Power-to-X model overview

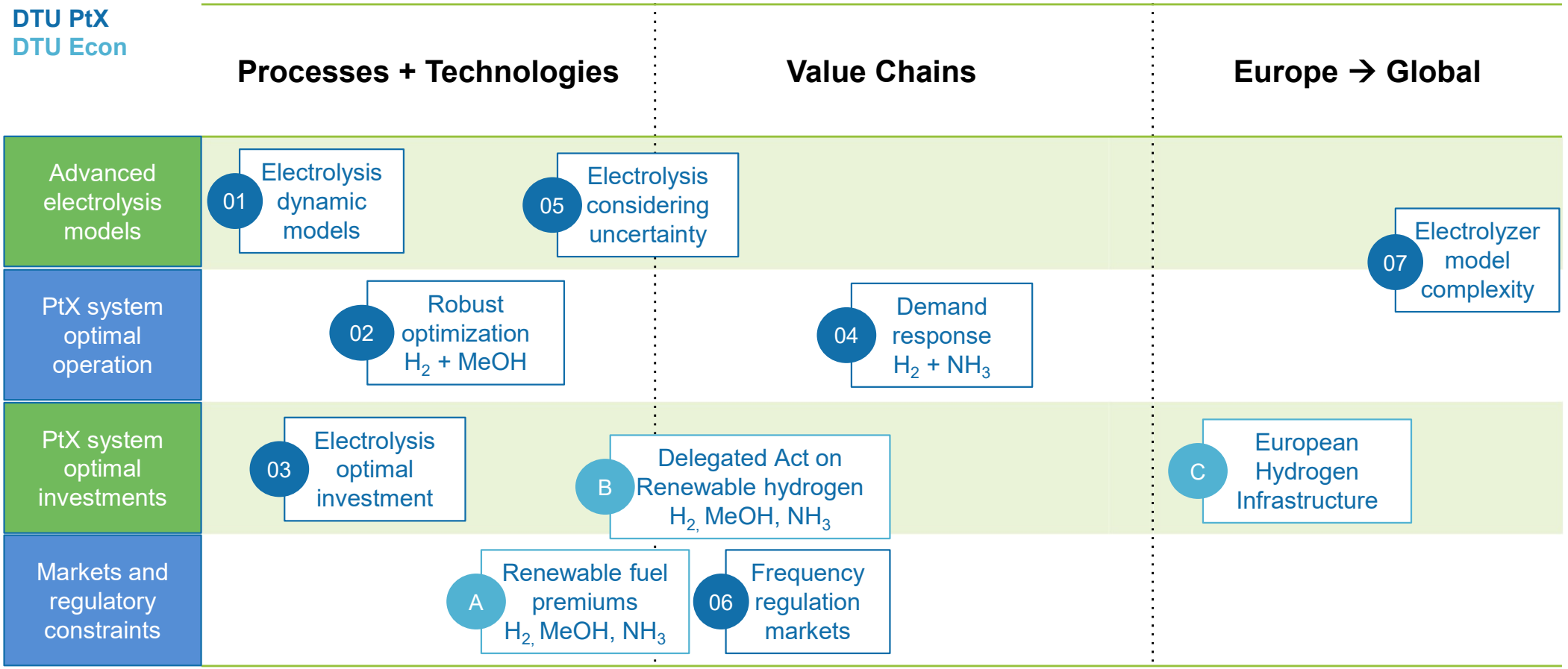
SuperP2G Stakeholder Meeting , 31st of March 2023

Lissy Langer
DTU Energy Economics & Modeling

This project has received funding in the framework of the joint programming initiative ERA-Net Smart Energy Systems' focus initiative Integrated, Regional Energy Systems, with support from the European Union's Horizon 2020 research and innovation programme under grant agreement No 775970.

Introducing the PtX model zoo

DTU PtX
DTU Econ



Impact of renewable fuel premiums on PtX hub operation: The EnerHub2X model

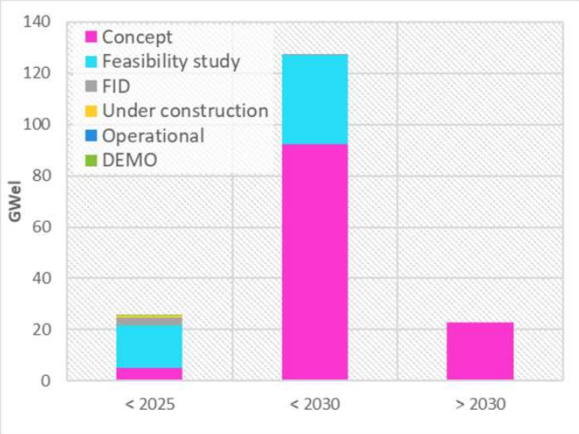
SuperP2G Stakeholder Meeting , 31st of March 2023

