Cost, emissions, and grid transformation implications of 24/7 CFE matching

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About RMI

Transforming the global energy system to secure a clean, prosperous, zero-carbon future for all.

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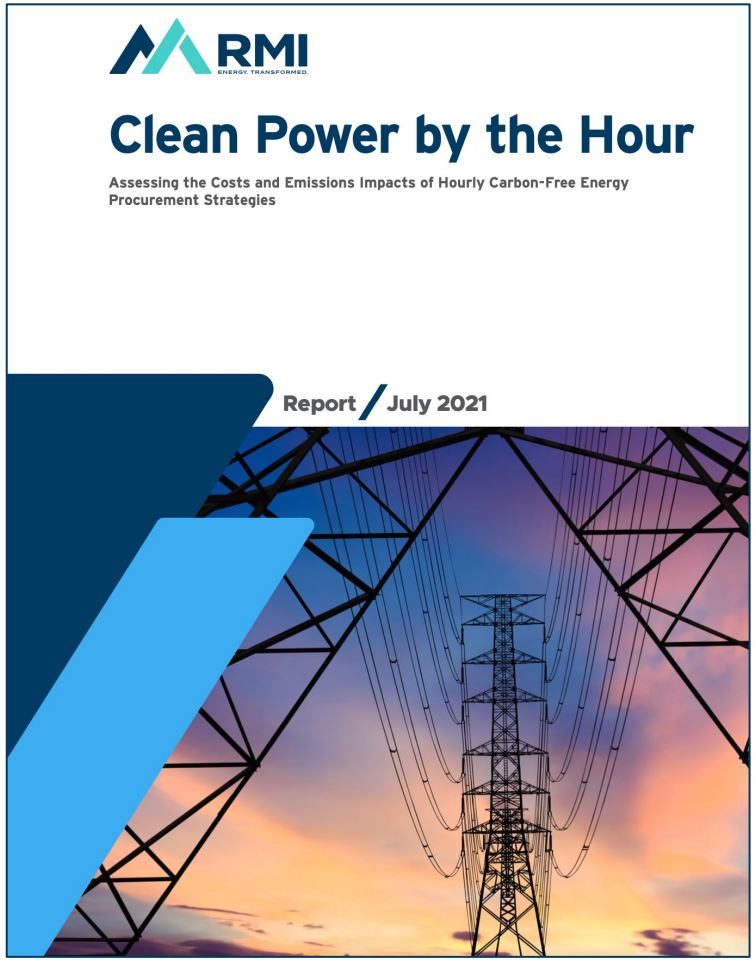
- Electricity
- Buildings
- Transportation
- Industry

USING Powerful Market Catalysts

- Policy
- Technology
- Climate Aligned Finance
- Climate Intelligence
- Education & Capacity Building
- Communications

