Synergies between AI Computing and Power Systems

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Farzaneh Pourahmadi, Olivier Corradi, and Pierre Pinson, “Synergies Between Artificial Intelligence Computing and Power Systems: Metrics, Scheduling, and Resilience,” IEEE Energy Sustainability Magazine, 2026.

Olivier Corradi, CEO, ElectricityMaps

Pierre Pinson, Imperial College London

Agenda

AI computing × power systems

01

Metrics

Measure AI electricity emissions.

02

Scheduling

Shift AI workloads to cleaner times and locations.

Core story: sustainable AI needs efficient models and grid-aware operation.

Research Questions

What must be answered to coordinate AI computing with power systems?

Main question

How can AI computing and power systems be coordinated to reduce emissions and improve reliability?

01 **Measure AI carbon footprint**
How should emissions from AI electricity use be measured clearly and fairly?

02 **Choose the right carbon metric**
Which signal gives useful guidance for scheduling without misleading accounting?

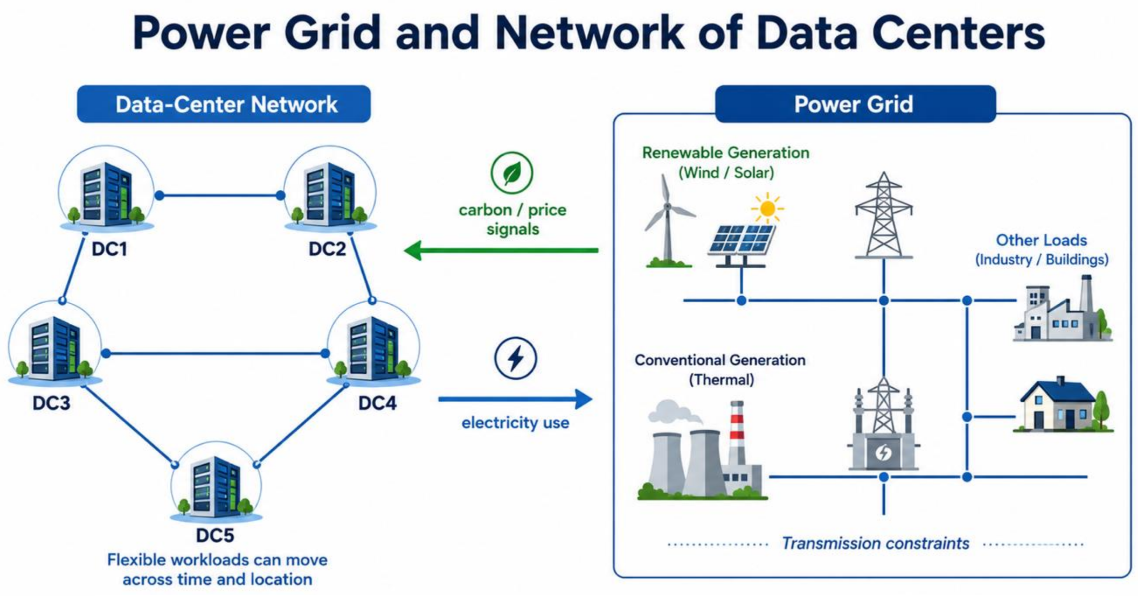
03 **Keep coordination trustworthy**
How can coordination remain fair, private, transparent, and hard to manipulate?

Takeaway: The core challenge is not only making AI efficient, but making AI electricity use grid-aware.

Carbon-aware load shifting: the basic idea

What it means

- Data centers have flexible computing jobs.
- Some jobs can start, stop, resume, or move.
- The data center follows a carbon signal to choose cleaner hours or locations.
- The same idea can also apply to EV charging and other flexible loads.



Simple words: run the job later, earlier, or somewhere else when electricity is cleaner.

Difference between accounting and load shifting

Carbon accounting

Question: How many emissions should be assigned to this consumer?

Good accounting wants totals to match real grid emissions.

