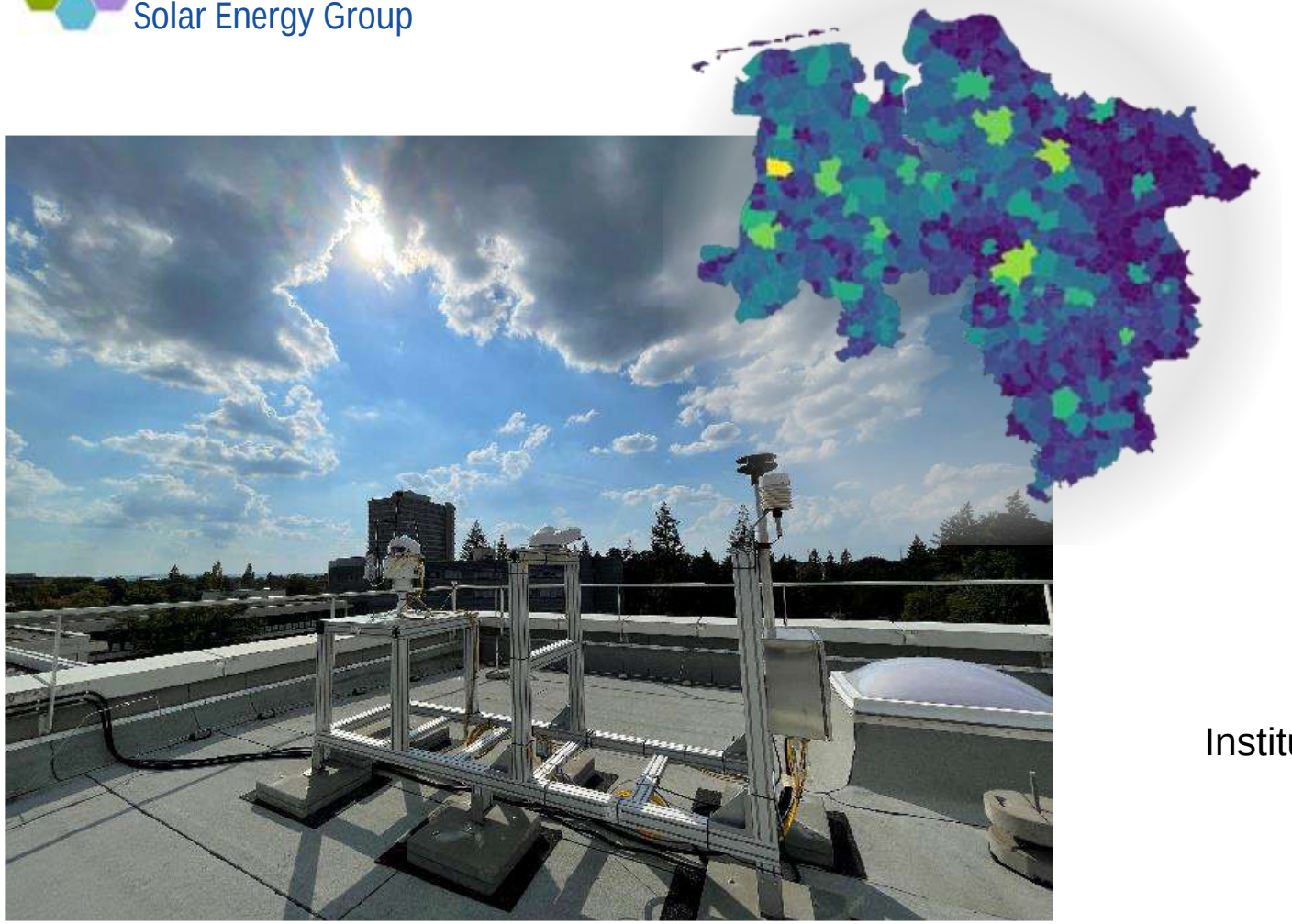
Institute of Solid State Devices
Solar Energy Group

