



G-PST/ESIG Webinar Series:

Connect Faster: Improving Renewable Energy Integration
With Modular Power Flow Control

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A Global Mission

G-PST Dramatically accelerate the transition to low emission and low cost, secure, and reliable power systems

ESIG Address the technical challenges associated with integrating multiple energy systems to enable clean, reliable, and affordable energy systems worldwide

Smart Wires Maximize the grid's transfer capacity in order to rapidly integrate renewable generation and accelerate the transition to an affordable, clean energy future



Overview

Current Challenges & Industry Trends

Intro to Modular Power Flow Control

PFC and Renewable Integration

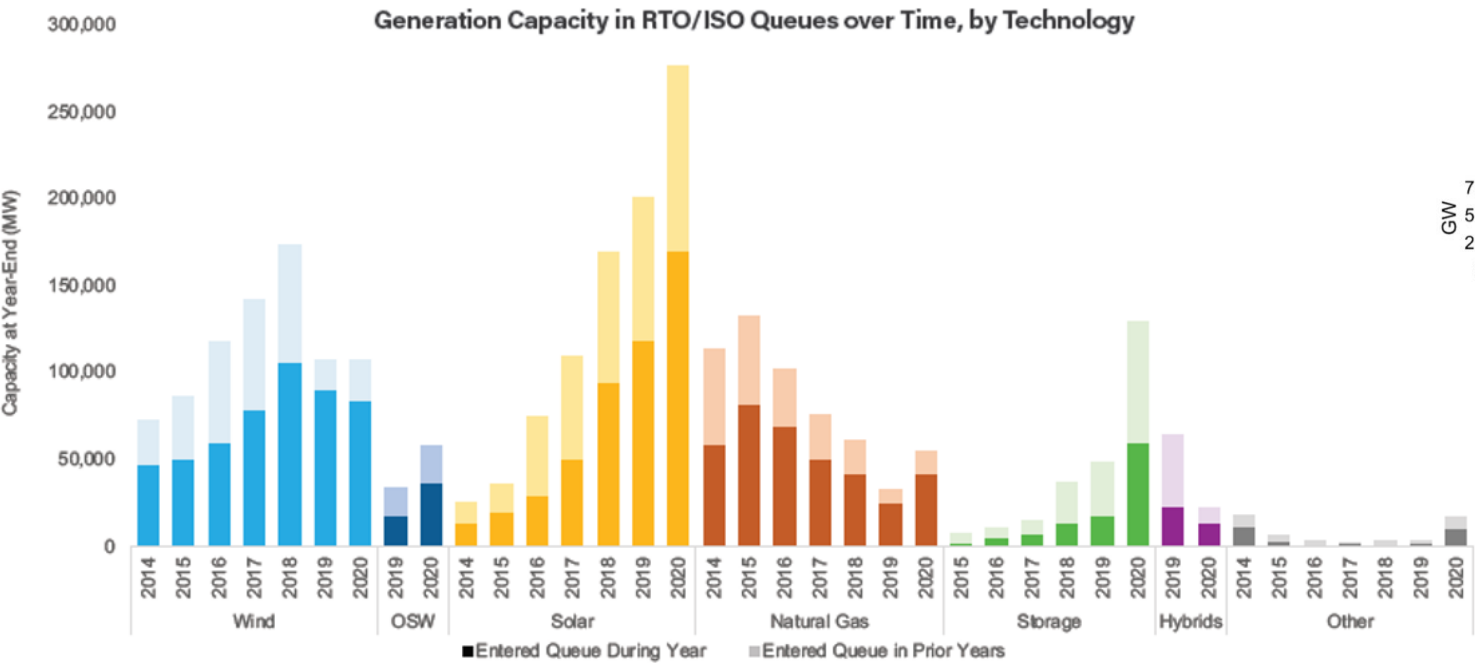
Studies and Use Cases



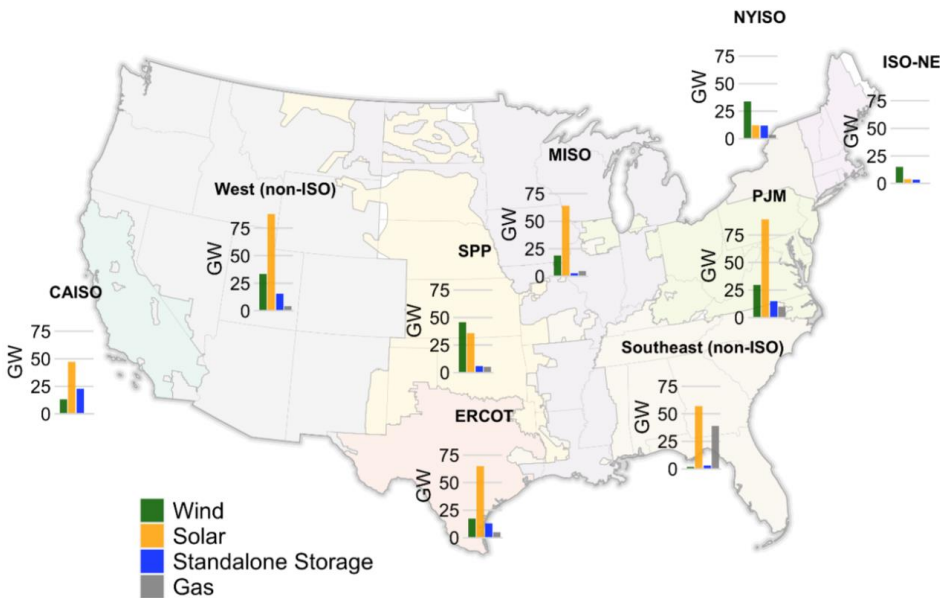
Trends - Large queues of RES waiting to connect



Capacity in RTO/ISO Interconnection Queues over Time
Nearly 277 GW of solar, 130 GW of storage, and 107 GW of wind in interconnection queue backlogs



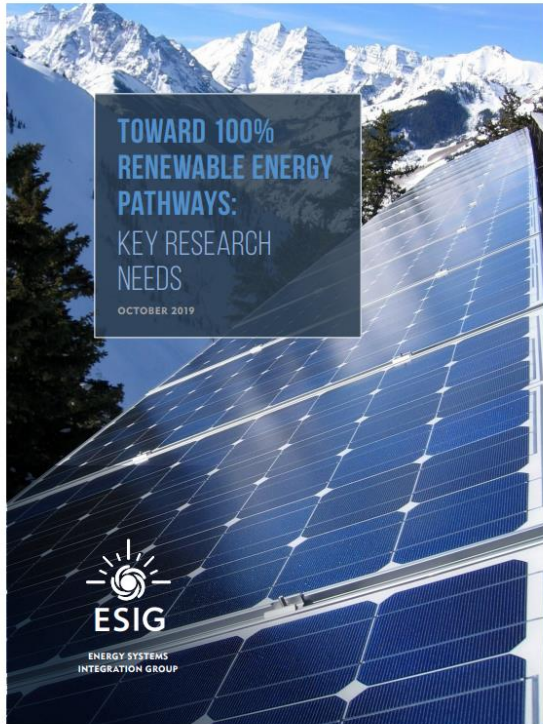
Source: 2020 ACP Clean Power Review



Source: 2021 LBNL



Trends - Industry wants to electrify to decarbonize



“Very likely pathways, based on technological and economic grounds, are renewable energy harnessed through the electricity system and the electrification of large parts of the economy”