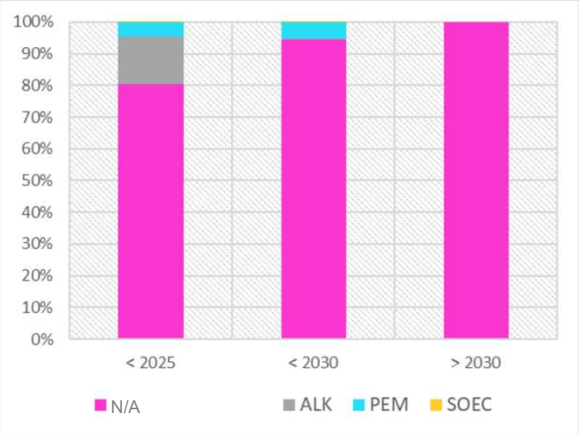
Lissy Langer
DTU Energy Economics & Modeling

This project has received funding in the framework of the joint programming initiative ERA-Net Smart Energy Systems' focus initiative Integrated, Regional Energy Systems, with support from the European Union's Horizon 2020 research and innovation programme under grant agreement No 775970.

Motivation: Power-to-X in Energy Hubs

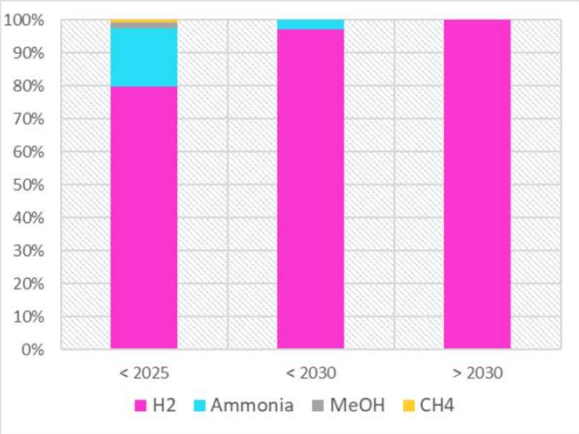