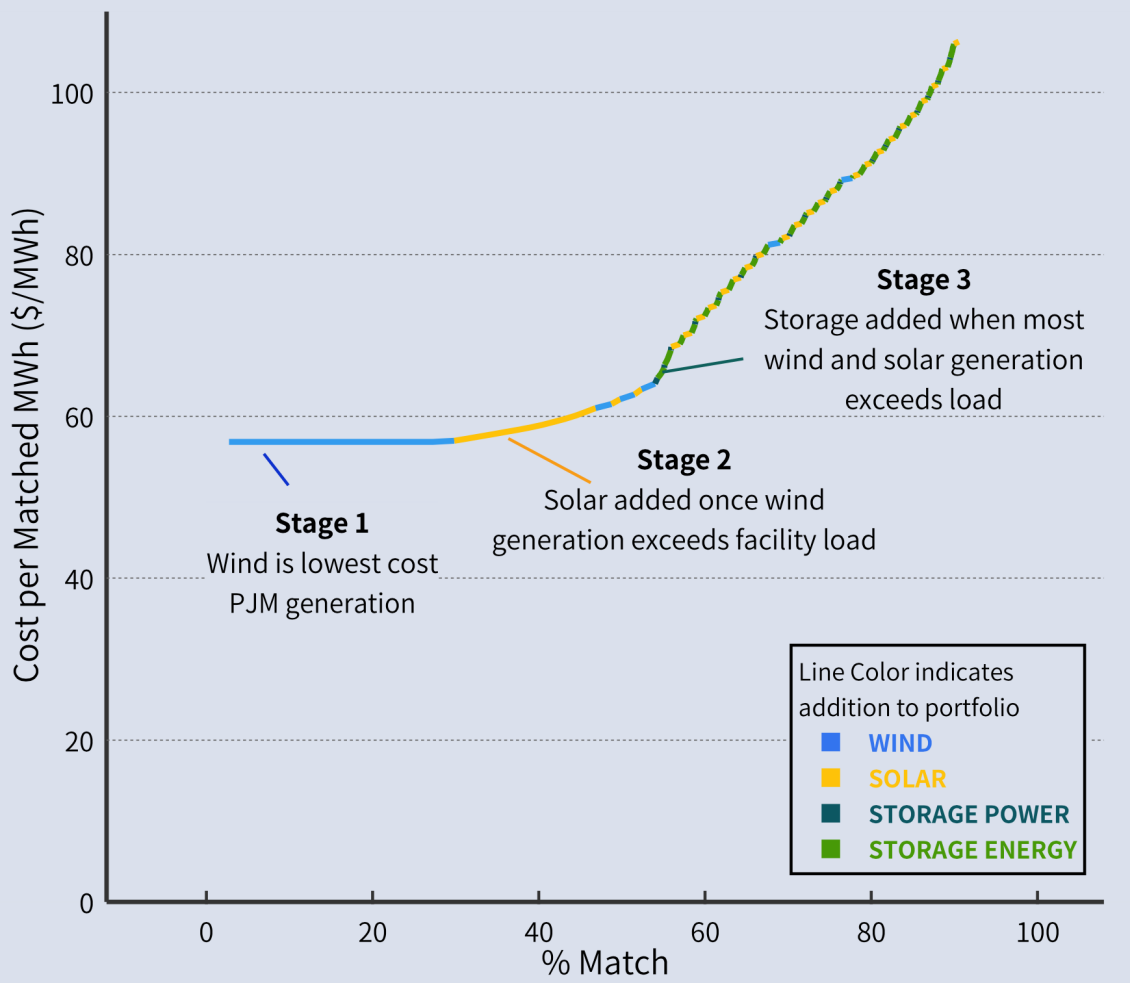
RMI's study assessed the cost, emissions, and market transformation impacts of "24/7 CFE" hourly matching

- **Approach:** Used a model which incrementally builds a least-cost portfolio to match a facility's hourly load with newly-built carbon free resources, applied in 7 global markets.
- **Scope:**
  - Modeled technologies widely available for new projects (i.e., wind, solar, Li-ion storage), with assessment of opportunities for emerging tech.
  - Quantification of short-run impacts, with comment on potential long-run implications.
- **Funding:** Supported by Microsoft, in advance of their "100/100/0" commitment.



Finding 1: Costs for hourly load matching rise in three distinct stages, well above costs for meeting annual procurement targets