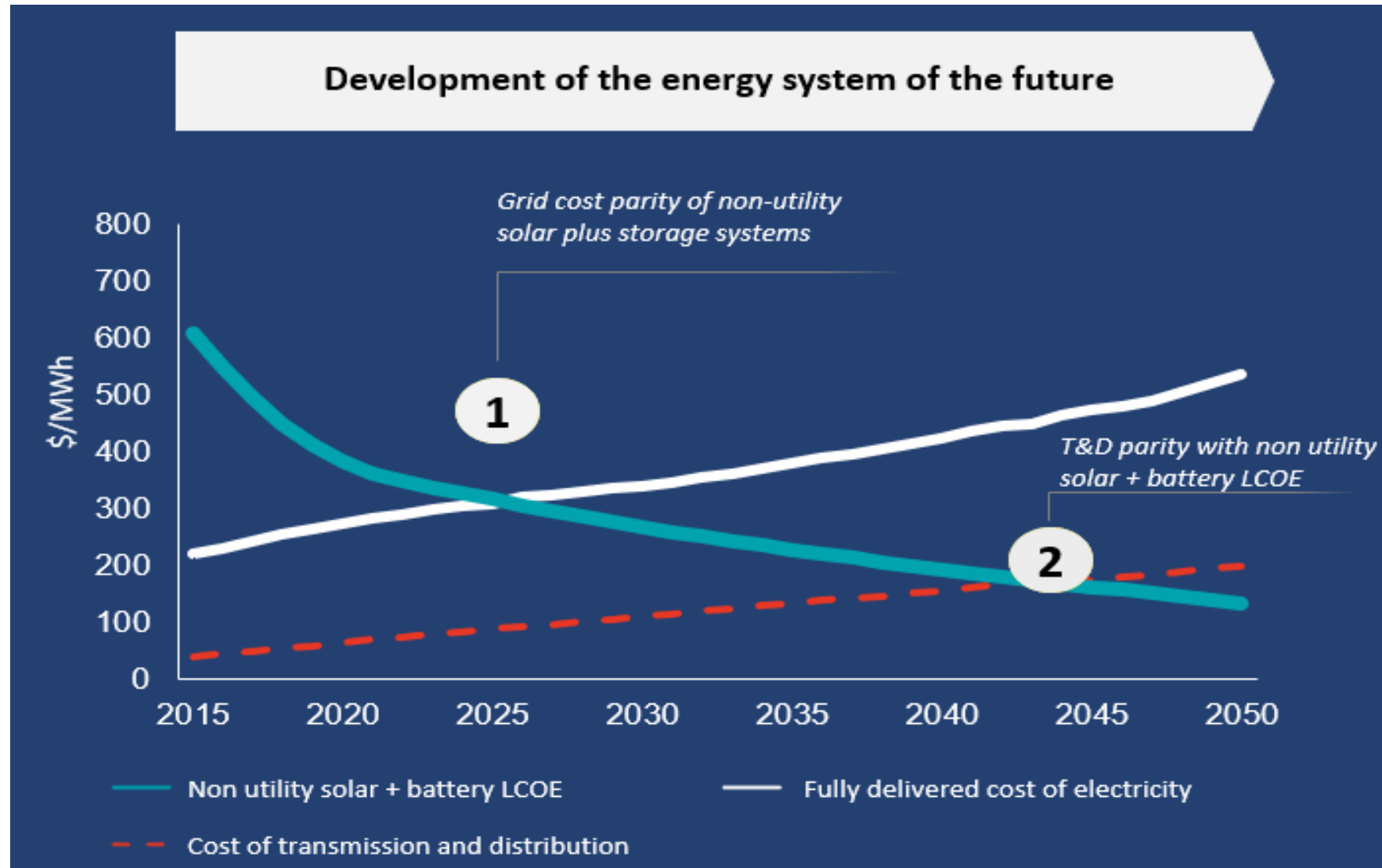


“To speed up industrial electrification efforts, we must abolish grid bottlenecks quickly, ensure that cross-border interconnectors enable free flow of energy between countries....”

Extract from open letter to Eu from Industry Leaders and MEP Group 10 July 2021

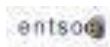


Trends - Grid costs becoming more significant component of energy costs, while solar and storage costs fall



Trends - 4. Technology is Mature





TECHNOLOGY READINESS LEVEL

ENTSO-E Technopedia

Welcome to ENTSO-E's new tool, the Technopedia!

Energy transition is underway, we help you to keep up with the new technologies related to the Transmission System Operators. Below you will find brochures of different innovative and state-of-the-art technologies covering the fields of transmission assets, system operations, digital and flexibility solutions. These up-to-date sheets will help you to understand each technology and their advantages, and also to show their readiness level.



