

Accelerating Interconnection of Large Loads Co-located with Generation Facilities

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JUNE 17, 2026

PRESENTED TO



2026 Summer Workshops: Flexible
Interconnections for Large Loads



Co-Location Addresses Priorities and Concerns from AI Data Center Growth

OPPORTUNITY

Aspirations for \$trillions in economic growth from Artificial Intelligence data centers¹

CHALLENGE: GRID LIMITS

Limited growth and concerns of **affordability, reliability** as pre-existing and planned transmission and generation capacity start running out

TECHNICAL SOLUTION: CO-LOCATION

Co-locating new data centers on-site with generation (new or existing) **minimizes, delays, or reduces the need for transmission**, providing **speed to power, hastening connection of new generation**, and **mitigating reliability and affordability impacts**

Priorities for AI data center customers:

1. Scale (0.1 – 1+ GW)
2. Reliability
3. **Speed to power**
4. **Regulatory certainty**
5. Cost effectiveness
6. **Low emissions**
7. Simplicity

1. PwC, [Sizing the Prize](#), 2017; Goldman Sachs, [Generative AI could raise global GDP by 7%](#), 2023

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America's Data-Center Build-Out Is Falling Way Behind Schedule

Top five AI data center bottlenecks (power, power, and more power)

wttw

POLITICS

Lawmakers Seek Ways to Prevent Data Centers From Straining Illinois' Power Grids

Medill Illinois News Bureau | April 9, 2025, 3:26 pm

UTILITY DIVE Deep Dive Opinion Library Events Press Releases Topics

Google, Intersect Power to develop co-located energy parks with \$20B of renewables, storage

Energy parks can provide grid services, but they face regulatory challenges, including uncertainty around the rules for co-located load, according to Energy Innovation.

Published Dec. 11, 2024

Ethan Howland Senior Reporter

FERC orders PJM to craft large load colocation rules

The decision is a win for independent power producers with gas-fired and nuclear power plants in the PJM Interconnection, according to Capstone analysts.

“Developers have requested that PJM study nearly 8.5 GW of large loads to be co-located with existing generator interconnections.”
– Stu Bresler, PJM

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Elon Musk's just fired up Colossus—the world's largest Nvidia GPU supercomputer built in just three months from start to finish

UTILITY

Trump plans to use emergency powers to fast-track generation co-located with AI

President Donald Trump's comments on building power plants for data centers appears to align with the views of FERC Chairman Mark Christie, ClearView Energy Partners said.

