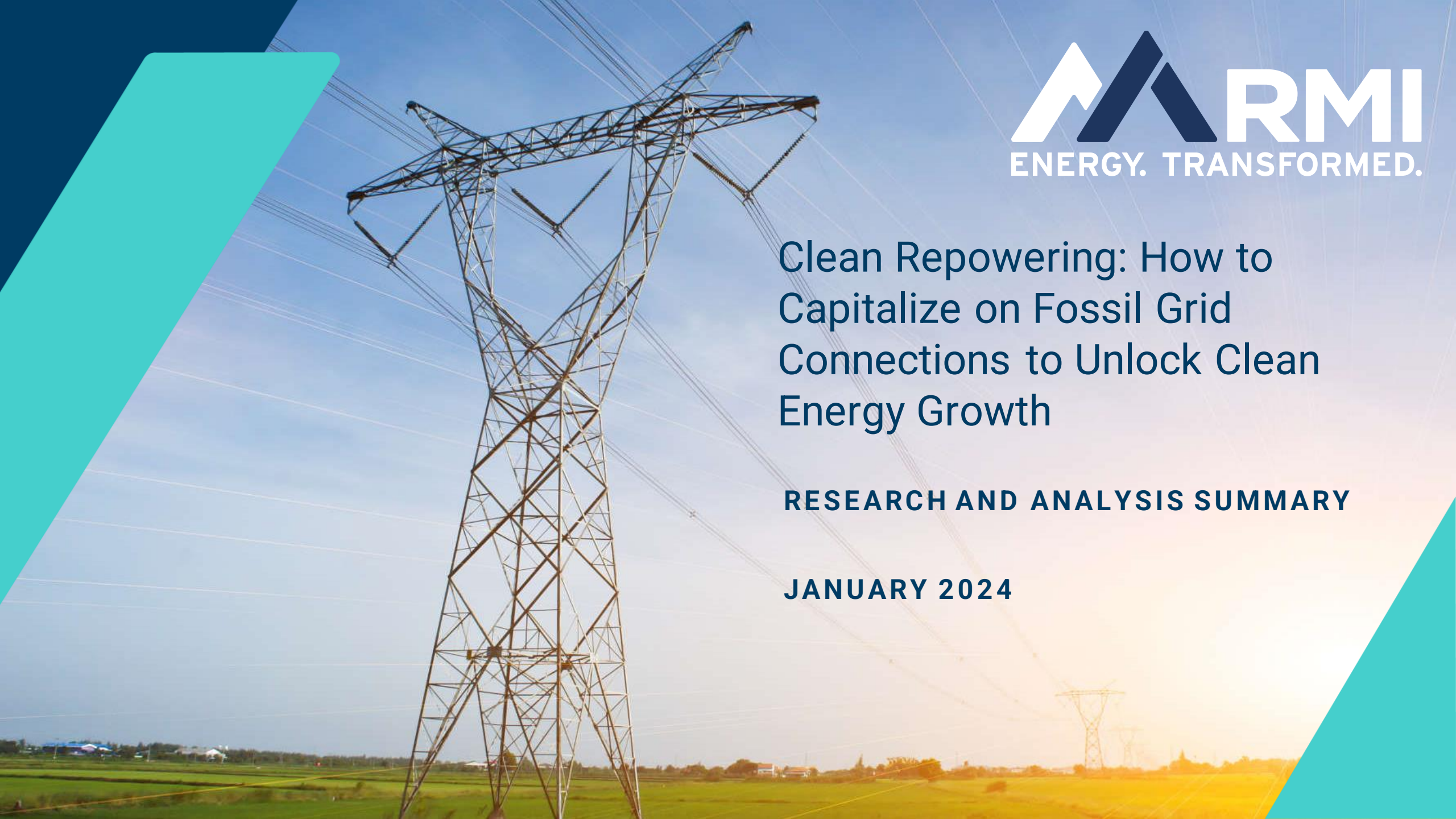


RMI
ENERGY. TRANSFORMED.

Clean Repowering: How to Capitalize on Fossil Grid Connections to Unlock Clean Energy Growth

RESEARCH AND ANALYSIS SUMMARY

JANUARY 2024

Clean Repowering:
What it is and why it’s needed

Executive Summary

More than 1.3 TW of proposed clean energy projects are stuck waiting years for permission to connect to the grid, while the demand for reliable, clean energy is skyrocketing.

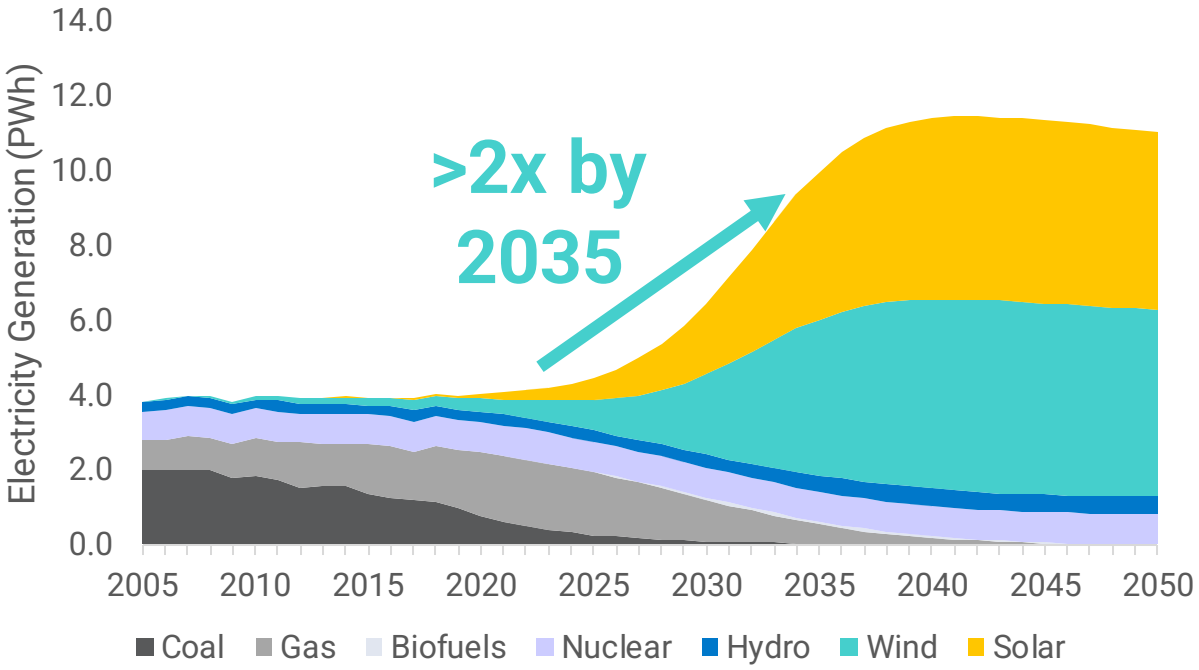
Clean repowering — siting clean energy alongside existing fossil generators to leverage their grid connections via much faster surplus or generator replacement processes — is a near-term fix to help break this logjam.

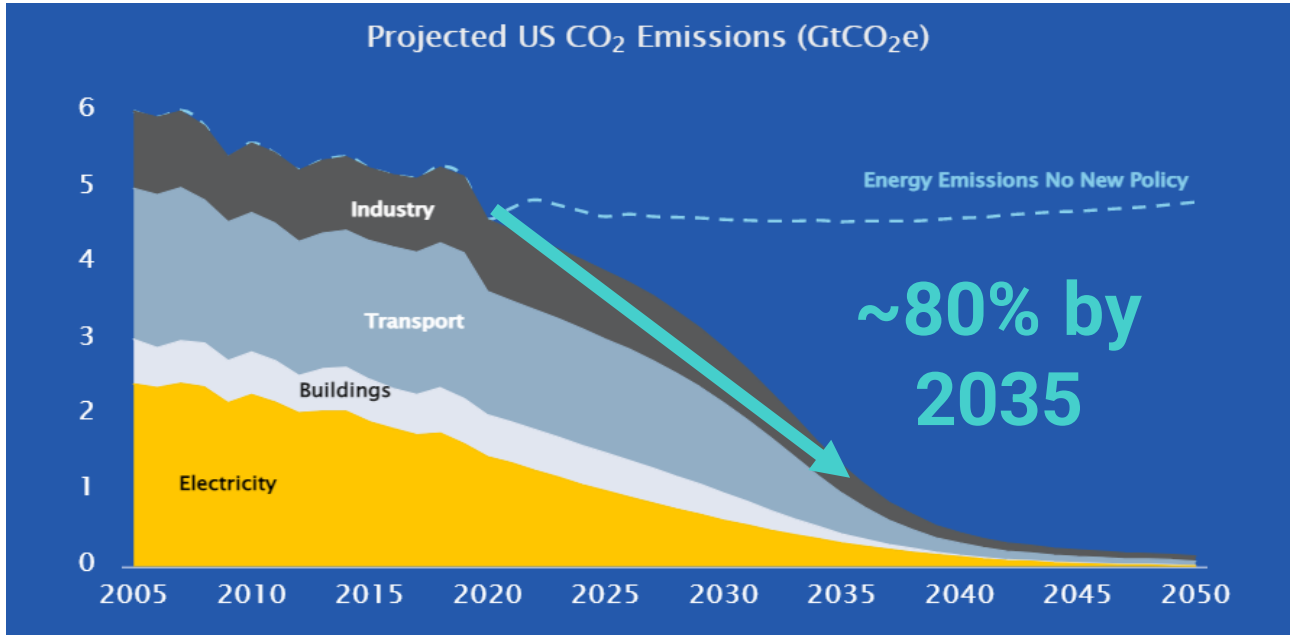
We have identified 250 GW of economic clean repowering opportunities on an asset-by-asset level across the country that make use of new IRA incentives and surplus interconnection or generator replacement processes.

These are “no-regrets” opportunities, as they can reduce NPV of system costs by $21B through 2054 relative to BAU without impacting grid reliability, and are primarily concentrated in MISO, PJM, and the Southeast.

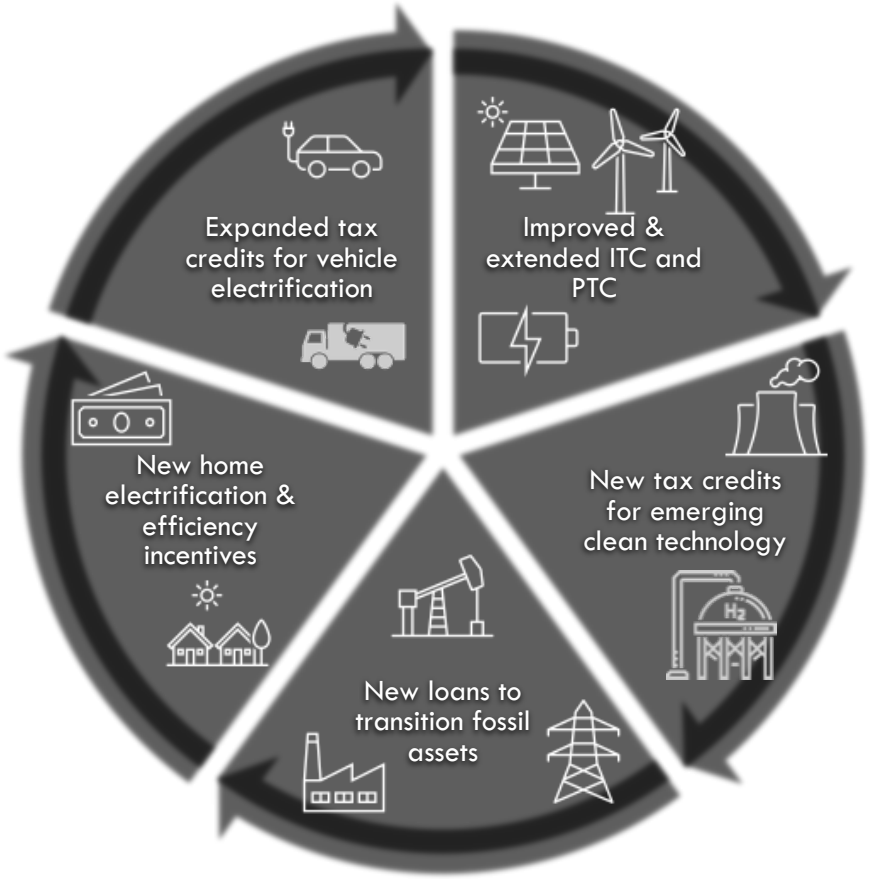
Establishing a generator replacement process in regions currently lacking a streamlined process could further expand this opportunity, unlocking up to 36 GW in PJM and ERCOT.

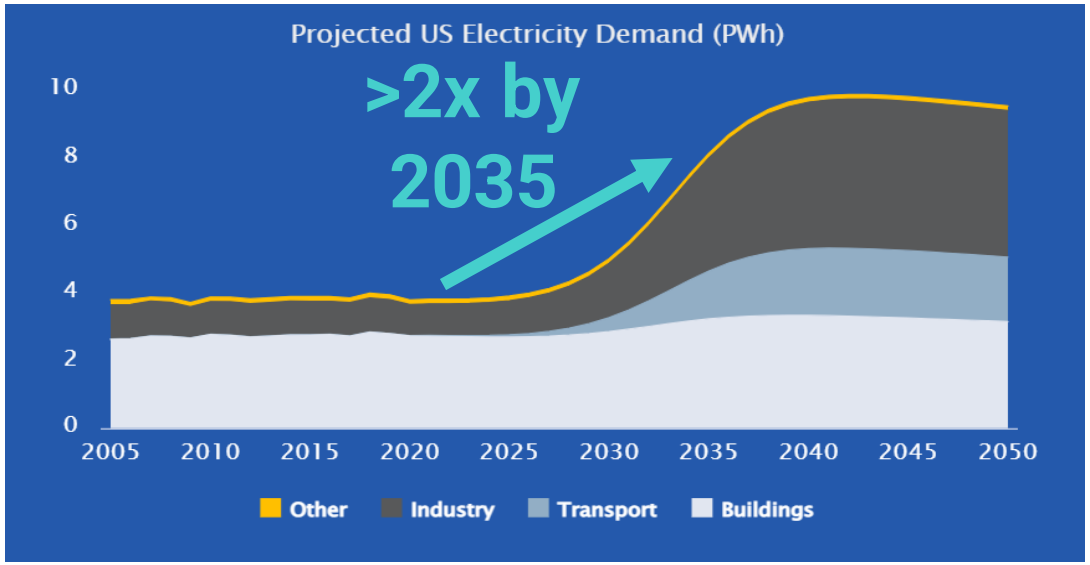
Achieving 1.5°C alignment requires the US electric sector to *reliably* meet ~2x demand while reducing emissions by 80% by 2035 - *not including AI-driven growth*





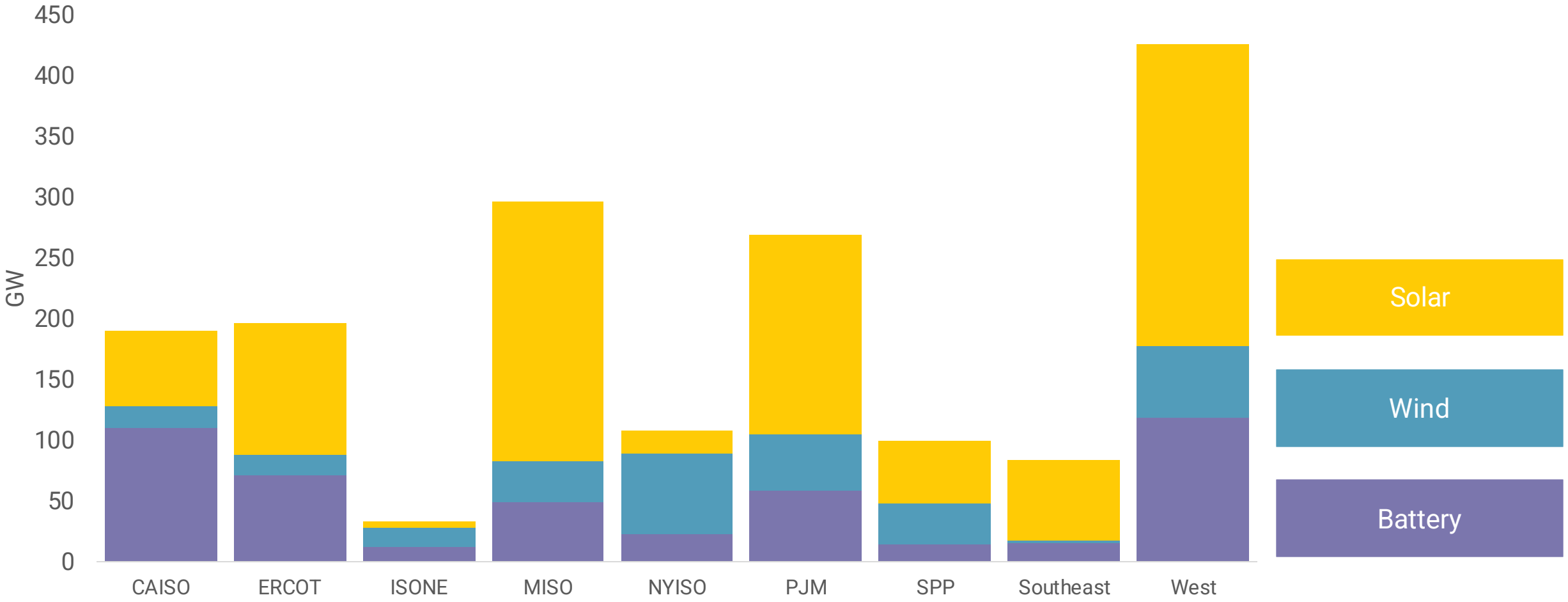
The Inflation Reduction Act (IRA) provides powerful incentives to supercharge both clean electricity deployment and electrification demand





Demand projection for 1.5°C aligned scenario

But US interconnection queues now have over 1.3 TW of renewables and storage with 3–5 years of wait time — a key barrier to 1.5°C alignment



Clean repowering — deploying clean energy using existing fossil plants' interconnections — can accelerate interconnection of cost-competitive clean energy

Regional interconnection rules include two cases that allow for a more streamlined process

Two key **IRA incentives** improve the economics

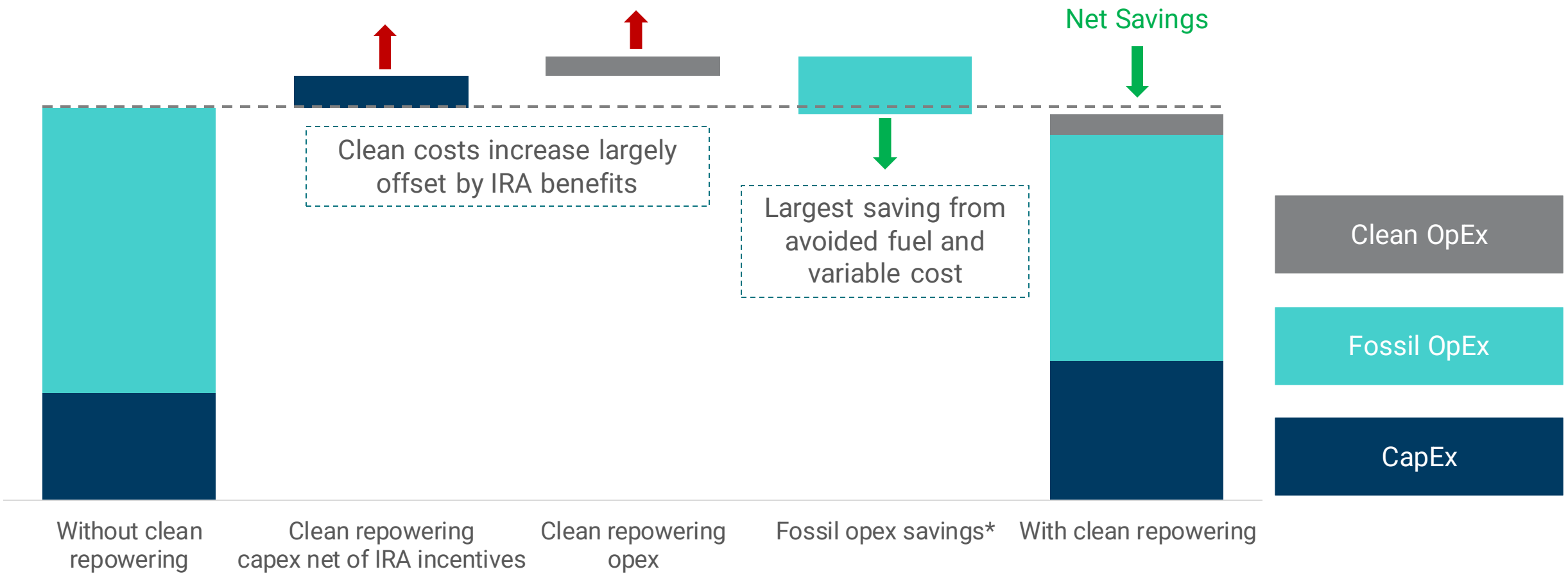
Surplus interconnection service: adding new generation at the site of an *existing* plant that would continue operating

Energy community tax credit bonuses: +10% on ITC or PTC

Generator replacement: adding new generation at the site of a *retiring* unit or plant

DOE Energy Infrastructure Reinvestment (EIR) Loans: up to $250B

Clean repowering creates savings by reducing fossil operating costs and offsetting clean capital costs with IRA incentives



*Including additional start up and ramp costs from lower utilization

Clean repowering is a 250 GW “no-regrets” option, as it can reduce system costs by an NPV of $21B over a 30-year planning horizon while adding resources to improve reliability

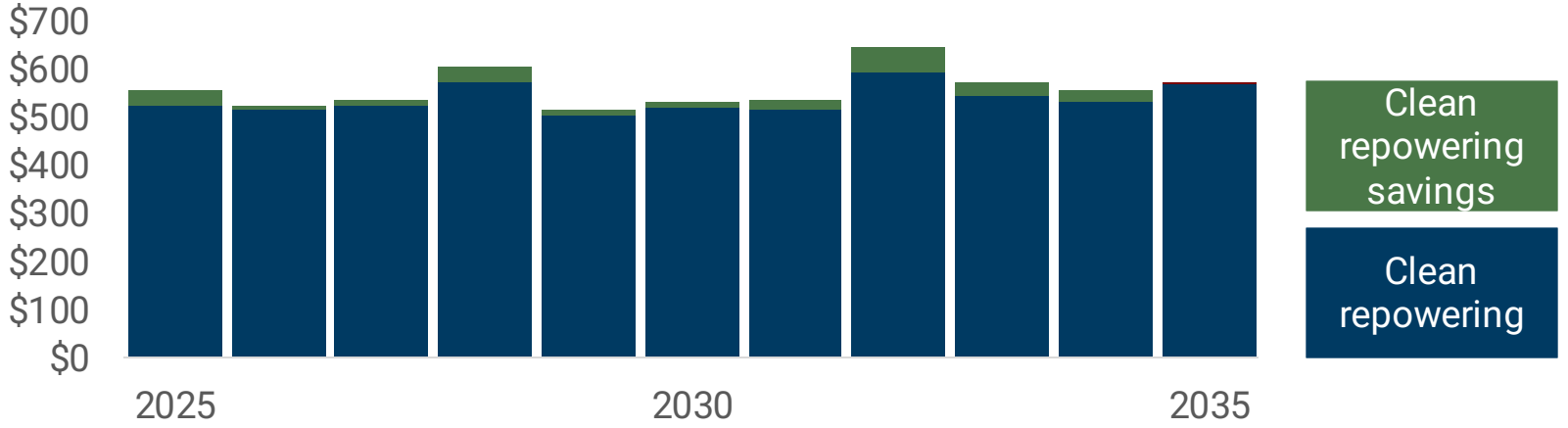
Affordability

- Avoids high costs of fossil fuel use and new transmission build
- Reduces interconnection process costs

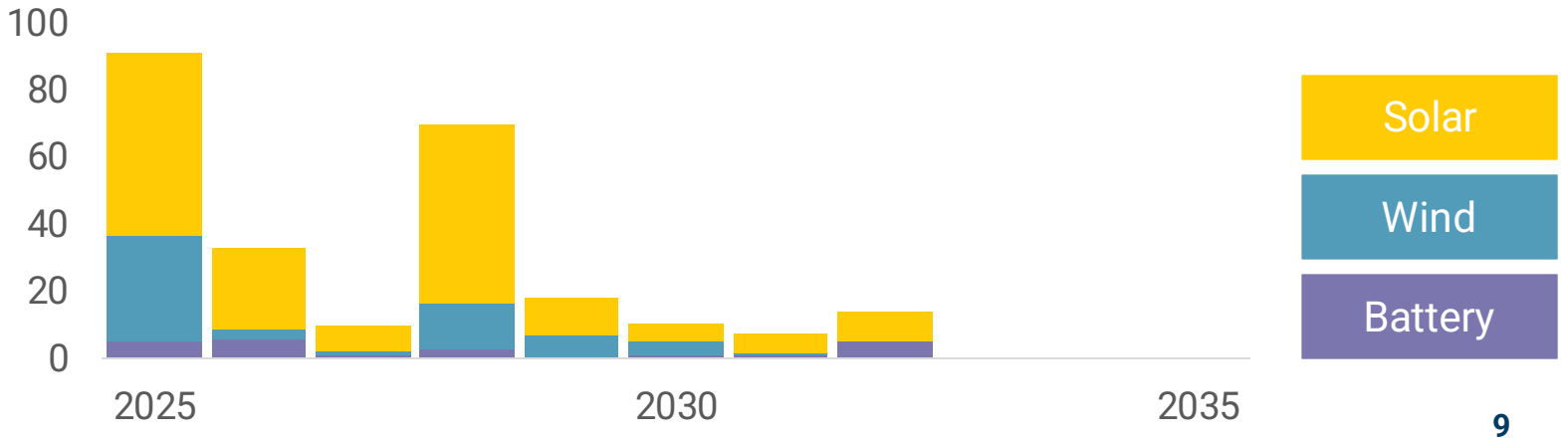
Reliability

- Minimizes grid impacts of new generation + retirements
- Faster interconnection can help mitigate near-term reliability risks

Clean repowering annual savings ($B)



Clean repowering annual deployment (GW)

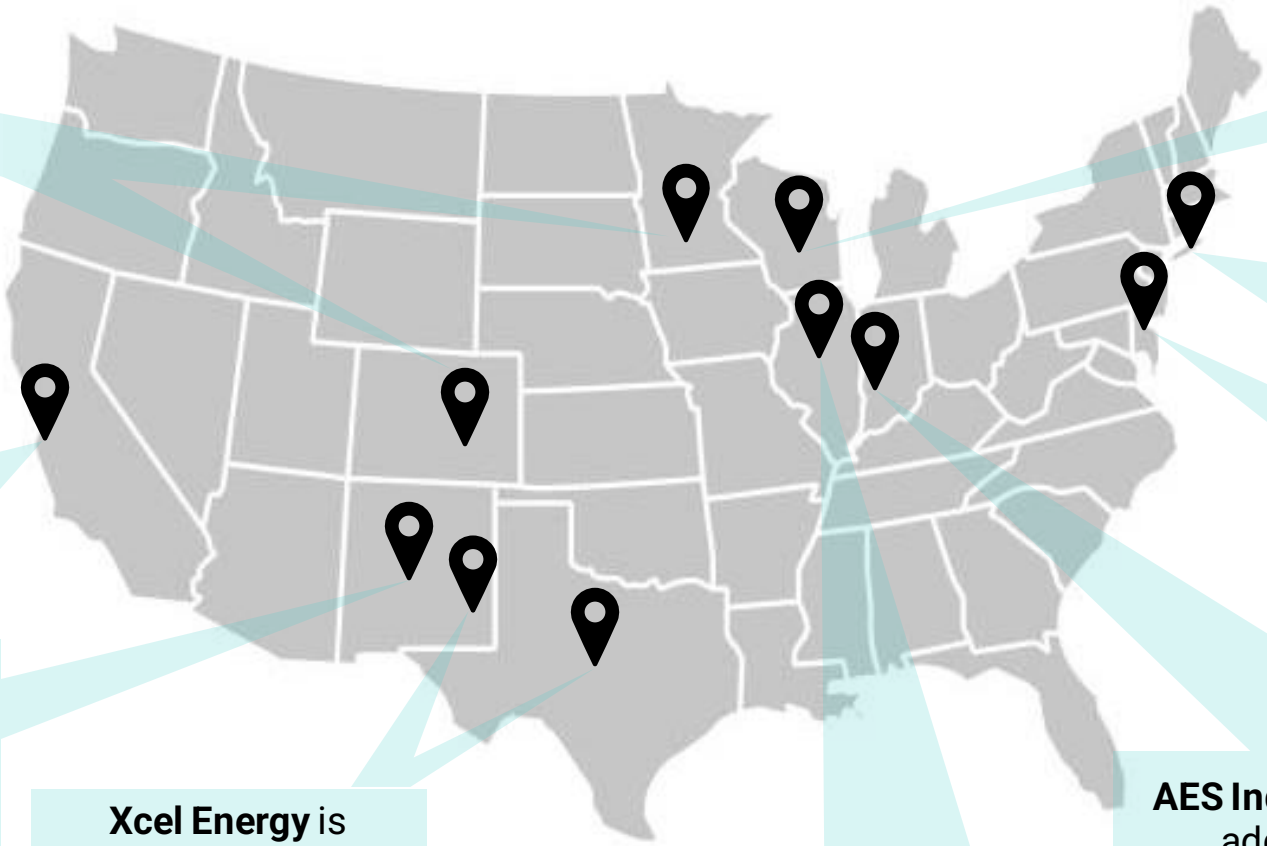


Plans for clean repowering projects are in development nationwide, and growing

Xcel Energy plans to replace coal plants in **Minnesota** and **Colorado** with solar and long-duration iron-air storage

