Assessing market effects of support instruments for renewables: Are they needed and how to design them?

German Case Study of project TradeRES

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German Case Study

Research question

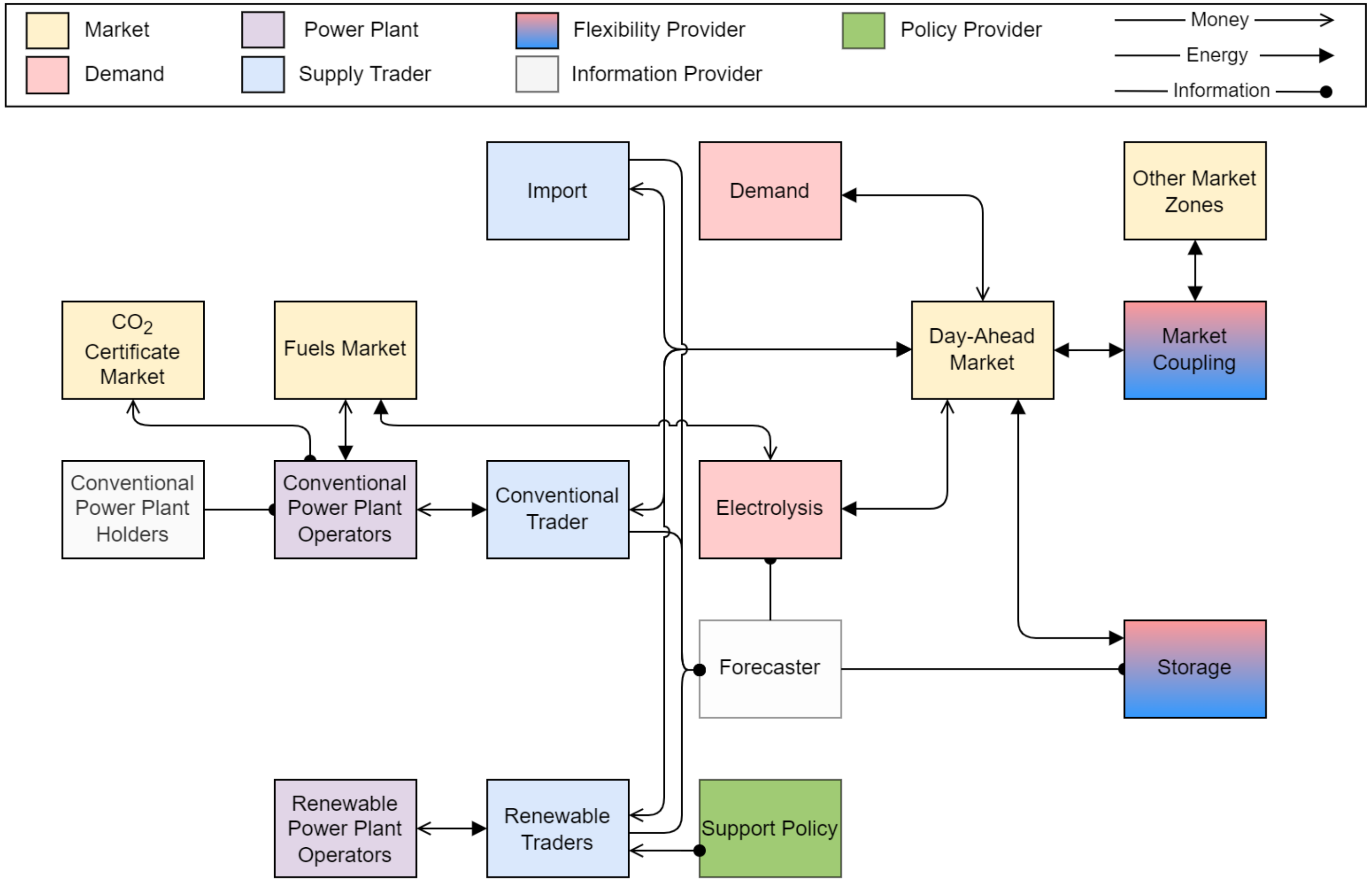
*Are **RES remuneration schemes** needed and if so, how should they be designed?*

Approach

- Dispatch simulation with agent-based market model AMIRIS
- RES traders bidding at opportunity costs for all support instruments
- Compare market performance indicators across different support instruments

AMIRIS

Agent-based **M**arket model for the **I**nvestigation of **R**enewable and **I**ntegrated energy **S**ystems



