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Flexible Interconnection Framework Initiative (FIFI) Initial Stakeholder Workshop

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Workshop Agenda

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Introductions and Opening Remarks Jason Pause – DPS Staff; Noah Ginsberg - NYSEIA	**8:00 – 8:15**
Flexible Interconnections: A (Brief) Overview Zach Caruso – Avangrid; Brian Yung – National Grid	**8:15 – 8:45**
Formal Definition of Flexible Interconnection Zach Caruso - Avangrid	**8:45 – 9:45**
Break	**9:45 – 10:00**
Technical Requirements of Flexible Interconnections Brian Yung – National Grid	**10:00 – 11:00**
Flexible Interconnection Planning Criteria Gabe Viscariello – National Grid	**11:00 – 12:00**
Lunch	**12:00 – 12:30**
Principles of Access Zach Caruso – Avangrid;	**12:30 – 2:00**
Break	**2:00 – 2:15**
Flexible vs. Firm Processes and Timelines Zach Caruso – Avangrid	**2:15 – 3:15**
Flexible Interconnection Framework Timeline Zach Caruso – Avangrid; Rick Abraham – National Grid	**3:15 – 4:00**

Flexible Interconnection Framework Initiative (FIFI)

At the June 2024 IPWG, DPS Staff requested Avangrid and National Grid propose a workplan for establishing a framework for Flexible Interconnections in New York State

At the September 2024 IPWG, Avangrid and National Grid proposed this draft workplan and was directed to begin developing the Framework

Objective

Develop a robust framework for continued deployment of Flexible Interconnections in NYSEG, RG&E and National Grid Territories.

A Few Guiding Principles

- Equitable Flexible Capacity Access
- Cost-Benefit Alignment
- The Most Cost-Effective Interconnection Solution
- Crawl-Walk-Run
- An Upstate New York Specific Framework

Flexible Interconnection: A (Brief) Overview

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How do we define Hosting Capacity?

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System Data

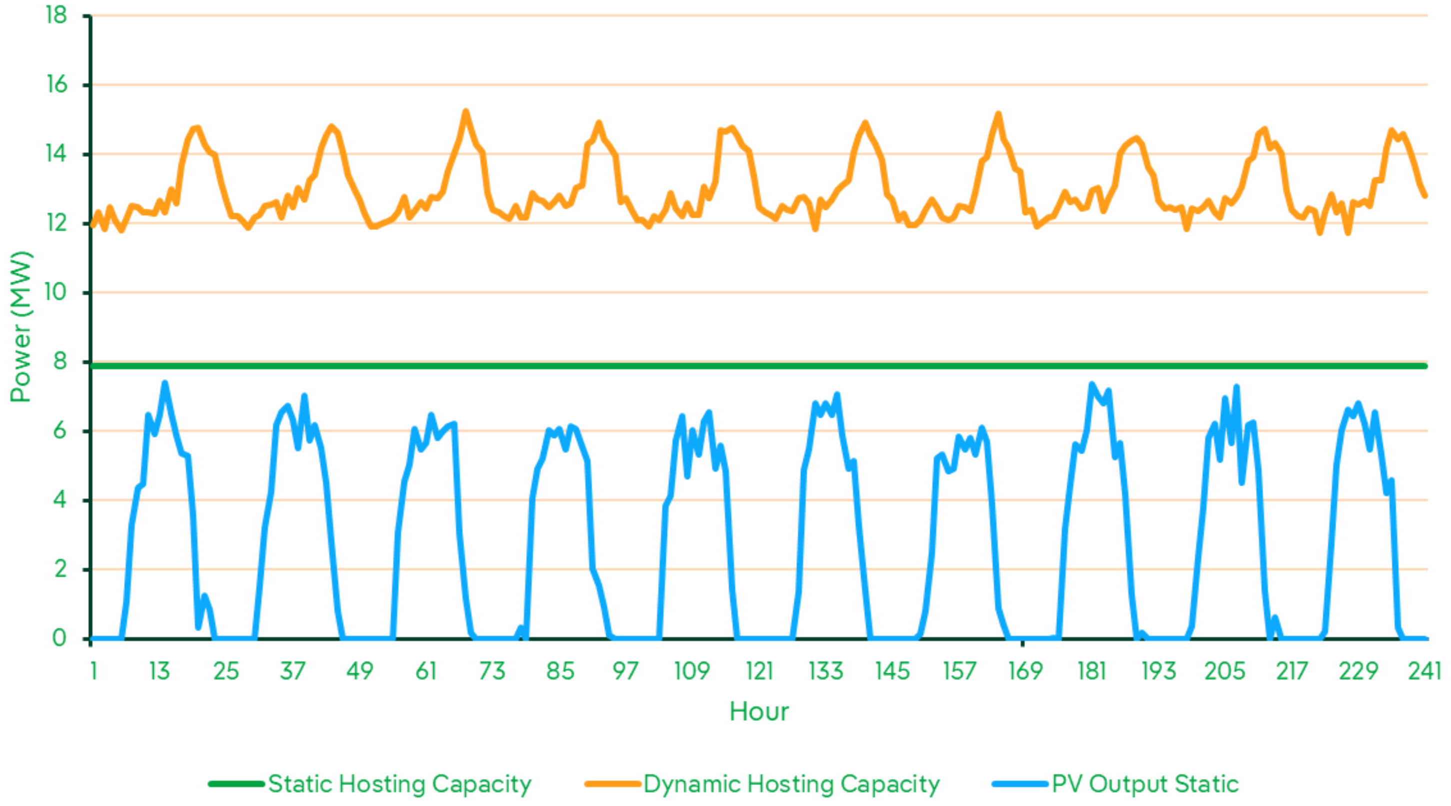
Constraint: Substation Transformer Thermal
Bank Nameplate Limit (CNR): 10.5 MVA
Bank Max Load: 8.56 MVA
Bank Min Load: 2.77 MVA

