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Interconnection Reform: How One Grid Operator Is Changing the Game

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Summary

Despite improvements enacted by the Federal Energy Regulatory Commission (FERC) in Order 2023, there is wide recognition among stakeholders, grid operators, power plant developers, and regulators that the process of connecting new power plants to the transmission grid needs additional improvements.

One grid operator, Southwest Power Pool (SPP), has developed a major reform proposal that synchronizes the long-term transmission planning process with the interconnection process and could serve as a model for other Regional Transmission Operators (RTOs), and Independent System Operators (ISO).

Although the new interconnection fees proposed as part of SPP's plan are higher than costs paid previously, based on our research most power plant developers believe that the higher fees are justified, provided the process makes it more likely that new power plants are interconnected.

This report describes the need for additional interconnection reform and explains why the SPP Consolidated Planning Proposal should be studied closely by other grid operators.

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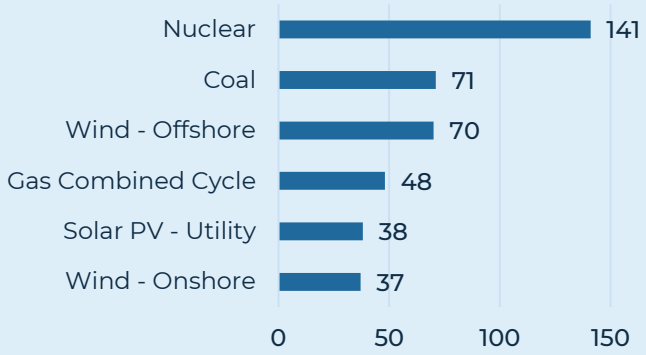
Introduction & Context

Despite whipsawing federal policy around incentives, solar and storage economics remain very competitive with conventional generation. Domestic module manufacturing capacity is growing, and solar continues to have strong public support.

Clean energy, solar and storage remain **extremely cost competitive with natural gas and nuclear**

Levelized Cost of Energy ($/MWh)[1]



U.S. solar module manufacturing capacity can now **fully supply the domestic market**

>56 GW

module manufacturing capacity online in the U.S. today[2]

And solar **continues to enjoy strong public support** in poll after poll

75%

of respondents agreed that solar power is good for America's economy[3]

Sources: 1 – Lazard LCOE+ June 2025 (simplified); 2 – U.S. SMI June 2025; 3 – SEIA/Global Strategy Group, June 2022.

