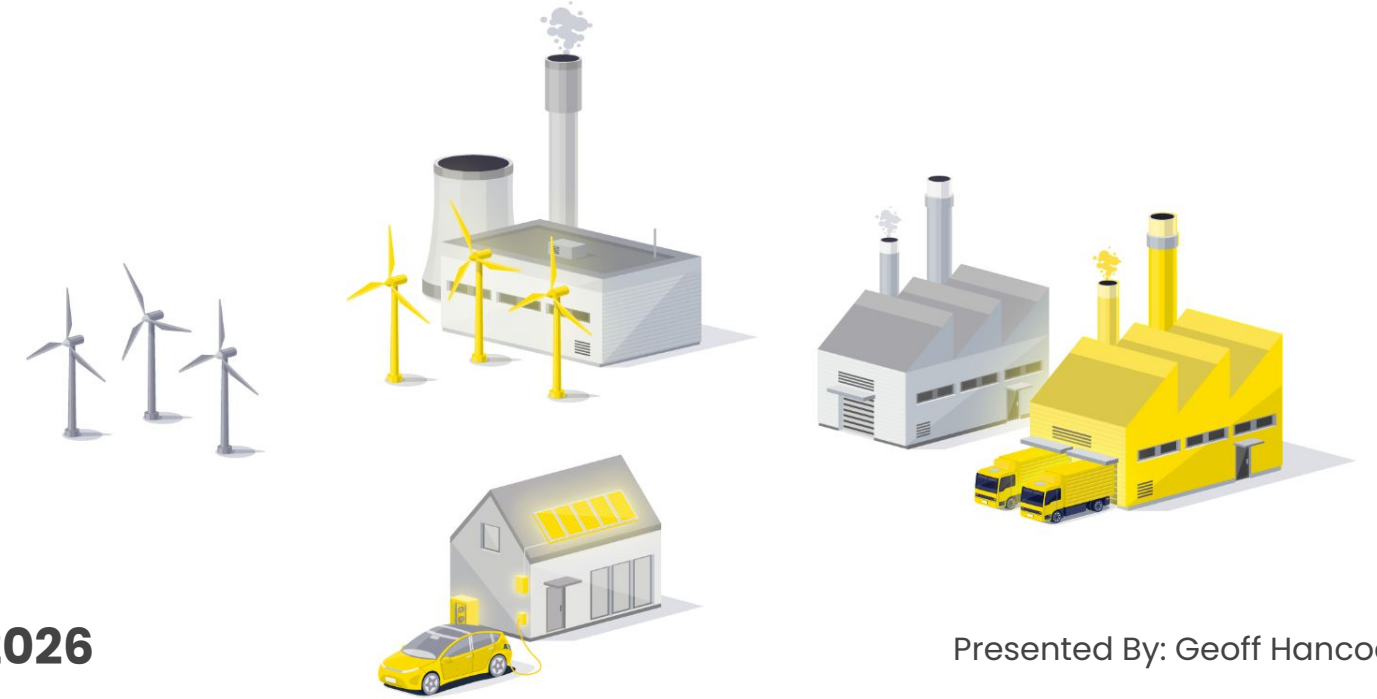
Case Study: Grid-Interactive Buildings Can Accelerate Decarbonization



25 February 2026

Presented By: Geoff Hancock

WattTime

How can a building help clean up the electricity grid?

Case Study: **Loyola U Schreiber Center**

Floor Area: **150,000 sq ft**

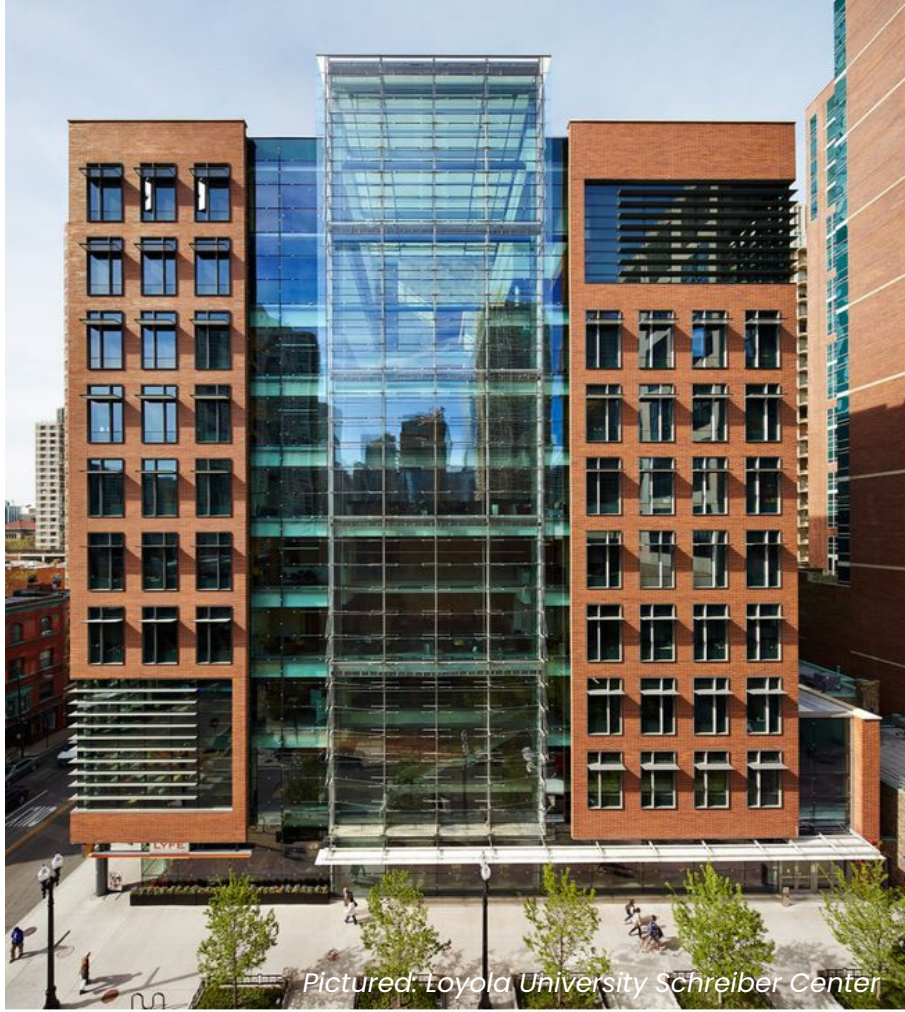
Year Built: **2015**

Location: **Chicago, IL**

Grid Balancing Authority: **PJM**

Project Team: **BrainBox AI, Berkeley CBE, WattTime**

Project Timeframe: **2022-2023**

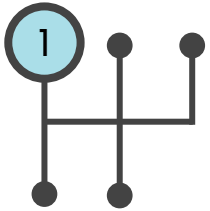


Pictured: Loyola University Schreiber Center

Insights & Actions

Insights: *electricity grid emissions concepts*

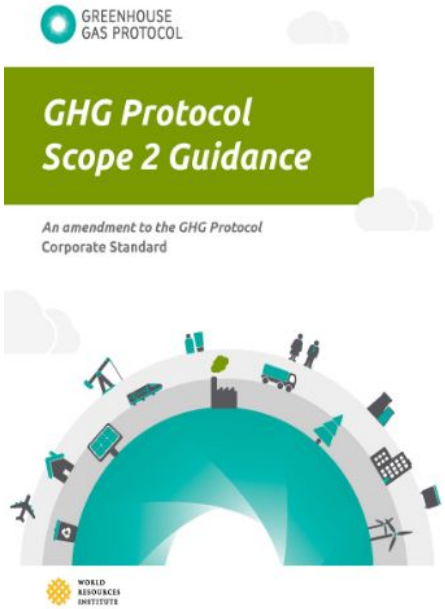
Actions: *things you can do to reduce emissions*



5 gears:
five concepts to help you level up

Annual GHG Reporting (Scope 2)

Typical annual GHG reporting treats all kWh equal, since there is a single CO_2 factor for each entire year



https://ghgprotocol.org/scope-2-guidance

https://www.epa.gov/egrid/detailed-data

eGRID total output CO_2 rate (lbs/MWh)

For a building:

All kWh look equal

Efficiency First

When all kWh look equal, efficiency is a good tool. Save as many kWh as you can.