Leibniz Universität Hannover



Solar potential in urban areas

Tobias Wietler

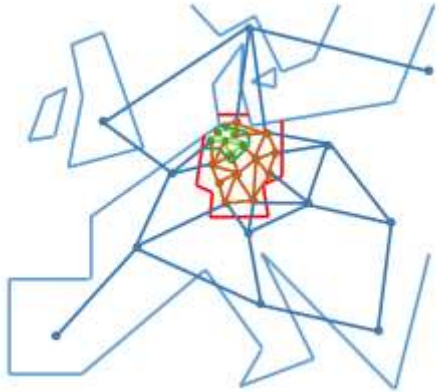
Leibniz University Hannover
Institute of Solid State Devices, Solar Energy Group

ISFH

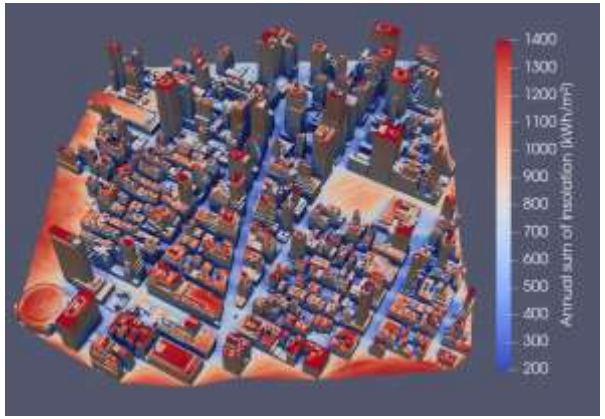
Institute of Solid State Physics
Solar Energy Group

- Head of group: Prof. Rolf Brendel (LUH & ISFH)
- 11 scientists + 3 graduate students
- Research software development for energy system analysis and solar potential calculation