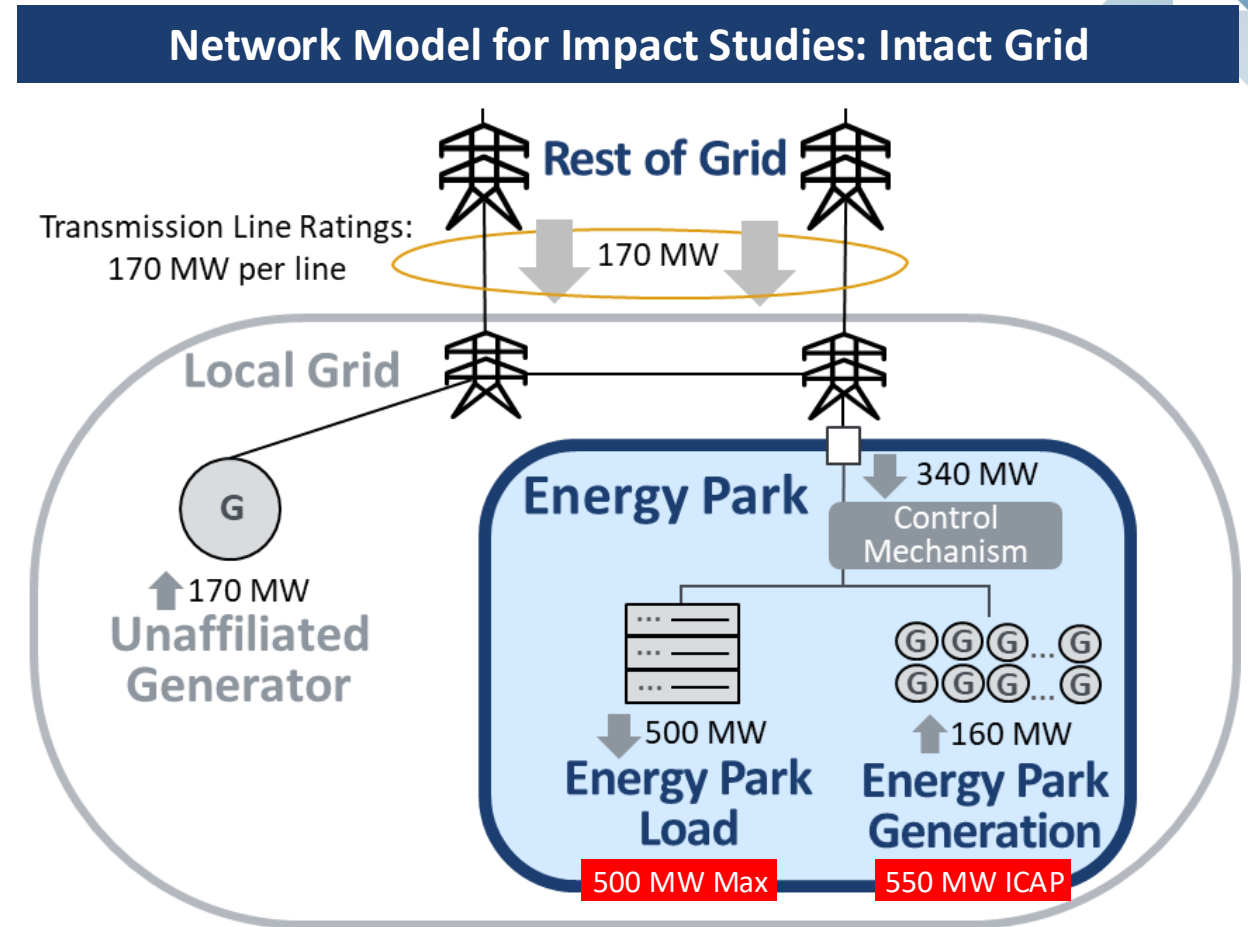
Published Jan. 24, 2025

Ethan Howland Senior Reporter

Co-locating generation and data centers “was largely my idea,” Trump said. “Nobody thought this was possible ... I told them that what I want you to do is build your electric generating plant right next to your plant as a separate building connected.”

