

# *MARKET DESIGNS FOR HIGH SHARES OF RENEWABLE ENERGY IN THE UK*

18th IAEE European Conference

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# Outline

- 1 Motivation
- 2 Model Framework
- 3 Market Designs
- 4 Results
- 5 Conclusion



# Motivation

- The energy transition will change the ways electricity is generated, distributed, and consumed.
- Renewable energy is at the core of this transition.
- Accelerating the energy transition requires a rethinking of the current market design.
- We review the international experience regarding support policies to present a market design that is robust against future increases of renewable generation capacity.

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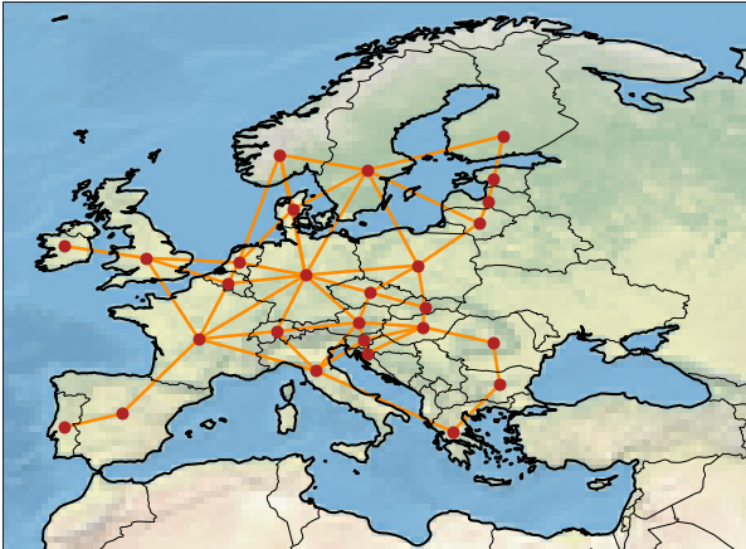
4 Results

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5 Conclusion

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# EuroMod: Model Inputs

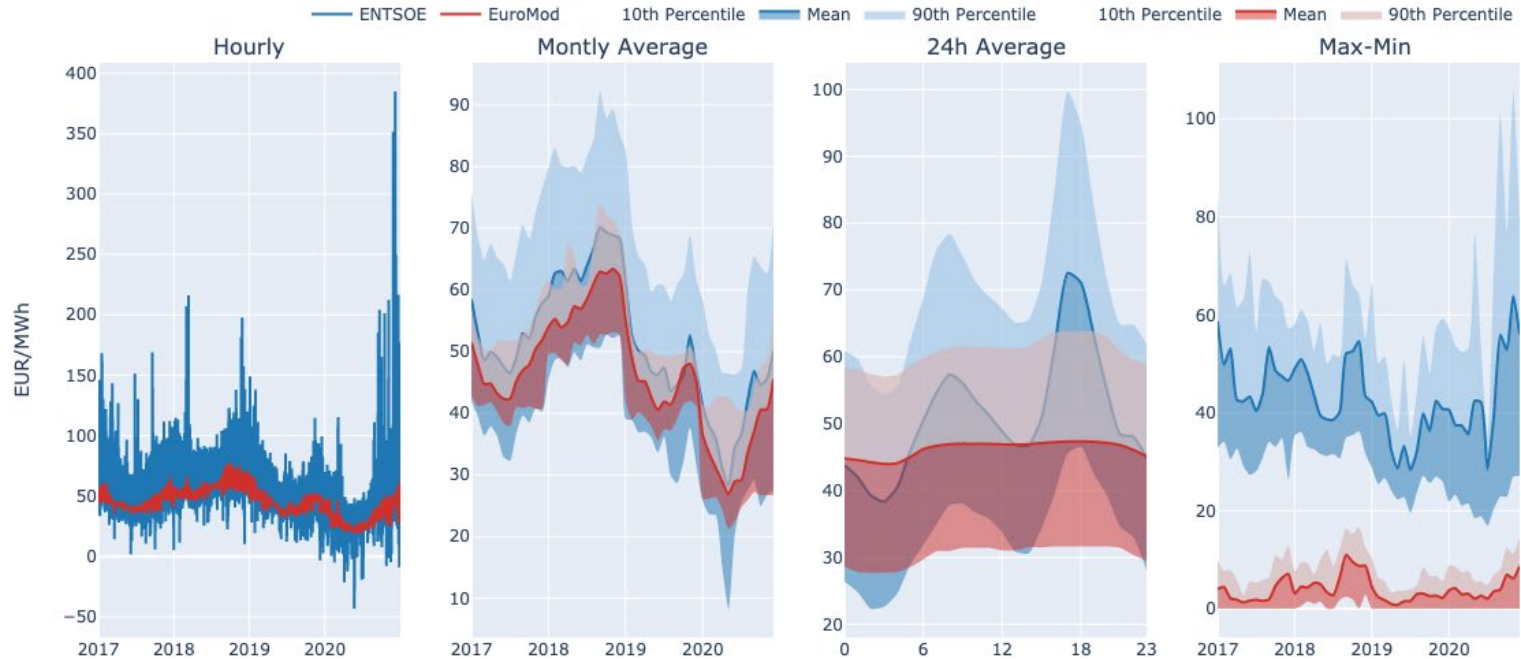


Mendes, Staffell, Green, (2023), "EuroMod: Modelling European power markets with improved price granularity"

