Western Norway University of Applied Sciences

Senter for Sjøsikkerhet

Harnessing the Power: A Case study on Small-Scale Hydropower for Hydrogen production

Liina Sangolt

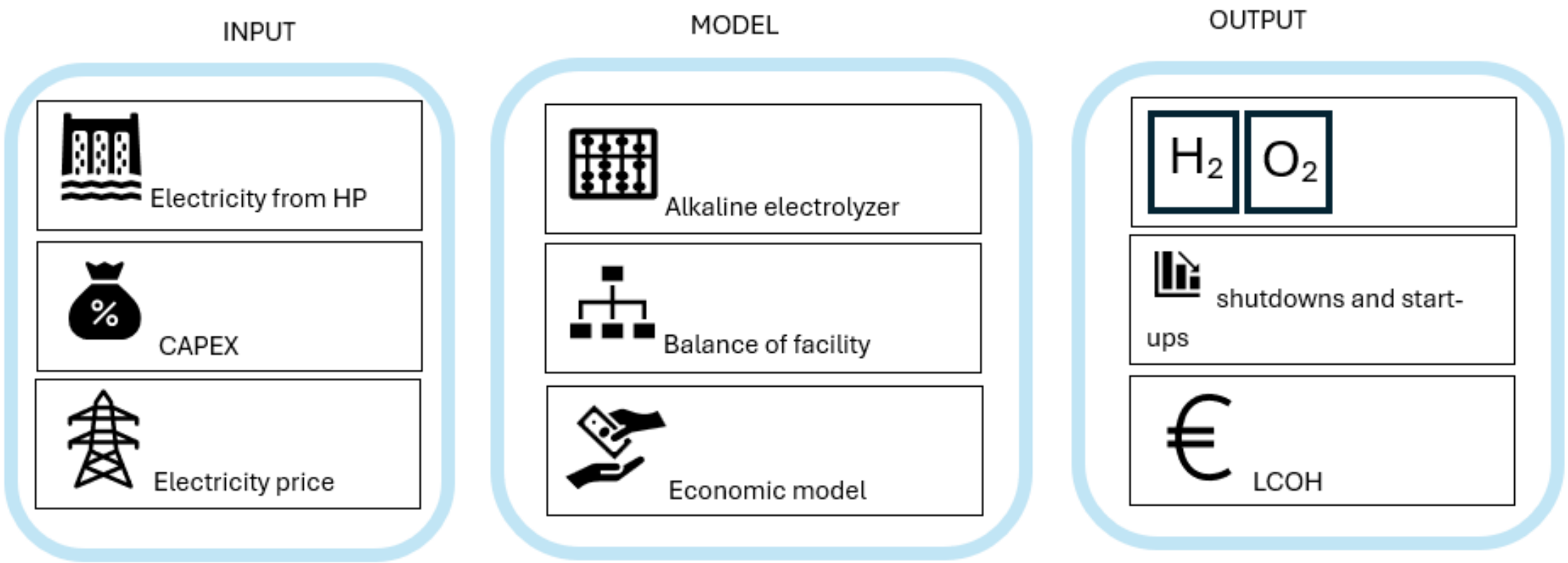
Supervisors: Velaug Myrseth Oltedal, Andres Olivares, Pawel Jan Kosinski

