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The Value of Grid-interactive Efficient Buildings

October 5th, 2021 | Brett Webster

2021 IEPR Commissioner Workshop

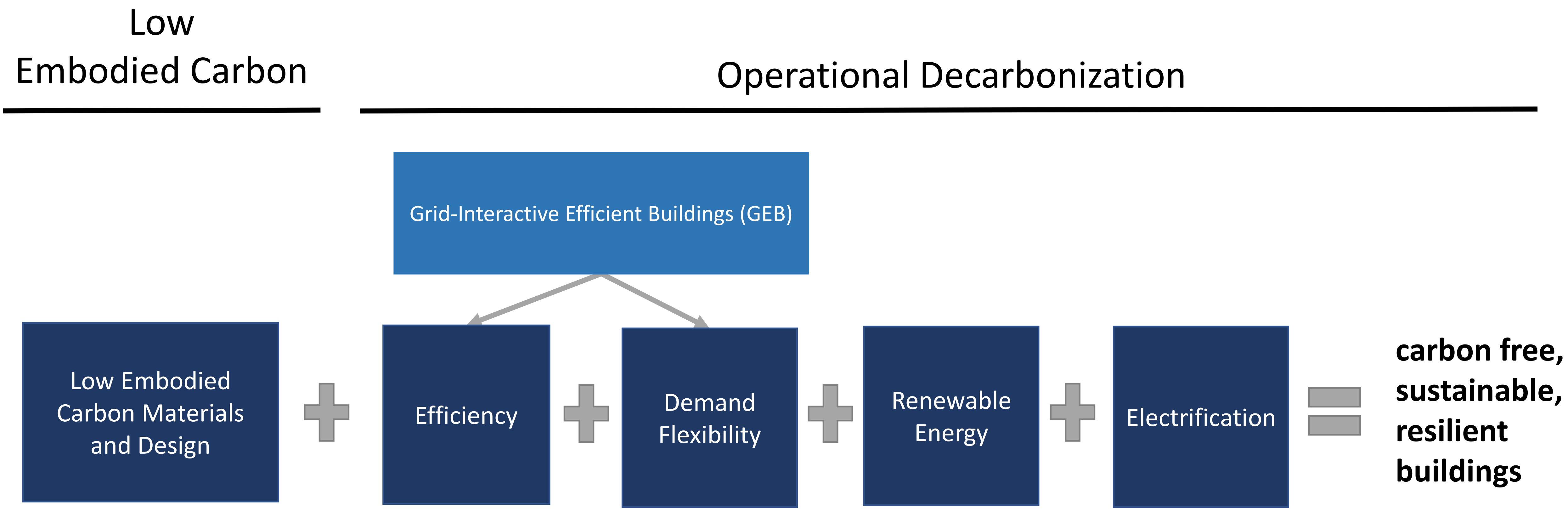
California Energy Commission

Agenda

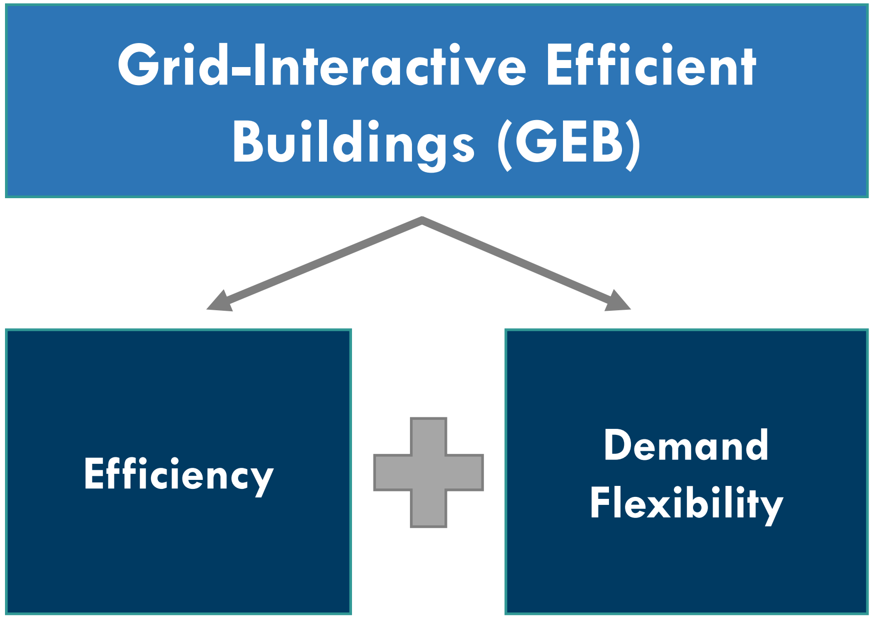
1. GEB: Why are they important for decarbonization?
2. Value to Building Owners and Occupants
3. Carbon value of GEB
4. Summary

WHY ARE GEB IMPORTANT FOR DECARBONIZATION?

