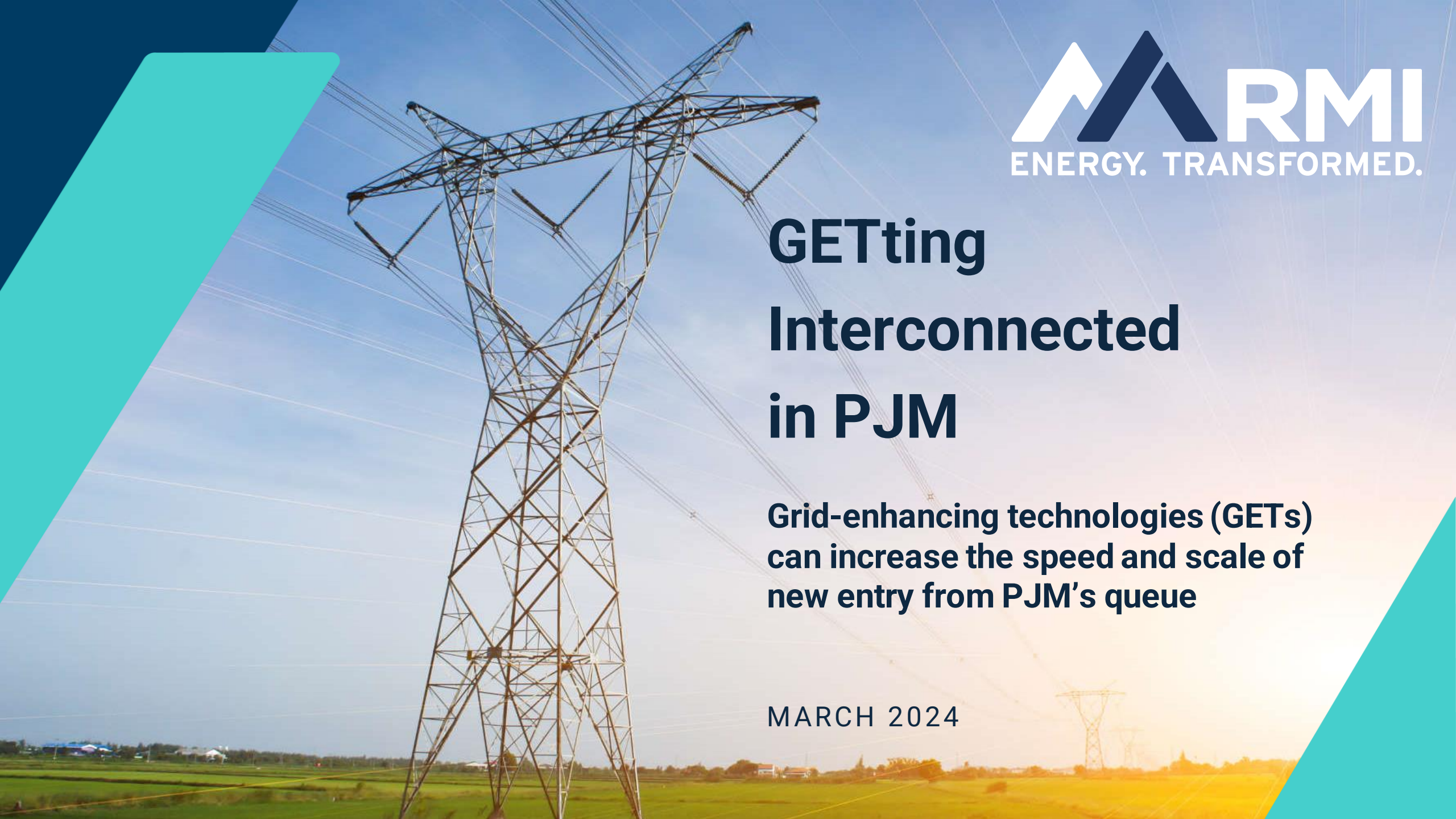


RMI
ENERGY. TRANSFORMED.

