



GHG Abatement Product

PJM CAPSTF

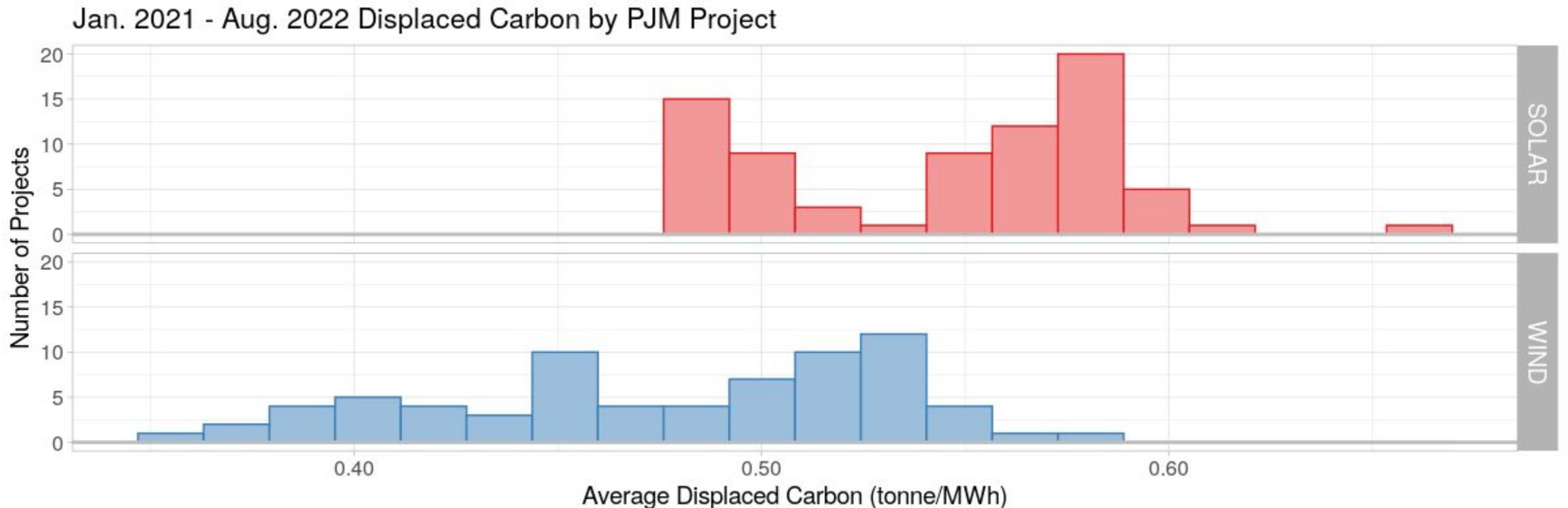
October 12, 2022

Summary

We propose designs for spot and forward-procured GHG-abatement products. Recognizing that the GHG abatement benefits of clean MWh vary widely by location and technology, these products provide buyers a way of compensating sellers fairly for the GHG abatement they are able to provide.