Firm

Firm Thermal Limit (75% CNR): 7.875 MVA
Firm Hosting Capacity: 7.875 MVA

Dynamic

Max Dynamic Hosting Capacity: 16.43 MVA
Min Dynamic Hosting Capacity: 10.64 MVA



Firm Hosting Capacity

The maximum amount of DER capacity the grid can accept over a period based on historical grid data and a set of worst-case assumptions.

Dynamic Capacity

The maximum amount of power the grid can accept at a specific time based on real-time, or near-real time, grid data.

Scheduled Firm Capacity

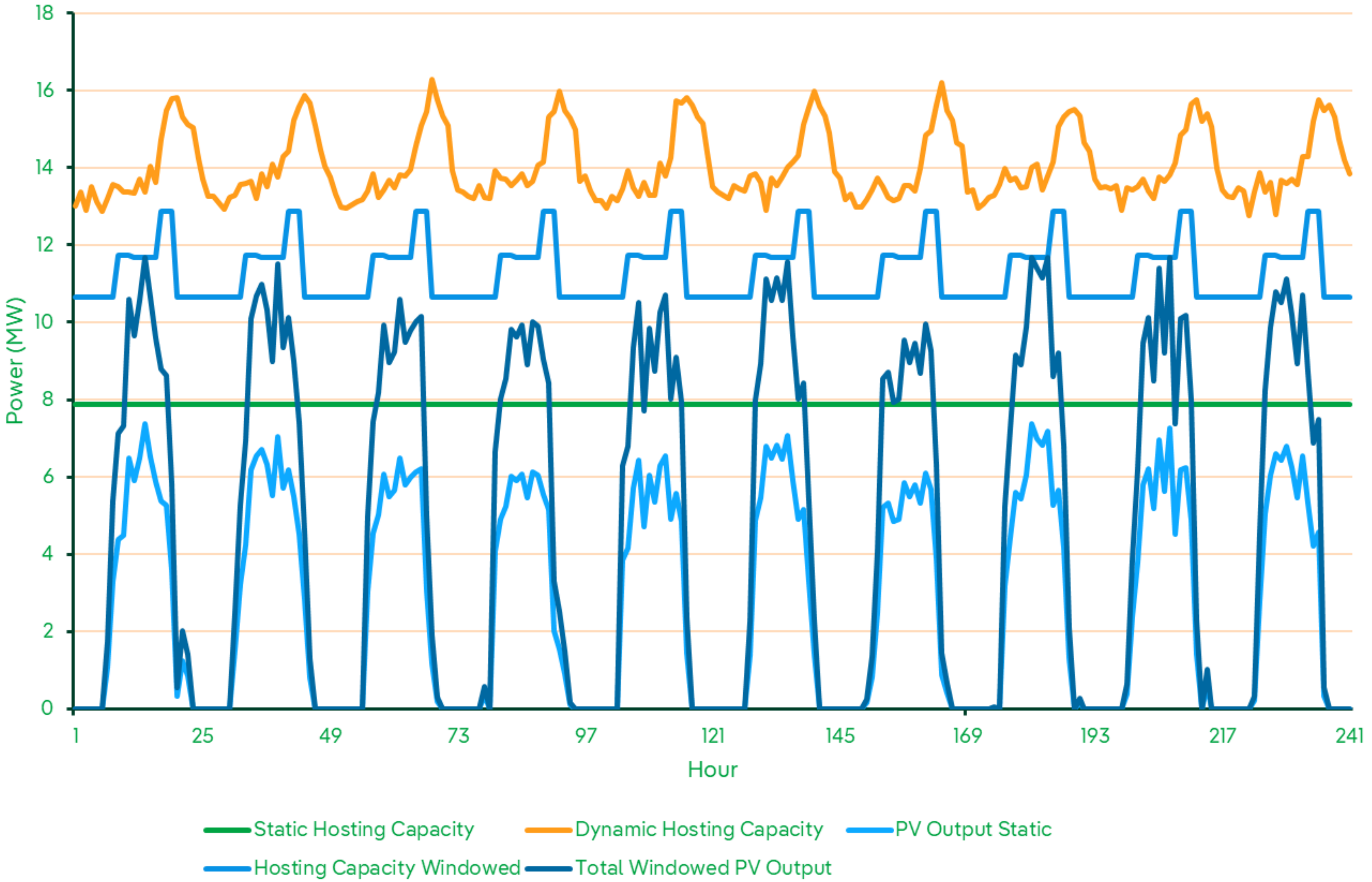
Defining Firm Capacity during specific windows in time can enable more capacity to interconnect by factoring in the daily and seasonal variability of system loading