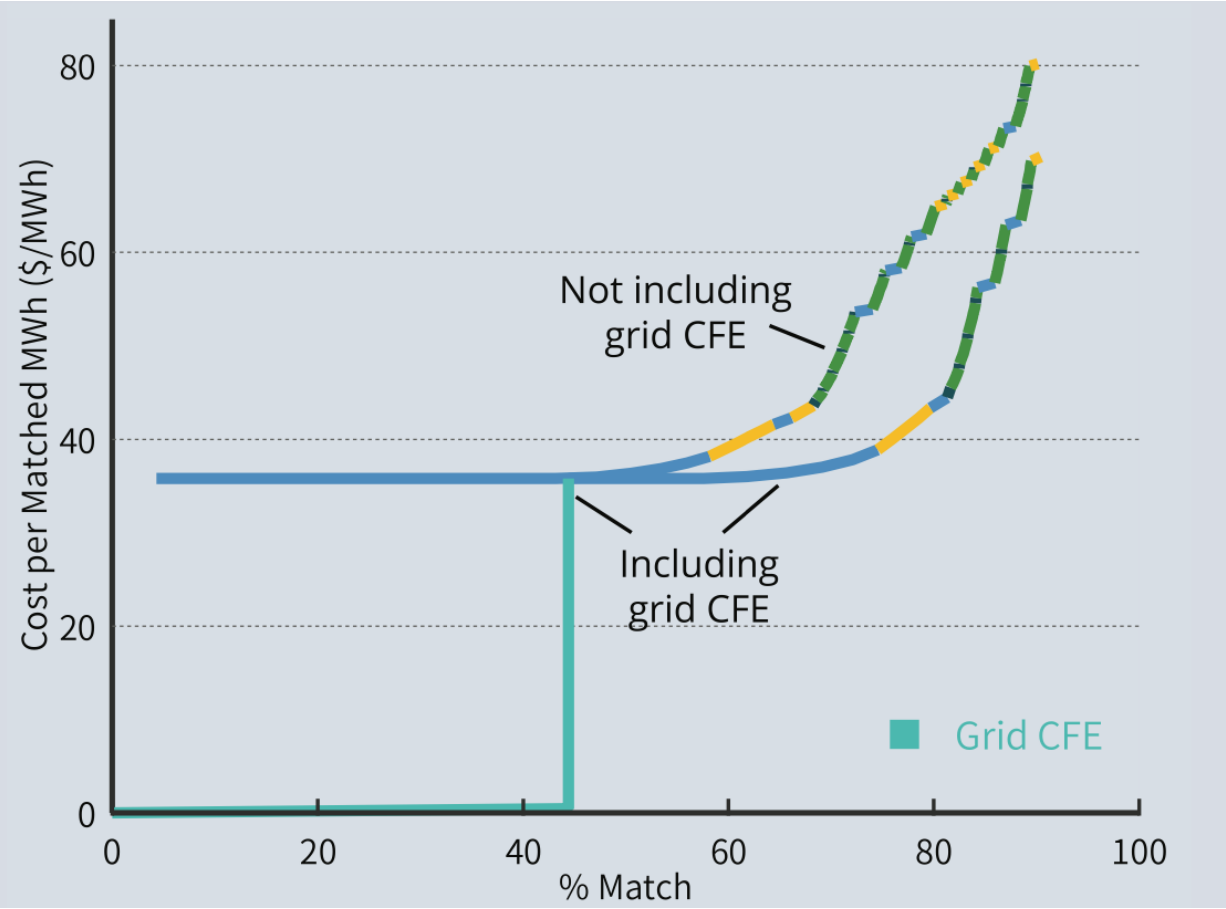
Hourly load matching costs for a data center in PJM



- **Stage 1:** Procured renewable generation is used to match facility load in all hours. *(0-30% hourly match for this example)*
- **Stage 2:** Procured renewable generation exceeds facility loads in some hours. *(30-60% hourly match)*
- **Stage 3:** Storage is used to balance renewables. *(60%+ hourly match)*

Finding 1, continued: Including "grid CFE" in portfolio metrics can lower costs and complement existing resources

Impact of including existing grid CFE in matching metric for a data center in SPP