- **agent-based** model for the power market
- **business-oriented**, strategic dispatch decisions
- different **regulatory framework** conditions
- available **open source**

https://dlr-ve.gitlab.io/esy/amiris/home/

AMIRIS
Agent Types

Markets
- Determine prices

Traders
- Fulfil marketing strategies

Plant operators
- Control power plants

Flexibility providers
- Optimise dispatch

Information provider
- Create forecasts

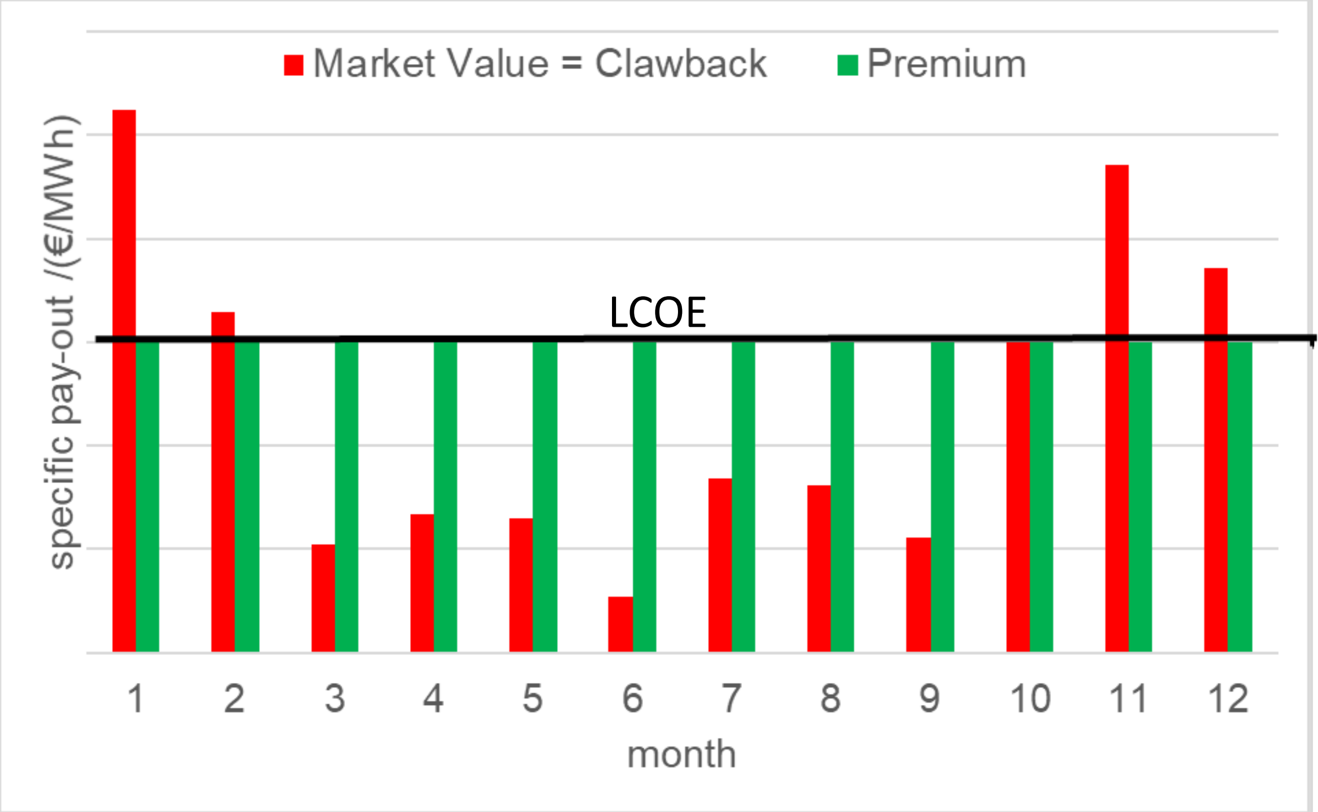
Policy
- Provide support

German Case Study

Research design

Analysed support instruments

- “**NONE**”: no support
- “**MPFIX**”: fixed market premium (ex ante)
- “**1-WAY-CFD**”: variable market premium (ex post) with a *monthly* reference period
- “**2-WAY-CFD**”: two-way Contracts for Differences (CfD) as extension to the market premium (ex post) with a *monthly* reference period
- “**CP**”: fixed capacity premium
- “**FIN_CFD**”: Financial CfD, as suggested by Schlecht et al. (2024) with country average as reference plant