# GETting Interconnected in PJM

## Grid-enhancing technologies (GETs) can increase the speed and scale of new entry from PJM's queue

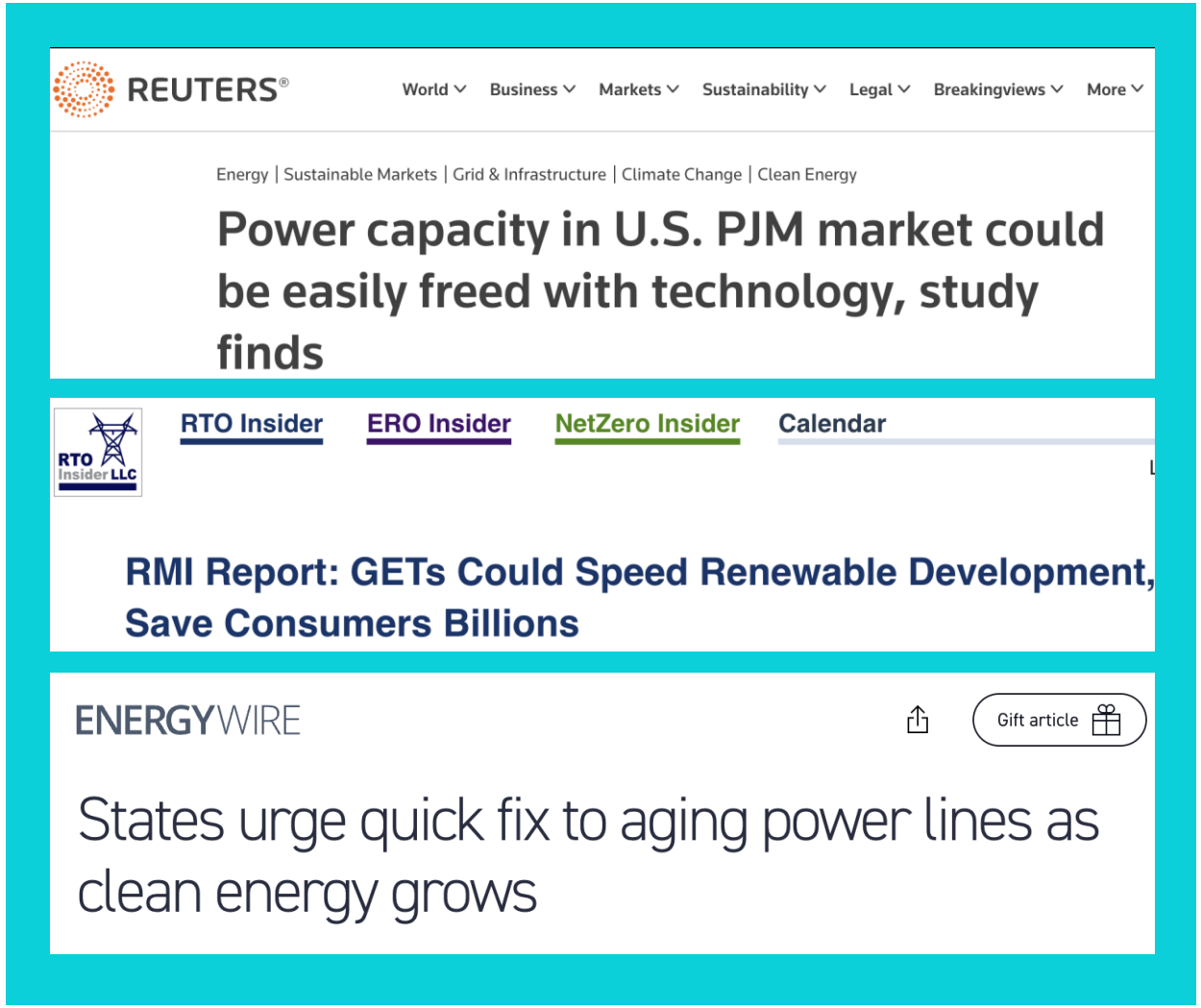
MARCH 2024

# We need to GET the most out of the grid we have

## GETs are gaining widespread attention and interest given today's capacity-constrained grid

In the past year, GETs have risen in prominence as quick, cost-effective transmission tools that can help us meet the growing demand for electricity:

- **FERC Order 2023** requires consideration of alternative transmission technologies (including some GETs) in interconnection studies
- **Federal funding** has supported GETs projects testing novel applications of the technologies
- **Half a dozen states** have introduced or passed legislation to encourage GETs deployment
- A growing number of **utilities** are pursuing GETs to meet transmission needs



# But barriers to GETs adoption remain

## GETs evaluation is not yet standardized and a lack of incentives impede their scaled deployment

Many utilities still lack **experience and familiarity** with these technologies and the range of use cases they may be suited for

GETs must be **incorporated into transmission models** and studies in order to support their routine evaluation in transmission planning processes