Why GHG-Indexing Matters

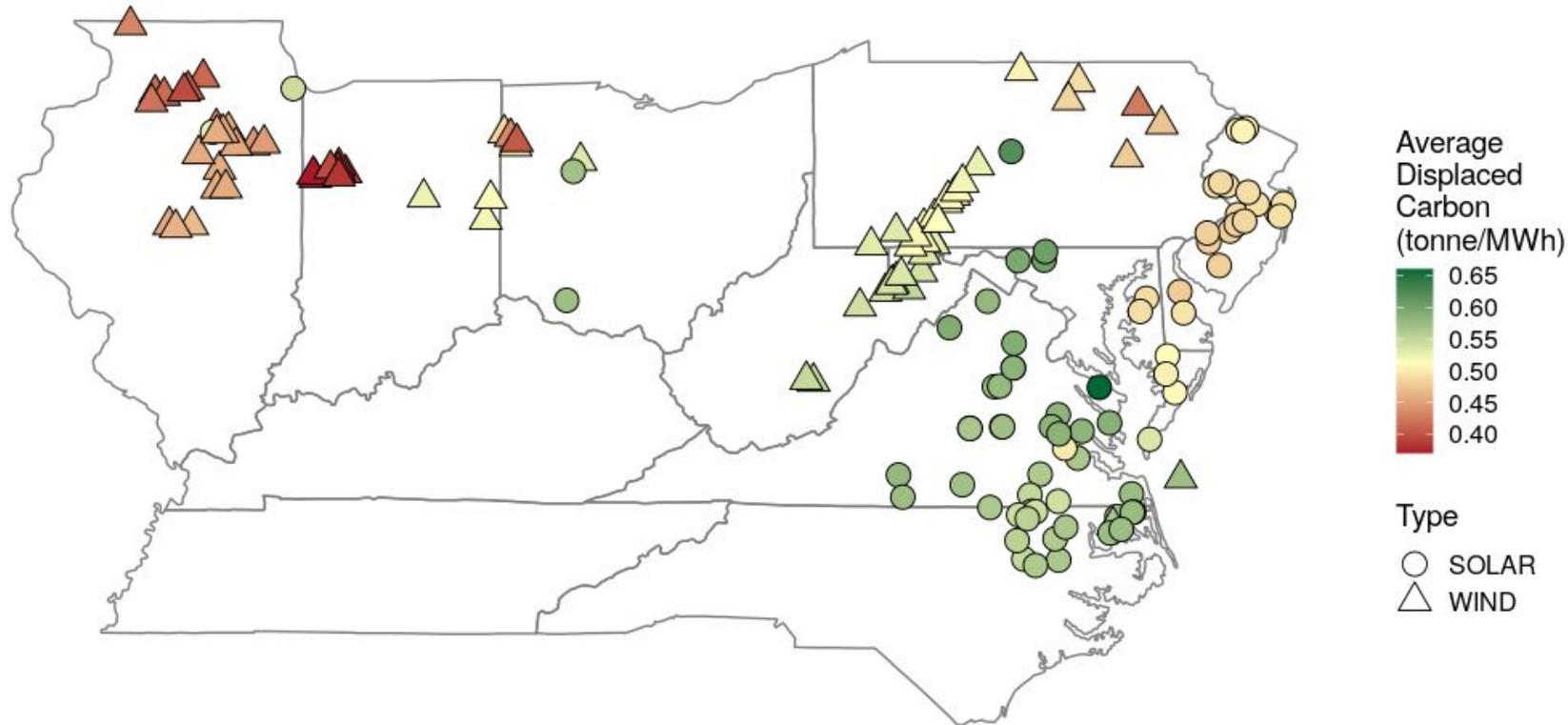
Based on PJM's marginal emissions data, there is a factor of 2 difference between the highest- and lowest-abating renewable resource in PJM over 20 months



Why GHG-Indexing Matters

GHG displacement shows substantial geographic as well as technology type variability. Nearby resources sometimes have quite different displaced carbon value