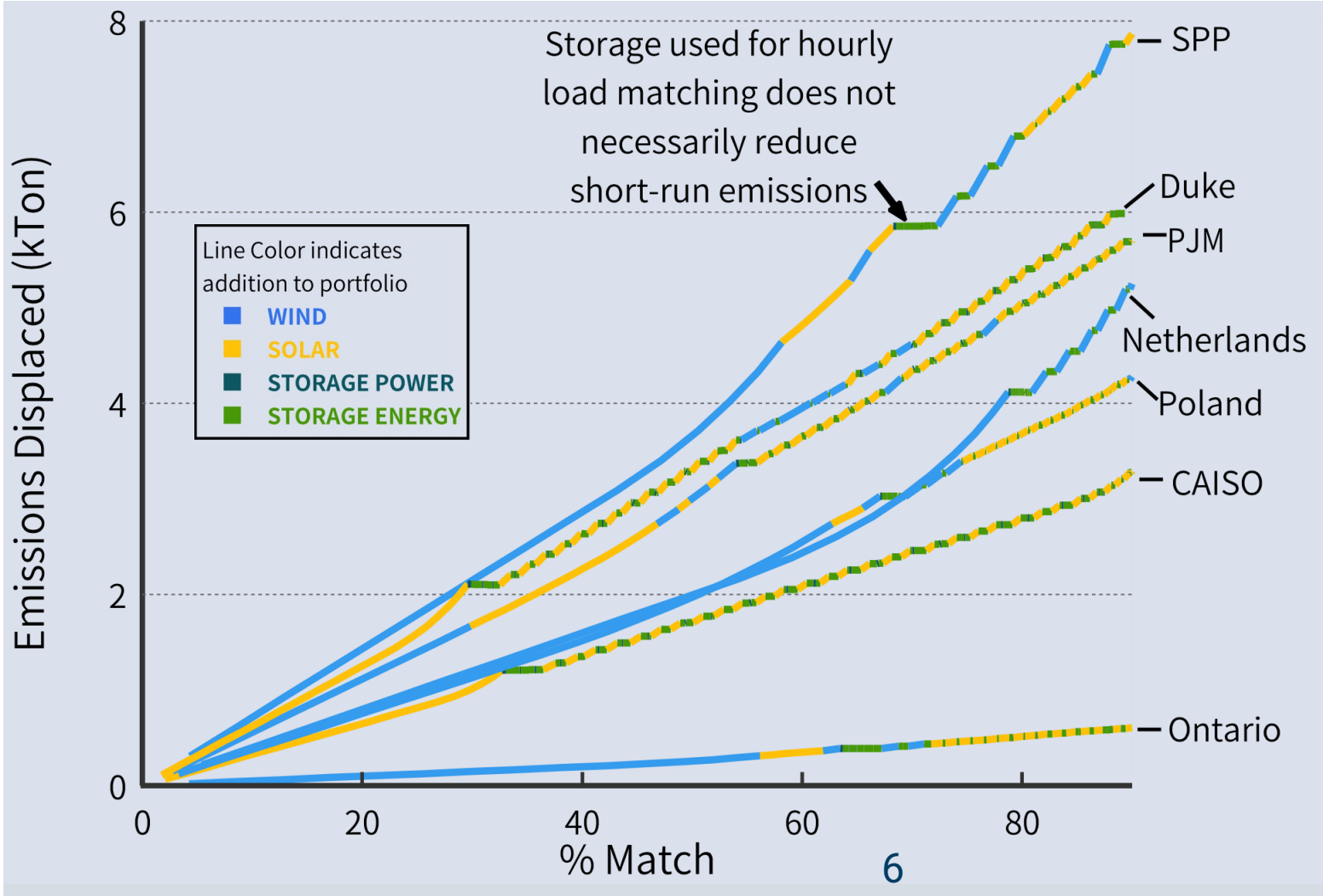
Including existing grid CFE in the procurement metric:

- **Gives buyers a higher "starting point"**
- **Lowers costs** for a given level of 24/7 matching
- **Shifts resource procurement choices** to complement existing CFE
- **Can better align investment and operational strategies** to support system-level emissions reductions

Finding 2: Near-term emissions reductions depend on the regional grid mix and operation of storage resources

- **Emissions benefits depend on the broader grid**. Any form of carbon-free energy procurement saves more carbon in the short term in grids with higher marginal emissions.
- **Optimizing storage to match facility load may not directly reduce emissions.** Co-optimizing storage dispatch with grid-level price and emissions signals can provide economic and carbon benefits.