Lots of early-stage ambition

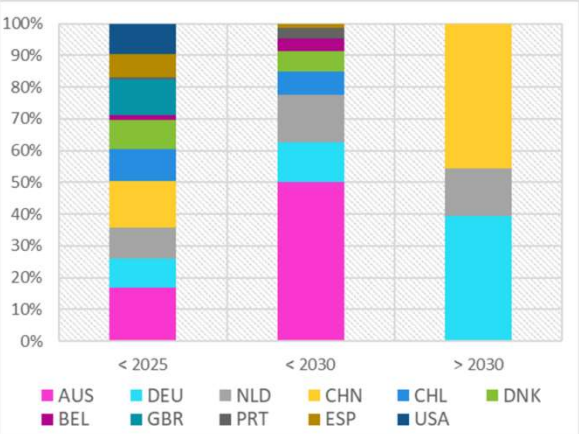




High technological uncertainty

High fuel uncertainty

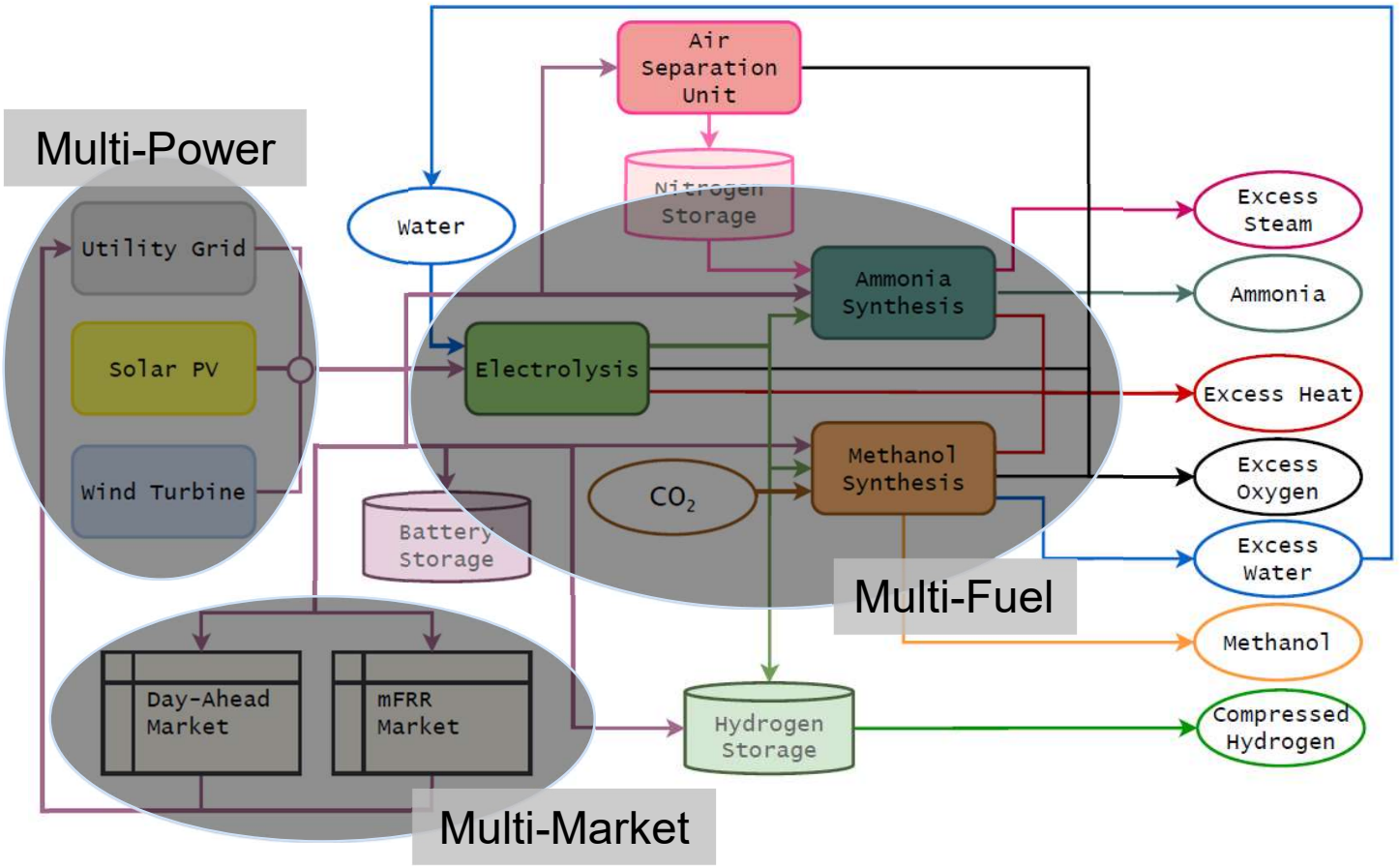




Some frontrunners

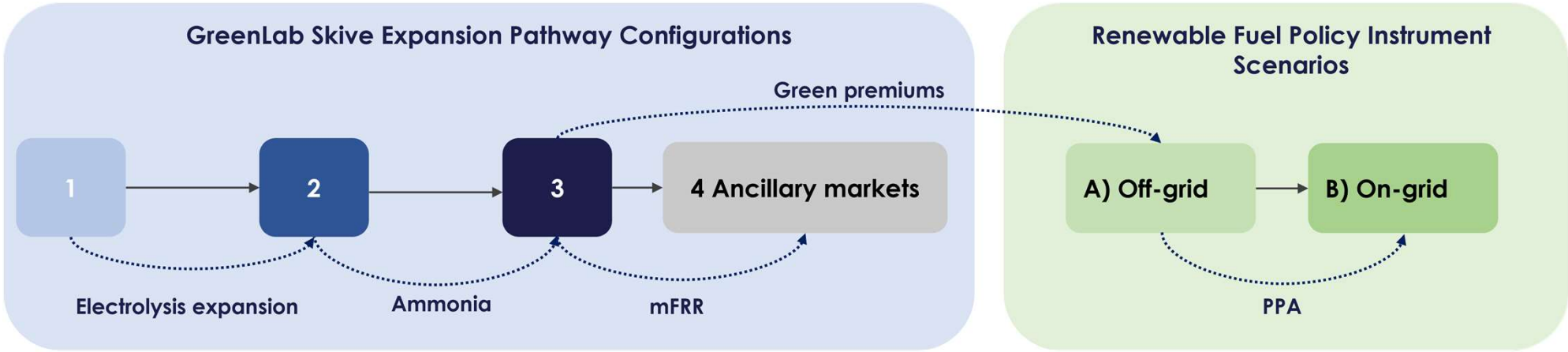
Data: IEA (2021)

GreenLab Skive: Technology Flow Chart



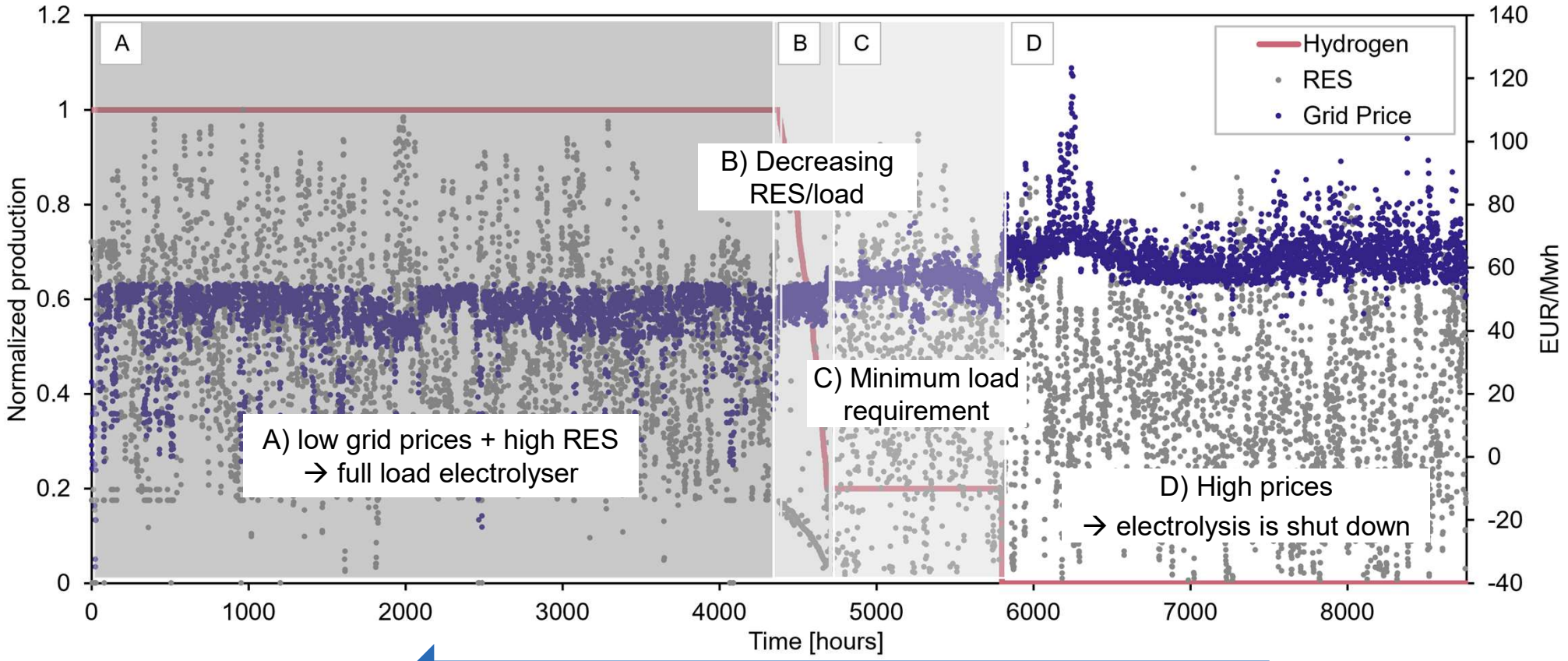
- Over one year with hourly time resolution
- Considering unit commitment
- Fixed fuel prices