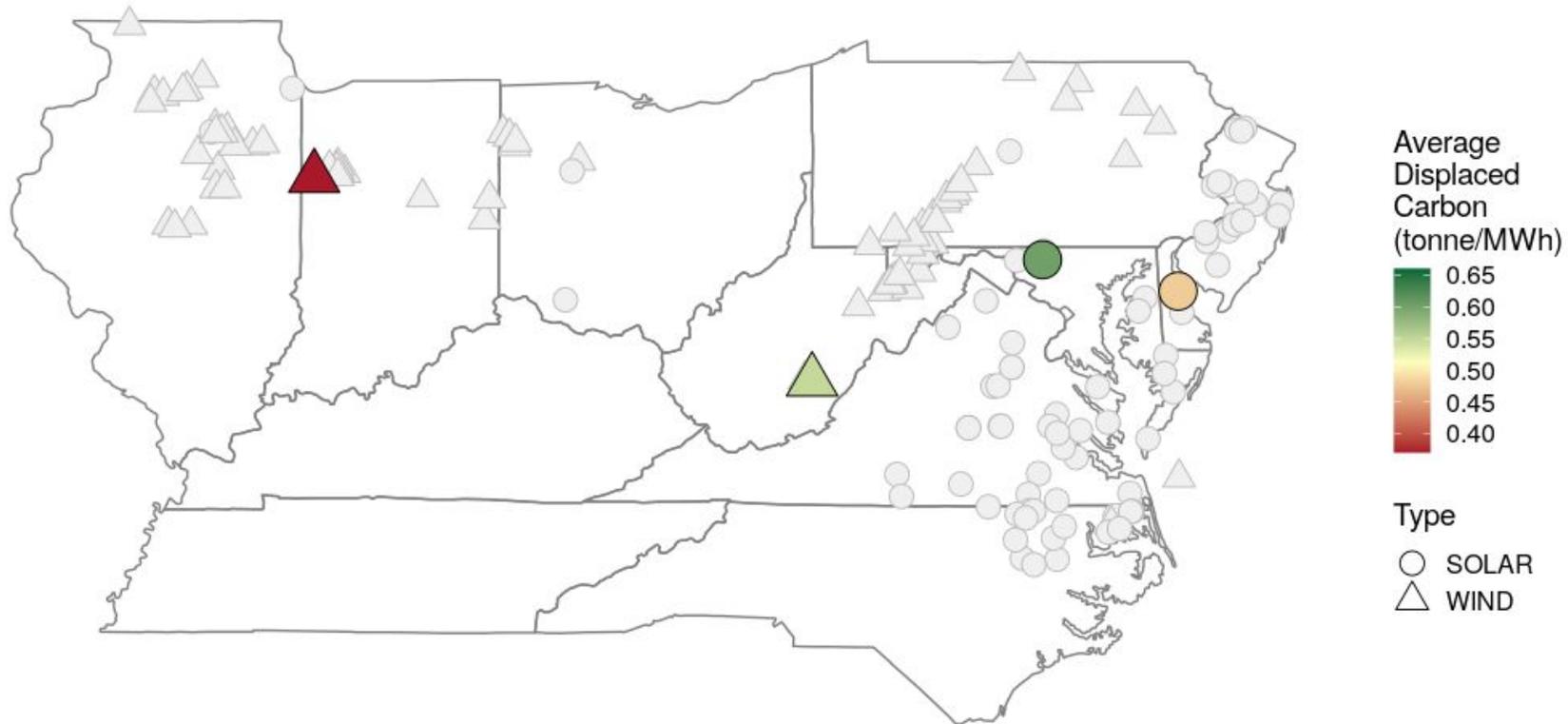
Jan. 2021 - Aug. 2022 Displaced Carbon by PJM Project



Why GHG-Indexing Matters

High-abating and low-abating resources help explain some of the drivers of this wide range in carbon impact value