Co-Locating w/ New Generation Avoids Transmission Upgrades

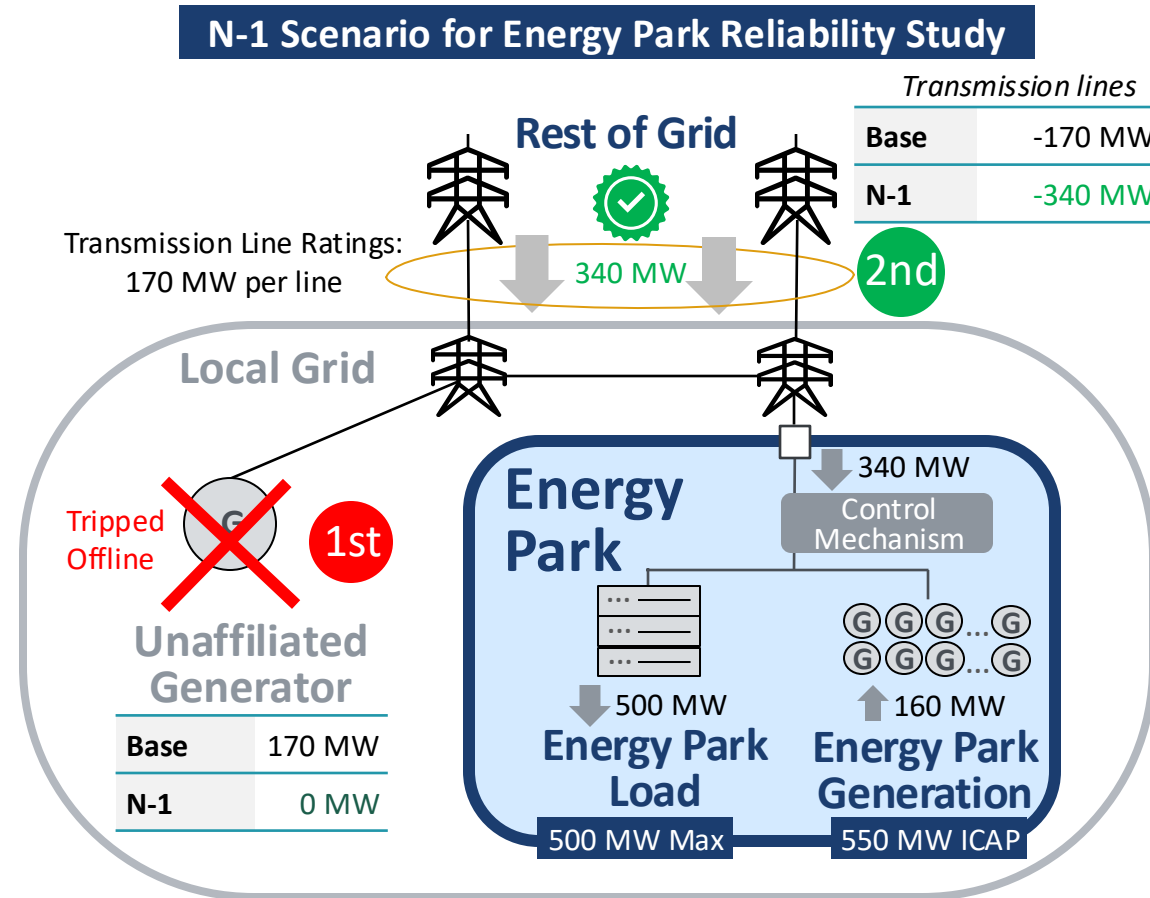
- It is intuitive that connecting an Energy Park (co-located load + generation) with 500 MW load with 550 MW of multiple generation units can significantly reduce grid impact in normal/intact grid conditions
 - **Net flows to a new load are lower when a new generator is producing there**
 - “Co-located” means same substation—can be different busses
- However, transmission upgrades are often driven by impacts under contingencies (N-1 and N-1-1)—**we show that co-location with new generation can also help avoid those upgrades**



Brattle, 2025, [Accelerating the Integration of New Co-located Generation and Loads](#)

