

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

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Report 

## 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, we analyze the selection of a power system.

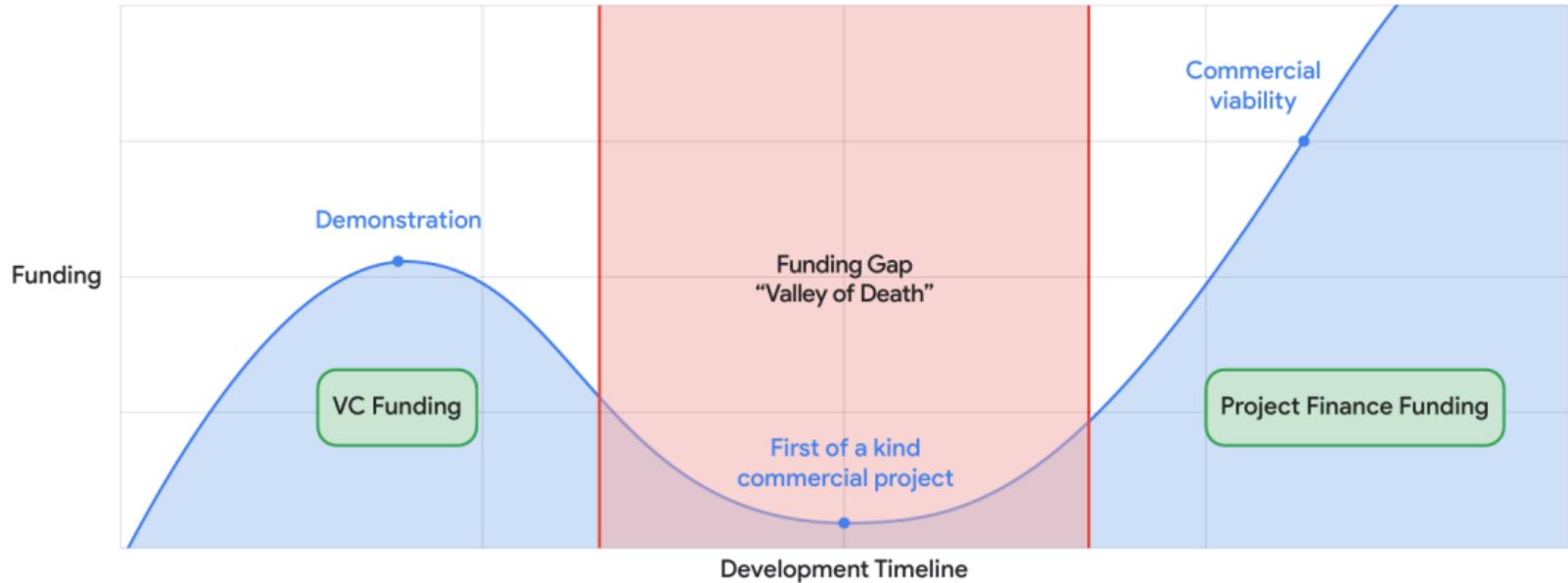
The study

Files

247CFE

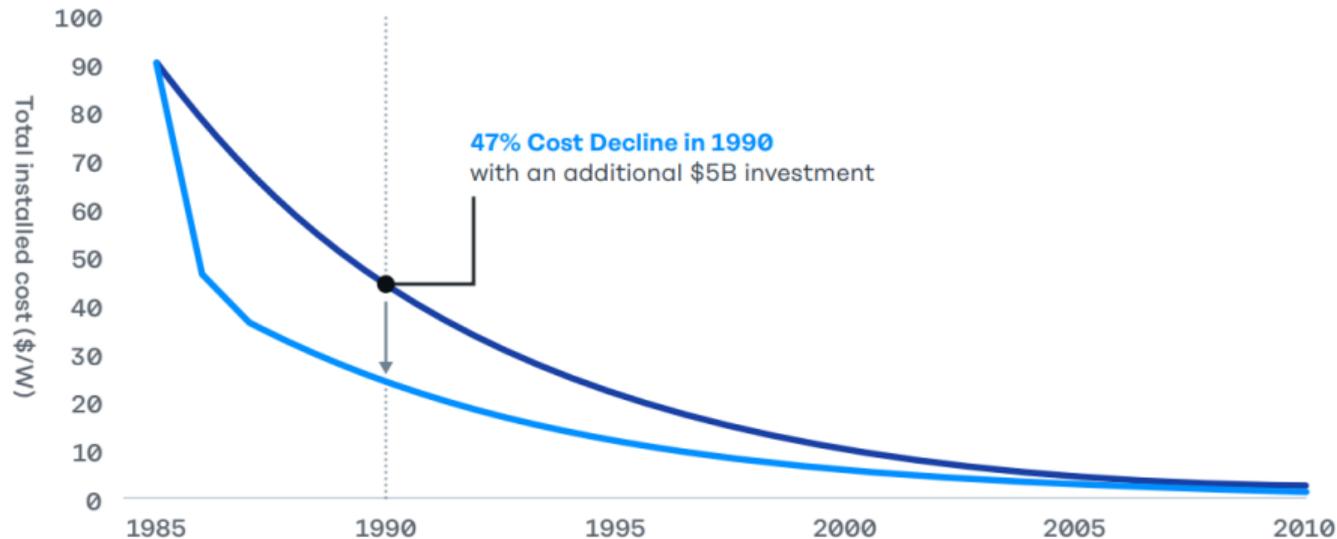


- Key focuses:
  - How can companies **achieve 24/7 CFE** matching?
  - What is the impact of hourly matching on **attributed emissions** of participants?
  - What are the **system-level impacts**?
  - What is the associated **cost premium**?
  - How do results change for different locations, time periods,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