Case Study: Loyola U Schreiber Center

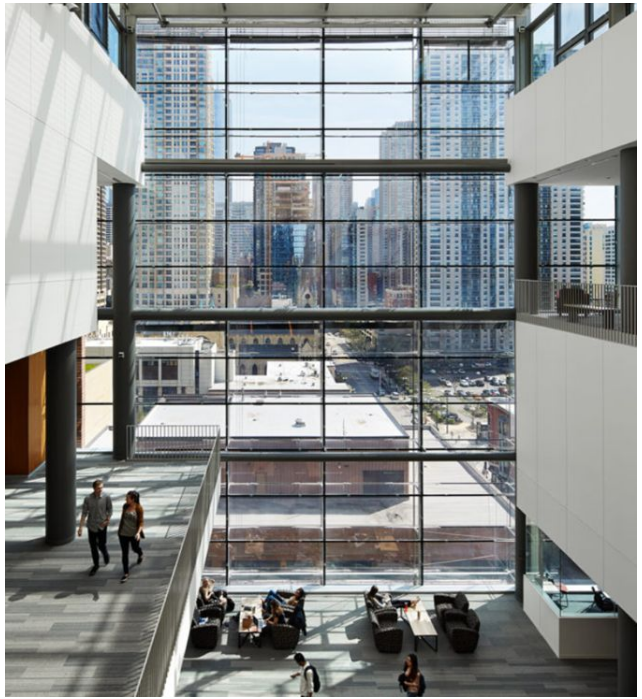
EUI: ~**90** kBtu/sf/year

Awards: **LEED Gold**

Design: **Daylighting, Active shading**

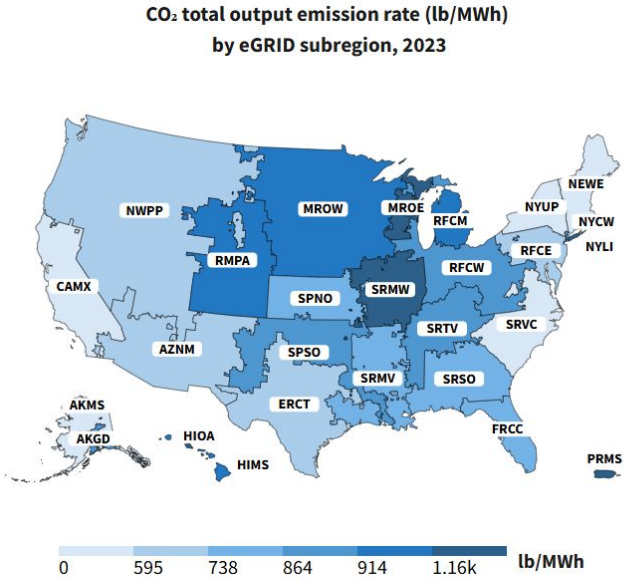
HVAC: **Passive ventilation, radiant heating & cooling, chilled beams, efficient water-cooled chillers**

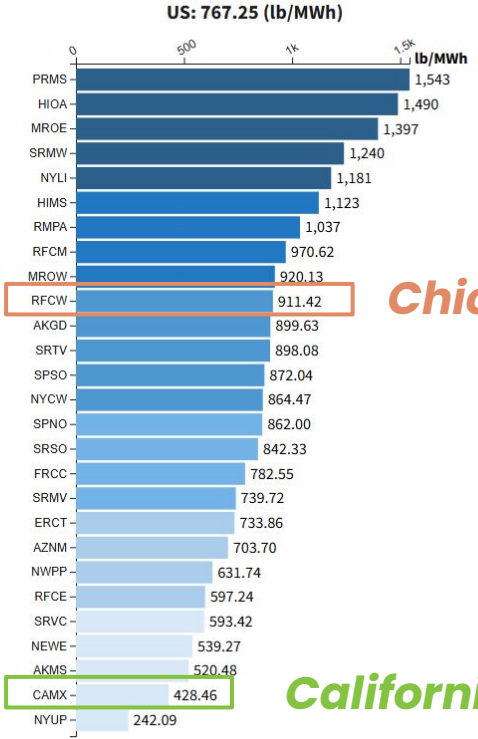
+ Controls Optimization (implemented by BrainBox AI in 2022)