Cost-of-service regulation can deter utilities from deploying low-Cap Ex, efficiency-enhancing tools like GETs, creating a need for **better aligned incentives**

# RMI released a new study on GETs as a way to accelerate new generator interconnection

## Deploy GETs (cost: $100M)

GETs are hardware and software tools that increase the efficiency of the grid

- Advanced Power Flow Controls (PFCs)
- Dynamic Line Ratings (DLR)
- Topology Optimization (TO)

## Interconnect 6.6 GW of clean energy

Using GETs as network upgrades supports faster and cheaper interconnection of new resources

- +Solar
- +Storage
- +Wind

## Save $1B annually

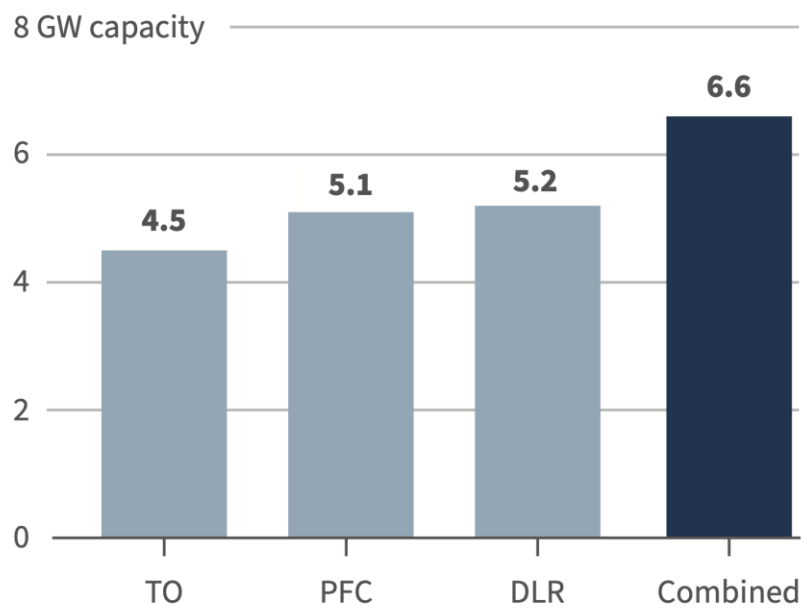
GETs and the lower-cost, carbon-free generation they enable could result in:

- $1B in annual production cost savings
- 12M tons of avoided CO2 emissions

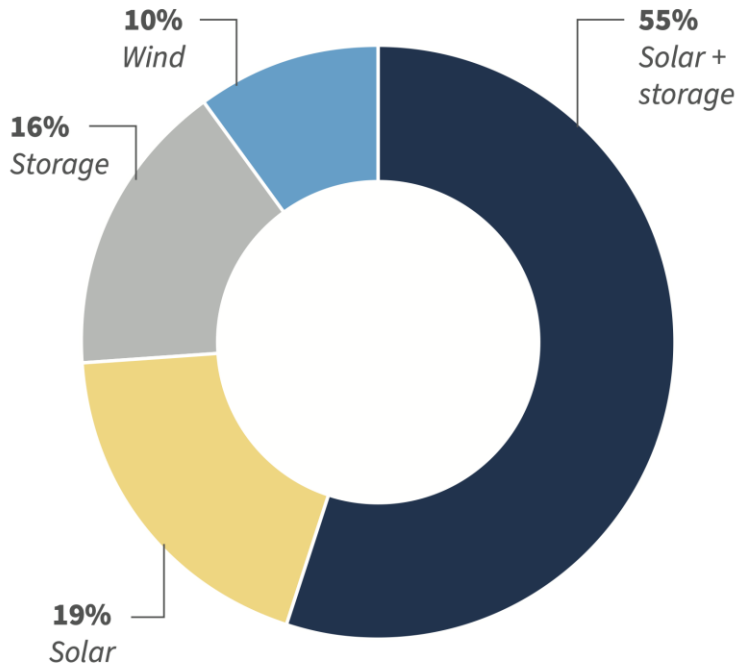
Link to report landing page: GETting Interconnected in PJM, published Feb. 2024