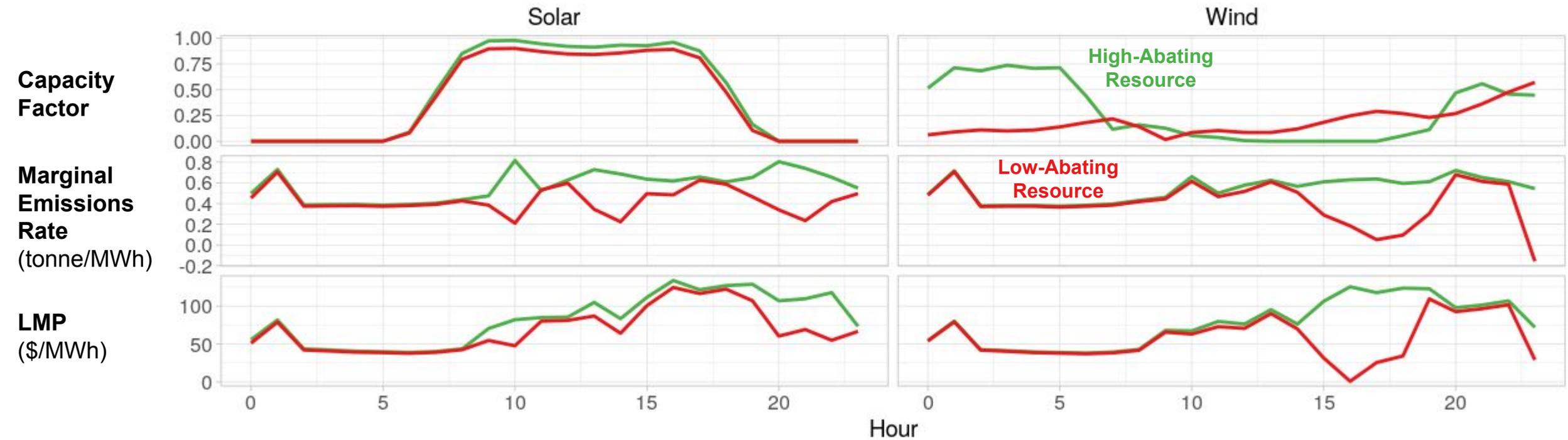
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Why GHG-Indexing Matters

Carbon abatement is driven by the timing of generation as well as the location-specific impact of marginal emissions rates

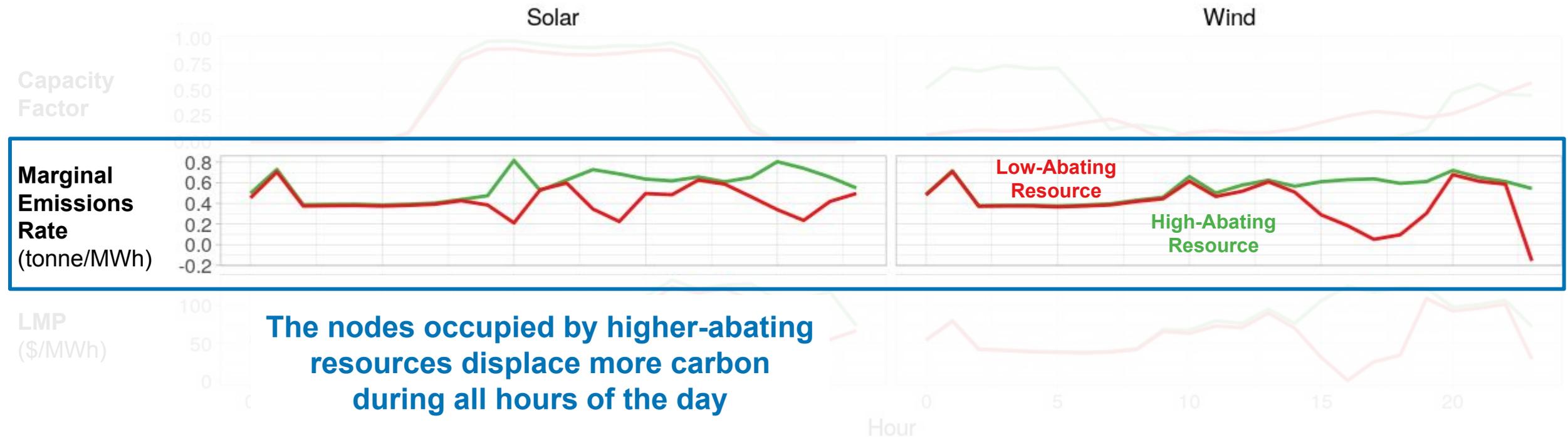
Highest and Lowest-Abating Solar and Wind Resources on 2022-06-25



