DOS
Distributed and Operating Systems.

Vessim: A Testbed for Carbon-Aware Applications and Systems

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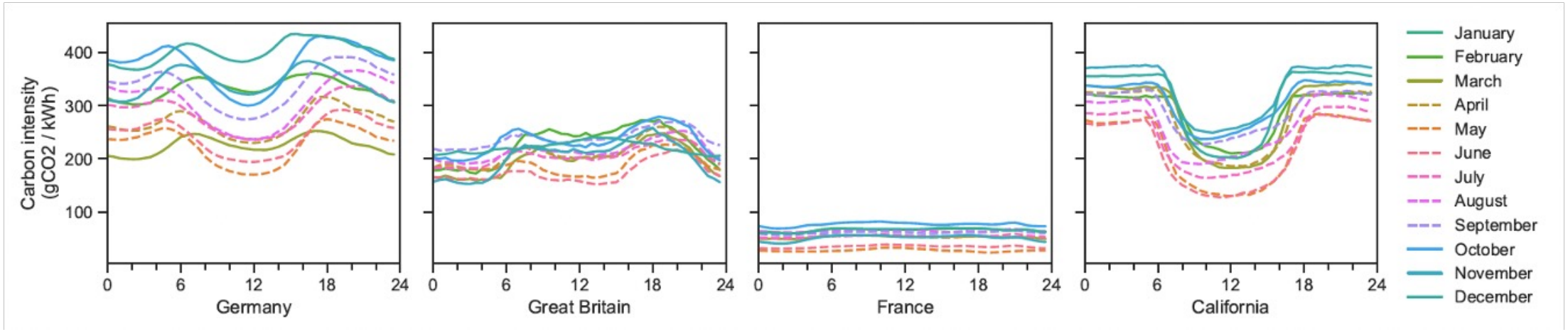
Carbon-Aware Computing

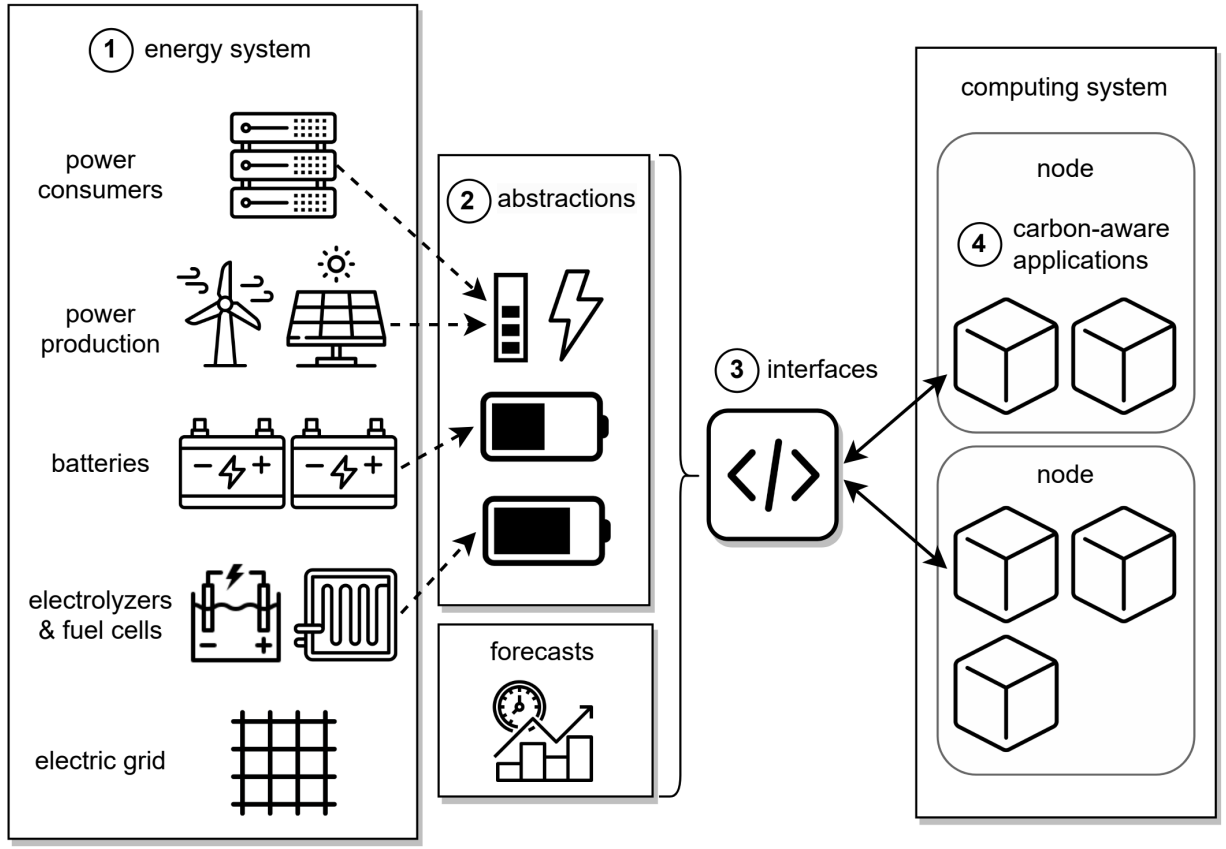
To reduce the associated carbon emissions from operating datacenters, we try to align their power demand with the **availability of low-carbon energy**.