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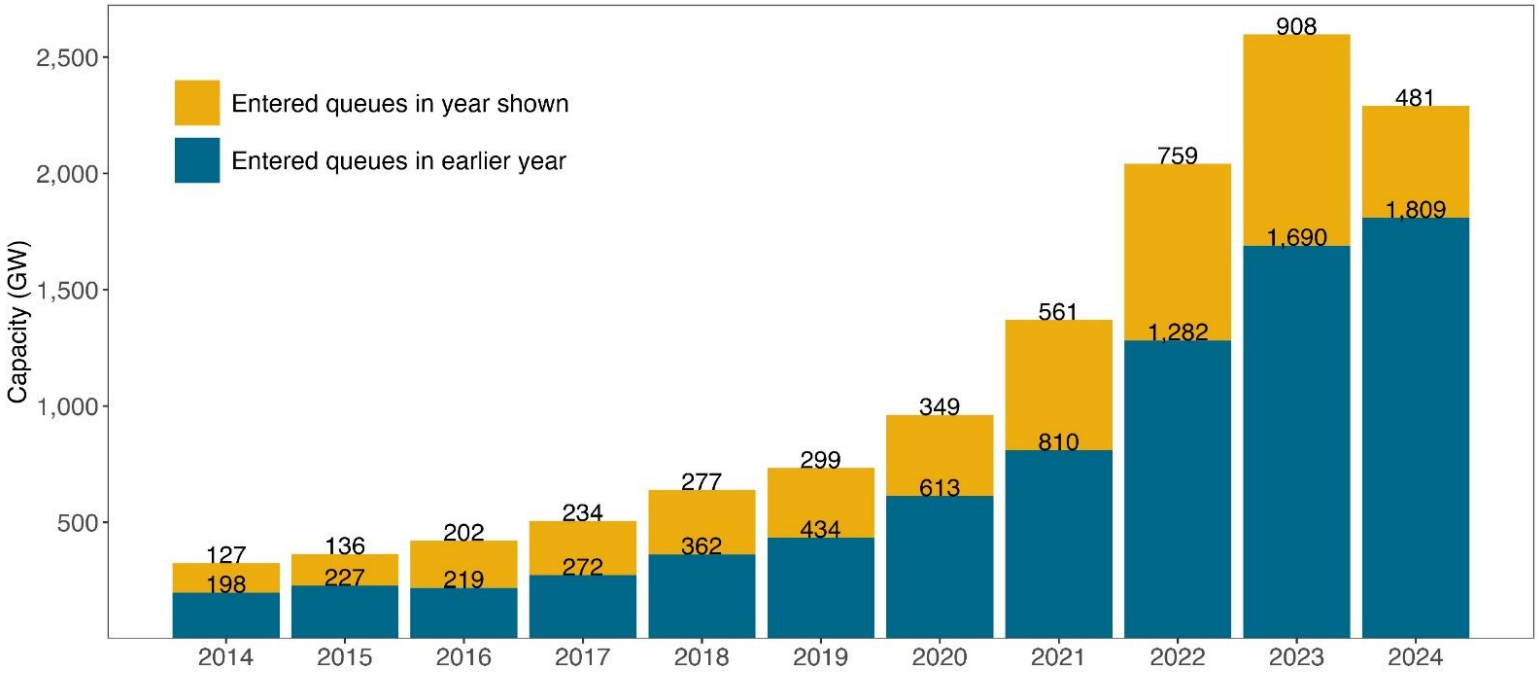
But interconnection bottlenecks are still a major stumbling block to deploying clean energy projects and roughly 2,300 gigawatts of projects remain stuck in the combined interconnection queues.

- Through the end of 2024, the volume of projects awaiting review, study, and approval in the interconnection queues amounts to roughly **2,300 gigawatts (GW)**[4] of electric generation and storage capacity.
- Although the size of the active interconnection queue through 2024 declined from 2,600 GW in 2023, the first decline in more than a decade, there is still significant capacity awaiting approval**.**
- For context, 2,300 GW is nearly double the total amount of electric capacity installed on the U.S. electrical grid today.[5]

Cumulative Capacity of Active Interconnection Requests, 2014-2024



Source: LBNL "Queued Up" (2024)