Vistra replaced its **Moss Landing** natural gas plant with 750 MW of 4-hr battery storage

PNM is prioritizing storage resources that "leverage existing interconnections" in its latest RFP



Xcel Energy is adding solar to two of its oldest natural gas units in **New Mexico** and **Texas**

Vistra is retiring its **Joppa** and **Edwards** coal plants and replacing them with battery storage

Alliant Energy received a grant from the DOE Office of Clean Energy Demonstrations to pilot a **compressed CO_2 energy storage** project at its Columbia Energy Center

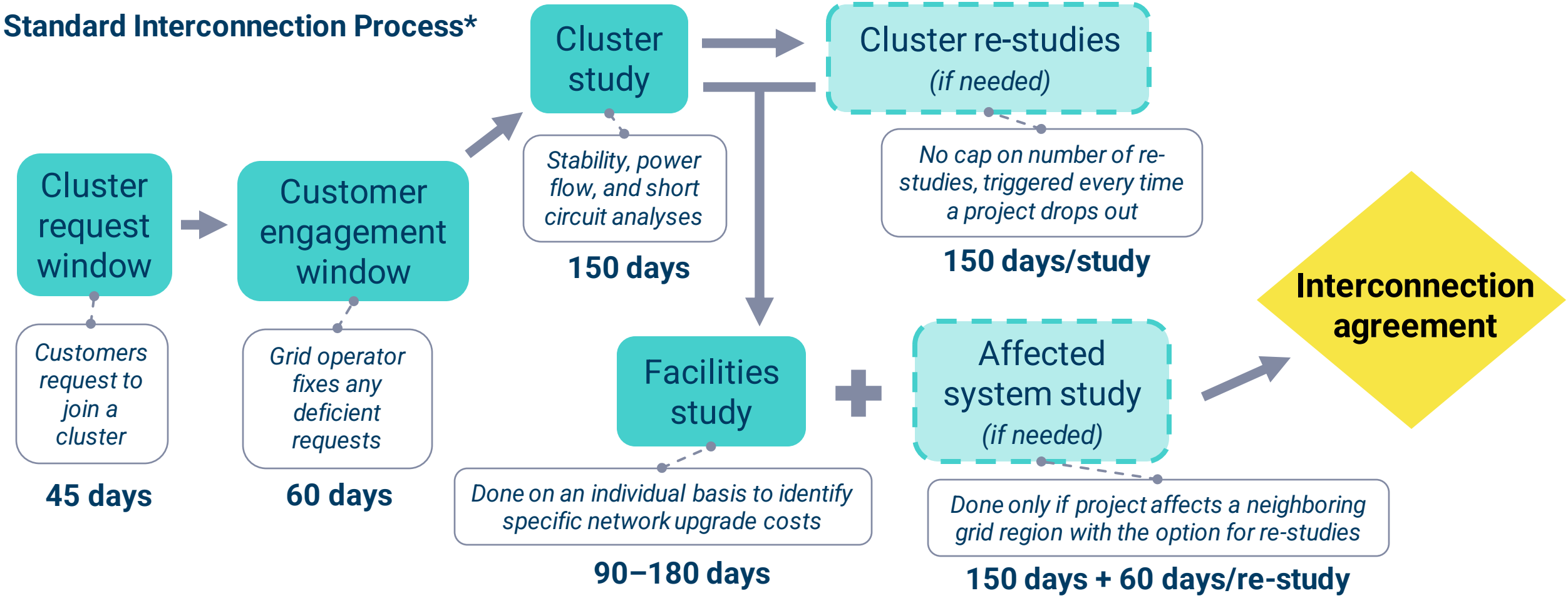
Several offshore wind projects along the East Coast are looking to use surplus or retiring fossil plant interconnections to connect to the grid

Elevate Renewables is deploying storage at existing natural gas generation facilities and currently has a pipeline of 5 GW across 25 locations in the Mid-Atlantic

AES Indiana is adding 200 MW of storage (in addition to natural gas) to its retiring **Petersburg** coal-fired power station

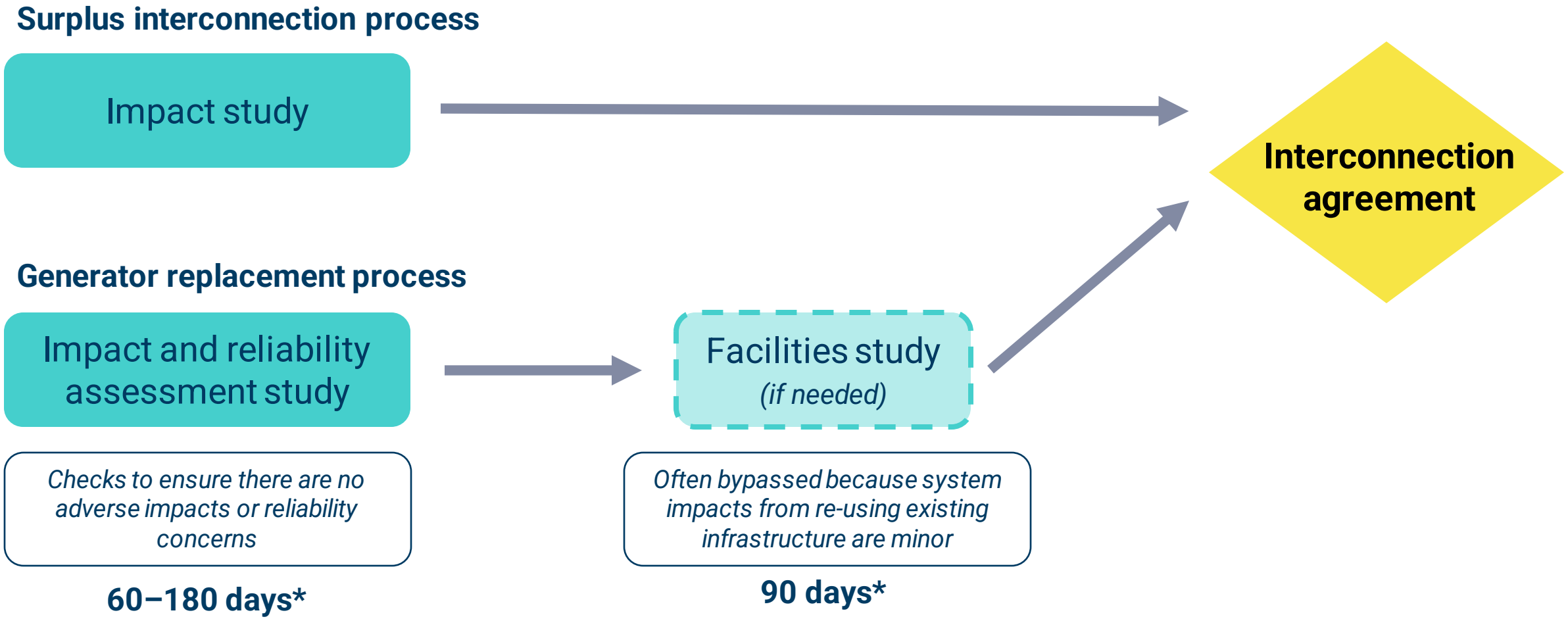
Clean Repowering:
How and why interconnection fast-tracks work

The standard interconnection study process has been a major source of project delays and costs



*Updated to reflect FERC Order 2023

“Fast-track” interconnection processes are shorter and simpler than the standard process

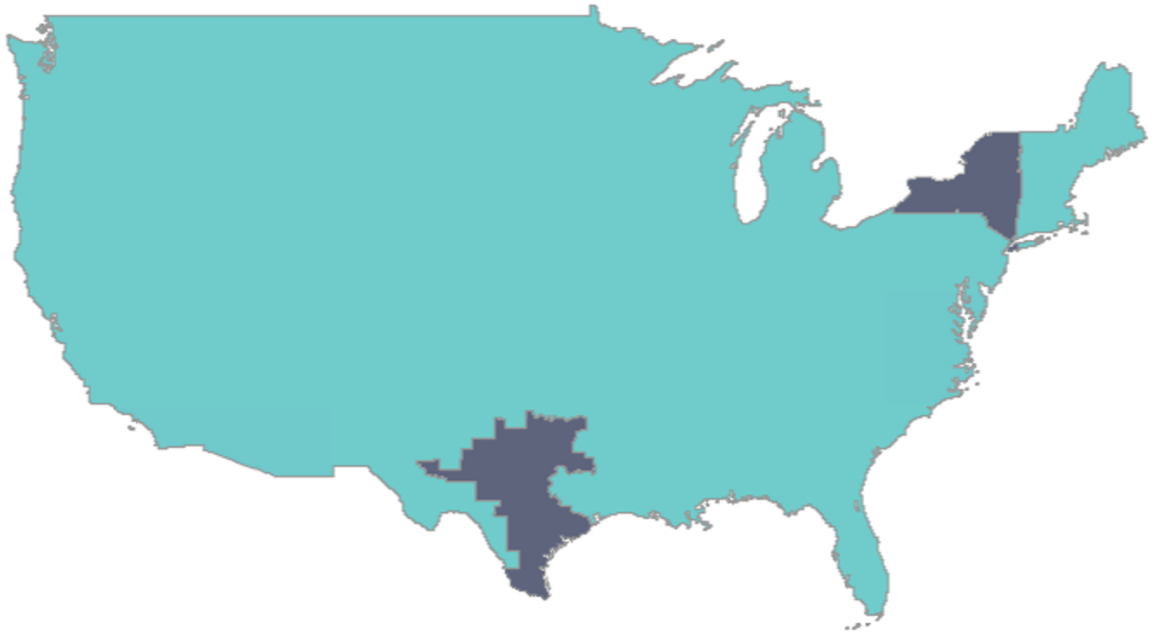


** Times vary by region and are not binding*

Surplus interconnection service requests are governed by a federal standard (FERC Order 845)

Key Components of FERC Order 845

- Priority is given to existing generation owners
- No network upgrades allowed
- Must not exceed total interconnection service of existing plant
- Interconnection rights expire within one year of existing facility retiring



All regions in the United States except for **NYISO** and **ERCOT** follow Order 845 requirements

- **NYISO** received a waiver based on its treatment of existing grid resources
- **ERCOT** is not FERC-jurisdictional and only has a process for adding storage to solar PV resources

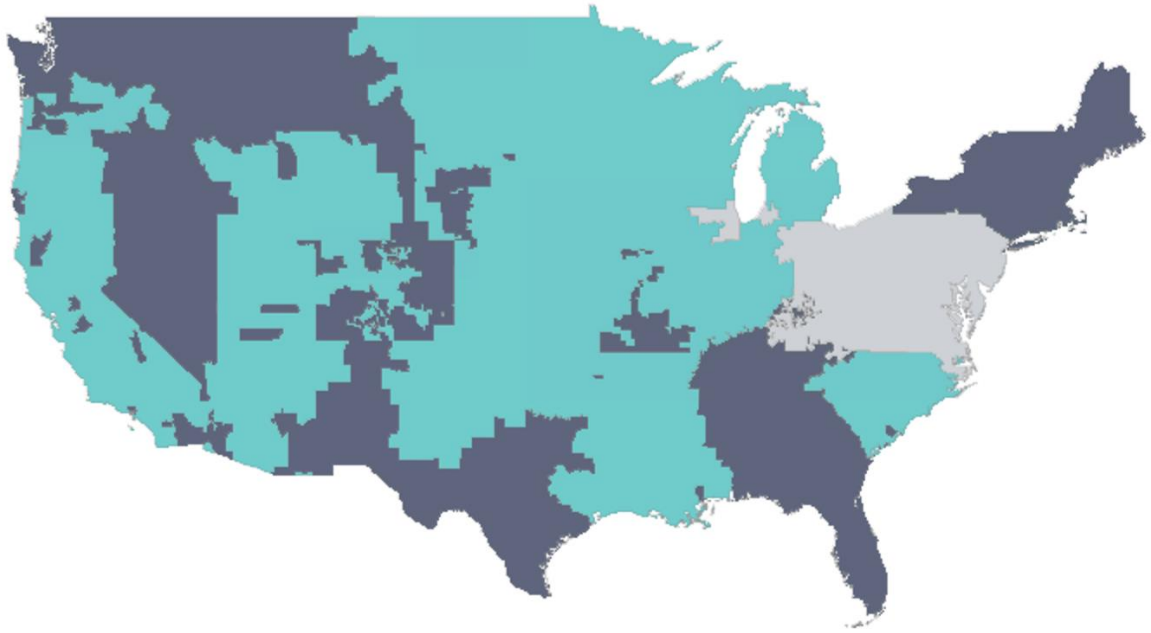
✓ *Has a surplus interconnection process*

✗ *Does not have a surplus interconnection process*

Generator replacement processes that are separate from the queue exist in some regions but not others

- **MISO** set the standard in 2018 with its generator replacement interconnection process
  - Requests must be made at least **one year prior** to retirement and new generation must come on line **within three years**
  - Initial process included **restrictions on plant ownership** that have been amended and relaxed over time
- **CAISO** and **ERCOT** have more limited processes that allow for in-kind replacements only
  - CAISO makes an exception for batteries at fossil plants
- **PJM** and **ISO-NE** do not have defined processes, yet
  - **PJM** initiated a stakeholder dialogue to consider the creation of a process in July 2023

Spreading generator replacement processes to new regions can increase the scale of the opportunity

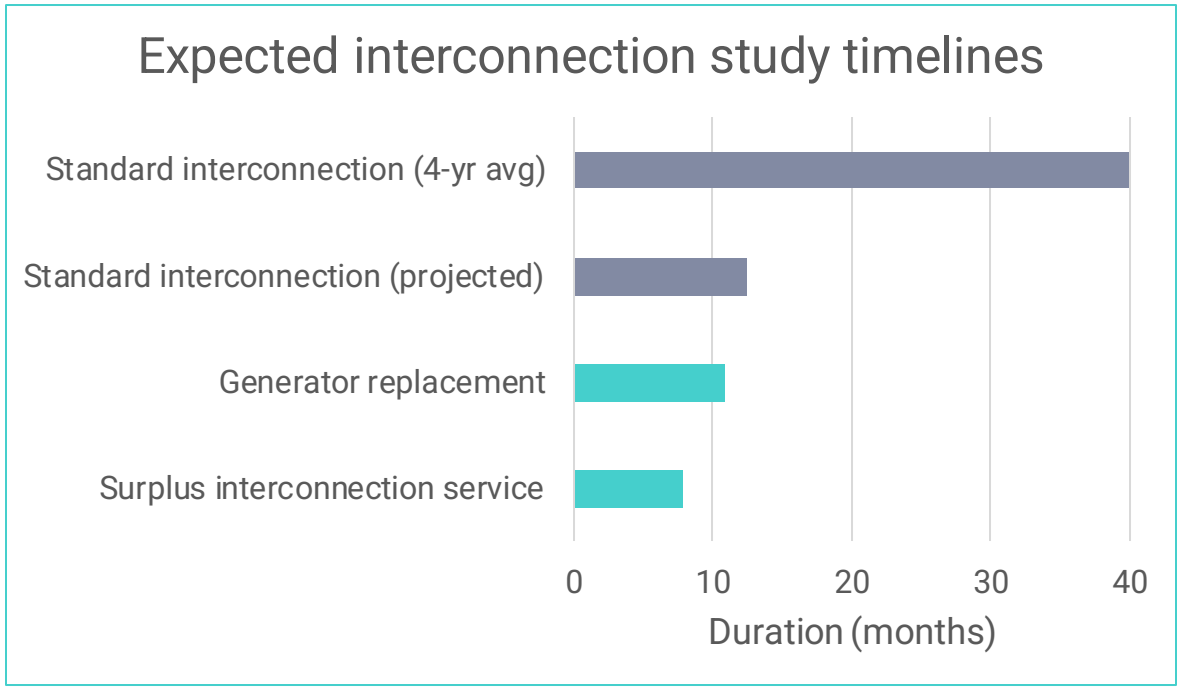


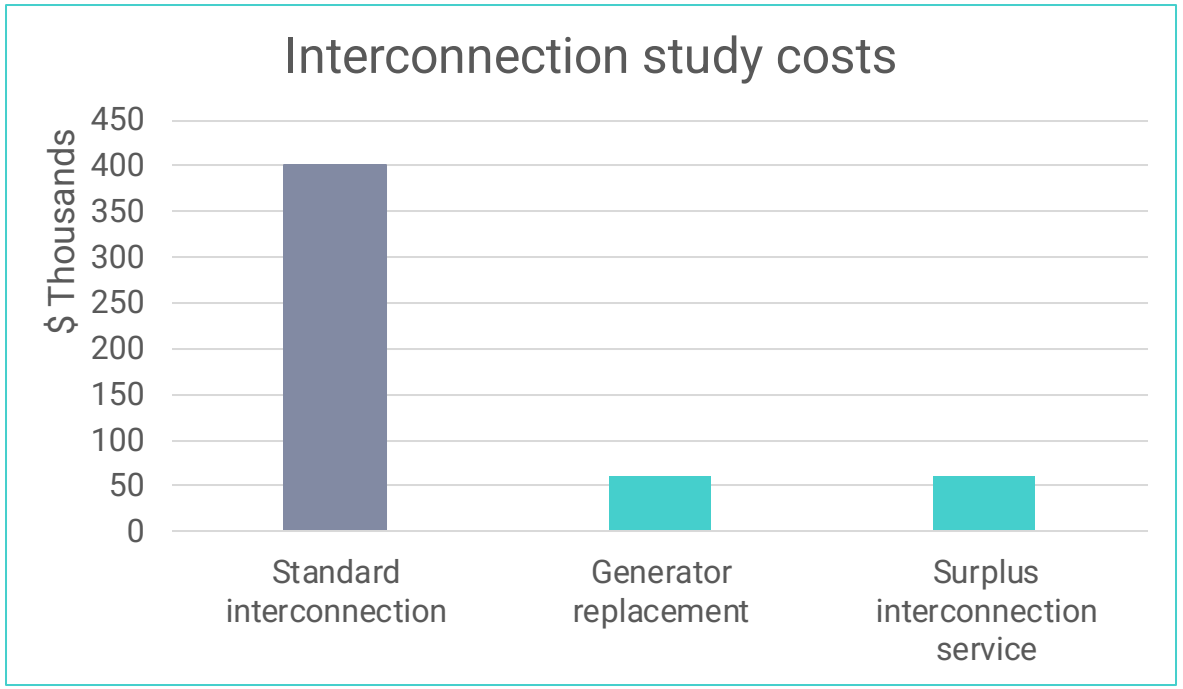
Has a generator replacement process separate from the standard interconnection queue

Separate generator replacement process pending

Does not have a separate generator replacement process

Both “fast-track” processes significantly reduce interconnection study timelines and costs





Data sourced from MISO; timelines and costs are comparable across regions

What is the case for a separate fast-track interconnection process?

Projects are connecting to the grid at **the same point of interconnection** (POI) as existing or retiring generation.

The existing generation has a set level of **capacity injection rights** that it may not be fully utilizing or will no longer be utilizing, if retiring.

The new on-site generation can efficiently utilize the spare capacity injection rights, **minimizing impact on the grid** compared to new "greenfield" generation.

Given differences in technologies and capabilities of the new generation, some level of interconnection study is needed, but the **study process can be streamlined** and simpler than the full interconnection study process.

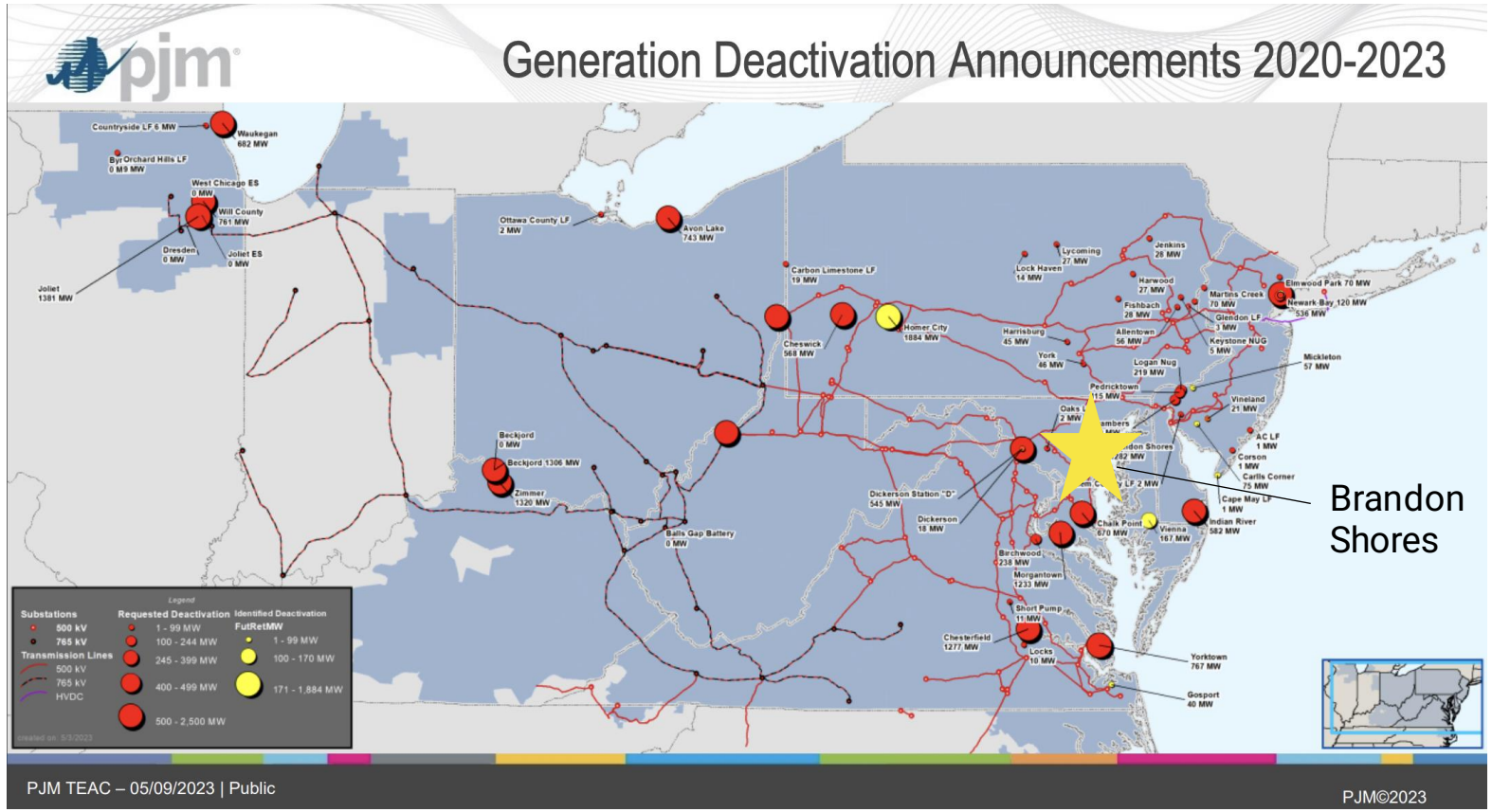
Clean repowering projects can help **maintain reliability** and **support local economic development and policy objectives** by connecting to the grid expeditiously and avoiding the need for costly, time-consuming transmission network upgrades.

Clean repowering is a multi-step, multi-jurisdictional process

Why is clean repowering needed?

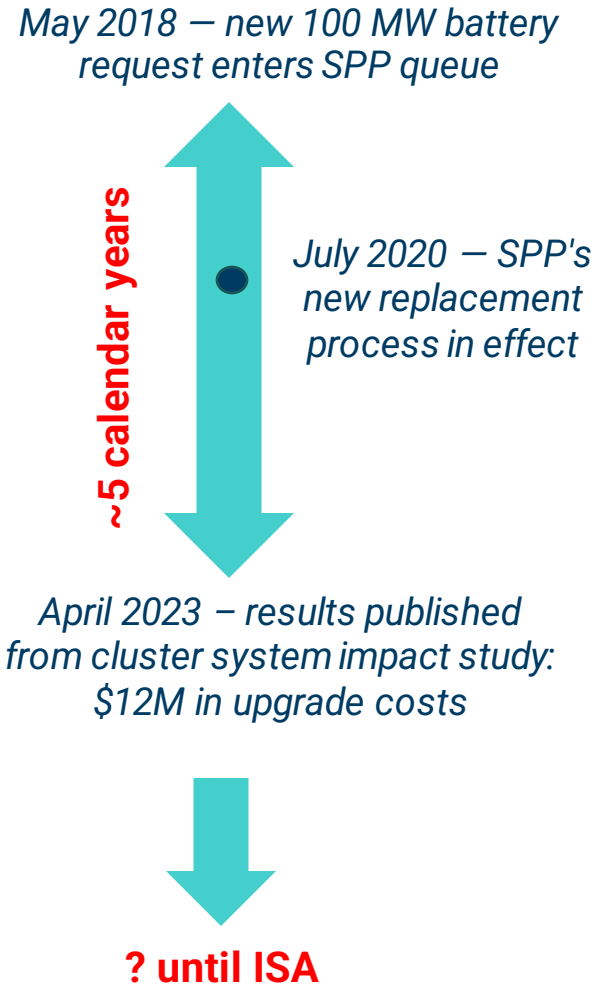
Ex. 1: Brandon Shores coal plant retirement delayed due to transmission impacts, lack of timely replacement options

- Brandon Shores coal plant in MD announced plans to retire in **2025**
- Deactivation study revealed significant **transmission upgrades** that would be required, necessitating delayed retirement, RMR contract
- 260 MW of storage at Brandon Shores are **waiting in the queue,** likely until ~2026
- Root causes of this sub-optimal outcome include lack of proactive transmission planning + **lack of efficient process for generator replacement in the region**



Why is clean repowering needed?

Ex. 2: OPPD's planned retirement of two coal units stymied by the slow interconnection of storage replacement resources



- OPPD had initially planned to **retire** its North Omaha Station coal plant at the end of 2023.
- Now, partly due to the delayed interconnection of its planned storage replacement project, OPPD plans to **keep operating the plant until 2026.**
- The storage project in question submitted an interconnection request in 2018 with an **expected in-service date of December 2024.**
- In April 2023, SPP published its System Impact Study for the cluster including the project, allocating nearly **$12M in upgrade costs** to the storage project.
- OPPD and others have cited the **delay in this project's progress through the interconnection queue** as a primary reason for postponing the retirement of their remaining coal units.

[*Note: SPP filed with FERC to create a generator replacement process in 2020, which was approved by FERC and effective on July 1, 2020, but that was after the initiation of the interconnection request for this storage project*]

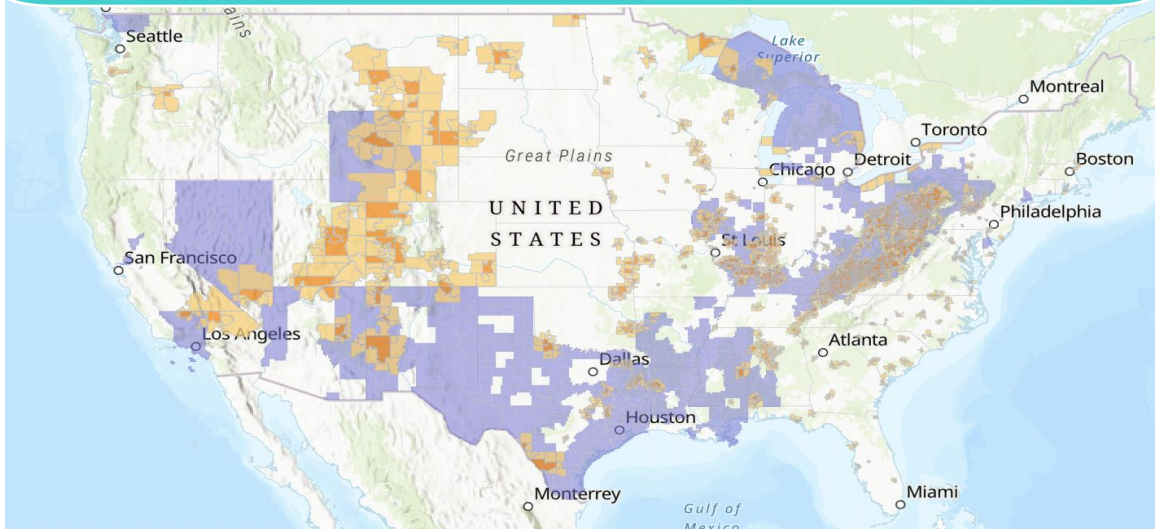
Clean Repowering:
How IRA incentives enhance the economics

Pre-IRA, clean energy incentives didn't work for fossil-heavy electric utilities and their customers: now they do

Utilities owning 80% of coal could efficiently use tax incentives to build **just 4 GW of solar per year — nationally.**	**Tax transferability and direct pay**
Tax normalization rules meant that IOU-owned solar + storage was far more expensive for consumers than PPAs.	**No storage ITC normalization**
New solar was seen as a threat to utility revenues and a **mandatory cost burden on consumers.**	**PTC for solar, LMI and EJ tax adders**
Fossil capital costs that don't go away with clean deployment **cost consumers ~$25B/year.**	**Energy Infrastructure Reinvestment (EIR)**
Permitting, transmission, and interconnection barriers make building out RE very challenging.	**EIR for reconductoring**

The IRA improves the economics of the clean repowering opportunity: Tax credits

Energy Community Tax Credit Bonus



- ✓ Projects qualify for a 10% bonus on the ITC and PTC if they are:
  - Located in or adjoining a coal closure (mine or power plant) community
  - On a site considered brownfield
  - In a metropolitan statistical area (MSA) that has fossil employment above 0.17% ***and*** an unemployment rate that is higher than average

Direct Pay

- ✓ States, localities, tribes, co-ops, and nonprofits receive a direct payment for the dollar value of the tax credit

Tax Credit Transfer

- ✓ Entities claiming tax credits can sell them to other buyers for cash, creating a tax credit transfer market

The IRA improves the economics of the clean repowering opportunity: DOE EIR program

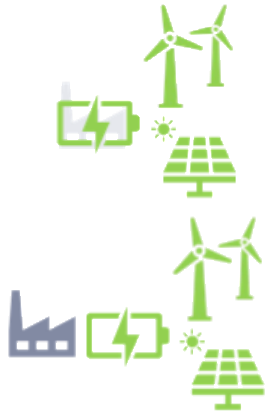
Department of Energy (DOE) Loan Program Office's (LPO's) Energy Infrastructure Reinvestment (EIR) Program

Qualifying Project

- Retool, repower, repurpose, or replace energy infrastructure that has ceased operations; OR
- Enable operating energy infrastructure to avoid, reduce, utilize, or sequester air pollutants or GHGs

→ **Generator replacement**

→ **Surplus interconnection**



Energy Infrastructure

A facility and associated equipment used for:

- The generation or transmission of electricity; OR
- The production, processing, and delivery of fossil fuels, fuels derived from petroleum, or petrochemical feedstocks

$250 billion in direct loan or loan guarantee authority

Can cover up to 80% of project costs and be repaid over up to a 30-year term

Priced at a 37.5bp spread over treasuries of comparable tenor

Must reach conditional commitment by September 30, 2026

Other Explicit Requirements

Must pass through savings and include community outreach

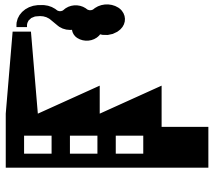
- Electric utilities must pass on financial benefits to customers/communities
- All entities must develop outreach plan

Remediation explicitly included

Examples:
- Plant decommissioning
- Coal ash ponds
- Mine reclamation
- Water pollution

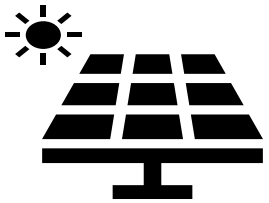
Electric utilities can utilize EIR low-interest debt to pull forward reinvestment in clean energy

Traditional Financing: Reinvestment in 2031



1 GW existing asset
$400M unrecovered balance

Plant balance paid off through rates (6.6% ROR)

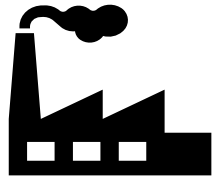


New Solar + Storage in 2031

Outcomes

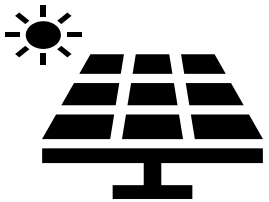
	2025	*30-year NPV*
Utility Earnings:	$15M	$430.1M
Ratepayer Costs:	$224M	$1.8B

Accelerated Reinvestment with EIR in 2025



1 GW existing asset
$400M unrecovered balance

EIR refinances unrecovered balance over 30 years



New Solar + Storage partially financed w/EIR debt

Outcomes

	2025	*30-year NPV*
Utility Earnings:	$67.1M	$488.6M
Ratepayer Costs:	$80.8M	$1.8B

Clean Repowering:
The scale of the opportunity

Our analysis identifies attractive clean repowering opportunities across the country by modeling the potential in each balancing authority

The model begins with all major **existing fossil generation** in the balancing authority and identifies the **potential renewable sites** within 45 km.