Pictured: Interior Atrium of Schreiber Center

Emissions Vary by Location



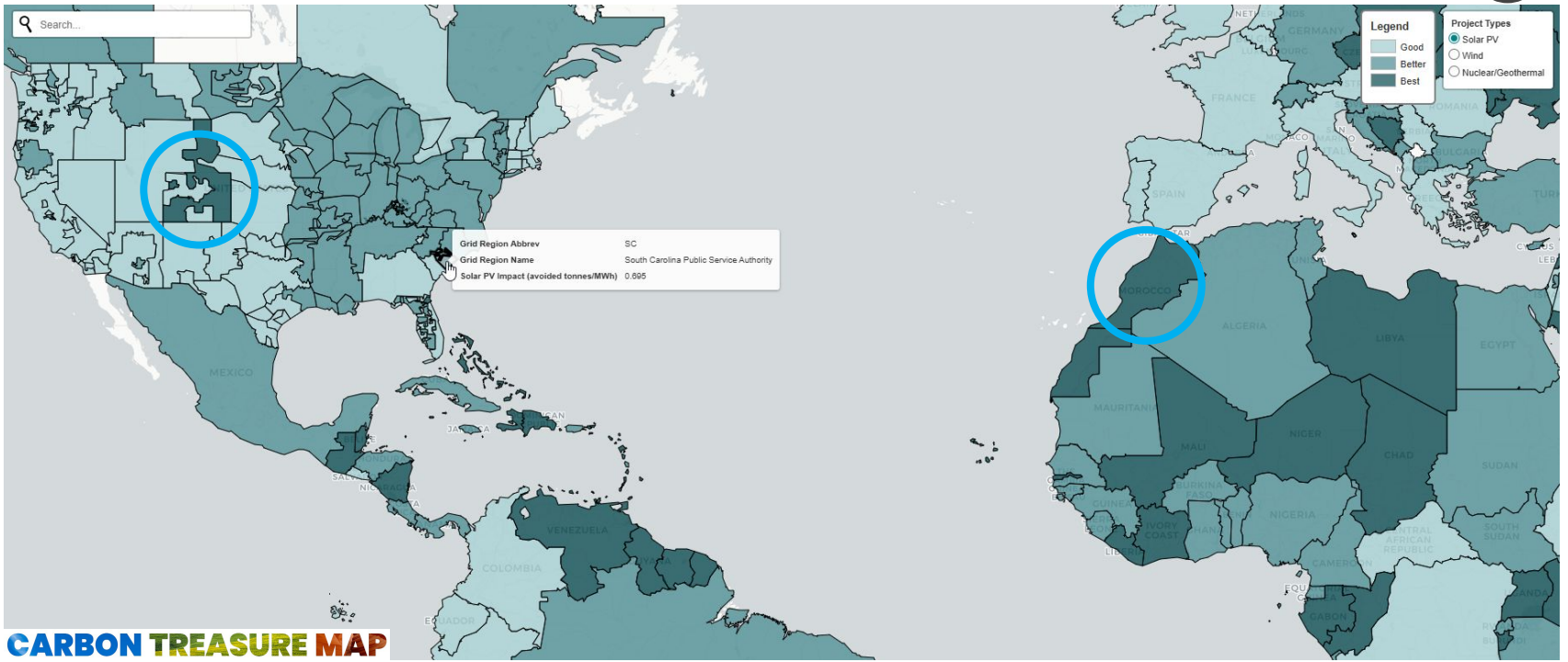


Chicago = 911 lbs/MWh

California = 428 lbs/MWh

Portfolio Choices to Maximize Impact

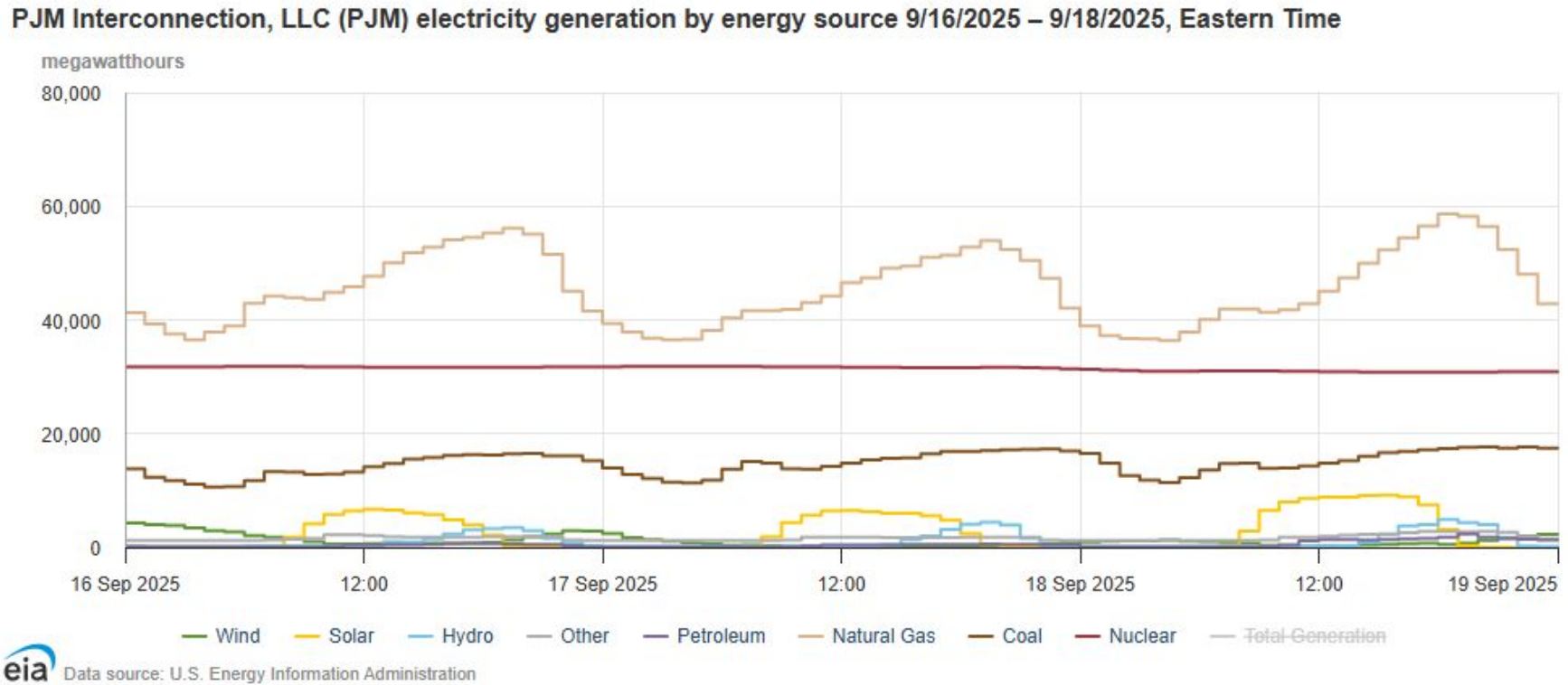
Prioritize energy efficiency and renewables procurement in places with the dirtiest electricity (low-hanging fruit)



https://carbontreasuremap.org/

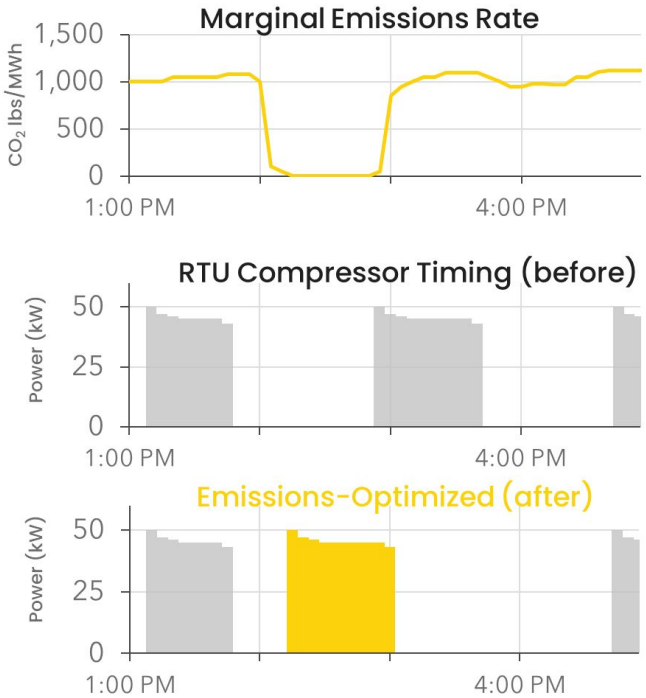
Emissions Vary by Time of Day

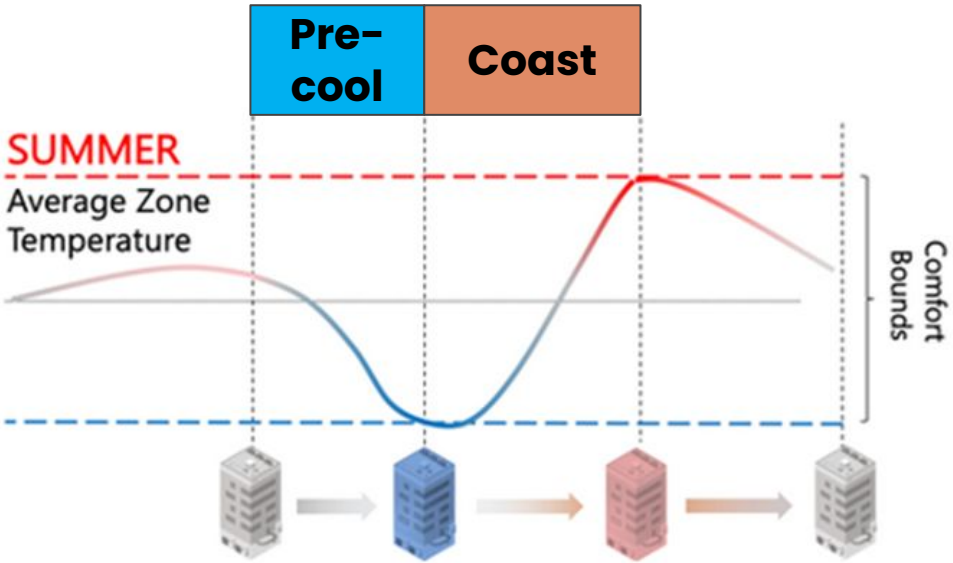
At different times of day there are different power plants running, some fuels emit more CO_2 when burned



Load Shifting to Reduce CO_2

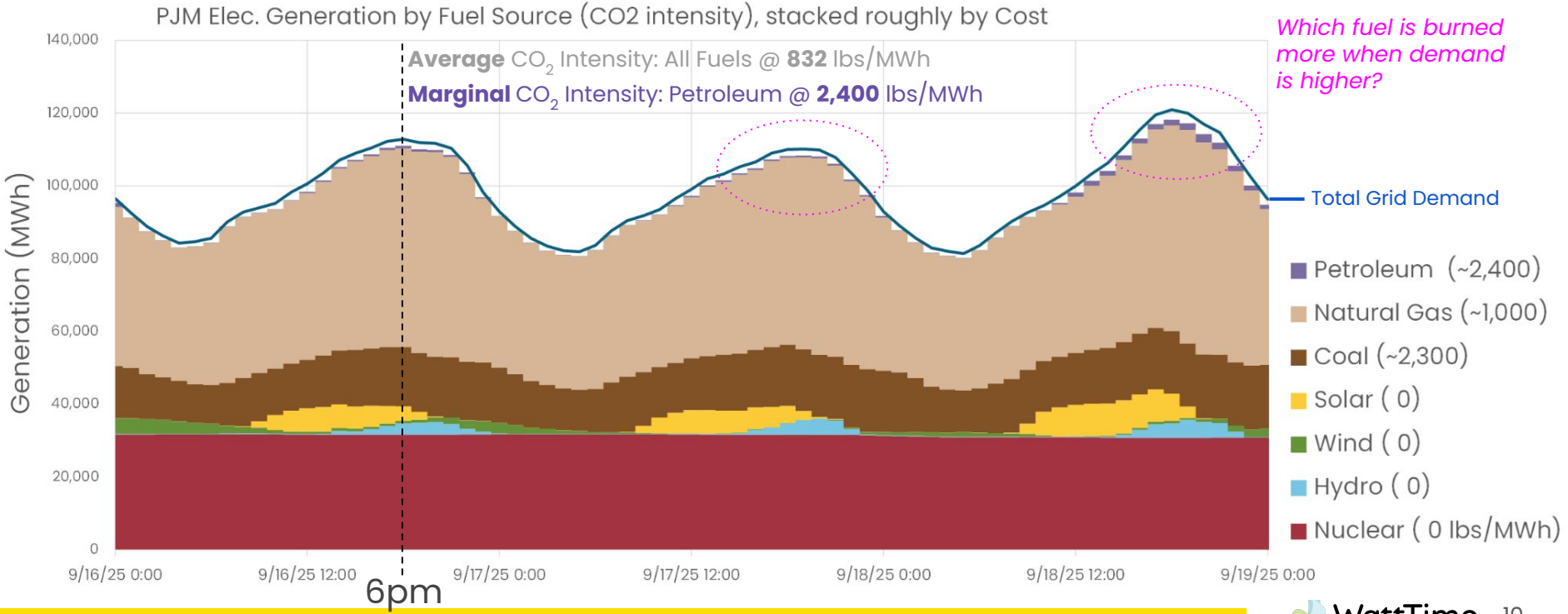
Many electric loads have flexible timing. Be greedy when emissions are low and stingy when they are high.





