

Agent-based Modelling of Green Hydrogen Electrolysis Covering the Investment and Dispatch Perspective

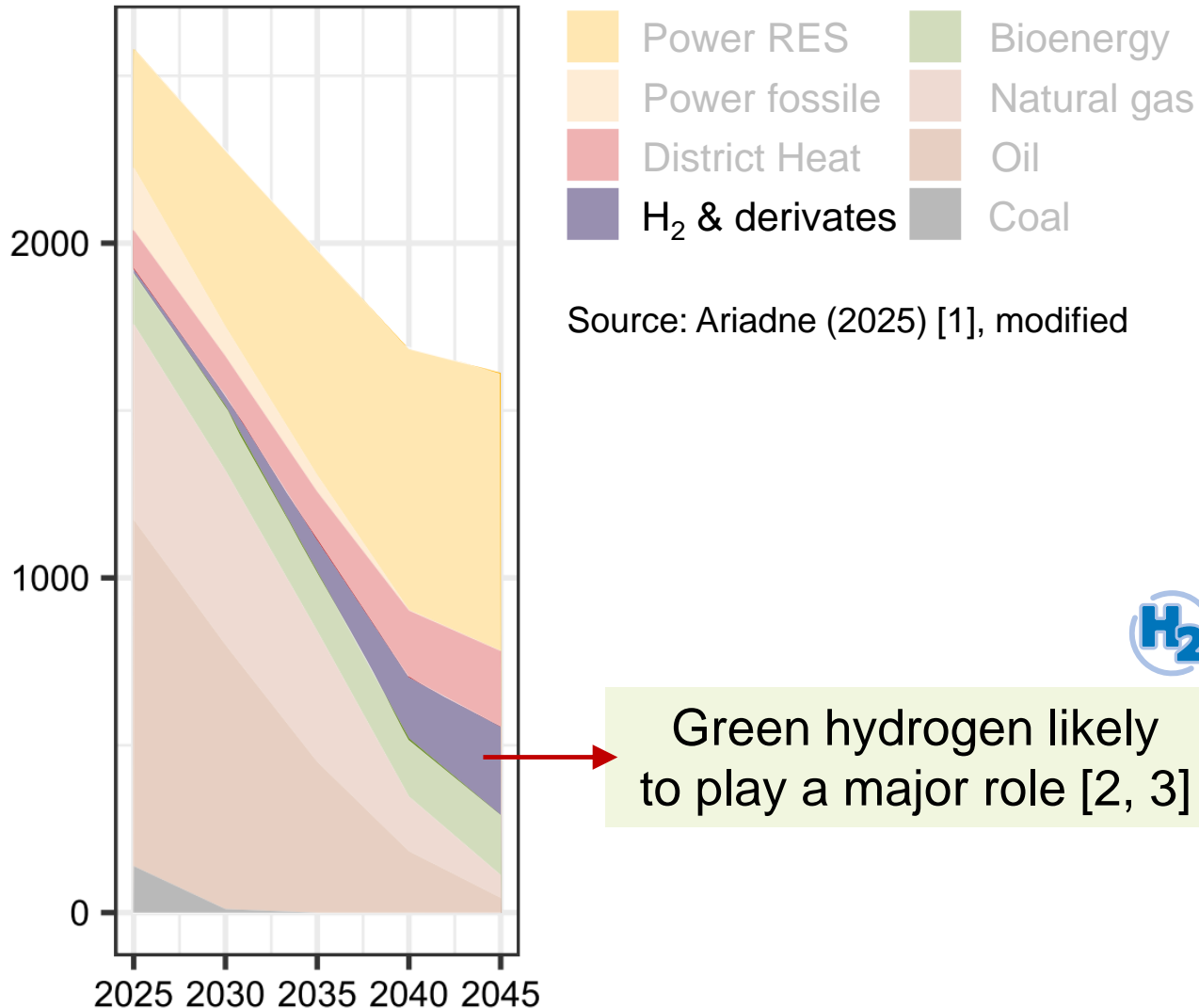
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Motivation & Research Questions