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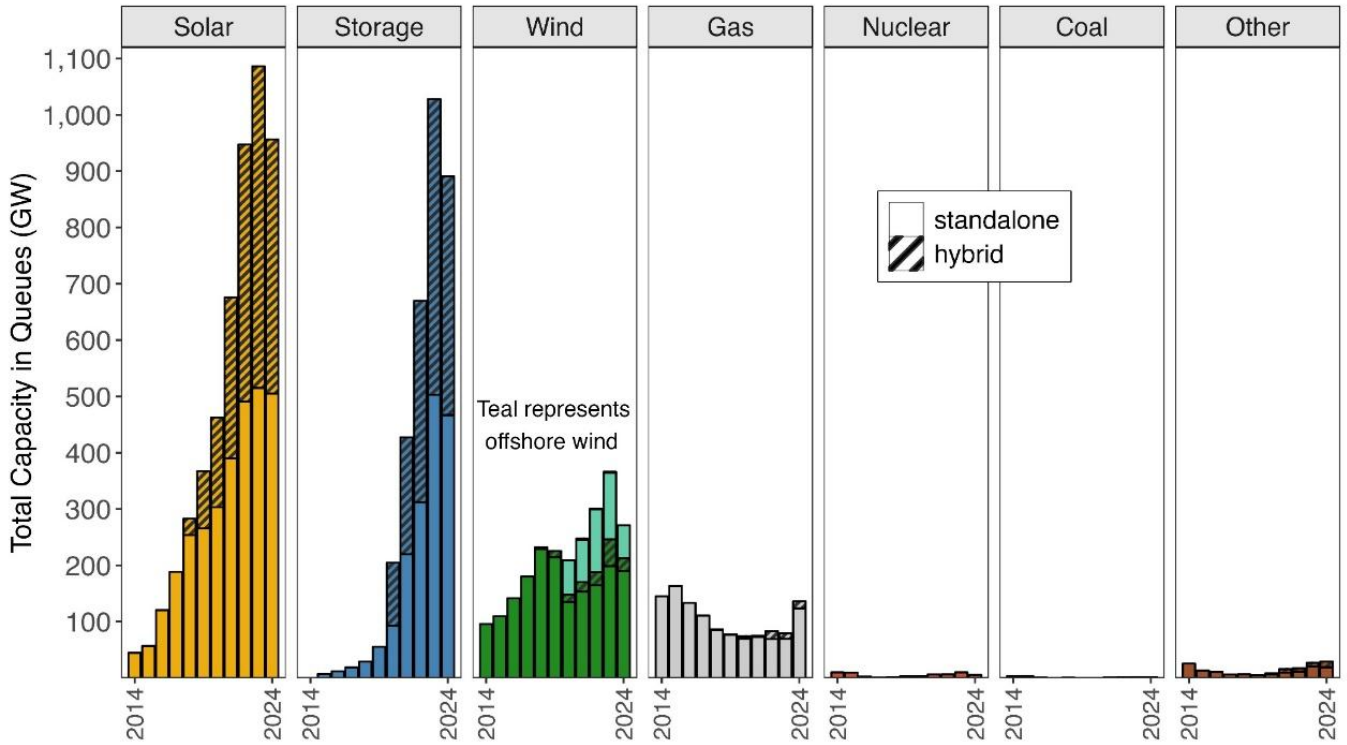
Furthermore, solar and storage projects account for 80% of the capacity stuck in interconnection queues.

Capacity of Active Interconnection Request by Generator Type, 2014-2024



Source: LBNL "Queued Up" (2024)

- Of the 2,300 GW currently in the queue, **1,847 GW or 80% are solar or storage projects.** Though this is a reduction from the 2,114 GW of solar or storage projects in the queue at the end of 2023, it amounts to only 8.1% in percentage terms.
- Of note, only 508 GW of new electric generating capacity entered the interconnection queues in 2024, the lowest total since 2020. Of these 508 GW, 61% were solar or storage projects.
- Several factors are likely driving the reduced number of queue entrants, including: RO/ISO freezes on new interconnection applications, elevated financing costs due to interest rates, supply chain problems due to tariffs, and challenges obtaining local permits.

