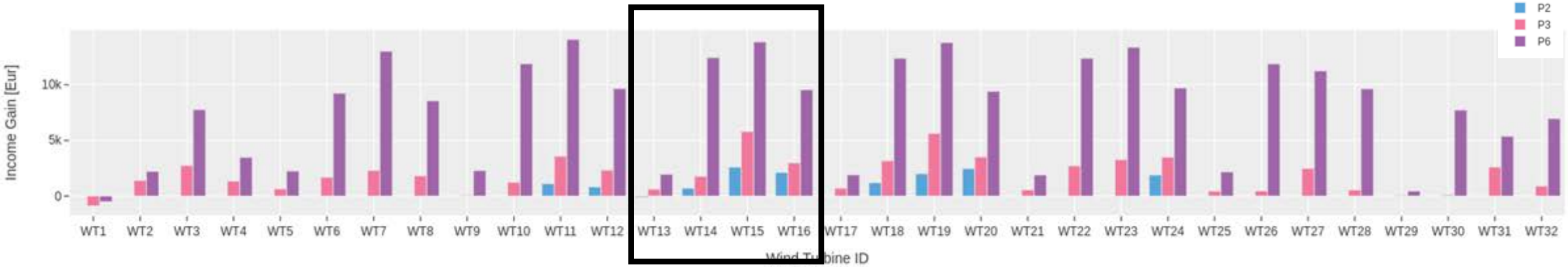
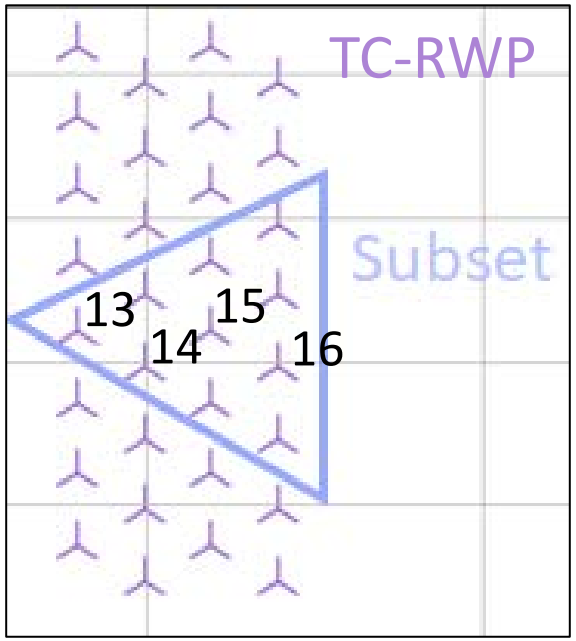
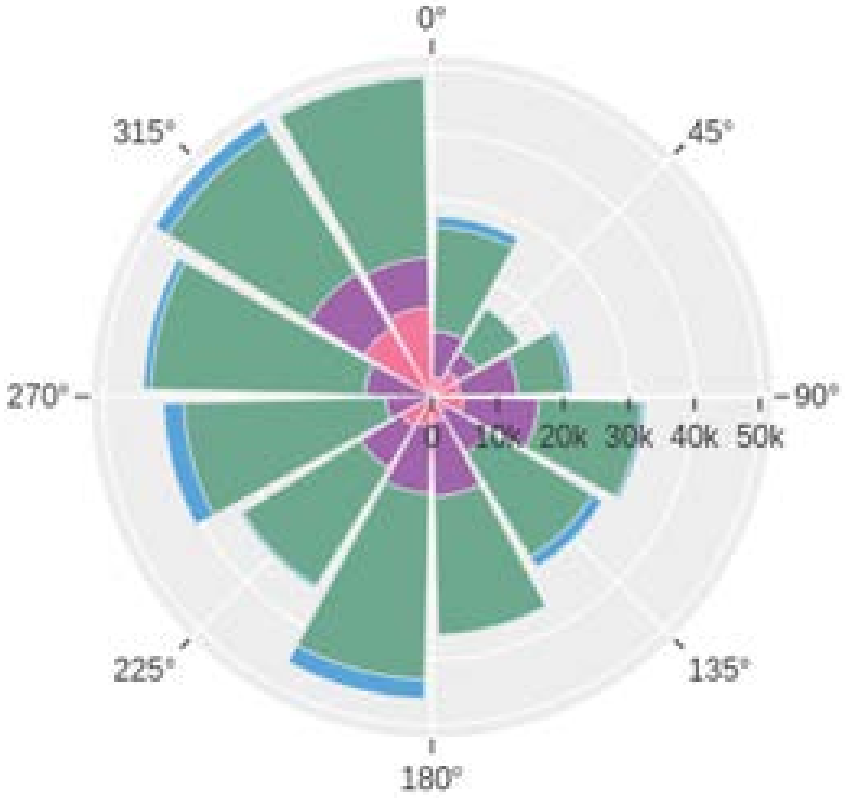
Income gain per turbine

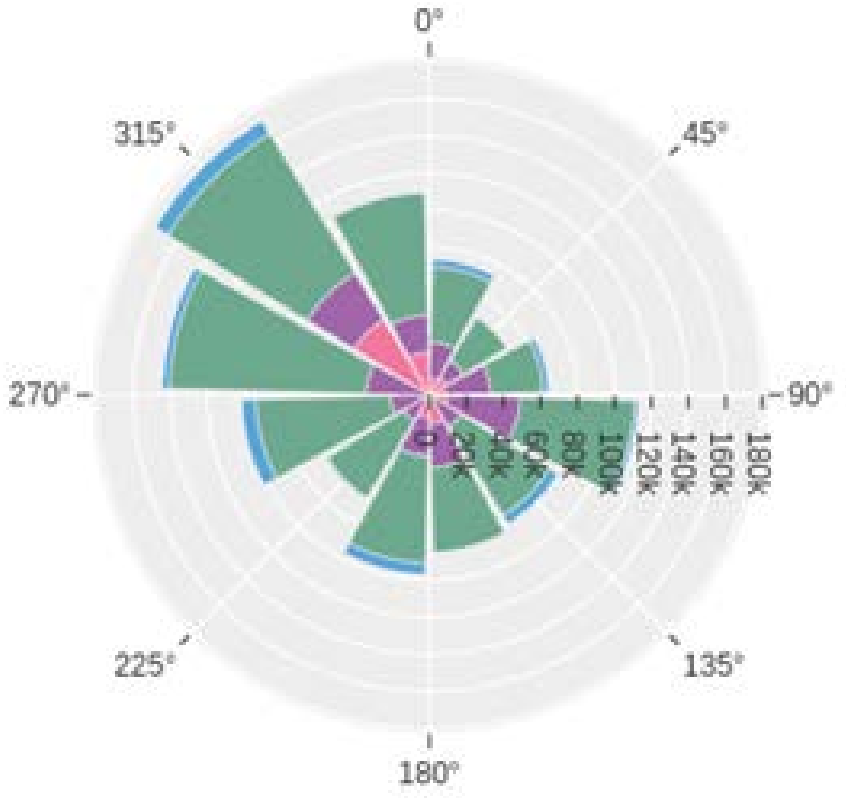




Income gain for high prices in 2020 and 2030



2020



2030

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Outlook

Final results of FarmConners
Market Showcases coming soon

→ windfarmcontrol.info

Datasets are available

→ Documentation

New projects?

→ Let's discuss!

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