The Recipe for Building Decarbonization



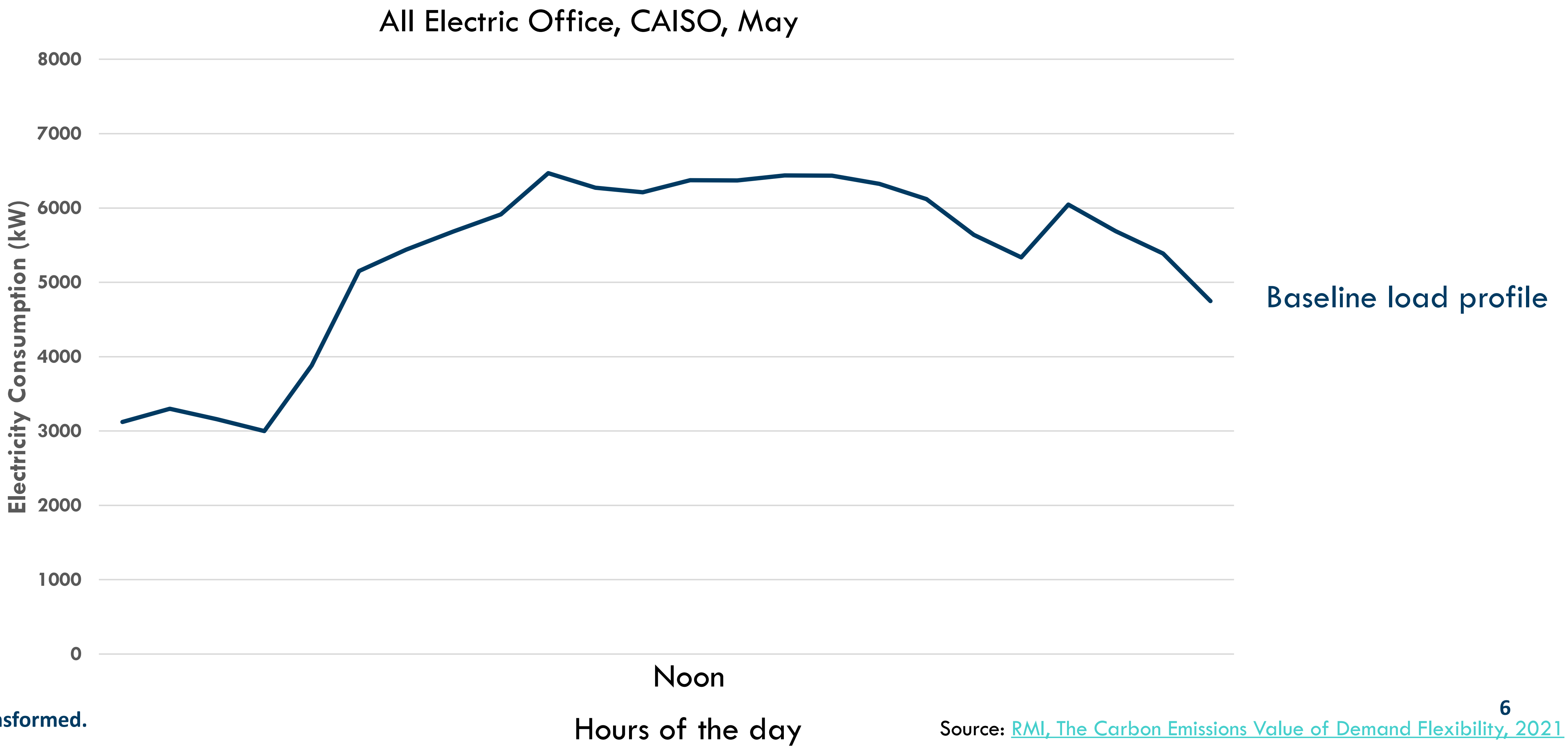
What are GEBs?



Grid-interactive efficient buildings (GEBs) are energy efficient buildings with smart technologies characterized by the active use of distributed energy resources (DERs) to **optimize energy** use for grid services, occupant needs and preferences, climate mitigation, and cost reductions **in a continuous and integrated way.**

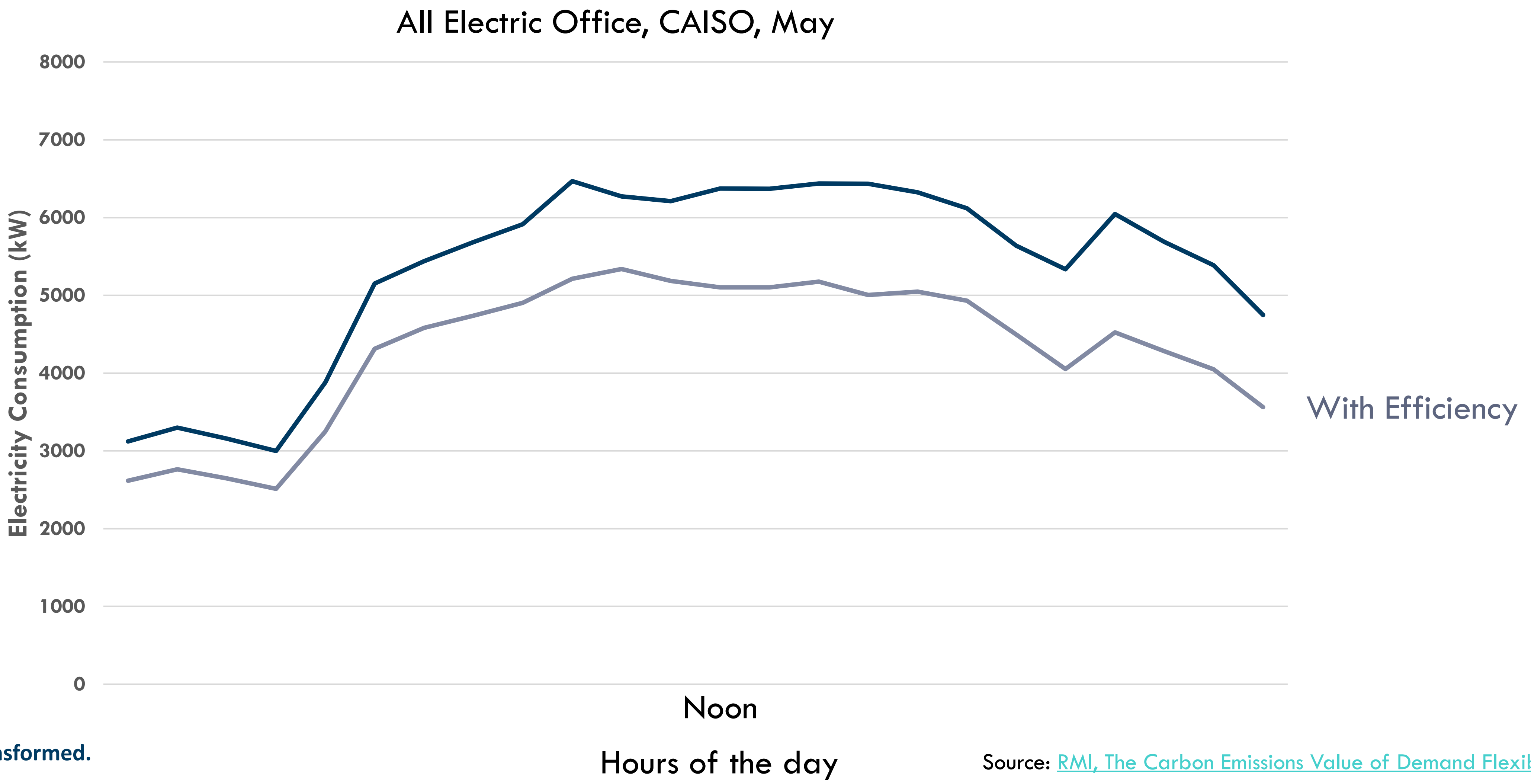
GEBs bring building and grid together!