German Case Study
Research design

Analysed support instruments	Parameterization
• "**NONE**": no support • "**MPFIX**": fixed market premium (ex ante) • "**1-WAY-CFD**": variable market premium (ex post) with a *monthly* reference period • "**2-WAY-CFD**": two-way Contracts for Differences (CfD) as extension to the market premium (ex post) with a *monthly* reference period • "**CP**": fixed capacity premium • "**FIN_CFD**": Financial CfD, as suggested by Schlecht et al. (2023) with country average as reference plant	**Premia** • Iteratively adjusted, such that each RES technology finances its total costs within a 0.1% tolerance band **Scenario** • Scenario data from energy system optimization model Backbone

TradeRES Scenarios

Differing in Flexibility of Demand and Supply

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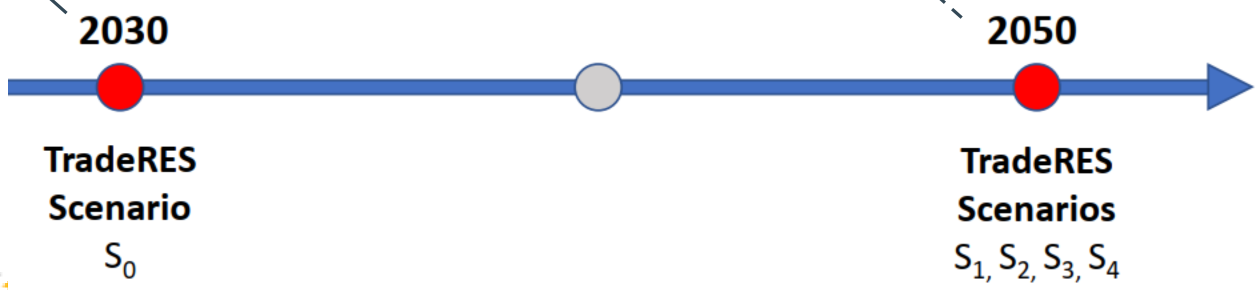
Demand-Side Flexibility ↑

High H_2 import price; High demand-side flexibility	**S2 flexible**	**S4 radical**
Low H_2 import price; Low demand-side flexibility	**S1 conservative**	**S3 variable**
	~85% wind + solar + hydro	≥ 95% wind + solar + hydro