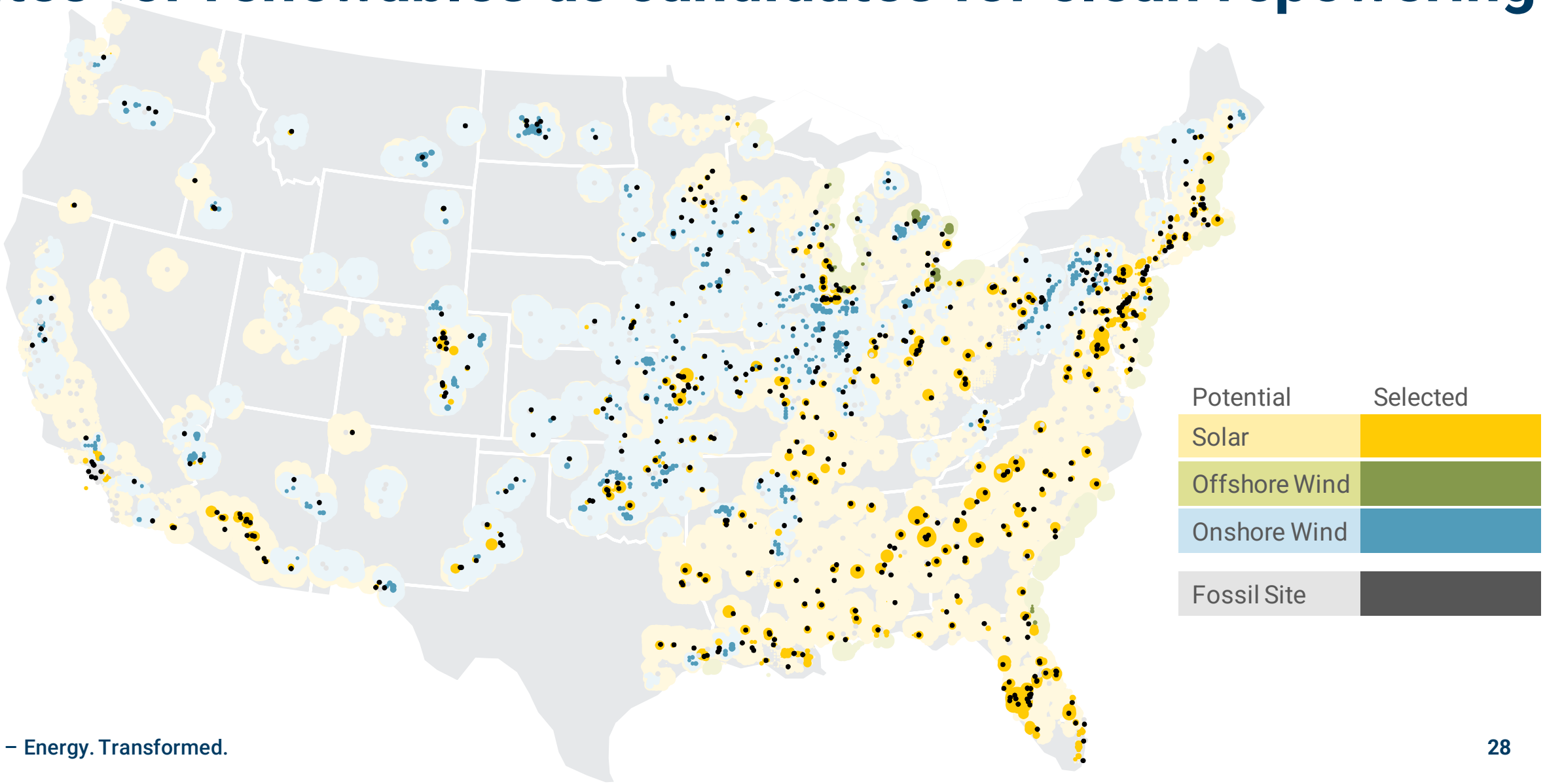
It then creates a set of portfolios in which it **selects increasing amounts of renewables and storage** at the sites where renewables are most attractive relative to the incumbent fossil generator.

For each portfolio, it **simulates hourly operations** using 15 years of historical data to estimate production costs and ensure there is no lost load.

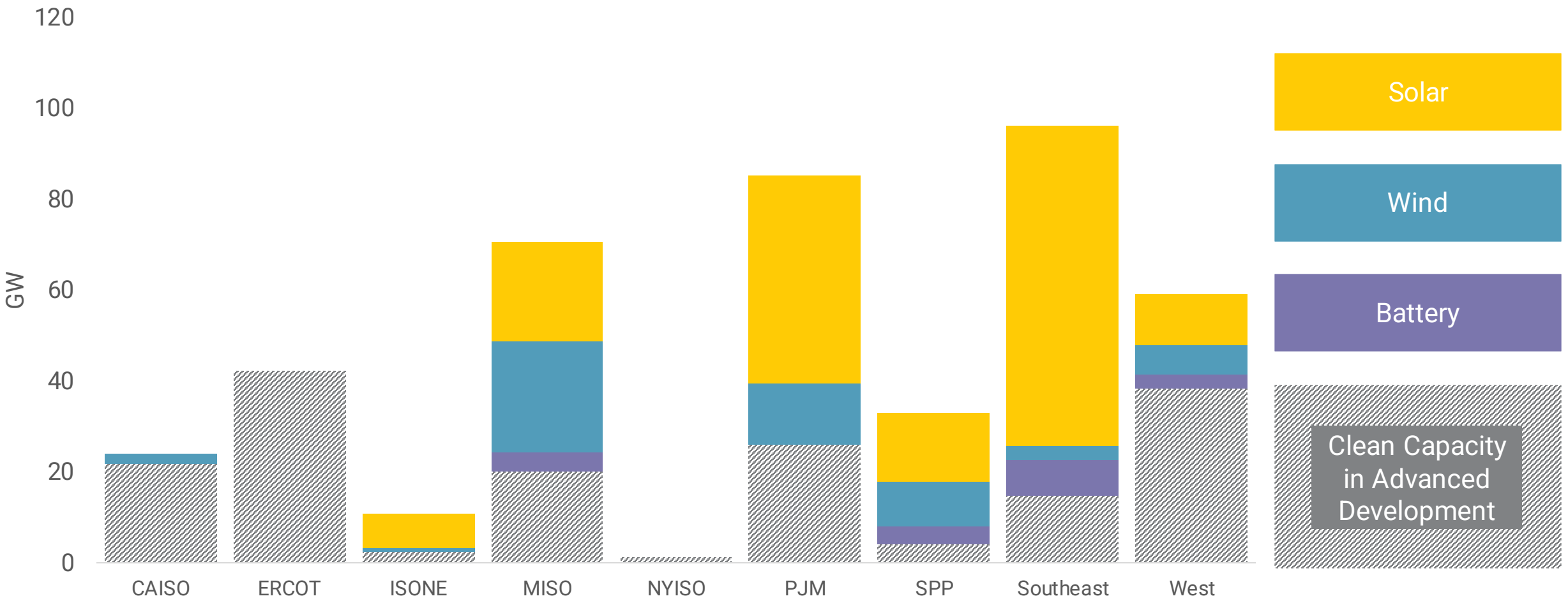
Finally, it selects the sequence of **portfolios that maximizes utility earnings** without increasing a balancing authority's aggregate levelized cost of generation, **factoring in applicable IRA provisions.**

See Modeling Approach for further details.

The model selected the most economically attractive sites for renewables as candidates for clean repowering

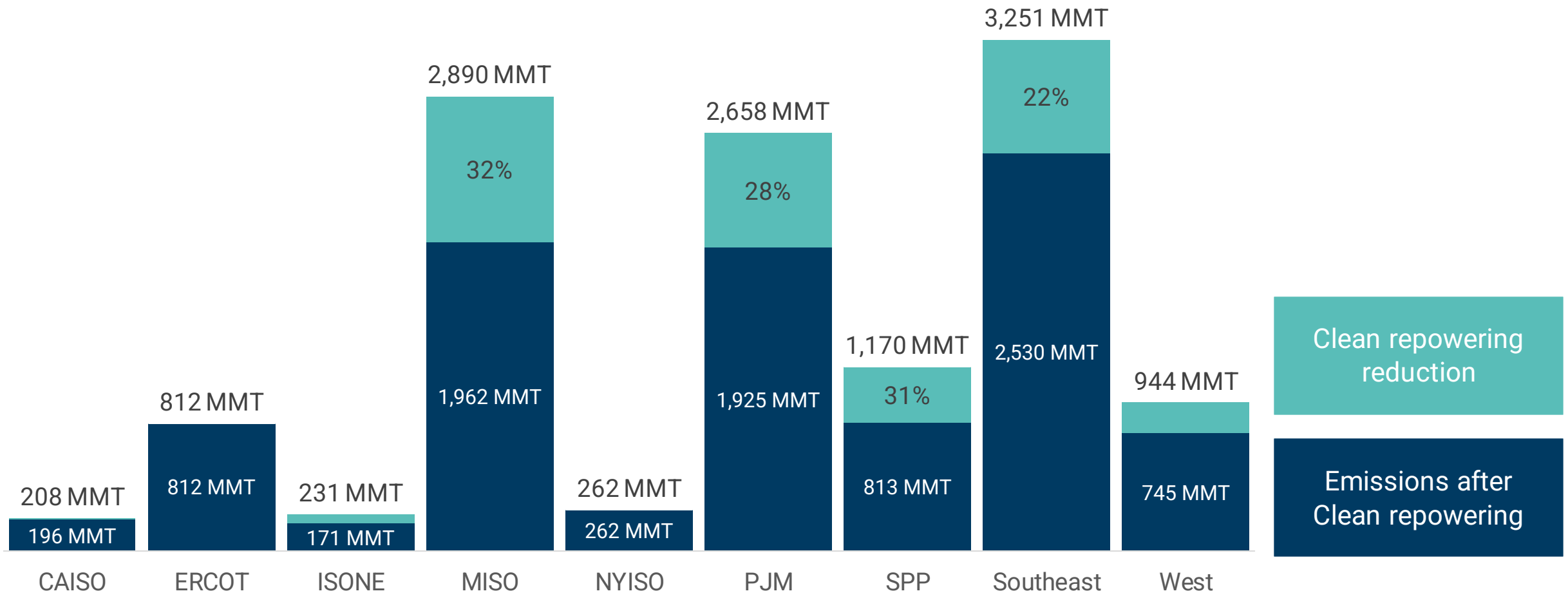


Clean repowering is a 250 GW opportunity* concentrated in MISO, PJM, and the Southeast

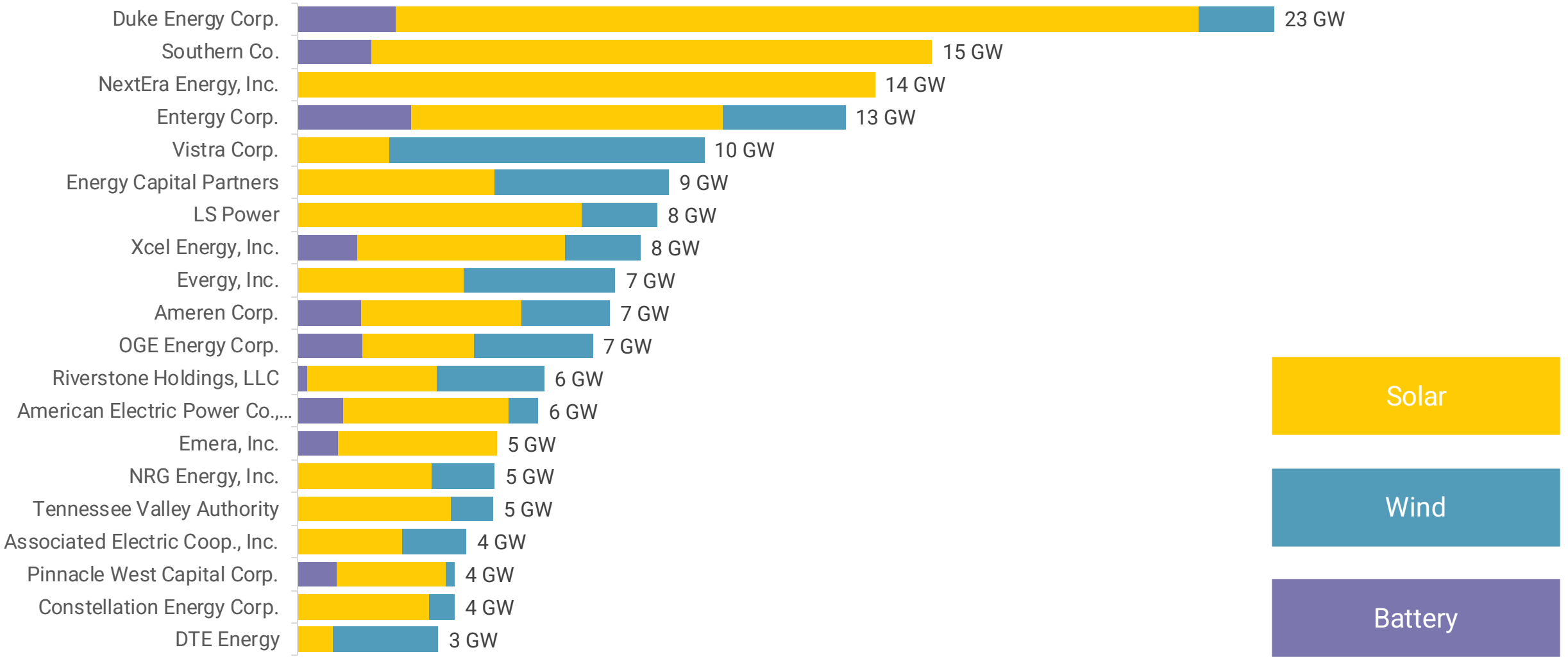


*on top of the 170 GW of clean generators in advanced development

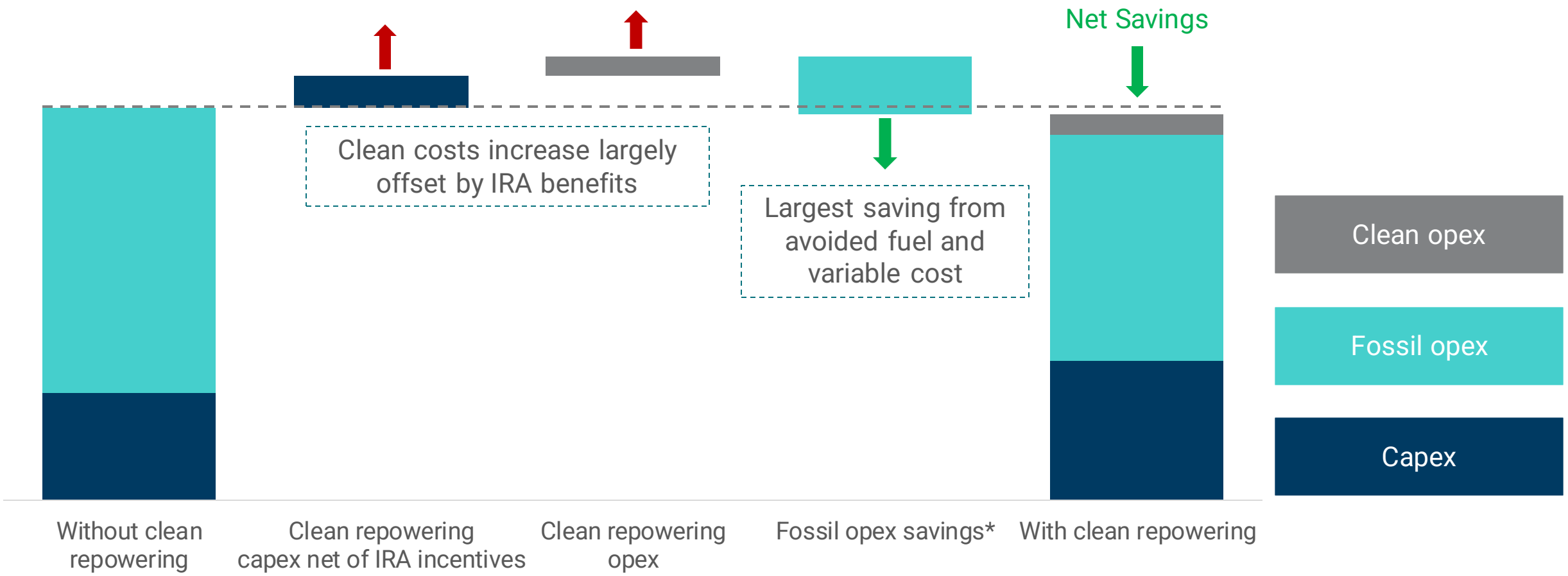
Clean repowering could reduce US electricity emissions by 25% relative to our counterfactual baseline through 2035



Over half of the clean repowering opportunity is concentrated with 20 generation owners



Clean repowering creates savings by reducing fossil operating costs and offsetting clean capital costs with IRA incentives



*Including additional start up and ramp costs from lower utilization

Clean Repowering:
Conclusions and calls to action

With the IRA, the time is now to look at uneconomic or underutilized generation and consider clean repowering

Takeaways

- Clean repowering can support **faster interconnection** of clean energy resources and minimize costly transmission network upgrades (for both the developer and the system as a whole).
- IRA incentives make this **even more economic** for asset owners to pursue — but some, like the EIR, are time-limited.
- Maximizing this opportunity will ensure we make the **best use of the existing grid** and minimize reliability risks associated with retiring generation.

Calls to action

Generation Owners	**Build** new clean generation at existing generation sites where possible
State Regulators	**Evaluate** IRPs and generation asset decisions accounting for economic and interconnection realities
System Operators and National Regulators	**Ensure** interconnection rules for such projects are just and reasonable, and extend throughout the United States

Clean Repowering: Region-specific slides

MISO: Interconnection Fast-Track Rules

Generator Replacement

- Replacement generator must be at same POI + voltage level
- Request must be made **at least 1 year before retirement** of existing plant, and new generator must come on line **within 3 years of the retirement date**
- Initial rules prohibited changes to **plant ownership** during the period from a year prior to making request until new generator is on line
    - MISO modified these rules in 2021 to permit **partial transfer** of the existing plant (incumbent must retain at least 25% equity ownership and ability to direct performance of the retiring plant)
    - FERC granted Vistra waiver in 2022 allowing for **affiliate ownership** of replacement generator

Surplus Interconnection Service

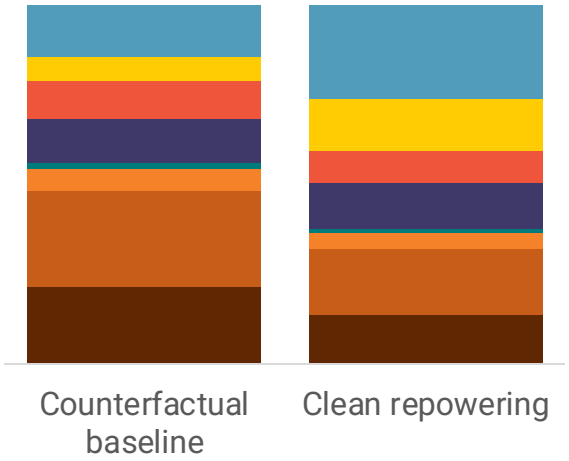
- Process follows FERC Order 845 guidelines (compliance filing approved June 2020)

Relevant Examples

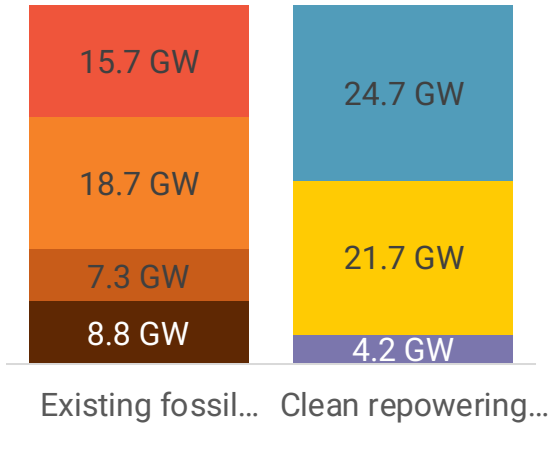
- **Vistra** plans to replace two recently retired Illinois coal plants (the 948 MW Joppa plant and 560 MW Edwards plant) with 37 MW **battery storage** projects owned by subsidiaries.
- **AES Indiana** (formerly IP&L) had planned to acquire a 250 MW **solar**/150 MWh **storage** project from NextEra to replace retiring capacity at its coal-fired Petersburg Generating Station; its latest IRP includes plans for 800 MWh of **storage** and **natural gas.**
- **Xcel Energy** has issued RFPs for a combined 710 MW of **solar** to be built near the site of its retiring Sherco Generating Station in Minnesota, with an aim of the new capacity being operational by 2025.

MISO opportunities

Generation in 2035

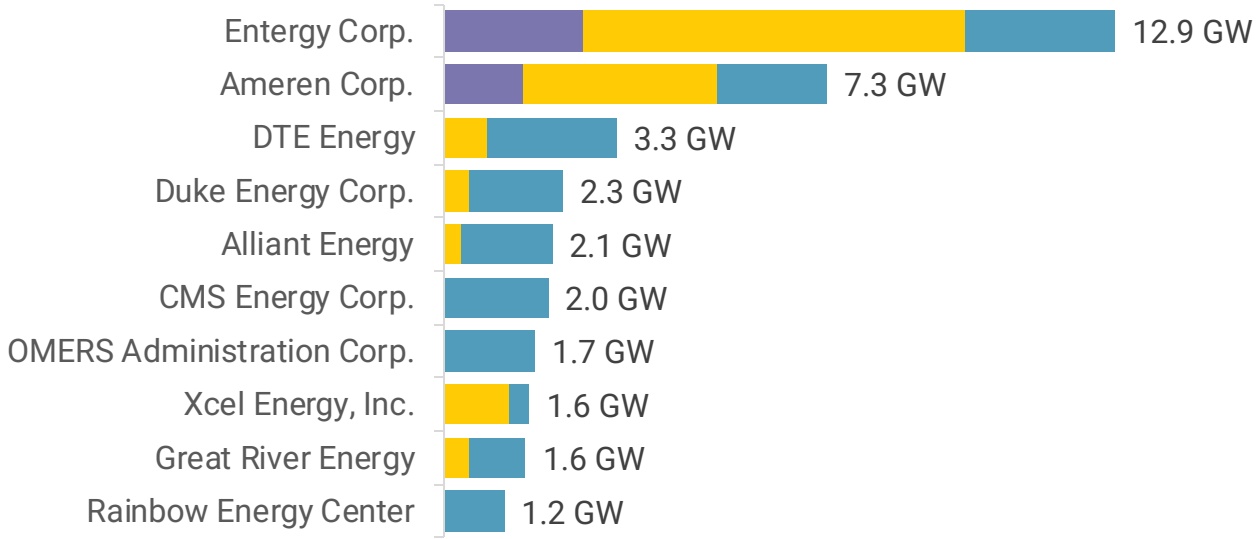


Clean repowering capacity



Clean repowering sites

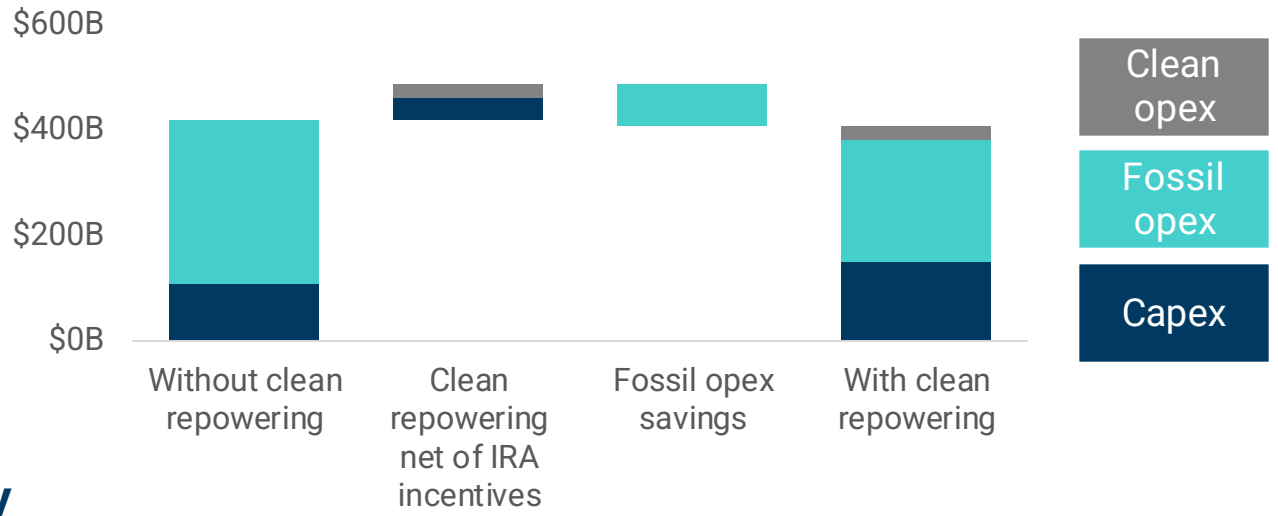
Top generation owners by clean repowering opportunity



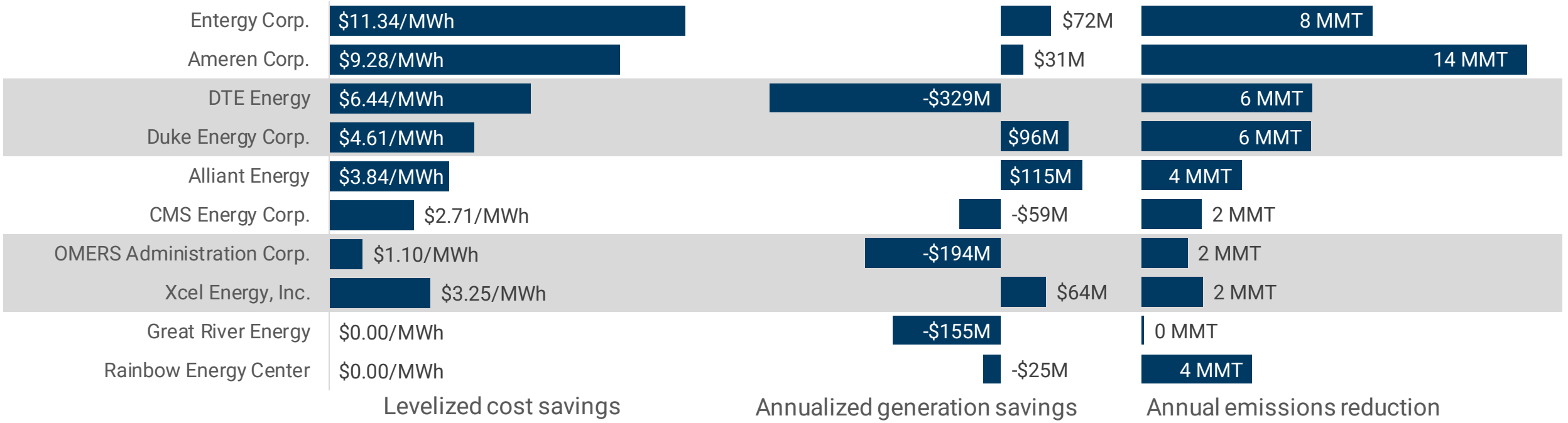
MISO savings

Total regional annualized savings	$ 608 million
Total reduction in annual carbon emissions	84 MMT

Cost impact of clean repowering



Top generation owners by clean repowering opportunity



Negative savings indicate cost increases. A generation owner's levelized cost or annualized generation cost can increase with clean repowering because of an increase in that owner's total generation or a change in the composition of its generation.