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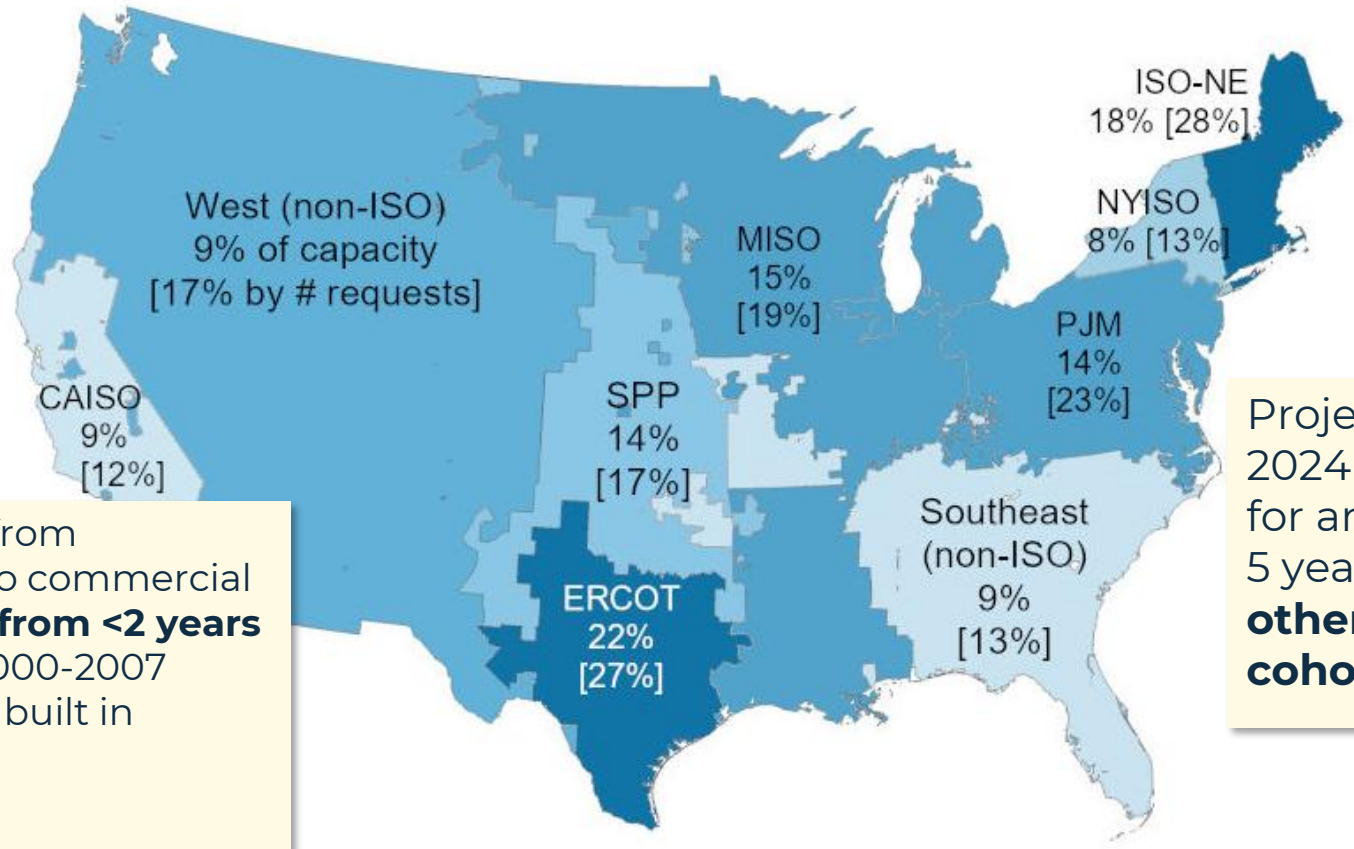
Keep in mind that most of the current capacity in the queues will not be built because many applications are based on incomplete system information. As a result, interconnection wait times have increased and projects completed in 2024 were in the queue for nearly 5 years on average.

Among a subset of queues across major regions for which data are available, **only 19% of projects** (and 14% of capacity) seeking connection from 2000 to 2019 have been built as of the end of 2024.



The typical duration from connection request to commercial operation **increased from <2 years** for projects built in 2000-2007 **to >4 years** for those built in 2019-2024.

Projects completed in 2024 were in the queue for an average of nearly 5 years, **longer than any other previous annual cohort**.

Source: LBNL "Queued Up" (2024)

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Part of the problem is that most grid-operators are still processing interconnection requests based on outdated methods that do not align with overall system planning and generator interconnection.

The current interconnection "request then analyze" method leads to:

- Delays, persistent restudies, and significant planning uncertainty when a project withdraws;
- Increased cost uncertainty for interconnection customers based on a constantly shifting landscape; and
- Can result in significant inequities because projects that connect to the grid later benefit from upgrades paid for by the first interconnecting customer.