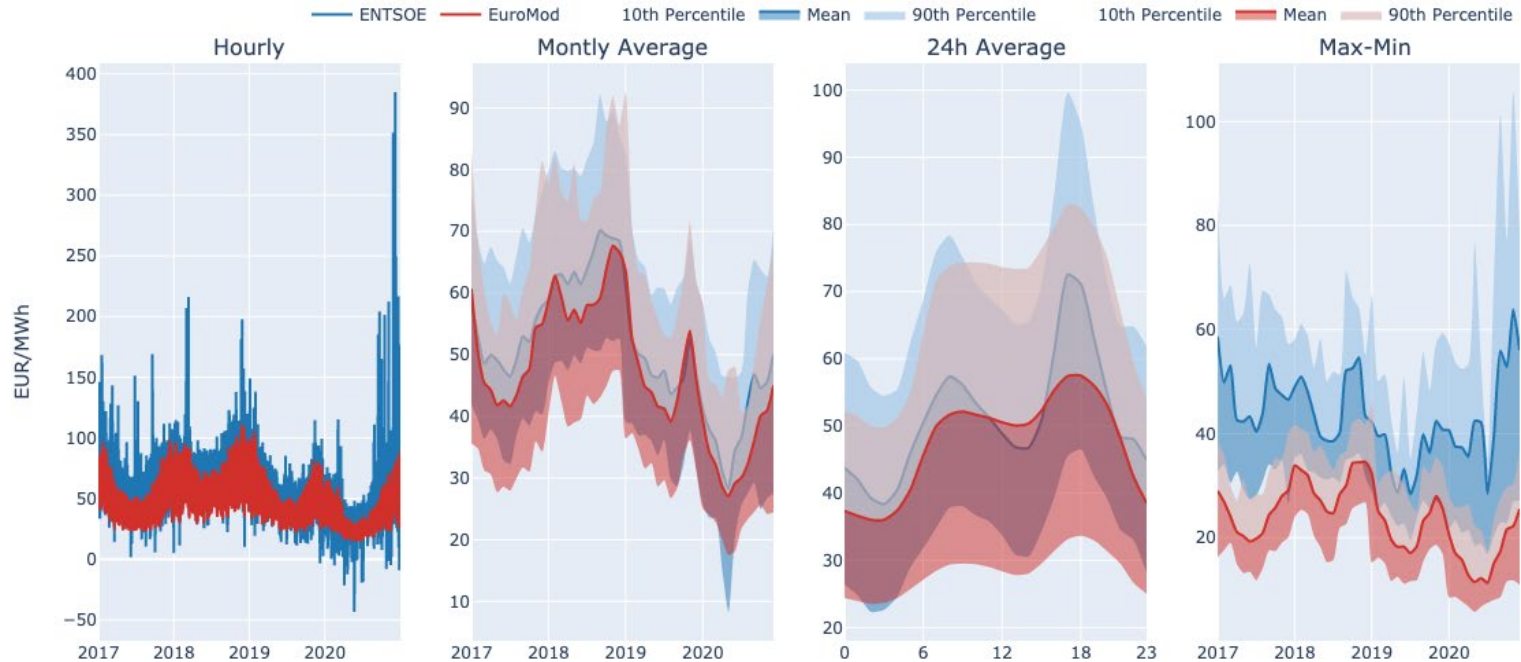
[Manuscript submitted for publication and available under request.]

- **Open-Source model available at:**  
<https://github.com/carlamtmendes/EuroMod>
- **Representation of the European power system:**
  - 27 European countries
  - Interconnectors based on NTC values
  - Power plant blocks (Biomass, Coal, Gas, Oil, Nuclear, Lignite, Other, Dam, PSClosed, PSEOpen, Battery)
- **Data:**
  - Historic capacities, res-infeed (RoR, Solar, WindOn, WindOff), demand and NTC based on ENTSO-E data
  - Fuel costs based on real data and BEIS and TYNDP future projections
  - Technical parameters based on literature (availabilities, efficiencies, carbon emission factors)
  - Future scenarios are based on TYNDP Scenarios 2020
- Coded in **GAMS**, using **CPLEX** solver
- Runs on an hourly basis (8760h)