Load shifting

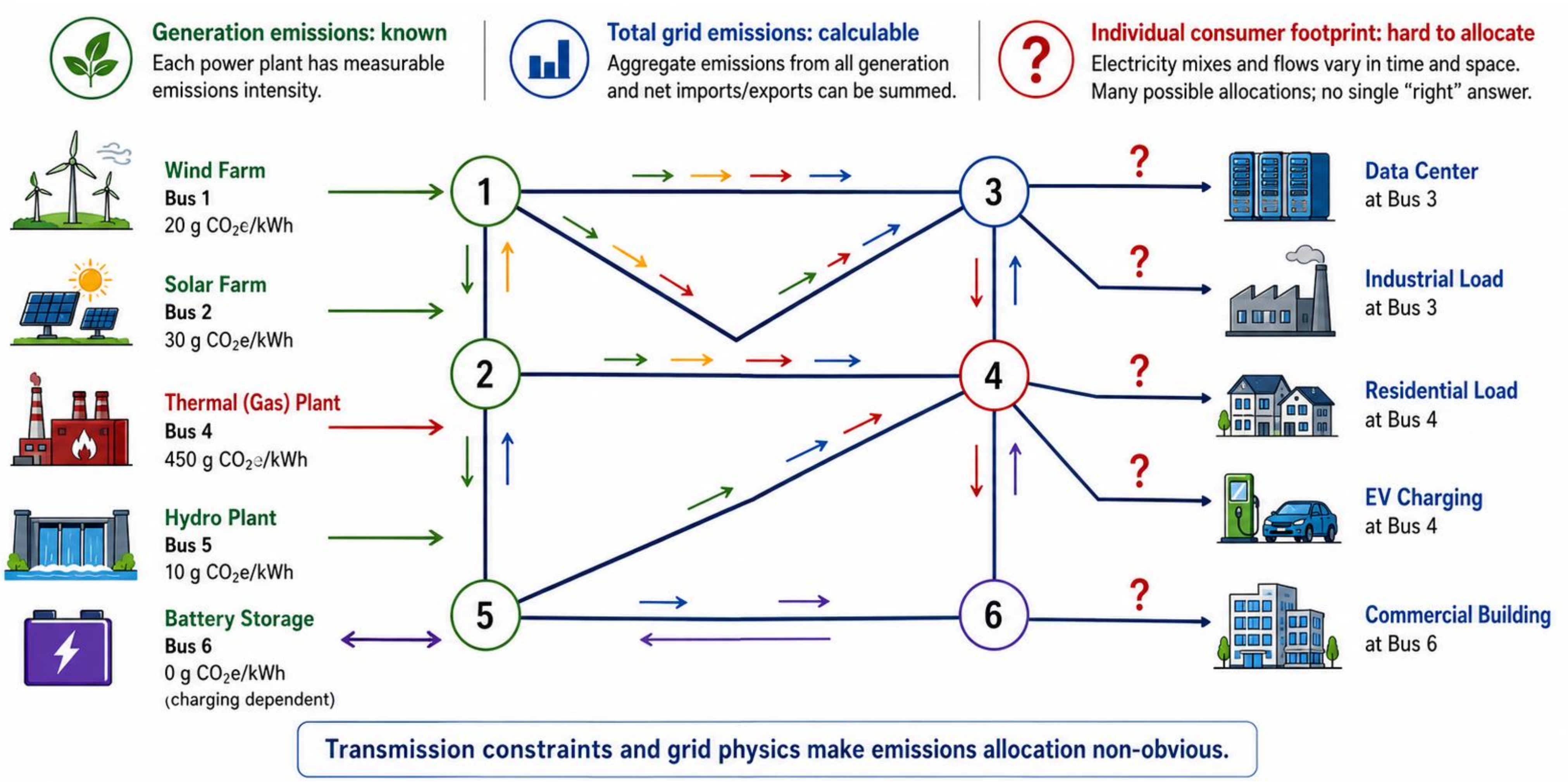
Question: What happens if this consumer moves electricity use?

Good shifting wants real total grid emissions to fall.

A metric can be good for reporting but bad for changing behavior.