Future carbon-aware computing systems require some kind of **visibility and control** over their energy system! [SoCC'21, ASPLOS'23, HotCarbon'23]

How to Test Your Carbon-Aware Computing System?

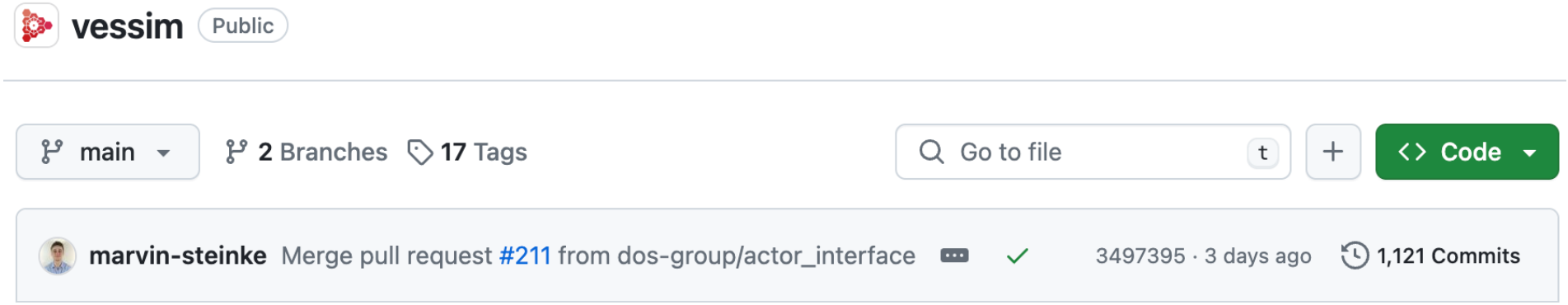
Due to **a lack of testing environments**, it remains challenging to perform research on carbon-aware systems!



