INTRODUCTION TO WATTTIME

VALUING MARGINAL EMISSIONS DATA FOR IMPACT

June 2021

Agenda

- Background
- Understand Marginal Emissions Data
- Driving Impact
- Case Studies and Partners
- Q & A

WattTime

“Giving people the power to choose cleaner electricity”

Who We Are

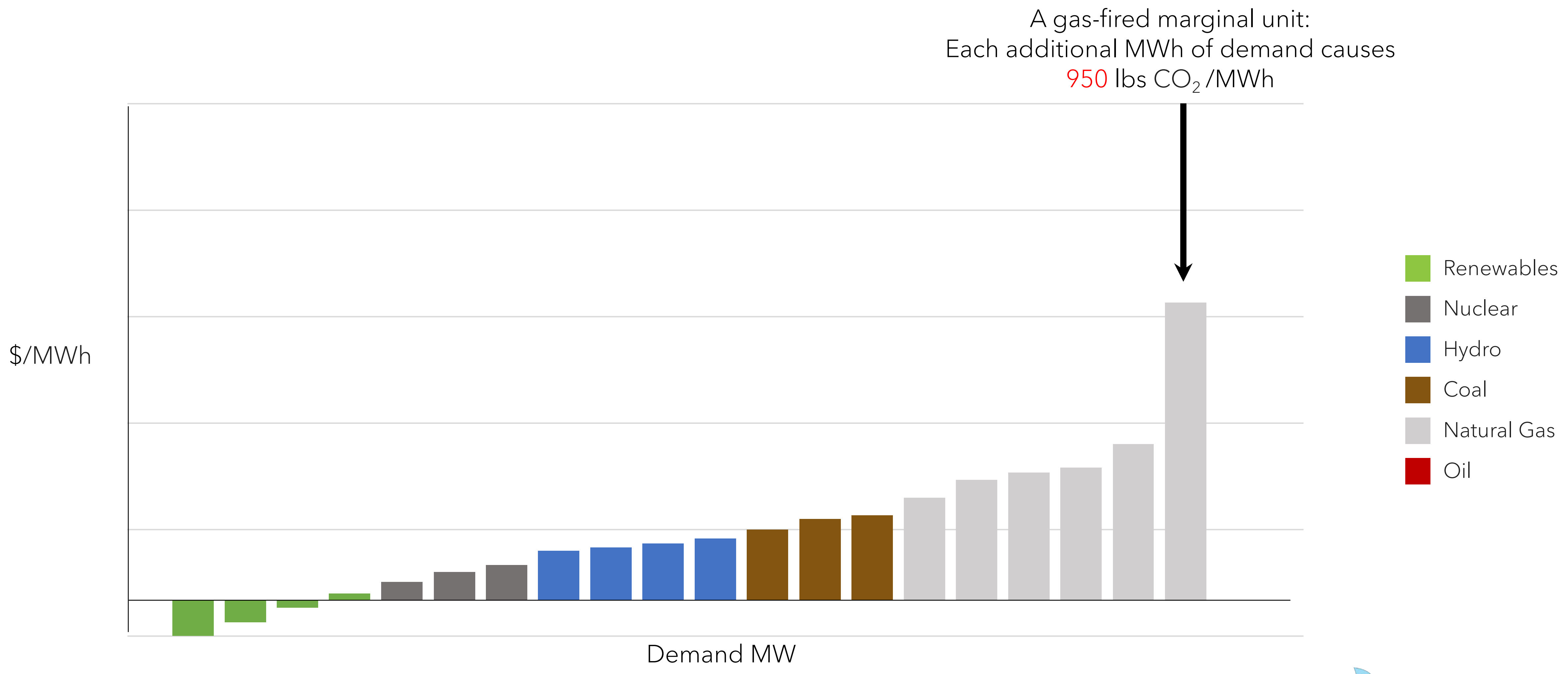
- High-tech nonprofit dedicated to accelerating new sustainability techniques
- Built by 200+ volunteers from Google, MIT, Climate Corp, DOE, and more
- Joined forces with Rocky Mountain Institute in 2017

What We Do

- Obsessed with understanding electric grid emissions at a granular level
- Help others use emissions data to take action towards achieving emissions reduction goals
- Provide granular emissions data (5-minute frequency) for all U.S. grid regions and in 30 countries and growing!