A better approach coordinates system planning and the interconnection queue, and would lead to:

- More certainty over costs for interconnecting customers;
- More equitable costs for all interconnection customers based on benefits;
- Clearer identification of needs and costs before generators apply to connect; and
- Would likely reduce the need for multiple restudies that slow down the entire process.

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The approach described above follows reform recommendations previously advanced by the Institute,[6] where we called on grid operators to:

- Develop comprehensive regional transmission planning processes that integrate the interconnection queue in planning for the full range of transmission projects; and
- Charge interconnecting customers only for the costs of upgrading the immediate infrastructure needed to connect their project using what we called an “entry fee.”

We called this “Game Changing Reform”, and the **Southwest Power Pool** has made tremendous progress advancing a detailed proposal along these lines that may serve as a model for other grid operators to emulate.

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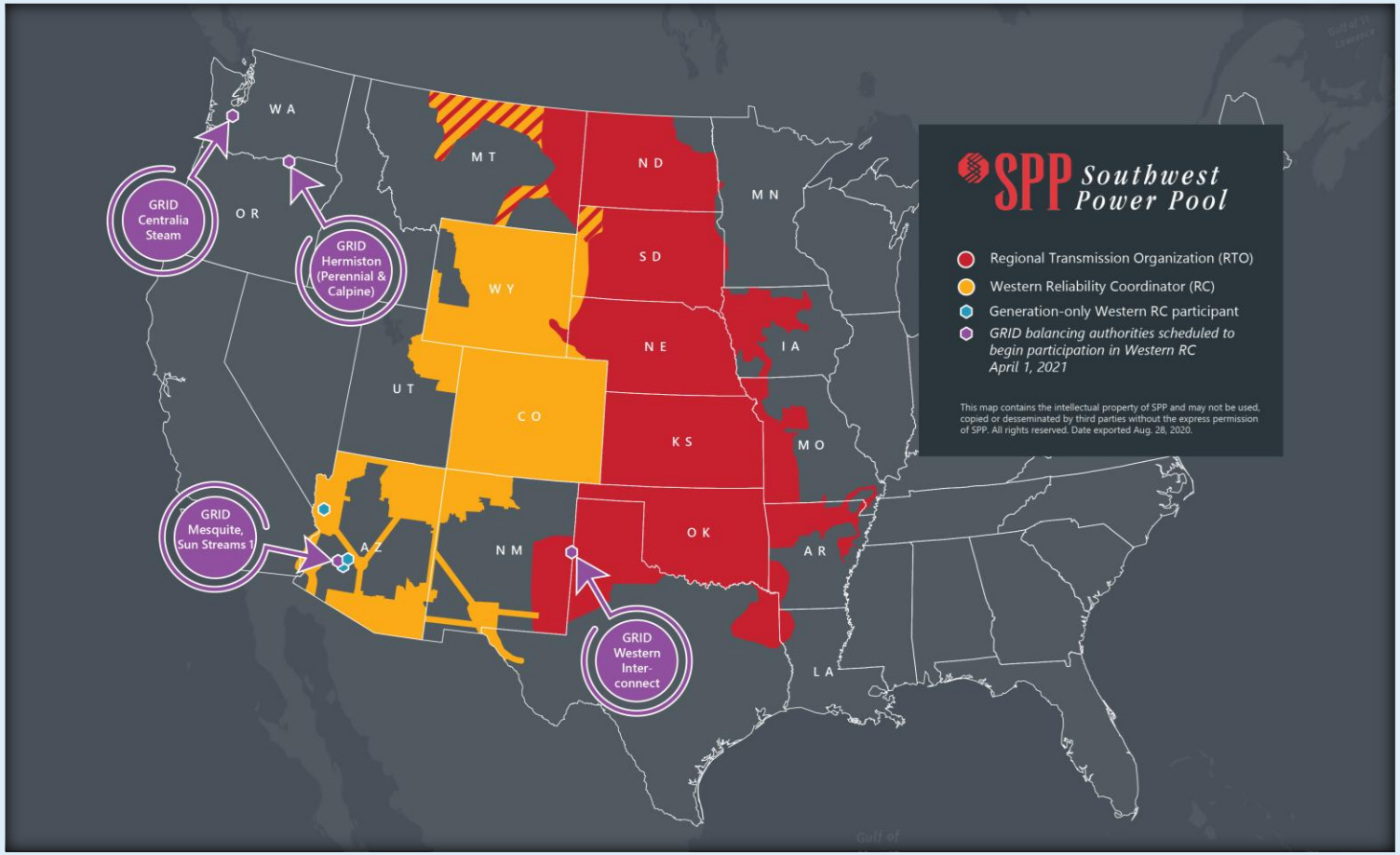
Southwest Power Pool (SPP): Consolidated Planning Process (CPP) & Reformed Generator Interconnection