As a result of these trends, the power sector is currently facing several key challenges:

Transmission constraints and curtailment on the grid

A significant backlog of new renewable generation stuck in interconnection queues

Integration and balancing of intermittent renewable sources

Long distances separating RE generation from load centers

Long wait times for industrial demand increases

Reduction in system inertia

Rise in voltage fluctuations

Higher ramp rates



The Benefit of Modular Power Flow Control

Safe & Reliable

- Deployed since 2012
- 2,500+ device-years
- Leverages decades of high-voltage power electronics experience

Valuable Capabilities

- Modular SSSC injects controllable voltage
- Increase/decrease power flows and perform dynamic services

Adaptable

- Flexible, scalable, redeployable
- Rapidly installed
- Voltage agnostic up to 500 kV

Economic

- Effectively solve problems
- Scale or redeploy solution in-step with needs
- Minimize risk & capital

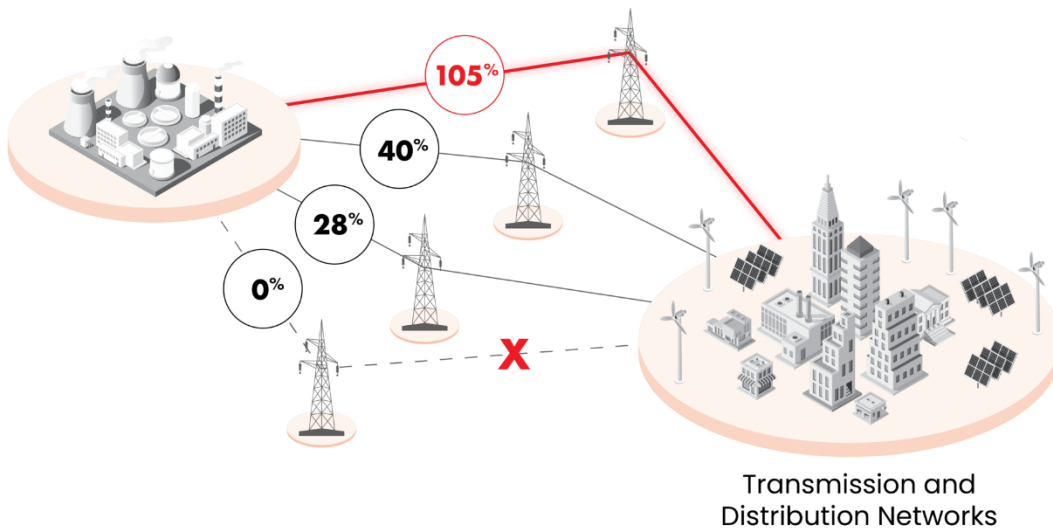
Maximizing the grid's transfer capacity to accelerate affordable, clean energy



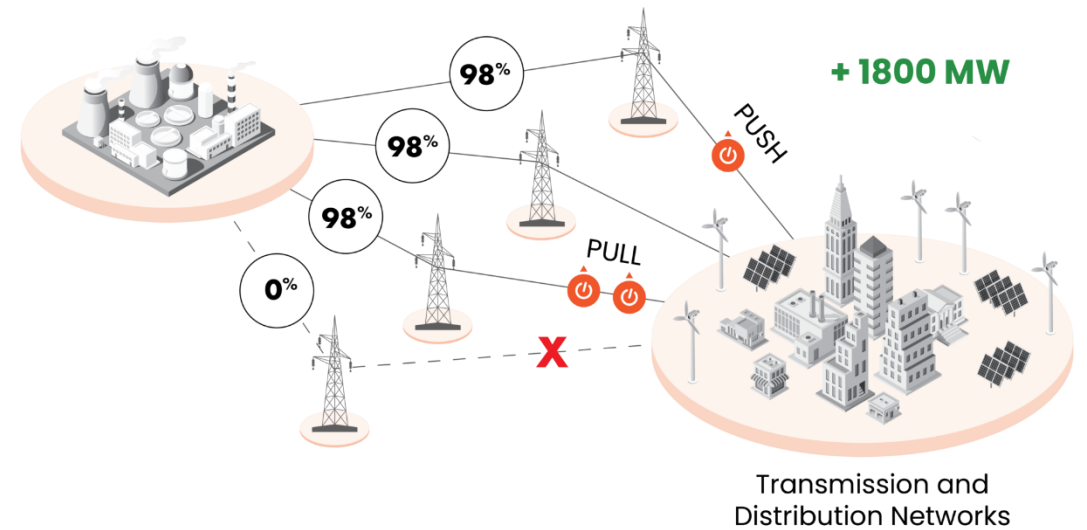
Power Flow Control Impact

Improving the Value of the Existing Grid

Before Power Flow Control



After Power Flow Control



Power flow control enables the efficient operation of the existing transmission grid



Why are RE Developers and IPPs Engaging?