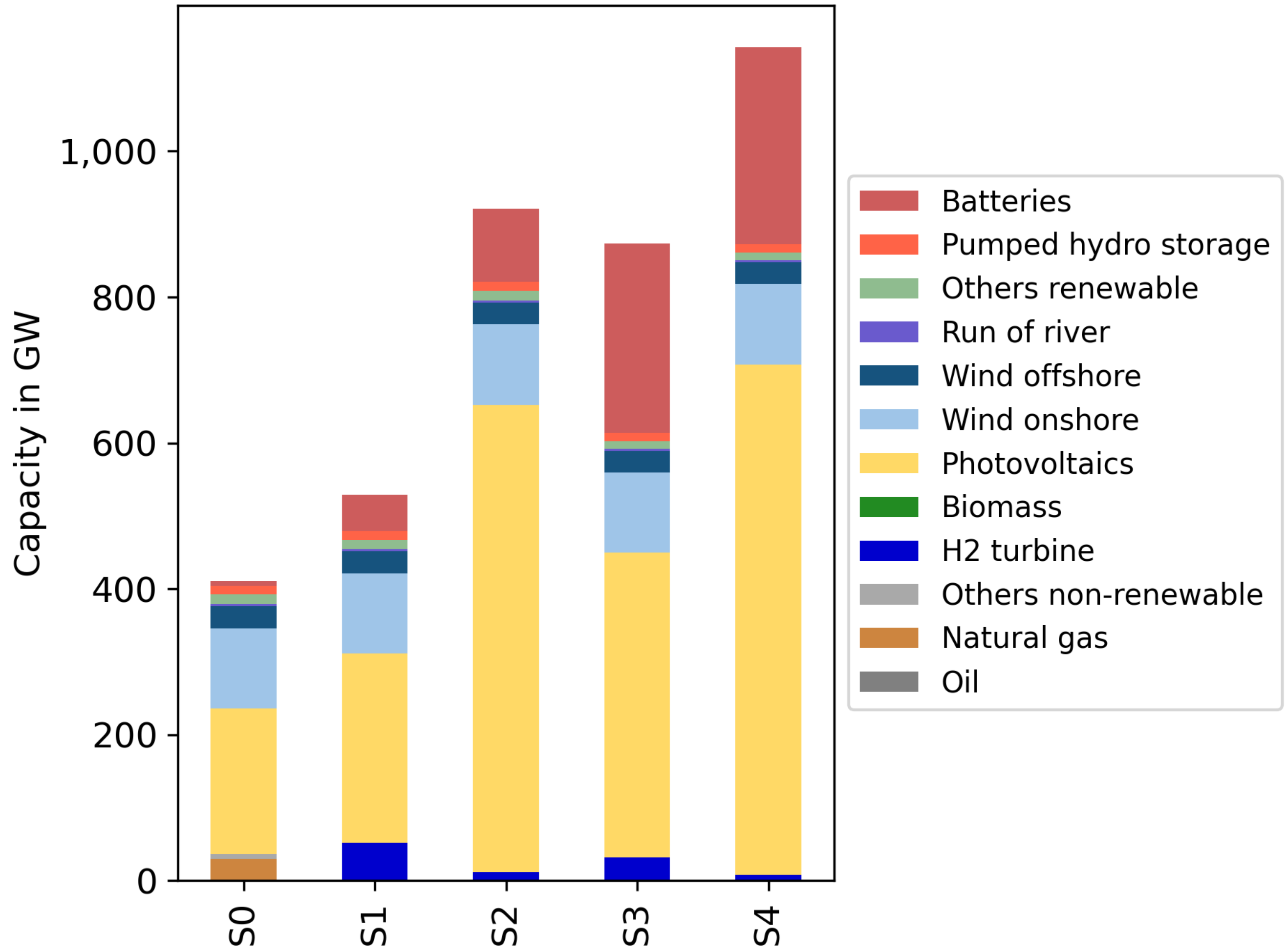
Non-thermal Supply Capacity →

S0 base*
~65% wind + solar + hydro