Scheduled Firm Capacity (Summer)

Window	Firm Capacity
8 – 10 AM	11.73 MVA
10 AM – 4 PM	11.68 MVA
4 – 6 PM	12.86 MVA
6 PM – 8 AM	10.64 MVA

Supervisory control measures are required to backstop compliance with capacity schedule

Process for updating capacity schedule and planning criteria for determining schedules must be defined and managed as system conditions change



We do not offer scheduled capacity today unless specifically requested in Appendix K for ESS

Flexible Hosting Capacity

To allow a DER to operate all the way up to the Dynamic Capacity of the system, a control system that provides capacity limits to the DER in real-time (or close to it) based on system conditions

Flexible Hosting Capacity

The maximum amount of DER capacity that can interconnect to the grid utilizing real-time control systems to allow the DER to operate up to the Dynamic Hosting Capacity available at any one time

Curtailment

Reduction of a DER's allowed instantaneous export capacity to the distribution grid.

DER that utilize Flexible Hosting Capacity will always have some risk of curtailment

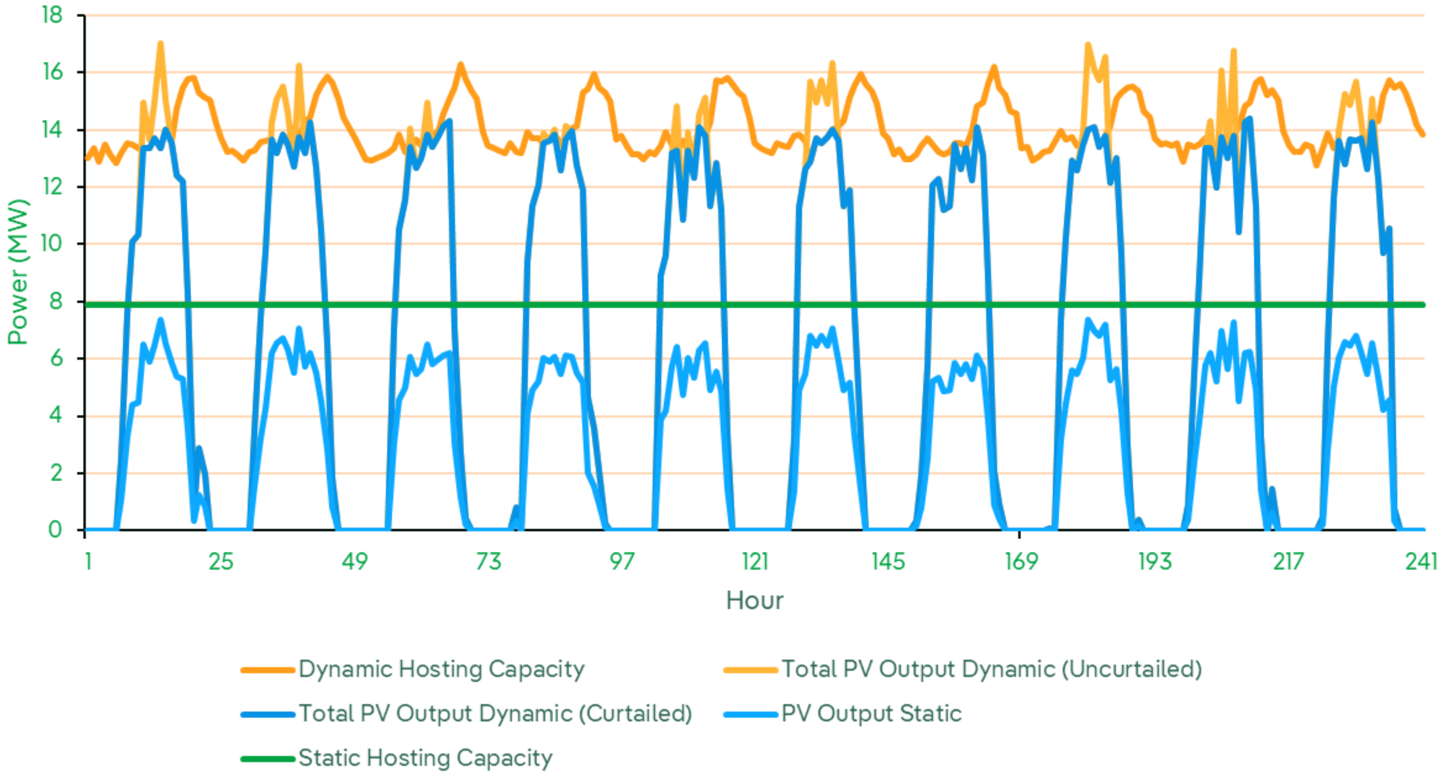
The DER Capacity that can interconnect with this approach is limited by economic and/or technical factors

Flexible

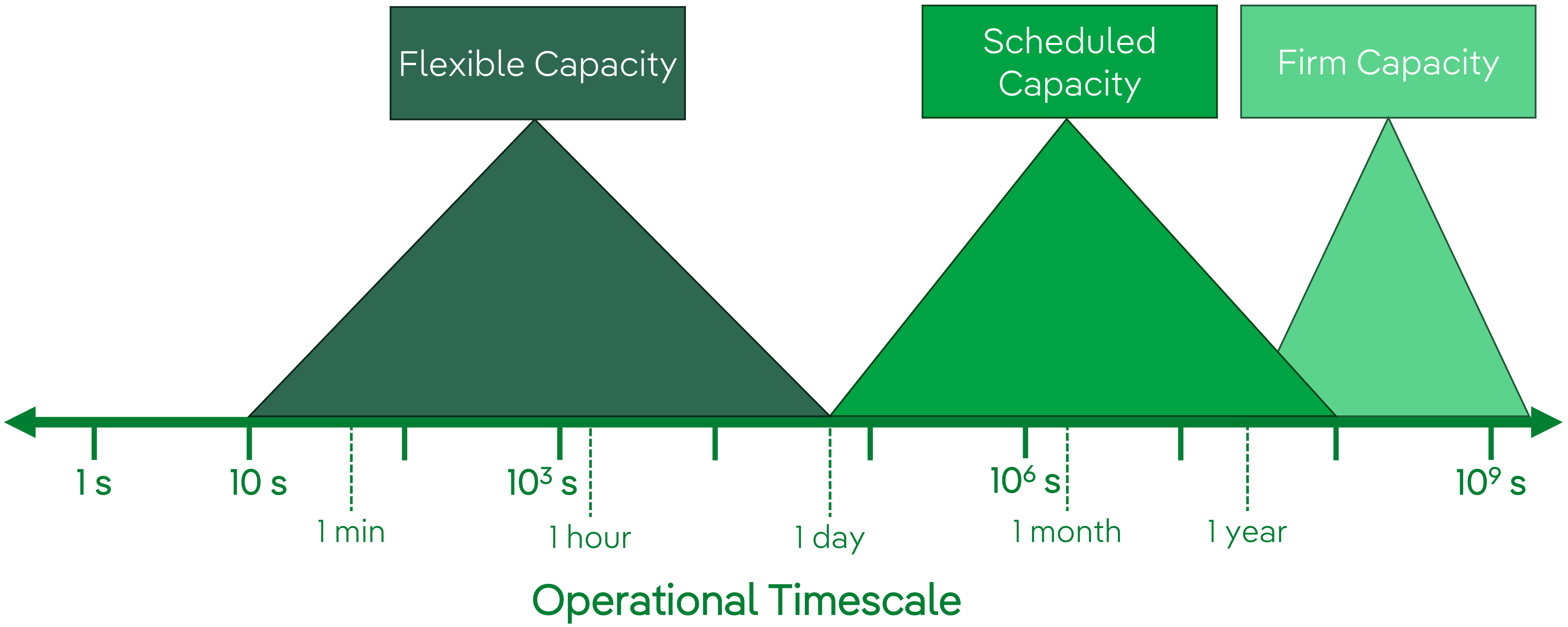
Max Flexible Hosting Capacity: 18.171 MVA