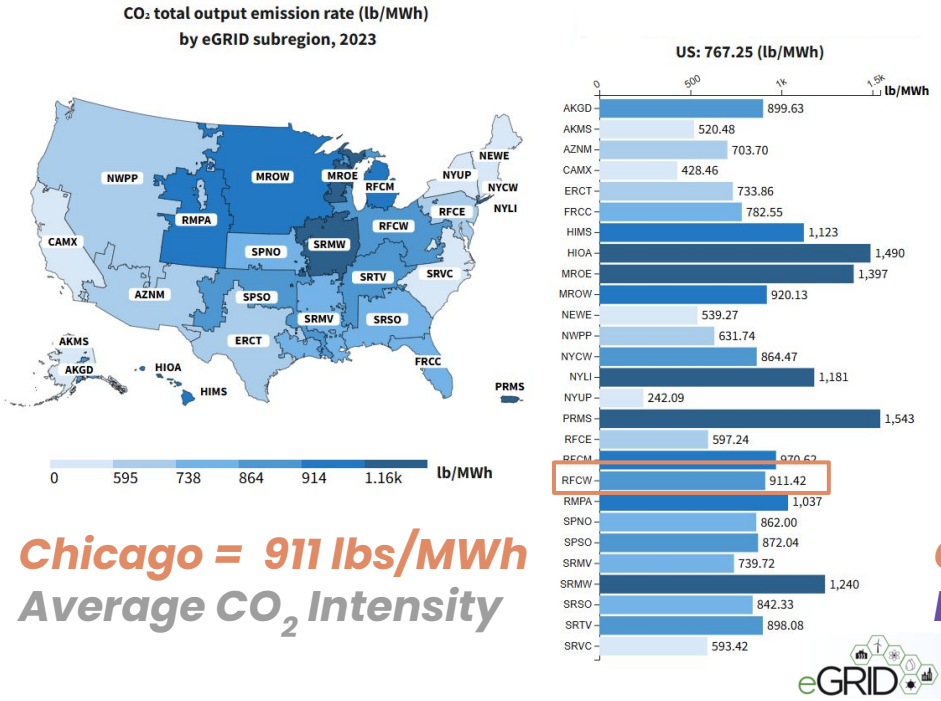
Average & Marginal

Grid operators dispatch the cheapest resources first. Fossil resources are typically stacked on last (marginal).



Average & Marginal

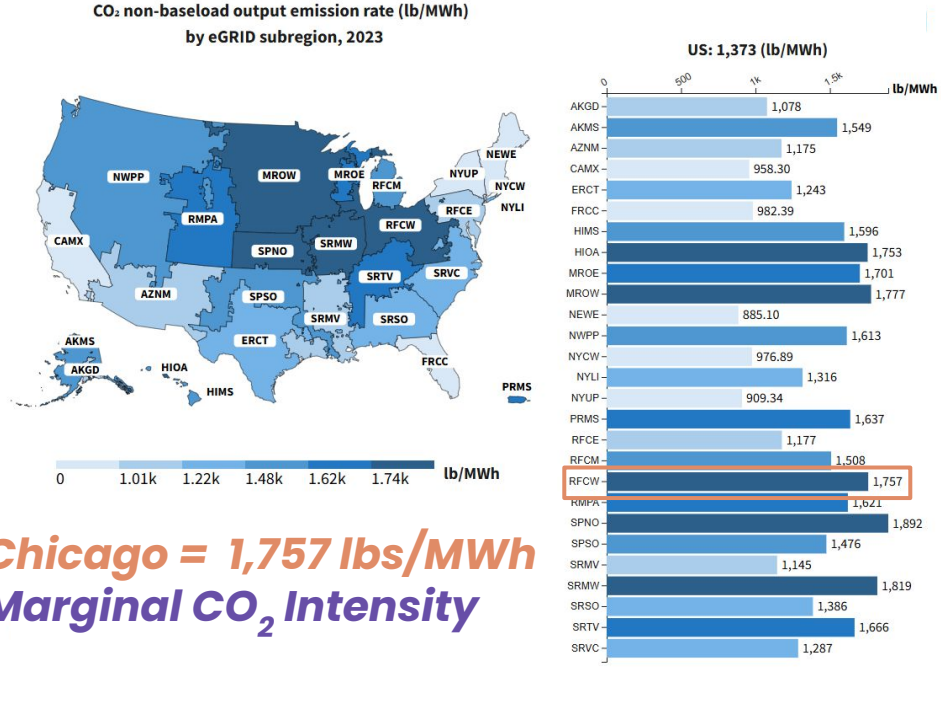
Total (Average)



Chicago = 911 lbs/MWh

Average CO_2 Intensity

Non-baseload (~Marginal)

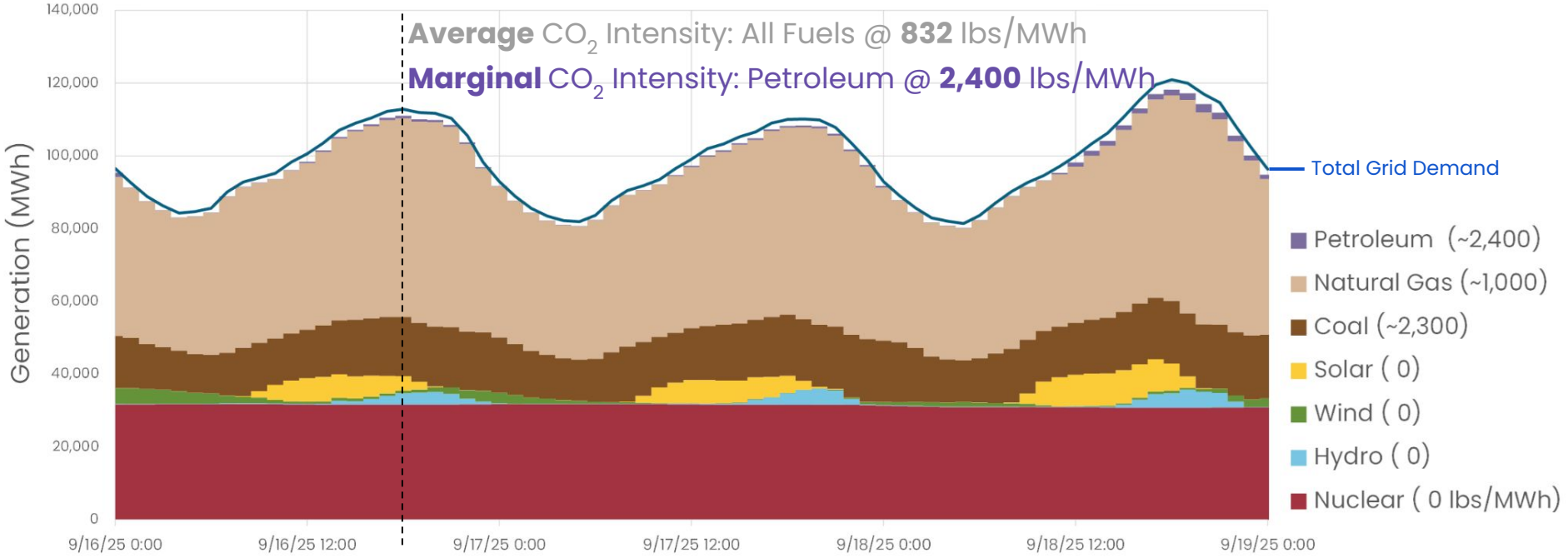


Chicago = 1,757 lbs/MWh

Marginal CO_2 Intensity

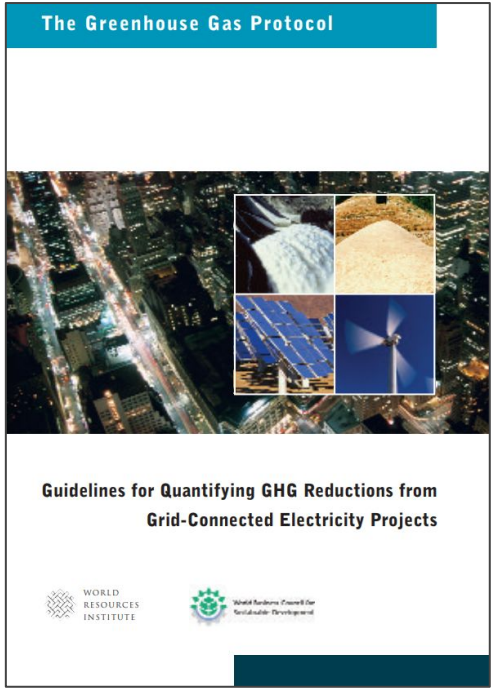
Use Average or Marginal?