Carbon footprint of electricity consumption

Why calculating the carbon footprint of electricity consumption is difficult



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Adjusted locational marginal	Marginal signal corrected so totals match system emissions	Good for short-term load shifting, total assigned emissions match total real emissions	Still volatile; for small shifts

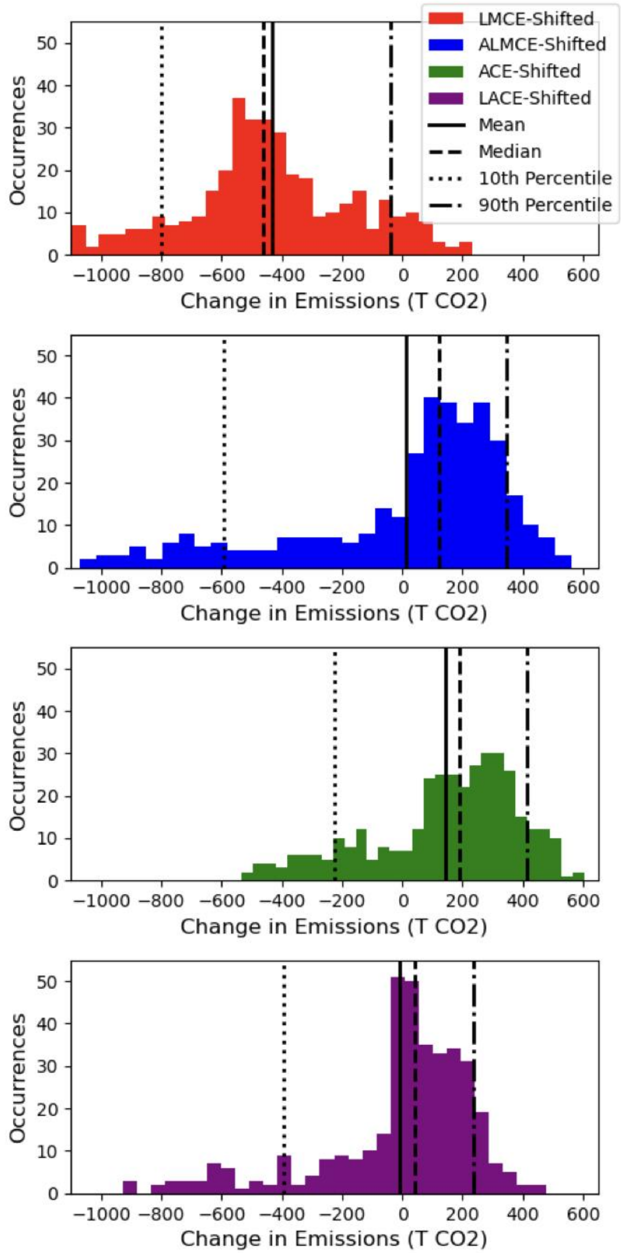
Common metrics

1 **All four metrics helped data centers**
When data centers followed any of the four metrics, their own accounted emissions went down.

2 **But only LMCE clearly helped the full system**
LMCE was the only metric that clearly reduced total system emissions.

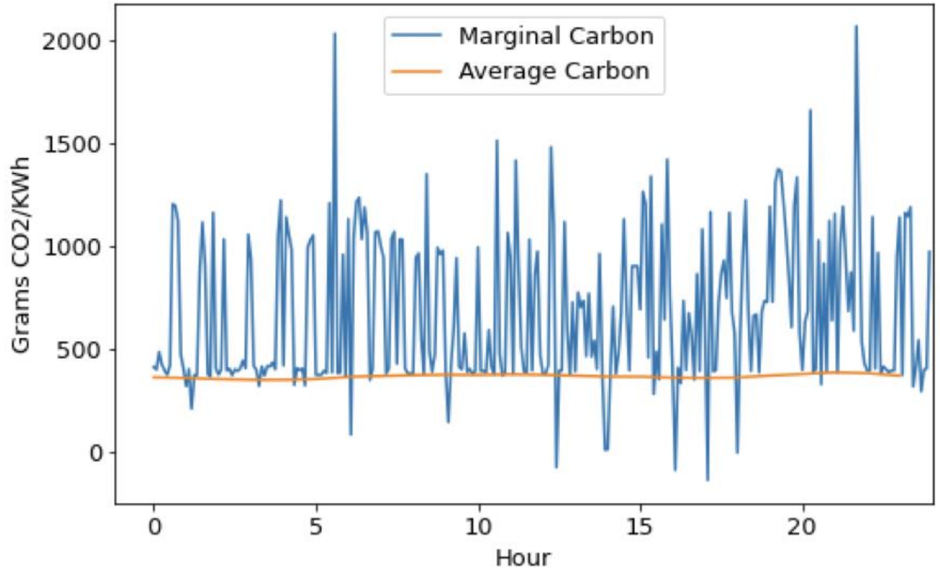
3 **Some popular metrics were misleading**
Using the average carbon metric increased total system emissions by about 0.33%. ALMCE and LACE showed little real system-wide improvement.