Scenarios



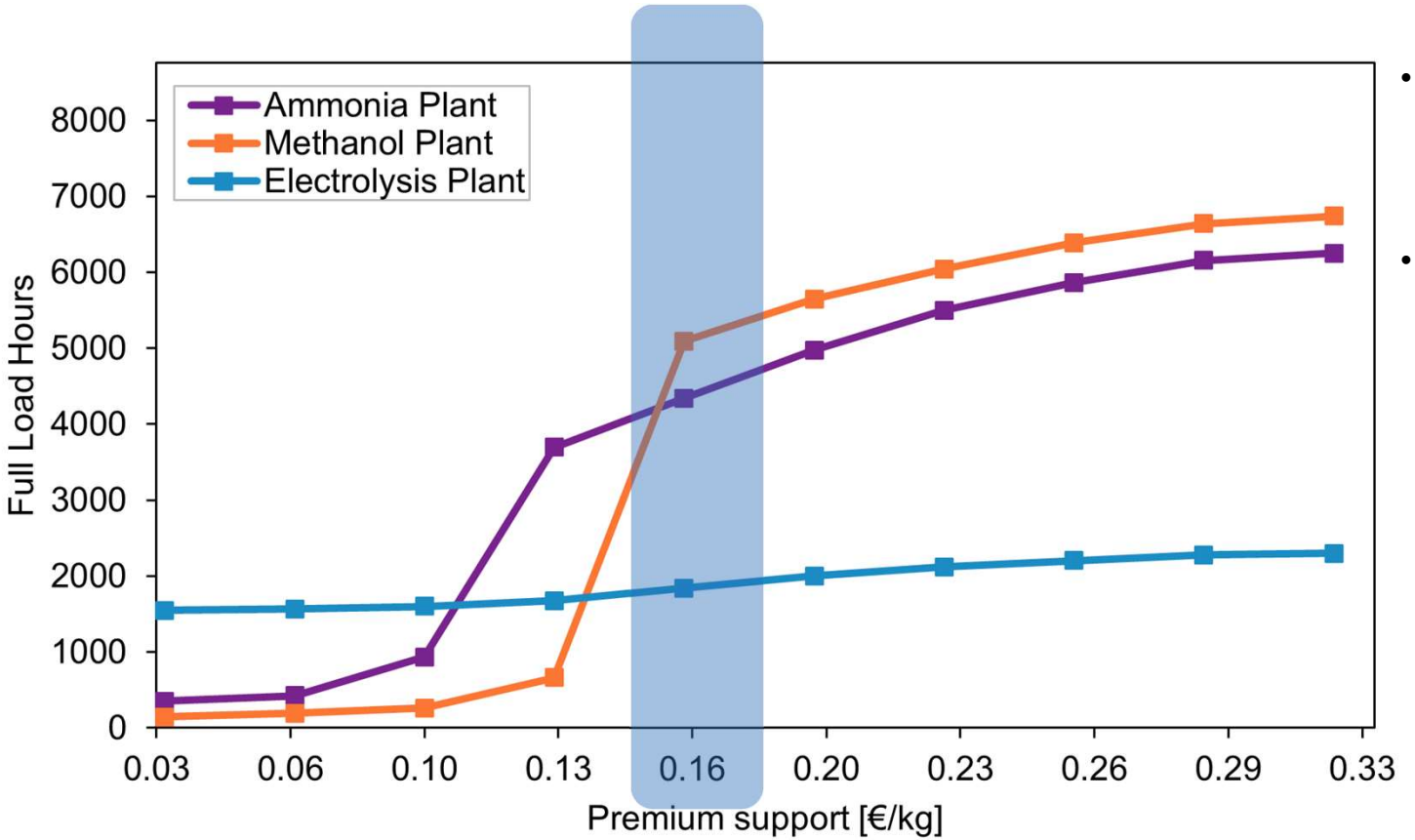
Kountouris, I., Langer, L., Bramstoft, R., Münster, M. and Keles, D., 2023. Power-to-X in energy hubs: A Danish case study of renewable fuel production. *Energy Policy*, *175*, p.113439.