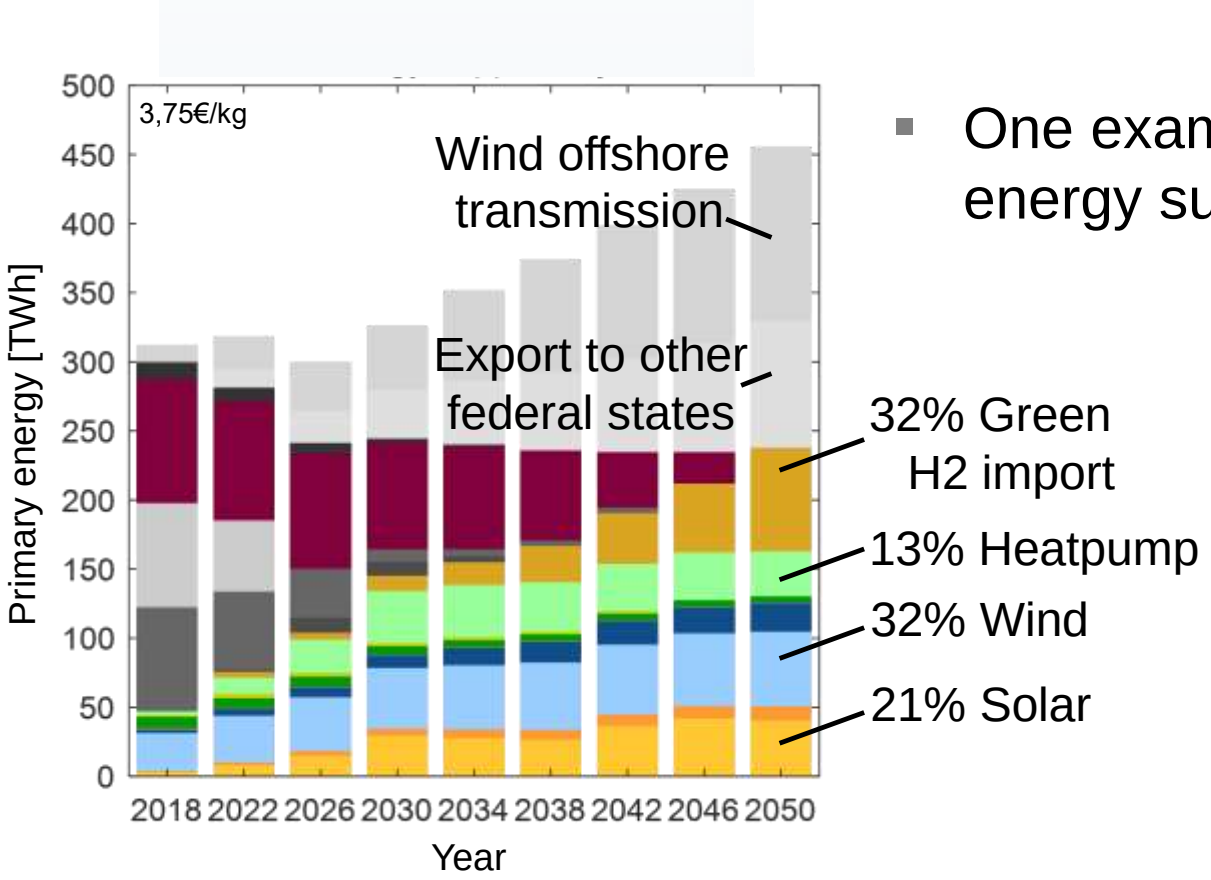
ESTRAM



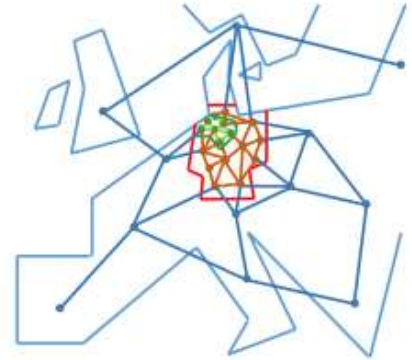
CityPV



100% renewable energy supply for Lower Saxony



- One example for 100% renewable energy supply in Lower Saxony

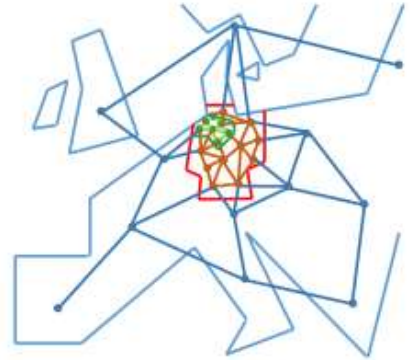


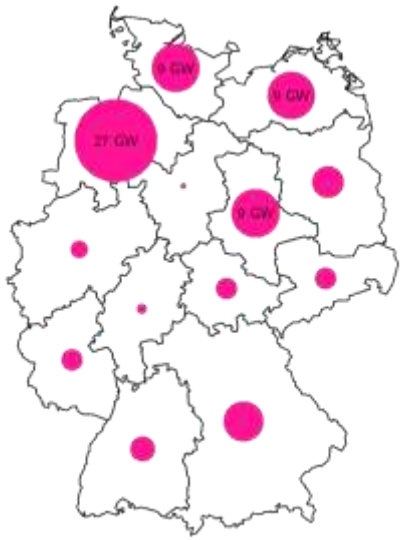
- This scenario: 60 GWp roof-top PV and 15 GWp utility-scale PV
- PV covers 21% of the primary energy demand of Lower saxony

Peterssen et al., *Simulative Kurzstudie zum Einsatz von Wasserstoff-technologie in Niedersachsen*. Projekt-Abschlussbericht, 2021.
DOI: 10.15488/15169

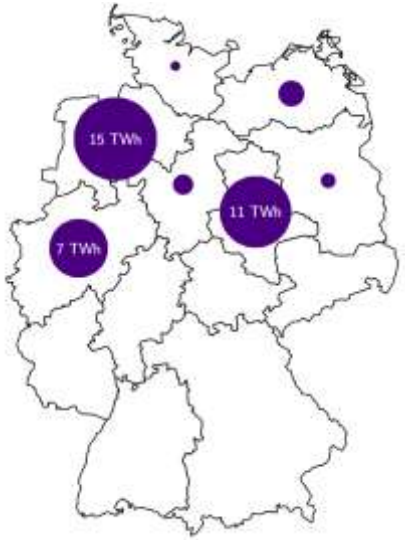
Where to built flexibility elements in a cost-optimized energy system in Germany?