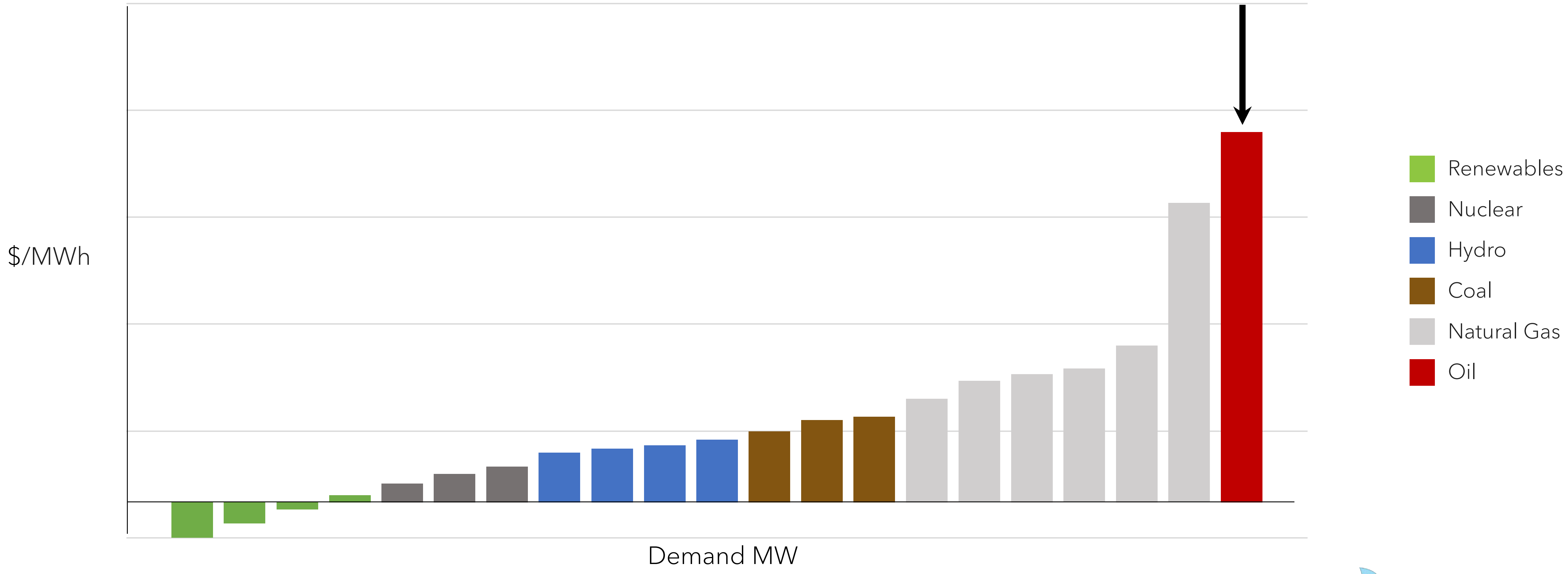
Understanding Marginal Emissions Data

Electric grids meet fluctuating demand by ramping the "marginal" generation resource