Curtailment: 1.8%

Avangrid-Specific Assumptions (For example purposes only): Last-In-First-Out, 10% Max Incremental Curtailment, 85% CNR Trim Threshold



The Operational Context



Flexible Interconnect Capacity Solution (FICS) REV Demo - Timeline

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REV Demo Proposal Filed July 1st, 2015, Implementation Plan Filed January 7th, 2016, Quarterly Reports filed every quarter on the NY DPS Website.	FICS tests a new business model for interconnecting DERs on constrained areas of the electric grid utilizing Flexible Interconnections
FICS allows NYSEG and RG&E to manage (curtail) DER output in real-time based on actual grid conditions as opposed to based on a studied worst-case scenario	FICS utilizes Active Network Management (ANM) technology from Smarter Grid Solutions (SGS) to perform curtailment
Two (2) FICS control schemes were deployed at two (2) substations in NYSEG and RG&E Territory – **Spencerport PV (15 MW)**	Additional DER developers expressed interest in utilizing FICS but did not proceed with a FICS solution due to other barriers to their interconnection

- FICS REV Demo Project Filed – July 1st, 2015
- FICS REV Demo Implementation Plan Filed – January 7th, 2016
- Discussions with DER #5-7 about potential FICS solution – August 2018
- Re-initiated discussions on ANM solution requirements for DER #1 – June 2019
- Final Acceptance Letter Sent to DER #1 – December 23rd, 2019
- ANM Agreement Executed for DERs #5-7 - November 16th, 2020
- Testing and Commissioning for DERs #5-7 - mid-April 2021
- Testing and Commissioning of DER #1 – September 2021
- Operation of Flexible Interconnection at DERs #5-7 - April 2021 to Present
- Intermediate Summary Report Filed – July 2024