Final Energy Demand for Germany in TWh/a

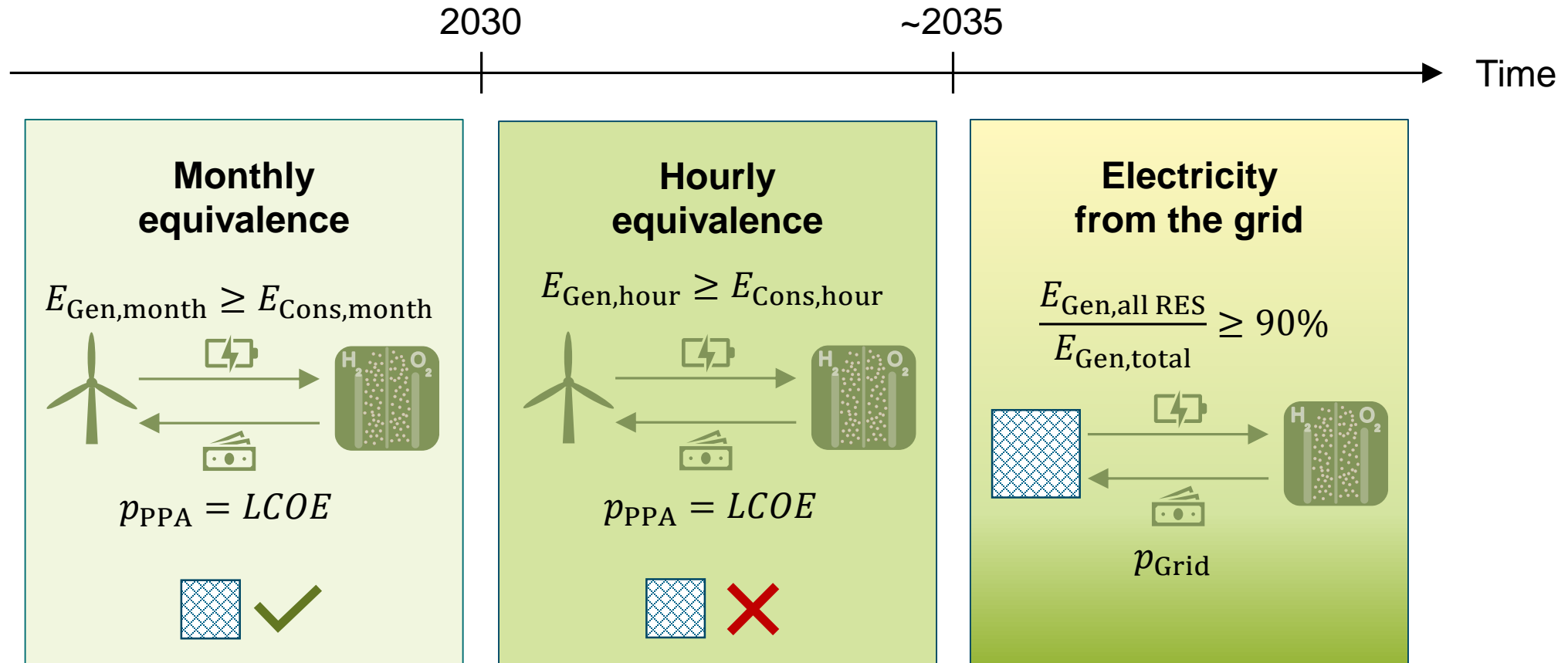


- Is green hydrogen production competitive to fossil alternatives?
- If not: How much subsidy is needed?
- How much investments to expect from an investor's point of view?