What can GEBs do?



Source: RMI, The Carbon Emissions Value of Demand Flexibility, 2021

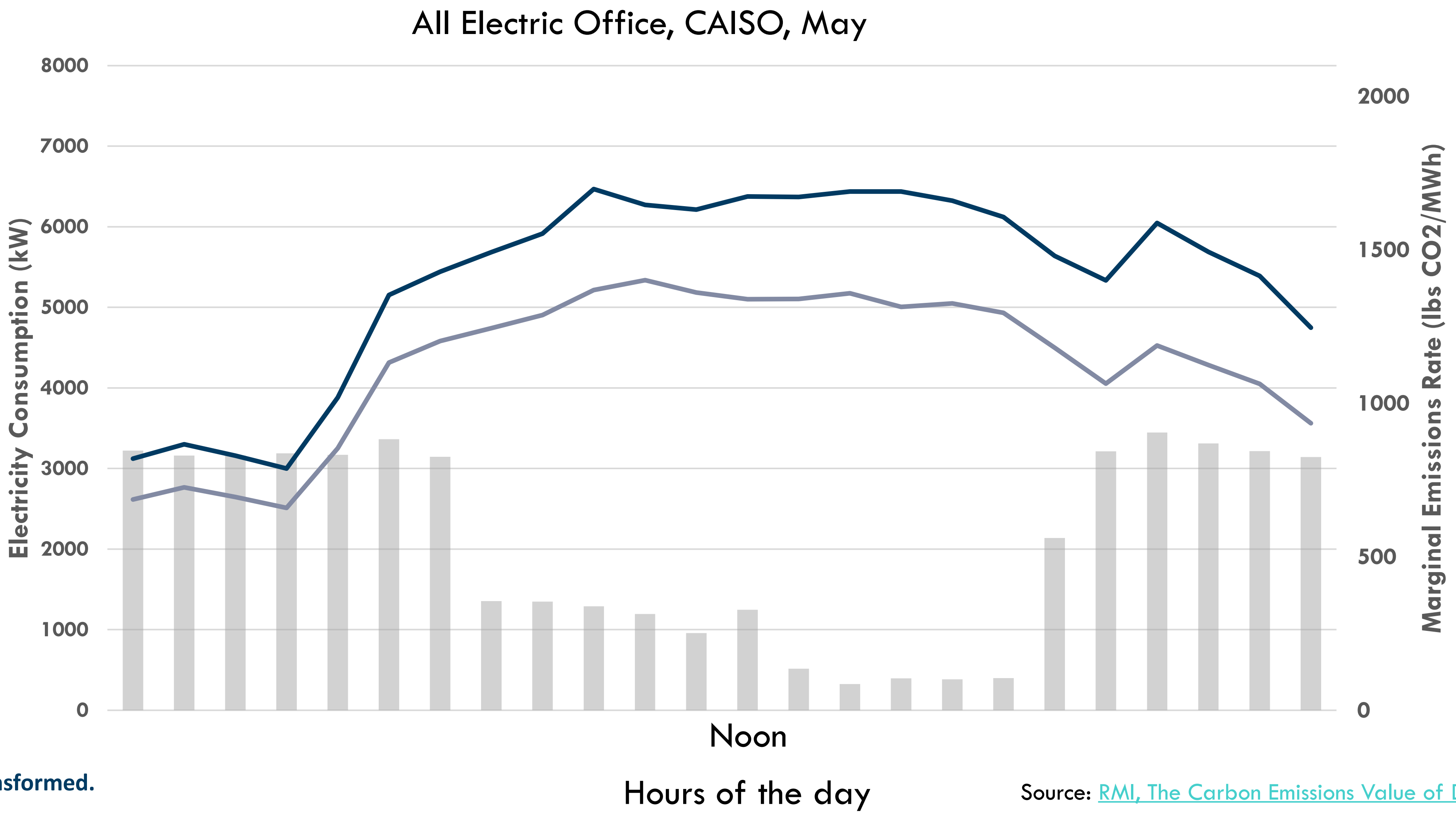
What can GEBs do?



Source: [RMI, The Carbon Emissions Value of Demand Flexibility, 2021]

What can GEBs do?