May 28th, 2024

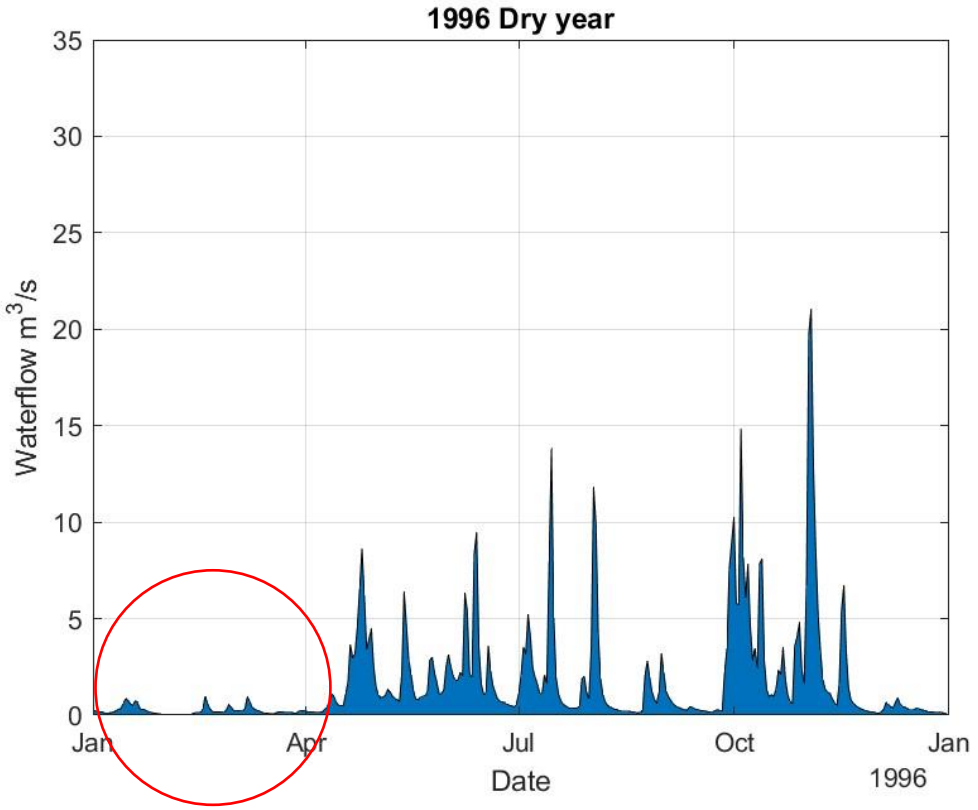
BACKGROUND

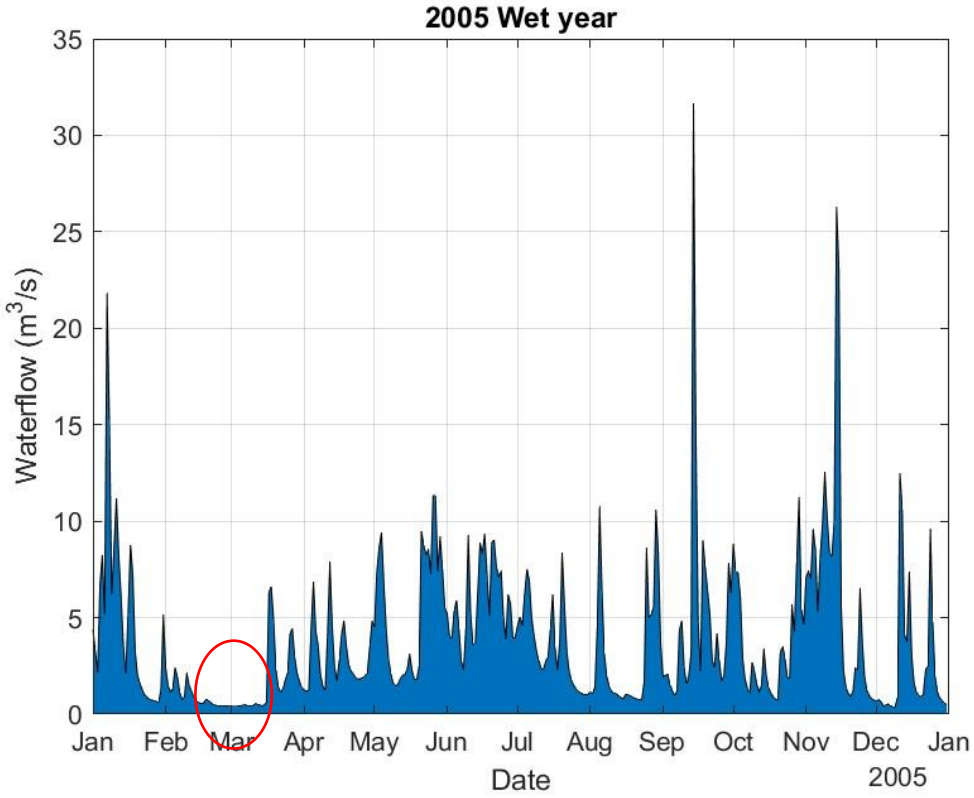
- 3 TWh of untapped run-off river power [1]
- Case example Bordalen River
- Inflow data from 01.01.1984-31.12.2013 [2]

