

On the role of 24/7 CFE in accelerating advanced clean electricity technologies

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Eurelectric 24/7 Carbon-Free Energy (CFE) Hub Meeting

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Model-based research on 24/7 CFE

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[Report](#) [Open](#)

System-level impacts of 24/7 carbon-free electricity procurement in Europe

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Show affiliations

Traditional power purchase agreements for renewable energy have seen rapid growth in recent years, but they only match supply and demand on average over a longer period such as a year. There is increasing interest from leaders in voluntary clean electricity procurement to cover their consumption with clean energy supply on truly 24/7 basis. Achieving 24/7 carbon-free energy means that every kilowatt-hour of electricity consumption is met with carbon-free electricity sources, every hour of every day.

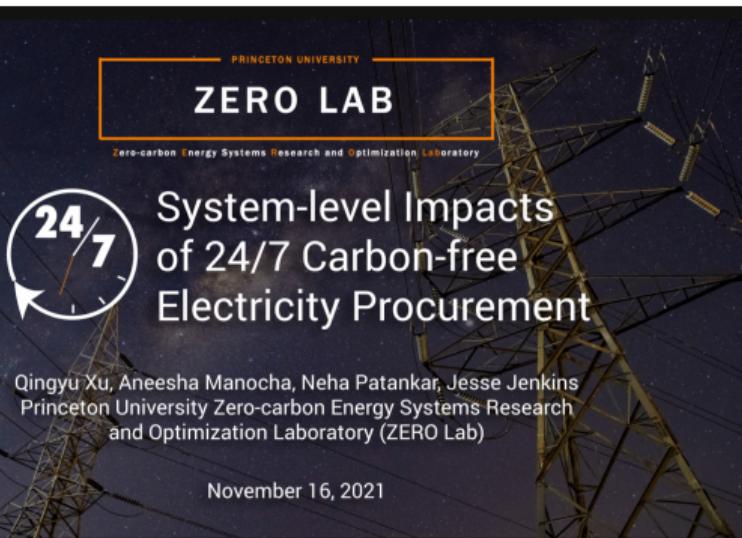
In this study
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The study

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247CFE-





PRINCETON UNIVERSITY
ZERO LAB
Zero-carbon Energy Systems Research and Optimization Laboratory

System-level Impacts of 24/7 Carbon-free Electricity Procurement

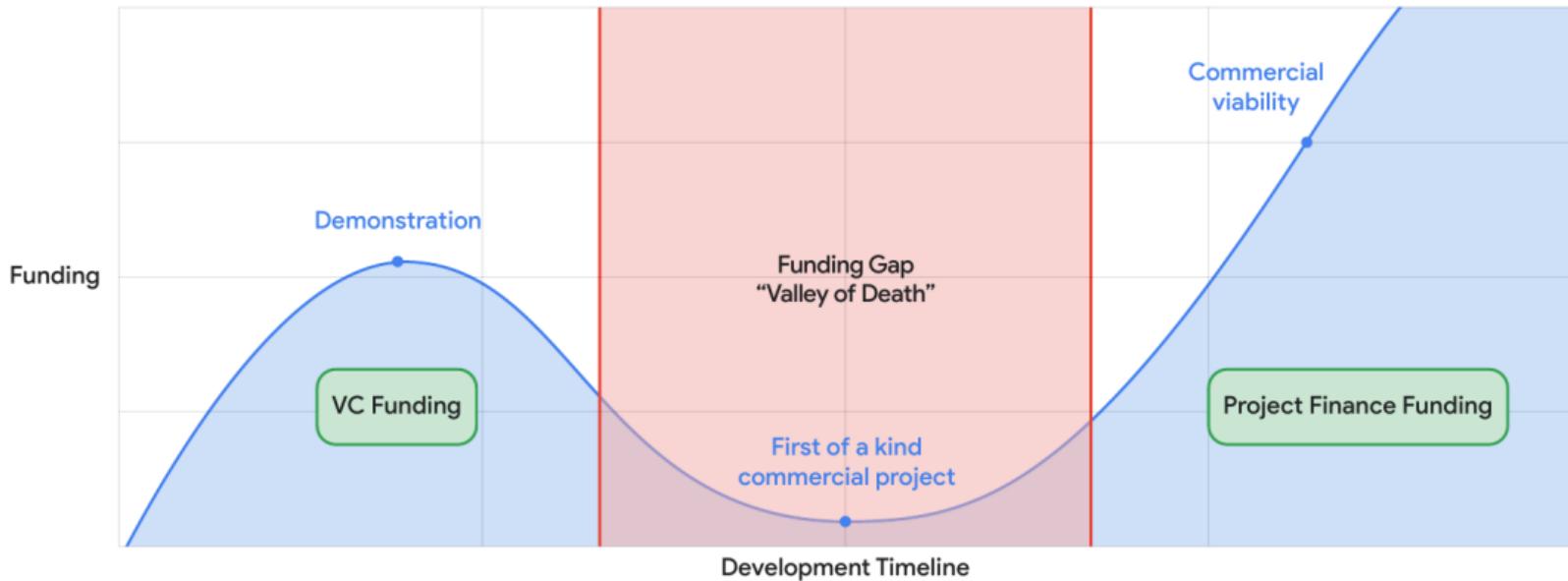
Qingyu Xu, Aneesha Manocha, Neha Patankar, Jesse Jenkins
Princeton University Zero-carbon Energy Systems Research
and Optimization Laboratory (ZERO Lab)