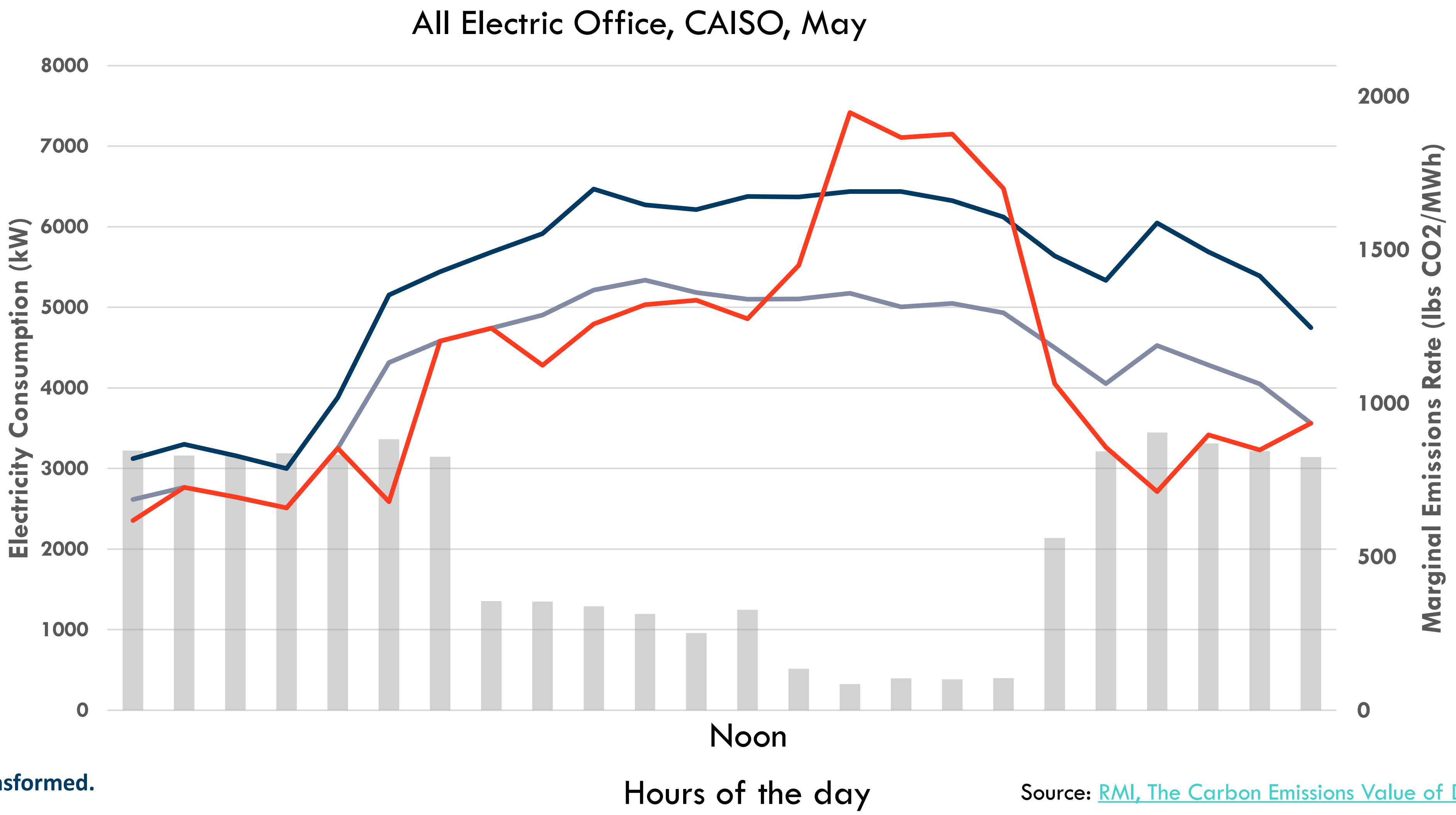
Electricity generation and carbon intensity is variable.



Source: [RMI, The Carbon Emissions Value of Demand Flexibility, 2021]()

What can GEBs do?

Building loads need to be flexible.

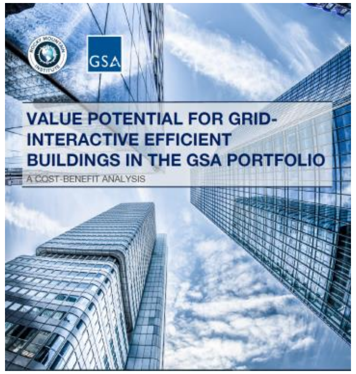


Efficient and flexible load profile

Source: RMI, The Carbon Emissions Value of Demand Flexibility, 2021

VALUE TO BUILDING OWNERS AND OCCUPANTS

Value Potential for Grid-Interactive Efficient Buildings in the GSA Portfolio



Best NPV:
- HVAC staging
- Staged laptop charging

Flex+EE/RE combo measures too:
- LEDs + controls
- Solar + storage

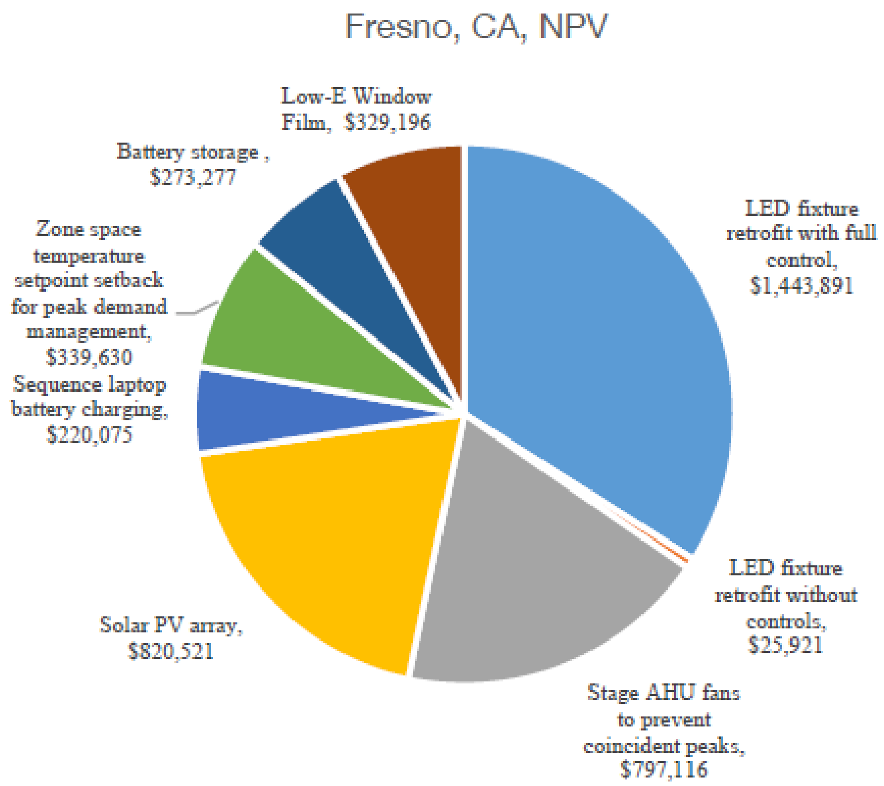
Direct Value
- $50M in annual cost savings (~20%)
- $206M in NPV
- Project-level payback under 4 years
- Flexibility to accommodate future rate structure changes