- 100% renewable energy system in 2050
- Transformation path based on current policy framework (laws and strategies)
- Cost optimization result:
  - → Electrolysis and H_2 storage capacity in the north-west
  - → Battery storage evenly distributed

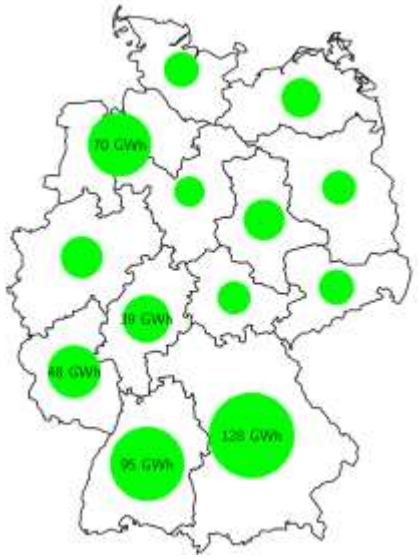




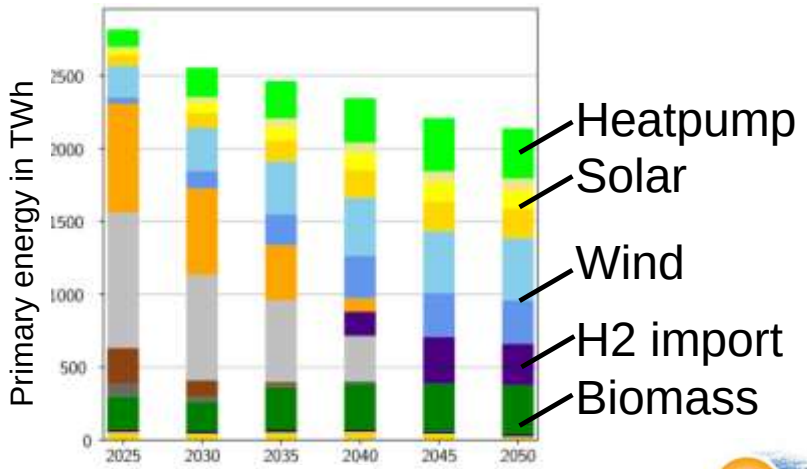
Electrolysis



H_2 storage

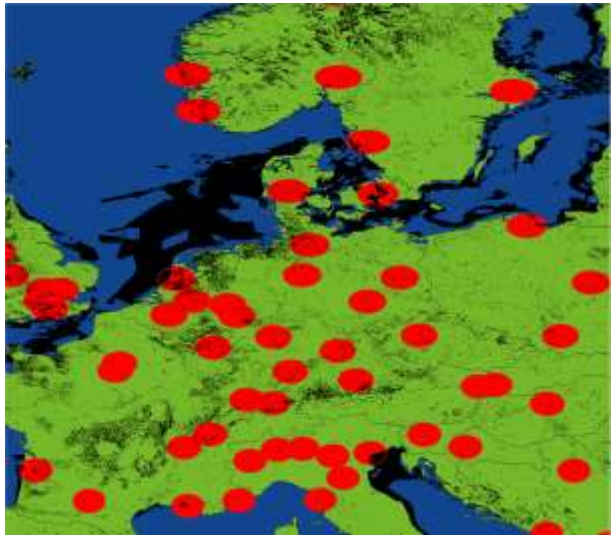


Batteries



Green hydrogen generation at international airport sites

RES potential analysis



- protected areas
- water depth

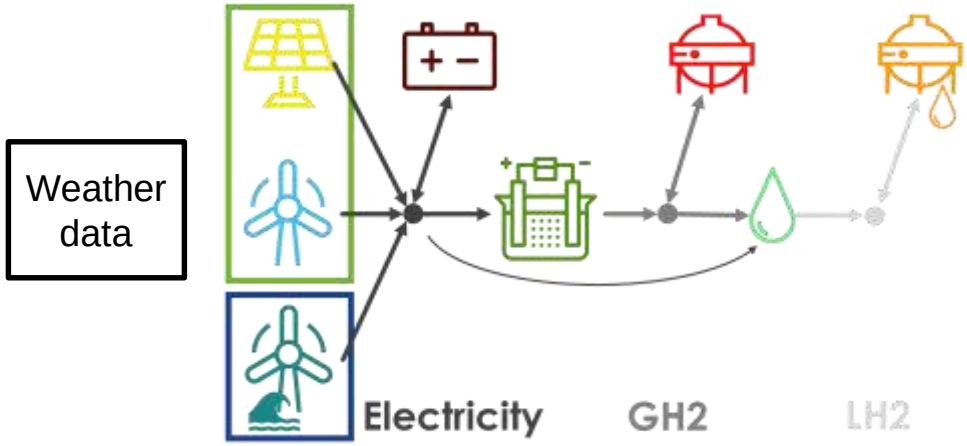
water surface area

- topology
- land classification
- farmland
- protected areas

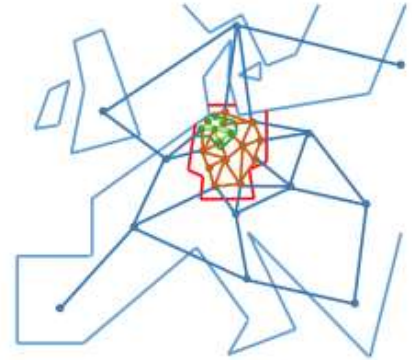
land surface area

100 km diameter

Energy system



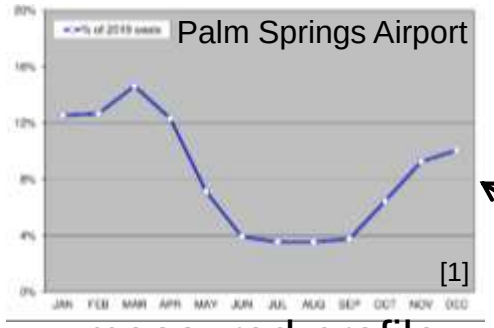
Solar	Liquification
Wind On	Battery Storage
Wind Off	H2 Storage
Electrolysis	LH2 Storage