Limited sector-coupling



TradeRES Scenarios

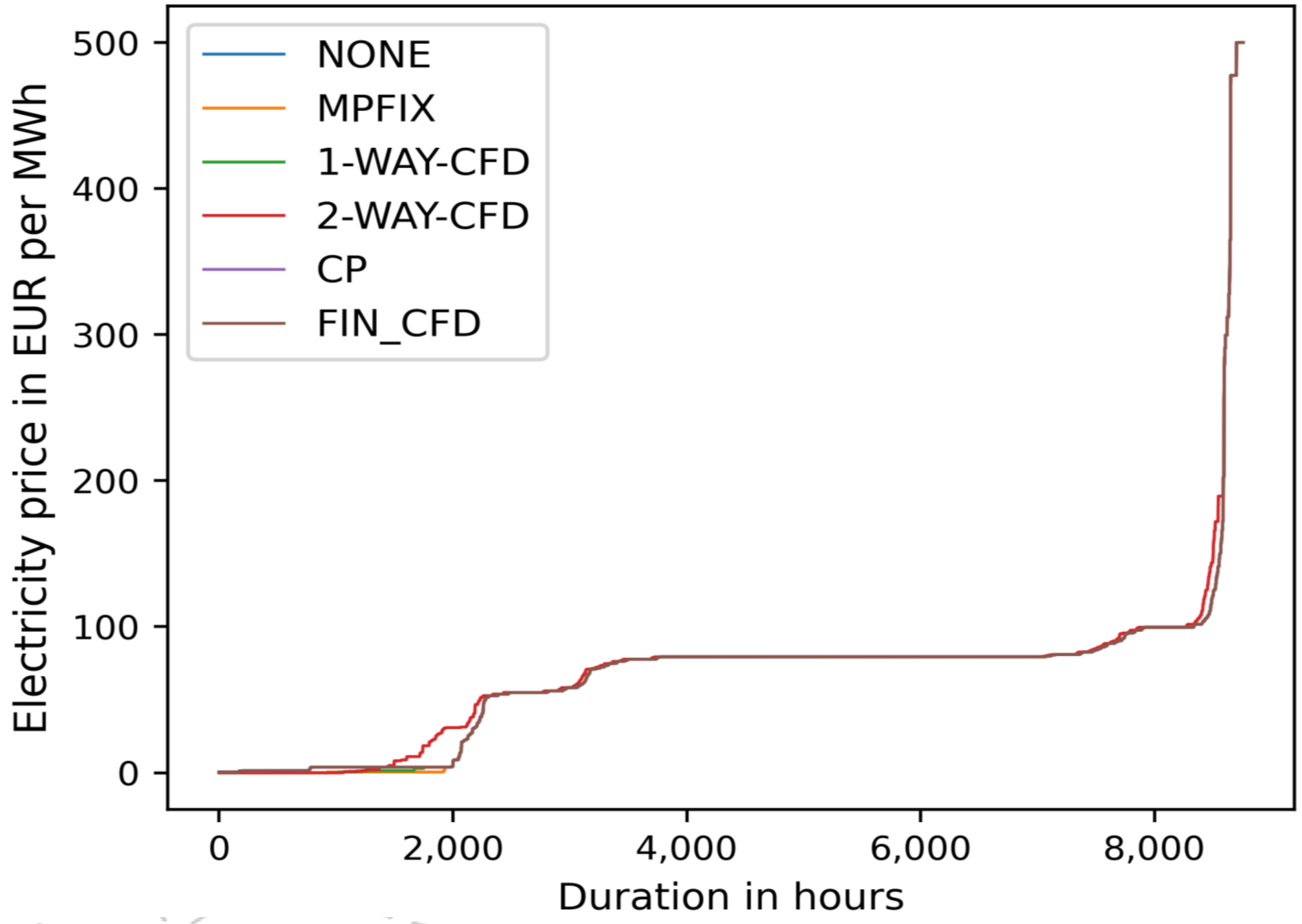
Installed capacities from Backbone[1]