Vessim: A Testbed for Carbon-Aware Applications and Systems

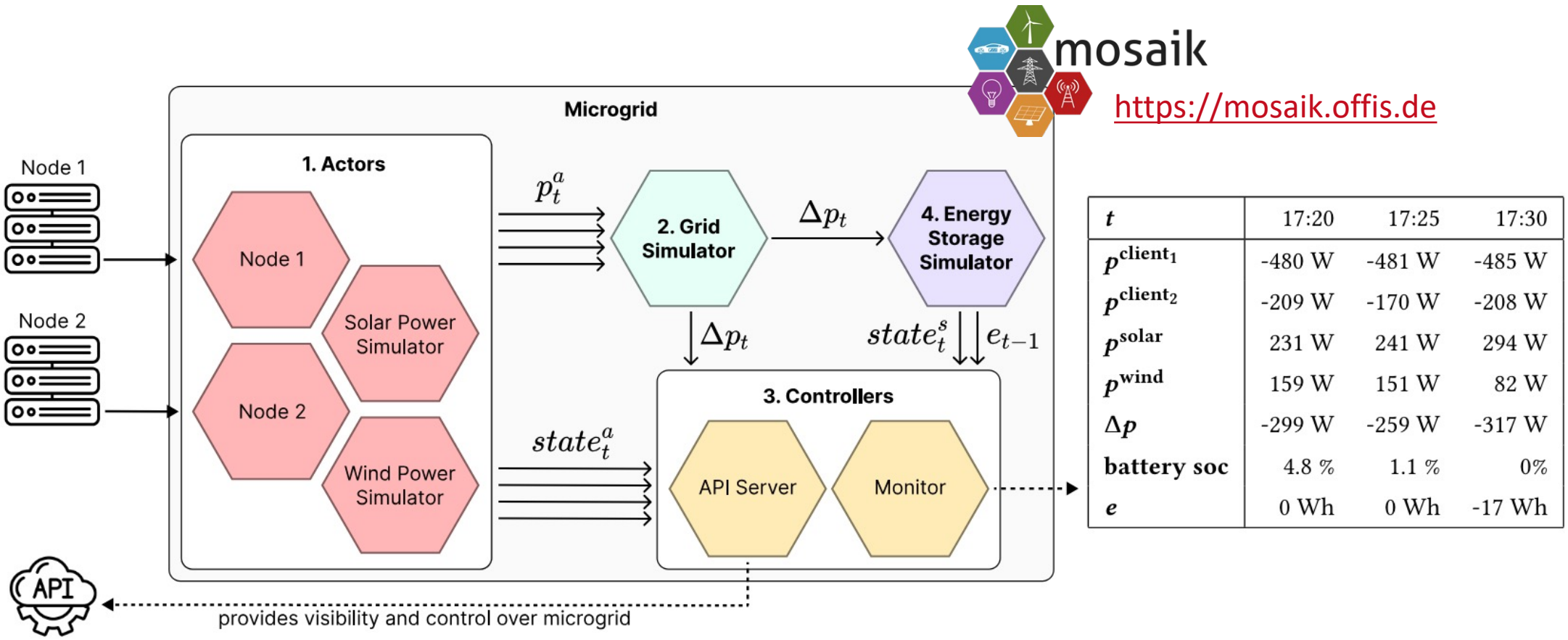
A co-simulation testbed for research at the intersection of computing and energy systems which

- connects domain-specific simulators for energy systems
- with real software and hardware
- and provides access to common datasets



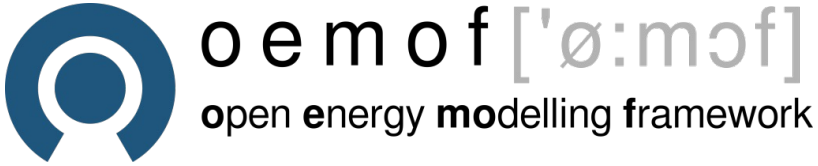
https://github.com/dos-group/vessim

Co-Simulation Methodology



t	17:20	17:25	17:30
p^{client_1}	-480 W	-481 W	-485 W
p^{client_2}	-209 W	-170 W	-208 W
p^{solar}	231 W	241 W	294 W
p^{wind}	159 W	151 W	82 W
Δp	-299 W	-259 W	-317 W
battery soc	4.8 %	1.1 %	0%
e	0 Wh	0 Wh	-17 Wh