yearly demand
100 kt LH2

½ Hamburg airport

Monthly demand profiles for airports



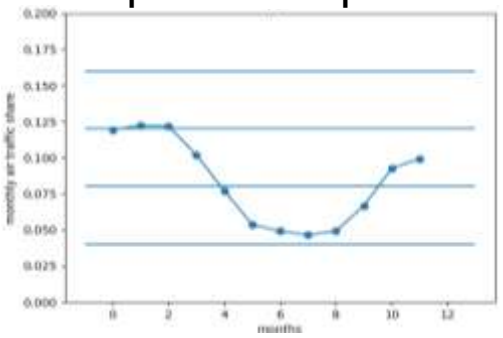
measured profile

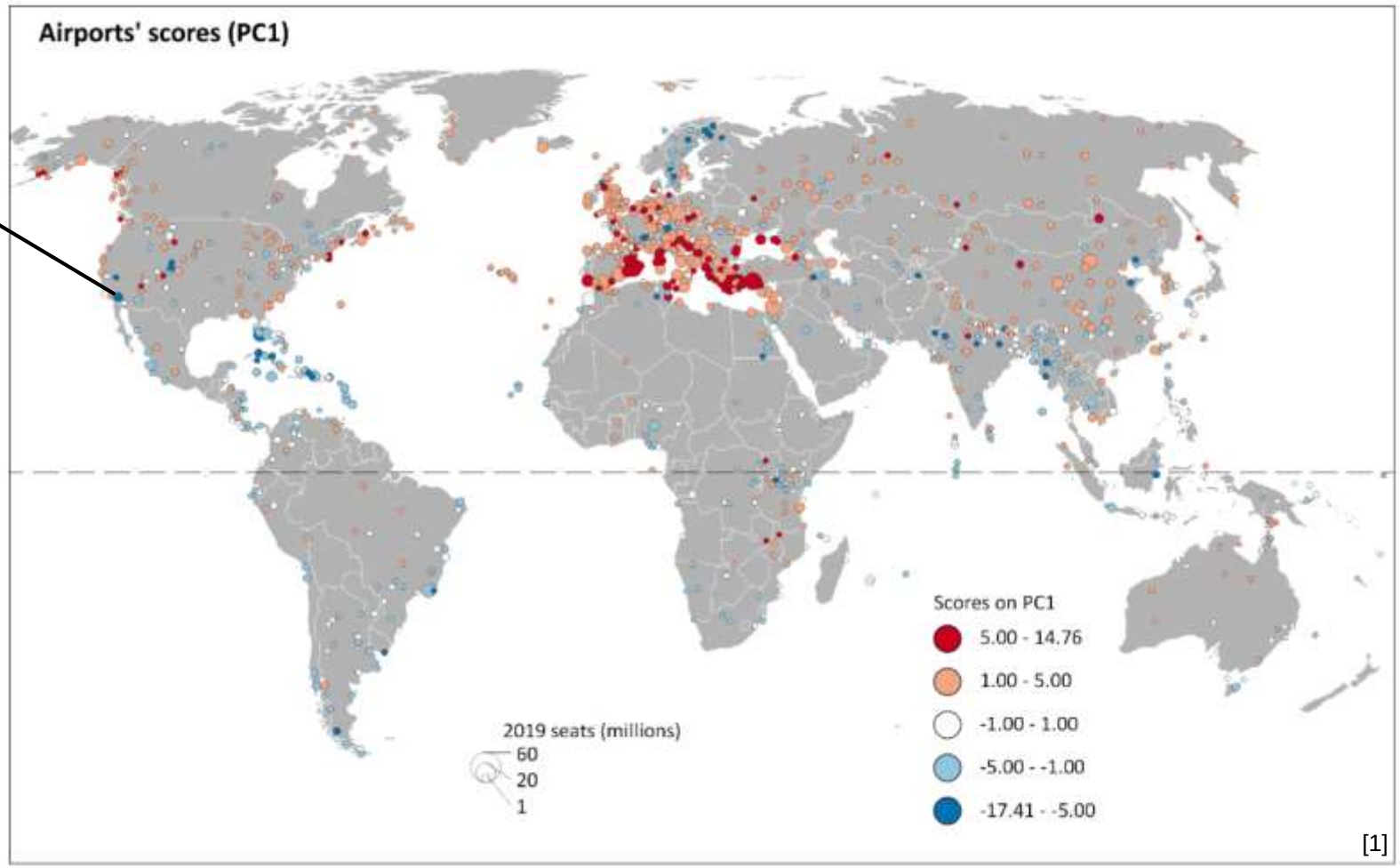
↓

statistical data analysis

↓

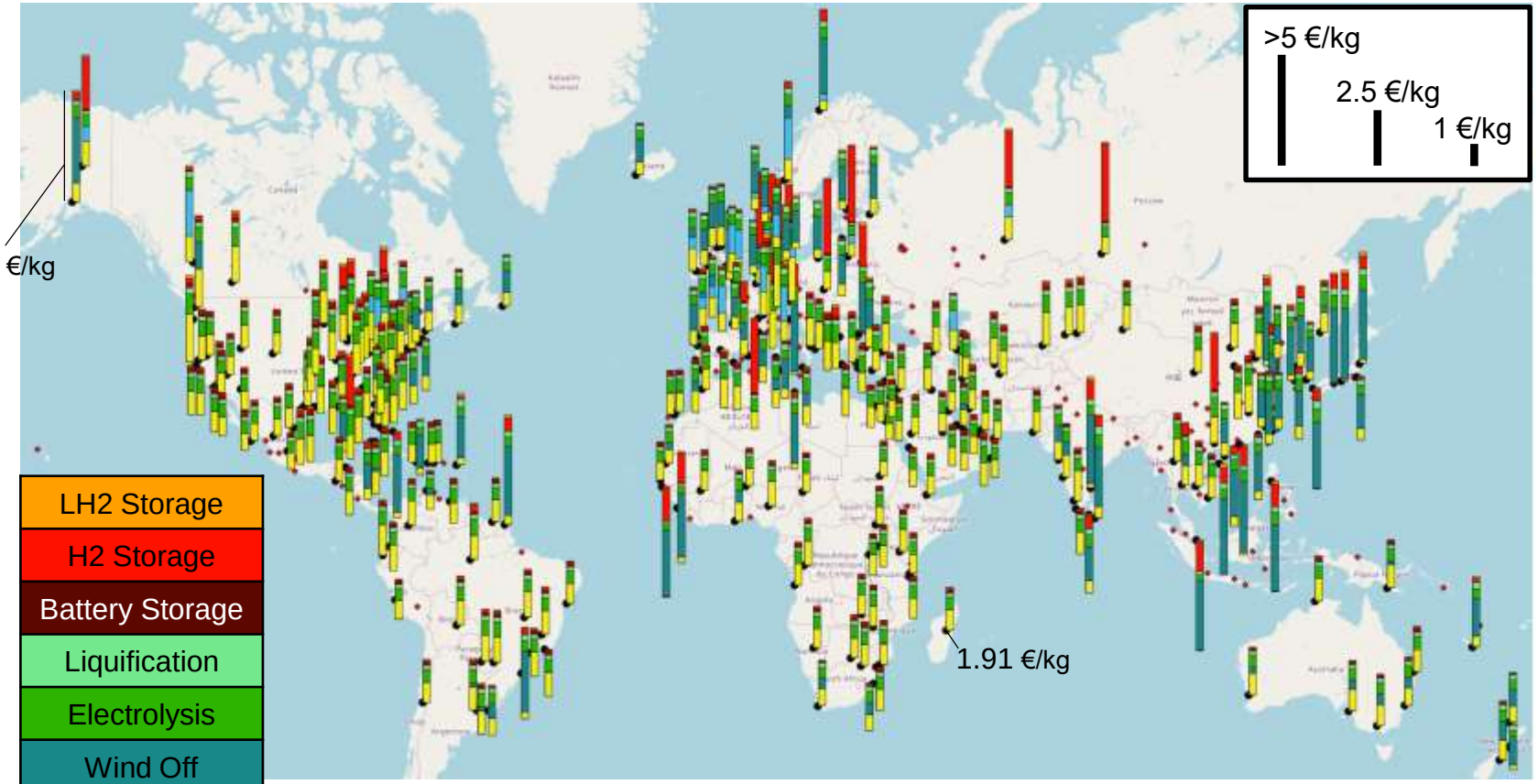
reproduced profile





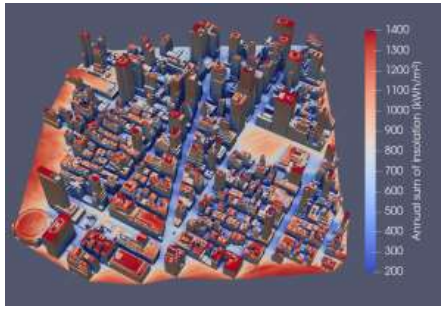
[1] Dobruszkes et al. (2022) *The monthly rhythms of aviation: A global analysis of passenger air service seasonality*, https://doi.org/10.1016/j.trip.2022.100582

Global LH2 production cost compositions



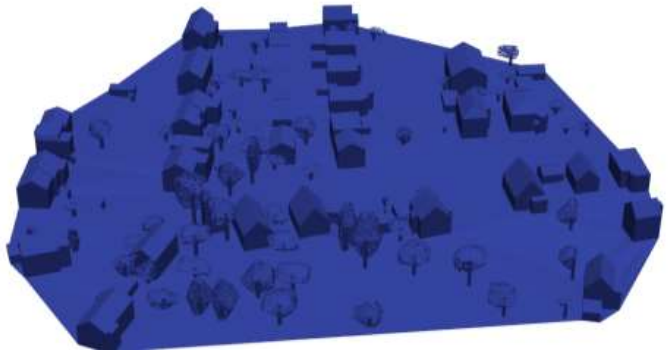
- Solar dominates most energy systems
- Wind onshore mostly in Europe
- Wind offshore increases LCOH
- Down to 1.5 €/kg LH2 at sites with sufficient land surface area and matching saisonality of airport demand and PV feed-in
- Up to 13 €/kg LH2 due to area restrictions and/or low RES feed-in
- Expensive H2 storage requirements if saisonality of airport demand and RES feed-in do not match