Takeaway: following a lower average-carbon period does not always reduce real emissions.

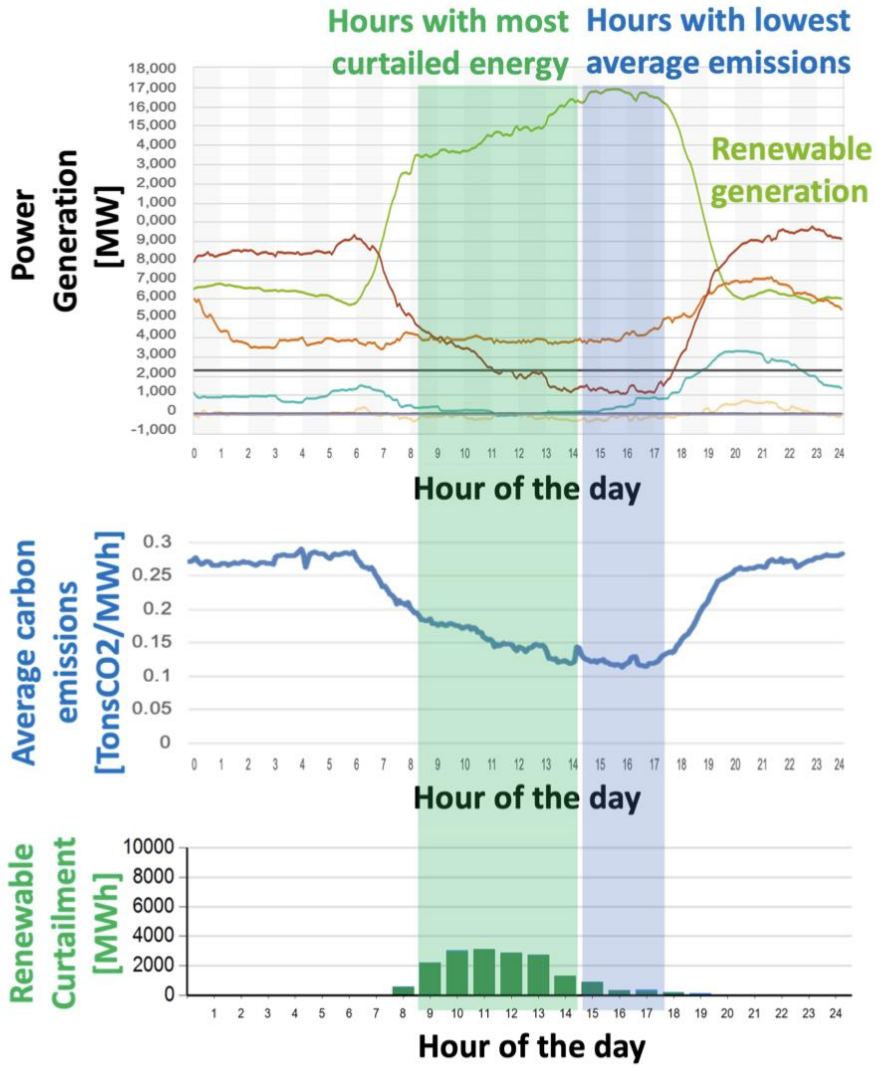


Gorka, Rhodes, and Roald, "ElectricityEmissions.jl: A Framework for the Comparison of Carbon Intensity Signals," arXiv:2411.06560, 2024.

Common metrics



Real-time locational marginal emissions have much higher volatility than the hourly average emissions!