Energy Park Integration Studies (N-1) – Grid Withdrawal

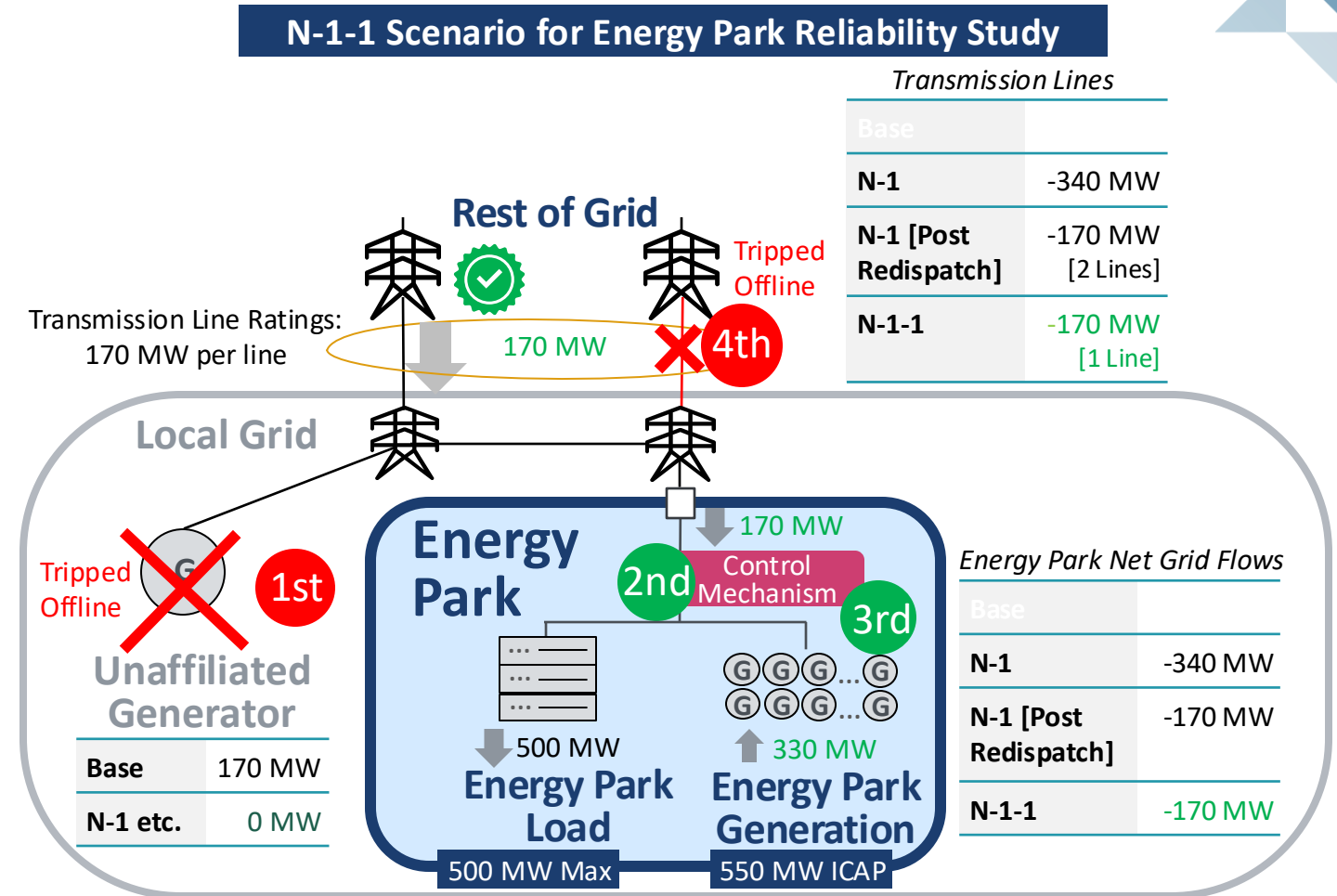
- In the N-1 case for reliability studies, an **unaffiliated** generator in the local grid trips *offline*
- As a result, 340 MW flows over the transmission lines, staying within rated capacity - no upgrades are triggered
- The system is then re-dispatched (*not shown*) after N-1, to increase the Energy Park's generation to 330 MW and limit grid withdrawals over the 2 transmission lines to 170 MW (**important for later!**)



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Energy Park Integration Studies (N-1-1) – Grid Withdrawal

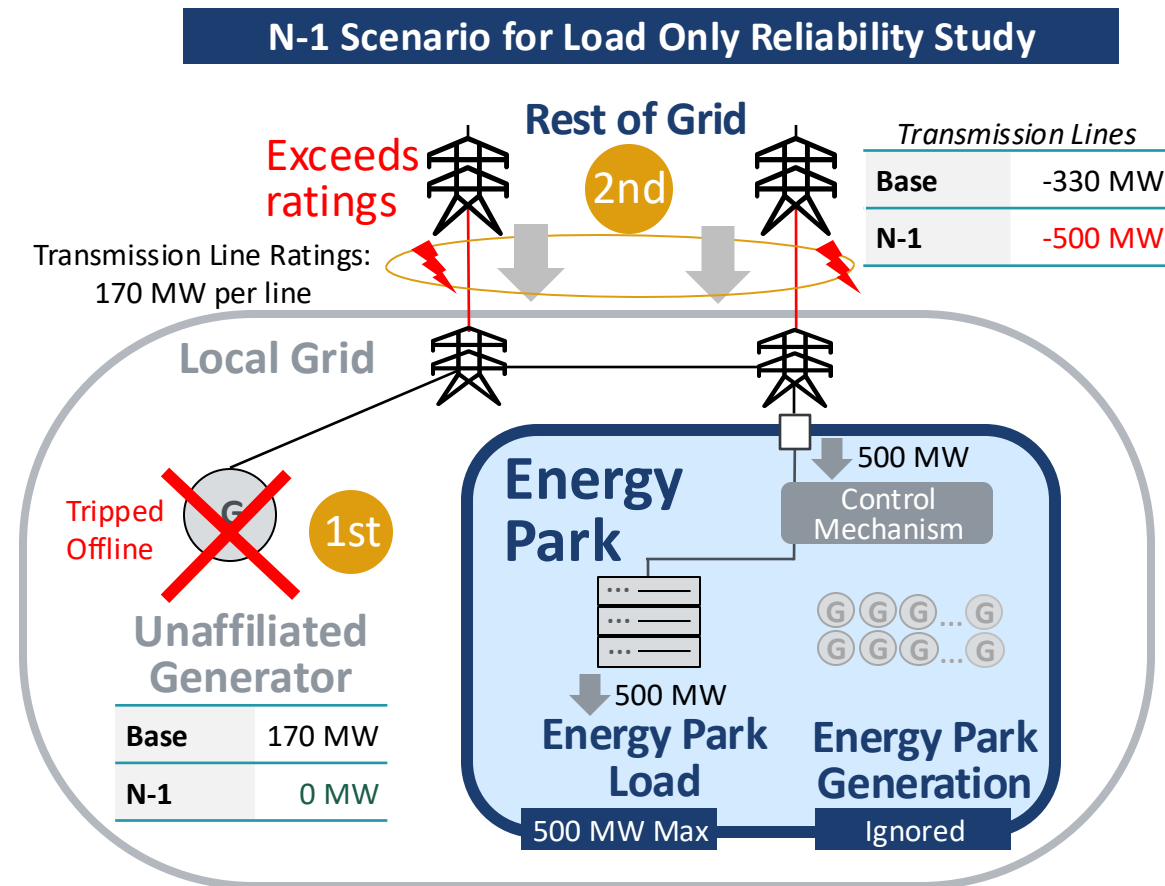
- In the N-1-1 case for reliability studies, one of the two external transmission lines trips *offline* **after operator redispatch of the energy park generation in response to N-1 condition**
 - Note, instead of dispatching internal generation to prepare N-1 system for the next contingency, a RAS could be armed to immediately dispatch the generation only when the contingency occurs (greatly reducing dispatch frequency)
- As a result, only 170 MW flows over a single transmission line, once again staying within rated capacity
- No upgrades are triggered