Operational Results (S1)



Renewable fuel premiums to increase full-load hours?

Renewable fuels premiums



- A 50% fuel premium for ammonia and methanol increases production substantially
- Capacity expansion needs to be harmonized between synthesizers and available RES

  → next paper

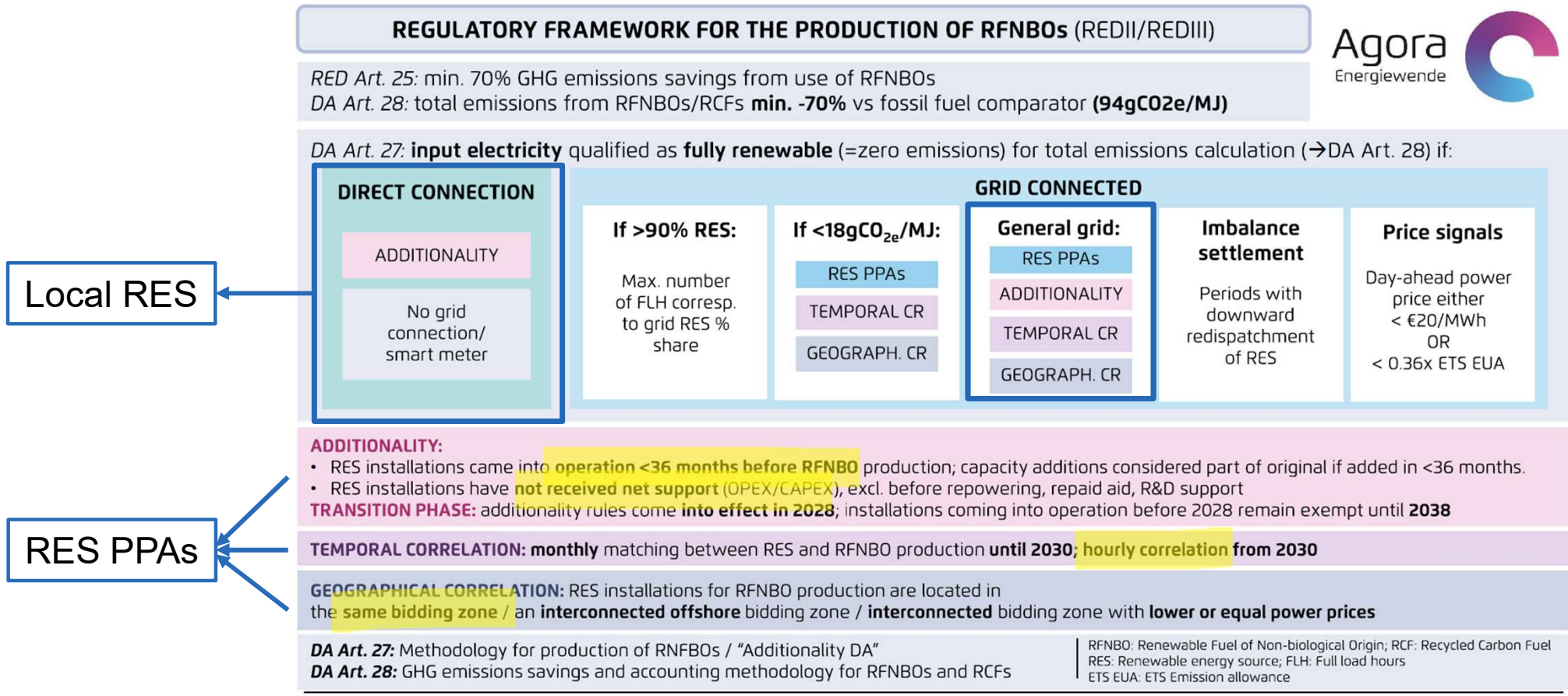
PtX hub investments under the Delegated Act: The EnerHub2X.spineopt model