Indirect Value
- Demonstrate federal and real estate industry leadership
- Enable deeper savings in ESPCs and UESCs
- Improve comfort, health, and productivity through better building controls

Societal Value
- Reduce grid-level generation, transmission, and distribution costs by up to $70M/y
- Savings ultimately benefit federal government and taxpayers
- Future rate structures will more directly share grid-level savings
- Reduce CO_2 emissions

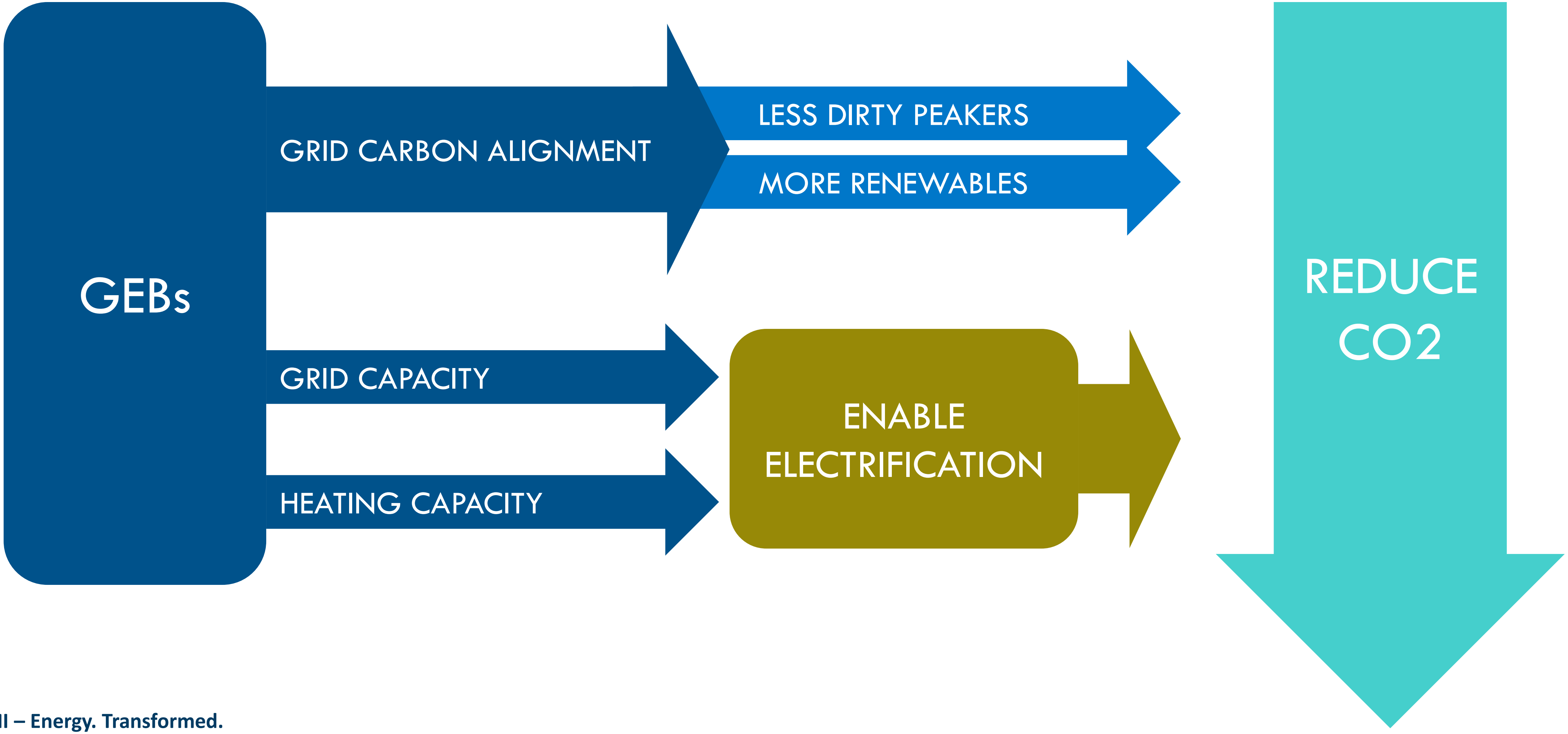
Value Potential for Grid-Interactive Efficient Buildings in the GSA Portfolio

- **GEBs measures have high NPV and short payback periods driven by low first costs (controls focused)**
  - Best returns from locations with high demand charges and time-varying rates
- **Value to grid and society depends on alignment between rate structures, grid operations, and carbon intensity**
  - Individual building peaks don't always match grid peaks