The different emissions rates are used to answer different questions.



Measure Impact

GHG Protocol's Project Protocol describes how to measure the avoided emissions of a project/intervention compared to a counterfactual baseline, requiring the use of marginal CO_2 factors

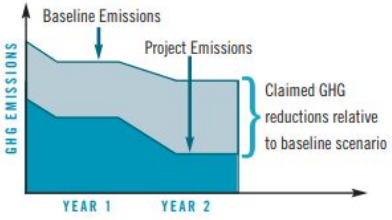


https://ghgprotocol.org/guidelines-grid-connected-electricity-projects

2.1 Quantifying GHG Reductions from Projects

Quantifying a project's GHG emission reductions is done by subtracting actual GHG emissions associated with the project's implementation from an estimate of GHG emissions under its "baseline scenario" (referred to as "baseline emissions"). See Figure 2.1.

FIGURE 2.1 Quantifying GHG Reductions from Projects

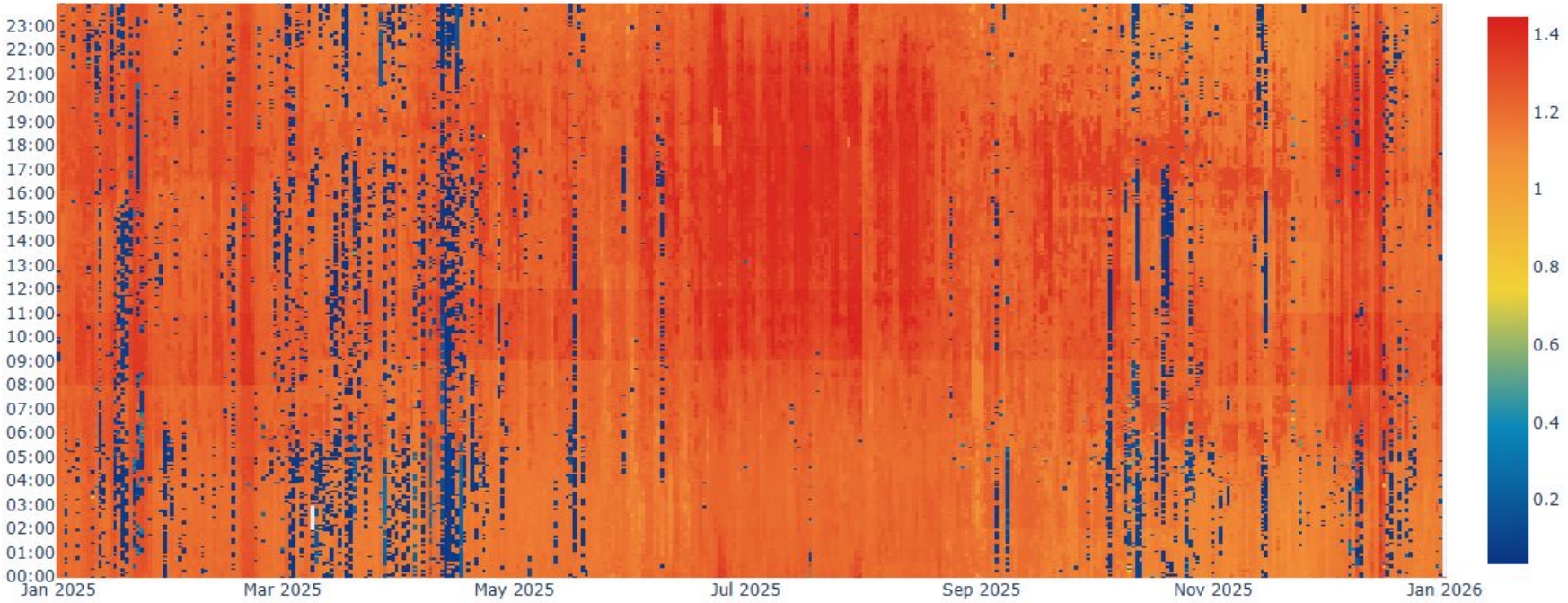


The *Project Protocol* refers to changes between baseline and actual emissions as "GHG effects." Fully accounting for GHG reductions requires assessing both the intended change caused by a project activity (i.e., its "primary effect") and any unintended changes (i.e., "secondary effects").[1] The primary effect for all grid-connected project activities is the reduction of combustion emissions from grid-connected power plants.[2]

Measure the Impact of a kWh

Your CO_2 impact is indicated by the marginal emissions rate, use it to measure the impact of your choices.

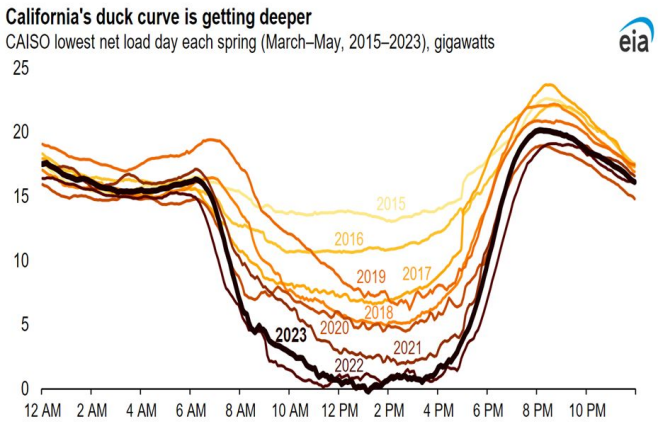
Chicago - Marginal CO_2 [lbs/kWh]



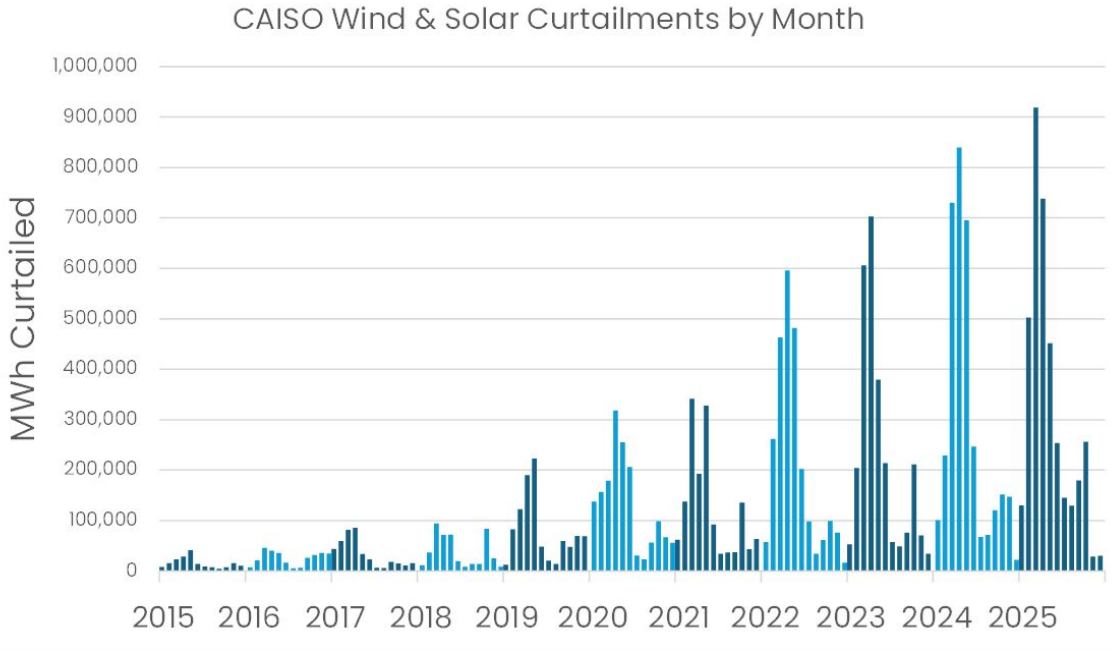
CO_2 MOER for PJM_CHICAGO from WattTime

Can Renewables be Marginal? Yes

Electric grids change rapidly, RE gets wasted. Increasing consumption during RE waste can reduce the waste.