## LP Model underestimates price results



## EuroMod increases price volatility and reduce price errors by 40%



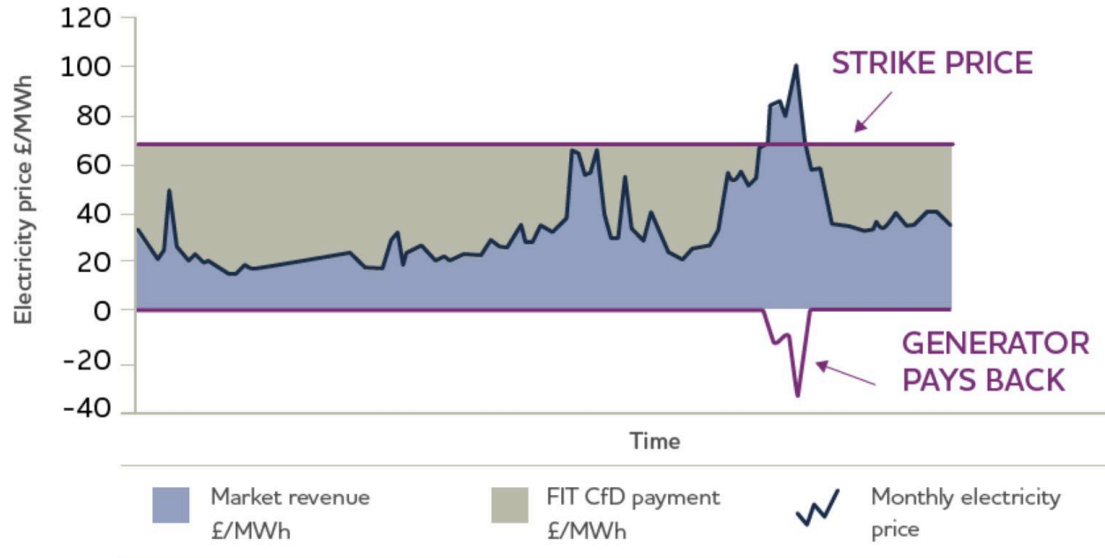
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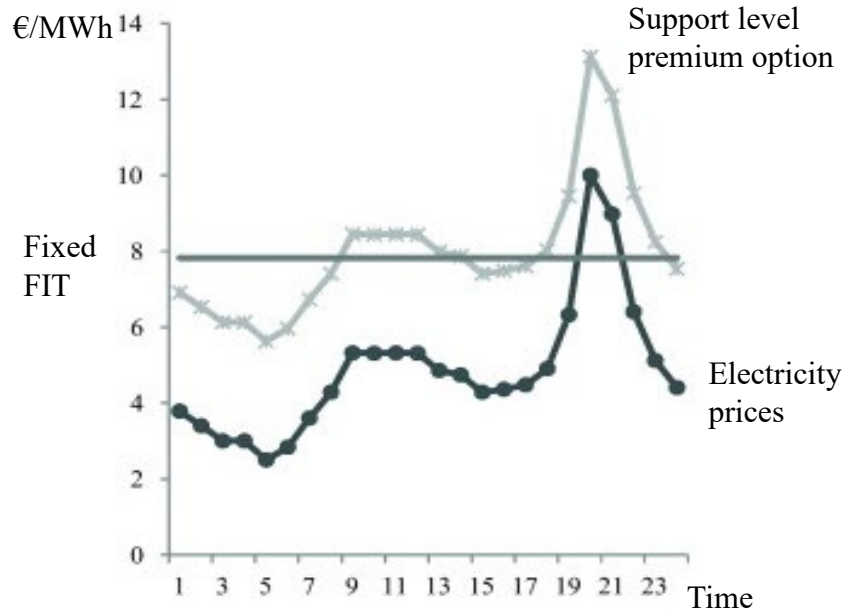