Emissions reductions from hourly load matching in modeled regions

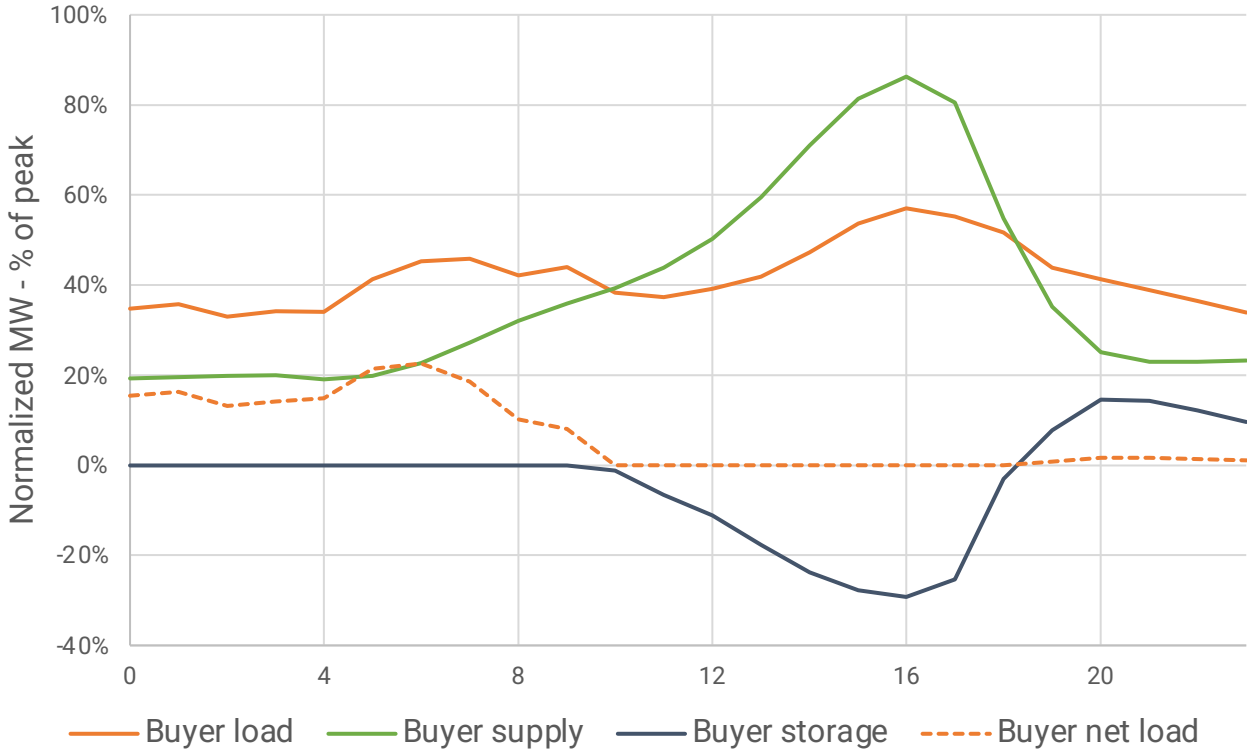


Finding 2, cont'd: The role of energy storage in supporting 24/7 CFE matching

Indicative case study:

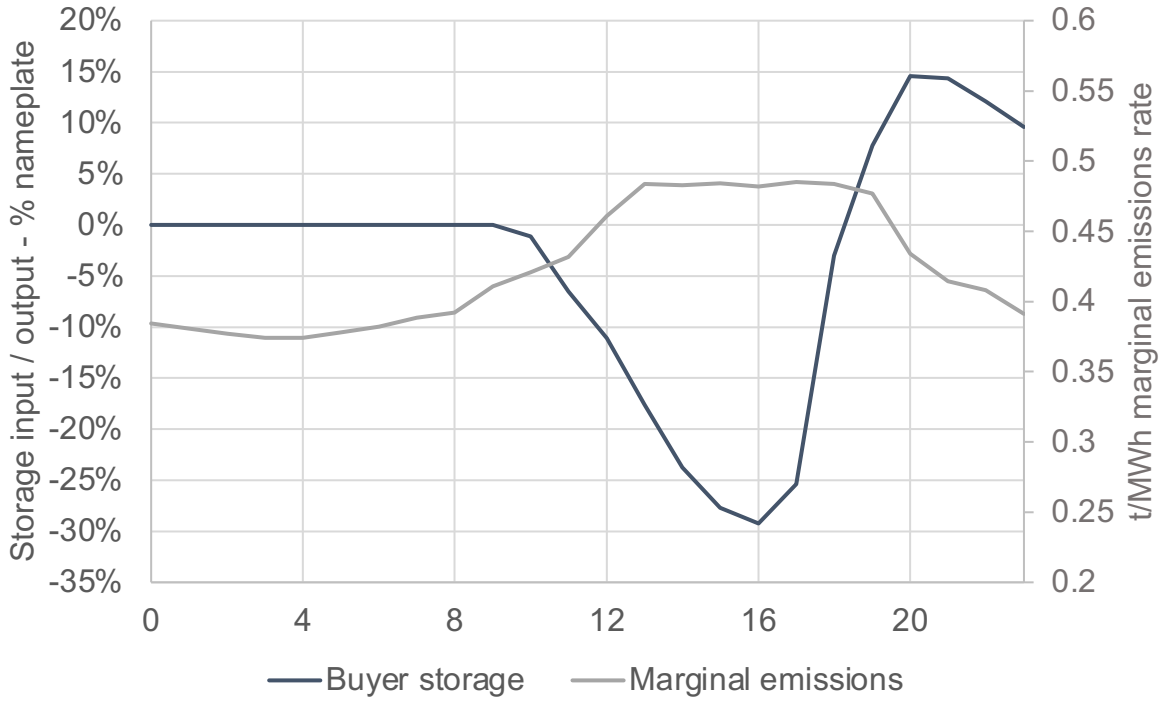
- California (CAISO NP15) commercial load profile
- Study year – 2019
- 90% annual CFE offset; 66% hourly match (w/o counting grid mix)
- Battery system (75% of peak load, 4 hours) can support 71% match