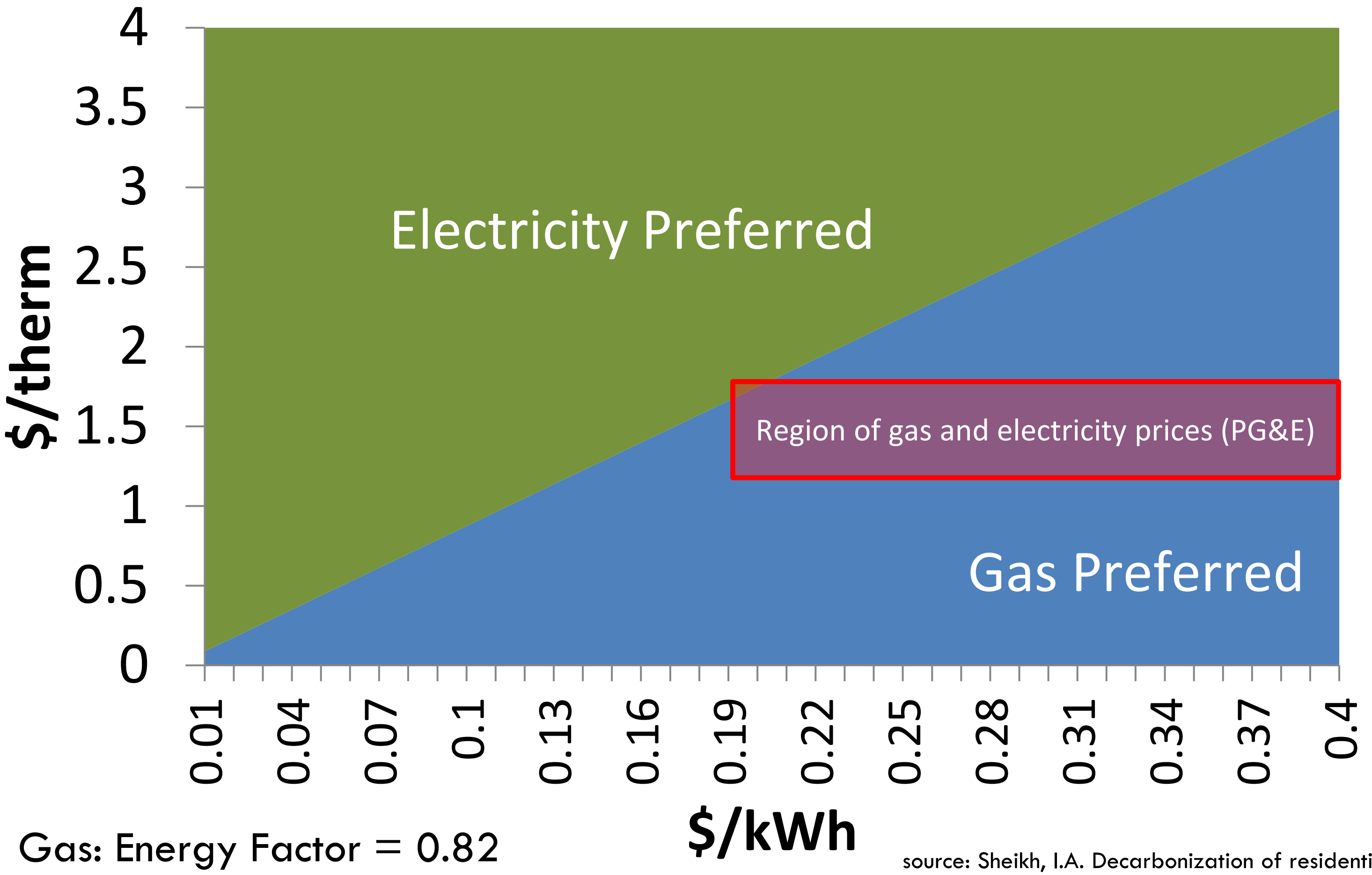
CARBON VALUE OF GEB

GEBs can reduce GHGs



GEBs can help enable electrification

- "Spark spread" still a barrier to electrification in many places
- Additional revenue streams from demand flex can help cost-effectiveness
- Need to ensure equitable access

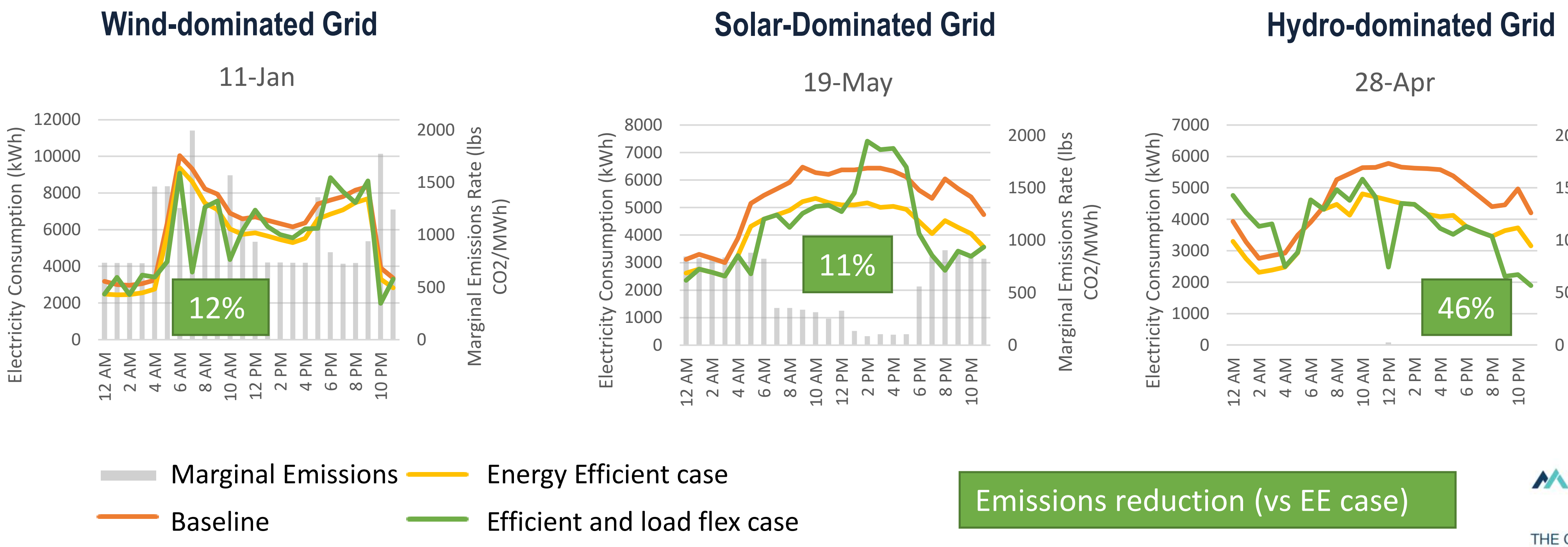


Gas: Energy Factor = 0.82
Electric: Energy Factor = 2.75

source: Sheikh, I.A. Decarbonization of residential space and water heating in California. Ph.D. Thesis, University of California, Berkeley, CA, USA, 2017.