Metrics may not show when renewable electricity is being wasted!

Gorka, Rhodes, and Roald, "ElectricityEmissions.jl: A Framework for the Comparison of Carbon Intensity Signals," arXiv:2411.06560, 2024.

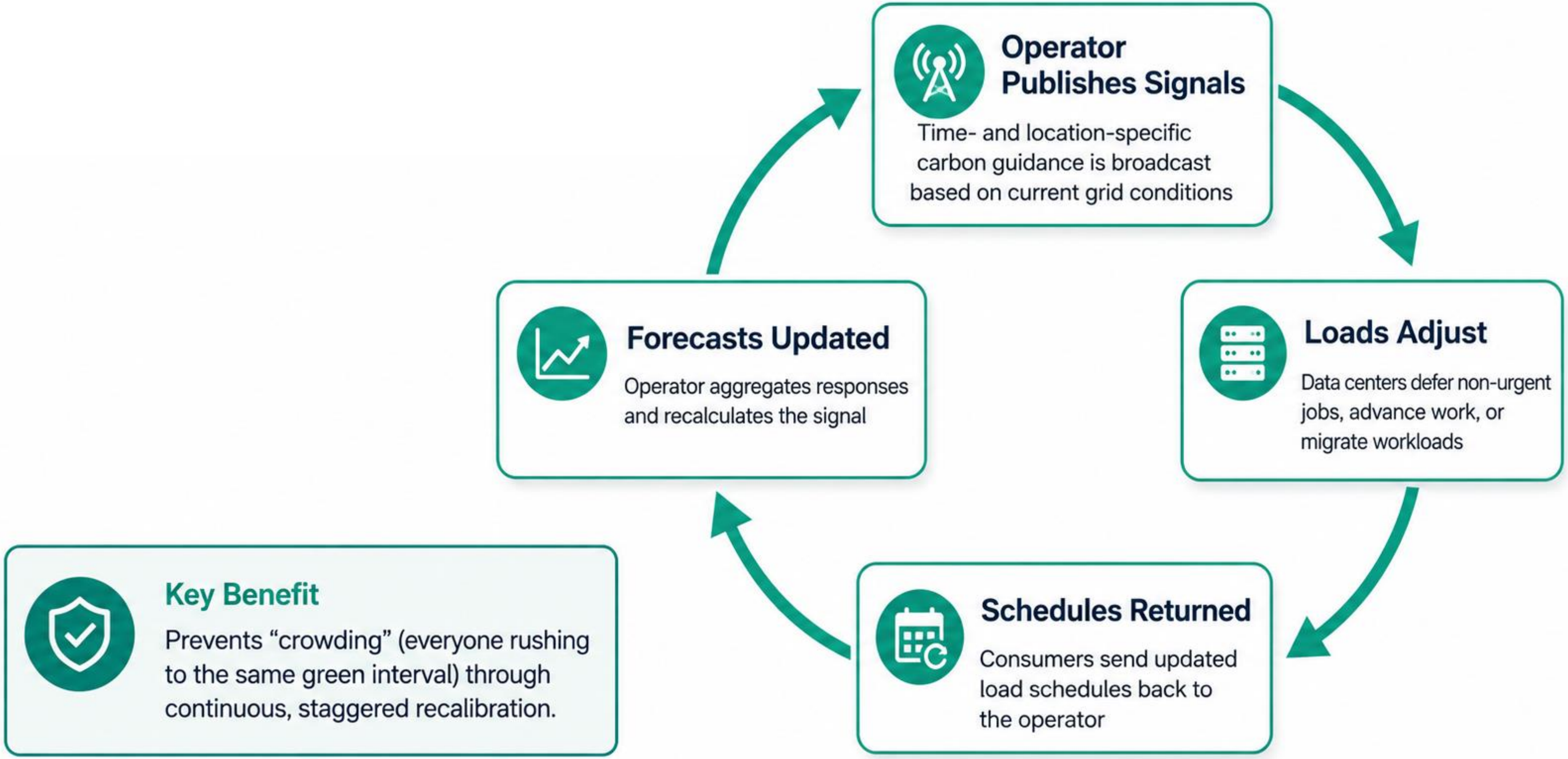
No single metric is perfect for both accounting and load shifting!