Example day – buyer load, CFE supply, and storage dispatch



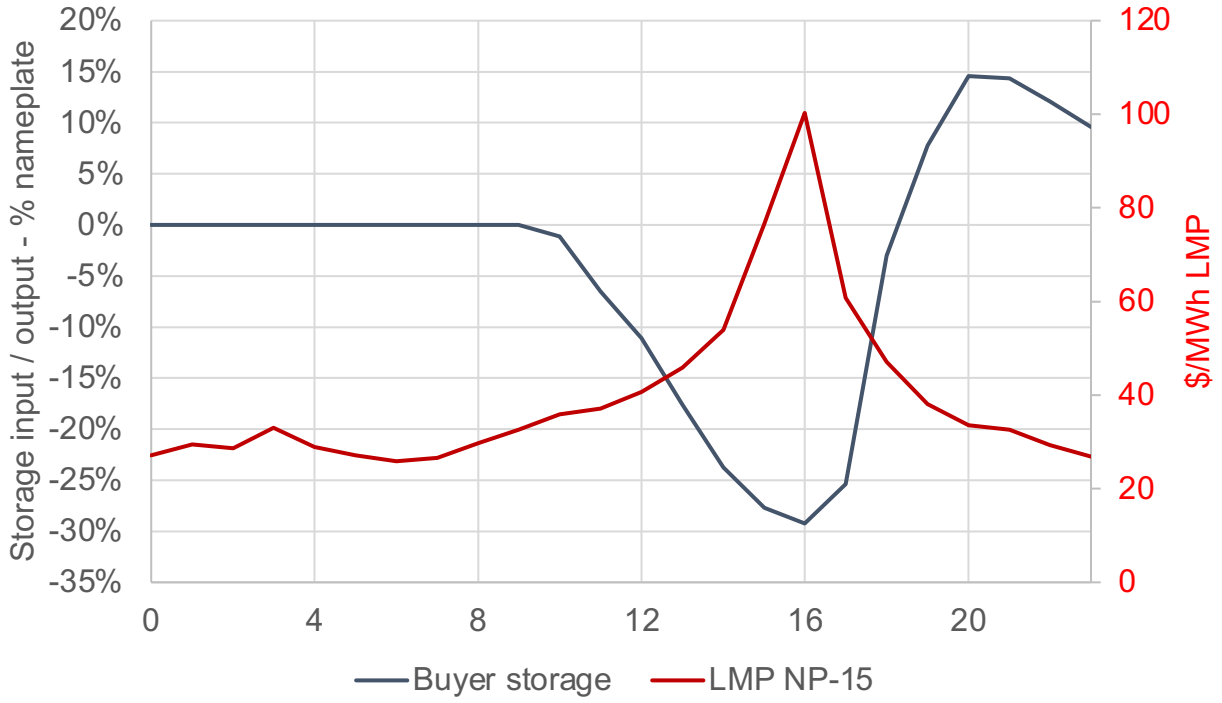
Finding 2, cont'd: Storage optimized solely for 24/7 CFE does not necessarily help short- or long-run decarbonization

Short-run emissions: marginal CO_2 emissions rates and storage dispatch



Battery charges mid-day when buyers' CFE is in "excess", but where within CAISO, marginal emissions rates still peak at that time

Long-run emissions: System price (LMP) and storage dispatch



Battery charges mid-day when CAISO LMP is high, sending signal for fossil fuel-fired power plants to operate more and remain online in the long run