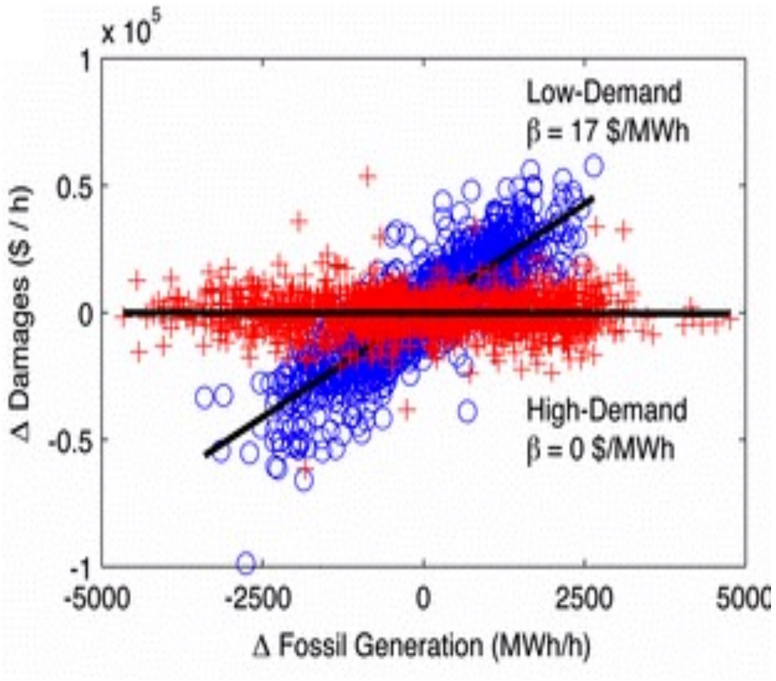


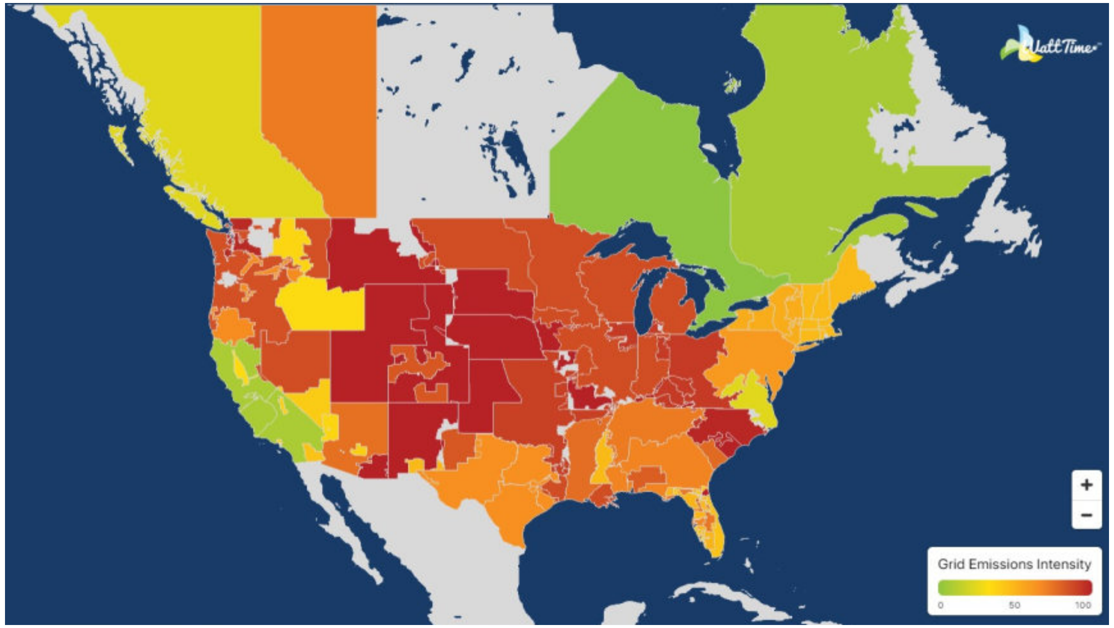
But *which* unit is marginal changes throughout the day

An oil-fired marginal unit:
Each additional MWh of demand causes
1,450 more lbs CO_2



Researchers from leading universities developed empirical techniques to detect this marginal emission intensity by grid

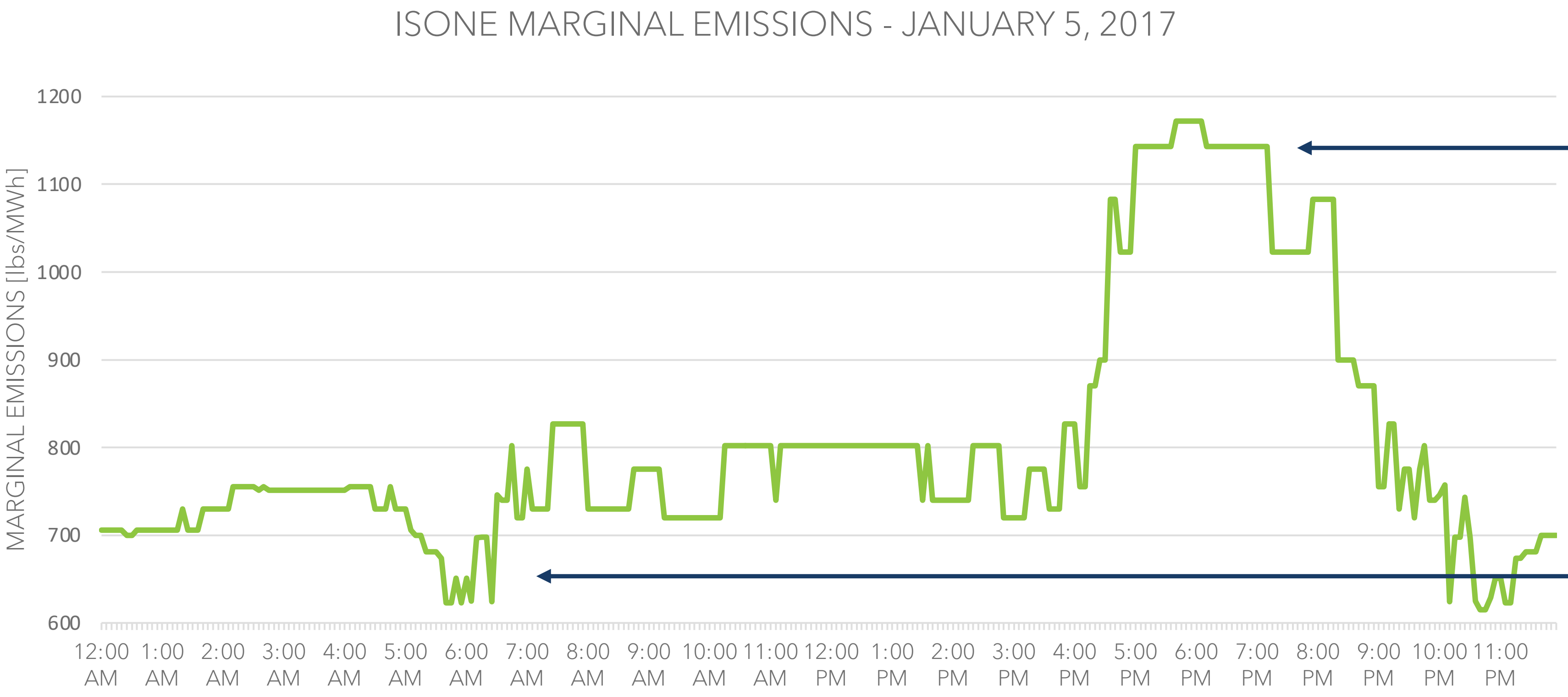




Data sources:

- EPA's Continuous Emissions Monitoring System (CEMS)
- Grid operators' Open Access Same-Time Information System (OASIS)
- Combined by algorithms initially based on Callaway et al (2017) and Siler-Evans et al (2013)
- Further developed by Berkeley, Stanford, & MIT researchers

Our founding team built an API that continuously detects & broadcasts "watt times" are clean

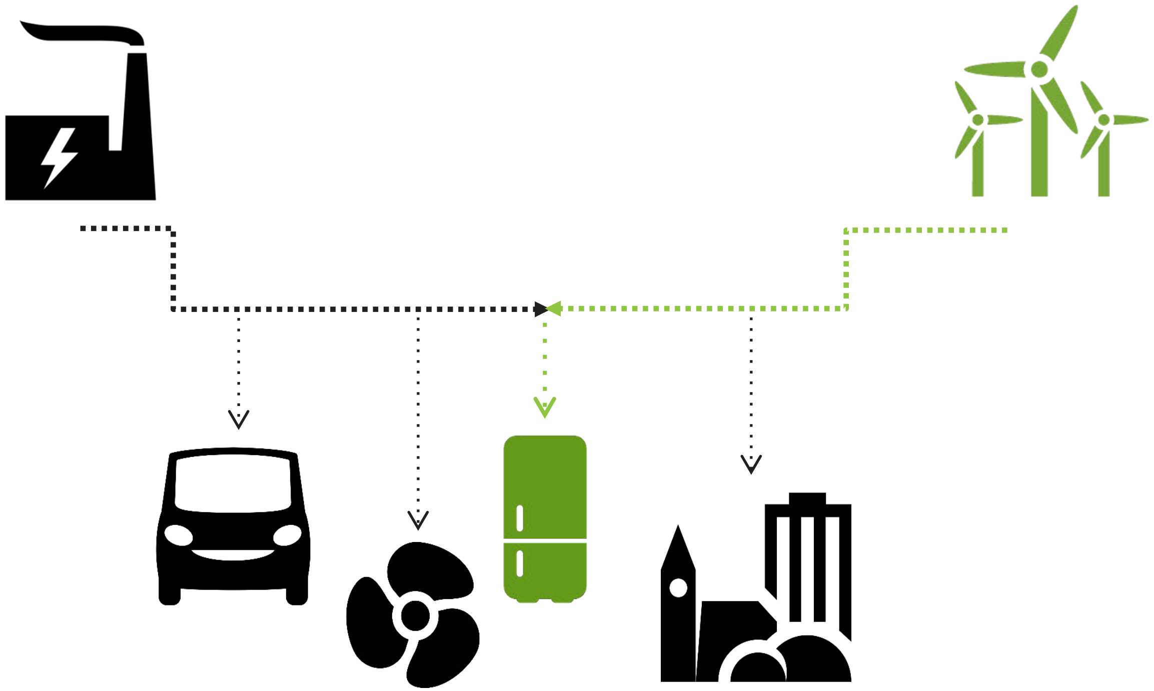


A dirty time on this grid. Shifting electricity towards this time **increases** GHG emissions.

A clean time on the grid. Shifting electricity towards this time **decreases** GHG emissions.

Driving Impact

University research shows *marginal* emissions data is typically the key to driving impact



WattTime was founded by UC Berkeley PhD students who developed the first empirical techniques to detect marginal emissions on an arbitrary power grid.

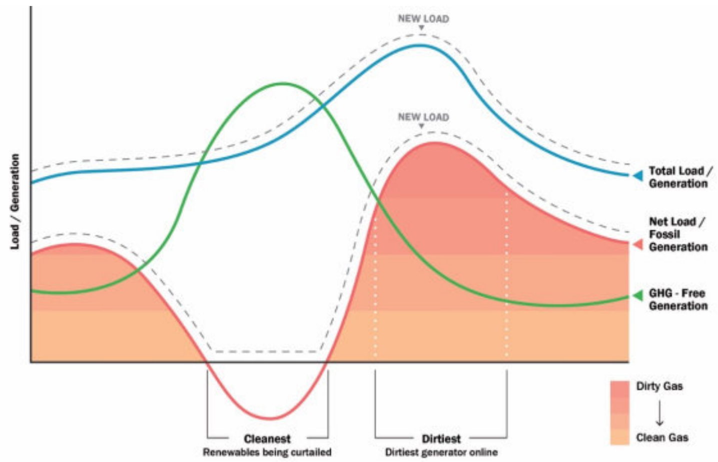
Marginal emissions rates (as opposed to average) reflect the change in emissions that will occur if electricity demand or supply is shifted from one time to another.

Optimizing the timing of devices for marginal emissions has been shown to dramatically improve emissions reduction potential.