Green hydrogen likely to play a major role [2, 3]



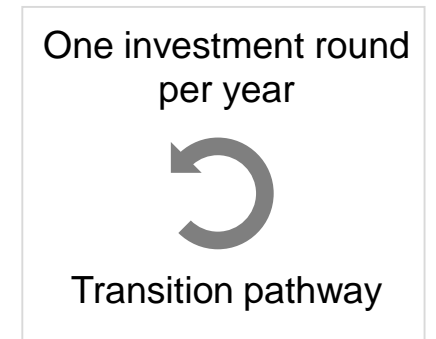
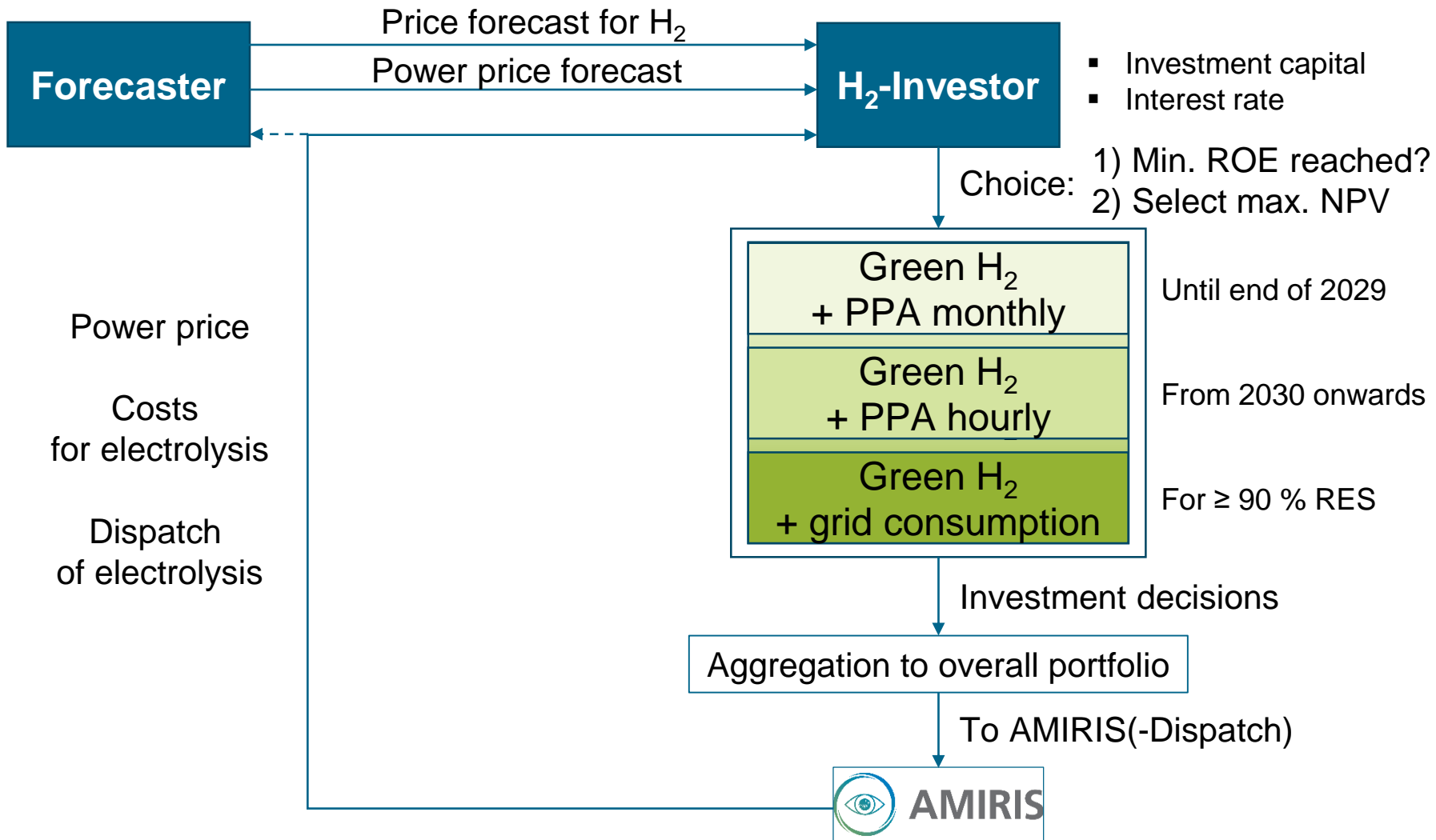
Background: Green Hydrogen Regulation