SuperP2G Stakeholder Meeting , 31st of March 2023

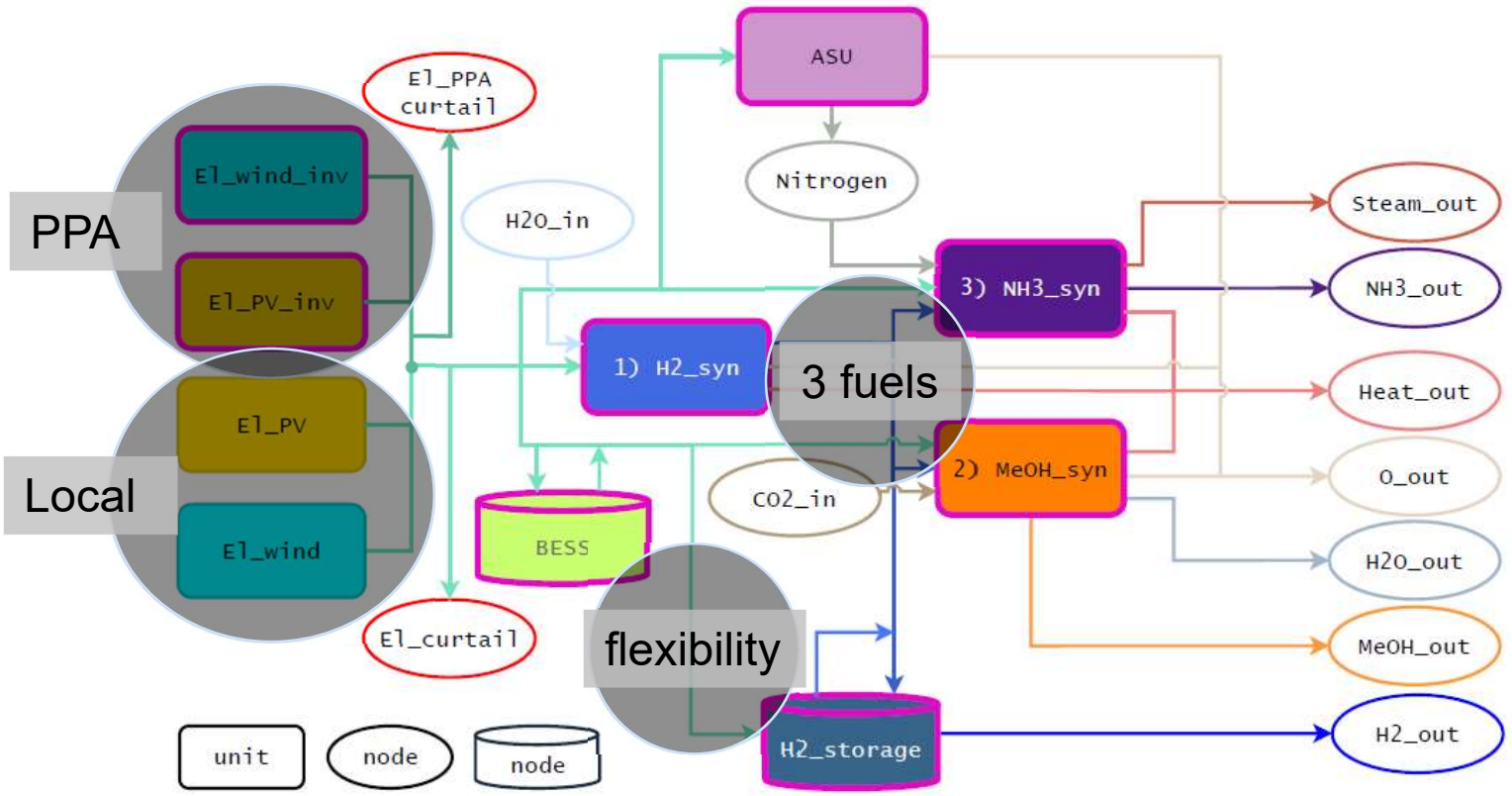
Lissy Langer
DTU Energy Economics & Modeling

This project has received funding in the framework of the joint programming initiative ERA-Net Smart Energy Systems' focus initiative Integrated, Regional Energy Systems, with support from the European Union's Horizon 2020 research and innovation programme under grant agreement No 775970.

Delegated Act on Renewable Fuels of non-biological origin (RFNBOs)



GreenLab Skive: Technology Flow Chart



- Over one year with hourly time resolution
- Considering unit commitment
- Fixed fuel prices
- **Capacity investments**