Southwest Power Pool (SPP) is a Regional Transmission Organization (RTO) that serves members in all or part of 14 states (red on map) and provides additional energy to customers in 23 states and provinces.

SPP serves over 500,000 square miles of territory, has more than 1,000 generators across the region, and as of 2024, 38% of the electricity generated was produced by wind projects.

SPP has been working on major planning and interconnection reforms since 2021, which they now call the Consolidated Planning Process (CPP).



Source: Southwest Power Pool

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The CPP is an integrated transmission planning process and interconnection reform proposal that begins with a long-term planning study that factors in the existing portfolio of generation, including proposed plants in the interconnection queue, and forecasts needed generation for the next 20 years to meet expected electricity demand.

The study is broken down into regional and sub-regional components across the entire service territory to provide a more granular analysis of system needs. Importantly, **this study also identifies prospective locations for generators to connect to the system**. Additional studies evaluate system needs on a 10-year time horizon and evaluate new generator impacts to the system.

In addition to increasing the technical “readiness requirements,” sometimes called “project maturity requirements”, for new power plants, the proposal assigns a grid contribution fee **(called the “GRID C”)** that encompasses both regional and subregional transmission costs, and any additional project specific costs (“directly assigned costs") when necessary.

Interconnection customers are then faced with a “decision point,” where they either commit to the assigned costs or they walk away. The planning process also results in additional transmission build out recommendations and construction.

Source for remaining slides: Southwest Power Pool

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The foundation of the CPP are two assessments of long-term system needs. These assessments, each spanning a different time horizon, are intended to share the same technical assumptions for modeling.

CPP-20: Long-term 20-Year Assessment

The CPP-20 is a comprehensive analysis, conducted **every three years,** looking 20 years into the future. This analysis serves as foundation for cost assignment (the Grid-C) and identifies planned locations for future generation. This assessment also establishes several scenarios for likely transmission build out.

CPP-10: Ten-Year Annual Assessment

The CPP-10 occurs **annually** and looks 10 years into the future. This analysis evaluates specific existing and proposed generator impacts and recommends any necessary and more immediate transmission construction.

Technical Assumptions

Planners have tried to ensure that the modeling approaches for 20-year & 10-year assessments are as comparable as possible by using similar technical assumptions and data sets. Each study uses the same sources for fuel trends, retirements, and policy goals. The aim is to achieve consistency between approaches that do not produce major variations in results.

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The CPP also reforms the interconnection process itself by implementing a series of procedural changes and by increasing project "readiness" or maturity requirements for entering the interconnection queue.

Interconnection Procedural Changes

Generator requests to interconnect are submitted via new "Cluster Windows" – batches of applications analyzed together – as well as studied individually.