- E_{Gen} : Renewable plant electricity generation
- E_{Cons} : Electrolyzer electricity consumption
- $LCOE$: Levelized cost of electricity of renewable plant
- p_{PPA} : Price of PPA with renewable plant
- p_{Grid} : Price for electricity withdrawal from grid
- PPA: Power purchasing agreement

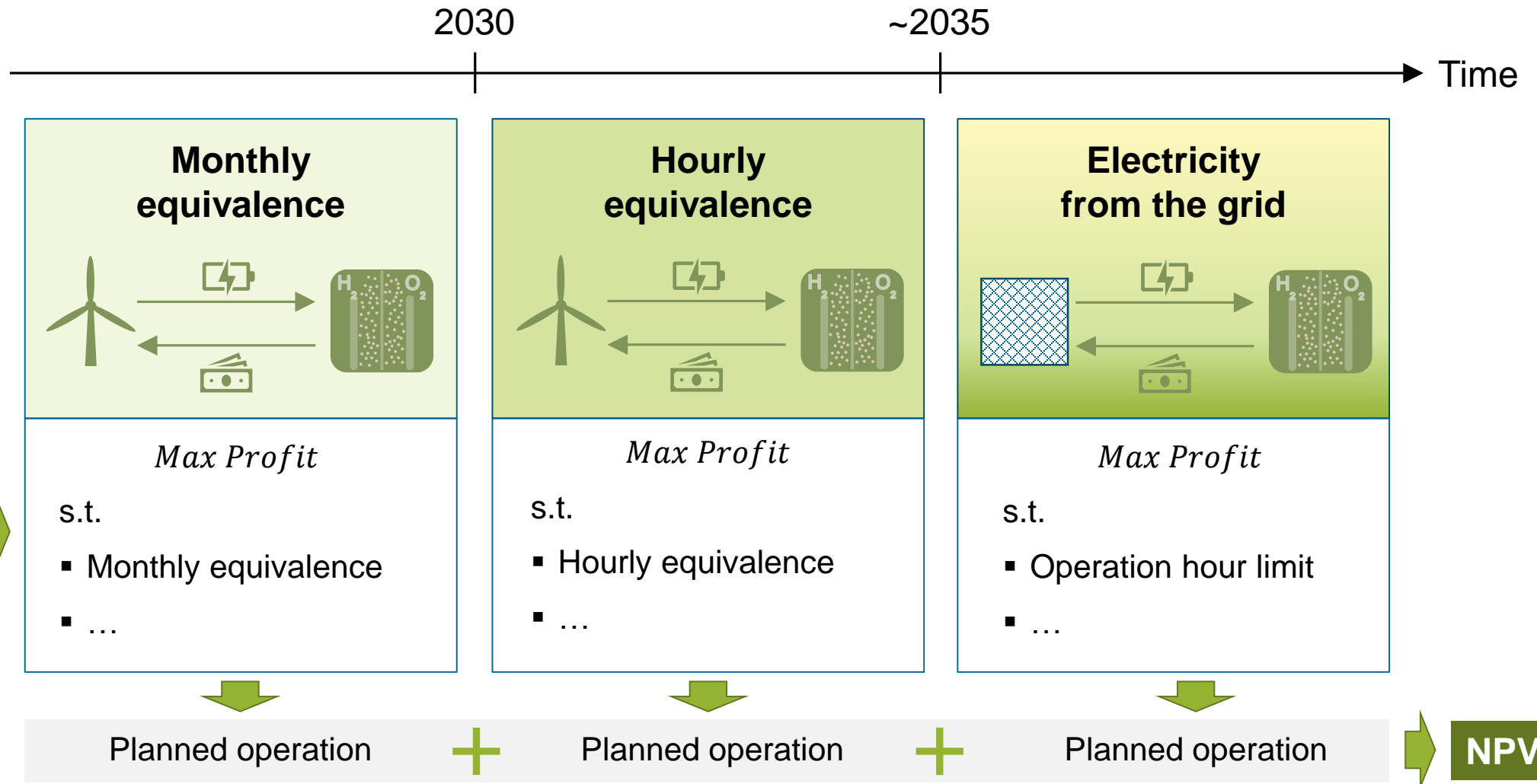
Source: EU Delegated Act 2023/1184 [4]

Investment Modelling Approach



NPV: Net Present Value
ROE: Return on Equity

Investment Decision



- Electrolyser size
- RES profile
- Price forecasts for H₂ & power
- PPA price

- s.t.
- Monthly equivalence
 - ...