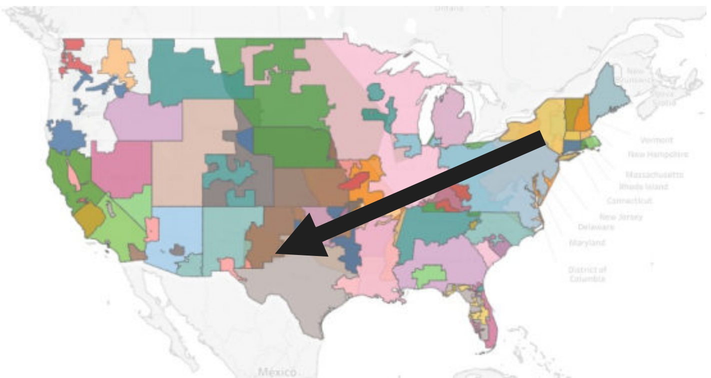
WattTime™

WattTime's marginal emissions data drives impact across a variety of scenarios

We estimate that 26 billion devices worldwide can use the same software to reduce ~330 million tons of CO_2 through "Automated Emissions Reduction"



Architects are using WattTime to go from net zero energy to zero-carbon buildings

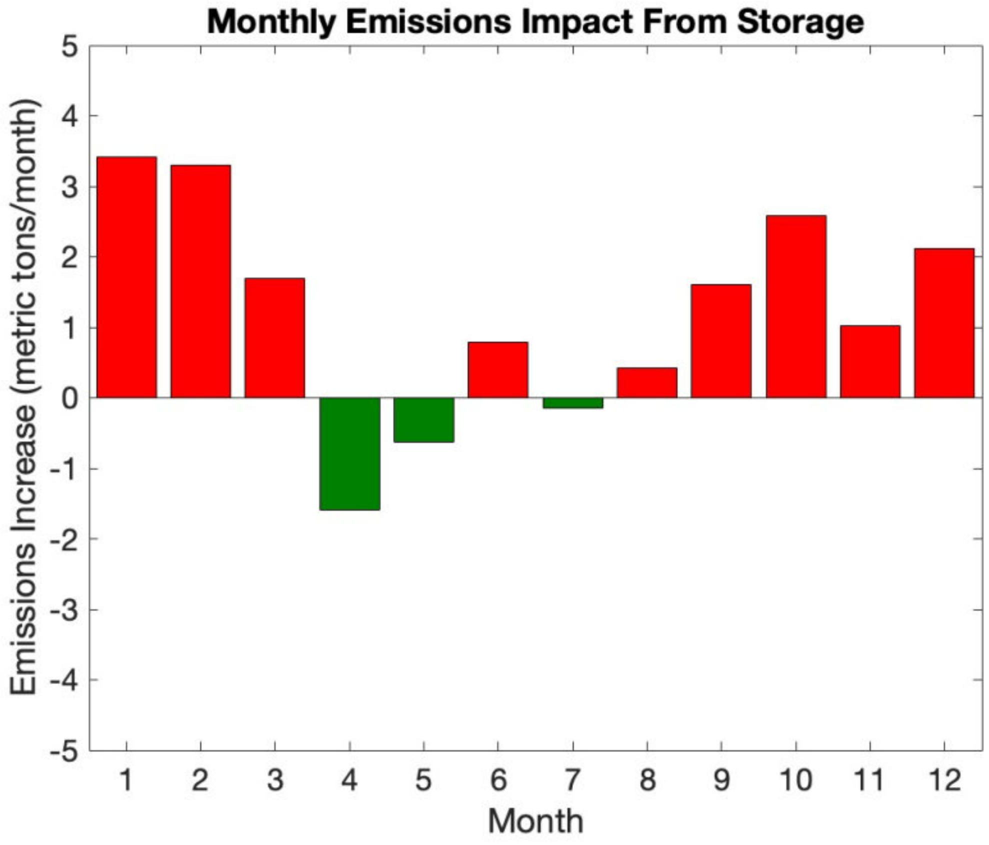


Renewable energy buyers are using marginal emission data to select the location(s) of their projects to multiply their impact by up to ~2.6x