*"Currently, the ISO's most effective tool for **managing oversupply** is to **'curtail' renewable resources**."*
– California ISO, 2017

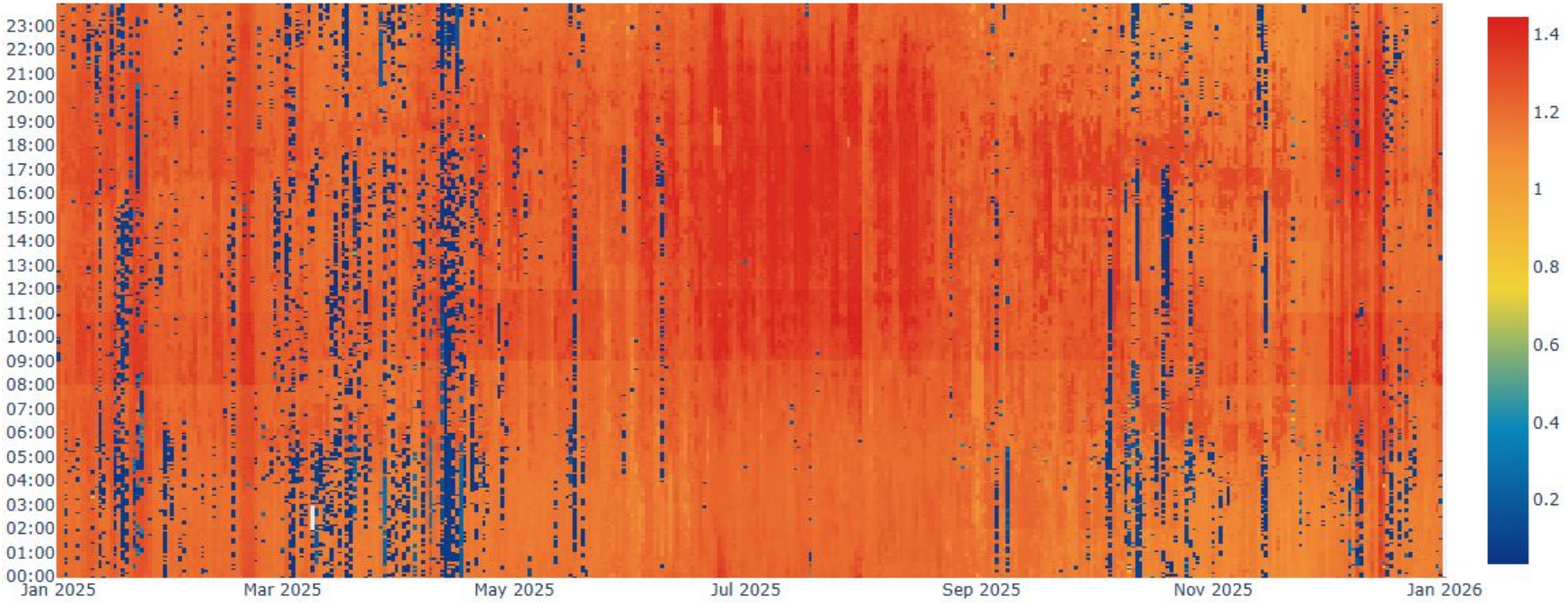


http://www.caiso.com/informed/Pages/ManagingOversupply.aspx

Activate More Renewables

When you increase load during curtailment, it can reduce renewable waste, and give you zero impact kWh.

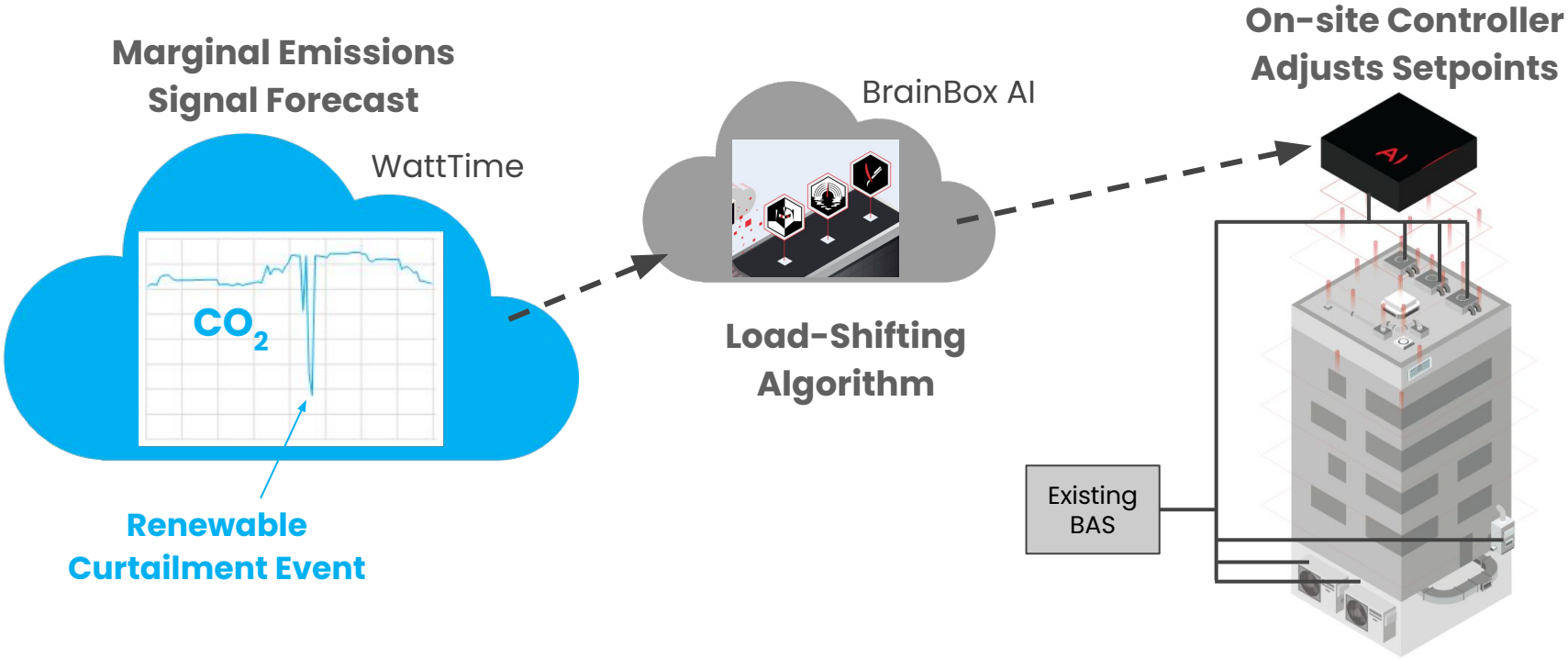
Chicago - Marginal CO_2 [lbs/kWh]