FICS Candidate Sites

DER #	Size (MW)	Resource Type	Interconnecting Utility	Substation	PCC Voltage (kV)	FICS Constraint	Deferred Capacity Upgrade(s)	Deferred Upgrade Cost Estimate	Application Result
1	1.98	Solar PV	NYSEG	Mason Corners	12.47	Low-Voltage on Adjacent Feeder	Install Two (2) Single-Phase Line Regulators on adjacent feeder	$165,074	Flexible Interconnection
2	0.45	Farm Waste Generator	NYSEG	Aurora	12.47	Substation Bank Thermal	Upgrade Sub. Transformer Bank	$3,875,000	Cancelled for failure to pay 25% of upgrade cost estimate by PSC mandated deadline
						Distribution Over-Voltage	Install New Three-Phase Line Regulator Bank	$70,000	
3	1.73	Solar PV	NYSEG	Peruville	4.8	Substation Regulator Thermal	Upgrade Sub. Regulator Bank	$215,950	Cancelled for failure to pay 25% of upgrade cost estimate by PSC mandated deadline
						Distribution Over-Voltage	Install New Three-Phase Line Regulator Bank	$70,000	
4	2.00	Solar PV	NYSEG	Richfield Springs	4.8	Voltage Flicker	None	None	Cancelled for failure to pay 25% of upgrade cost estimate by PSC mandated deadline
5	5.00	Solar PV	RG&E	Sta. 113	12.47	Substation Bank Thermal	Substation Bank Thermal	$3,294,444	Flexible Interconnection
6	5.00	Solar PV	RG&E	Sta. 113	12.47	Substation Bank Thermal	Substation Bank Thermal	$3,294,444	Flexible Interconnection
7	5.00	Solar PV	RG&E	Sta. 113	12.47	Substation Bank Thermal	Substation Bank Thermal	$3,294,444	Flexible Interconnection
8	5.00	Solar PV	RG&E	Sta. 8333	34.5	Voltage Regulator Variation	None	None	Cancelled at developer request prior to approaching RG&E about FICS
9	5.00	Solar PV	RG&E	Sta. 419	12.47	Voltage Flicker	None	None	Static Interconnection

Lessons Learned

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Customer Perspective

Developer Willingness to Accept Curtailment

Developers are willing to accept occasional curtailment of their site output in exchange for the ability to avoid certain expensive grid upgrades that would be required for a static interconnection

Technical Perspective

Site Selection

The following criteria were found to increase developer willingness to pursue a Flexible Interconnection:

- Expensive static capacity upgrades
- Thermal and/or Steady State Voltage Constraints
- Existing Voltage Class of Distribution Feeder (>5kV)
- Lower Generation-to-Load Ratio

Non-Network Curtailment

The reliability of the communications medium used by the ANM Scheme is a critical factor in the amount of Non-Network Curtailment experienced by a site.

Lessons Learned (Technical Perspective Cont.)

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Curtailment Analysis

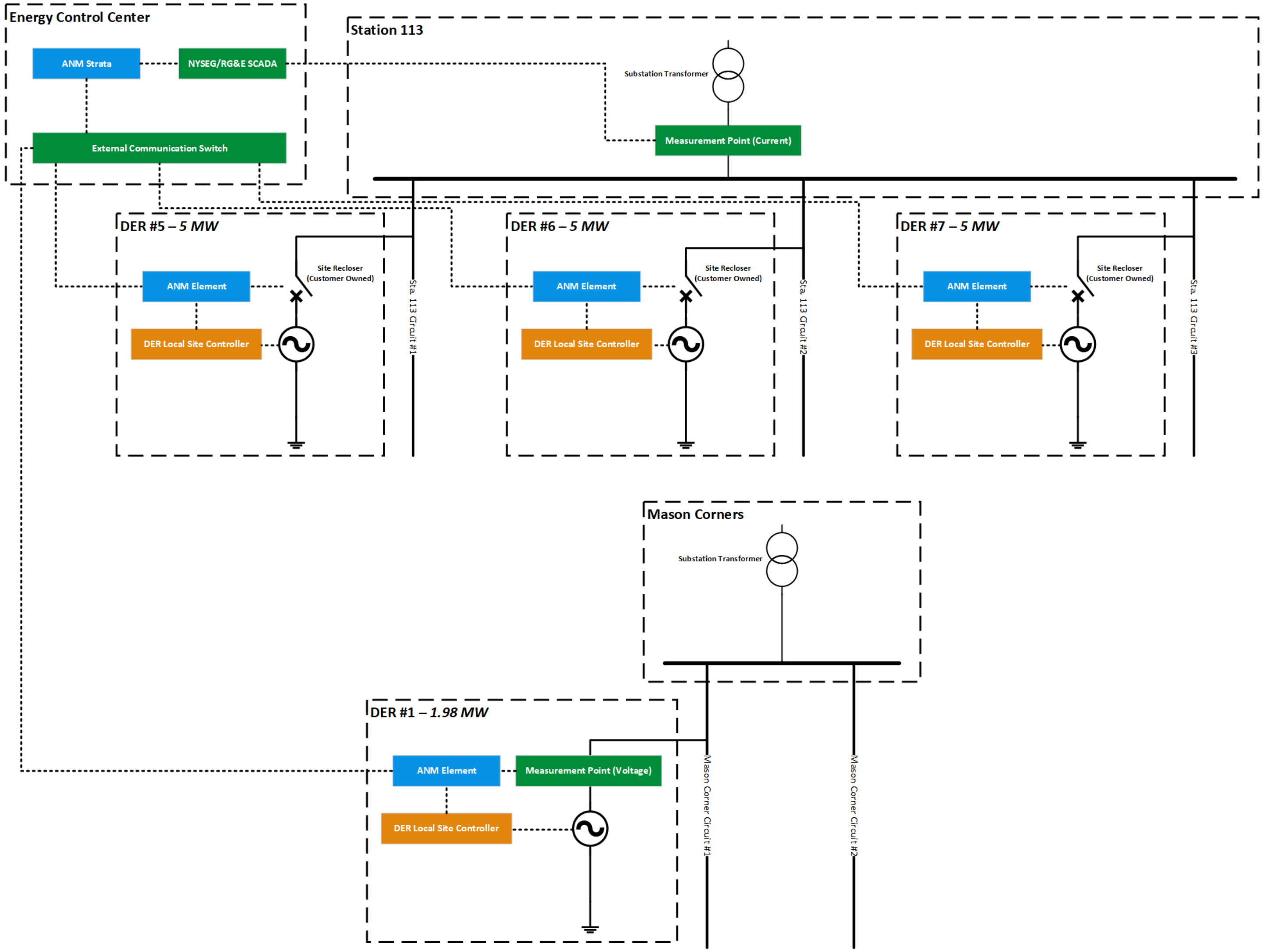
A variety of external factors can have a sizable impact on the amount of Network Curtailment predicted in a Curtailment Analysis. Utilities should explore utilizing sensitivity and probabilistic analysis strategies in their curtailment analysis methodology