November 16, 2021

- Key focuses:
 - How can companies **achieve 24/7 CFE matching?**
 - What is the impact of hourly matching on **attributed emissions** of participants?
 - What are the **system-level impacts**?
 - What is the associated **cost premium**?
 - How do results change for different locations, time periods, CFE scores, consumption profiles, etc.?
- Consensus:

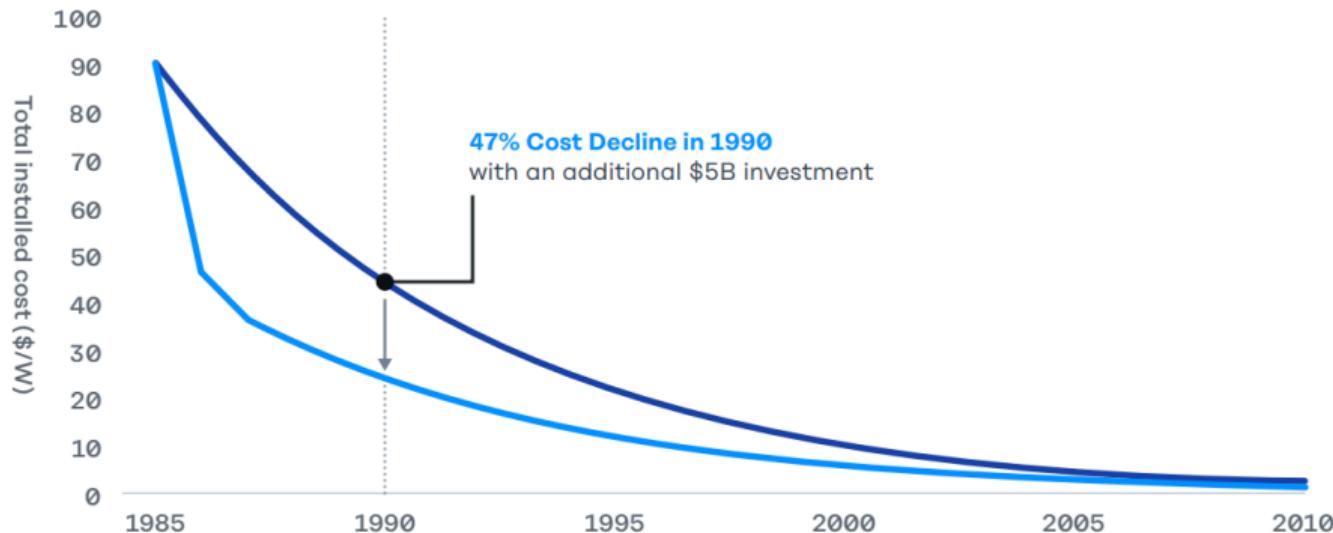
24/7 CFE matching creates **an early market for advanced clean energy technologies** like long-duration energy storage and clean firm generators

Barriers to advanced clean technology commercialization



Earlier, Larger-Scale Investments in Solar Would Have Brought Costs Down Sooner.