# GETs could enable 6.6 GW of new clean resources to come online by 2027

## Each GET was assessed individually and in combination



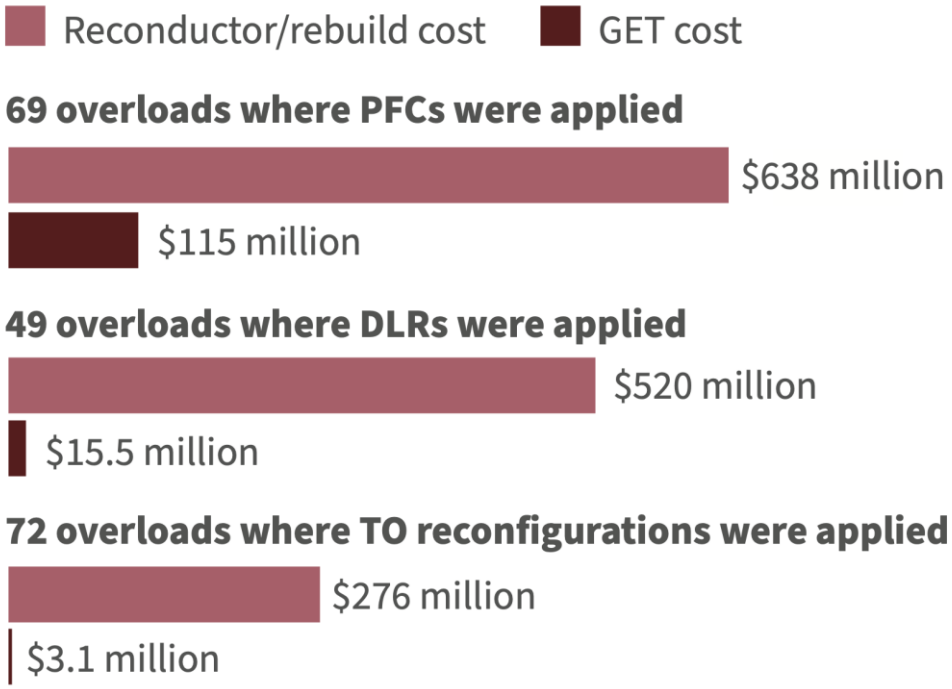

## This amounts to ~5% of all queued generation analyzed




RMI Graphics. Source: Quanta analysis

# GETs provide dramatic cost savings for developers compared to default network upgrades

## GETs are $272-523M cheaper than traditional network upgrades




RMI Graphic. Source: Quanta analysis

These technologies should be evaluated as a matter of course in grid operator interconnection studies.

Until the regulatory framework is in place to enable that, **developers can request GETs consideration for their projects**, as described in a case study in our report.

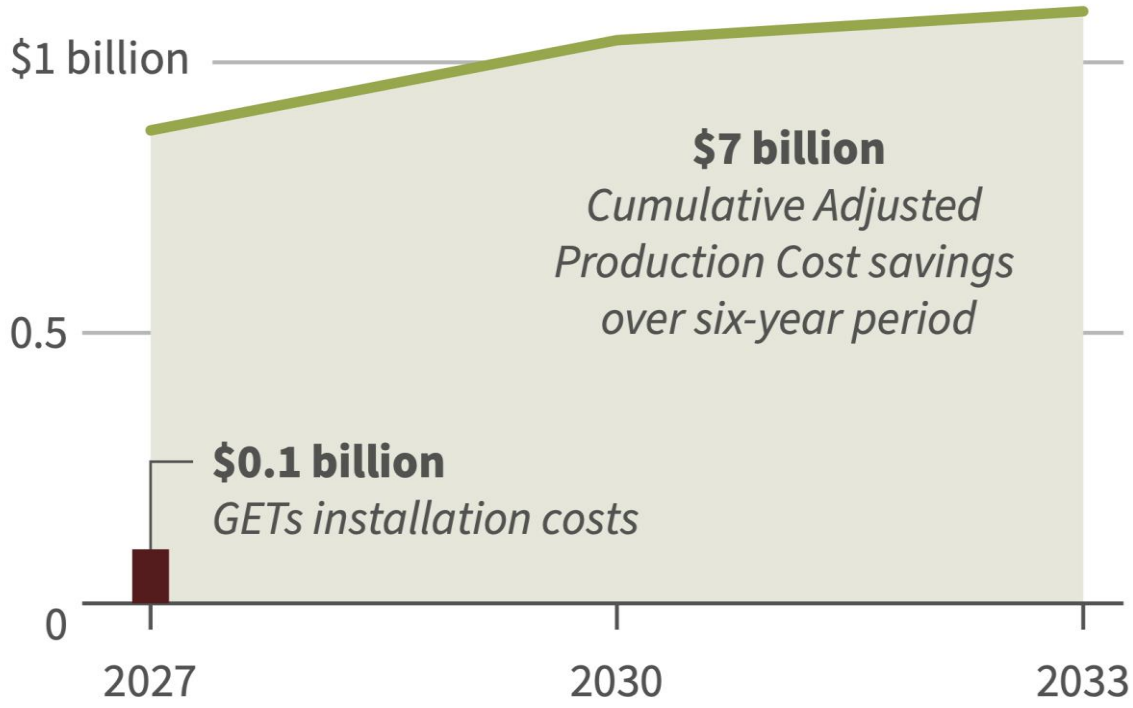
# GETs drive lower electricity costs for consumers across PJM