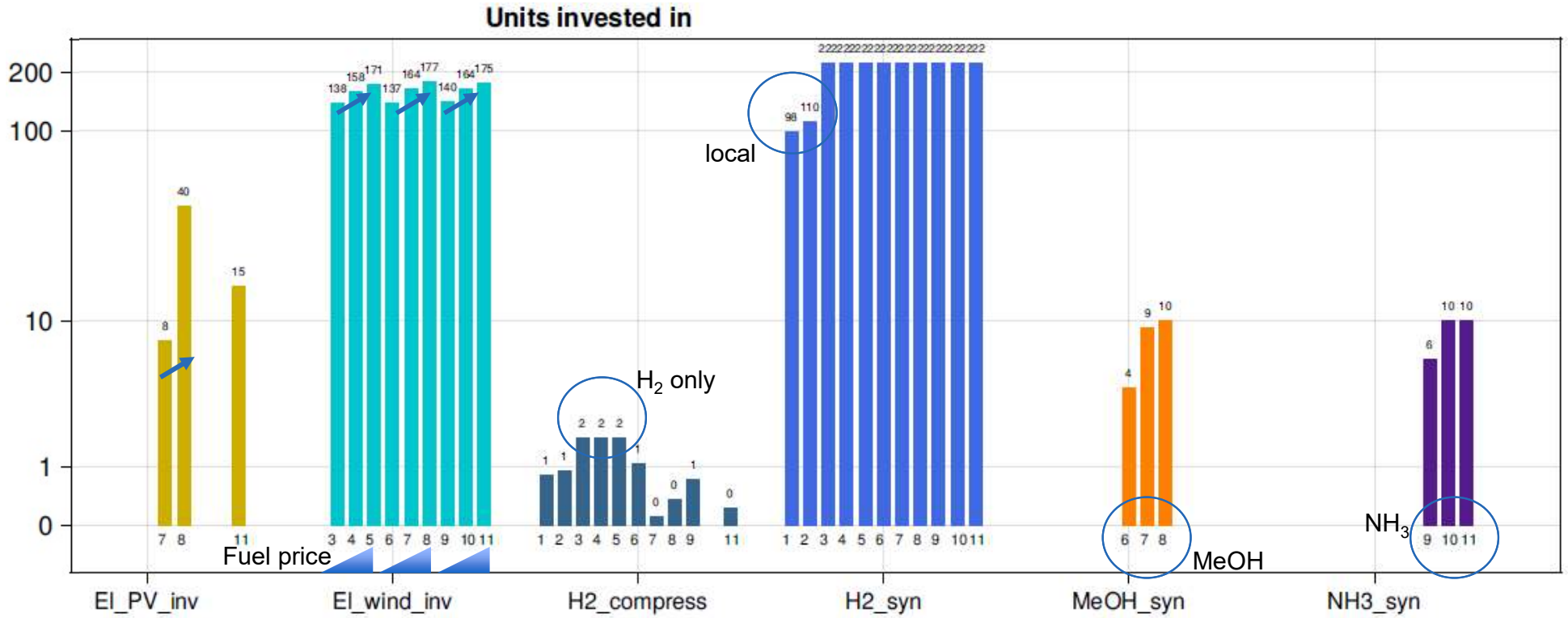
Scenarios

No	Fuels		RES		Fuel price
0	H_2		Local		1x
1	H_2		Local		1.5x
2	H_2		Local		2x
3	H_2		Local	PPA	1x
4	H_2		Local	PPA	1.5x
5	H_2		Local	PPA	2x
6	H_2	MeOH	Local	PPA	1x
7	H_2	MeOH	Local	PPA	1.5x
8	H_2	MeOH	Local	PPA	2x
9	H_2	NH_3	Local	PPA	1x
10	H_2	NH_3	Local	PPA	1.5x
11	H_2	NH_3	Local	PPA	2x

- P2X price projections made for 2030 by the Danish Energy Agency:
  - H_2 €2.16 per kg
  - MeOH €0.65 per kg
  - NH_3 €0.46 per kg

Langer, L., Kountouris, I., Bramstoft, R., Münster, M. and Keles, D., 2023. Renewable fuel regulation: Implications for e-fuel production infrastructure in energy hubs. *Under review in European Energy Market Conference 2023*.