In the US, less than 20% of renewable energy projects in GI queues reach commercial operation ([LBNL](#)). Transmission constraints are the #1 reason for project failure. RTOs/ISOs are looking for cost effective ways to integrate renewables.

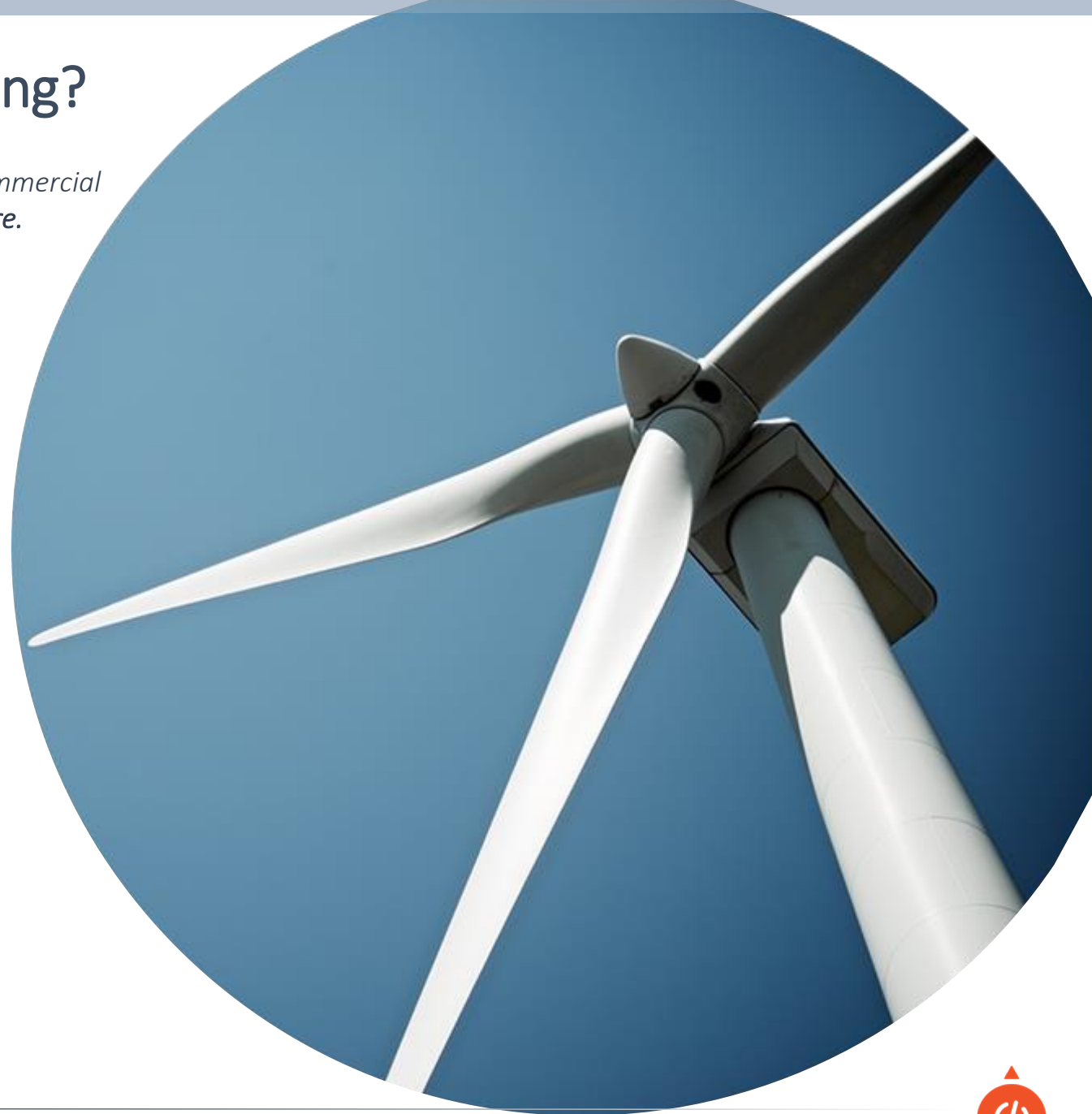
Enable more and faster interconnection of new solar, wind, and storage projects