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

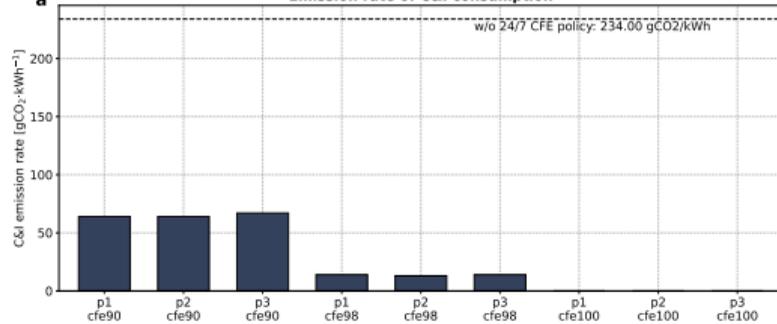
- Historical Cost Decline
- Estimated cost decline if we funded \$5B of projects between 1985 and 1990



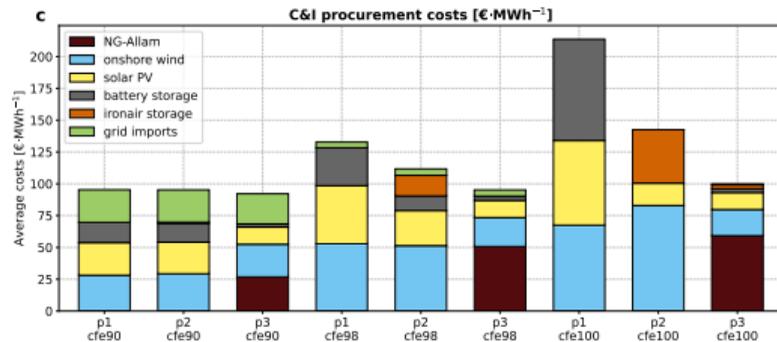
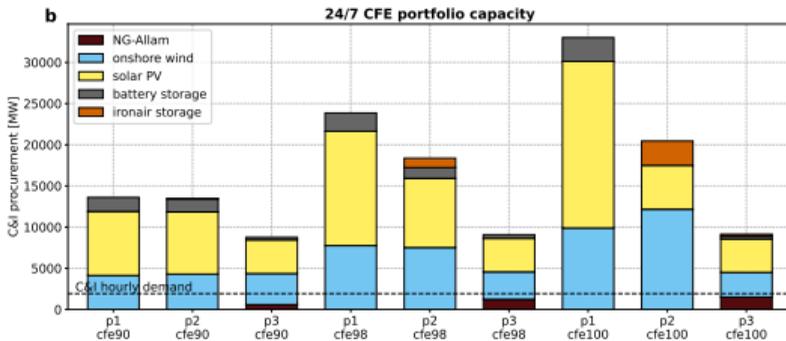
Source: Breakthrough Energy analysis; data from MIT and IRENA

- 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/](https://247cfe.github.io/)
  - 📄 Code: [github.com/PyPSA/247-cfe](https://github.com/PyPSA/247-cfe)