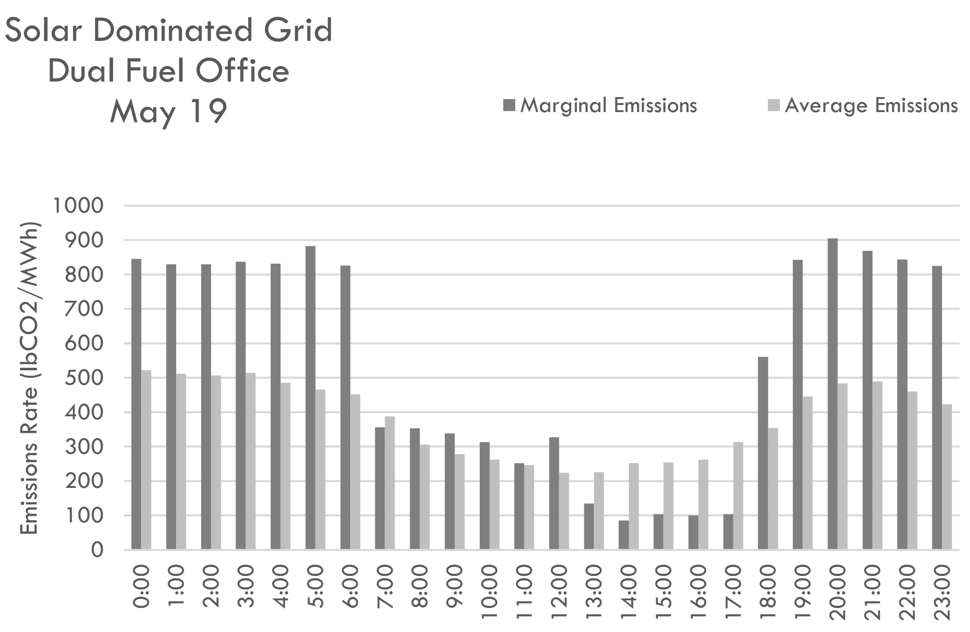
The Carbon Emissions Impact of Demand Flexibility

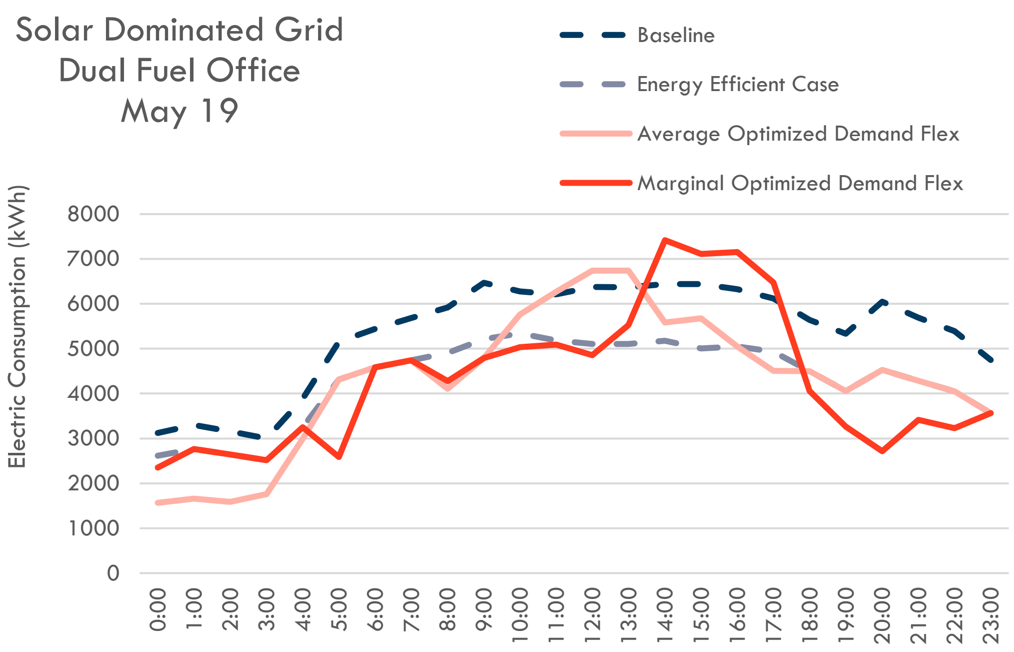
All electric office



Carbon Signal Type

An average signal would encourage different behavior in buildings than a marginal signal