- s.t.
- Hourly equivalence
 - ...

- s.t.
- Operation hour limit
 - ...

Planned operation

+

Planned operation

+

Planned operation

→ **NPV**

s.t.: such that
NPV: net present value

Proof of concept: Scenario setup



- Germany
- Single market zone

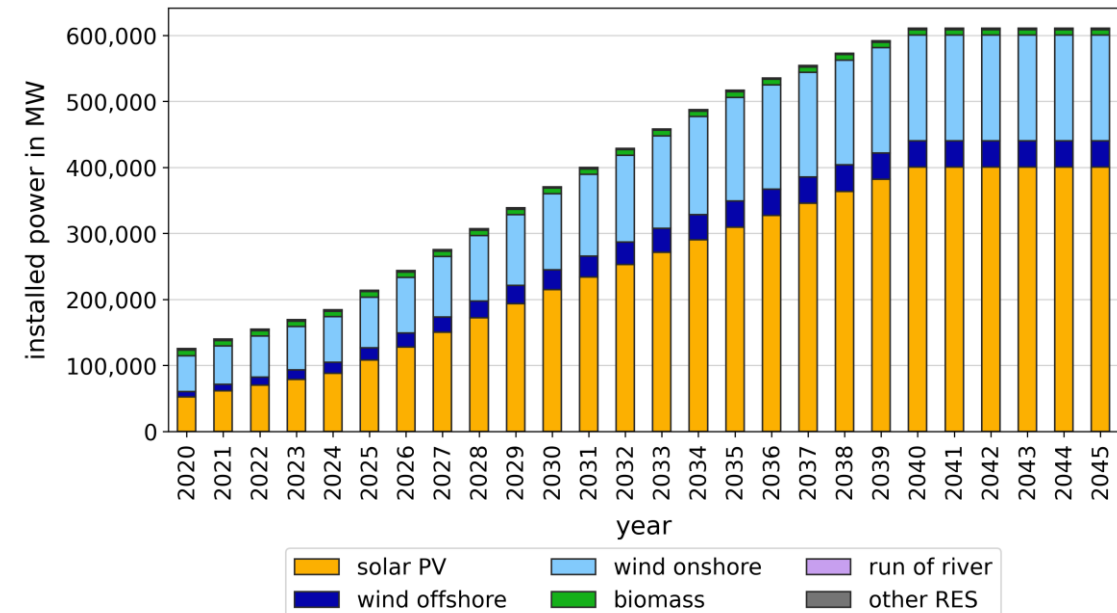


- Pathway: investments 2020 to 2030
- Hourly dispatch resolution

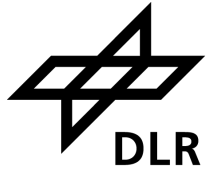


- Brownfield scenario from Kochems (2024) [5]
 - RES expansion according to national goals
 - Coal phase out 2030, endogenous backup