MISO top clean repowering opportunities

							Counterfactual			Clean repowering					
Plant Name	Owner	Ultimate Parent	State	Region	Technology	Capacity	Utilization	Emissions	Annualized NPV	Utilization	Emissions	Annualized NPV	Battery	Solar	Wind
						MW	%	tonne/yr	$million/yr	%	tonne/yr	$million/yr	MW	MW	MW
Sabine	Entergy Texas	Entergy	TX	MISO	Gas ST	2,051	0%	6,621	43.5	23%	2,434	315.5	616	1,409	372
Nine Mile Point	Entergy Louisiana	Entergy	LA	MISO	Gas ST	2,142	0%	43,890	110.7	21%	20,374	266.7	81	1,759	
Midland Cogeneration Venture	Midland Cogeneration Venture	OMERS Administration	MI	MISO	Gas CC	1,849	32%	2,493,802	412.8	50%	874,049	597.1			1,744
Dan E Karn	Consumers Energy Co	CMS Energy	MI	MISO	Gas ST	1,402	0%	-	338.0	39%	-	453.4			1,363
Little Gypsy	Entergy Louisiana	Entergy	LA	MISO	Gas ST	1,251	0%	2,881	32.4	20%	1,154	165.1	355	985	
Rush Island	Union Electric Co - (MO)	Ameren	MO	MISO	Coal	1,242	67%	7,248,526	370.2	47%	2,352,018	420.2	191	476	549
Waterford 1 & 2	Entergy Louisiana	Entergy	LA	MISO	Gas ST	891	0%	1,826	31.9	25%	810	169.0	316	876	
Audrain Generating Station	Union Electric Co - (MO)	Ameren	MO	MISO	Gas CT	814	12%	541,090	264.0	29%	56,794	179.5	357	704	100
Coal Creek	Rainbow Energy Center	Rainbow Energy Center	ND	MISO	Coal	1,210	81%	8,760,449	386.0	84%	4,823,388	406.2			1,156
Sioux	Union Electric Co - (MO)	Ameren	MO	MISO	Coal	1,099	6%	689,965	86.6	29%	129,936	144.5	37	624	444
Cayuga	Duke Energy Indiana	Duke Energy	IN	MISO	Coal	1,062	25%	2,379,032	332.0	45%	1,007,835	398.5			1,015
Baxter Wilson	Entergy Mississippi	Entergy	MS	MISO	Gas ST	1,328	0%	13,632	37.8	10%	7,487	141.9	349	538	
Hot Spring Generating Facility	Entergy Arkansas	Entergy	AR	MISO	Gas CC	715	25%	613,972	282.5	39%	302,701	270.4	160	248	454
Venice	Union Electric Co - (MO)	Ameren	IL	MISO	Gas CT	586	13%	397,602	113.4	27%	43,019	114.4	278	575	
Renaissance Power Plant	DTE Electric Company	DTE Energy	MI	MISO	Gas CT	782	7%	270,899	72.6	40%	80,180	100.5			765
Gerald Andrus	Entergy Mississippi	Entergy	MS	MISO	Gas ST	781	0%	372	27.9	29%	112	103.4			764
Greenwood (MI)	DTE Electric Company	DTE Energy	MI	MISO	Gas ST	815	1%	47,627	78.1	41%	12,576	295.1			761
Monroe (MI)	DTE Electric Company	DTE Energy	MI	MISO	Coal	3,280	43%	12,473,392	1,092.4	34%	7,146,431	1,146.1			726
Lewis Creek	Entergy Texas	Entergy	TX	MISO	Gas ST	543	0%	9,436	25.8	25%	4,321	104.3	192	532	
Marshalltown Generating Station	Interstate Power and Light Co	Alliant Energy	IA	MISO	Gas CC	706	78%	1,775,400	232.9	82%	887,844	192.0			690
Holland Energy Facility	Holland Energy	Holland Energy	IL	MISO	Gas CC	702	62%	1,472,064	227.2	67%	645,561	227.6			686
Vermillion Energy Facility	Duke Energy Indiana	Duke Energy	IN	MISO	Gas CT	692	0%	4,604	34.6	38%	1,149	94.6			673
Goose Creek Energy Center	Union Electric Co - (MO)	Ameren	IL	MISO	Gas CT	684	3%	146,924	59.7	40%	14,199	85.1			669
Washington Parish Energy Center	Entergy Louisiana	Entergy	LA	MISO	Gas CT	400	0%	1,094	24.2	26%	434	95.5	256	395	
Harding Street	Indianapolis Power & Light Co	AES	IN	MISO	Gas ST	663	0%	18,074	67.7	24%	6,507	103.7		644	
R M Schahfer	Northern Indiana Pub Serv Co	NiSource	IN	MISO	Coal	1,943	0%	26,495	12.8	12%	11,582	87.5			623
Raccoon Creek Energy Center	Union Electric Co - (MO)	Ameren	IL	MISO	Gas CT	456	7%	204,472	87.1	28%	16,377	84.3	171	348	98
Big Cajun 2	Louisiana Generating	Cleco	LA	MISO	Gas ST	626	5%	171,436	83.0	28%	49,015	111.9		609	
Emery Station	Interstate Power and Light Co	Alliant Energy	IA	MISO	Gas CC	603	83%	1,665,748	213.1	84%	804,027	173.1			588
Harry L. Oswald	Arkansas Electric Coop	Arkansas Electric Coop.	AR	MISO	Gas CC	600	40%	885,434	148.4	44%	380,547	132.9		481	103
Whiting Clean Energy	BP Alternative Energy	BP PLC	IN	MISO	Gas CC	577	39%	934,314	152.1	54%	326,171	229.0			543
Lake Catherine	Entergy Arkansas	Entergy	AR	MISO	Gas ST	752	0%	-	0.4	23%	-	51.4			540
Lakefield Junction	Great River Energy	Great River Energy	MN	MISO	Gas CT	536	1%	24,971	32.9	45%	4,975	91.8			522
Pinckneyville	Union Electric Co - (MO)	Ameren	IL	MISO	Gas CT	380	40%	743,409	183.7	30%	110,360	81.4	148	369	
Wheatland Generating Facility	Duke Energy Indiana	Duke Energy	IN	MISO	Gas CT	500	0%	1,724	19.4	29%	279	54.5		387	105
Pleasant Valley (MN)	Great River Energy	Great River Energy	MN	MISO	Gas CT	468	1%	33,958	29.3	44%	7,614	81.1			457
Alpine Power Plant	Wolverine Power Supply Coop	Wolverine Power Supply Coop	MI	MISO	Gas CT	454	4%	103,877	44.2	39%	25,847	71.4		4	440
Big Stone	Otter Tail Power Co	Otter Tail	SD	MISO	Coal	450	50%	2,021,413	158.5	72%	1,015,173	156.3			440
Coyote	Otter Tail Power Co	Otter Tail	ND	MISO	Coal	450	54%	2,335,918	156.0	69%	1,085,418	150.0			440
Angus Anson	Northern States Power Co - Minnesota	Xcel Energy	SD	MISO	Gas CT	406	2%	49,367	15.9	45%	13,345	40.6			397
Lawrence County Station	Hoosier Energy R E C	Hoosier Energy Rural Electric Coop.	IN	MISO	Gas CT	402	4%	91,653	30.4	26%	41,943	50.2		391	
Calcasieu	Entergy Louisiana	Entergy	LA	MISO	Gas CT	359	0%	172	21.9	28%	50	58.4	34	52	299
Concord	Wisconsin Electric Power Co	WEC Energy Group	WI	MISO	Gas CT	382	0%	3,397	22.0	30%	708	49.6		281	93

Utilization is essentially the capacity factor of the interconnection; it is calculated as the total generation of all the resources associated with the incumbent fossil generator divided by the capacity of the incumbent fossil generator multiplied by the number of hours in the period.

PJM: Interconnection Fast-Track Rules

Generator Replacement

- **CIR transfers** are permitted, but no process for separate/fast-track interconnection study of new resource
- Currently **considering the development of such a process** via a stakeholder engagement effort launched in late July in the PJM Interconnection Process Subcommittee
  - Issue Charge approved by PJM Planning Committee on June 6
  - Initiated by Elevate Renewables and East Kentucky Power Cooperative

Surplus Interconnection Service

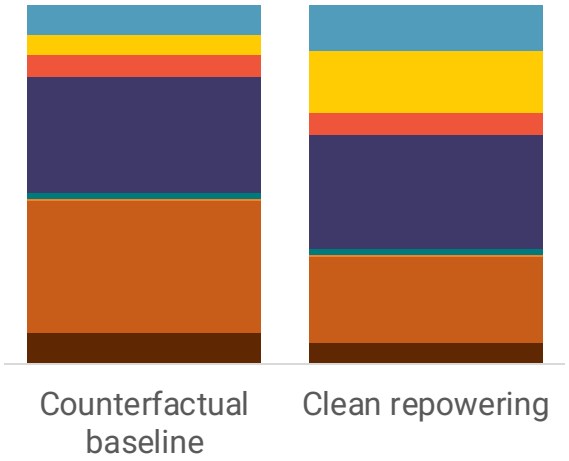
- Process modeled after FERC Order 845
  - Cannot have a "material impact" on the transmission system
  - Cannot impact any customers in the existing queue and network upgrades they might need
- From 2020 (when process began) to 2022, one surplus request has been received

Relevant Examples

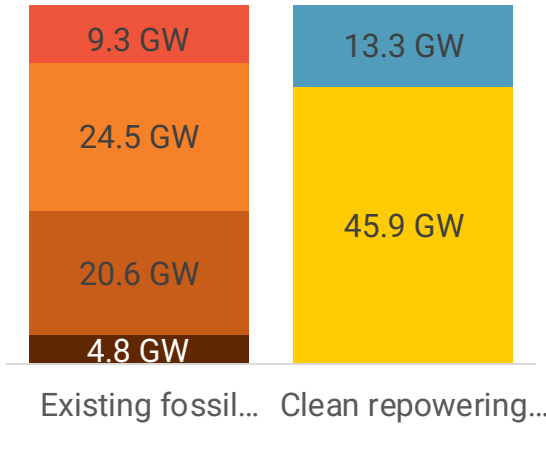
- **Elevate Renewables** is pursuing the deployment of **storage at existing gas generation facilities** using the surplus interconnection process and currently has a pipeline of 5 GW across 25 locations.
- Several soon-to-be-retired coal plants in PJM are receiving significant attention for potential CIR transfers and reuse of their interconnections, including **Homer City Generating Station** in Pennsylvania, which is retiring this summer.
- Offshore wind projects in PJM have paid for CIR transfers from several recently retired coal and nuclear plants and are investigating new options to do so (e.g., **Indian River** coal plant in Delaware, retiring 2026).

PJM opportunities

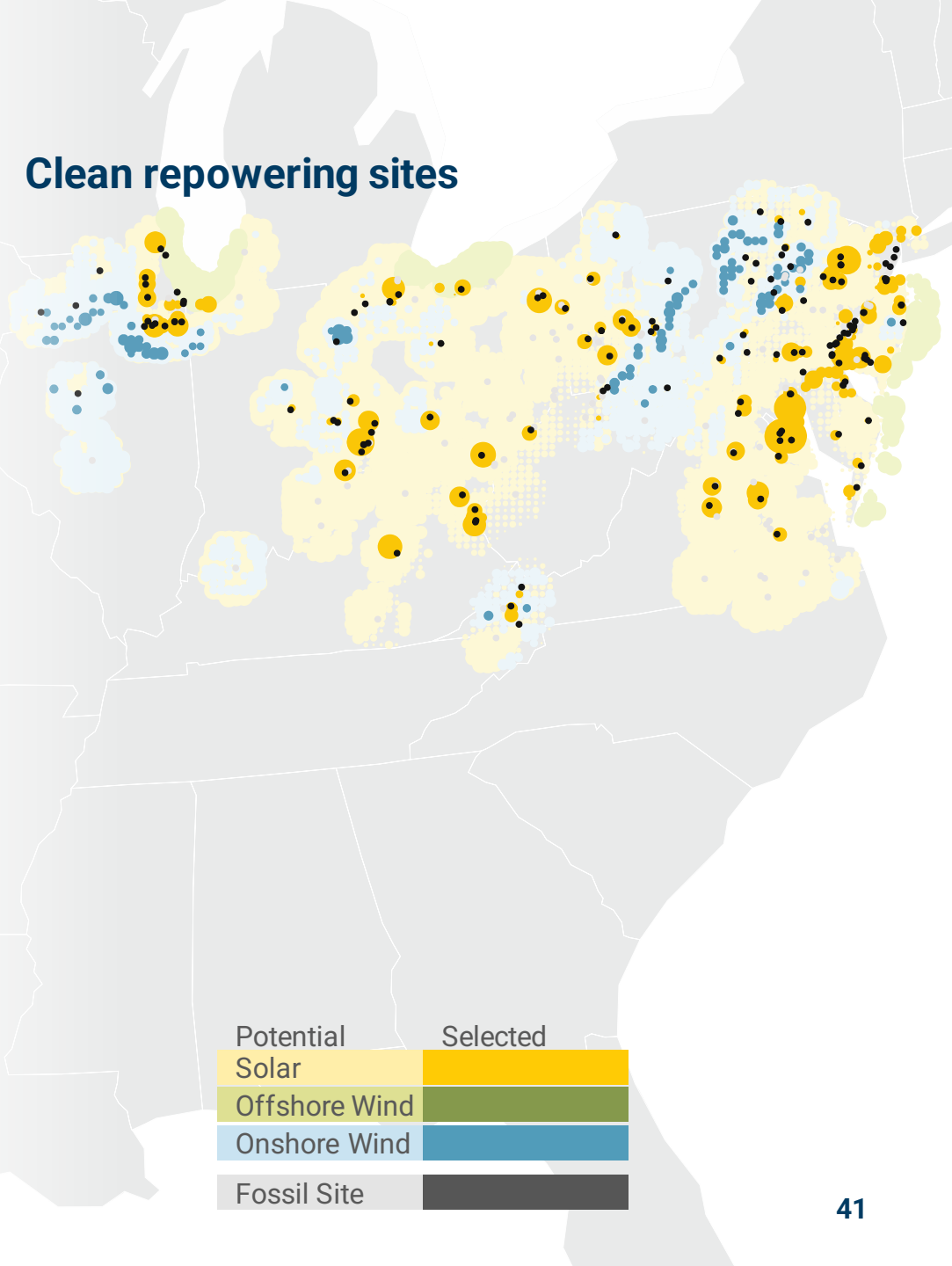
Generation in 2035



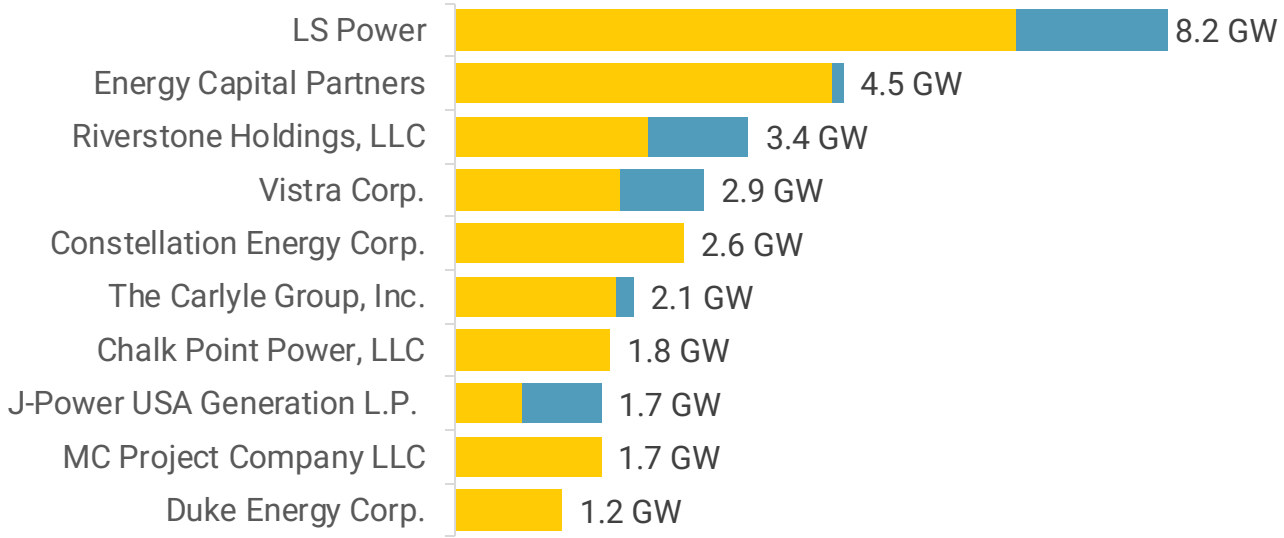
Clean repowering capacity



Clean repowering sites



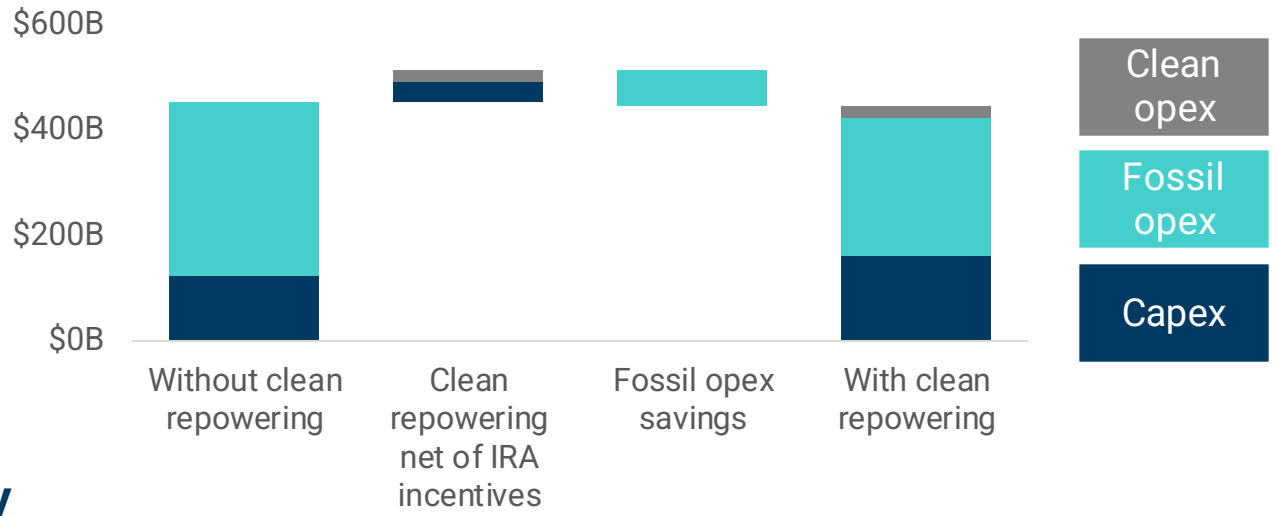
Top 10 generation owners by clean repowering opportunity



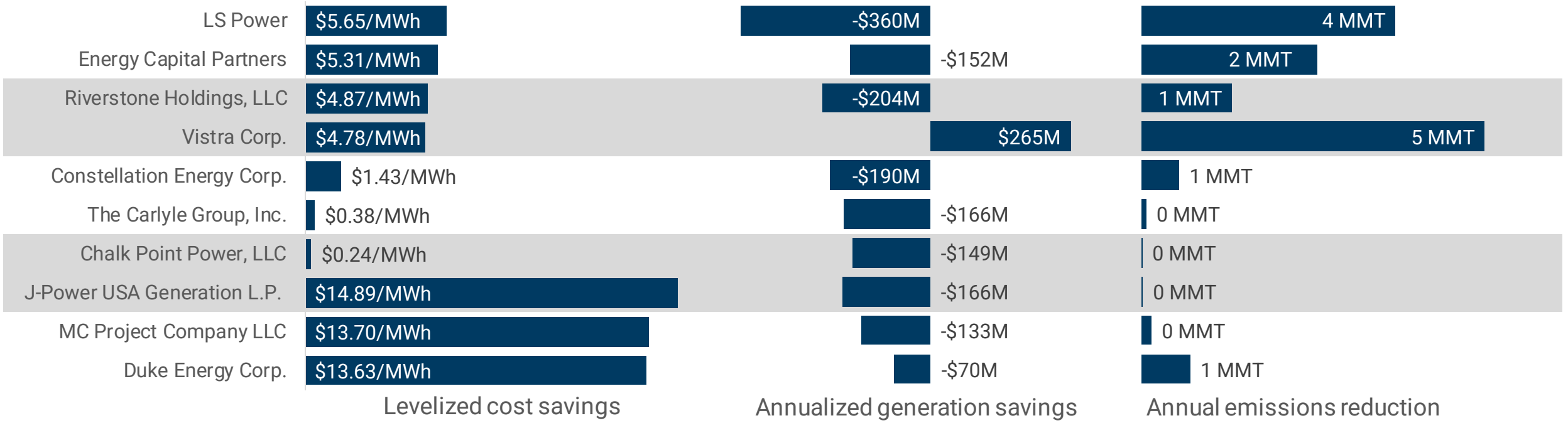
PJM savings

Total regional annualized savings	$ 433 million
Total reduction in annual carbon emissions	69 MMT

Cost impact of clean repowering



Top generation owners by clean repowering opportunity



Negative savings indicate cost increases. A generation owner's levelized cost or annualized generation cost can increase with clean repowering because of an increase in that owner's total generation or a change in the composition of its generation.

PJM top clean repowering opportunities

							Counterfactual			*Clean repowering*					
Plant Name	**Owner**	**Ultimate Parent**	**State**	**Region**	**Technology**	**Capacity**	**Utilization**	**Emissions**	**Annualized NPV**	**Utilization**	**Emissions**	**Annualized NPV**	**Battery**	**Solar**	**Wind**
						MW	*%*	*tonne/yr*	*$million/yr*	*%*	*tonne/yr*	*$million/yr*	*MW*	*MW*	*MW*
Elwood Energy LLC	JPower USADevelopment Co Ltd	J-Power USAGeneration	IL	PJM	Gas CT	1,728	0%	17,260	99.2	31%	5,013	259.0		770	914
TalenEnergyMartins Creek	MC Project Company	MC Project Company	PA	PJM	Gas ST	1,701	2%	226,749	187.3	27%	89,318	317.1		1,676	
Brandon Shores	Brandon Shores	Riverstone Holdings	MD	PJM	Coal	1,370	8%	1,160,259	286.4	29%	598,290	346.0		1,331	
Chalk Point Power	Chalk Point Power	Chalk Point Power	MD	PJM	Gas ST	1,318	0%	5,340	130.8	27%	2,854	235.8		1,299	
CPVFairview EnergyCenter	CPVFairview	CPVFairview	PA	PJM	Gas CC	1,197	33%	1,646,791	279.7	55%	632,058	287.3		44	1,125
TalenEnergyMontour	TalenEnergyMontour	Riverstone Holdings	PA	PJM	Coal	1,775	7%	1,145,431	309.6	28%	505,079	376.7		5	1,150
Riverside GeneratingLLC	Riverside GeneratingCo	LSPower	KY	PJM	Gas CT	1,150	0%	9,798	66.1	26%	3,711	168.9		1,132	
Bethlehem PowerPlant	Calpine Bethlehem	EnergyCapital Partners	PA	PJM	Gas CC	1,153	55%	2,368,760	322.4	54%	1,255,445	331.8		998	124
TenaskaWestmoreland GeneratingStation	DGCWestmoreland	DGCWestmoreland	PA	PJM	Gas CC	1,134	41%	1,890,283	287.8	48%	870,654	299.6		594	510
Hay Road	Calpine Mid-Atlantic Generation	EnergyCapital Partners	DE	PJM	Gas CC	1,098	37%	1,552,450	283.8	42%	772,251	284.6		1,067	
Aurora	AuroraGeneration	LSPower	IL	PJM	Gas CT	1,086	1%	72,814	70.3	28%	20,502	156.2		746	310
Moxie Freedom Generation Plant	Moxie Freedom	Moxie Freedom	PA	PJM	Gas CC	1,058	95%	3,046,187	453.0	85%	1,537,981	371.4			974
Hummel Station LLC	HummelStation	LSPower	PA	PJM	Gas CC	1,194	90%	3,433,844	511.2	78%	1,826,075	429.7			952
RollingHills Generating	RollingHills Generating	ArcLightCapital Partners	OH	PJM	Gas CT	978	1%	72,125	63.1	23%	24,940	133.0		952	
Clean EnergyFuture-Lordstown, LLC	Clean EnergyFuture-Lordstown	Clean EnergyFuture	OH	PJM	Gas CC	962	61%	2,050,008	350.2	55%	1,113,286	319.6		934	
JKSmith	East Kentucky Power Coop	East Kentucky Power Coop.	KY	PJM	Gas CT	1,055	4%	288,497	113.6	27%	366,810	176.7		896	
KeysEnergyCenter	PSEGKeysEnergy Center	Public Service Enterprise Group	MD	PJM	Gas CC	831	45%	1,123,934	267.2	46%	564,438	236.5		779	
Troy Energy LLC	LSPower Development	LSPower	OH	PJM	Gas CT	796	2%	61,871	52.6	23%	19,475	108.7		773	
EddystoneGeneratingStation	Exelon Power	Constellation Energy	PA	PJM	Gas ST	782	0%	9,703	79.9	27%	2,809	146.8		771	
Ironwood LLC	Helix Ironwood	LSPower	PA	PJM	Gas CC	778	76%	2,024,551	259.8	68%	1,056,927	252.7		424	332
CPVSt Charles EnergyCenter	CPVMaryland	CPVMaryland	MD	PJM	Gas CC	775	25%	641,297	180.4	36%	289,165	178.2		754	
BergenGeneratingStation	BergenGeneratingStation	BergenGeneratingStation	NJ	PJM	Gas CC	1,401	42%	2,049,240	371.7	38%	1,188,517	334.2		752	
Essential Power Rock Springs LLC	Essential Power Rock Springs	TheCarlyle Group	MD	PJM	Gas CT	773	1%	29,402	47.5	25%	9,612	102.9		751	
Hamilton Patriot Generation Plant	Hamilton Patriot	Hamilton Patriot	PA	PJM	Gas CC	870	95%	2,529,322	366.3	83%	1,385,143	319.6			750
Doswell EnergyCenter	Doswell Ltd Partnership	LSPower	VA	PJM	Gas CC	752	13%	383,735	122.4	30%	161,204	147.7		731	
University ParkNorth	LSPUniversity Park	LSPower	IL	PJM	Gas CT	726	1%	29,044	45.1	23%	7,513	97.8		700	
EdgeMoor	Calpine Mid-Atlantic Generation	EnergyCapital Partners	DE	PJM	Gas ST	698	1%	23,942	73.1	25%	7,780	120.7		680	
Lawrenceburg Power, LLC	Lightstone Generation	Lightstone Generation	IN	PJM	Gas CC	1,232	65%	2,522,653	457.9	60%	1,776,978	407.5		676	
Madison	Duke EnergyIndiana	Duke Energy	OH	PJM	Gas CT	692	0%	4,237	64.1	24%	2,002	117.5		673	
Lincoln GeneratingFacility	Earthrise Energy, PBC	Earthrise Energy, PBC	IL	PJM	Gas CT	692	0%	1,185	38.7	30%	421	88.5		341	330
Armstrong	Armstrong Power	LSPower	PA	PJM	Gas CT	688	5%	165,255	55.1	24%	60,907	100.4		668	
Tait Electric GeneratingStation	Kimura Power	RocklandCapital	OH	PJM	Gas CT	670	0%	20,011	39.7	26%	7,341	101.3		660	
HangingRock EnergyFacility	DynegyHanging Rock EnergyFacility	Vistra	OH	PJM	Gas CC	1,430	74%	3,508,408	581.1	56%	2,161,786	480.0		616	
Shawville	Shawville Power	Shawville Power	PA	PJM	Gas ST	626	2%	58,241	78.9	42%	18,845	127.1			612
Nelson EnergyCenter	Invenergy Services	Invenergy	IL	PJM	Gas CC	628	46%	811,535	192.9	58%	345,910	195.4			608
TenaskaVirginia GeneratingStation	TenaskaVirginia I	Tenaska Energy	VA	PJM	Gas CC	1,011	37%	1,235,640	275.8	35%	653,563	239.8		603	
KendallCounty Generation Facility	DynegyKendall Energy	Vistra	IL	PJM	Gas CC	1,256	28%	1,228,380	323.3	30%	587,023	280.2		128	473
Cordova Energy	Cordova EnergyCo	Berkshire Hathaway	IL	PJM	Gas CC	611	49%	937,832	218.8	56%	336,999	187.2			598
PSEGKearnyGenerating Station	KearnyGeneratingStation	KearnyGeneratingStation	NJ	PJM	Gas CT	916	2%	77,300	48.3	16%	29,841	88.0		584	
Robert PMone Plant	Buckeye Power	Buckeye Power	OH	PJM	Gas CT	594	0%	12,103	33.0	37%	2,711	99.4			581
Zion EnergyCenter	Zion Energy	EnergyCapital Partners	IL	PJM	Gas CT	597	0%	3,304	33.9	23%	1,274	79.7		580	
Homer City GeneratingStation	Homer City Holdings	Homer City Holdings	PA	PJM	Coal	2,012	12%	2,148,392	395.1	13%	1,138,691	393.0		568	
Woodsdale	Duke EnergyKentucky	Duke Energy	OH	PJM	Gas CT	572	0%	471	40.0	26%	172	76.4		562	

Utilization is essentially the capacity factor of the interconnection, it is calculated as the total generation of all the resources associated with the incumbent fossil generator divided by the capacity of the incumbent fossil generator multiplied by the number of hours in the period.