- Scenarios are dominated by **PV** and **batteries**, especially for flexible scenarios S2 and S4
- Backup capacity: **H2 turbines**, particularly in S1 and S3
- Little investment in wind

[1]https://gitlab.vtt.fi/backbone/backbone

Day-ahead electricity prices
Scenario S1



MPFIX, 1-WAY-CFD

vRES traders factor opportunity cost of premium in supply bids
→ lower prices

2-WAY-CFD

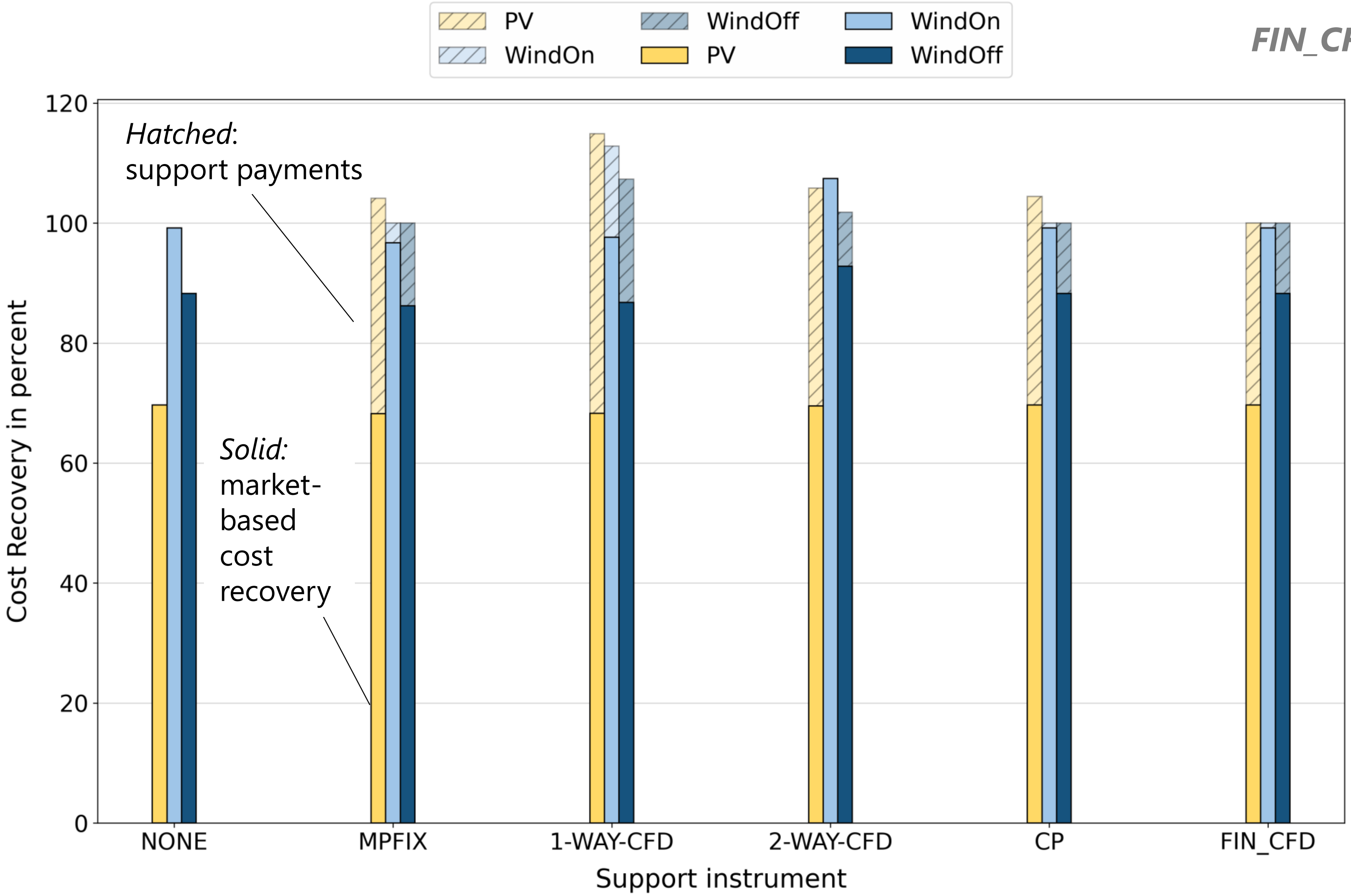
vRES traders bid at higher prices due to payback obligation in clawback periods
→ higher prices