Solar potential analysis with CityPV



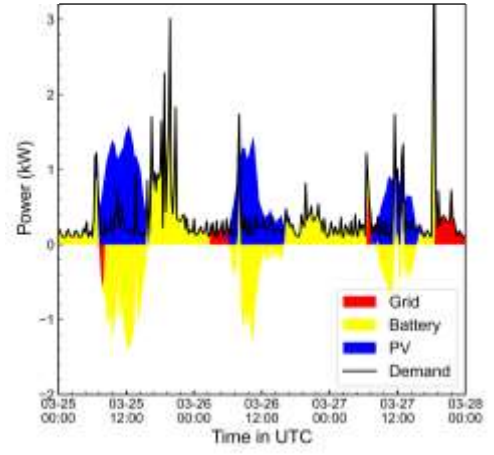
- Extensive Python-based toolbox
- Realistic consideration of shading in urban areas
- Parallelized GPU ray tracing
- Yield forecast and BIPV design including (partial) shading

Irradiation results with high spatial & temporal resolution



Scalable solar potential analysis from city to country level

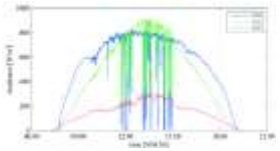
Design and operational management of the building energy system



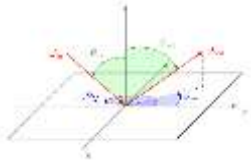
Solar potential analysis with CityPV

Environment model

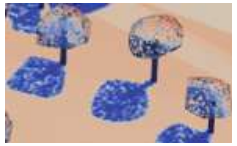
Weather data



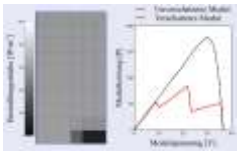
Reflecion model



Vegetation model



PV yield model



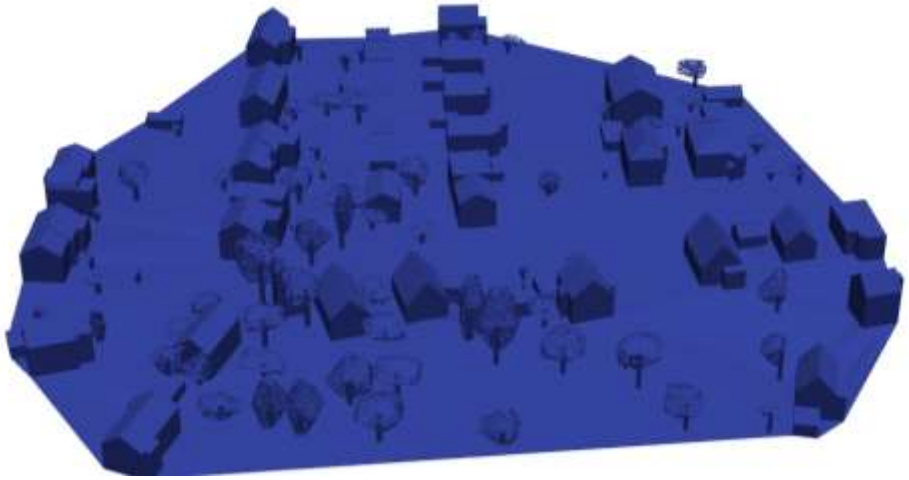
Building energy system model

Simulation scene

parallelized GPU-raytracing

Spatially and temporally resolved irradiation

Thank you!



Tobias Wietler
Solar Energy Group
Institute of Solid State Physics
wietler@solar.uni-hannover.de