Renewable capacities



Proof of concept: Technology & cost assumptions

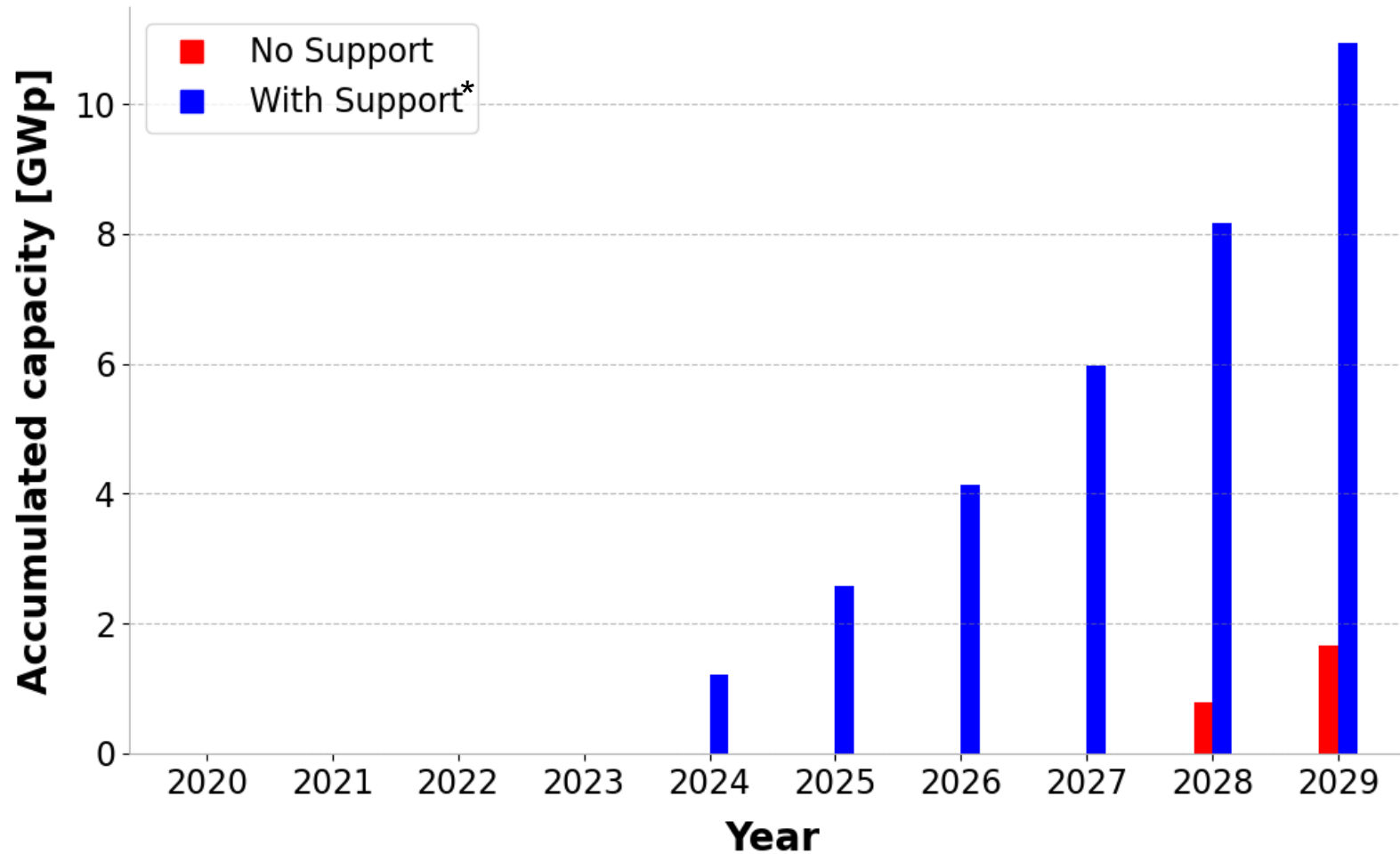


Parameter	2020	2030
Electrolysis investment expenses [6]	~2.093 €/kW	1.160 €/kW
Fixed costs [6]	3% p.a.	
Electrolyser efficiency [7]	65%	
Equity share*	40%	
WACC*	7.62%	
Wind PPA price [8]	70 €/MWh	
Hydrogen selling price [9]	95 €/MWh	

*assumptions based on survey & expert interviews

WACC: weighted average cost of capital

Results



Average full load hours

No support	3,872
With Support*	3,370

* Investment support of ~1.091 €/kW (40% of initial investments)

Support necessary to foster green hydrogen investments

Conclusion



Key Messages

- Proof of concept for agent-based model for green hydrogen investments and dispatch.
- Found market-driven green hydrogen investments only in later years.
- Introducing investment support, significantly higher investments can be observed.

Outlook

- Compare against alternative investments: Grey hydrogen, blue hydrogen.
- Consider different scenarios and a more granular spatial resolution.
- Analyse policy influence.

Imprint



Topic: **Agent-based modelling of green hydrogen electrolysis covering the investment and dispatch perspective**

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Sources 1



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