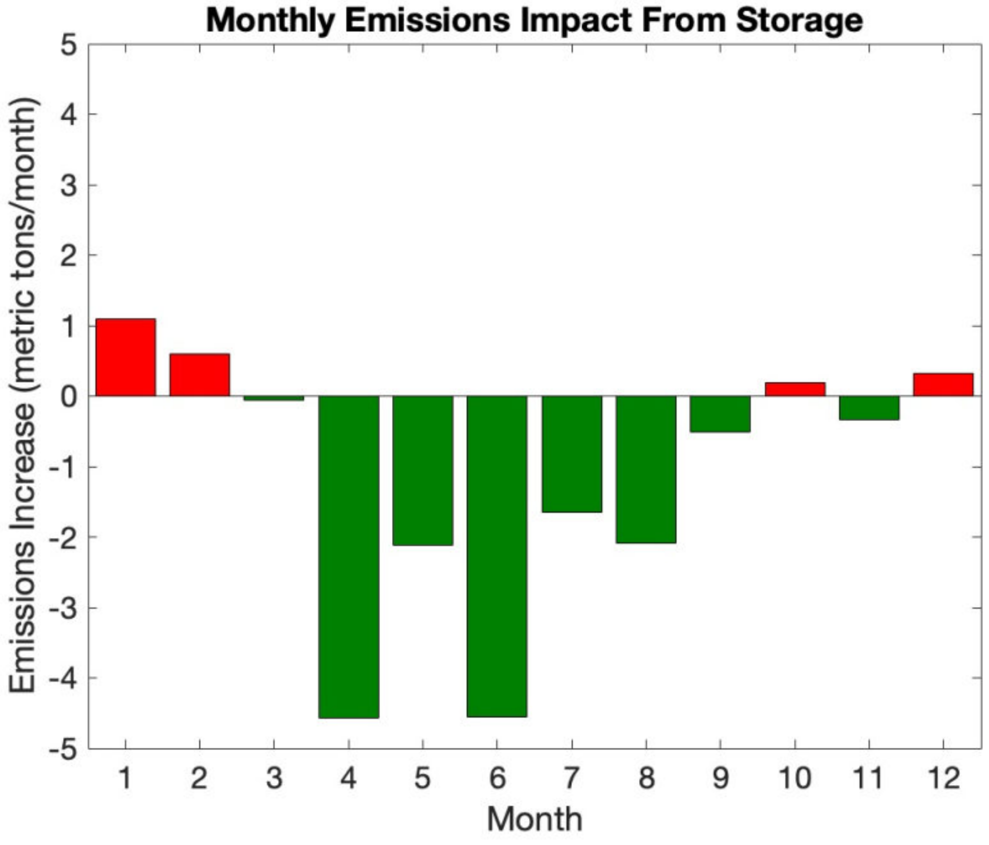
Case Studies and Partners

Case study: Voluntary Marginal Emissions-Optimized Energy Storage

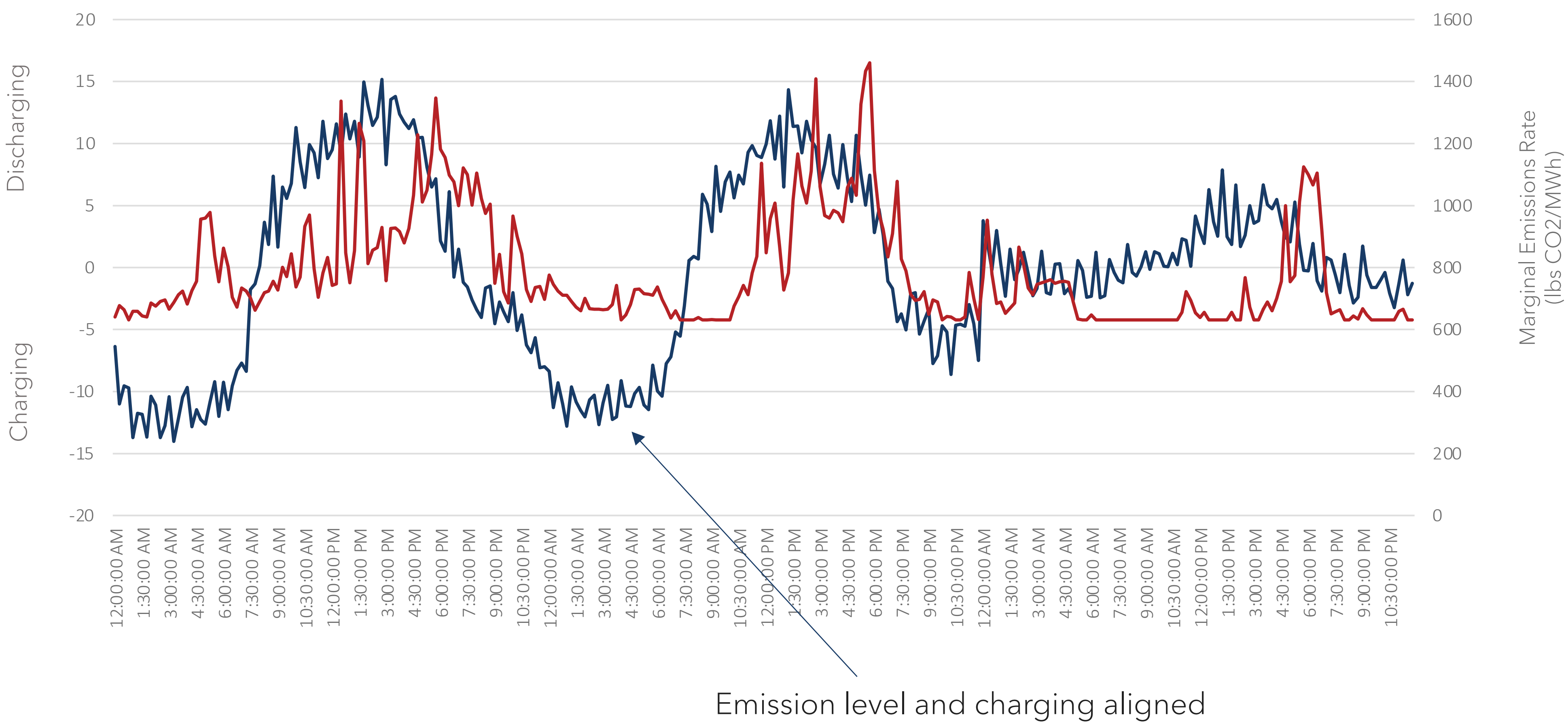
Without Emissions Co-Optimization



With Emissions Co-Optimization



Case study: The California PUC mandated the use of WattTime marginal emissions data to optimize energy storage timing – eliminating pollution from the program



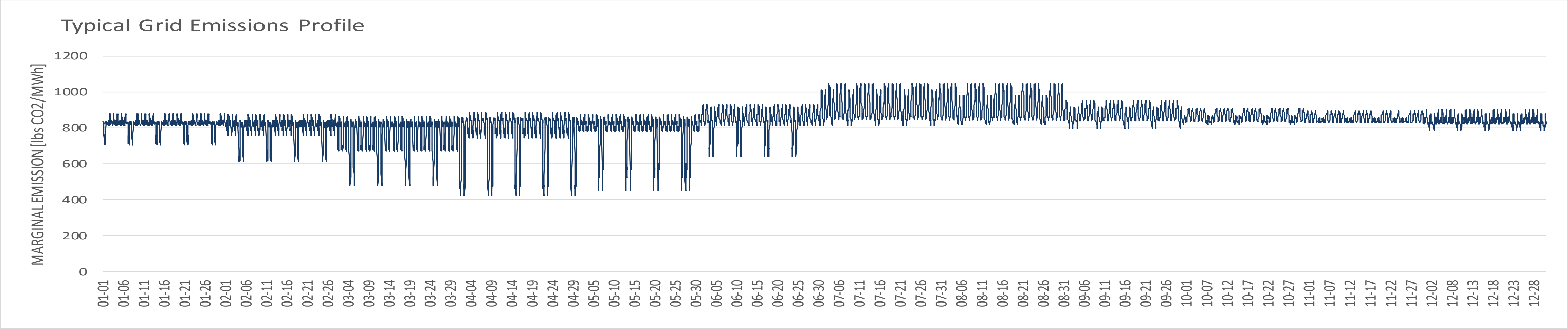
[California solves batteries' embarrassing climate problem]

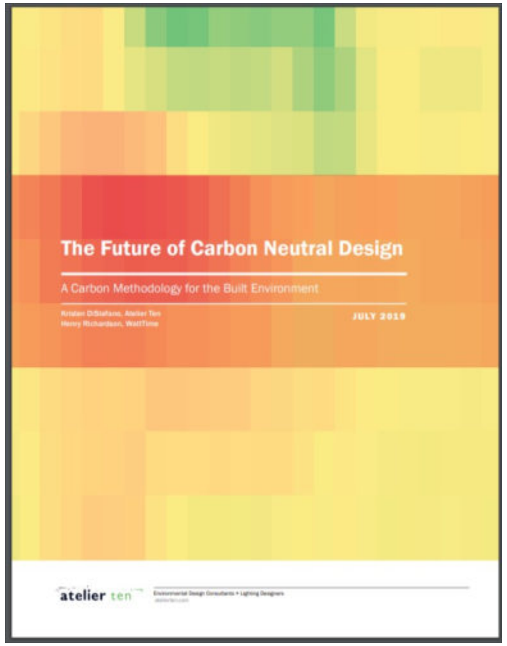
Case study: Boston University Renewable Energy Procurement

Comparison of Renewable Energy Project Selection Criteria

Criteria	Weight	Solar 2	Wind 7	Wind 9	Criteria Explanation	Notes
		Weighted Rank				
Impact New Build	Required	☑	☑	☑	Project will generate new renewable power that would not otherwise have been generated	Project additionality is a prerequisite
Education & Research Opportunities	Required	☑	☑	☑	Project will benefit students and faculty by allowing access to the project sites and real time data	Access to real time data and access to the project site(s) is a prerequisite
Green-e Certified RECs	Required	☑	☑	☑	Third party certified project-based RECs	Project-based Green-e Certified RECs are necessary to validate the claims for the emissions reductions