Southeast: Interconnection Fast-Track Rules

Generator Replacement

- Some utilities have processes in place, modeled after MISO's
  - **Duke** Energy Progress and Carolinas, filed 2022
  - **Dominion South Carolina**, filed 2020

Surplus Interconnection Service

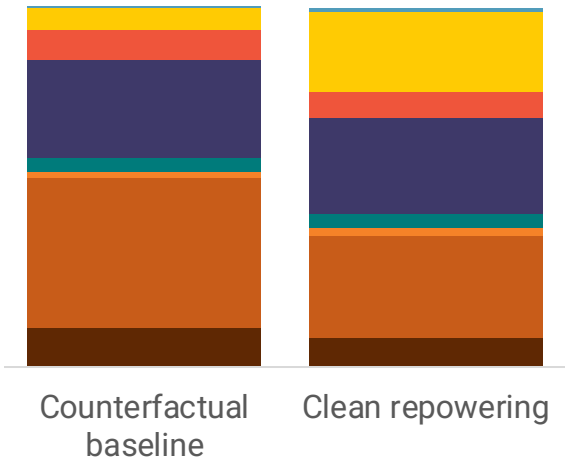
- All utilities have processes closely modeled on FERC Order 845
- Specifics on study timelines and deposits vary by utility

Relevant Examples

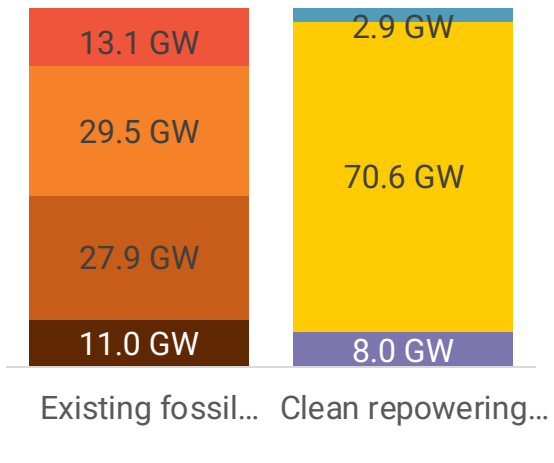
- Many utilities are planning to retire most of their coal capacity in the coming decade, but few utilities have confirmed clean repowering projects. **Most plan to replace the coal with gas.**
- **LG&E/KU** plan to add a **battery storage** facility at the retiring E.W. Brown Coal Generating Station along with a new **gas plant** and off-site solar.
- **Tennessee Valley Authority** is considering adding **solar/storage** to replace coal, but additions would be **off-site.**

Southeast opportunities

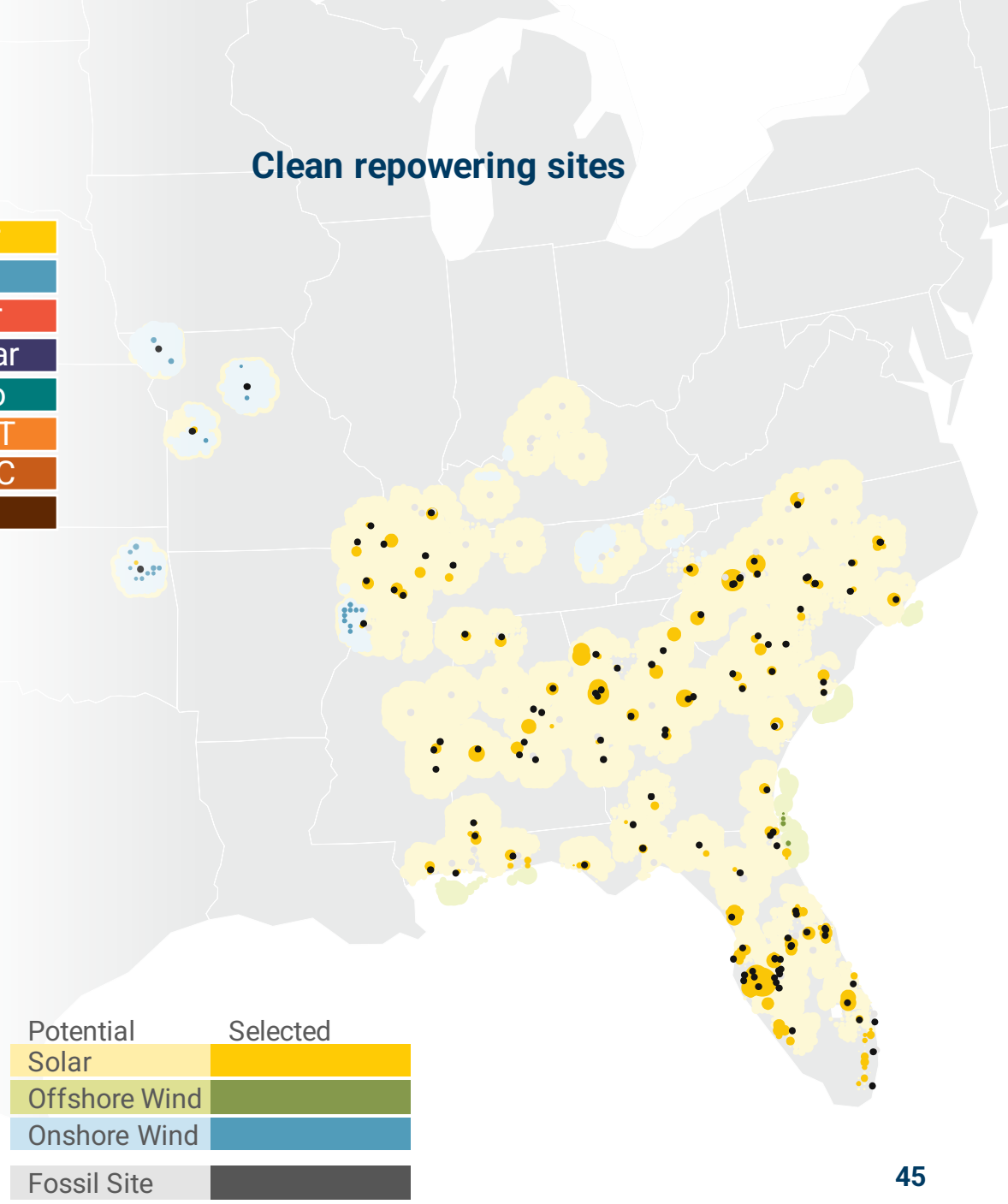
Generation in 2035



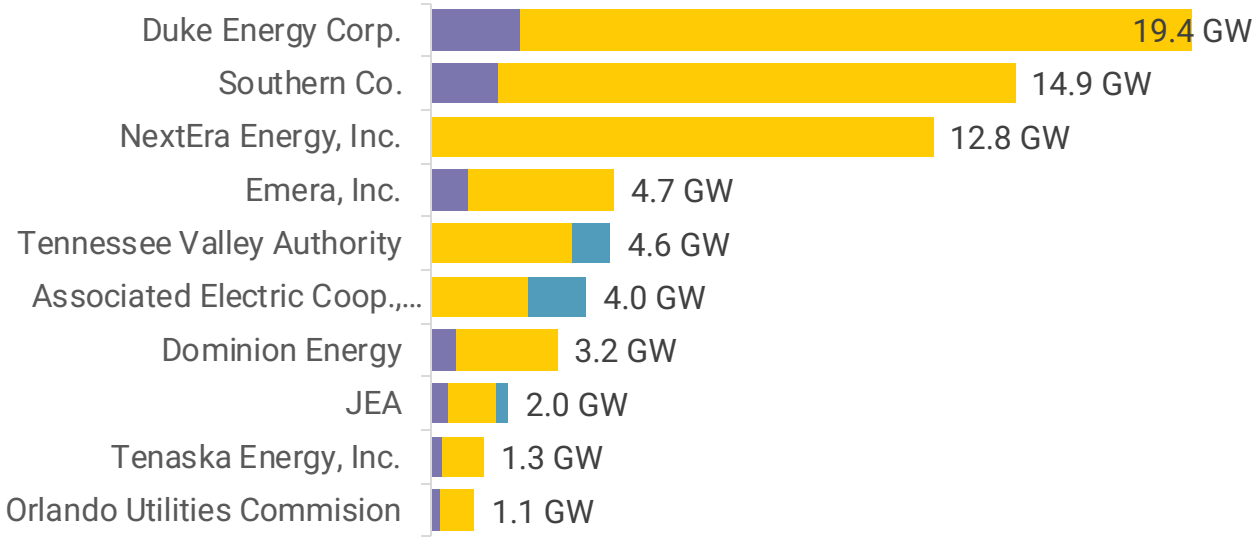
Clean repowering capacity



Clean repowering sites



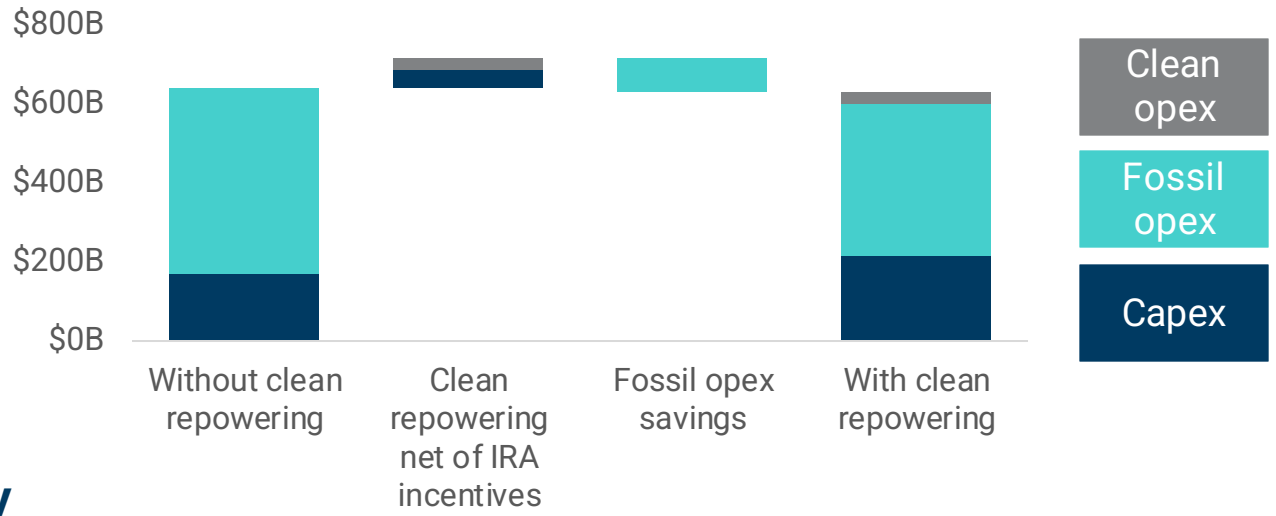
Top 10 generation owners by clean repowering opportunity



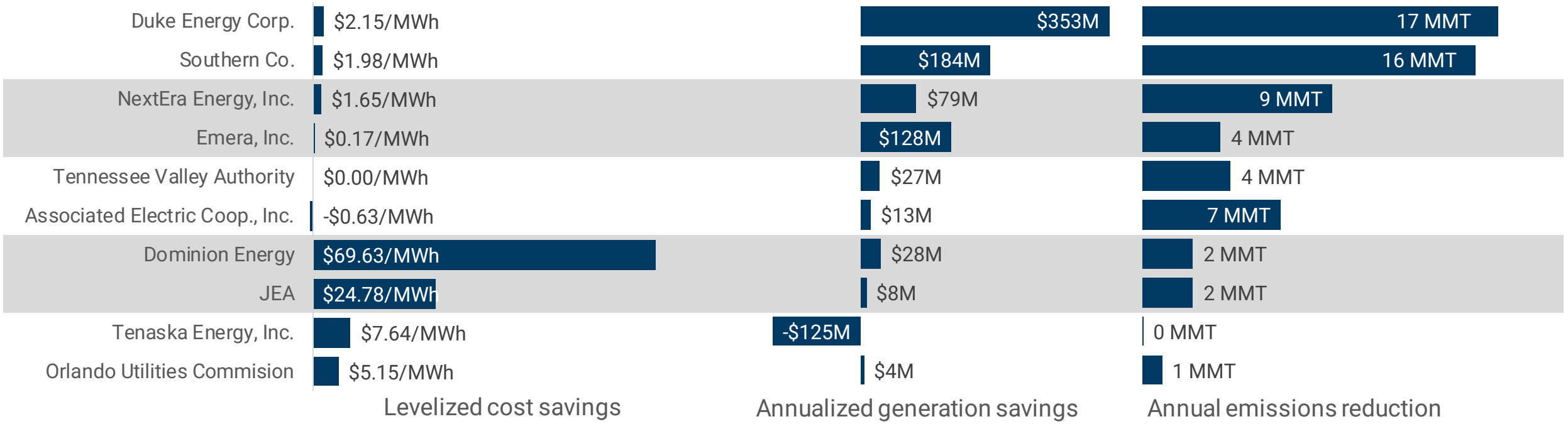
Southeast savings

Total regional annualized savings	$ 493 million
Total reduction in annual carbon emissions	70 MMT

Cost impact of clean repowering



Top generation owners by clean repowering opportunity



Negative savings indicate cost increases. A generation owner's levelized cost or annualized generation cost can increase with clean repowering because of an increase in that owner's total generation or a change in the composition of its generation.

Southeast top clean repowering opportunities

							Counterfactual			Clean repowering					
Plant Name	Owner	Ultimate Parent	State	Region	Technology	Capacity	Utilization	Emissions	Annualized NPV	Utilization	Emissions	Annualized NPV	Battery	Solar	Wind
						MW	%	tonne/yr	$million/yr	%	tonne/yr	$million/yr	MW	MW	MW
Bowen	Georgia Power Co	Southern Co.	GA	Southeast	Coal	3,499	11%	3,273,772	1,191.0	21%	1,550,307	1,120.8	755	2,889	
Crystal River	Duke Energy Florida	Duke Energy	FL	Southeast	Gas CC	1,971	28%	2,193,640	609.1	35%	865,984	587.1	494	1,933	
Wansley	Georgia Power Co	Southern Co.	GA	Southeast	Coal	1,904	5%	842,346	363.0	25%	388,694	441.7	476	1,863	
H L Culbreath Bayside Power Station	Tampa Electric Co	Emera	FL	Southeast	Gas CC	2,014	43%	2,953,394	677.8	43%	1,523,520	645.0	461	1,804	
Martin	Florida Power & Light Co	NextEra Energy	FL	Southeast	Gas CC	2,449	34%	2,724,536	826.7	46%	1,848,228	856.3		2,212	
Manatee	Florida Power & Light Co	NextEra Energy	FL	Southeast	Gas ST	1,727	0%	26	122.1	28%	206	231.4		1,706	
Lincoln Combustion	Duke Energy Carolinas	Duke Energy	NC	Southeast	Gas CT	2,290	0%	3,088	77.7	17%	105	167.4		1,704	
P L Bartow	Duke Energy Florida	Duke Energy	FL	Southeast	Gas CC	1,254	61%	2,761,038	618.9	54%	1,378,592	551.4	313	1,224	
Fort Myers	Florida Power & Light Co	NextEra Energy	FL	Southeast	Gas CC	1,722	33%	1,881,913	606.1	44%	1,262,353	618.9		1,419	
Anclote	Duke Energy Florida	Duke Energy	FL	Southeast	Gas ST	1,112	1%	73,891	106.0	26%	11,213	226.7	278	1,098	
Tenaska Georgia Generation Facility	Tenaska Georgia I	Tenaska Energy	GA	Southeast	Gas CT	1,099	0%	24,829	61.9	24%	11,198	186.2	276	1,078	
Lauderdale	Florida Power & Light Co	NextEra Energy	FL	Southeast	Gas CT	1,968	0%	464	138.7	17%	7,613	217.3		1,199	
Allen	Tennessee Valley Authority	Tennessee Valley Authority	TN	Southeast	Gas CC	1,171	34%	1,188,246	274.2	51%	730,605	347.7		116	1,008
Gulf Clean Energy Center	Florida Power & Light Co	NextEra Energy	FL	Southeast	Gas ST	1,229	0%	6,797	115.4	26%	2,469	186.3		1,119	
Hines Energy Complex	Duke Energy Florida	Duke Energy	FL	Southeast	Gas CC	2,266	78%	6,079,690	1,246.5	53%	3,396,724	946.6	226	880	
E C Gaston	Alabama Power Co	Southern Co.	AL	Southeast	Gas ST	1,061	7%	370,548	275.9	32%	122,269	349.5		1,047	
Chouteau	Associated Electric Coop	Associated Electric Coop.	OK	Southeast	Gas CC	1,070	74%	2,640,392	398.9	70%	1,193,508	325.0		93	946
Manatee	Florida Power & Light Co	NextEra Energy	FL	Southeast	Gas CC	1,225	51%	2,028,501	494.7	57%	1,396,662	490.2		1,015	
Yates	Georgia Power Co	Southern Co.	GA	Southeast	Gas ST	807	6%	261,212	96.4	27%	92,073	146.0	202	797	
McIntosh	Georgia Power Co	Southern Co.	GA	Southeast	Gas CT	810	0%	4,659	45.5	26%	274	105.7	200	797	
Washington County Power LLC	Georgia Gulf Generating	Georgia Gulf Generating	GA	Southeast	Gas CT	796	1%	43,906	49.3	26%	12,074	128.4	200	784	
Oleander Power Project LP	Oleander Holdings	NextEra Energy	FL	Southeast	Gas CT	994	0%	427	55.1	28%	25,515	152.8		982	
Wayne County	Duke Energy Progress - (NC)	Duke Energy	NC	Southeast	Gas CT	980	1%	37,465	59.9	22%	73,506	108.0		943	
Broad River Energy Center	Broad River Energy	Broad River Energy	SC	Southeast	Gas CT	985	4%	207,847	93.1	25%	263,592	142.8		941	
Rockingham County CT Station	Duke Energy Carolinas	Duke Energy	NC	Southeast	Gas CT	978	3%	175,174	81.6	22%	128,357	111.9		936	
Dahlberg	Southern Power Co	Southern Co.	GA	Southeast	Gas CT	919	0%	109	50.8	28%	39	114.3		908	
Crystal River	Duke Energy Florida	Duke Energy	FL	Southeast	Coal	2,443	11%	2,412,314	334.8	13%	1,269,321	374.5	185	720	
Vandolah Power Station	Northern Star Generation Services Co	Northern Star Generation	FL	Southeast	Gas CT	728	3%	114,610	60.5	26%	20,234	143.8	184	716	
Intercession City	Duke Energy Florida	Duke Energy	FL	Southeast	Gas CT	709	0%	2,914	33.4	26%	329	120.7	179	700	
New Madrid	Associated Electric Coop	Associated Electric Coop.	MO	Southeast	Coal	1,300	35%	3,768,958	373.4	31%	1,600,382	379.9		869	
Columbia Energy Center (SC)	Dominion Energy South Carolina	Dominion Energy	SC	Southeast	Gas CC	669	73%	1,681,824	292.8	76%	1,112,660	306.0	167	659	
Fort Myers	Florida Power & Light Co	NextEra Energy	FL	Southeast	Gas CT	835	0%	21	60.7	28%	1,207	115.4		825	
Polk	Tampa Electric Co	Emera	FL	Southeast	Gas CC	1,166	41%	1,550,036	444.7	35%	811,675	384.3	168	655	
W S Lee	Duke Energy Carolinas	Duke Energy	SC	Southeast	Gas CC	847	80%	2,204,928	431.8	72%	1,439,092	379.1		809	
Williams	South Carolina Genertg Co	Dominion Energy	SC	Southeast	Coal	660	9%	479,906	207.2	30%	332,981	227.3	165	642	
Osprey Energy Center Power Plant	Duke Energy Florida	Duke Energy	FL	Southeast	Gas CC	644	8%	177,410	123.9	30%	92,185	157.2	161	633	
Mill Creek (SC)	Duke Energy Carolinas	Duke Energy	SC	Southeast	Gas CT	799	0%	8,107	51.5	22%	4,462	90.0		775	
Calhoun Energy Center	Harbert Power Fund V	Harbert Power Fund V	AL	Southeast	Gas CT	748	2%	62,605	51.9	29%	16,927	115.1		738	
Northside Generating Station	JEA	JEA	FL	Southeast	Gas ST	564	22%	638,838	150.8	31%	148,030	160.4	184	553	
Tenaska Lindsay Hill Generating Station	Tenaska Alabama Partners	Tenaska Alabama Partners	AL	Southeast	Gas CC	939	30%	915,892	209.8	40%	625,583	225.7		733	
Greene County	Alabama Power Co	Southern Co.	AL	Southeast	Gas CT	720	0%	10,442	37.0	29%	1,969	95.7		710	
Cleveland Cnty Generating Facility	Southern Power Co	Southern Co.	NC	Southeast	Gas CT	736	5%	186,103	71.6	26%	236,899	106.9		703	
L V Sutton Combined Cycle	Duke Energy Progress - (NC)	Duke Energy	NC	Southeast	Gas CC	730	38%	919,662	267.0	35%	395,154	205.3		697	

Utilization is essentially the capacity factor of the interconnection, it is calculated as the total generation of all the resources associated with the incumbent fossil generator divided by the capacity of the incumbent fossil generator multiplied by the number of hours in the period.

SPP: Interconnection Fast-Track Rules

Generator Replacement

- Replacement process modeled after MISO's
- **Differences:**
  - The SPP Tariff does not contain a generator retirement process
  - SPP's process includes provisions for transferring designation of a Network Resource facility from an existing generator to a replacement (FERC ER20-1536-000)
  - SPP includes "fast track" process option that costs $1k but the generator must be <4 MW (SPP Tariff Attachment V § 14)

Surplus Interconnection Service

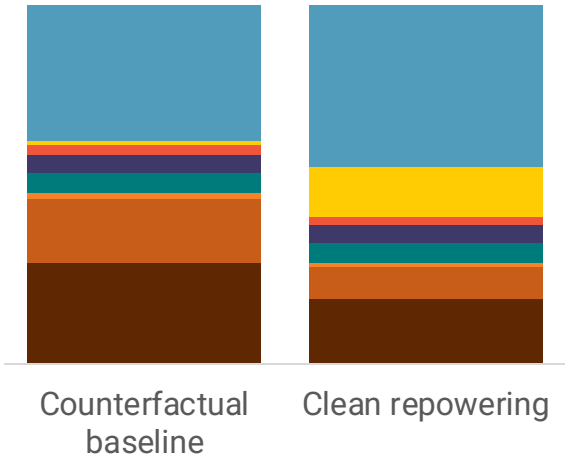
- Process modeled after FERC Order 845 (compliance filing approved January 2020)

Relevant Examples

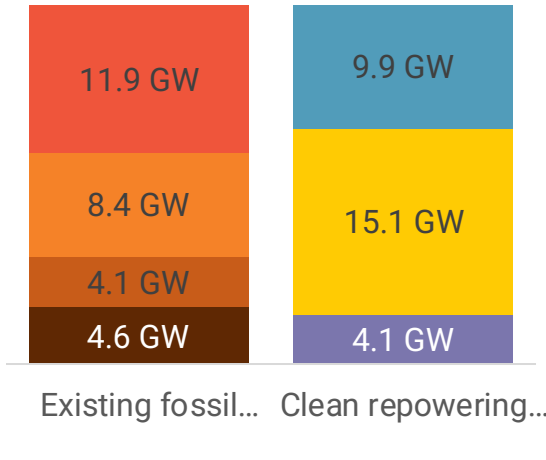
- **Omaha Public Power District** is struggling to convert a retiring coal unit to battery storage due to interconnection delays and high network upgrade costs faced by the storage facilities.
- **Great River Energy**'s intended replacement of the Coal Creek Station with renewables was thwarted by local opposition and pushback from North Dakota policymakers.

SPP opportunities

Generation in 2035

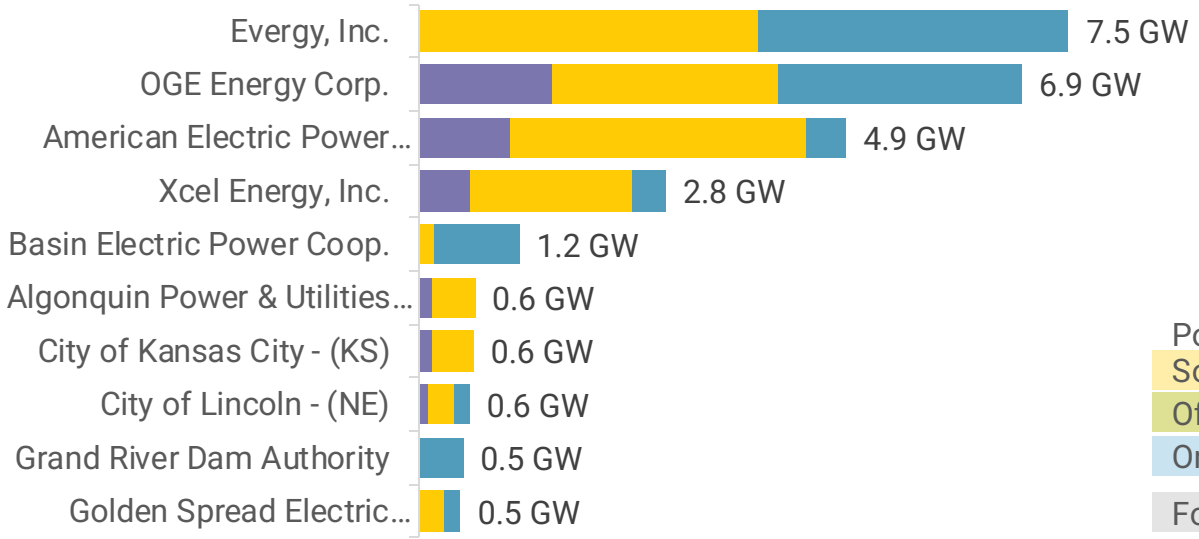


Clean repowering capacity



Clean repowering sites

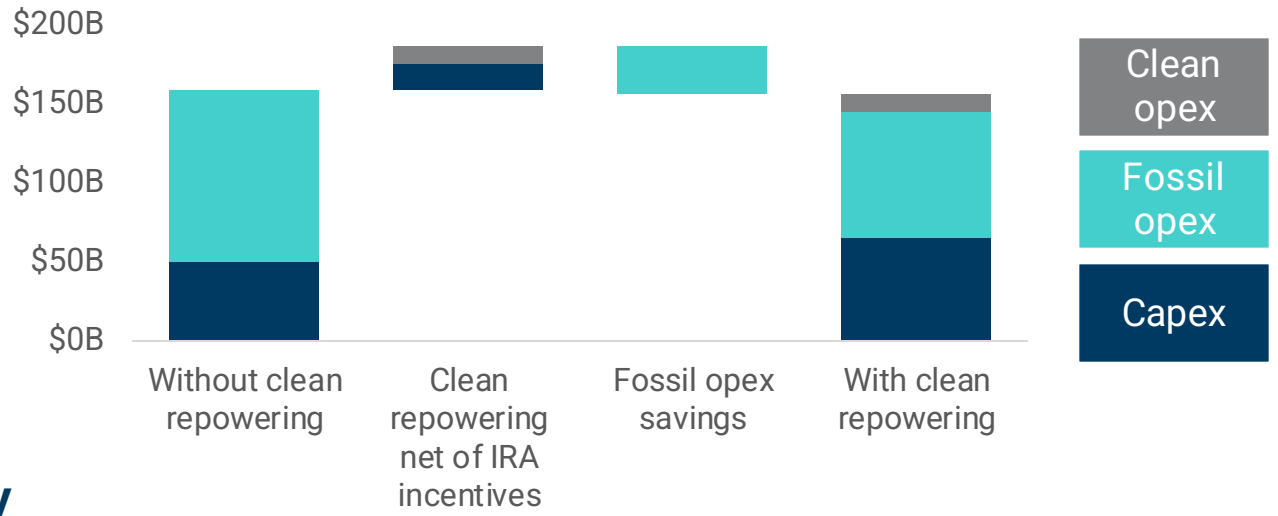
Top 10 generation owners by clean repowering opportunity



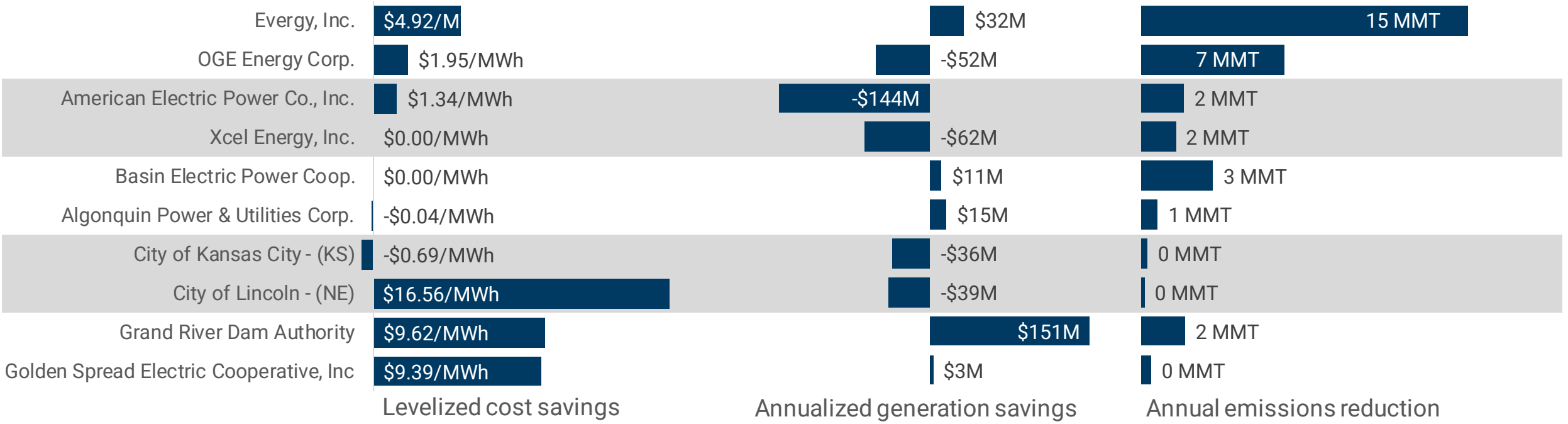
SPP savings

Total regional annualized savings	$ 151 million
Total reduction in annual carbon emissions	39 MMT

Cost impact of clean repowering



Top generation owners by clean repowering opportunity



Negative savings indicate cost increases. A generation owner's levelized cost or annualized generation cost can increase with clean repowering because of an increase in that owner's total generation or a change in the composition of its generation.