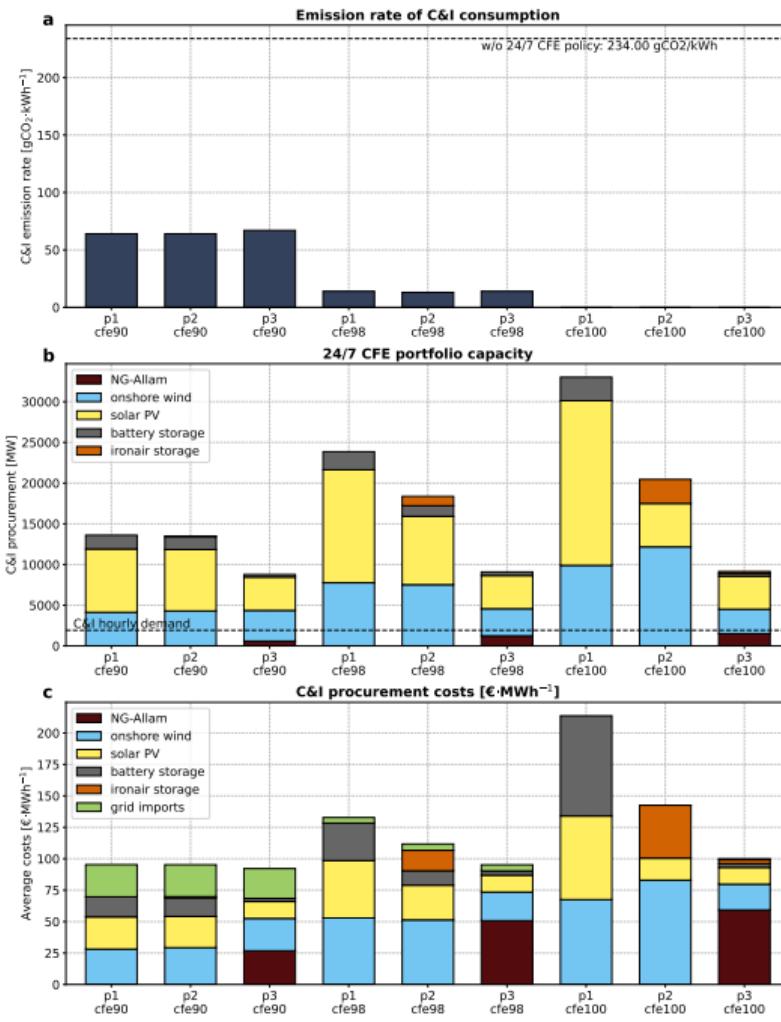
- Historical Cost Decline
- Estimated cost decline if we funded \$5B of projects between 1985 and 1990



Source: Breakthrough Energy analysis; data from MIT and IRENA

Research questions

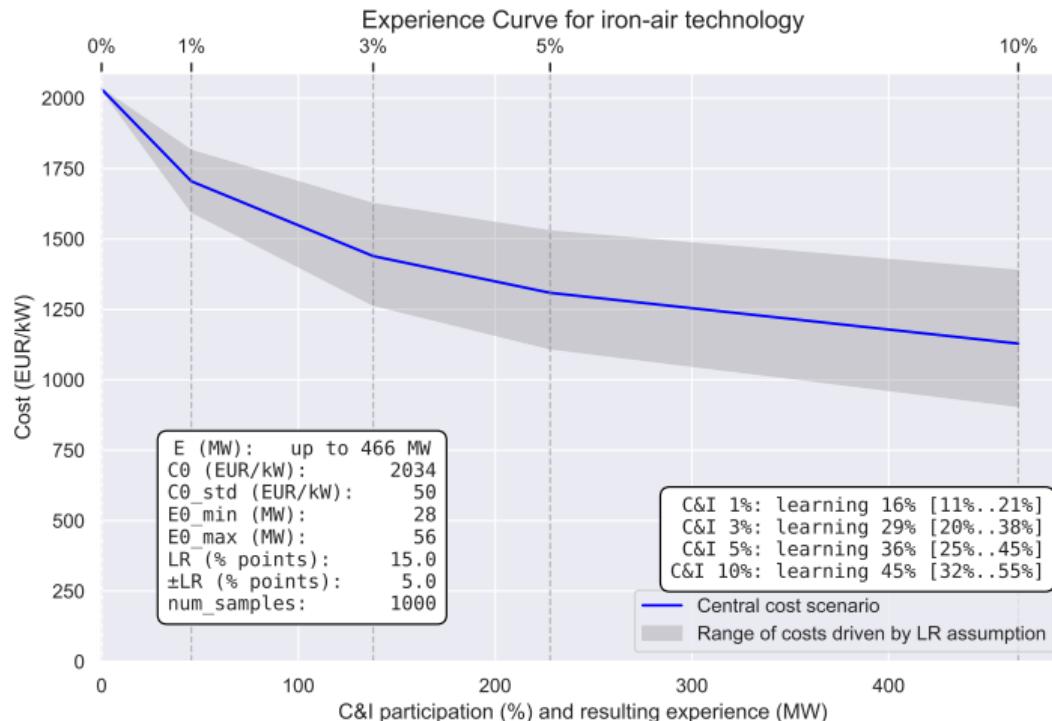
- Key focuses:
 - What role can 24/7 CFE play in accelerating advanced clean electricity technologies?
 - How can 24/7 CFE procurement facilitate **technology learning**?
 - What are the associated **system decarbonization** effects?
- Open research:
 - ❑ Study to be released soon: 247cfe.github.io/
 - ❑ Code: github.com/PyPSA/247-cfe