General limitations of carbon-aware load shifting

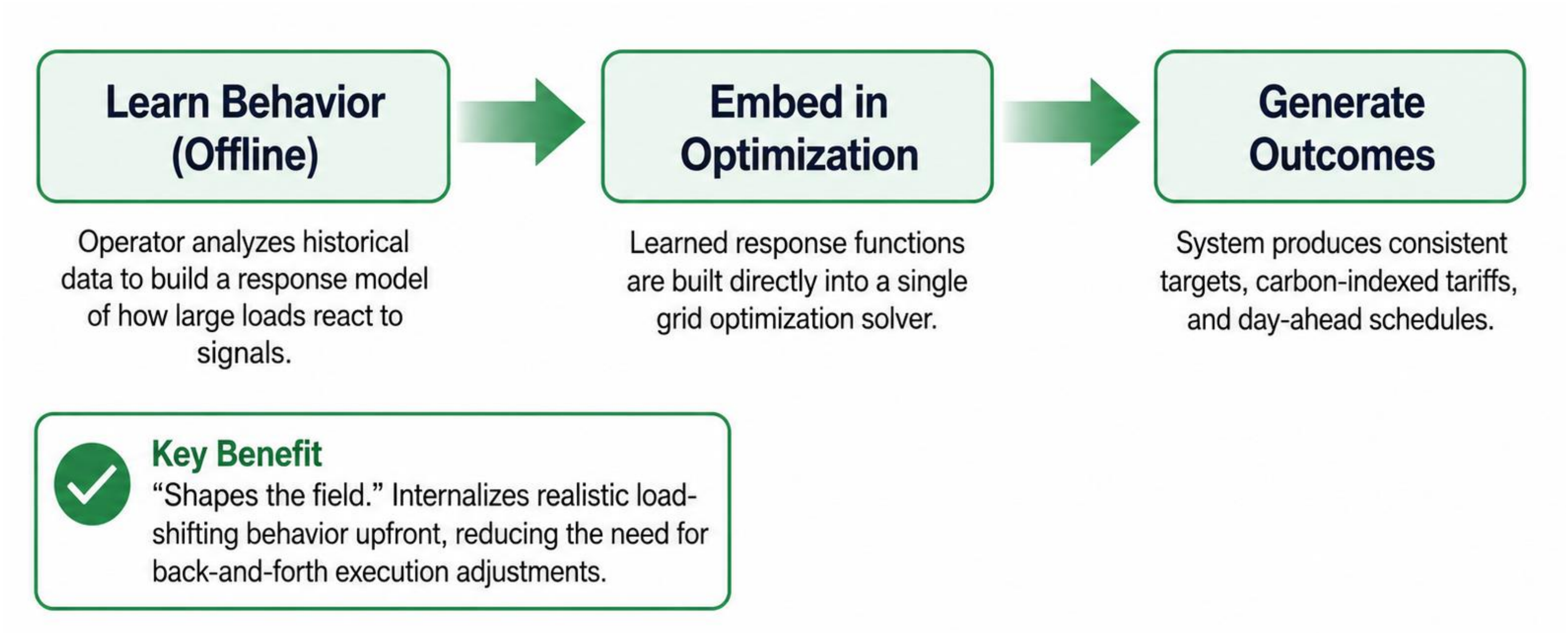
1	**Overshifting**	Too much load moves into the same “clean” hours, but there may not be enough extra clean energy.
2	**Cancellation**	Different consumers follow different metrics and their shifts cancel each other out.
3	**Marginal generator only**	Short-term shifting often changes only the marginal generator, not the whole generation mix.
4	**Data + uncertainty**	Carbon signals depend on forecasts and incomplete grid data.

Good carbon-aware design needs coordination, not just everyone chasing the lowest number.

Scheduling: Iterative mechanism



Scheduling: Integrated mechanism



Final takeaway

Carbon-aware AI is not just about using less electricity.

It is about using electricity at the right time, in the right place, with the right carbon signal.

The target is not lower reported emissions for data centers.

The target is lower total grid emissions with reliability and fairness.

Thank you!

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