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Highest and Lowest-Abating Solar and Wind Resources on 2022-06-25

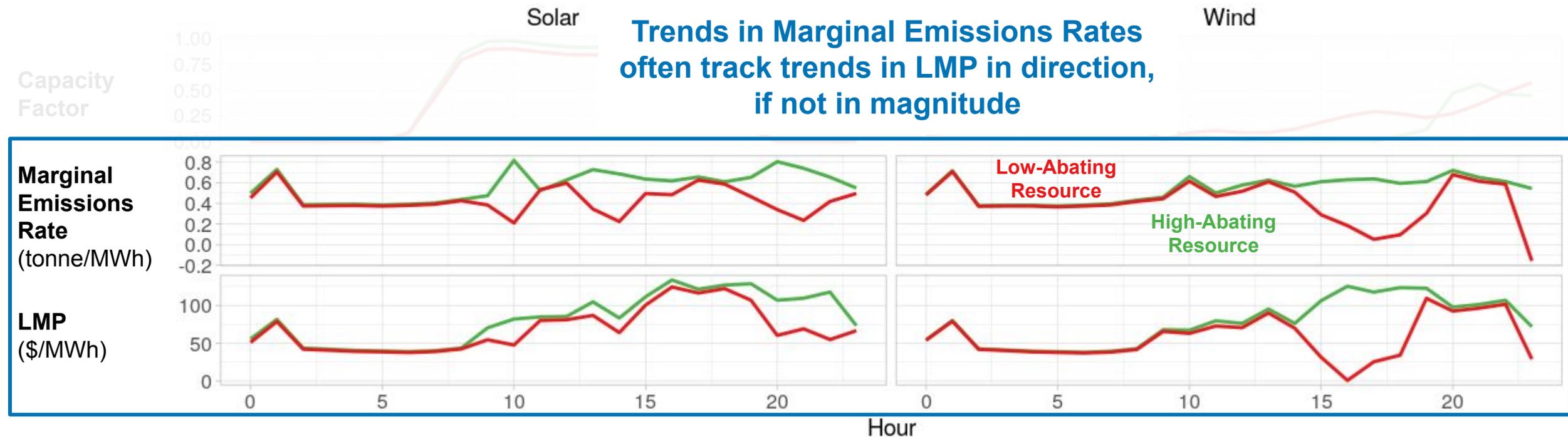


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Highest and Lowest-Abating Solar and Wind Resources on 2022-06-25

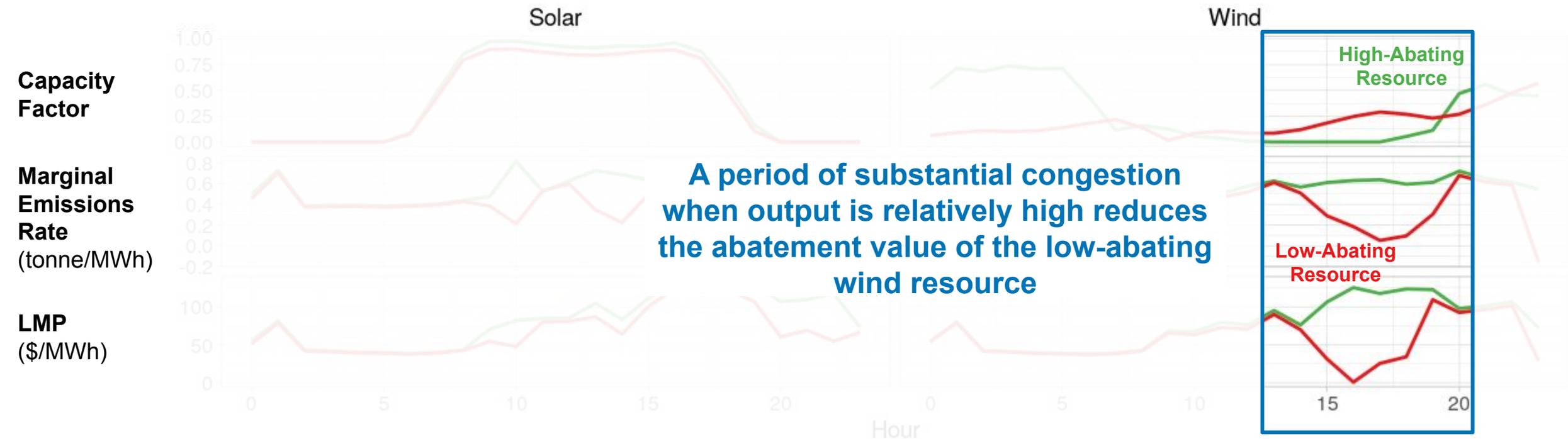
Trends in Marginal Emissions Rates often track trends in LMP in direction, if not in magnitude