CO_2 MOER for PJM_CHICAGO from WattTime

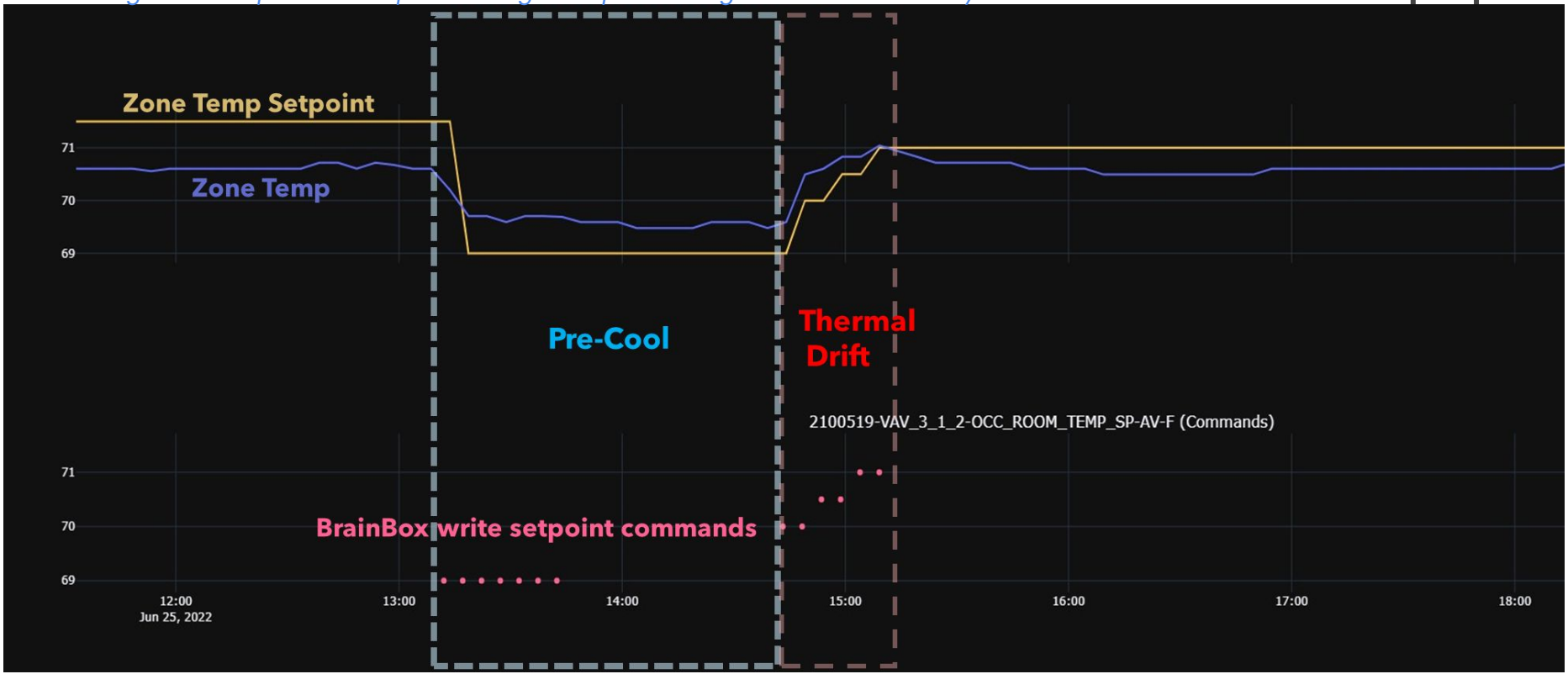
Case Study: Optimize / Load Shift

With a real-time (ideally forecast) marginal CO_2 signal, you can schedule electricity use at the cleanest times



Case Study: Optimize / Load Shift

Building HVAC Response to setpoint changes for pre-cooling to shift the electricity load



Case Study: Optimize / Load Shift

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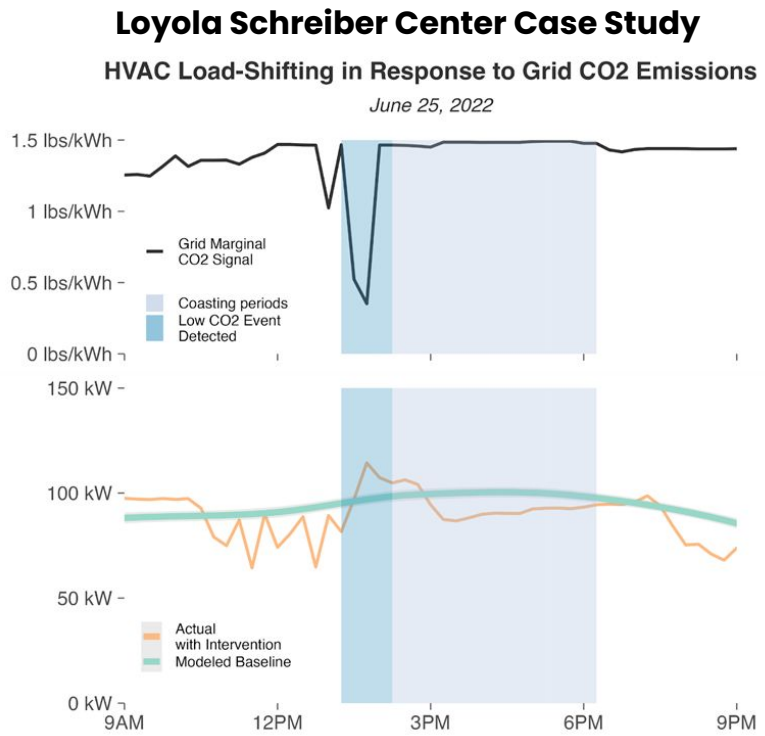
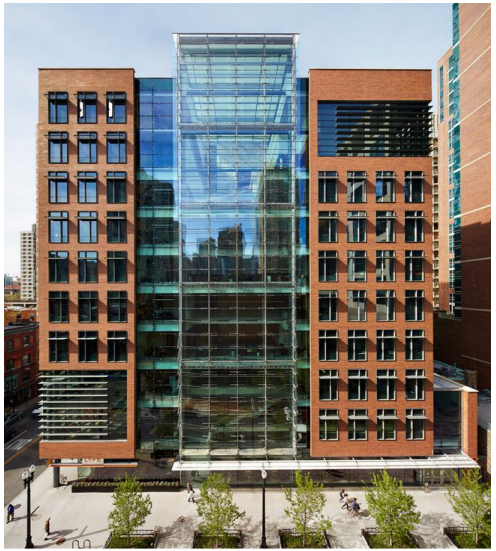


https://www.sciencedirect.com/science/article/pii/S2352710224027025

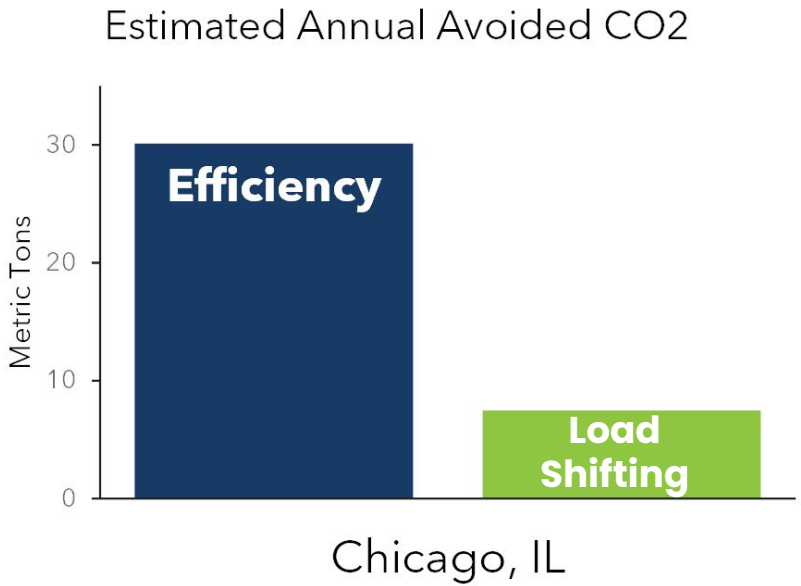


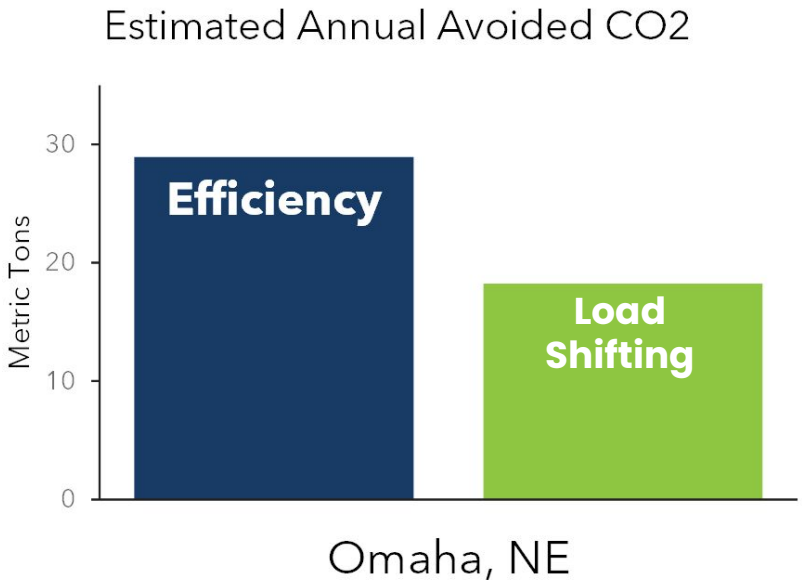
Case Study Overall Results:
15% Reduction in CO_2 Emissions
during CO_2 events plus the following 4 hours