Lower cost of generation interconnections, including ancillary upgrades for high voltage interconnections

Increase gross margin and reduce curtailment of generation by mitigating congestion

Balance intermittent generation from various sources across the grid

Increase flexibility of site selection



Unlocking the Queue

Grid Enhancing Technologies (GETs) Study in Southwestern Power Pool (SPP)

Unlocking the queue:

How advanced transmission technologies can double renewable energy build



Grid-Enhancing Technologies (GETs):

hardware or software that increases the capacity, efficiency, and/or reliability of transmission facilities



Dynamic Line Ratings

Measure the true capacity of transmission lines based on ambient conditions



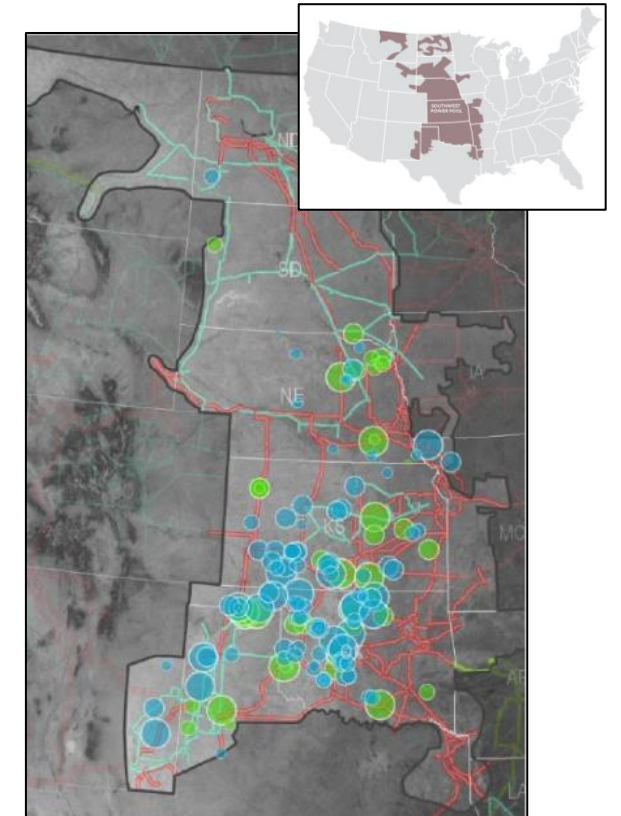
Advanced Power Flow Control

Reroutes power from congested to underutilized lines



Advanced Topology Control

Identifies grid reconfigurations to reroute flows around bottlenecks



SPP Generation Interconnection Queue
9,400 MW of RE projects in queue



Unlocking the Queue

Results

When utilizing
GETs, SPP can
integrate an
additional

2.7 GW

of renewable
energy

The Benefits of GETs in Kansas and Oklahoma



2x

the renewable
energy capacity



Paid for in
6 MONTHS



3 MILLION TONS
carbon emissions avoided
annually



**\$175
MILLION**

annual production
cost savings



11,300
650

direct short-term jobs
direct long-term jobs

Potential Nationwide Benefits



**20
MILLION**

carbon emissions cuts
equal to 20 million cars
off the road



OVER \$5 BILLION
production cost savings



TENS OF THOUSANDS
of local construction jobs, and thousands
of long-term, high-paying jobs



IMMEDIATE PROGRESS
towards a decarbonized grid

NextEra Energy, EDF Renewables, and Duke Energy funded the SPP Brattle study to develop a real-world use case of broad GETs impact on RE integration.



nationalgrid



5 Circuits

3 Sites

Manufacturing to commissioning

For delivery of expansion

Savings for UK consumers

500 MW across 3 boundaries



Increasing Cross Border Capacity

GETs provide multiple benefits by enhancing cross border capacity:

1. **Resource sharing** – use of excess renewables
2. **Efficiency and markets**, more competitive generation benefits consumers and industry
3. **Improves resilience** to unforeseen or natural events
4. Larger systems enable **efficient decarbonization at scale**
5. Easier to manage certain other technical issues e.g. inertia in larger systems