# Contract for Differences (CFDs)

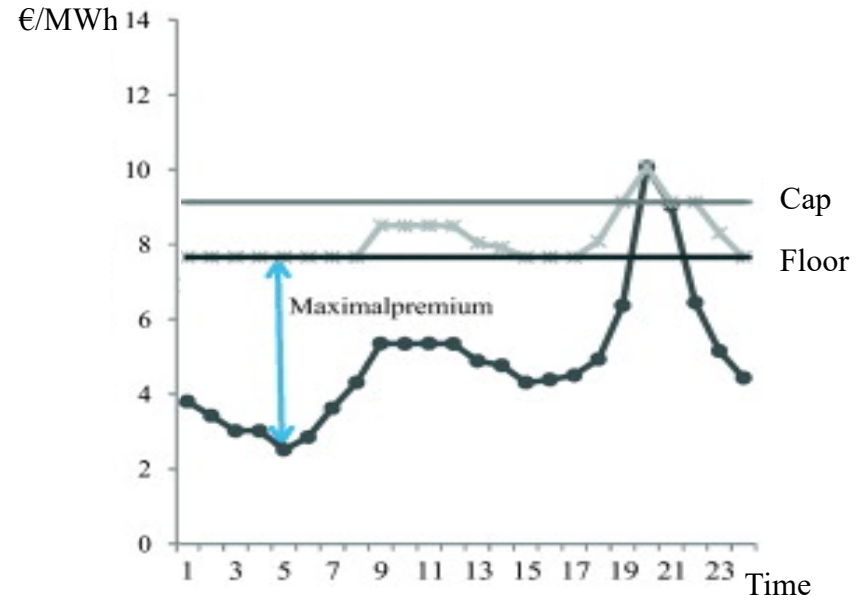




- Feed-in Premium



- Feed-in Premium with Cap and Floor



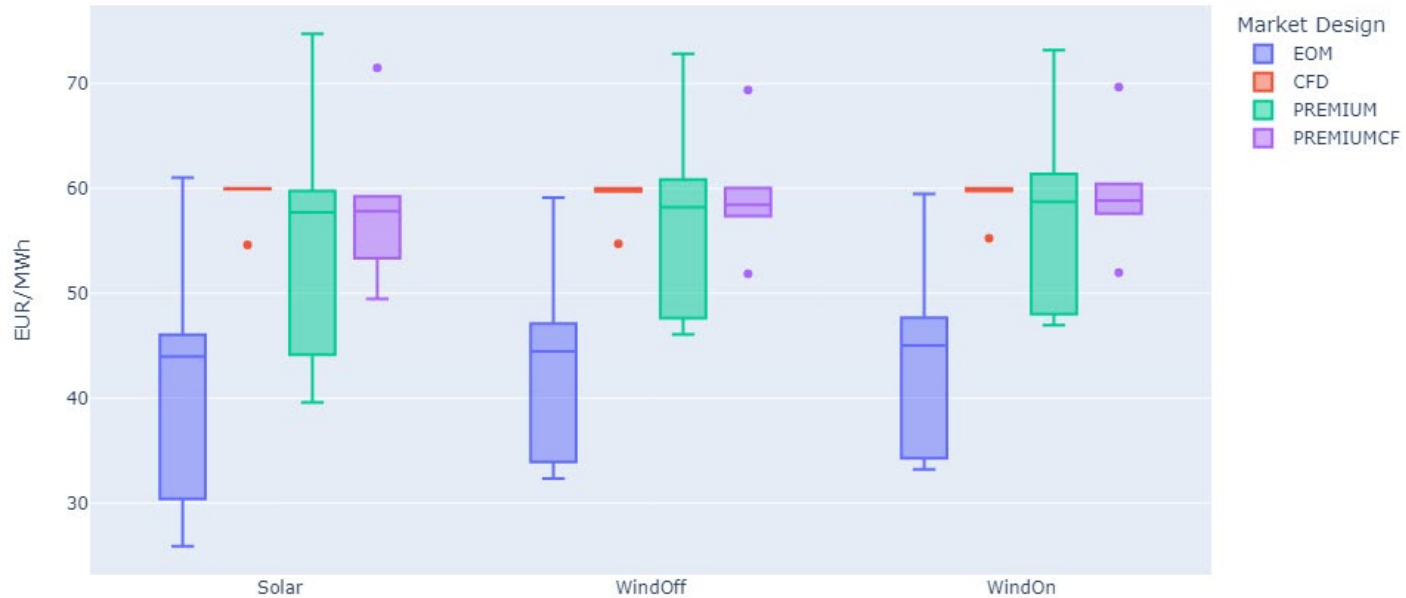
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## CFDs and Premium allow for higher revenues in a world with high RES shares

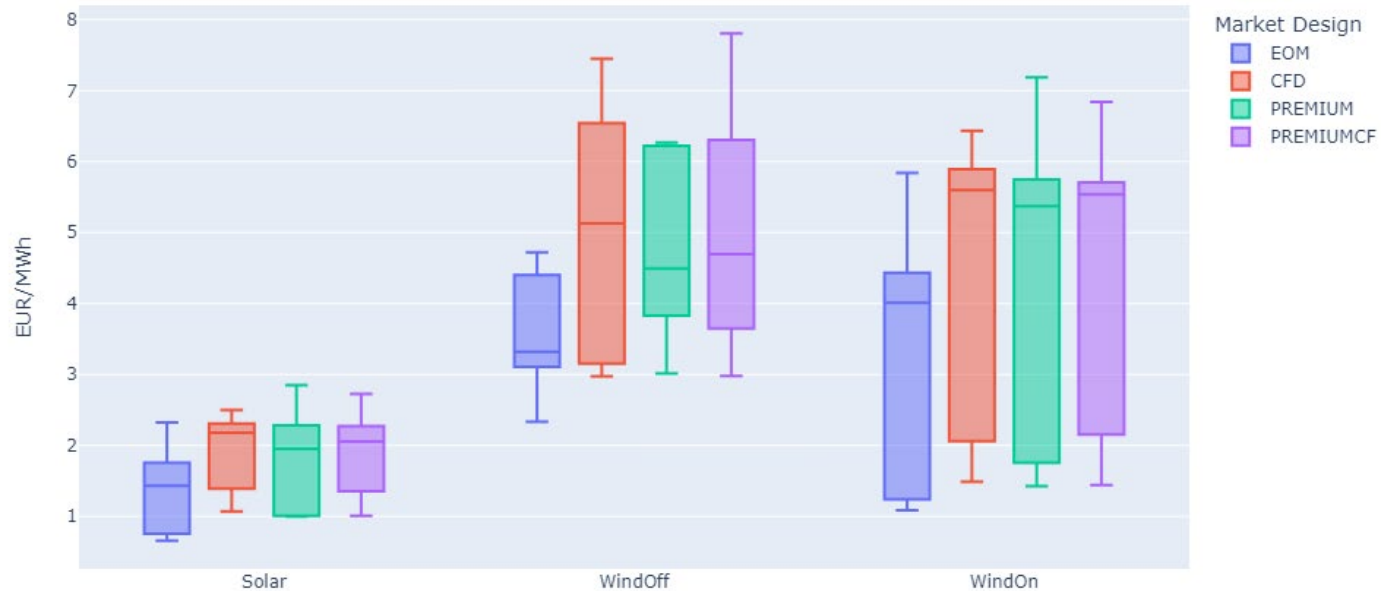
Yearly Revenues from 2017-2020, 2030 - 2040