SPP top clean repowering opportunities

							Counterfactual			Clean repowering					
Plant Name	Owner	Ultimate Parent	State	Region	Technology	Capacity	Utilization	Emissions	Annualized NPV	Utilization	Emissions	Annualized NPV	Battery	Solar	Wind
						MW	%	tonne/yr	$million/yr	%	tonne/yr	$million/yr	MW	MW	MW
Seminole	Oklahoma Gas & Electric Co	OGE Energy	OK	SPP	Gas ST	1,701	8%	715,731	236.5	32%	240,972	381.5	380	655	992
Jeffrey Energy Center	Evergy Kansas Central	Evergy	KS	SPP	Coal	2,160	43%	9,169,810	744.1	40%	3,044,019	635.9			1,495
La Cygne	Evergy Kansas South	Evergy	KS	SPP	Coal	1,599	58%	8,351,114	527.5	60%	5,088,418	536.8		1,039	453
Redbud Power Plant	Oklahoma Gas & Electric Co	OGE Energy	OK	SPP	Gas CC	1,434	85%	4,140,357	673.1	65%	1,483,735	485.8	15	26	1,370
Horseshoe Lake	Oklahoma Gas & Electric Co	OGE Energy	OK	SPP	Gas ST	826	4%	178,524	76.5	24%	43,502	180.2	474	809	
Wilkes	Southwestern Electric PowerCo	American Electric PowerCo.	TX	SPP	Gas ST	882	0%	9,608	47.6	28%	598	103.2	269	863	
Muskogee	Oklahoma Gas & Electric Co	OGE Energy	OK	SPP	Gas ST	1,317	9%	605,451	206.3	29%	153,551	262.1			1,105
J Lamar Stall Unit	Southwestern Electric PowerCo	American Electric PowerCo.	LA	SPP	Gas CC	624	28%	580,415	123.4	41%	226,290	129.5	190	616	
Mustang	Oklahoma Gas & Electric Co	OGE Energy	OK	SPP	Gas CT	462	18%	390,651	106.8	31%	138,074	145.4	266	455	
McClain Energy Facility	Oklahoma Gas & Electric Co	OGE Energy	OK	SPP	Gas CC	551	89%	1,574,242	268.5	55%	665,671	198.3	263	447	
Emporia Energy Center	Evergy Kansas Central	Evergy	KS	SPP	Gas CT	730	3%	115,576	41.4	32%	18,176	67.9		209	488
Jones	Southwestern Public Service Co	Xcel Energy	TX	SPP	Gas ST	495	1%	14,905	17.4	32%	4,826	43.1	150	487	
Leland Olds	Basin Electric Power Coop	Basin Electric Power Coop.	ND	SPP	Coal	656	35%	2,289,198	177.9	60%	1,374,349	190.9			623
Northeastern	Public Service Co of Oklahoma	American Electric PowerCo.	OK	SPP	Gas ST	473	0%	12,314	28.6	26%	772	61.2	144	460	
Antelope Valley	Basin Electric Power Coop	Basin Electric Power Coop.	ND	SPP	Coal	954	68%	6,184,216	296.2	62%	4,074,173	307.3		175	357
Lawrence Energy Center	Evergy Kansas Central	Evergy	KS	SPP	Coal	566	28%	1,536,744	158.1	26%	315,303	123.8		498	
Empire Energy Center	Empire District Electric Co	Algonquin Power & Utilities	MO	SPP	Gas CT	379	3%	80,203	35.6	29%	32,847	52.5	114	371	
Nichols	Southwestern Public Service Co	Xcel Energy	TX	SPP	Gas ST	475	1%	24,777	13.0	44%	15,006	51.5	24	76	380
Northeast (MO)	Evergy Metro	Evergy	MO	SPP	Other Fossil	490	0%	6,960	14.2	23%	1,729	39.3		474	
Jones	Southwestern Public Service Co	Xcel Energy	TX	SPP	Gas CT	365	14%	244,296	51.2	38%	106,498	59.8	110	357	
Mustang Station Unit 4	Golden Spread Electric Cooperative	Golden Spread Electric Cooperative	TX	SPP	Gas CT	472	11%	259,280	42.7	37%	114,013	66.1		253	205
Knox Lee	Southwestern Electric PowerCo	American Electric PowerCo.	TX	SPP	Gas ST	501	1%	20,250	42.6	21%	13,222	61.0	107	345	
Harry D Mattison Gas Plant	Southwestern Electric PowerCo	American Electric PowerCo.	AR	SPP	Gas CT	349	0%	24	19.5	28%	6	48.1	106	343	
Tulsa	Public Service Co of Oklahoma	American Electric PowerCo.	OK	SPP	Gas ST	435	0%	2,272	32.5	20%	163	56.8	104	331	
Plant X	Southwestern Public Service Co	Xcel Energy	TX	SPP	Gas ST	434	1%	24,652	13.9	27%	10,490	33.8	103	331	
Southwestern	Public Service Co of Oklahoma	American Electric PowerCo.	OK	SPP	Gas ST	483	0%	13,158	20.9	34%	1,070	50.9	26	82	300
West Gardner	Evergy Metro	Evergy	KS	SPP	Gas CT	408	1%	36,625	16.7	28%	64,920	36.5		295	96
Gordon Evans Energy Center	Evergy Kansas South	Evergy	KS	SPP	Gas CT	375	2%	40,406	25.9	38%	6,063	39.2			355
Cunningham	Southwestern Public Service Co	Xcel Energy	NM	SPP	Gas ST	265	2%	27,025	7.8	35%	12,792	22.2	81	261	
South Harper	Evergy Missouri West	Evergy	MO	SPP	Gas CT	351	1%	26,694	24.9	27%	44,468	40.7		225	110
Cunningham	Southwestern Public Service Co	Xcel Energy	NM	SPP	Gas CT	254	9%	124,898	34.7	38%	54,133	38.6	78	250	
Spring Creek Energy Center	Evergy Kansas Central	Evergy	OK	SPP	Gas CT	338	2%	37,880	14.3	39%	49,635	26.2			317
Quindaro	City of Kansas City - (KS)	City of Kansas City - (KS)	KS	SPP	Gas ST	239	0%	-	28.2	28%	-	53.1	73	237	
Mooreland	Western Farmers Elec Coop	Western Farmers Elec Coop	OK	SPP	Gas ST	305	0%	1,647	17.0	44%	172	48.4	14	44	250
Hawthorn	Evergy Metro	Evergy	MO	SPP	Gas CC	313	34%	424,472	78.0	31%	105,355	49.2		301	
Lieberman	Southwestern Electric PowerCo	American Electric PowerCo.	LA	SPP	Gas ST	278	0%	568	23.6	24%	15	36.8	70	224	
Rokeby	Lincoln Electric System	City of Lincoln - (NE)	NE	SPP	Gas CT	263	1%	24,514	32.5	41%	7,030	50.7	22	71	187
Greenwood (MO)	Evergy Missouri West	Evergy	MO	SPP	Gas CT	259	0%	4,980	13.3	23%	1,511	26.4		251	
Thomas Fitzhugh	Arkansas Electric Coop	Arkansas Electric Coop.	AR	SPP	Gas CC	185	7%	55,216	27.9	30%	14,500	37.7	56	182	
Hutchinson Energy Center	Evergy Kansas Central	Evergy	KS	SPP	Gas CT	213	0%	5,367	11.1	25%	-	17.1		206	
Frontier	Oklahoma Gas & Electric Co	OGE Energy	OK	SPP	Gas CC	131	54%	256,009	57.4	40%	81,701	44.7	75	128	
Terry Bundy Generating Station	Lincoln Electric System	City of Lincoln - (NE)	NE	SPP	Gas CC	149	5%	28,951	23.9	29%	5,383	33.7	45	146	
Horseshoe Lake	Oklahoma Gas & Electric Co	OGE Energy	OK	SPP	Gas CT	148	7%	47,829	17.9	20%	15,549	28.8	70	118	

Utilization is essentially the capacity factor of the interconnection, it is calculated as the total generation of all the resources associated with the incumbent fossil generator divided by the capacity of the incumbent fossil generator multiplied by the number of hours in the period.

CAISO: Interconnection Fast-Track Rules

Generator Replacement

- **Requesting replacement (CAISO BPM)**
  - Generator must be currently interconnected to CAISO and have delivered energy within the past 3 years
  - Request must be generated by the **owner** of said generator
  - Request must utilize the same "fuel source" and POI
    - All *combustible* fuel sources considered the same for repowering purposes
    - **Energy storage** will be considered the same fuel source
  - Requestor must demonstrate that there will **not be any adverse impact to grid**
  - Even if there are no adverse impacts, a facilities study may still be required
- **Cost and time (CAISO Tariff § 25)**
  - $50k study deposit, approximately 115 business days

Surplus Interconnection Service

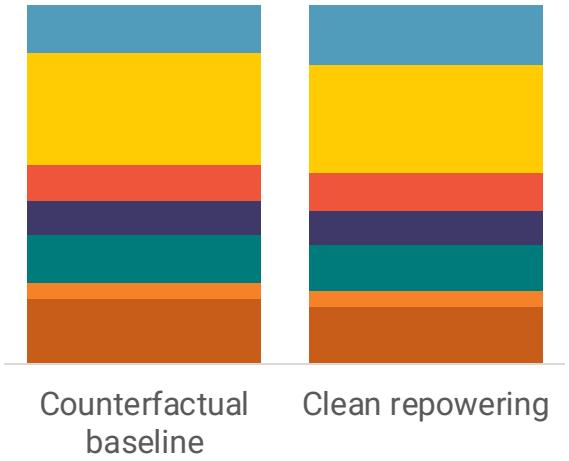
- Process follows FERC Order 845 guidelines (compliance filing approved Feb 2020)

Relevant Examples

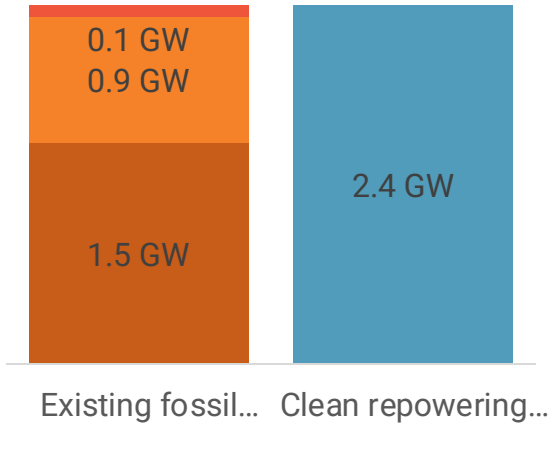
- Historically, the generator replacement process has primarily been utilized to convert steam turbines to gas.
- **Vistra** has replaced its Moss Landing Power Plant gas turbines with hundreds of MWs of batteries.

CAISO opportunities

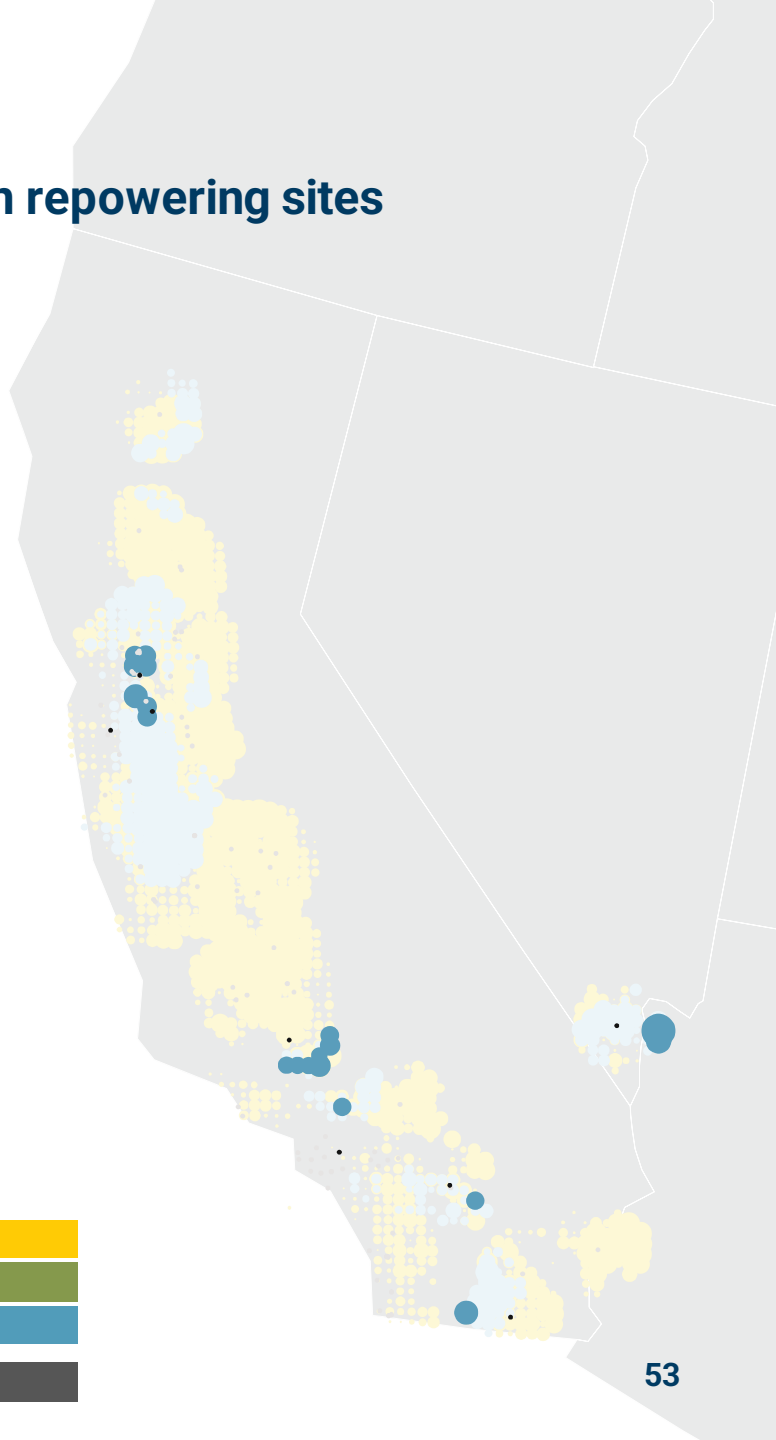
Generation in 2035



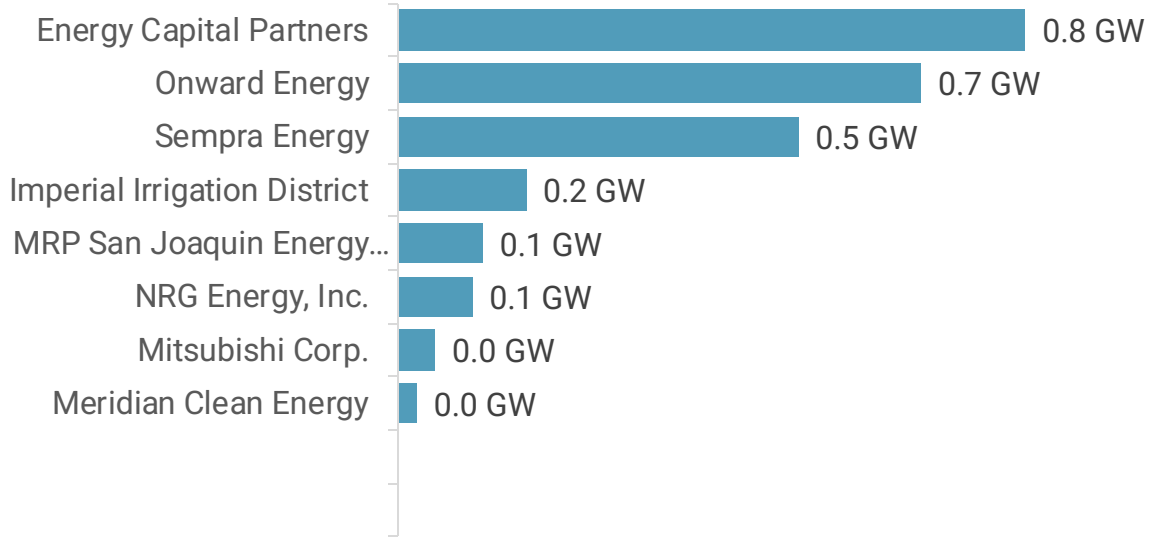
Clean repowering capacity



Clean repowering sites



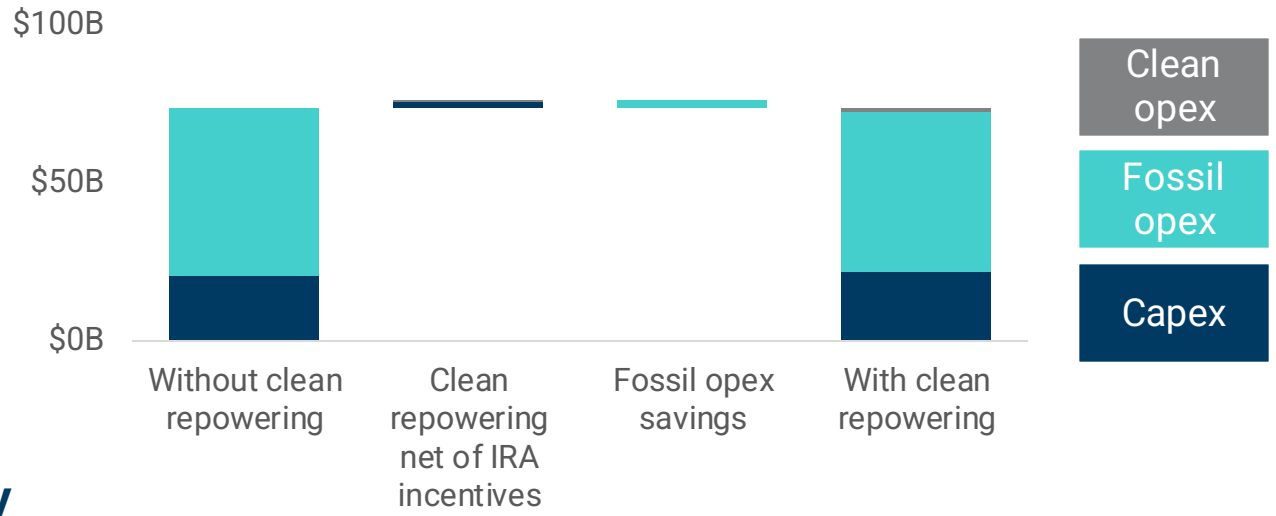
Top 10 generation owners by clean repowering opportunity



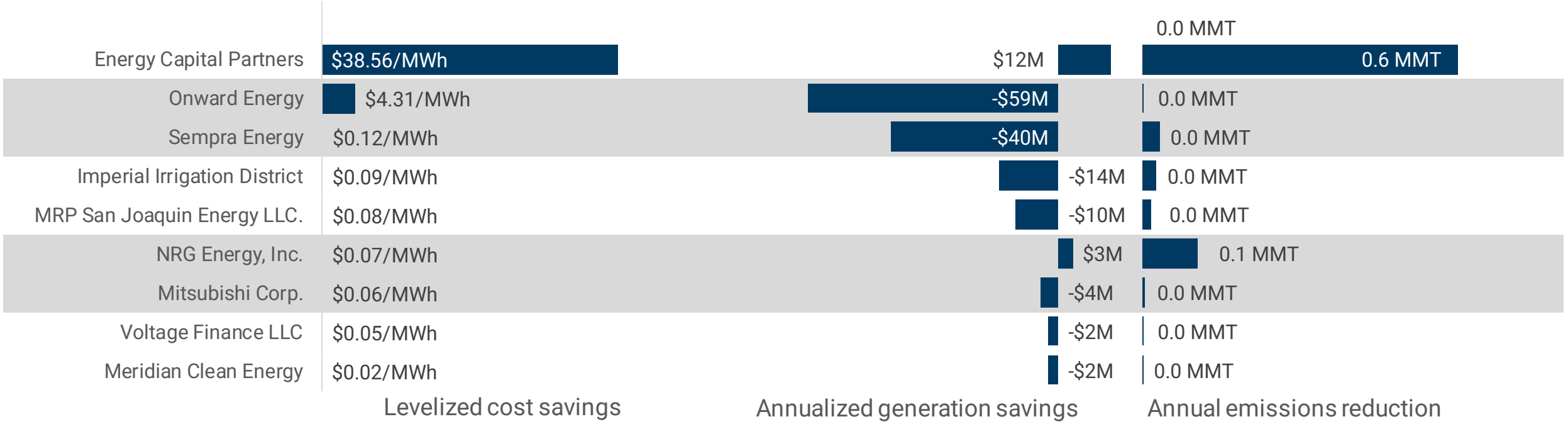
CAISO savings

Total regional annualized savings	$ 7 million
Total reduction in annual carbon emissions	2 MMT

Cost impact of clean repowering



Top generation owners by clean repowering opportunity



Negative savings indicate cost increases. A generation owner's levelized cost or annualized generation cost can increase with clean repowering because of an increase in that owner's total generation or a change in the composition of its generation.

CAISO top clean repowering opportunities

							Counterfactual			Clean repowering					
Plant Name	Owner	Ultimate Parent	State	Region	Technology	Capacity	Utilization	Emissions	Annualized NPV	Utilization	Emissions	Annualized NPV	Battery	Solar	Wind
						MW	*%*	*tonne/yr*	*$million/yr*	*%*	*tonne/yr*	*$million/yr*	*MW*	*MW*	*MW*
Pastoria EnergyFacility, LLC	Calpine- Pastoria EnergyCenter	EnergyCapital Partners	CA	CAISO	Gas CC	779	37%	930,364	236.1	56%	630,127	255.3			689
Marsh LandingGeneratingStation	Clearway Energy	Onward Energy	CA	CAISO	Gas CT	828	0%	6,651	49.4	28%	5,362	107.1			667
Desert Star EnergyCenter	Desert Star EnergyCenter SDG&E	Sempra Energy	NV	CAISO	Gas CC	537	0%	4,801	11.8	30%	4,801	55.6			511
Los Esteros Critical EnergyCenter	Los Esteros Critical EnergyFacility	EnergyCapital Partners	CA	CAISO	Gas CC	306	4%	43,947	40.3	15%	35,836	48.8			111
Tracy Combined Cycle Power Plant	MRP San Joaquin Energy	MRP San Joaquin Energy	CA	CAISO	Gas CC	336	8%	95,557	49.2	17%	80,344	59.1			108
Walnut Creek EnergyPark	Walnut Creek	NRG Energy	CA	CAISO	Gas CT	500	0%	2,052	28.3	5%	1,238	37.7			95
Sentinel EnergyCenter, LLC	Diamond Generatingration	Mitsubishi	CA	CAISO	Gas CT	800	0%	5,552	45.9	4%	3,482	55.0			95
El Centro Hybrid	Imperial Irrigation District	Imperial Irrigation District	CA	CAISO	Gas CC	277	15%	153,229	46.5	24%	127,721	51.9			85
El Centro Hybrid	Imperial Irrigation District	Imperial Irrigation District	CA	CAISO	Gas ST	132	0%	871	7.8	22%	519	15.5			78

Utilization is essentially the capacity factor of the interconnection, it is calculated as the total generation of all the resources associated with the incumbent fossil generator divided by the capacity of the incumbent fossil generator multiplied by the number of hours in the period.

Non-RTO West: Interconnection Fast-Track Rules

Generator Replacement

- Some utilities have processes in place, modeled after MISO's
  - Public Service Co. of Colorado (**Xcel**), filed 2021
  - **PacifiCorp**, filed 2022
  - **Arizona Public Service Co**., filed 2023

Surplus Interconnection Service

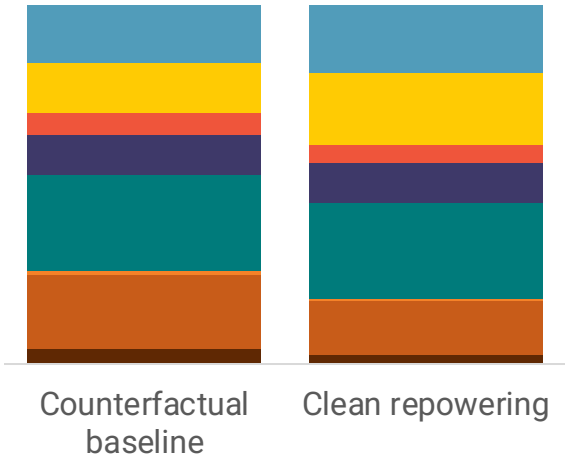
- All utilities have processes closely based on FERC Order 845
- Specifics on study timelines and deposits vary by utility

Relevant Examples

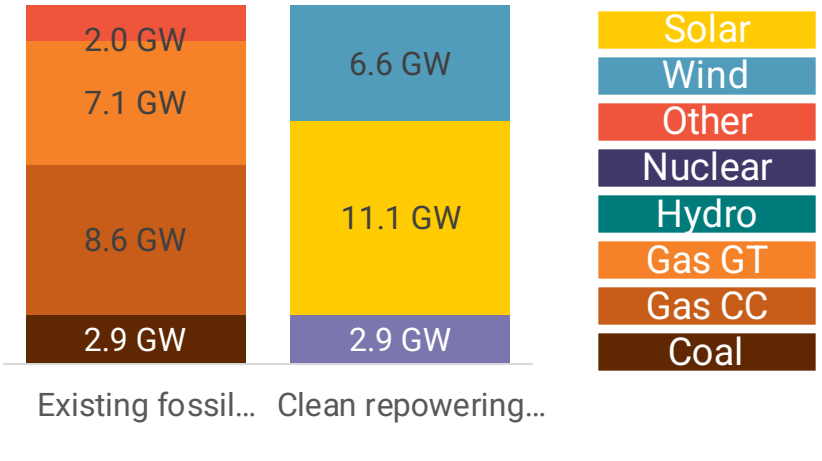
- **NV Energy** had planned to replace the 522 MW North Valmy coal plant with 600 MW of **solar + storage;** now moving to switch the plant to gas and add 400 MW of solar + storage.
- **Xcel Energy** is adding **solar** and **long-duration storage** to its retiring coal plant in Pueblo, CO, and plans to add **solar** to two of its oldest natural gas units in New Mexico and Texas.
- **Salt River Project** is undergoing a **repurposing study** for its 773 MW Coronado Coal Generating Station; considering renewables + storage, hydrogen, long-duration storage, and advanced nuclear.
- **PacifiCorp is** planning to replace several coal plants with **small modular nuclear** reactors from TerraPower.
- Intermountain Power Agency plans to replace its 1,800 MW coal plant with 840 MW turbines powered by **hydrogen generated from renewables.**