To encourage strategic and beneficial interconnections, **SPP will identify and treat requests at *planned locations*, and *unplanned locations* differently.**

For example, interconnection requests at an unplanned location, or those that go beyond the capacity of an identified location, can result in directly assigned costs to the generator.

This combination of carrots and sticks will be used to strategically guide interconnection applications without prohibiting generator interconnection.

Customer Readiness Requirements

Customers must pay an application fee and study deposits, and must provide project financial information, detailed project technical data, and evidence that the developers have appropriate site control or other required milestones.

Importantly, while under the CPP financial commitments from customers are increased from the status quo, the tradeoff is increased certainty.

Eventually, 100% of costs will be assigned at the "decision point" and developers will have the option to choose not to proceed without penalty.

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Interconnections at planned and unplanned locations ultimately differ around which costs are assigned.

Planned Locations

Specific locations and maximum interconnection capacity will be identified during the CPP study cycles.

These locations are subject to **GRID-C, Transmission Owner Interconnected Facilities, and Affected Systems upgrade charges, if assigned.**

If planned locations are oversubscribed, customers can reduce capacity to match the planned capacity of this location. Any generation beyond the planned capacity will result in directly assigned costs to the generator.

Planned locations are also "technology agnostic", meaning wind, solar, gas, and storage projects are on equal footing and sites have some flexibility around the exact point of interconnection.

Unplanned Locations

Unplanned locations are subject to all these costs **plus Network Upgrades Costs, Shared Network Upgrades Costs, and Affected Systems upgrade charges, if assigned.**

These charges can be significant and serve as a major incentive to develop projects in planned locations.

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The estimated Generalized Rates for Interconnection Development, or GRID-C(s), are broken down by type of service requested (either ERIS or NRIS) and by zone. In effect, there are multiple GRID-Cs across the service territory and estimated costs are higher than historical costs.

ERIS (Energy Resource Interconnection Service by Subregion)

- Allows injections on an **"as available" energy basis** but doesn't guarantee transmission service.
- Potential Cost Range: **$17 – 27/kW.**
- These costs are between 73% and 86% higher than historical costs, with the reminder that this fee captures contributions toward transmission build out & other upgrade costs.

NRIS+ (Network Resource Interconnection Service by Subregion)

- Reflects the needs of **firm transmission service.**
- Potential Cost Range **$24-$34/kW.**
- These costs are ~100% to 110% higher than historical costs, with the reminder that this fee captures contributions toward transmission build out & other upgrade costs.

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Certainty vs. Cost

While the upfront costs are higher for ERIS and NRIS upgrades under the CPP, more costs are embedded in this phase, and developers have guaranteed certainty for project completion and connection at the end of the process.

The historical lower costs keep queue times long, do not consider the full costs of running the grid, and overall do not guarantee certainty for project completion.

Throughout the stakeholder process, interconnecting customers have signaled that they are willing to pay significantly higher costs in exchange for the reliability of the new process.

Conversely, higher cost without greater certainty is not progress and would simply be backsliding against the status quo.

A final feature of the proposal is establishing a “Decision Point,” or the final opportunity for interconnecting customers to proceed or withdraw from the queue without penalty.

Minor Project Reconfigurations Allowed

At the decision point, interconnecting customers can reduce project capacity by up to 10%.

Other minor design changes such as equipment modifications based on technological advancements are also allowed.

Final Requirements

Furthermore, the project must maintain site control of land on which the generating facility will sit, demonstrate at least 75% site control of the tie line and must meet one of the other developmental milestones as outlined in the detailed requirements.

Pay Financial Securities

At the decision point, 100% of the GRID-C fee is due.

In addition, in the event directly assigned upgrade costs are applicable (outside of the GRID-C), 20% of the payments are due less amounts that have already been paid.

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SPP estimates that the CPP proposal will result in wide ranging system benefits and cost savings in the following areas:

- Significantly speeding up interconnection times from 18 months to an expected 7 months, reducing the interconnection process by a year.
- Fewer delays to projects reaching commercial operation due to unplanned restudies, which drive up costs, delay timely interconnection, and punish ratepayers with higher prices.
- Reduced overall study costs thanks to the coordinated process as well as 75% fewer restudies resulting in millions of dollars in cost savings.