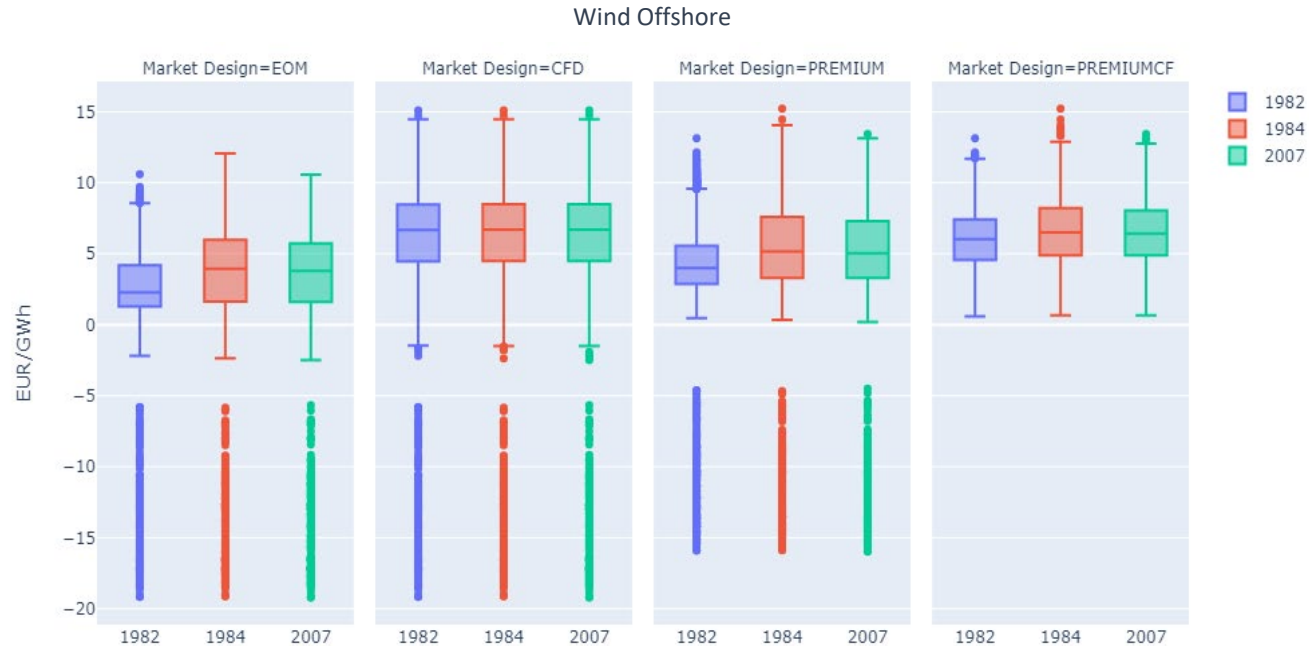
## CFDs and Premium with Cap & Floor create higher costs for consumers