Non-RTO West opportunities

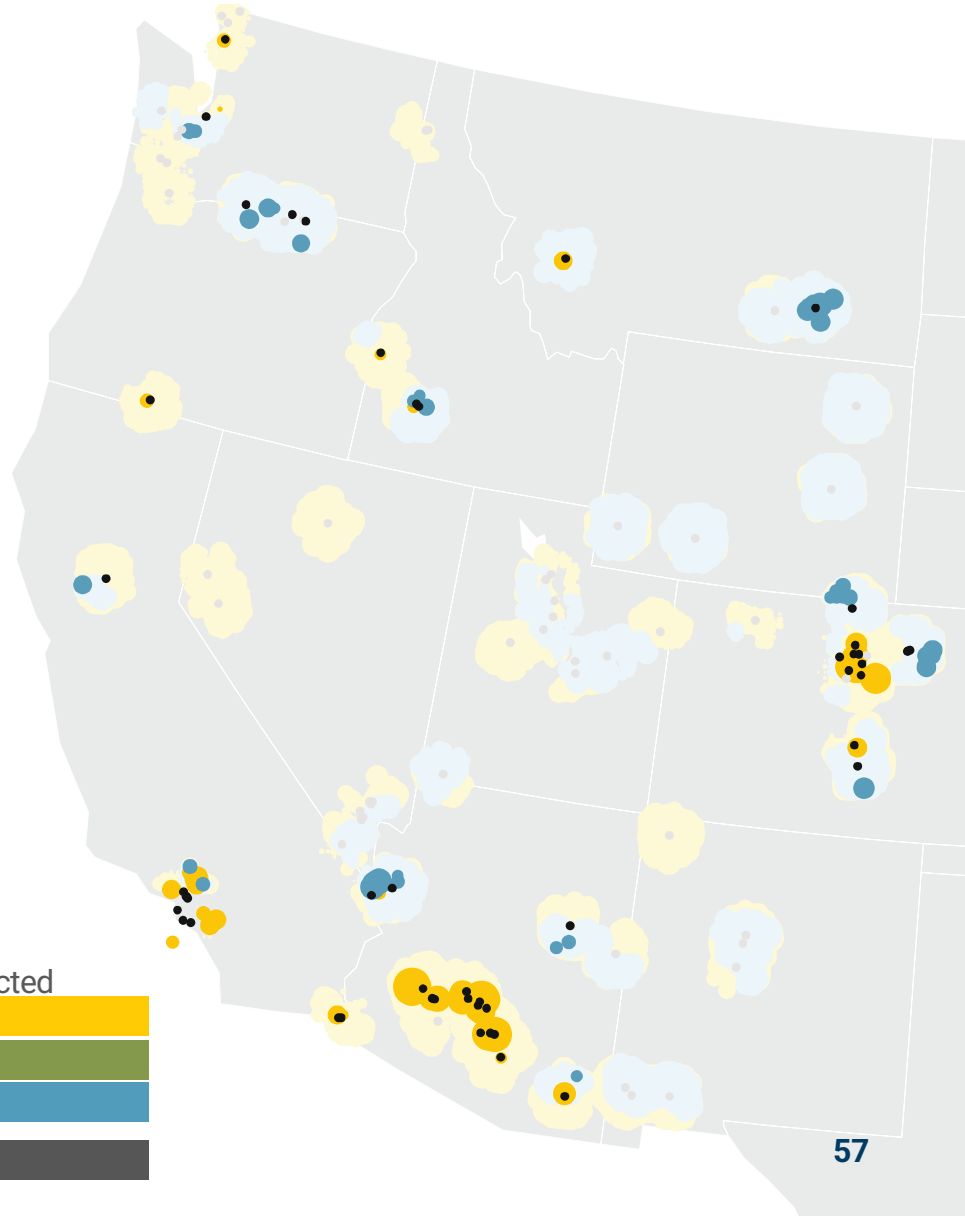
Generation in 2035



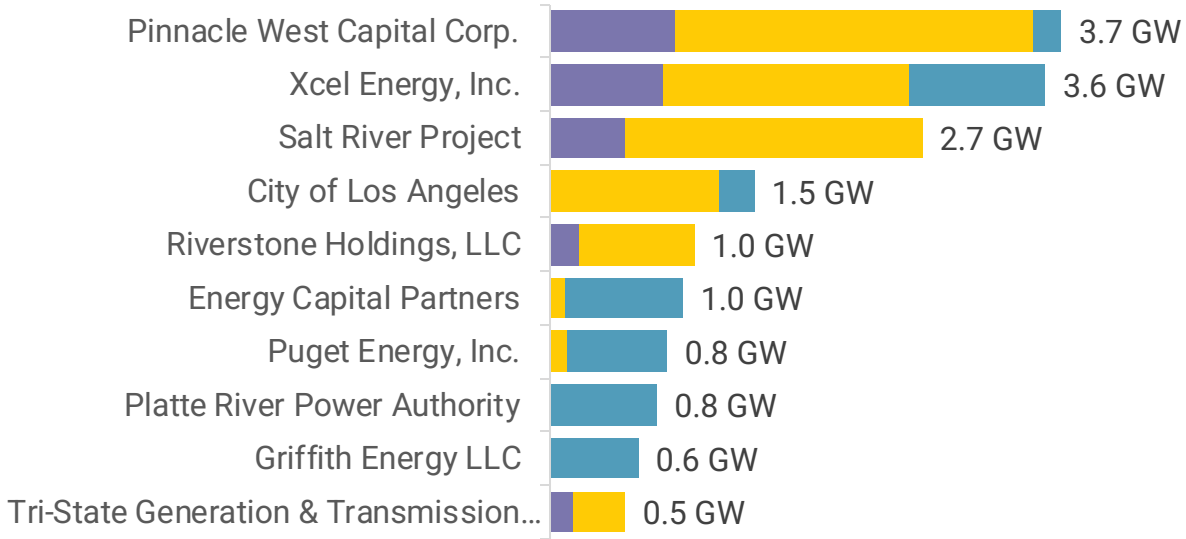
Clean repowering capacity



Clean repowering sites



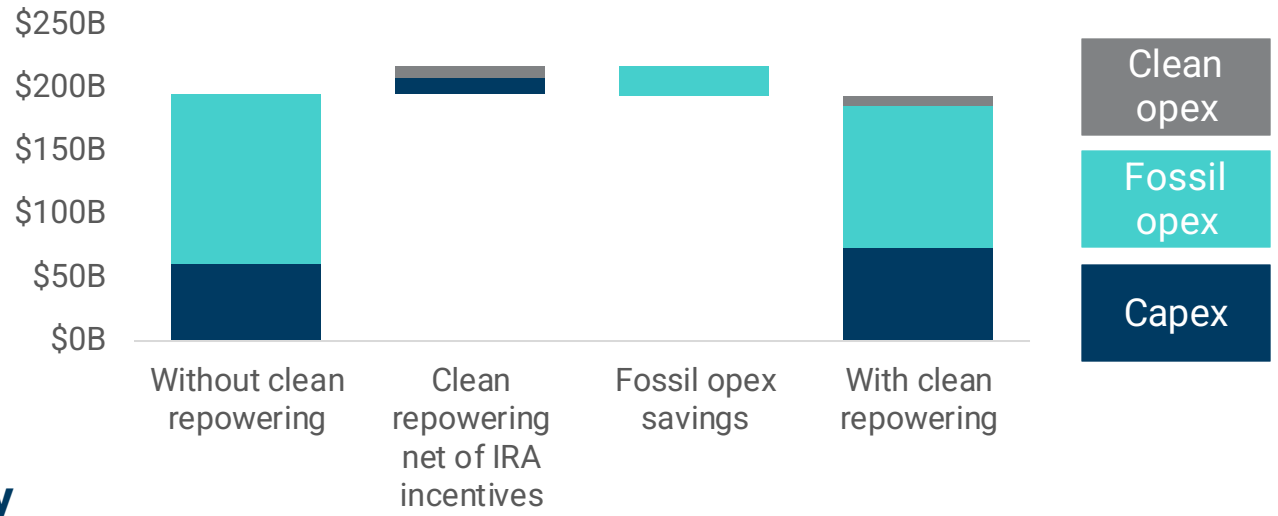
Top 10 generation owners by clean repowering opportunity



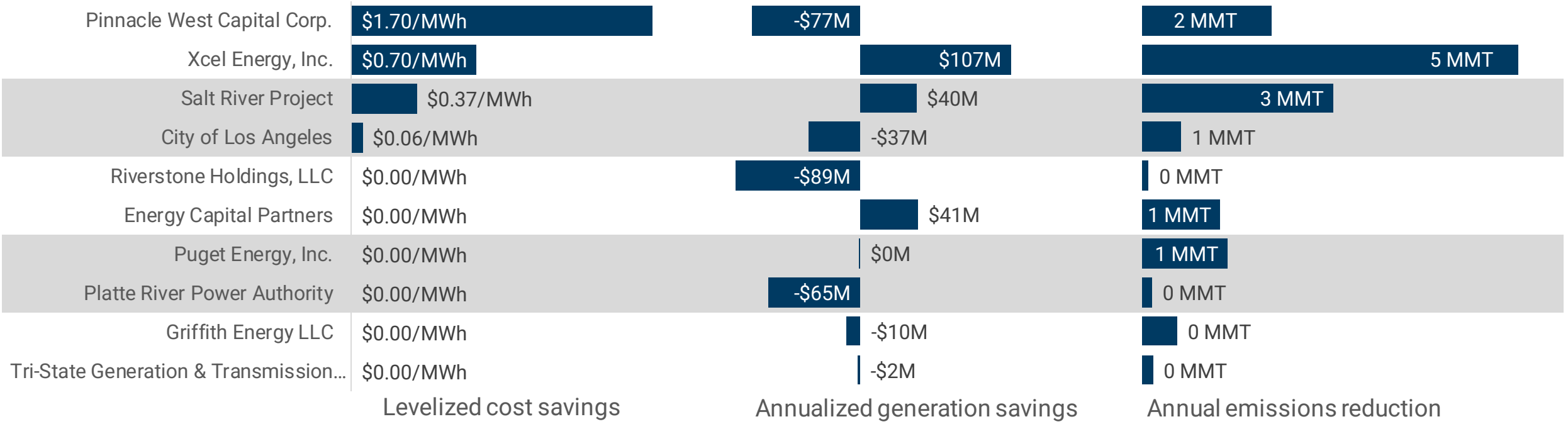
Non-RTO West savings

Total regional annualized savings	$ 151 million
Total reduction in annual carbon emissions	21 MMT

Cost impact of clean repowering



Top generation owners by clean repowering opportunity



Negative savings indicate cost increases. A generation owner's levelized cost or annualized generation cost can increase with clean repowering because of an increase in that owner's total generation or a change in the composition of its generation.

Non-RTO West top clean repowering opportunities

							Counterfactual			Clean repowering					
Plant Name	Owner	Ultimate Parent	State	Region	Technology	Capacity	Utilization	Emissions	Annualized NPV	Utilization	Emissions	Annualized NPV	Battery	Solar	Wind
						MW	%	tonne/yr	$million/yr	%	tonne/yr	$million/yr	MW	MW	MW
Colstrip	Puget Sound Energy	Puget Energy	MT	West	Coal	2,363	39%	8,503,056	486.2	48%	5,434,265	501.5			1,558
Ocotillo	Arizona Public Service Co	Pinnacle West Capital	AZ	West	Gas CT	916	5%	207,929	103.4	30%	113,098	173.6	287	797	
Harquahala Generating Project	New Harquahala Generating Co	Riverstone Holdings	AZ	West	Gas CC	1,277	4%	204,206	145.8	23%	111,393	231.2	210	834	
Coolidge Generation Station	Salt River Project	Salt River Project	AZ	West	Gas CT	726	0%	15,529	41.5	32%	10,162	120.8	180	709	
Cherokee	Public Service Co of Colorado	Xcel Energy	CO	West	Gas CC	626	47%	964,337	232.8	47%	391,831	196.8	278	605	
Sundance	Arizona Public Service Co	Pinnacle West Capital	AZ	West	Gas CT	605	2%	60,589	47.5	32%	29,902	108.6	250	592	
Desert Basin	Salt River Project	Salt River Project	AZ	West	Gas CC	646	43%	939,931	187.9	57%	548,123	226.5	162	640	
West Phoenix	Arizona Public Service Co	Pinnacle West Capital	AZ	West	Gas CC	1,101	27%	1,116,714	240.8	32%	734,051	231.1	91	596	
South Point Energy Center	South Point Energy Center	Energy Capital Partners	AZ	West	Gas CC	708	35%	903,041	190.7	44%	451,300	196.4		101	576
Griffith Energy LLC	Griffith Energy	Griffith Energy	AZ	West	Gas CC	655	36%	807,572	189.6	47%	312,317	196.7			641
Blue Spruce Energy Center	Public Service Co of Colorado	Xcel Energy	CO	West	Gas CT	398	3%	58,542	40.8	29%	23,299	60.1	178	384	
Cherokee	Public Service Co of Colorado	Xcel Energy	CO	West	Gas ST	381	0%	248	5.0	31%	195	64.9	169	375	
Pawnee	Public Service Co of Colorado	Xcel Energy	CO	West	Coal	552	60%	3,096,143	208.9	62%	1,455,865	226.3			524
Valley (CA)	Los Angeles Department of Water & Power	City of Los Angeles	CA	West	Gas CC	630	31%	652,968	206.1	48%	452,569	218.9		274	249
Red Hawk	Arizona Public Service Co	Pinnacle West Capital	AZ	West	Gas CC	1,140	49%	1,930,011	351.5	36%	1,069,609	281.5	128	390	
Rawhide	Platte River Power Authority	Platte River Power Authority	CO	West	Gas CT	507	2%	69,366	52.4	49%	20,286	87.8			495
Agua Fria	Salt River Project	Salt River Project	AZ	West	Gas ST	390	0%	172	34.1	32%	160	84.6	97	386	
Haynes	Los Angeles Department of Water & Power	City of Los Angeles	CA	West	Gas ST	1,606	0%	1,403	43.2	9%	1,262	85.9		454	
Fort St Vrain	Public Service Co of Colorado	Xcel Energy	CO	West	Gas CT	281	2%	27,955	26.2	27%	8,984	41.6	124	270	
Kyrene	Salt River Project	Salt River Project	AZ	West	Gas CC	292	26%	260,671	68.8	48%	148,024	88.3	72	289	
Arlington Valley Energy Facility	Arlington Valley	Capital Power	AZ	West	Gas CC	713	50%	1,201,307	244.8	39%	662,614	197.4	30	307	
JM Shafer Generating Station	Tri-State G & T Assn	Tri-State G&T	CO	West	Gas CC	397	19%	267,670	92.6	26%	123,857	82.4	104	226	
Fountain Valley Power Facility	Fountain Valley Power	IIF BH Investments	CO	West	Gas CT	228	4%	44,832	29.2	31%	16,455	40.6	102	221	
Manchief Electric Generating Station	Public Service Co of Colorado	Xcel Energy	CO	West	Gas CT	300	9%	138,242	43.3	40%	43,995	54.5			289
Rawhide	Platte River Power Authority	Platte River Power Authority	CO	West	Coal	294	11%	274,480	26.5	49%	183,895	53.2			280
Apache Station	Arizona Electric Pwr Coop	Arizona Electric Pwr Coop	AZ	West	Gas ST	286	8%	121,526	34.3	30%	64,880	44.3		199	78
Coyote Springs II	Avista	Avista	OR	West	Gas CC	287	44%	403,081	68.4	59%	245,689	71.4			272
Frederickson Power LP	Atlantic Powerration	Atlantic Powerration	WA	West	Gas CC	318	38%	393,439	71.9	46%	247,837	85.4		17	246
Evander Andrews Power Complex	Idaho Power Co	IDACORP	ID	West	Gas CT	271	0%	5,940	19.0	28%	2,900	34.9		89	170
Comanche (CO)	Public Service Co of Colorado	Xcel Energy	CO	West	Coal	1,635	34%	4,687,462	249.2	23%	2,493,394	244.9			252
Harbor	Los Angeles Department of Water & Power	City of Los Angeles	CA	West	Gas CC	246	0%	1,087	19.2	29%	985	40.3		228	
Frank Knutson	Tri-State G & T Assn	Tri-State G&T	CO	West	Gas CT	154	1%	13,175	10.1	29%	3,855	21.6	68	149	
Goldendale Generating Station	Puget Sound Energy	Puget Energy	WA	West	Gas CC	303	62%	607,163	79.7	66%	410,000	73.6			216
Cholla	Arizona Public Service Co	Pinnacle West Capital	AZ	West	Coal	1,129	7%	765,212	104.0	10%	408,687	103.6			213
Scattergood	Los Angeles Department of Water & Power	City of Los Angeles	CA	West	Gas CT	214	1%	13,332	15.4	32%	11,019	32.9		211	
Yucca	Arizona Public Service Co	Pinnacle West Capital	AZ	West	Gas CT	241	3%	46,024	20.6	19%	44,990	41.3	86	119	
Valmont Combustion Turbine Project	Public Service Co of Colorado	Xcel Energy	CO	West	Gas CT	142	0%	1,828	8.0	29%	600	21.9	64	138	
Sutter Energy Center	Calpine Sutter	Energy Capital Partners	CA	West	Gas CC	636	42%	933,832	196.5	30%	513,340	163.6		7	192
Dave Gates Generating Station	North Western Energy (MT wind/thermal)	North Western	MT	West	Gas CT	203	17%	205,924	20.4	36%	143,492	27.1		196	
Magnolia Power Project	Southern California PPA	Southern California PPA	CA	West	Gas CC	388	48%	640,100	149.0	52%	494,509	139.4		186	
Bennett Mountain	Idaho Power Co	IDACORP	ID	West	Gas CT	173	1%	7,908	11.4	29%	3,684	23.9			164
Spindle Hill Energy Center	Invenergy Services	Invenergy	CO	West	Gas CT	420	5%	108,078	42.0	9%	37,324	40.6	48	103	
Yucca	Imperial Irrigation District	Imperial Irrigation District	AZ	West	Gas ST	87	1%	3,787	8.3	32%	2,383	23.8	62	86	

Utilization is essentially the capacity factor of the interconnection, it is calculated as the total generation of all the resources associated with the incumbent fossil generator divided by the capacity of the incumbent fossil generator multiplied by the number of hours in the period.

ISO-NE: Interconnection Fast-Track Rules

Generator Replacement

- No separate interconnection study/process currently in place

Surplus Interconnection Service

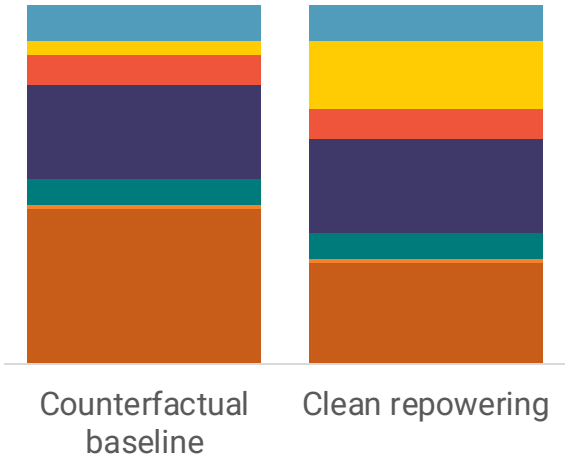
- Process follows FERC Order 845 (compliance filing approved March 2020)

Relevant Examples

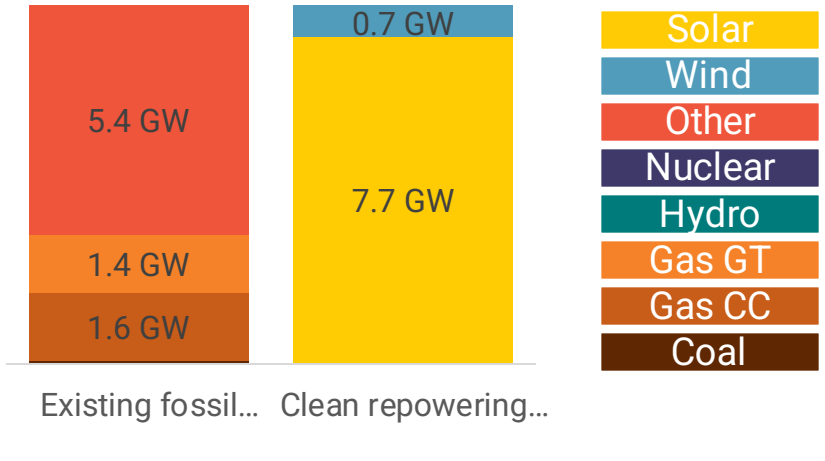
- Several **offshore wind** farms in development are exploring the ability to use interconnection infrastructure from retiring or retired fossil plants along the New England coast, such as the Brayton Point coal plant in Somerset, MA, which is being redeveloped into an offshore wind supply chain and staging hub. The **South Coast Offshore Wind Project** has plans to interconnect via Brayton Point's substation.
- Advocates are currently working to retire the **Merrimack Station** in Bow, NH, the last coal plant in New England. It failed to clear the latest ISO-NE capacity market, meaning its days are numbered. No clean repowering project has been considered yet due to ISO-NE's lack of a separate process.

ISO-NE opportunities

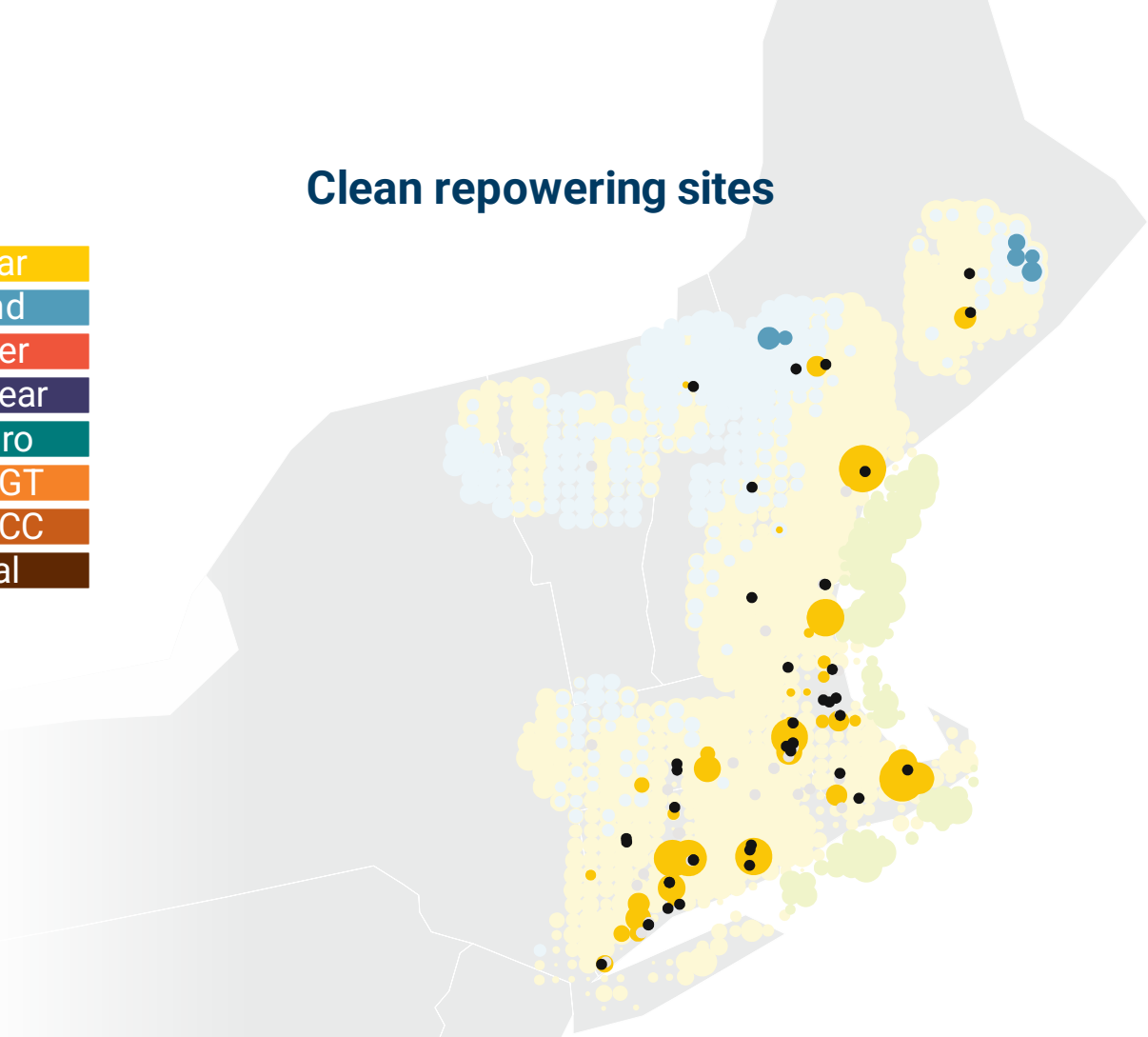
Generation in 2035



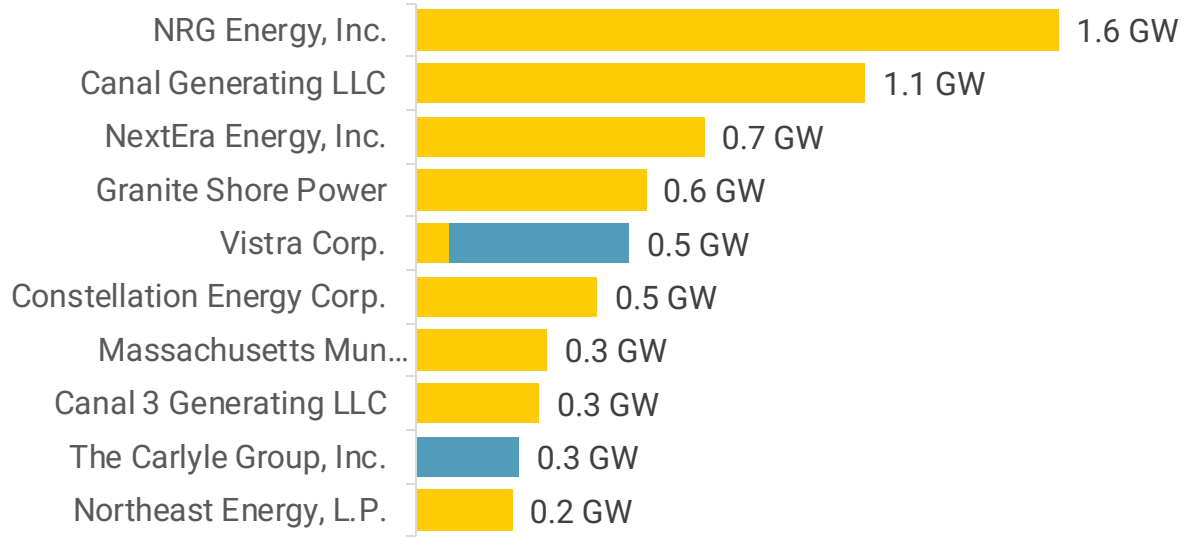
Clean repowering capacity



Clean repowering sites



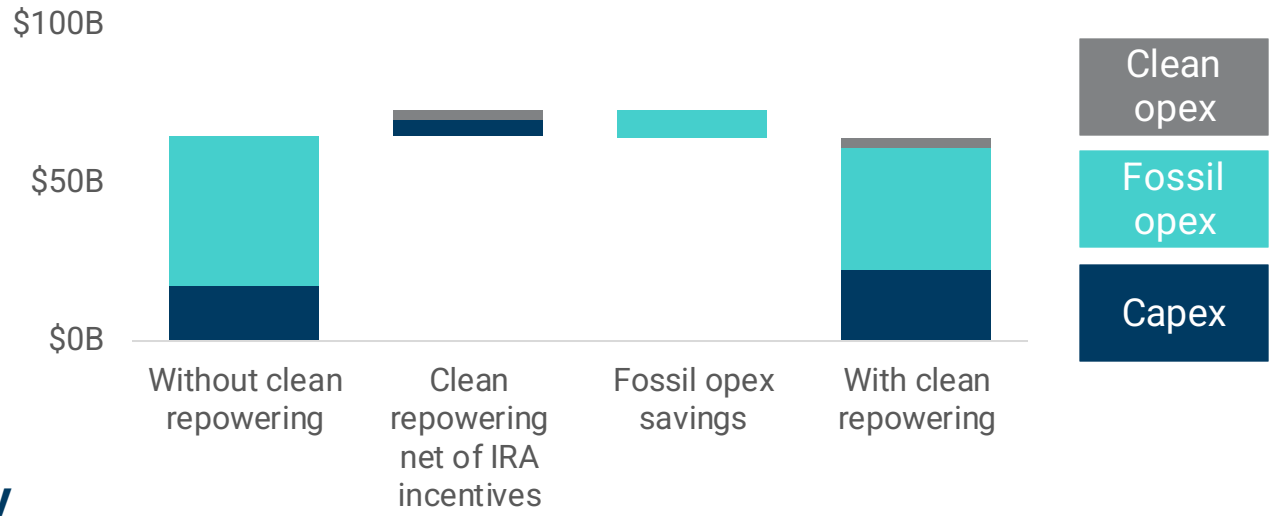
Top 10 generation owners by clean repowering opportunity



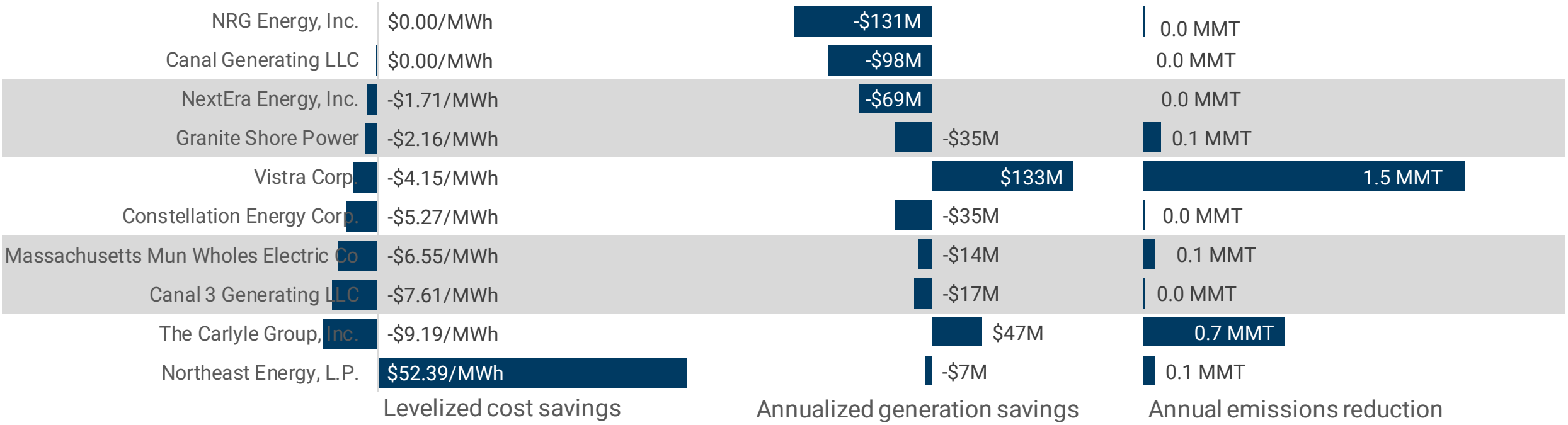
ISO-NE savings

Total regional annualized savings	$ 63 million
Total reduction in annual carbon emissions	6 MMT

Cost impact of clean repowering



Top generation owners by clean repowering opportunity



Negative savings indicate cost increases. A generation owner's levelized cost or annualized generation cost can increase with clean repowering because of an increase in that owner's total generation or a change in the composition of its generation.