## Once online, production cost savings from GETs + new generation can total $1B per year

These savings are driven by both:

- Lower operating expenses of the new renewable resources displacing fossil-fuel generation, and
- Existing renewable generation benefitting from reduced congestion due to GETs

CO2 emissions are reduced **3.5% in 2027**, avoiding 12 million tons of $CO_2e$




RMI Graphic. Source: Quanta analysis

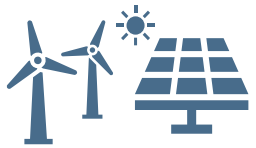
# We make the following recommendations to spur commercialization of GETs

**PJM**

- PJM should institute robust evaluation of GETs across its interconnection and transmission planning practices
- PJM should ensure its staff has the requisite training and modeling tools

**Transmission owners**

- Transmission owners should build their internal capacity on GETs through studies and deployments
- Forums like the ESIG GETs User Group are a great venue to support resource sharing



**Developers**

- Developers should propose and support GETs evaluation as network upgrades for their interconnection projects wherever applicable

**Regulators**

- State regulators should provide oversight and guidance to spur GETs adoption by their jurisdictional utilities
- FERC should take additional steps to provide a comprehensive national regulatory framework that supports GETs adoption

# Thank you

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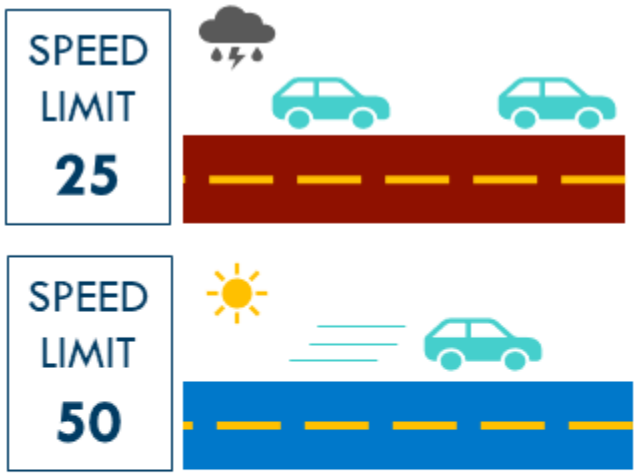
# Appendix

# Grid Enhancing Technologies (GETs) At a Glance

## Dynamic Line Ratings

Adjusting the carrying capacity of transmission lines based on real-time measurement of ambient conditions

Transit analogy: real-time adjusted speed limits




## Advanced Power Flow Controls

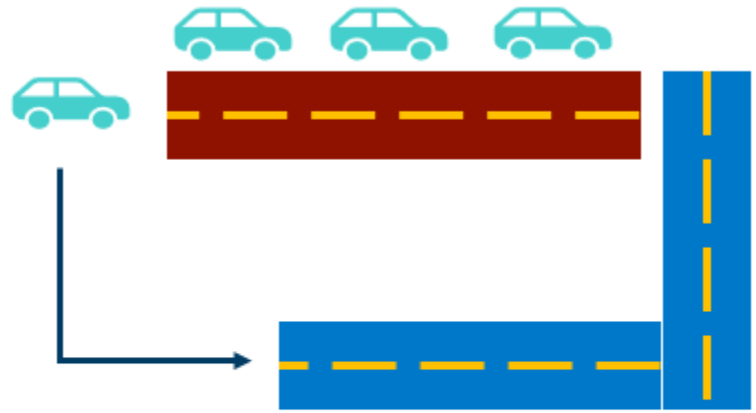
Hardware solutions that push power away from lines with capacity constraints and pull power to lines with spare capacity