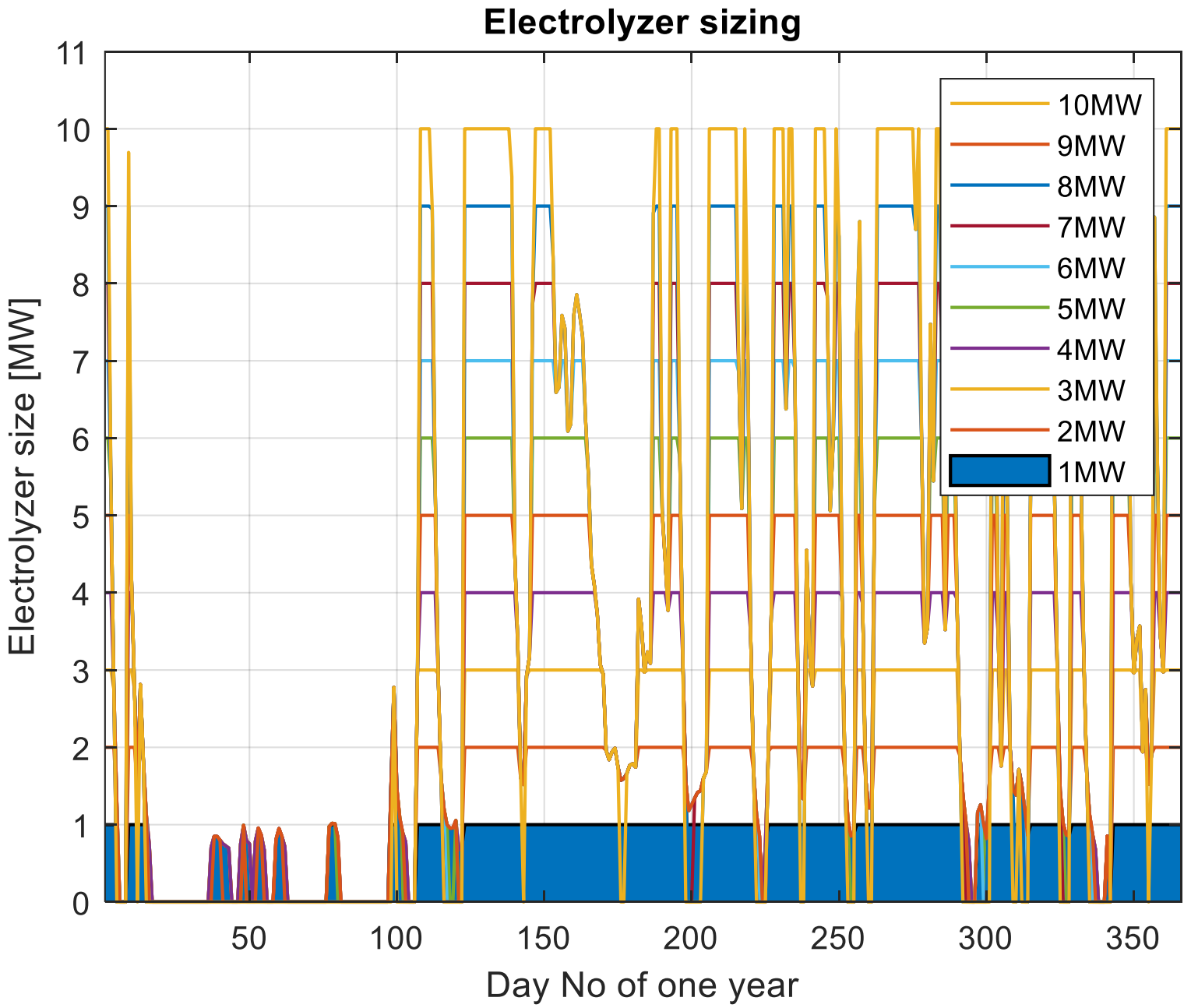
SCHEMATIC OF MODEL

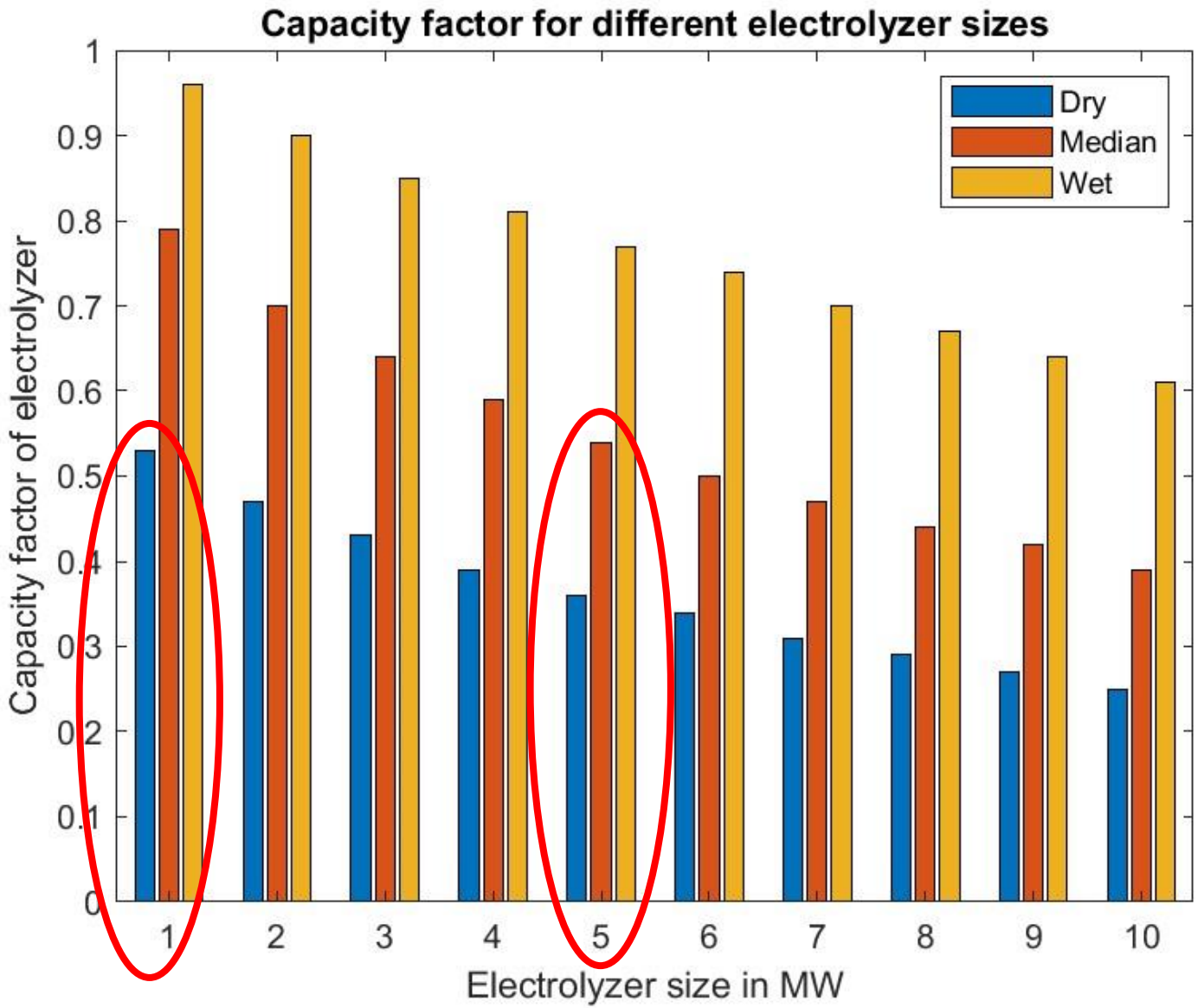