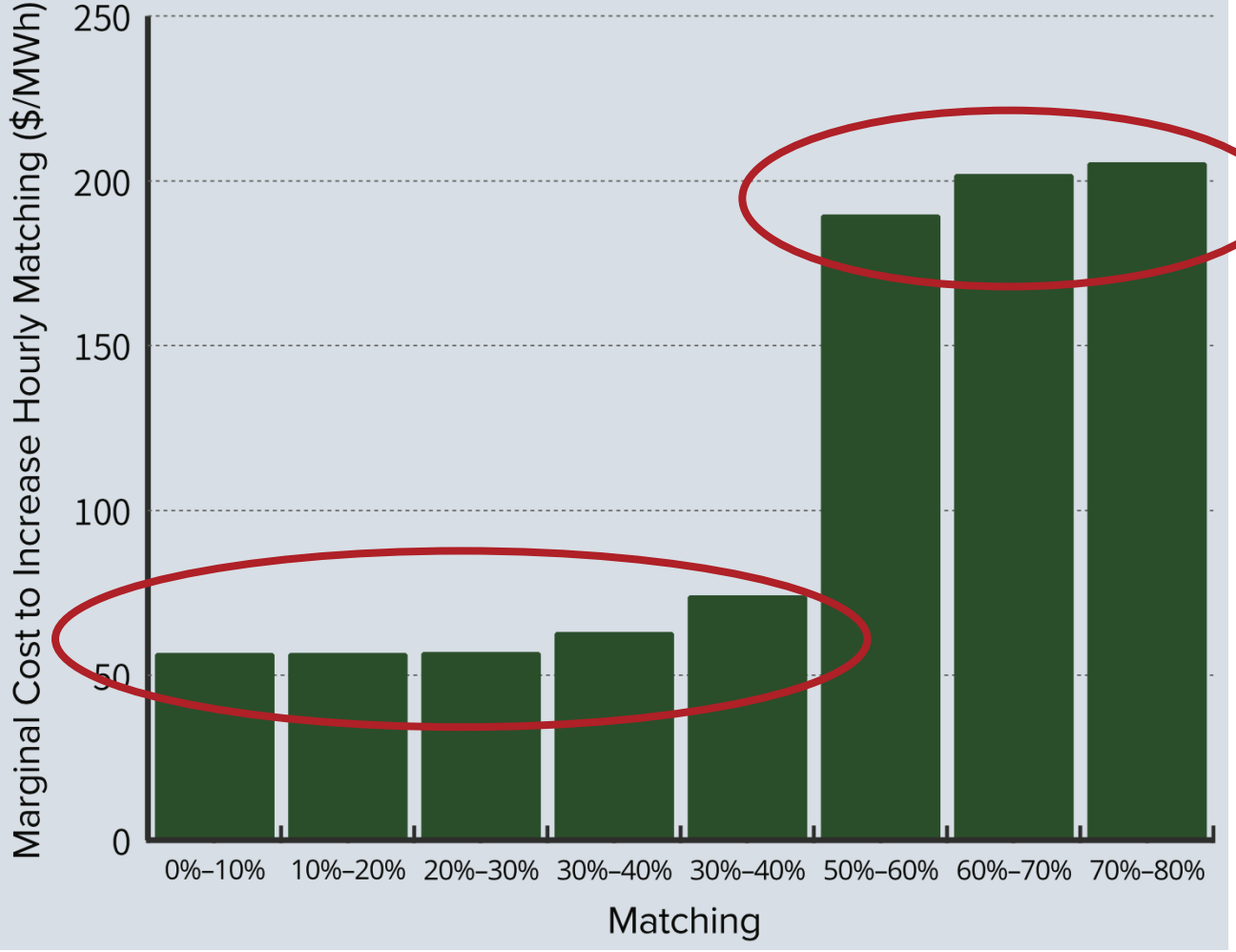
Finding 2, cont'd: Storage can play a climate-aligned role in a buyer's CFE portfolio as the grid decarbonizes

Summary of procurement implications for buyers in regions at different stages of grid decarbonization

	Grid characterization		
	Phase 1: Fossil-dominated	**Phase 2: Some renewable curtailment**	**Phase 3: High renewables, significant curtailment**
Examples	PJM today	Parts of SPP today	CAISO in 5+ years
Buyers' wind or solar projects…	Always offset fossil generation and reduce CO_2 emissions	Are sometimes curtailed	Provide limited emissions reductions by themselves
Buyers' storage resources…	Can reduce emissions if optimized for system needs, but tend to increase emissions if used solely to shape facility load to match procured renewables.	Can reduce renewable curtailment, reduce emissions, and add grid value (e.g., capacity) that accelerates decarbonization.	Provide significant system-level value and emissions reductions if optimized for system needs.