Daily emissions reductions from demand flexibility

<1%

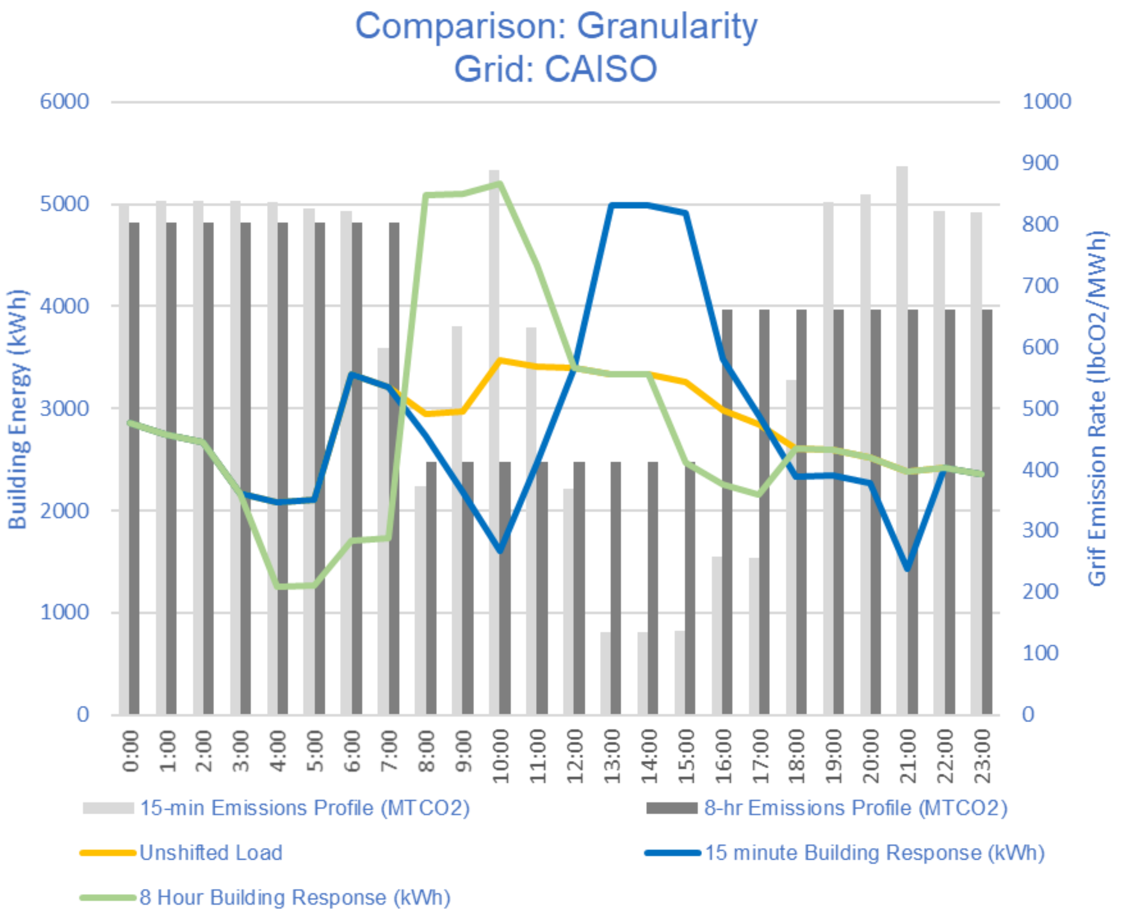
11%

- **A marginal signal better reflects the emissions impacts of load shifting**
- **Building operation optimized on a marginal signal may lead to >2X emissions reduction compared to an hourly average signal.**
- **Marginal and average emissions may not always be correlated, thus there are grid conditions where using an average signal for optimization could increase grid emissions (Shown in the IESO Ontario example).**

Carbon Signal Characteristics

		Timestep			
		15-min	1-hour	3-hour	8-hour
LEVEL OF ADVANCE NOTICE	Real Time	Max Carbon Reduction (100%)	88%	69%	44%
	Hour Ahead	71%	63%	54%	38%
	Day Ahead	65%	57%	51%	36%

This table shows the loss in efficacy of a signal to yield its maximum potential carbon reduction as the timestep and level of advance notice change



- **The level of advanced notice and timestep of a signal determines the behavior of the building.**
- **Buildings will respond differently, depending on the signal selected**
- **The signal characteristics will determine the emissions savings potential**

Demand Flexibility in New York City Buildings: Benefits beyond Carbon

Reduction of peaker plant run times would improve the air quality in surrounding neighborhoods and begin to reverse health inequities in locales like New York City's South Bronx and Sunset Park, dubbed **"Asthma Alley"** due to its proximity to peaker plants

GridOptimal

nbi new buildings institute

LEED v4.1

GridOptimal Metric	What it Measures
Grid Peak Contribution	Degree to which building demand contributes to load on the grid during system peak hours
Onsite Renewable Utilization Efficiency	Building's consumption of renewable energy generated onsite (not exporting to grid) over a year
Grid Carbon Alignment	Degree to which the building demand contributes to upstream (grid) carbon emissions over a year
Energy Efficiency vs. Baseline	Percent better than code (annual total energy use)
Short-Term Demand Flexibility	Building's ability to reduce demand (shed) for 1 hour
Long-Term Demand Flexibility	Building's ability to reduce demand (shed) for 4 hours
Dispatchable Flexibility	Building's ability to automatically reduce demand (shed) for 15 minutes, controlled by utility/ third party
Resiliency	Building ability to island from grid and/or provide energy for critical loads for 4-24 hours; motor soft start capability to help grid restart after outage

SUMMARY

Key Takeaways

- Policies and programs should be designed to capture cost AND carbon value of GEBs
- Alignment between rates, wholesale market programs, and carbon intensity is critical to maximizing benefits of GEBs
- Carbon signal is important: type, timestep, and level of advance notice
- Bundling GEBs with electrification efforts can reinforce value propositions (incentive adders for 'smart and connected' electric equipment)
- GEBs should be thought of as an arrow in the quiver of building decarbonization, not a standalone objective

Additional Resources

- *Value Potential for Grid-Interactive Efficient Buildings in the GSA Portfolio: A Cost-Benefit Analysis*, Rocky Mountain Institute, 2019.
- *The Carbon Emissions Impact of Demand Flexibility, RMI, 2021.*
- *Demand Flexibility in New York City Buildings: Benefits beyond Carbon,* RMI, 2021.
- *The Economics of Demand Flexibility: How "flexiwatts" create quantifiable value for customers and the grid.* Rocky Mountain Institute, August 2015.
- New Buildings Institute – GridOptimal Initiative

THANK YOU

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