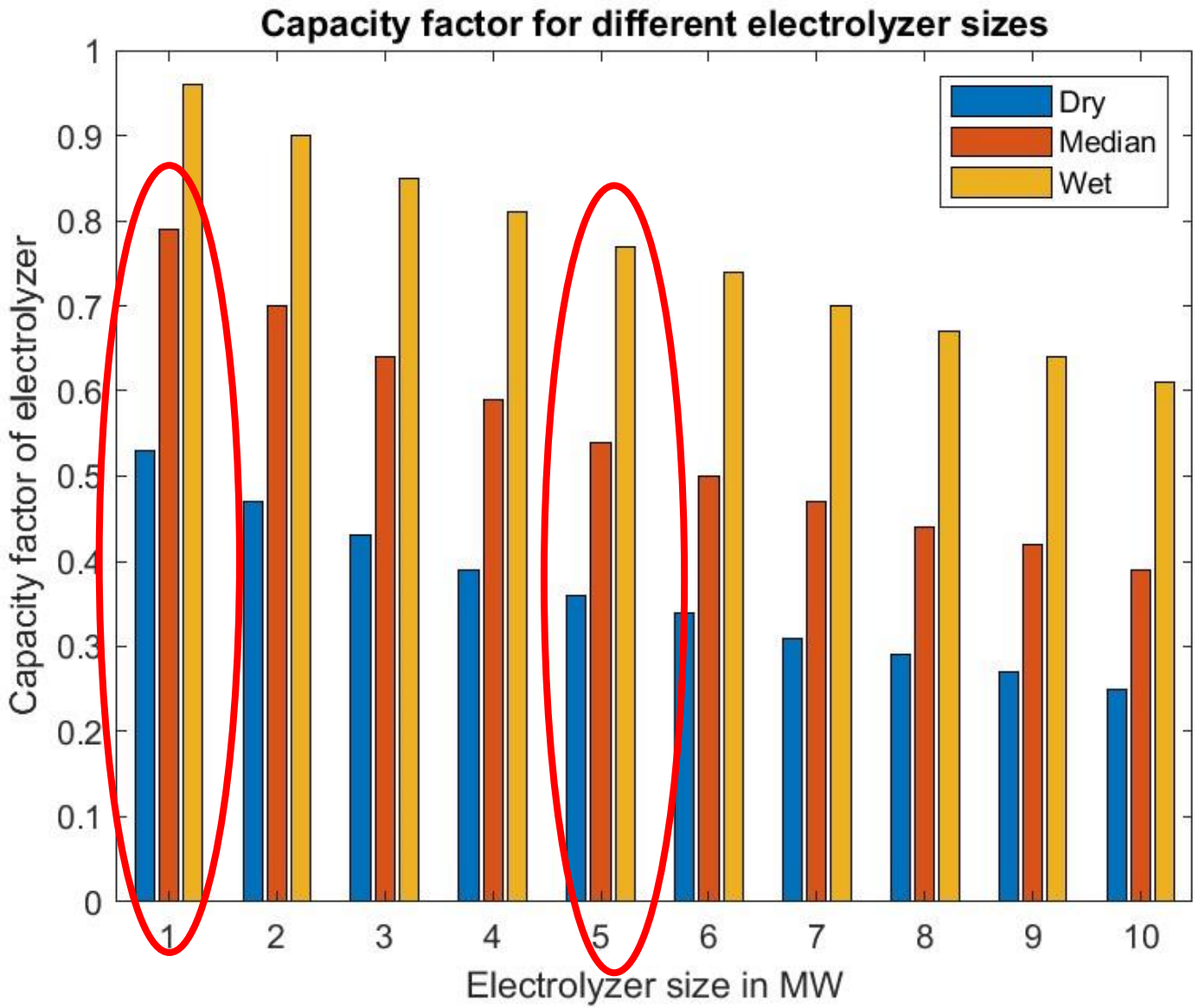
Inflow water data – seasonal and yearly variations