Project Developer Financial Strength	Required	☑	☑	☑	Long-term owner/operators have resources, experience, & financial strength to manage relationship over term	
Bid Size Flexibility	Required	☑	☑	☑	Ability to provide 200,000 MWh/yr or 100,000 MWh/yr capacity to allow flexibility on strategy as determined by BU	
Project Economics (strong NPV/MWh)	30%	3	1	2	Financial strength based on risk-adjusted, projected cash flows, and impact on BU financial position and credit rating	The driver in a Contract for Differences is the margin modeled between the PPA price and the grid price/MWh. Favorable project economics are a prerequisite
GHG Reduction (CO2e lb/MWh)	30%	3	1	2	Projected likely marginal GHG savings per MWh over the term of the project; favor projects with highest overall GHG reduction with consideration for higher early reductions	Strong correlation between high grid carbon intensity at time of renewable energy production; the purpose of is to maximize the BU's impact on GHG reduction
Environmental& Health Co-benefits	20%	2	1	2	Favor projects with lower construction and operational environmental and health impacts	
Integration with BU on-site procurement	10%	1	1	1	Integrate PPA purchases and sales into BU's energy purchasing through hedges or other mechanisms	
Term Length	10%	2	2	1	Offer 12 vs 15 year term; shorter term length ranks higher	
		2.5	1.1	1.8		