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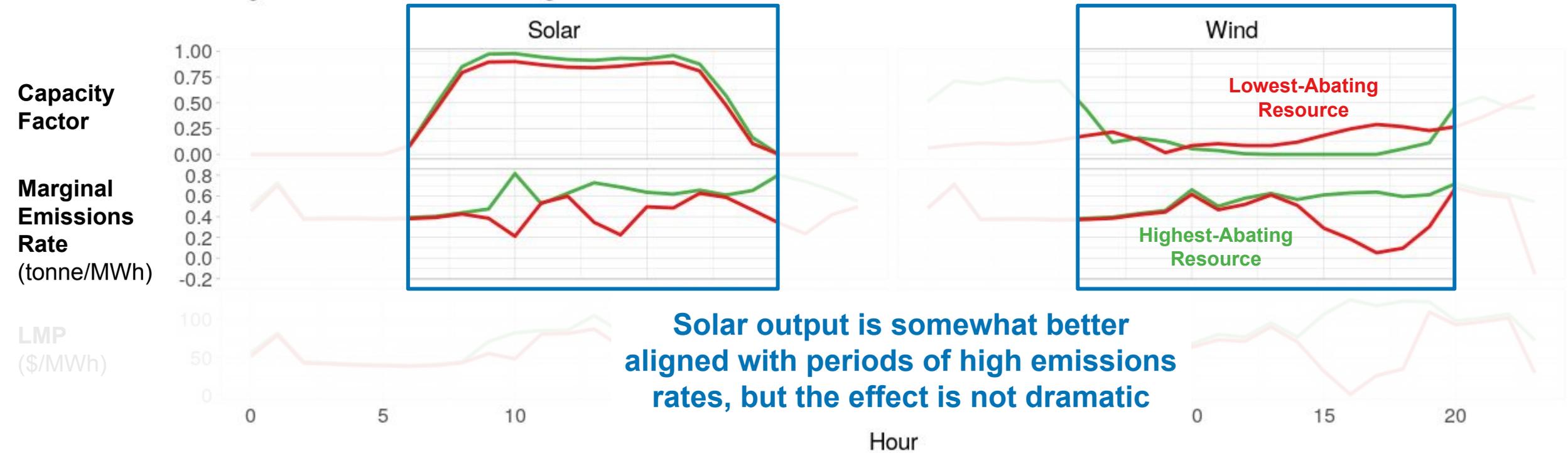
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Spot Product Definition

Spot product is real-time delivered carbon abatement as measured by PJM-telemetered generation and PJM-calculated nodal marginal emissions rates

Hourly Delivered Abatement from Qualified Resources

$$\begin{array}{ccc} \text{Delivered} & = & \text{Net} \\ \text{Abatement} & & \text{Generation} \times \text{Marginal} \\ \textit{tonne} & & \textit{MWh} \quad \textit{tonne/MWh} \end{array}$$