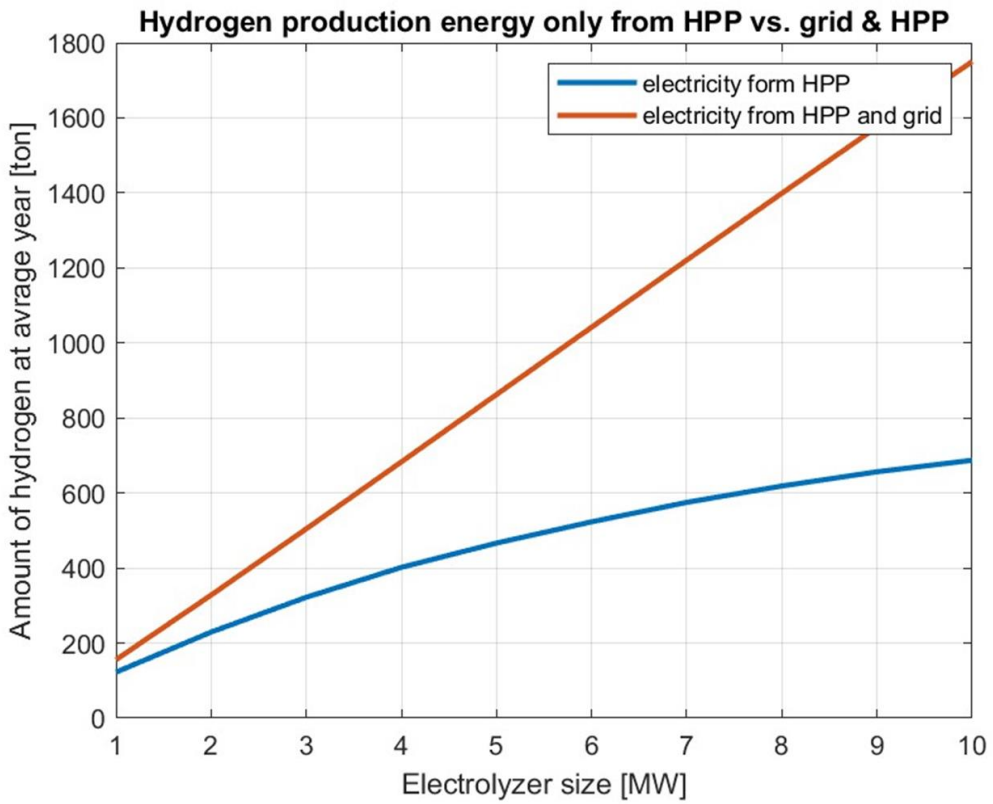



Electrolyzer sizing
Electrolyzer size [MW]
Day No of one year
0
1
2
3
4
5
6
7
8
9
10
11
50
100
150
200
250
300
350
10MW
9MW
8MW
7MW
6MW
5MW
4MW
3MW
2MW
1MW