FARCROSS

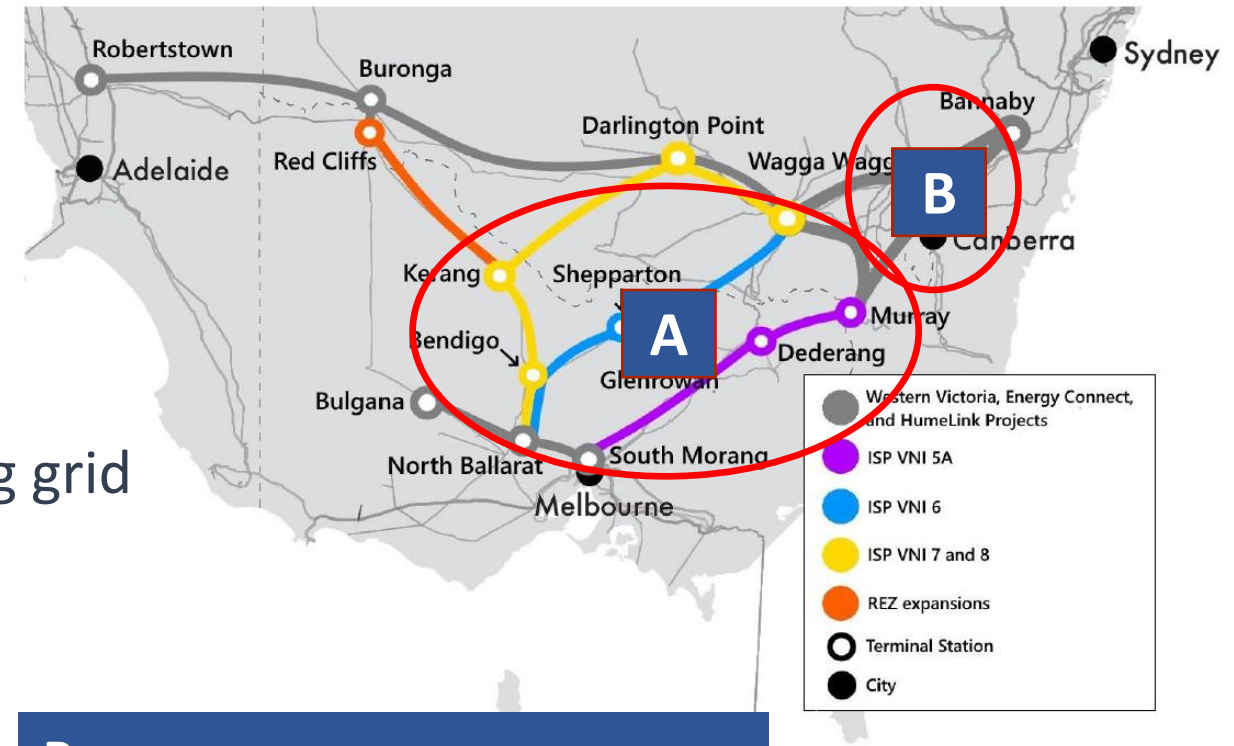
- 5 GW+ cross border capacity required by 2030 across Europe and available capacity on cross border lines must be minimum 70% by 2025 for all EU countries
- Project implements state-of-the art technologies including PFC, DLR, and WAMPAC to enhance the capacity and efficiency of transmission grid assets.
- PFC deployment increases cross-border capacity between Greece and its neighbors, enable local renewable generation and in N-1 contingency. Initial analysis shows up to 140MW increase.



Decarbonization will require some new large-scale traditional infrastructure

GETs can enhance and/or enable projects that would otherwise be marginal:

- 1 Release some benefit early
- 2 Enable outages for construction
- 3 Resolve downstream constraints
- 4 Balance flows between new and existing grid



A. New 500kV/330kV Infrastructure is required to increase transfer capacity between Victoria and NSW. GETs allows you to fully utilise the capacity delivered by new infrastructure.

B. New 500kV Infrastructure to connect Snowy Hydro plus other REZ to Sydney adding GETs north of Bannaby future proofs the overall solution by unblocking a downstream constraint.



What Next?



1. Wide-Area Optimization



2. On-Grid Cost Competitiveness



3. Power Electronics Based System



4. Digitization of the Grid



5. Improve Global Incentives



6. Broad Rollout