CP, FIN-CFD

support not based on production
→ no price impact

Cost recovery rates for vRES
Scenario S1

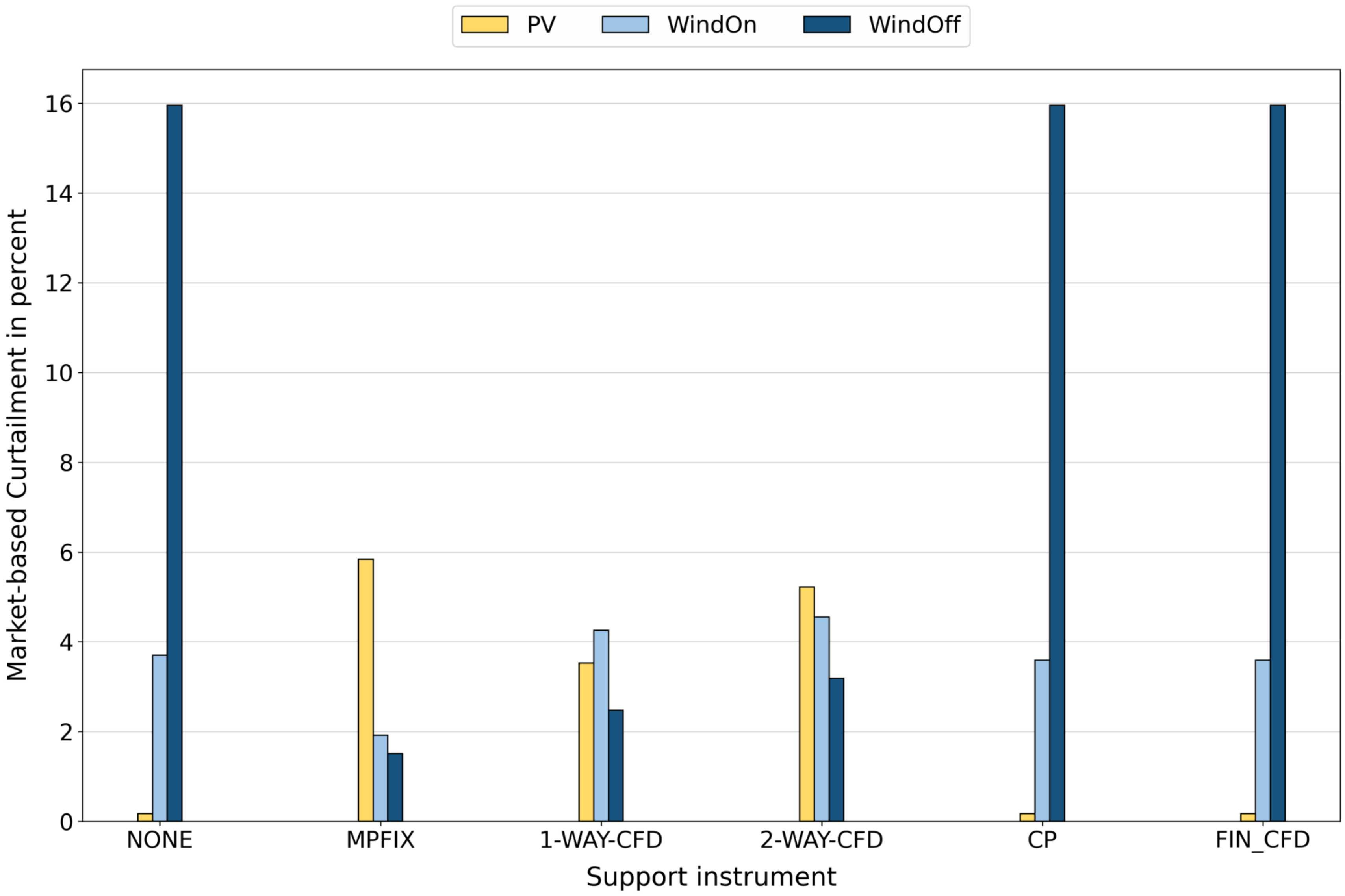
FIN_CFD reference plant = actual plant



- No market-based refinancing for **rooftop PV** in any case
- **Wind** can (almost) recover costs on the market
- **1-WAY-CFD** and **2-WAY-CFD**: additional support payments during months with insufficient market incomes
- **2-WAY-CFD**: higher prices due to negative premia in clawback periods and corresponding bidding / curtailment
- **Refinancing with support**: *ideally parameterized* market designs

Market-based curtailment of vRES

Scenario S1



Offshore wind

Highest variable costs among considered vRES technologies

→ Heavy **curtailment** for NONE, CP and FIN_CFD (no dispatch distortions)

MPFIX & CFD

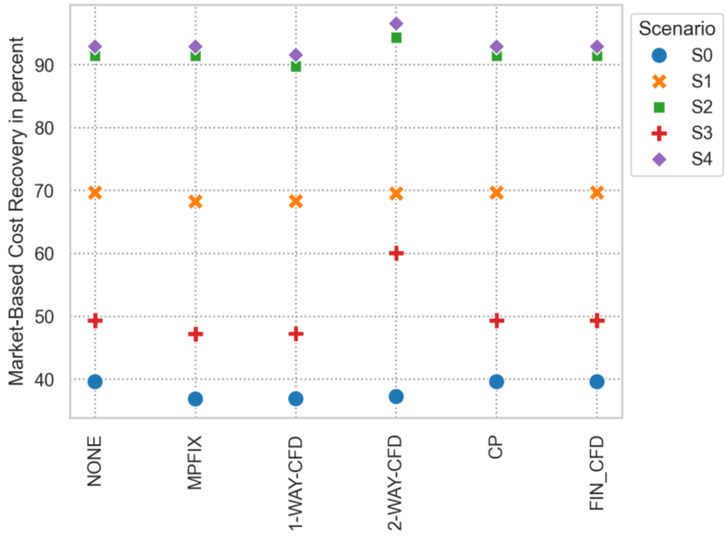
Bids & merit order impacted by expected premium payments