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Evaluating Load Only Contingency Studies: N-1 scenario triggers upgrades

- In the case of a load-only study, **the N-1 case will trigger upgrades** because the available dispatch of energy-park generation is ignored
- Loss of the neighborhood generation results in **500 MW flowing over the two external 170 MW transmission lines**, creating an overload
- **Study methods matter**: a similar result obtains if the Energy Park limiter function is ignored or all Energy Park generation units are assumed to be tripped in a contingency



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Rapid Interconnection Study Process for co-located Load and Gen

Rapid study to confirm minimal material impact

- Utilizes the same studies already used today, except **NO deliverability** studies for firm net injections or withdrawals
 - Co-located load **relies on self-supply or flexibility (curtailment) for firmness** rather than on the network
 - Net grid injections or withdrawals limited when necessary
- Resolves study violations through operational means (**flexibility** rather than physical upgrades) whenever practical and reliable
 - Steady state pre-contingency violations can be addressed through operational **flexibility** (curtailment) via Security Constrained Economic Dispatch (SCED), do not require network upgrades
- Relies on **defined static operational limits** where necessary to avoid transmission upgrades (for instance due to post contingency dynamic stability limits) by limiting the maximum allowable net grid injections or withdrawals to certain study-determined levels (or even zero) at any time
- Short circuit violations assumed to require local upgrades

Interaction with Operations: Potential RAS Use Cases for Faster Interconnection

Limit transmission withdrawals at a new large load site co-located with new generation

- A large load site can limit withdrawals by relying on co-located generation; if generation at the co-located generation facility fails to limit net withdrawals, a power flow relay at the point of interconnection can automatically reduce the load to limit withdrawals, limiting any impact on the grid
- Such a relay is sometimes called a remedial action scheme (RAS) but because it monitors and controls non-bulk electric system facilities it is often referred to simply as a “power flow relay”

Use storage for a RAS instead of load curtailment

- Co-located storage (front-of-the-meter or behind-the-meter) can be used for instantaneously reducing net inflows in lieu of load curtailment
- This use case could be combined with the other use cases above such that co-located storage operates as a normal market asset during non-outage season, but a RAS-support asset during outage season