Emission rate of C&amp;I consumption

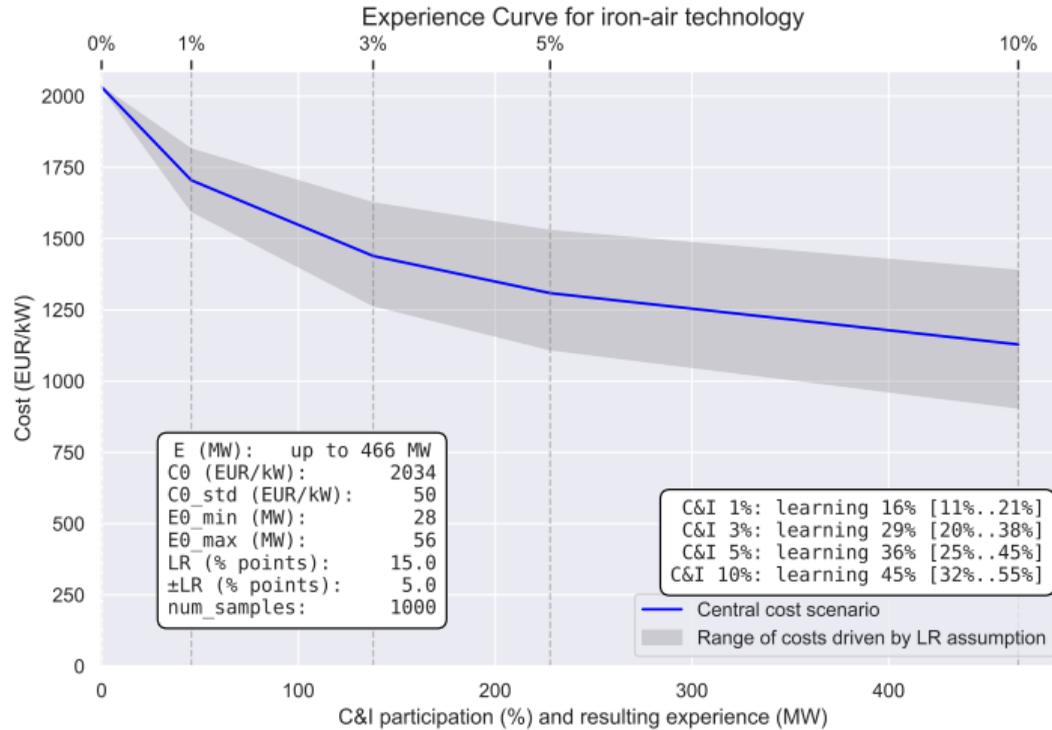


- With only wind, solar and batteries, a **large portfolio** is needed to bridge dark wind lulls (*Dunkelflauten*)
- This makes the last 2% of hourly CFE matching to come with a **high cost premium**
- Adding **LDES** to the mix (here: iron-air battery) or **clean firm generation** technology (here: 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 gCO<sub>2</sub>/kWh. As CFE target tightens, emissions of 24/7 CFE participants **drop to zero**

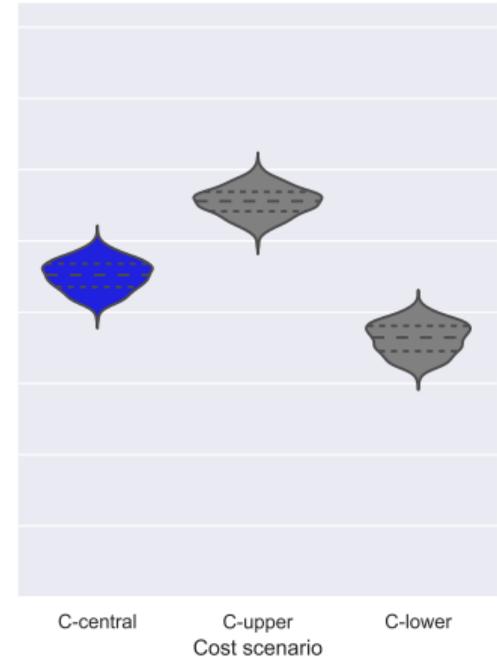


Scenario: Germany 2025  
 5% of C&I demand (1900 MW) follow 24/7 CFE  
 24/7 CFE with 90%, 98% 100% score  
 p1 commercially available technologies  
 p2 above plus LDES  
 p3 above plus clean firm generator

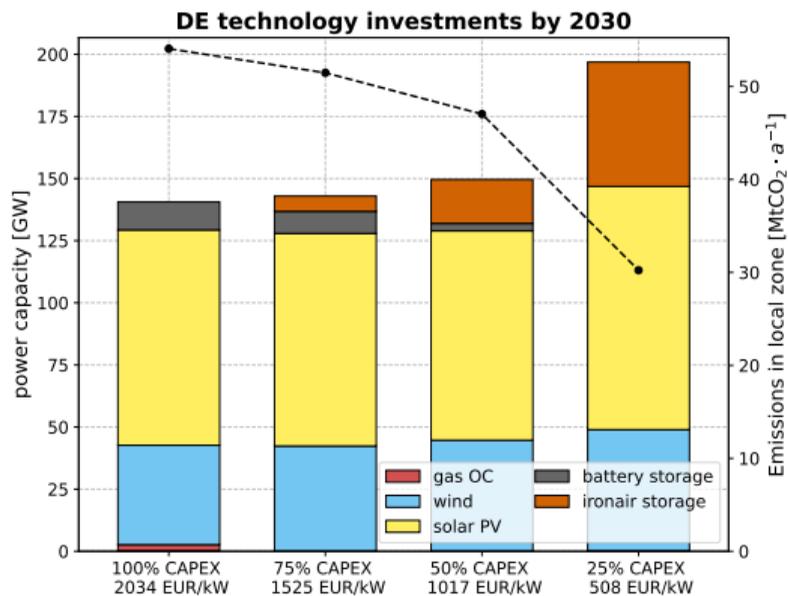
# Impact of 24/7 CFE procurement on technology learning



Monte Carlo simulation (initial technology experience & costs)



Scenario: 24/7 CFE with 100% score  
 [0%..10%] of C&I demand follow 24/7 CFE



- 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 twice**<sup>1</sup> with  $LR \approx 0.15$   
<sup>1</sup>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: [247cfe.github.io/](https://247cfe.github.io/)

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

📄 code: [github.com/PyPSA/247-cfe](https://github.com/PyPSA/247-cfe)

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