(To Be) Integrated Simulators, Data Sources, and Applications



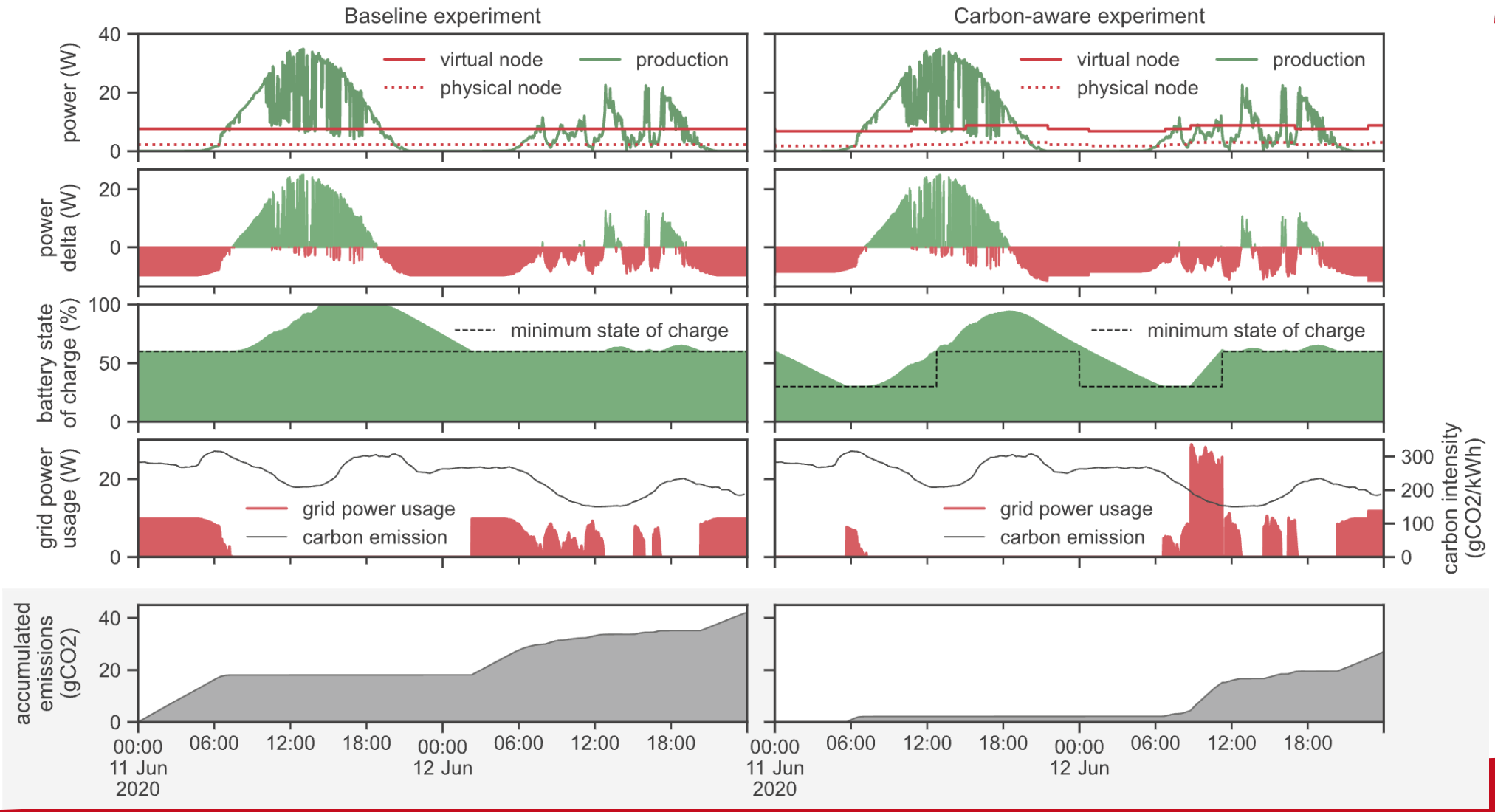
Example Scenario: Python API

```python
import vessim as vs

class CustomController(vs.Controller):
    ...

environment = vs.Environment()
environment.add_microgrid(
  actors=[
    vs.Actor("physical node", signal=vs.HttpPowerMeter("https://127.0.0.2:8080/power"),
    vs.Actor("virtual node", signal=vs.HttpPowerMeter("https://234.182.11.2/power"),
    vs.Actor("solar", signal=vs.HistoricalSignal.load("solcast2022_global", ...))
  ],
  storage=vs.SimpleBattery(...),
  controllers=[vs.Monitor(outfile="result.csv"), vs.CustomController(...)],
  step_size=60, # 1 min
)
environment.run(until=24 * 3600)
```

Example Scenario: Results



Conclusion

Vessim is a co-simulation testbed which

- enables research at the intersection of computing and energy systems
- supports development of carbon-aware applications in continuous integration pipelines
- As well as their operation as a digital twin

Github

- https://github.com/dos-group/vessim

Further references

- Software-in-the-Loop Simulation for Developing and Testing Carbon-Aware Applications. Software: Practice and Experience 53 (12). 2023.
- FedZero: Leveraging Renewable Excess Energy in Federated Learning. ACM e-Energy. 2024. https://github.com/dos-group/fedzero

Contact

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