Capacity factor for different electrolyzer sizes
Dry
Median
Wet
Capacity factor of electrolyzer
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1
2
3
4
5
6
7
8
9
10
Electrolyzer size in MW


Capacity factor for different electrolyzer sizes
Capacity factor of electrolyzer
Electrolyzer size in MW
Dry
Median
Wet
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1
2
3
4
5
6
7
8
9
10

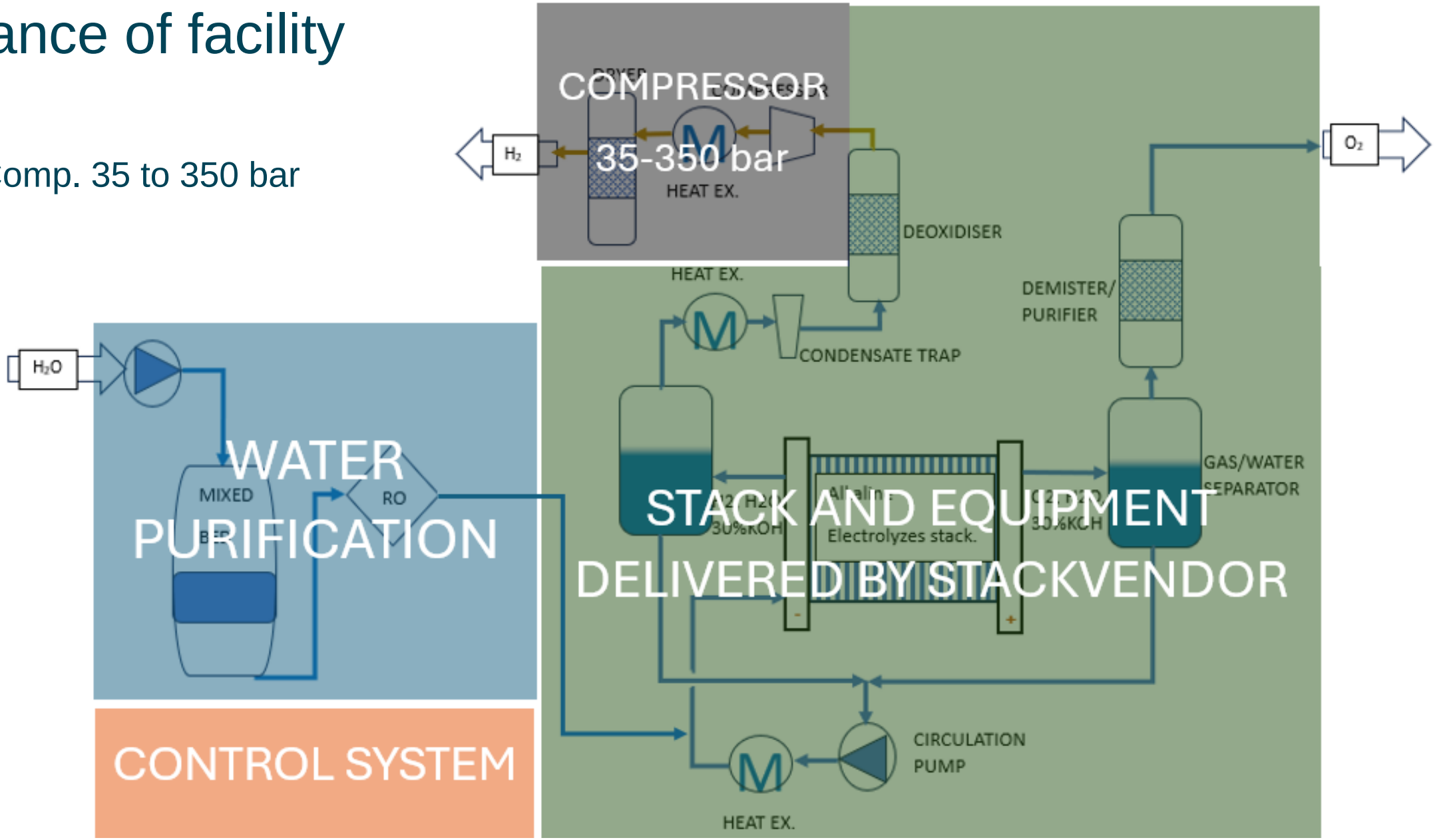
Hydrogen production from available energy