Yearly Costs from 2017-2020, 2030 - 2040



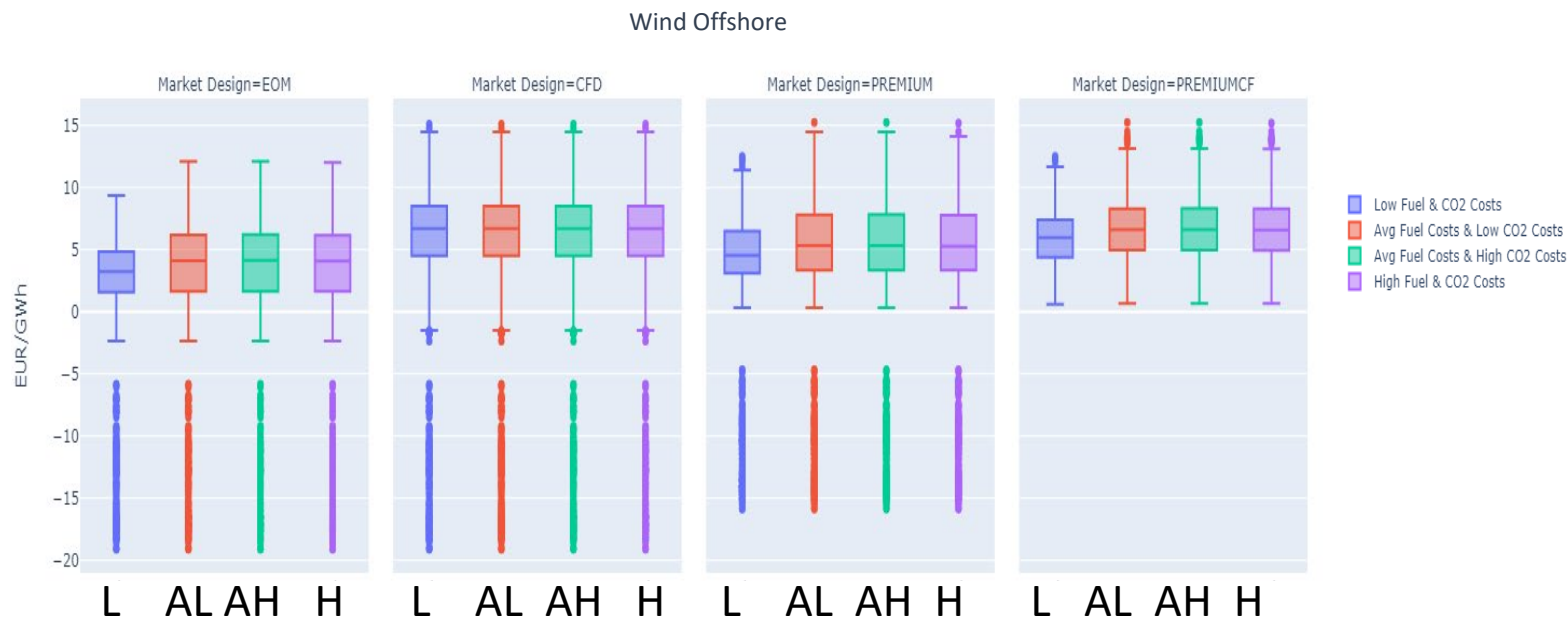


## CFDs provide higher revenues for atypical years





## CFDs lowers the risk for periods with high variation of fuel & CO<sub>2</sub> costs



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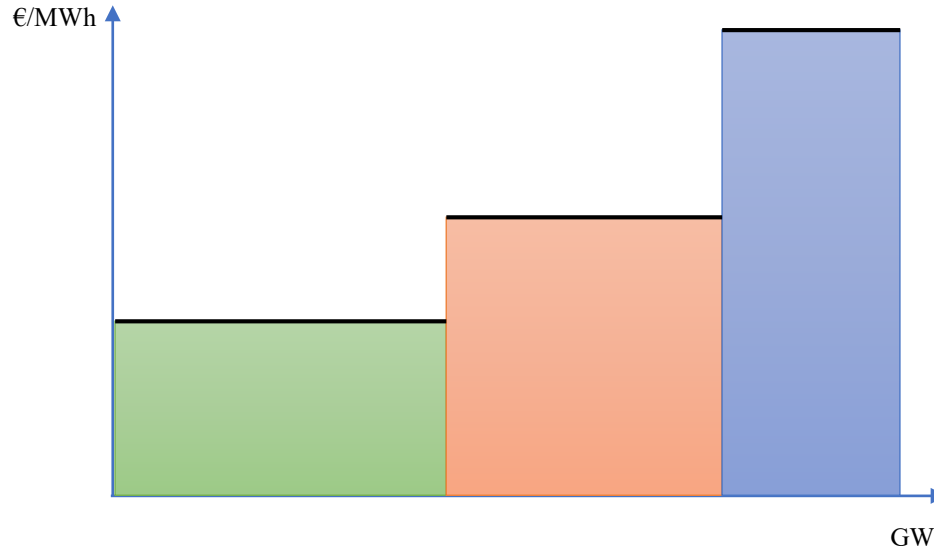


## Conclusion

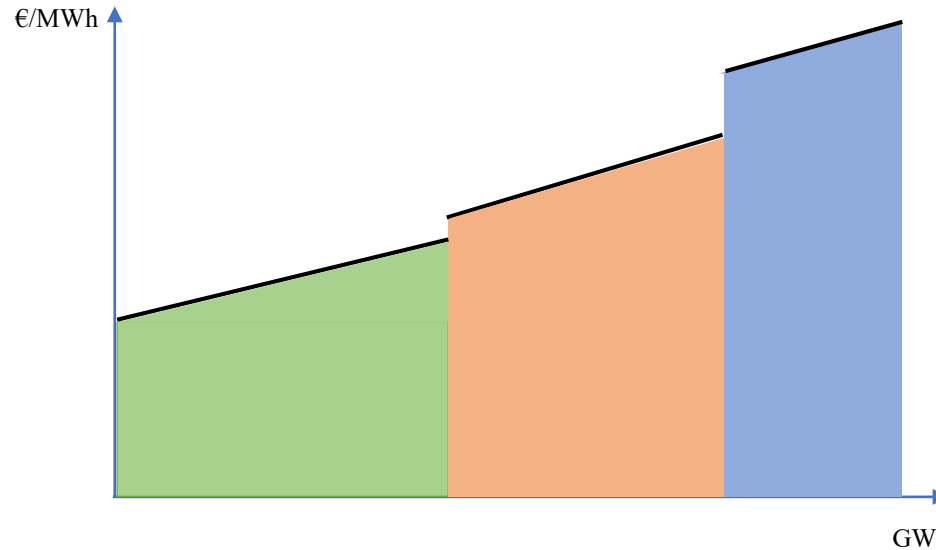
- CFDs and Premium with Cap & Floor are the two market designs that allow higher revenues for generators, which reflects higher costs to consumers.
- Premium with Cap & Floor protects generators against negative prices. However, it does not give generators the right incentives to ramp down during periods of negative prices.
- Market support mechanisms allow generators to hedge future revenues against external factors, such as different weather years or fuel & CO<sub>2</sub> costs.
- CFDs allow generators to get stable revenues when extreme situations happen.

Thank you!