Results measured by Berkeley CBE

Case Study: Comparing Options

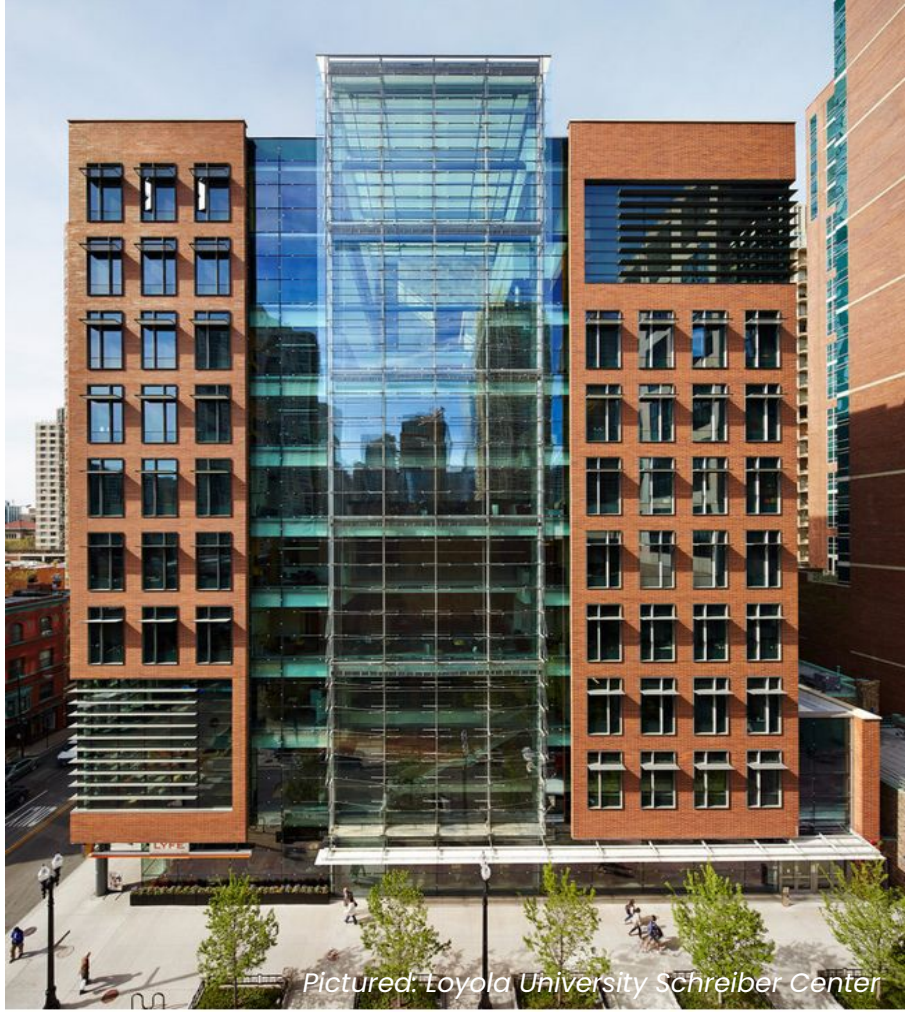
The relative benefit of measures depends on the building profile and the location (electric grid emissions profile).





How can a building help clean up the electricity grid?

1. **Efficiency:** use fewer kWh
2. **Location:** prioritize dirty grids
3. **Timing:** shift kWh to clean times
4. **Optimize** on Marginal CO_2 for deeper carbon reductions
5. **Reducing Renewable Waste** unlocks more renewables



Pictured: Loyola University Schreiber Center

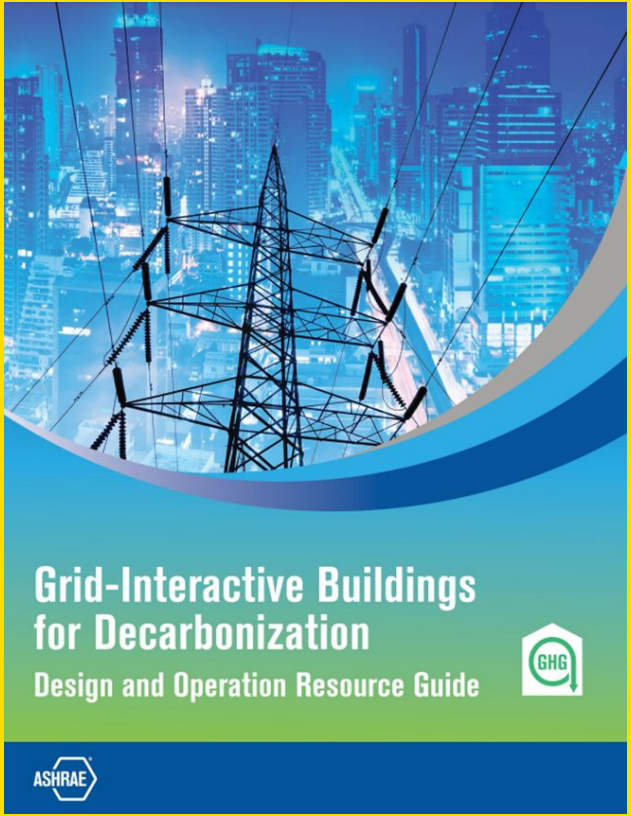
Thank you!

Geoff Hancock

geoff@watttime.org

reach out any time!

(2023) ASHRAE Guide for Grid-Interactive Buildings



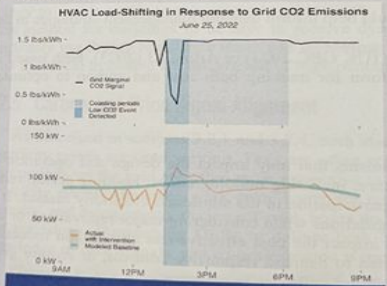
CASE STUDY: LOYOLA UNIVERSITY SCHREIBER CENTER

- Location: Chicago, IL
- Building size: 150,000 ft² (14,000 m²)
- Building type: Office
- Construction type: Existing building

Loyola University's Schreiber Center is a LEED® Gold office and classroom building located in downtown Chicago, Illinois (10 stories, built in 2015). The HVAC plant uses condensing gas boilers for heating and electric water-cooled chillers serving a chilled beam system for cooling. There are a number of passive and active envelope measures to improve energy performance and indoor environmental quality.

Loyola University Schreiber Center.

A public/private consortium worked with Loyola's facilities team to automatically shift HVAC loads in response to a real-time carbon signal and reduce the building's source emissions caused by electricity use. The building's cloud-based HVAC optimizer autonomously sent commands to the existing BAS through an on-site gateway device. This HVAC optimizer used a new algorithm to ingest the marginal grid CO_2 signal from WattTime at five-minute intervals and precondition the building during periods when the grid was cleaner, reducing emissions in later periods when the grid was less clean.



Grid carbon emissions and actual vs. modeled baseline emissions on a summer day.

For example, on June 25, 2022, the carbon signal dropped substantially, and in response, the HVAC optimizer precooled the building by decreasing the space temperature set points. The CO_2 signal increased again an hour later and remained high. During this period, the set points returned to normal, and the HVAC system used less energy due to the earlier precooling.

The year-long study ended in June 2023 and used a novel Measurement & Verification (M&V) methodology (Raftery et al. 2023) developed by CBE where each day is randomly assigned as an intervention or a baseline day, and the carbon reduction algorithm only operates on intervention days. The benefits of this M&V method are that it takes less time to quantify performance, allows for quantification of confidence in the measurement, and is more robust to inevitable changes in the building over time. Using this method, the measured CO_2 emissions during the combined event window (low emissions period plus subsequent coasting period) decreased from an average of 26 kg/hr (57 lb/hr) to 22 kg/hr (49 lb/hr), a 15% reduction, during the cooling season due to the load-shifting strategy. Operating a flexible building in this way reduces carbon emissions, shifts reliance off of high-polluting power plants, and reduces the likelihood that renewable energy is curtailed.

For more information on this study, see: http://dx.doi.org/10.2139/ssrn.4531516.