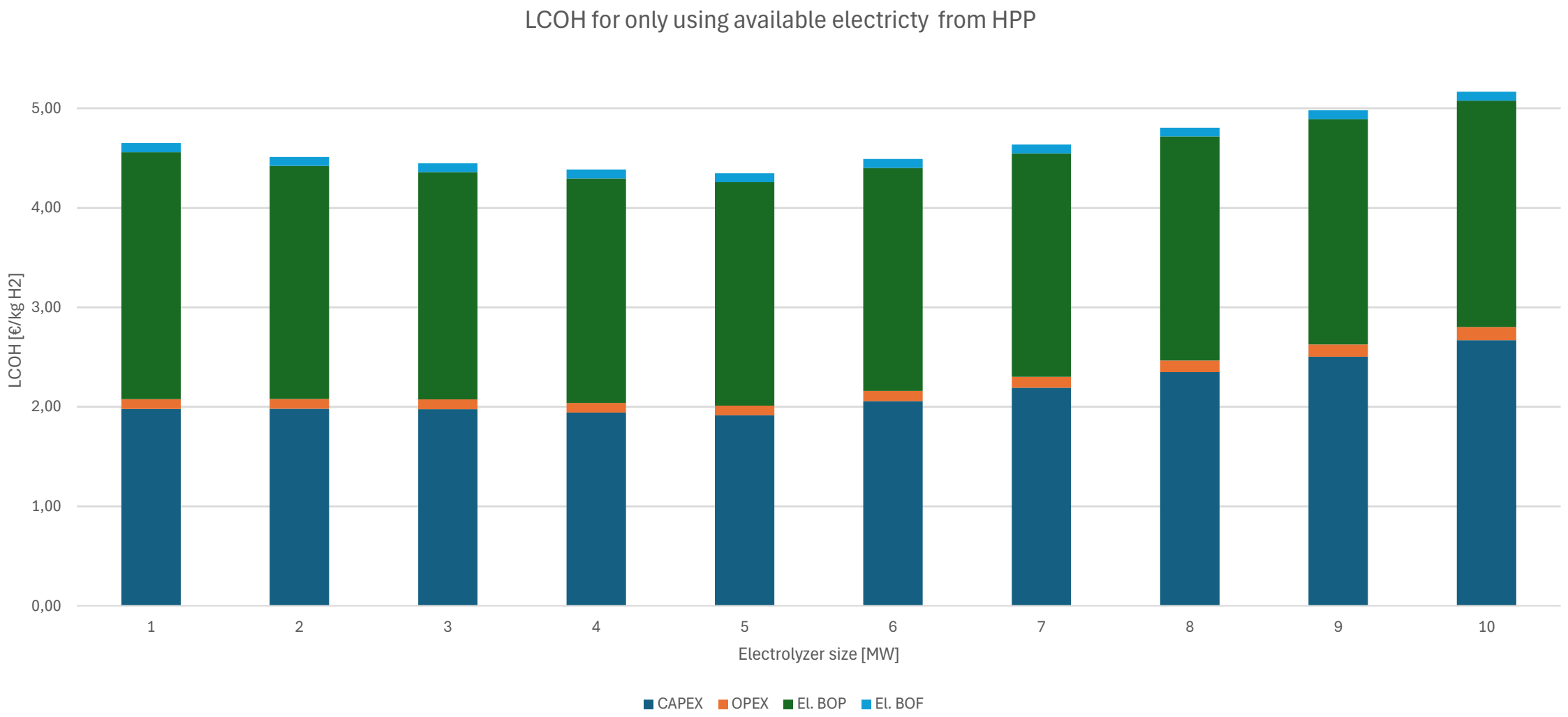
- From 6 MW and higher, at least half the energy must be purchased from the grid.
- Assumptions for electricity price:
- From HPP 0,044 €/kWh
- From grid is 0,088 €/kWh.