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Questions for Further Research

Additional Questions

We end where we began. Our 2024 paper entitled “Game Changing Interconnection Reform” called for more tightly coordinating the transmission planning process and the interconnection application process and revisiting the incentives embedded in the interconnection process.

The SPP proposal does exactly that.

Although we believe this framework is a model for other RTOs to emulate, several follow up questions emerged from our investigation. Like most policy proposals, the answers will be revealed during implementation.

The most significant of these questions is at what point will GRID-C costs at planned locations switch from encouraging development to discouraging development. Although developers see benefit from the cost certainty that flows from the GRID-C, very high GRID-C costs may hinder projects from moving ahead.

A second question emerges from a related workstream at the Institute, siting and permitting reform. CPP’s focus on identifying strategic locations on the grid to encourage generation that maximizes benefits is smart. But what exactly are those locations optimized for? Grid planners are likely optimizing for grid needs alone – why wouldn’t they?

But siting new power plants is a far more delicate balancing act that requires considering factors beyond what is best for the grid itself. As we have learned in our other work related to the Solar Uncommon Dialogue, optimizing sites for g benefits, environmental benefits, and community needs is complicated.

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Study References

1. Lazard. "*Lazard's LCOE+ (June 2025).*"" Lazard, June 2025, https://www.lazard.com/media/eijnqja3/lazards-lcoeplus-june-2025.pdf.
2. Wood Mackenzie, and Solar Energy Industries Association. "*U.S. Solar Market Insight: Q2 2025*." SEIA, 9 June 2025, https://www.seia.org/research-resources/solar-market-insight-report-q2-2025.
3. SEIA - Global Strategy Group, June 2022. https://seia.org/wp-content/uploads/2022/09/SEIA-2022-Public-Opinion-Polling-Takeaways.pdf
4. Rand, Joseph, Nick Manderlink, Will Gorman, Ryan H. Wiser, Joachim Seel, Julie Mulvaney Kemp, Seongeun Jeong, and Fritz Kahrl. "*Queued Up: 2024 Edition, Characteristics of Power Plants Seeking Transmission Interconnection As of the End of 2023*." Lawrence Berkeley National Laboratory, Apr. 2024, https://emp.lbl.gov/sites/default/files/2024-04/Queued%20Up%202024%20Edition_R2.pdf.
5. U.S. EIA. "*Electric Power Monthly*." https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=table_6_02_a.
6. Gahl, David, Melissa Alfano, and Tiana Elame. "*Game Changing Interconnection Reform: Reshaping Transmission Planning and Realigning Incentives*." 25 Apr. 2024, https://www.ssii.org/wp-content/uploads/2025/04/SI2-Interconnection-Whitepaper-04.25.24.pdf.
7. Southwest Power Pool. "*Consolidated Planning Process.*" https://www.spp.org/engineering/consolidated-planning-process/.

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About the Solar and Storage Industries Institute

Solar & Storage Industries Institute (SI2)

Who We Are

Not-for-profit organization, dedicated to accelerating the deployment of solar and energy storage across the United States.

Affiliated with the national trade association of the solar and storage industry.

What We Do

We conduct evidence-based research to deliver solutions, actionable policy options, and initiatives to help lower renewable energy costs.

Why the Work Matters

Solar & storage technologies are critical tools for delivering affordable, reliable clean energy that is helping to meet growing energy demand & address the climate crisis.

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SI2's Major Work Areas Addressing Renewable Energy Costs

Siting & Permitting

Agrivoltaics

Model Policy

Interconnection

SI2 is identifying **barriers to deployment**, developing field tested **best practices** and **convening stakeholders** to foster collaboration and open pathways to solar and storage deployment

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