## LP Model: Generators of a technology group have the same variable costs

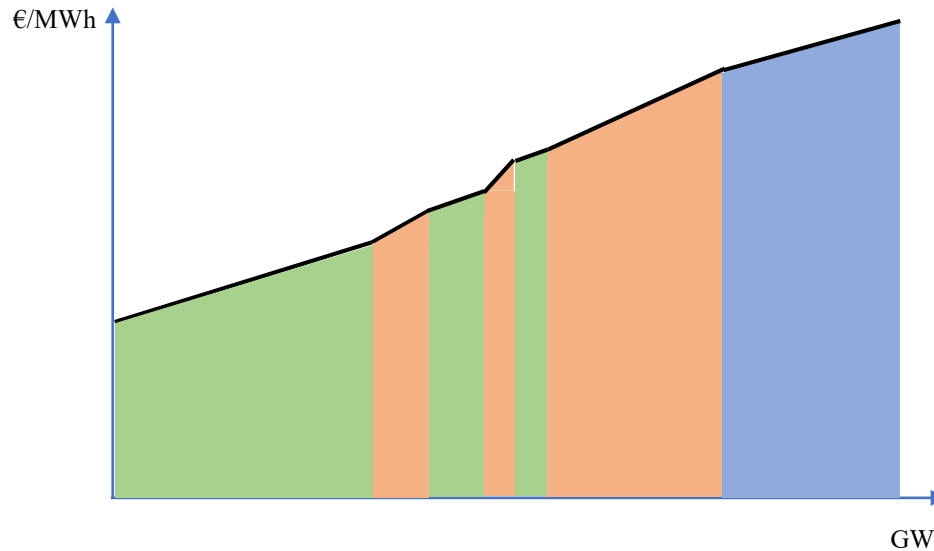


## QCP Model: Generators of a technology group have different variable costs

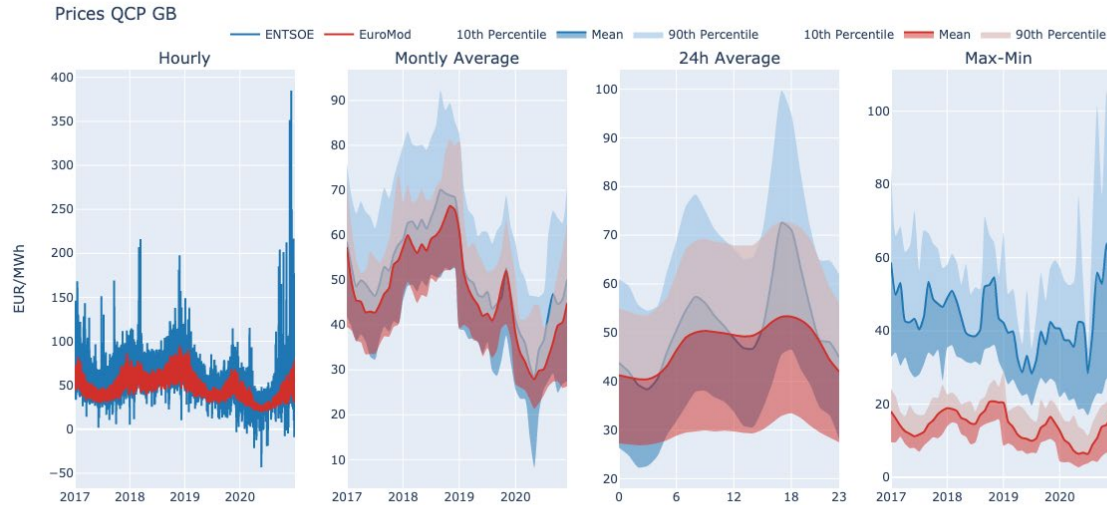




## QCP Model: Generators of a technology group have different variable costs

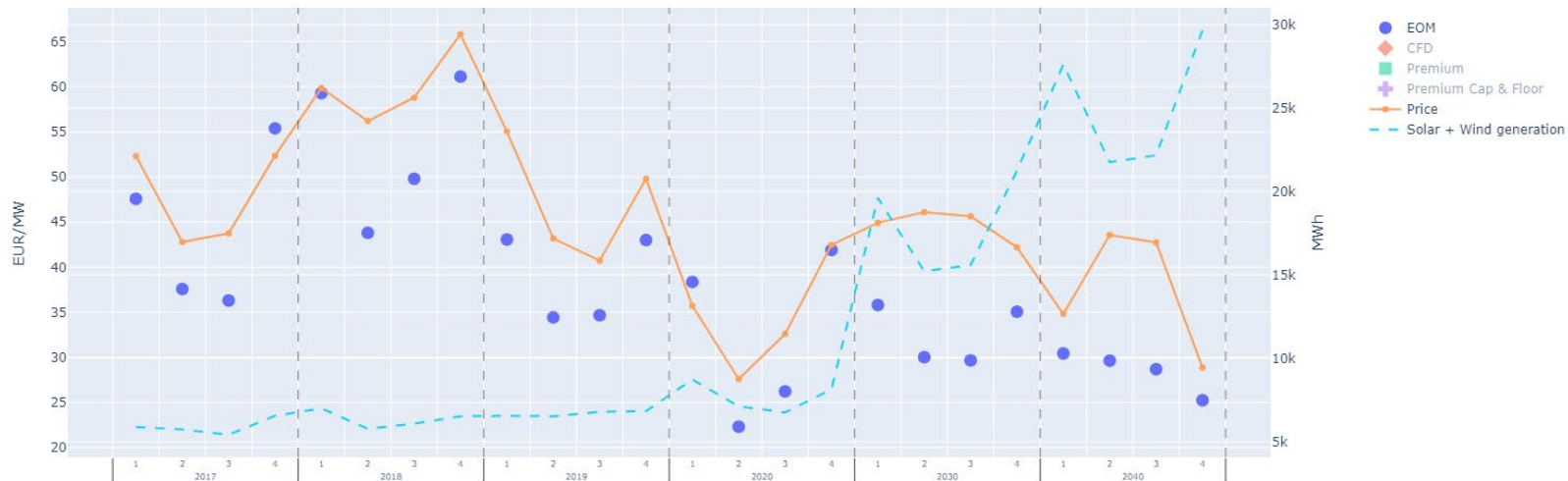


# QCP model slightly improves price results



## Revenues from EOM decrease by 32% as RES generation increase

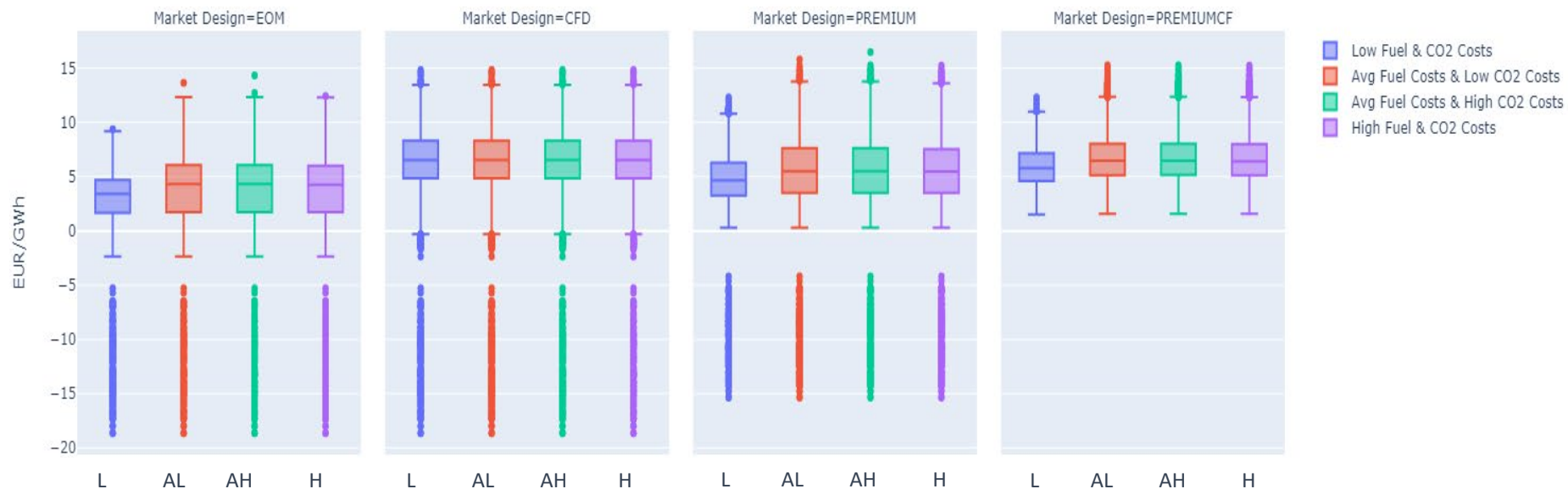
