

Sustainable energy for research facilities in Europe

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Motivation



- Climate change
- Energy import diversification (politics and war)
- Long-term price stability
- (Dis-) advantage for first movers
- Research and research institutions need to become sustainable.
- (European case) Significant energy imports today and in future.

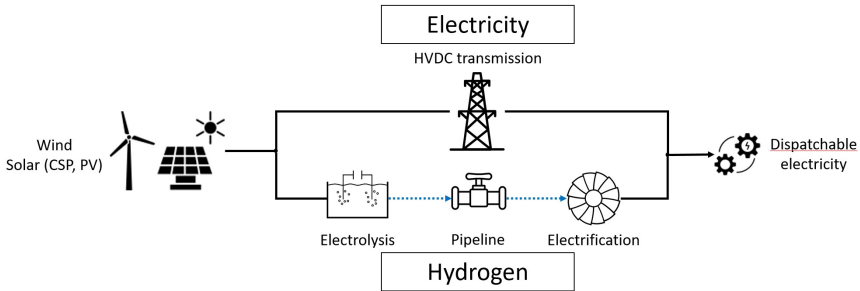
How to power research institutions with renewable energy?



- CERN requires electricity similar to a medium-sized European city (440 GWh/a to 1200 GWh/a)
- Large research institutions in same region
- Southern France / western Switzerland with good existing power and gas infrastructure
- Suitable location for imports across Mediterranean
 - Electricity
 - Hydrogen gas



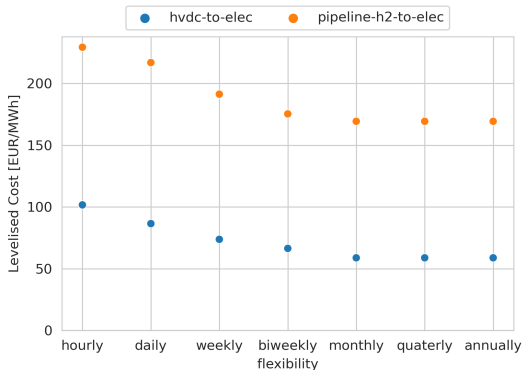
Concept



- Provide electricity from renewables *on demand* via imports
 - Electricity via HVDC lines
 - Hydrogen via pipeline
- Component cost and efficiencies
- Energy and commodity flows
- Influence of demand flexibility
- Bottom up, green field, techno-economic investment optimization

Results

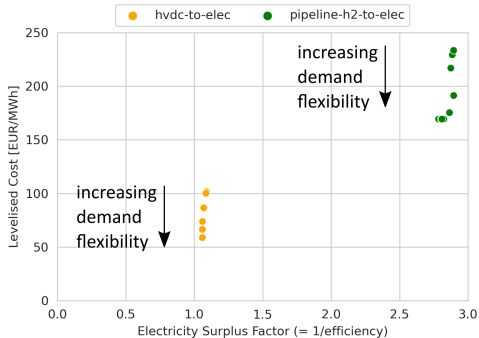
Cost comparison and flexibility effects



Direct electricity imports are cheaper, cost for H₂ by pipeline are 2 to 3 times higher

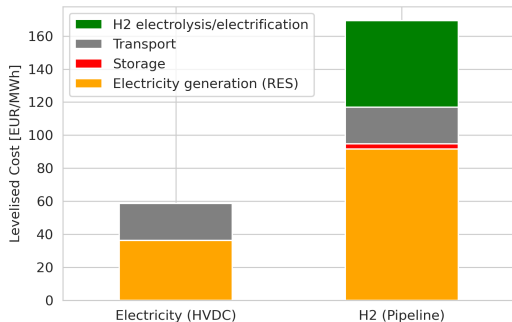
- Increasing import demand flexibility decreases cost (≤ 50 EUR/MWh)
- Comparison to French spot market electricity prices:
 - 310 EUR/MWh to 700 EUR/MWh (2nd week March 2022)
 - 4 EUR/MWh to 103 EUR/MWh (2nd week March 2021)
- Long term cost stability: Up-front investment with low running cost

Electricity Round-Trip Efficiencies (RTEs)



Electricity infrastructure scales with electric RTE

- Direct electricity imports ≤ 2.5 times more efficient
- Similar transport losses for HVDC and H₂ pipeline (H₂ pipeline are less efficient than CH₄ pipelines)
- Major electricity losses in electrolysis and H₂ re-electrification



Electric inefficiency and H₂ equipment drive cost

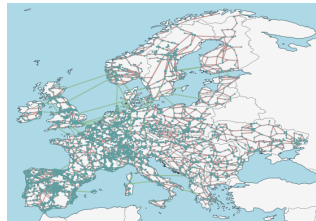
- ca. 3x higher electricity demand ca. 3x higher cost
- Similar transport cost
- H₂ technologies add on top
- Reduced import flexibility requires storage (additional cost not shown)

Interested in energy system modelling?



- `openmod-initiative.org`
- Mailinglist + forum + wiki
- Open models: data and code

PyPSA-EUR now includes Moldova & Ukraine



- Highly resolved electricity network model
- Updated version to reflect recent events
- Fully open model + data
- `pypsa-eur.readthedocs.io`

Summary

Summary

- Options supplying research institutions with renewable energy exists
- Importing electricity is 2 to 3 times cheaper than importing H₂
- Significantly lower infrastructure requirements for electricity imports

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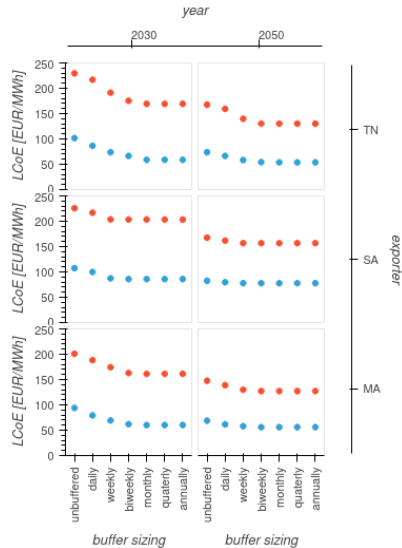
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Backup

LCoEs 2030/2050 all scenarios all exporters no CSP



LCoEs 2030/2050 all scenarios all exporters with CSP