Spot Product Definition

Spot product is real-time delivered carbon abatement as measured by PJM-telemetered generation and PJM-calculated nodal marginal emissions rates

- **Supply:** Qualifying resources produce delivered abatement by producing clean energy that displaces carbon emitting generation
- **Demand:** Entities who have an interest in reducing carbon emissions (e.g. states, corporates, non-profits) purchase abatement
- **Tracking/Retirement:** PJM EIS or similar entity tracks generation and associated abated carbon from qualifying resources at monthly level (does *not* have to be hourly) to support tracking, trading, and retirement
- **Market Structure:** No additional market design would be necessary. Existing mechanisms (e.g. bilateral trades, brokered trades) should suffice

Forward Product Definition

Forward product is a contract to deliver a pre-defined quantity of spot carbon abatement at an agreed-upon price over the course of the delivery period

- **Supply:** Existing or new qualifying resources that anticipate delivering abatement during the delivery period and who want to lock-in a price for their abatement
- **Demand:** Entities who have a long-term interest in reducing carbon emissions and are interested in locking in a price for their abatement
- **Auction Details:** Could be procured through the capacity market (i.e. in an ICCM construct), a standalone FCEM, or a state procurement by aligning details including delivery period, forward period, qualification requirements, credit requirements
- **Quantity Risk:** Could either be assigned to seller (i.e. seller pays a penalty for under-delivery) or buyer (i.e. buyer purchases all delivered abatement at forward price)

Forward Product Settlement

Forward product would be settled at the forward price based on the quantity of abatement delivered over the course of the delivery period

$$\begin{array}{r} \text{Payment to} \\ \text{Seller} \\ \$ \end{array} = \begin{array}{r} \text{Forward} \\ \text{Price} \\ \$/\text{tonne} \end{array} \times \begin{array}{r} \text{Total Delivered} \\ \text{Abatement} \\ \text{tonne} \end{array} \\ - \begin{array}{r} \text{Penalty} \\ \text{Price} \\ \$/\text{tonne} \end{array} \times \begin{array}{r} \text{Abatement} \\ \text{Shortfall} \\ \text{tonne} \end{array}$$

Forward Product Settlement

To reduce risks to sellers, forward product could be structured without a shortfall penalty (more similar to a PPA), but this would have other implications

$$\begin{array}{ccc} \text{Payment to} & = & \text{Forward} \\ \text{Seller} & & \text{Price} \\ \$ & & \$/\text{tonne} \end{array} \times \begin{array}{c} \text{Total Delivered} \\ \text{Abatement} \\ \text{tonne} \end{array}$$

Implications of eliminating shortfall penalty:

- **Less risk for seller**
- **More risk for buyer**
- **Harder to qualify suppliers**