Transit analogy: railroad switching stations that direct trains to free tracks

## Topology Optimization

Software solutions that automatically route power flows around congested areas

Transit analogy: re-routing drivers around traffic



# Our rigorous analysis emulates PJM's own interconnection study methodology

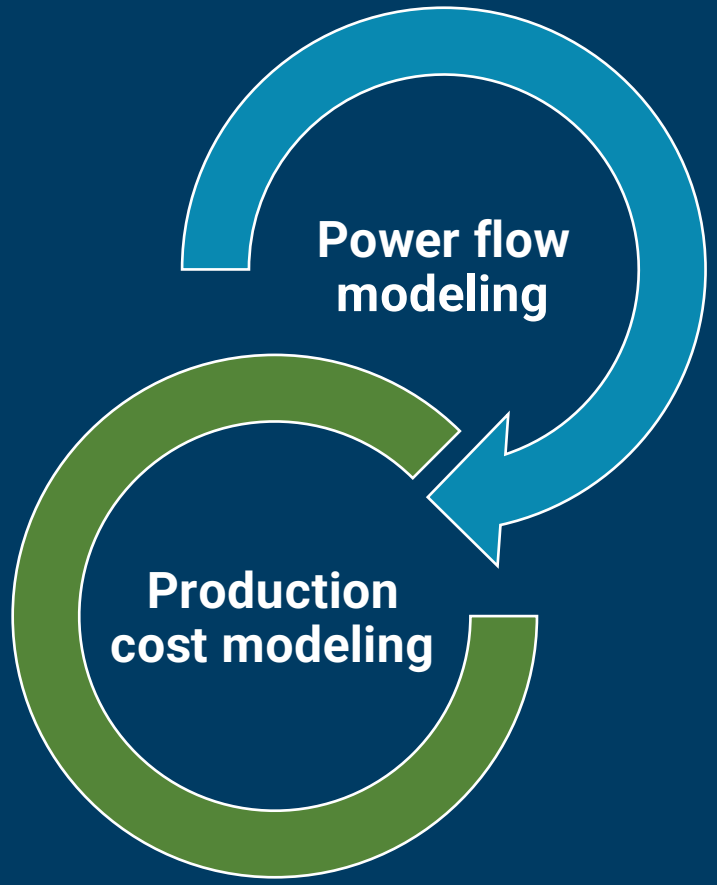
**Scope**

3 types of GETs:
Dynamic Line Ratings (DLR)
Power Flow Controls (PFCs)
Topology Optimization (TO)

5 states:
Pennsylvania, Ohio, Illinois, Indiana, and Virginia

3 future years:
2026, 2028, and 2030

3 grid conditions:
Summer peak, winter, and light-load




All queued generation and GETs were incorporated into a power flow model + contingency analysis to assess thermal overload violations

Cost and emissions benefits from queued projects that, with GETs, could feasibly be operable in PJM by 2026 were quantified



Source: Quanta analysis

# Each GET was incorporated into the power flow modeling with a unique method informed by deep-dive analysis

| | | | |
|---|---|---|---|
| **Our modeling** | A 10% uprate to represent DLR was applied to all overloads during summer peak | A python script was utilized to place and select the number of PFCs in the study | TO was given credit for overloads arising from P1, P2, P4, and P7 contingencies |
| **Deep-dive analysis** | A deep-dive analysis of DLR throughout the year at multiple locations revealed an average 17% uprate in summer conditions | A Python script provided by the vendor was utilized in conjunction with PSSE to automate the modeling; PFCs are only applicable in meshed grids | A deep-dive analysis of overload cases revealed TO is best-suited to address the above contingency conditions in meshed grids |

We designed this to be a replicable approach that could help grid operators and utilities incorporate GETs into their own grid planning models.

# These fast-to-deploy, flexible transmission tools can accelerate interconnection and deliver substantial savings

## GETs are applicable in a planning paradigm

- Some GETs are viewed today as only operational tools; this fails to recognize their full potential

## GETs can be modeled and deployed reliably

- Quanta and GETs vendors pressure-tested GETs application to ensure no adverse impacts elsewhere in the system while respecting all reliability criteria

## GETs are complementary transmission solutions

- GETs can work well in combination (particularly DLR, which can be effectively paired with PFCs or TO) and serve as bridge solutions to longer-term transmission upgrades or as part of a broader transmission project

*We hope to work with transmission owners and utilities to leverage this analysis as a capacity-building tool, as well as support new regulations or policies that promote uptake of GETs*