Finding 3: Hourly procurement can create demand for emerging technologies needed to fully decarbonize the grid

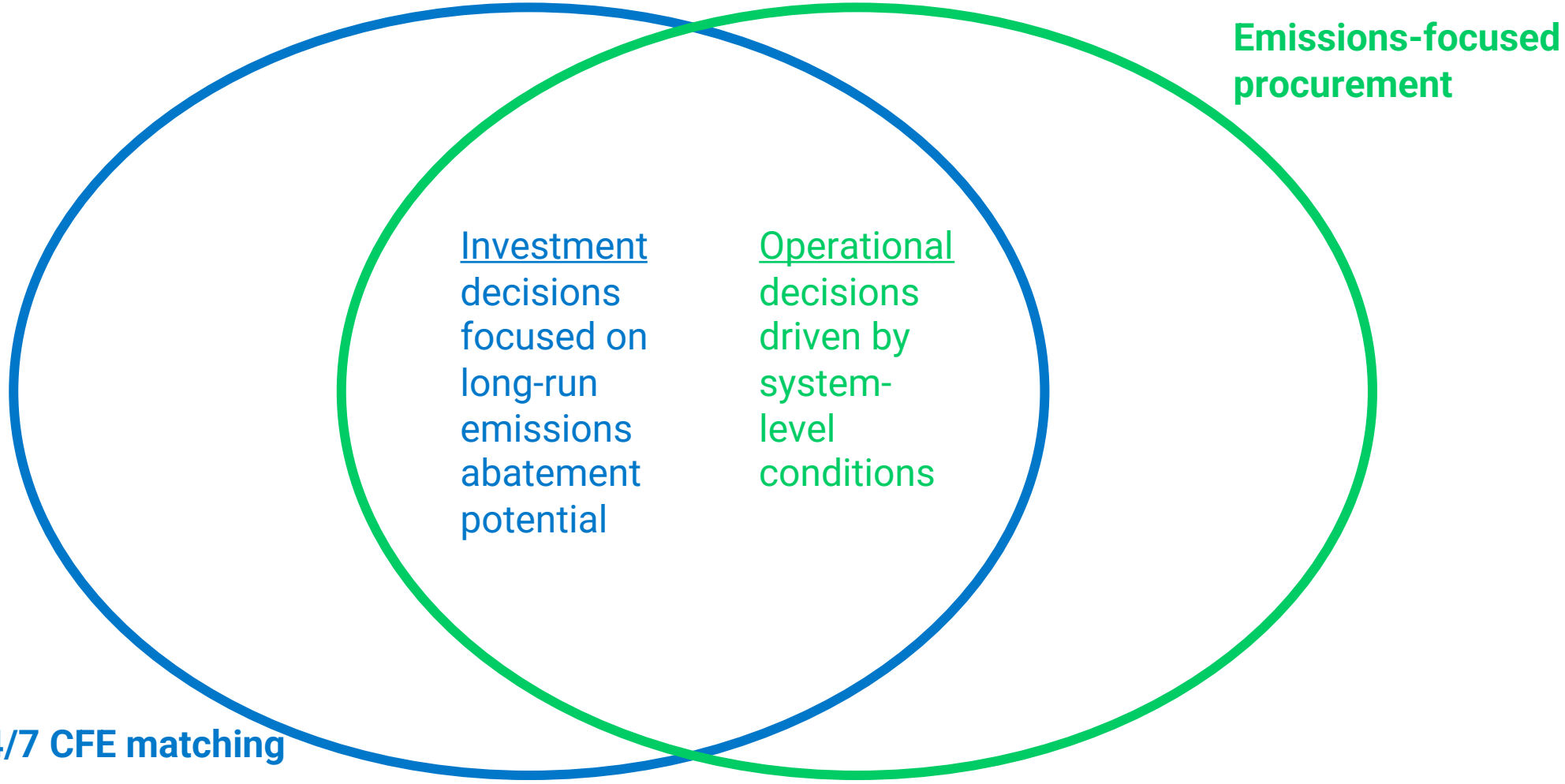
Marginal costs to increase level of hourly load matching, PJM data center



The final ~50% of hourly matching is very costly without a broader set of CFE technologies

The first ~50% of hourly matching is low-cost

Well-crafted procurement strategies, and policies to shape them, can support both near- and long-term emissions reductions



Thank you

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