Balance of facility

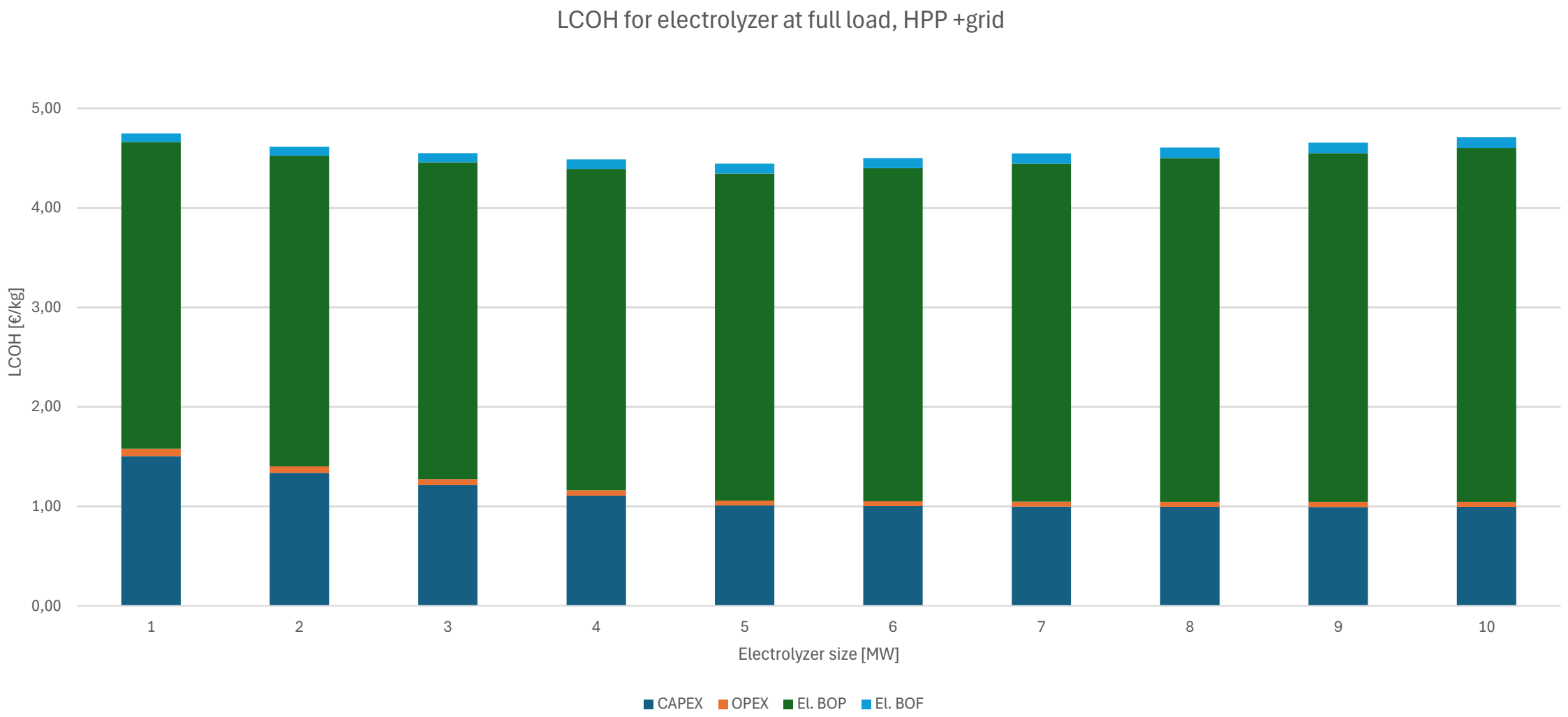
- Comp. 35 to 350 bar



Case 1: Utilize all the available electricity from grid



CASE 2: Utilize all the available electricity from HP, rest from grid



Conclusion

Cost range for hydrogen produced by run-off river power plant was 4,2-5,1 €/kg.

In the context of this case study the 5 MW electrolyzer demonstrated the lowest LCOH, under the assumption of specific electricity prices.

References:

- [1] ENERGI21 (2018). "Nasjonal strategi for forskning, utvikling, demonstrasjon og kommersialisering av ny klimavennlig energiteknologi." from https://www.regjeringen.no/contentassets/23d2b1c0760d46009295042636 4d593e/energi21strategi2018lr.pdf.
- [2] (2023). "Kraftverk i Rullestad og Skromme." Konsesjonssaker. https://www.nve.no/konsesjon/konsesjonssaker/konsesjonssak?id=5477&type=V-1
- [3] Ulleberg, O. (2003). "Modeling of advanced alkaline electrolyzers: a system simulation approach." International journal of hydrogen energy **28**(1): 21-33.
- [4] Kyrre Sundseth, S. M.-H., Kjetil T. Midthun, Vibeke S. Nørstebø (2019). Potensial for lønnsom utbygging av vassdrag i Rullestad. Hydrogenproduksjon ved småkraftverk, SINTEF**:** 27.

Thanks for your attention!

Questions?

- You can find me on LinkedIn
- or e-mail Liina.Sangolt@hvl.no

- Thanks to

HyValue

HySchool.no

Western Norway University of Applied Sciences

Senter for Sjøsikkerhet

UNIVERSITAS BERGENSIS