Interaction with Resource Adequacy

Co-located load + generation **can also be RA neutral if:**

- Energy park brings enough generation (UCAP) to match its load with G-1 redundancy OR
- Energy park brings enough UCAP **through load flexibility + generation**
- **Bilateral Integration of Generation Portfolios and Load (BIGPAL)**
 - Performance risk and ELCC risk managed by bilateral parties
 - Performance obligation is net-zero MW withdrawals during grid emergencies (i.e., backstop of load curtailment if co-located generator fails to perform)
- Consider a 100 MW data center with 100 MW battery [**co-located**]
 - During an emergency event if battery supplies 100 MW for the duration, **data center not subject to curtailment**
 - If storage were to be exhausted before end of grid emergency, data center provides **backstop curtailment** of 100 MW (switching to permitted back-up generation) until end of emergency (but before end of demand response call)
 - In either case: operator gets net-zero withdrawals during tight conditions **which ensures reliability**
 - Curtailment-backed bilateral UCAP is accredited at the lesser of the ICAP of the co-located generator and the load (e.g., 100 MW in our example), and so **capacity impact** = data center ICAP – bilateral UCAP = 0 MW when matched, **which ensures affordability**

BIGPAL vs Traditional BYOG:

- Data Center DR is *backstop*, not called upon unless contracted bilateral capacity resources are short when needed
- Allows parties to assume performance risk through contractual means which is *internalized*

Main Takeaways

Energy Parks and similarly proximate portfolios of new loads and generation offer significant market and grid planning benefits

- Avoids supply shortages by supplying new loads with co-located new generation
- Reduces and/or defers the need for “firm” service to loads and generation, thereby avoiding grid the costs and delays associated with transmission upgrades (and boosting incentive for new load to bring new supply, easing market tightness)
- Allowing net imports from the grid (when possible and economic) reduces cost of to Energy Park load
- Allowing net exports to the grid (when possible and economic) benefit the rest of the market

Barriers need to be addressed to enable the benefits of such co-location (or near-location) of load and generation

- **Separate** grid planning processes for generation and load **do not capture** of co-location benefits
- Operational standards do not yet exist to enable reliable and controllable “net” interactions of co-located loads and generation with the grid (without which planners cannot assume reliably-controlled interactions)
- Co-location also needs to be enabled in resource adequacy frameworks (to ensure neutral RA impact)

Progress is being made by some of the grid operators, FERC, and the states

Presenter Bio



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Aniruddh Mohan is an Energy Associate at the Brattle Group. He specializes in the evaluation of energy technologies at a systems level, with expertise in electricity markets and energy policy. His most recent work focuses on the interconnection and resource adequacy challenges posed by large loads such as data centers. He has filed expert testimony to FERC on the expedited interconnection of co-located large load facilities with generation resources and is also involved in several wholesale electricity market reform initiatives including bilateral capacity contracts, advanced generator retirement planning, and long-term transmission planning. He has published research on energy systems in several leading peer-reviewed journals using interdisciplinary methods such as optimization models and techno-economic analysis.

Dr. Mohan holds a PhD in Engineering & Public Policy from Carnegie Mellon University.

Appendix



Role of Flexibility and Control Mechanism

Simplest approach:

- Energy park control mechanism dispatches energy park generation (and load curtailment, if applicable) to optimize economics
- Could allow load withdrawals at maximum load capability, and injections at maximum generation capability

Option to reduce transmission impact via limits on net power exchange (potentially provisional):

- Load flexibility is an inherent feature of the energy park
- Dispatch generation (and, if necessary, load flexibility) to always ensure **net withdrawals and injections stay within defined limits**
- Could ensure withdrawals never exceed some limit that is a fraction of the full load by relying on a fleet of co-located generator units

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Rapid flexible interconnection is achieved by focusing planning mitigations to only those needed to cover reliability needs not secured in operations:

Potential Violations	Potential Mitigations
Short circuit violations	Assume local upgrades needed, not further discussed
Common-mode contingency steady-state violations if not studied in Contingency Analysis (i.e., EMS)	<ul style="list-style-type: none">• Post-contingency curtailment via remedial action scheme (RAS) where practical, potentially as interim measure), <i>or</i>• Pre-contingency curtailment (w/ common-mode outages in Contingency Analysis/SCED)
Post-contingency dynamic stability violations especially for severe, rare common-mode outages (P4/P5/P7); add'l stress-test dispatch cases, 60-90 days adequate. 90+ days in some cases	Combination of: <ul style="list-style-type: none">• Joint operating limit on <u>net</u> withdrawal or injection (potentially interim)• Network Upgrades

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