Case study: Carbon Profiles for Building Energy Modelling





- Based on 2-3 years of historical emissions data
- Normalized to account for typical meteorological year
- Indicate building location and simulation year

https://www.atelierten.com/app/uploads/2019/07/Carbon-methodology-paper-190724.pdf

WattTime Works with a Variety of Different Types of Partners

Microsoft

enel x

DNV

CPower

salesforce

REBA
Renewable Energy Buyers Alliance

Draper Richards Kaplan FOUNDATION

SAPIENT

Q & A

Thank You

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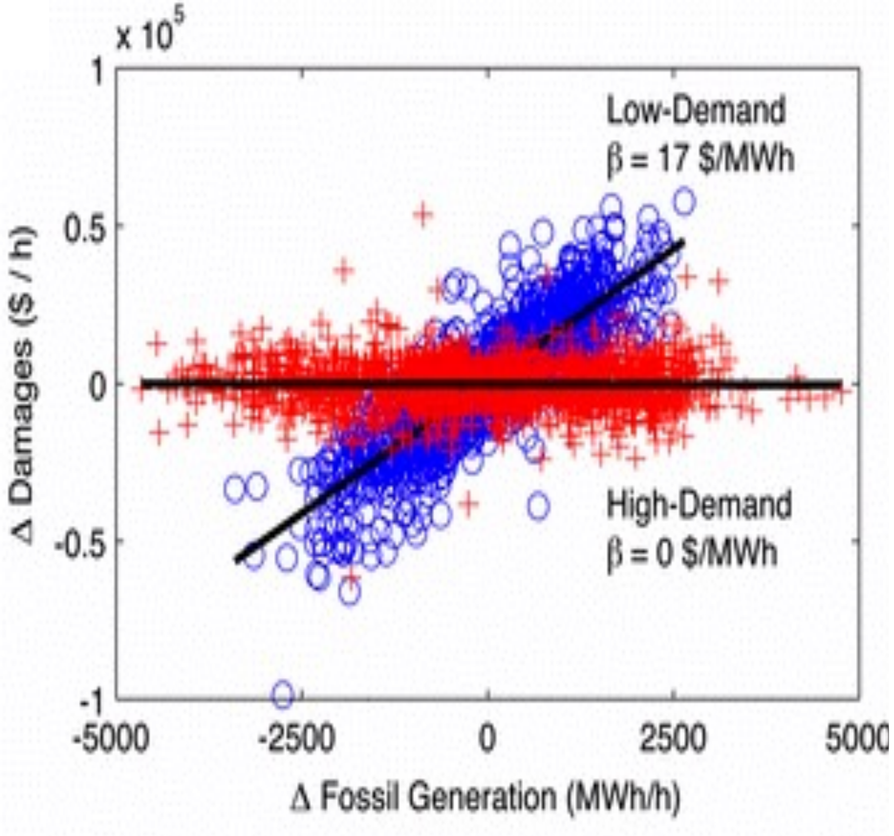
Appendix: How we derive our marginal emissions algorithm



Data sources:

- EPA's Continuous Emissions Monitoring System (CEMS)
- Grid operators' Open Access Same-Time Information System (OASIS)
- Satellite data from Climate TRACE
- Combined by econometric algorithms initially based on Callaway et al (2017) and Siler-Evans et al (2013)

Appendix: Small changes on the margin today can add up to major emissions reductions and impact over time

Planning for next kilowatt-hour…

- Using current technology and data about marginal emissions, customers are **empowered to make informed decisions about their energy consumption.**
- These immediate emissions savings are verifiable, easily demonstrated, and simple to quantify.

... leads to grid operational changes …

- As more customers make incremental changes to their usage, there will be an **emerging opportunity to adjust the control signals and directly impact power plant operational decisions** (i.e., unit commitment).
- While harder to quantify, these savings can be much greater (e.g., targeted shifting to eliminate the need for coal plant operation).

… and eventually impacts resource investment

- As these operational impacts are reflected in system operations, spot prices, and forward capacity prices, **emissions-aware load shifting can drive emissions-reducing investment decisions.**
- These impacts are difficult to forecast but could materially increase investment in renewable energy resources.

Source: RMI analysis