→ **Displacement** of PV by offshore wind

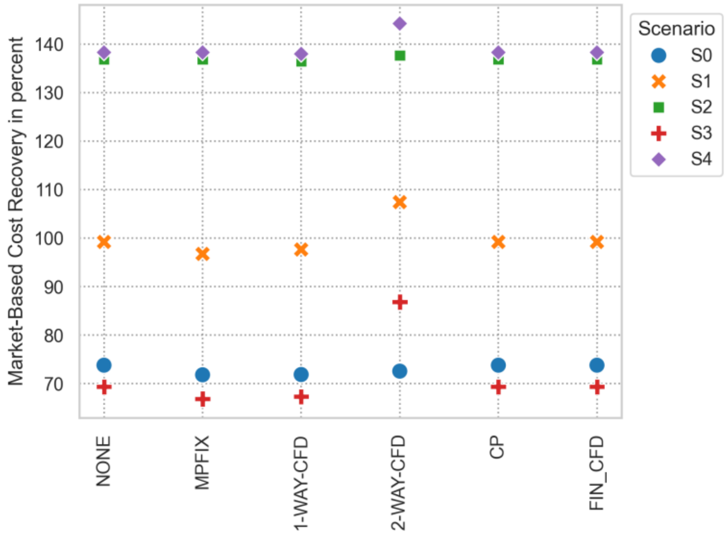
Market-based cost recovery

Scenarios S0-S4

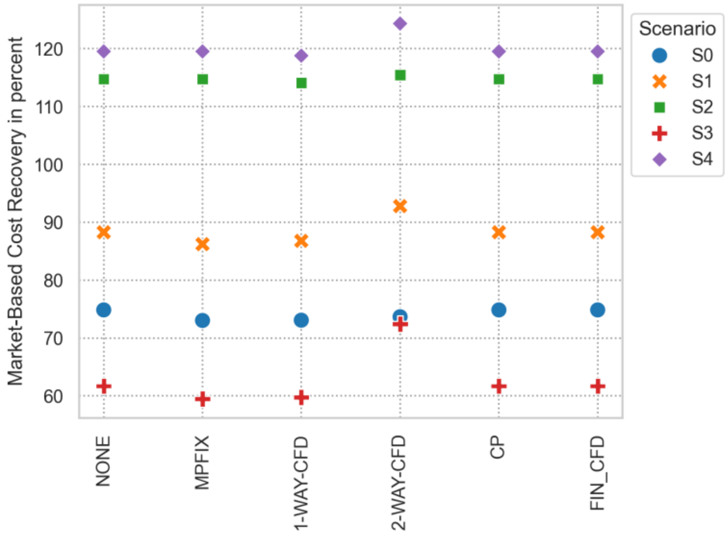
PV



Wind Onshore



Wind Offshore



- Highest cost recovery rates for flexible scenarios S2 and S4, because **higher flexibility increases market values for RES**
- S3: lowest prices and market values for PV and wind across all scenarios (high share of cheap imports)
- **2-WAY-CFD significantly changes market behavior**
- **Differences between scenario**s have a greater impact than those between supporting instruments!

Summary and conclusion

- Support instruments are likely required to **de-risk RES investments**
  - Especially for rooftop-PV

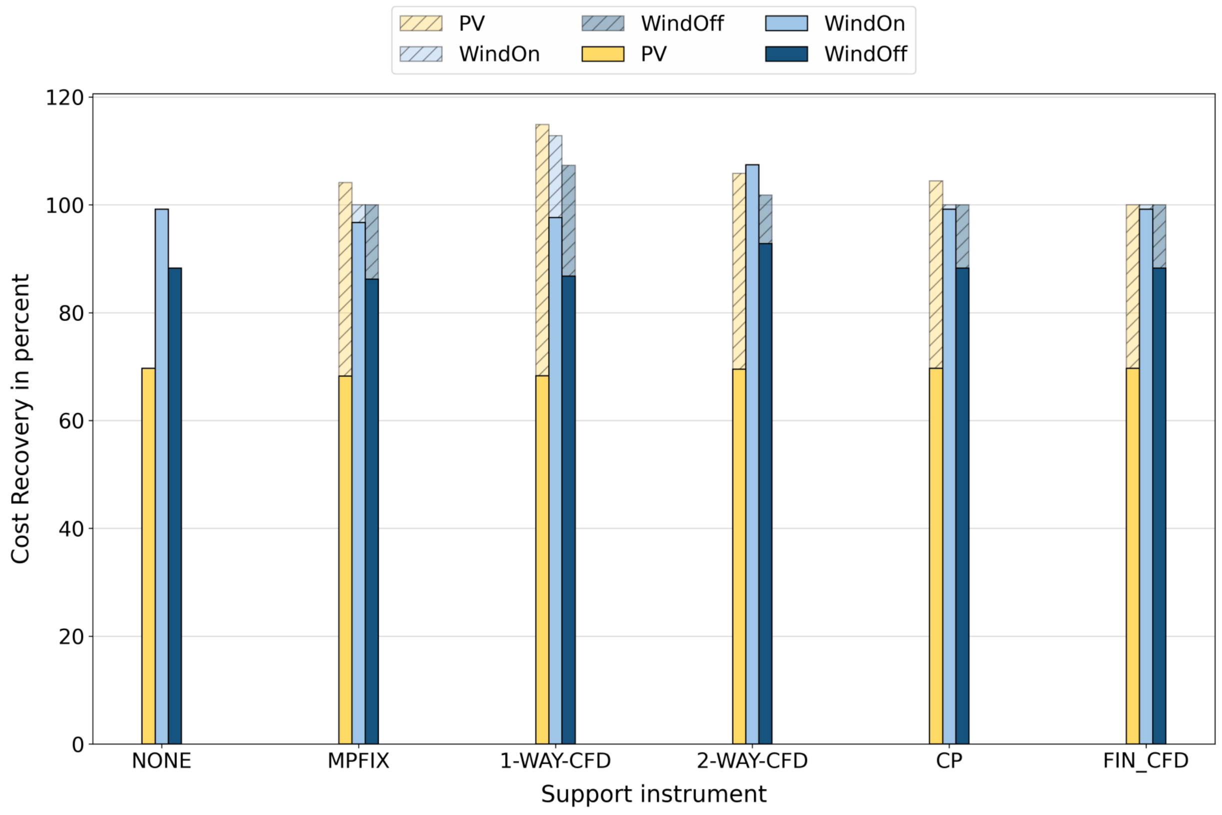
- Results are **highly sensitive** with regard to scenario assumptions
  - Flexibility stabilizes market values for RES

- **2-WAY-CFD** tends to
  - Increase market-based cost recovery
  - Increase market prices
  - Increase curtailment

- Real-world **difficulty** of “good” instrument parametrisation not considered

Thank you!

https://traderes.eu/



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