ISO-NE top clean repowering opportunities

							Counterfactual			Clean repowering					
Plant Name	Owner	Ultimate Parent	State	Region	Technology	Capacity	Utilization	Emissions	Annualized NPV	Utilization	Emissions	Annualized NPV	Battery	Solar	Wind
						MW	%	tonne/yr	$million/yr	%	tonne/yr	$million/yr	MW	MW	MW
Canal	Canal Generating	Canal Generating	MA	ISONE	Other Fossil	1,165	0%	-	129.9	26%	-	226.1		1,148	
William F Wyman Hybrid	FPL Energy Wyman	NextEra Energy	ME	ISONE	Other Fossil	846	0%	-	57.7	25%	-	130.8		833	
Maine Independence Station	Casco Bay Energy Co	Vistra	ME	ISONE	Gas CC	550	25%	484,672	130.2	42%	214,012	142.9			459
Middletown	Middletown Power	NRG Energy	CT	ISONE	Other Fossil	433	0%	648	31.3	25%	228	70.5		426	
Montville Station	NRG Montville Operations	NRG Energy	CT	ISONE	Other Fossil	420	0%	1,053	31.8	25%	596	67.7		409	
Newington	Granite Shore Power	Granite Shore Power	NH	ISONE	Gas ST	414	0%	1,112	41.2	20%	831	61.3		396	
Middletown	Middletown Power	NRG Energy	CT	ISONE	Gas ST	353	0%	745	33.8	20%	289	51.0		338	
Canal	Canal 3 Generating	Canal 3 Generating	MA	ISONE	Gas CT	330	0%	5,649	19.8	20%	2,368	36.4		316	
Rumford Power LLC	Rumford Power	The Carlyle Group	ME	ISONE	Gas CC	275	19%	185,636	55.2	44%	74,978	61.6			264
Stony Brook	Massachusetts Mun Wholes Electric Co	Massachusetts Mun Wholes Electric Co	MA	ISONE	Other Fossil	280	0%	-	18.6	19%	-	34.1		263	
Exelon West Medway II LLC	Exelon Power	Constellation Energy	MA	ISONE	Gas CT	264	0%	2,013	15.1	20%	1,089	29.0		253	
Bellingham Cogeneration Facility	Northeast Energy Associates	Northeast Energy	MA	ISONE	Gas CC	386	9%	119,431	53.6	18%	68,235	60.3		247	
GenConn Devon LLC	GenConn Devon	GenConn Devon	CT	ISONE	Other Fossil	242	0%	-	11.9	25%	-	33.2		237	
GenConn Middletown LLC	GenConn Middletown	GenConn Middletown	CT	ISONE	Other Fossil	242	0%	-	11.7	25%	-	34.2		237	
Devon Station	Devon Power	NRG Energy	CT	ISONE	Other Fossil	430	0%	-	11.1	13%	-	31.0		220	
Wallingford Energy	Wallingford Energy	LS Power	CT	ISONE	Gas CT	350	0%	2,829	20.0	12%	1,054	30.7		202	
Bucksport Generation LLC	Bucksport Generation	Bucksport Generation	ME	ISONE	Gas CT	187	3%	23,662	14.3	21%	16,439	23.3		179	
New Haven Harbor	Generation Bridge II New Haven	Generation Bridge II New Haven	CT	ISONE	Other Fossil	182	0%	-	8.6	20%	-	15.9		172	
Androscoggin Energy Center	Pixelle Androscoggin	Pixelle Androscoggin	ME	ISONE	Gas CT	164	6%	37,116	24.2	23%	23,503	30.1		155	
Exelon Medway LLC	Exelon Power	Constellation Energy	MA	ISONE	Other Fossil	135	0%	-	5.2	25%	-	18.4		133	
Milford Power LP	Starwood Energy Group Global	Starwood Energy Group Global	MA	ISONE	Gas CC	249	4%	39,975	30.6	12%	20,597	33.4		115	
Cleary Flood Hybrid	City of Taunton	City of Taunton	MA	ISONE	Gas CC	118	0%	1,329	10.5	20%	662	15.9		113	
Potter Station 2	Town of Braintree - (MA)	Town of Braintree - (MA)	MA	ISONE	Gas CT	116	0%	597	6.0	20%	225	12.1		111	
Cos Cob	Connecticut Jet Power	NRG Energy	CT	ISONE	Other Fossil	115	0%	-	4.4	21%	-	11.5		111	
Potter Station 2	Town of Braintree - (MA)	Town of Braintree - (MA)	MA	ISONE	Gas CC	101	0%	1,443	7.9	20%	887	13.2		97	
Schiller	Granite Shore Power	Granite Shore Power	NH	ISONE	Coal	100	6%	86,047	16.1	25%	71,064	20.6		96	
Masspower	Masspower	Vistra	MA	ISONE	Gas CC	261	17%	151,456	49.0	18%	104,414	48.2		86	
Stony Brook	Massachusetts Mun Wholes Electric Co	Massachusetts Mun Wholes Electric Co	MA	ISONE	Gas CC	255	4%	40,135	32.6	9%	23,453	35.0		81	
AL Pierce	Connecticut Mun Elec Engy Coop	Connecticut Mun Elec Engy Coop	CT	ISONE	Gas CT	84	0%	256	4.3	20%	158	8.8		80	
Montville Station	NRG Montville Operations	NRG Energy	CT	ISONE	Gas ST	75	0%	0	6.7	20%	-	10.1		72	
M Street Jet	Massachusetts Bay Trans Auth	Massachusetts Bay Trans Auth	MA	ISONE	Other Fossil	69	0%	-	2.6	25%	-	9.1		68	
Waters River	City of Peabody- (MA)	City of Peabody- (MA)	MA	ISONE	Gas CT	65	0%	24	3.3	20%	8	6.8		62	
Algonquin Windsor Locks	Algonquin Windsor Locks	Algonquin Power& Utilities	CT	ISONE	Gas CC	71	1%	1,883	6.3	16%	825	9.0		54	
Deer Island Treatment Plant	Massachusetts Wtr Rauth-Deer I	Massachusetts Wtr RAuth-Deer I	MA	ISONE	Other Fossil	52	0%	18	1.9	20%	17	4.7		50	
Exelon Framingham LLC	Exelon Power	Constellation Energy	MA	ISONE	Other Fossil	43	0%	-	1.7	25%	-	5.7		41	
Merrimack	Granite Shore Power	Granite Shore Power	NH	ISONE	Other Fossil	37	0%	-	1.4	25%	-	5.2		37	
Dartmouth Power Associates LP	Dartmouth Power Associates	Dartmouth Power Associates	MA	ISONE	Gas CC	74	11%	26,847	12.0	15%	16,051	11.8		31	
Tanner Street Generation	BT Generation Holdings	BT Generation Holdings	MA	ISONE	Gas CC	151	1%	7,972	9.2	4%	4,124	10.1		26	
Dartmouth Power Associates LP	Dartmouth Power Associates	Dartmouth Power Associates	MA	ISONE	Gas CT	23	0%	78	1.3	20%	25	2.4		22	
Branford	Connecticut Jet Power	NRG Energy	CT	ISONE	Other Fossil	22	0%	-	0.8	25%	-	3.0		22	
Franklin Drive	Connecticut Jet Power	NRG Energy	CT	ISONE	Other Fossil	22	0%	-	0.8	25%	-	2.9		22	
Torrington Terminal	Connecticut Jet Power	NRG Energy	CT	ISONE	Other Fossil	22	0%	-	0.8	25%	-	2.9		22	
Schiller	Granite Shore Power	Granite Shore Power	NH	ISONE	Other Fossil	21	0%	-	1.0	25%	-	3.0		21	

Utilization is essentially the capacity factor of the interconnection, it is calculated as the total generation of all the resources associated with the incumbent fossil generator divided by the capacity of the incumbent fossil generator multiplied by the number of hours in the period.

NYISO: Interconnection Fast-Track Rules

Generator Replacement

- **Capacity Resource Interconnection Service (CRIS) transfer process** allows Capacity Interconnection Rights (CIRs) to be transferred to new facility at same electrical location if the new facility becomes operational within three years from deactivation of original facility, **with no deliverability evaluation required** (*also permitted for facilities that are not deactivating*)
- New facilities must still go through the interconnection queue for full interconnection service in addition to CIRs

Surplus Interconnection Service

- No process — NYISO received a waiver from FERC for Order 845 compliance due to NYISO's unique treatment of existing generating resources via its Minimum Interconnection Standard process
  - FERC's Order 845 surplus service assumes that resources dispatch at full output under normal conditions and thus might have "headroom" available for transfer.
  - NYISO's Minimum Interconnection Standard instead assumes that a facility can be redispatched to mitigate adverse reliability impacts, hence there is no surplus "headroom" available for transfer

Relevant Examples

- **Elevate Renewables** is developing a utility-scale energy storage facility at the **Arthur Kill Generating Station** located in the borough of Staten Island, New York City, NY.

ERCOT: Interconnection Fast-Track Rules

Generator Replacement

- Replacement must be “in-kind” or below an aggregate real power rating of 10 MW (see Planning Guide § 5)
  - Otherwise, must enter through the standard interconnection process

Surplus Interconnection Service

- ERCOT is not FERC-jurisdictional so does not have to comply with Order 845
- Recently created a separate interconnection process to add battery energy storage to an existing solar or hybrid resource (see ERCOT Key Topic Concept #13)

Relevant Examples

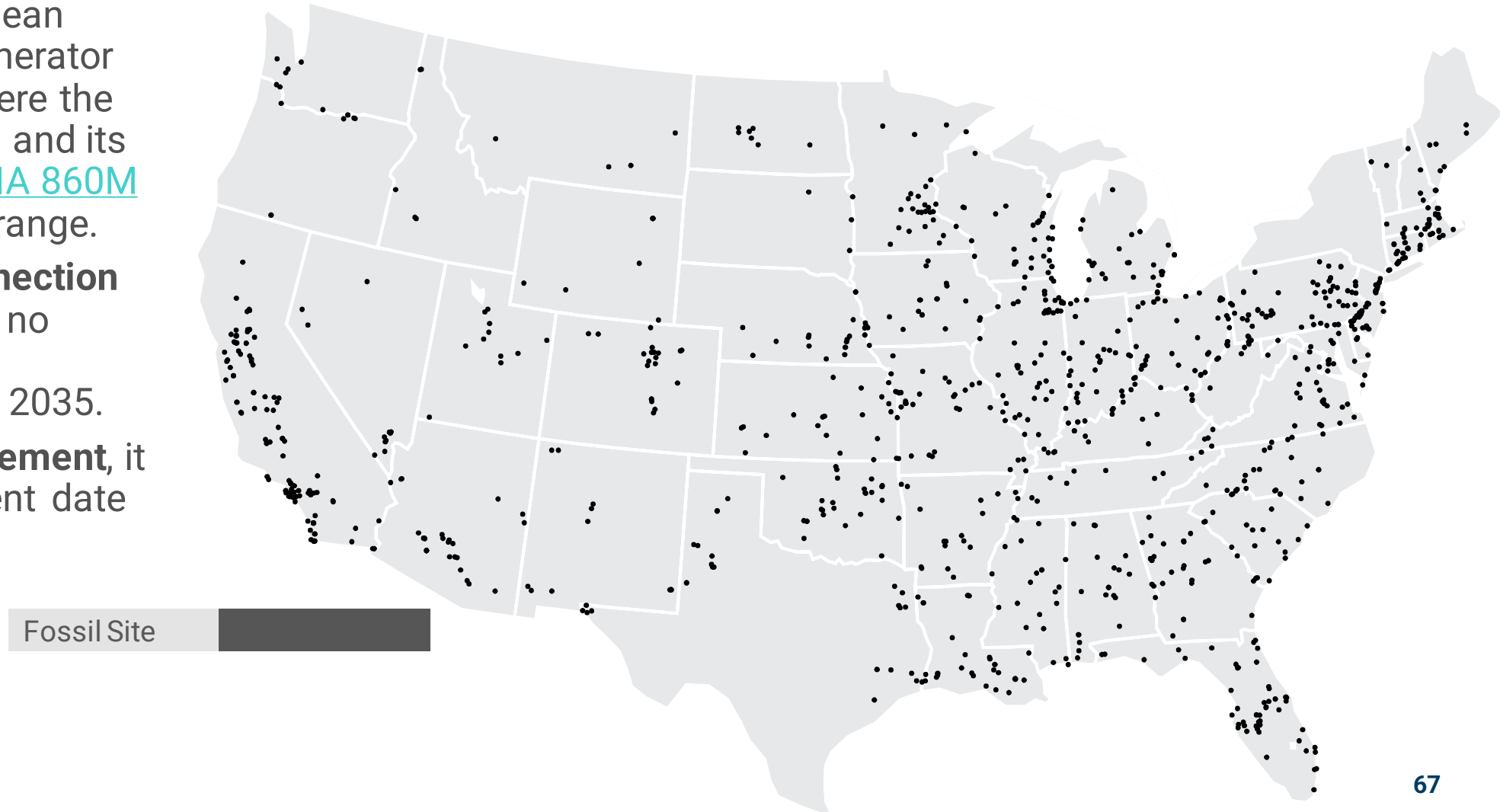
- None

Clean Repowering: Modeling approach

The model begins with all major **existing fossil generators** in a grid region eligible for clean repowering

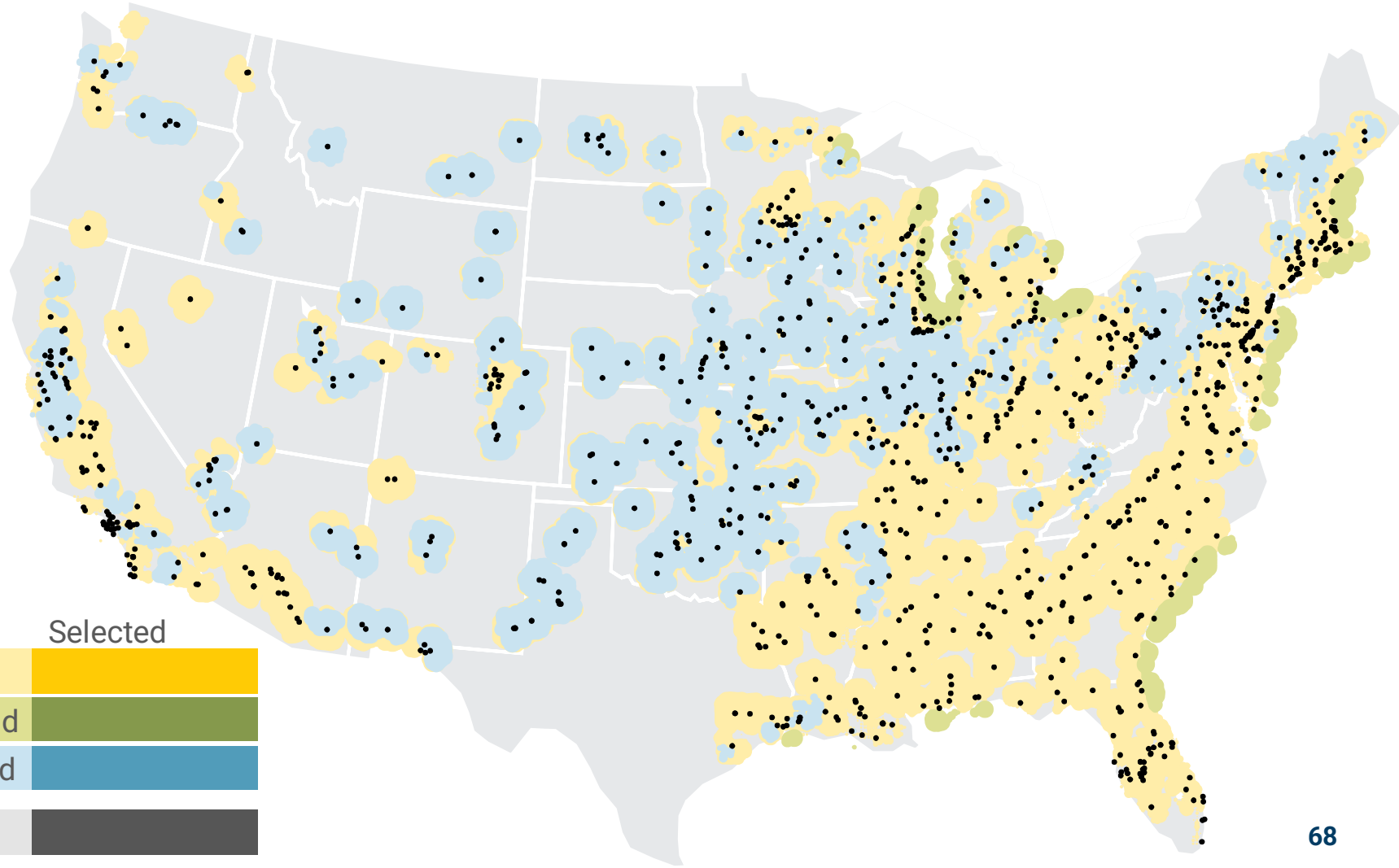
To be considered for clean repowering, a fossil generator must be in a region where the relevant process exists and its retirement date from EIA 860M must be in the correct range.

- For **surplus interconnection service**, it must have no retirement date or a retirement date after 2035.
- For **generator replacement**, it must have a retirement date before 2036.



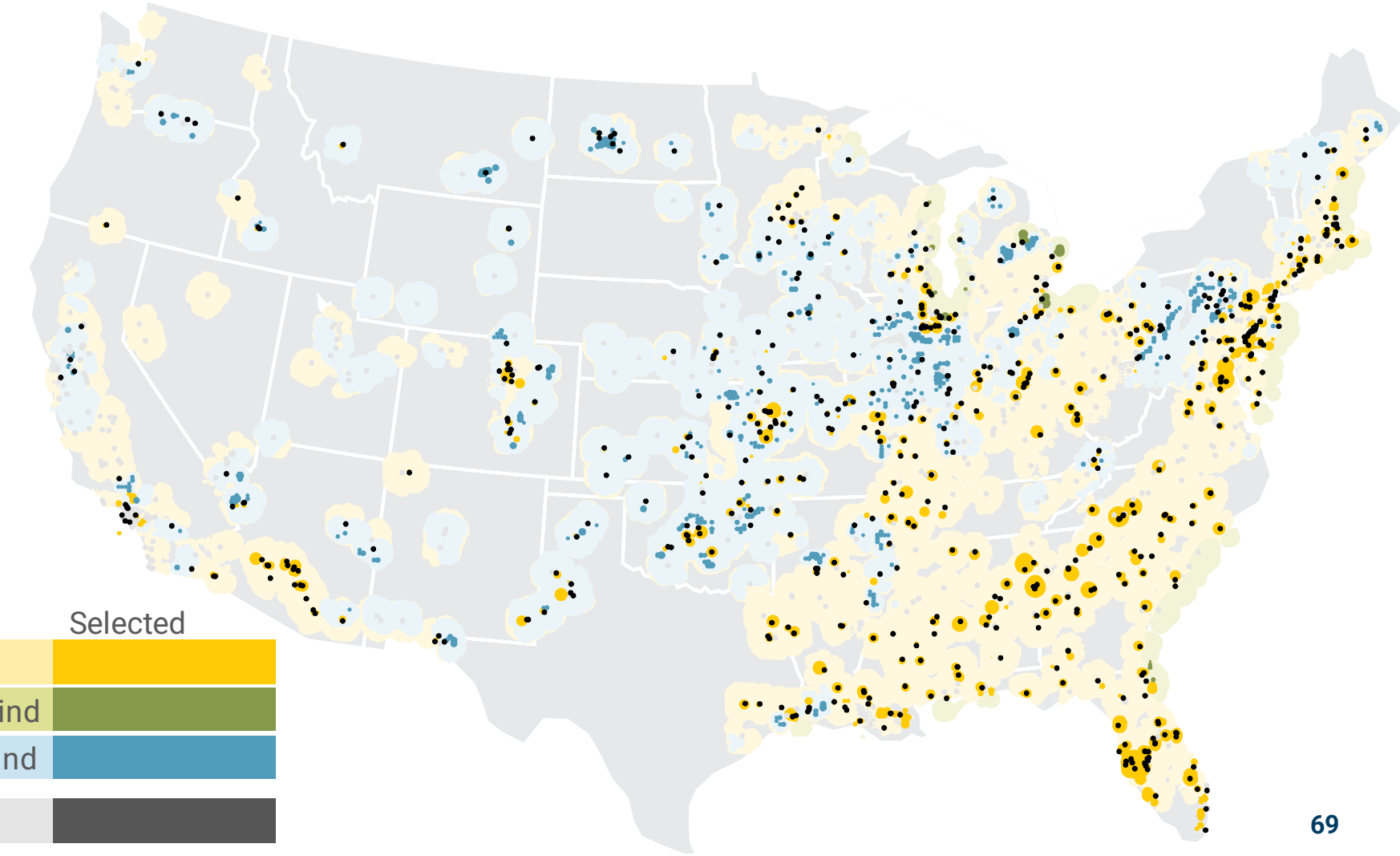
It identifies **potential renewable sites** within 45 km of each fossil site

Potential renewable sites come from NREL Renewable Supply Curves and include resource quality and the quantity of renewables that can be deployed there given reference land exclusions.



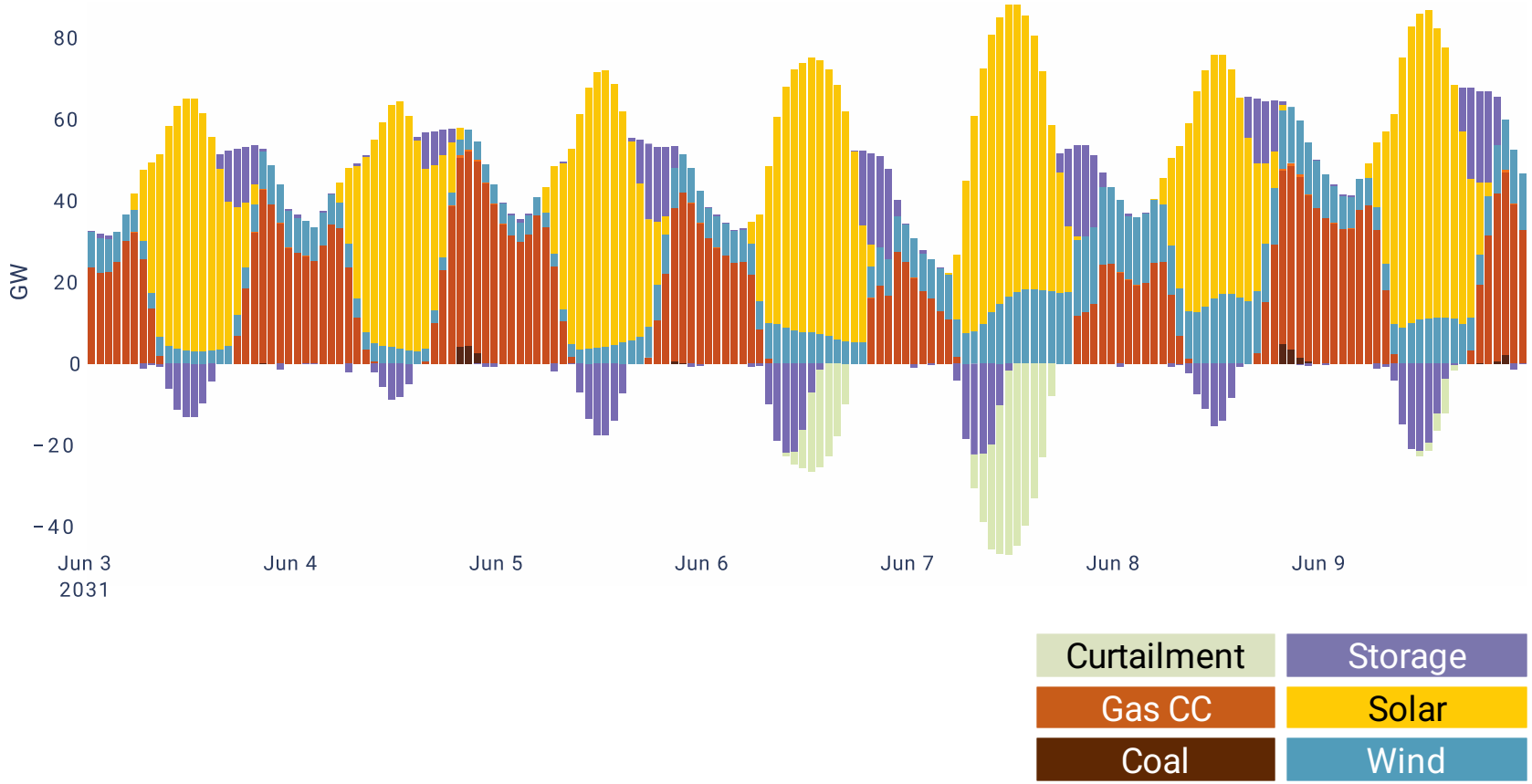
It then creates a set of portfolios in which it **selects increasing amounts of renewables and storage** at the sites where renewables are most attractive relative to the incumbent fossil generator

It selects renewables to maximize replacement of historical fossil dispatch and minimize cost constrained by siting limitations and the incumbent generator's capacity to avoid transmission upgrades beyond spur lines.

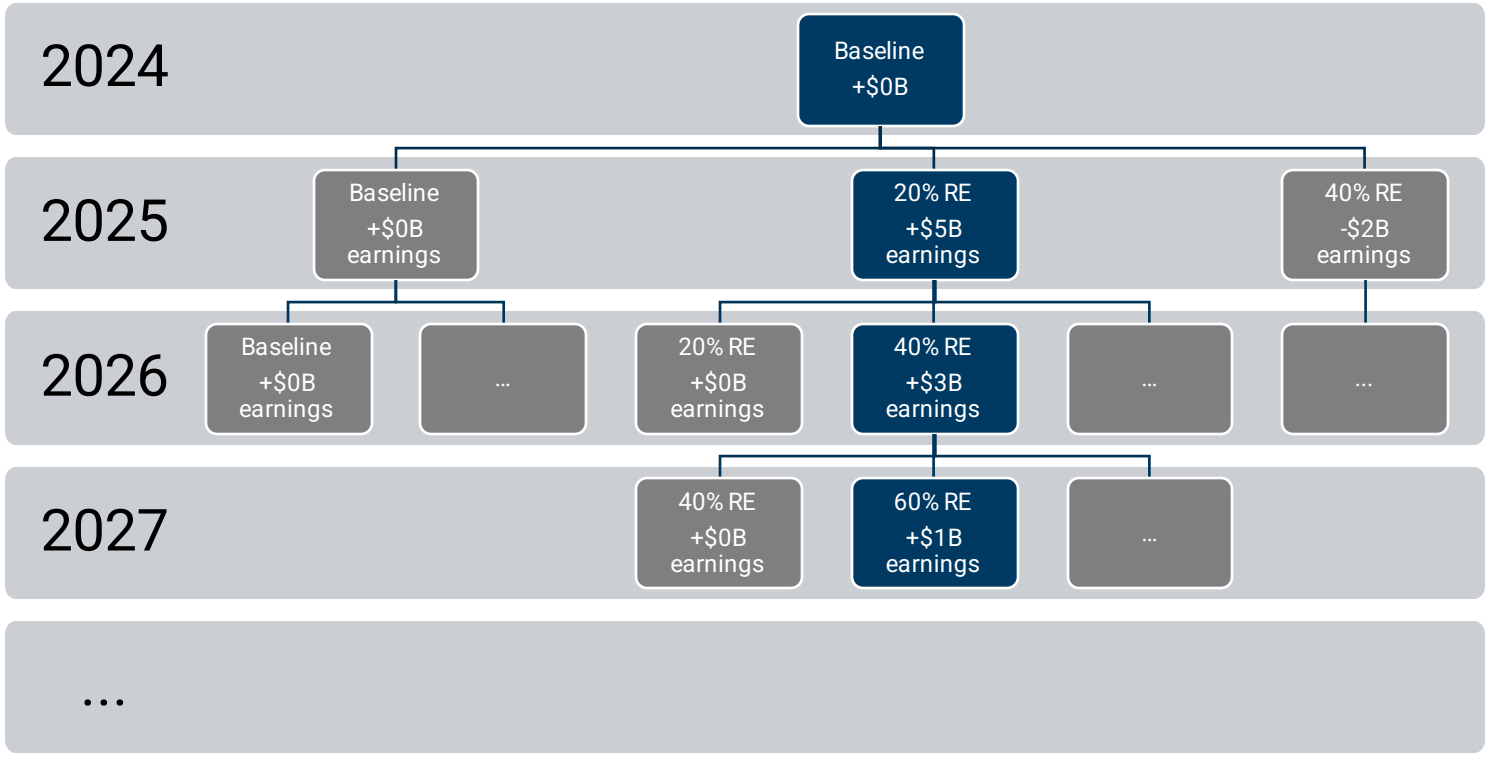


For each portfolio, it **simulates hourly operations** using 15 years of historical data to estimate production costs, emissions, and reliability under different weather and fuel price conditions

- Simulations employ a simplified economic dispatch logic to determine fossil and storage operations before and after renewable deployment.
- Interconnection constraints are enforced by preventing the hourly output of clean repowering renewables and the associated incumbent fossil generator from exceeding the fossil generators' capacity.
- Fossil operating costs are estimated using a regression of historical plant-level FERC 1, EIA 860 and 923, and EPA CAMD fuel and operating cost and operational data to best reflect impacts of changing utilization patterns on generation costs.



Finally, for each region it selects the sequence of **portfolios that maximizes utility earnings** without increasing the region's aggregate levelized cost of generation, **factoring in applicable IRA provisions**



Optimal portfolio selection employs detailed financial analysis using:

- utility-specific financial metrics such as allowed ROE/ROR and equity ratios; and
- Inflation Reduction Act provisions such as New ERA, EIR, and direct pay/transferability.