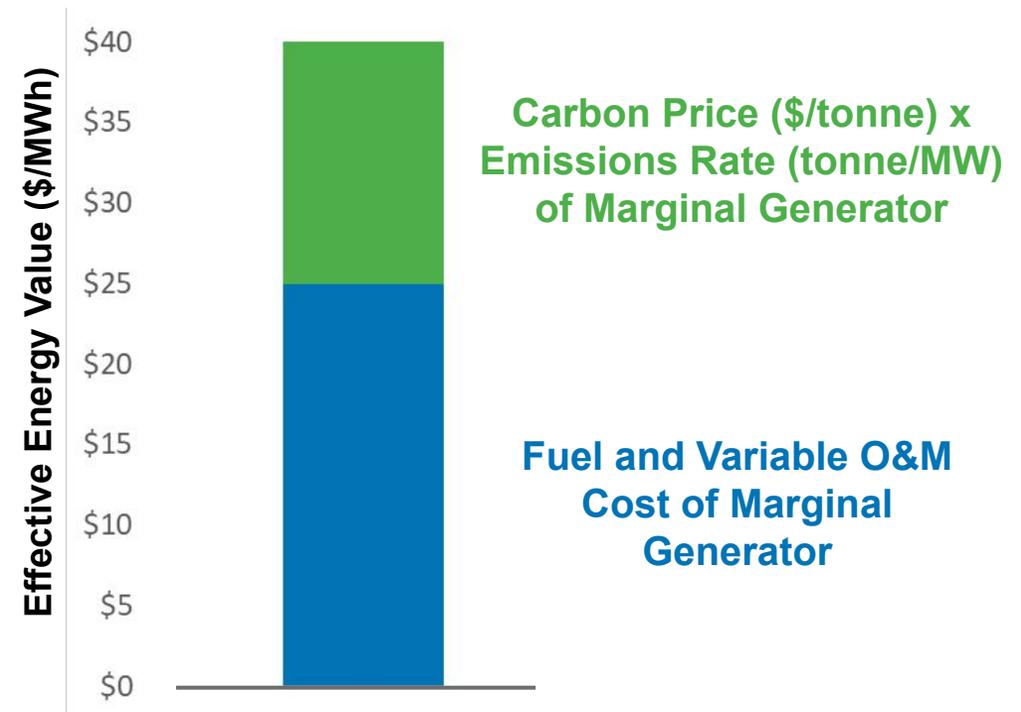
~~$$\begin{array}{ccc} \text{Penalty} & \times & \text{Abatement} \\ \text{Price} & & \text{Shortfall} \\ \$/\text{tonne} & & \text{tonne} \end{array}$$~~

Why Would You Buy This Product?

A GHG abatement product offers several advantages for buyers who have GHG abatement as a central goal for their procurement

- **Buy what you want:** If your goal is to abate carbon, buying a carbon abatement product makes sense
- **Enables storage:** A GHG abatement product naturally integrates storage and incentivizes storage operation that maximizes carbon reduction
- **Closer to efficient:** Similar to a carbon price, clean resources are compensated more based on how effectively they reduce emissions

Payment to Clean Resources Under a Carbon Price and GHG Abatement Product



Core Elements of a GHG Abatement Product

The core elements of a GHG abatement product are the following:

- **GHG-Indexing:** Spot product is GHG abatement calculated using PJM-telemetered net generation and PJM nodal marginal emissions rates
- **Single Certificate:** GHG abatement is another attribute of a generation certificate: certificate can be used for its energy value or GHG abatement value, *but not both*
- **Tracking:** Net generation and GHG abatement are tracked through an attribute tracking services (e.g. GATS). This does *not* require hourly tracking within GATS.

Interactions With Other Solution Elements

A variety of different GHG abatement products could be developed to meet the needs of stakeholders while still retaining the core elements of a GHG abatement product. By way of example, the regional and state products summarized below could be designed as GHG Abatement-type products

	Example Regional Product	Example State Product
Product Type	GHG-Abatement	GHG-Abatement
Qualified Suppliers	All zero-emitting resources in PJM	Resources in state x
Demand Participation Model	Price/quantity bids by any buyer	State government only
Forward Period	Three years	Three years
Delivery Period	One year	One year
Shortfall Penalty Price	1.1x MAX(Forward Price, Spot Price)	1.1x MAX(Forward Price, Spot Price)
Forward Procurement Platform	Integrated with RPM	State procurement
Price Lock-In	3 years for new resources	3 years for new resources

Analysis Request

We request that PJM model the impact of a GHG Abatement product transacted on the forward regional clean attribute market. We would like the analysis to focus on how prices, costs, and regional GHG emissions compare between this product and the other products under consideration.

Contact Information



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Dr. David Luke Oates leads REsurety's Power Markets Research team. Dr. Oates and his team develop analytical tools to address REsurety's customers' needs by combining expertise in wholesale electricity markets with optimization and statistical methods.

Dr. Oates holds a Ph.D. in Engineering and Public Policy from Carnegie Mellon University and a Bachelor's degree in Engineering Physics from Queen's University, Canada.

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