- With only wind, solar and batteries, a **large portfolio** is needed to bridge dark wind lulls (*Dunkelflauten*)
- This makes the last 2% of hourly CFE matching to come with a **high cost premium**
- Adding **LDES** to the mix (here: iron-air battery) or **clean firm generation** technology (here: NG-Allam plant) **reduces the portfolio size** and **limits the cost premium**
- Procurement affects **average emissions rate** of used electricity. Background grid (here: Germany 2025) has 234 gCO₂/kWh. As CFE target tightens, emissions of 24/7 CFE participants **drop to zero**

Scenario: Germany 2025
5% of C&I demand (1900 MW) follow 24/7 CFE
24/7 CFE with 90%, 98% 100% score
p1 commercially available technologies
p2 above plus LDES
p3 above plus clean firm generator

Impact of 24/7 CFE procurement on technology learning

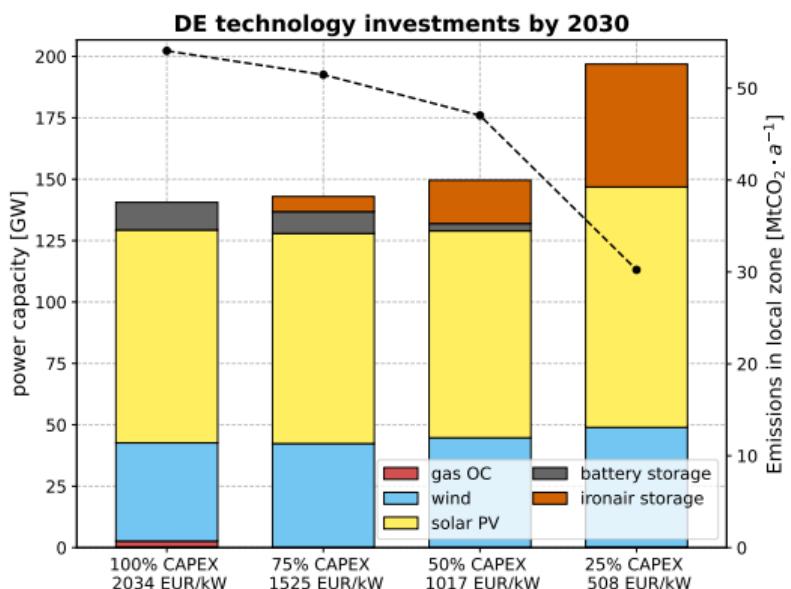


Monte Carlo simulation
(initial technology experience & costs)



Scenario: 24/7 CFE with 100% score
[0%..10%] of C&I demand follow 24/7 CFE
Learning model & Monte Carlo parametrisation are on figure

Impact of technology learning on background energy system



- Iron-air battery storage breaks even into technology investment mix with 25% CAPEX reduction (basis level: \$2300/kW)
- **System-level emissions drop:** iron-air storage substitutes fossil-based peakers, and allows for efficient use of renewable excess energy
- For this effect, announced capacity of iron-air battery **has to be doubled twice¹** with $LR \approx 0.15$
¹ 56.5 MW / 5.65 GWh is planned by 2025 ↗
- ca. **EUR 0.35B investment** required to bring iron-air technology for economical break-even (an estimate based on LR, initial experience & costs, background system assumptions)

1. **Companies and governments** working to match their consumption with clean electricity round-the-clock **can play a catalytic role** in innovation, financeability, and widespread diffusion of technologies required for a wider societal transition to secure, reliable and decarbonized energy systems.
2. There are **multiple channels** through which 24/7 CFE procurement facilitates system-level decarbonization:
 - *Profile and Volume* mechanisms, see [Riepin & Brown \(2023\), Xu et al. \(2021\)](#)
 - Technology learning makes 24/7 CFE more affordable and broadly available
 - Technology learning facilitates an earlier deployment of advanced clean electricity technologies in energy systems

Contacts, Resources, Acknowledgements

Webpage: Learn more about our work on 24/7 CFE: 247cfе.github.io/

Code: This project is done in a spirit of open and reproducible research:

🔗 code: github.com/PyPSA/247-cfe

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