Investment decisions

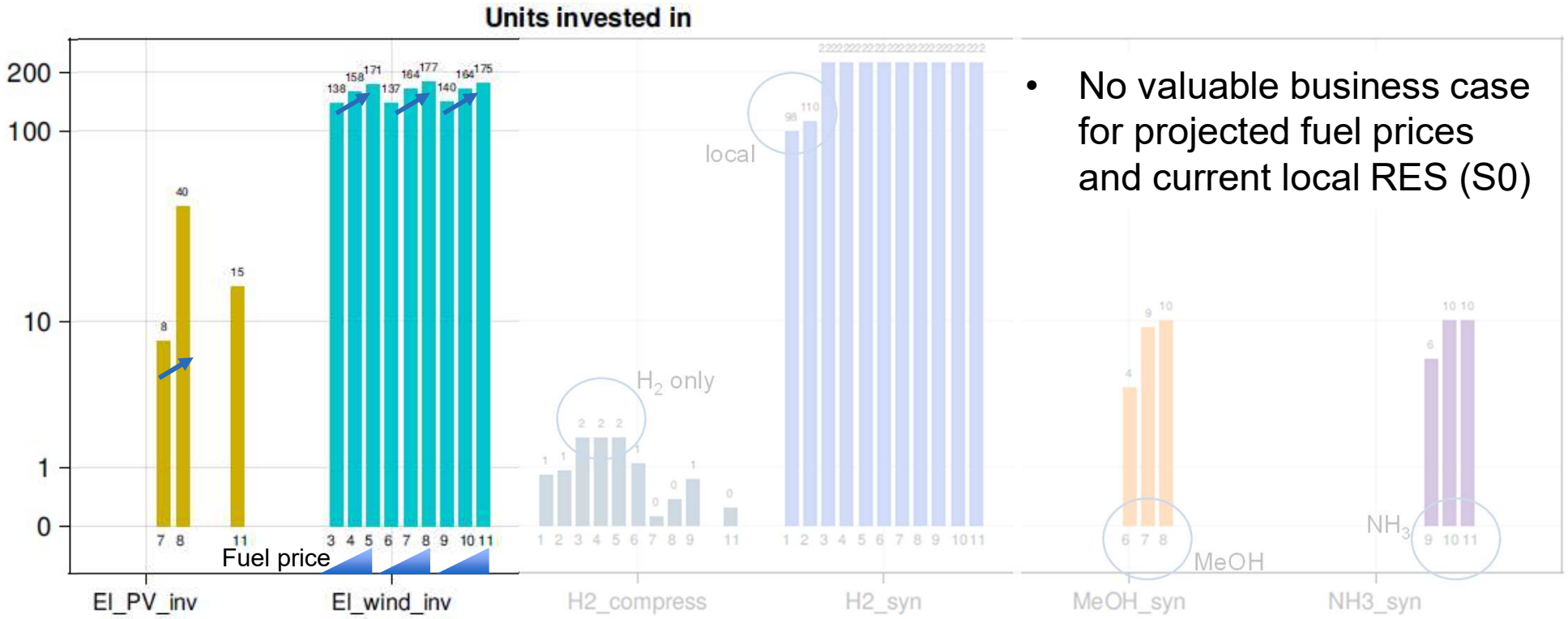


Massive additional PPA needed

H_2 seems no regret with PPA

At higher prices full capacity

Investment decisions



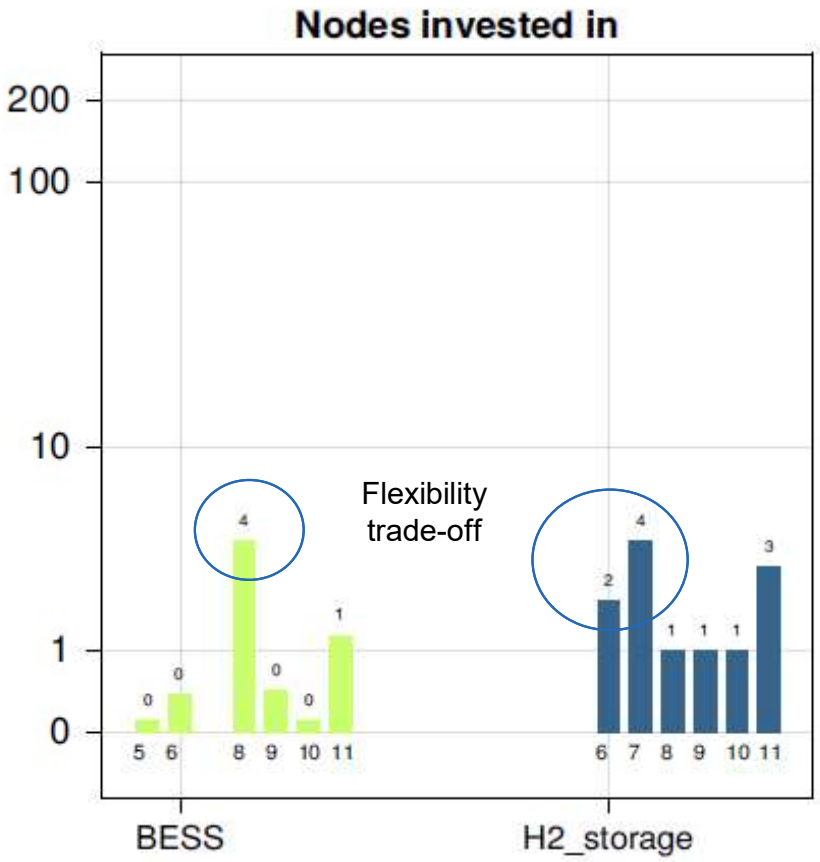
- No valuable business case for projected fuel prices and current local RES (S0)

Massive additional PPA needed

H_2 seems no regret with PPA

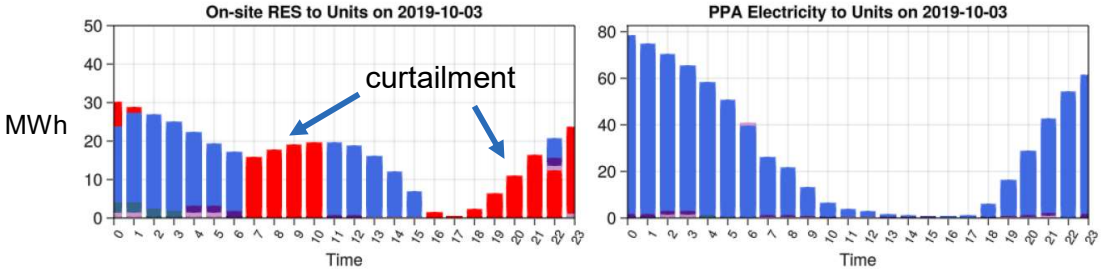
Full capacity at higher prices

Flexibility requirements



- Trade-off between batteries, H_2 storage, and overcapacity
- Higher flexibility requirements for MeOH than NH_3

- PPAs become essential
- Sharing of risks and rewards with local RES owners will drive model behavior



Operation Results, Electrolysis expansion