Quarterly Average Revenue in GB for Solar and Wind





## Higher revenues and spread with CFDs

Hourly Wind Onshore revenues by fuel scenario in 2040

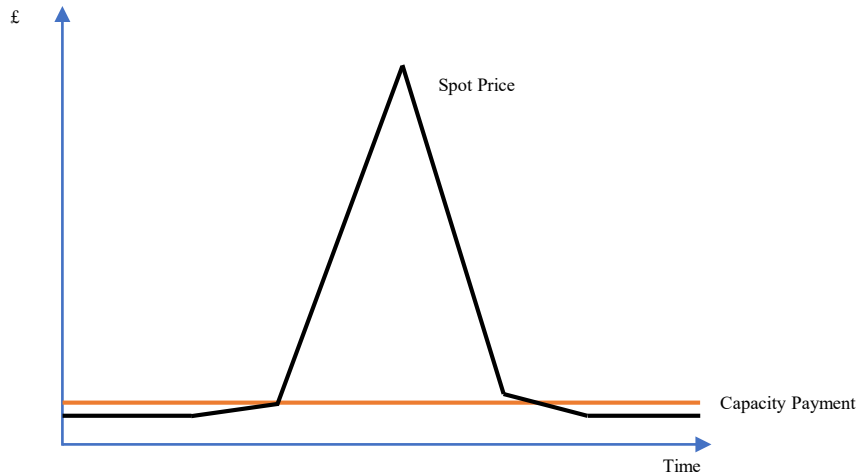




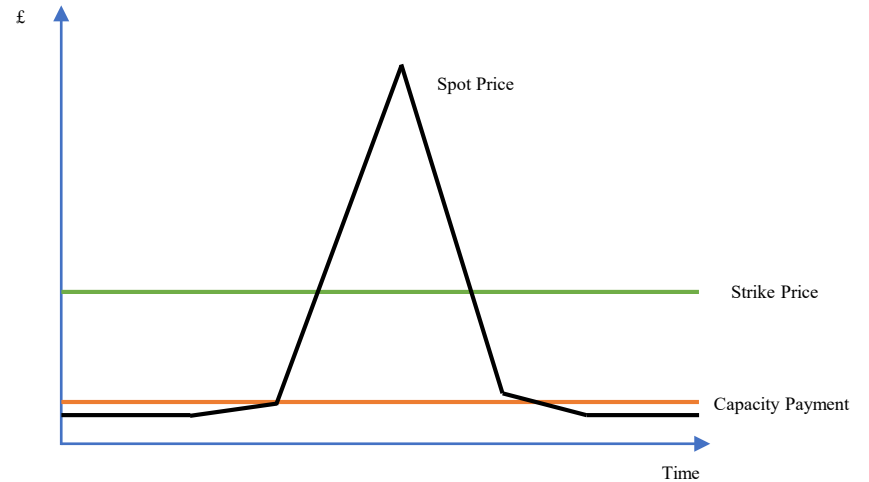
Climate Years



- Capacity Markets



- Capacity Markets with Real Options





## CFDs provide higher revenues for atypical years

Hourly Wind Onshore revenues by climate year in 2040