DER Monitoring and Control

There is significant development work still needed to design and standardize the DER Gateway-to-DER Interface

Curtailment and Trip Thresholds for Thermal Constraints

NYSEG and RG&E currently utilize a 75% CNR under no load threshold to determine whether an upgrade is triggered by a DER and have internally agreed to set the curtailment thresholds for Flexibly Interconnected DER at 85% CNR going forward.



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Lessons Learned (Regulatory Perspective)

Regulatory Perspective

NY SIR Process

The SIR process is not designed to accommodate the additional stages of analysis and decision making inherent in Flexible Interconnections

Principles of Access

The Companies learned that LIFO can be an effective Principles of Access policy for Flexible Interconnections due to the greater curtailment certainty it brings for participating developers. A final decision on what Principles of Access to use for Flexible Interconnections going forward has not been made.

Overview of National Grid's flexible interconnection pilot

- Active Resource Integration Pilot under C084928 Clean Innovation Project was filed and approved through last NMPC rate case (Case 20-E-0380); this pilot has transitioned into formal development of the **Flexible Connection** product within National Grid

- **What problem does it seek to solve:** unbottle community solar development in desirable areas currently limited with hosting capacity constraints

- **What solution is being utilized:** digital software and hardware operational technology that enables National Grid to actively manage distributed generation to mitigate electric distribution system constraints

- **What benefit has been realized:** flexible connection option through this pilot has reduced interconnection costs of at least one community solar project near Canastota, NY by $5.95M and its connection time by at least 3 years by avoiding a major substation upgrade

Feb-May 2021
Three Developers Submitted DG Applications for Pilot

Sep 2021
NMPC JP Approved

Aug 2022
Finalized Pilot Agreement and Curtailment Impact Analysis

Mar-Sep 2022
Town Moratorium

Dec 2022
Executed Contract with DERMS Vendor

Mar 2023
Executed Customer Agreement for 1st Flexible Connection Site

Nov 2023
Executed Customer Agreement for Test Flexible Connection with an Existing DG Site

Dec 2023
Pre-Production Testing Completed

May 2024
Site Acceptance Testing Complete

Q3 FY25 (In Progress)
2nd Flexible Connection Site In-Service

Flexible Connections | Lessons learned from first sites

	Utility-DER Comms and Control Interface	Constraint Mgmt Limitations	IT/OT Convergence and Resourcing	Non-Compliance Monitoring
What have we learned	Implementing DNP3 mapping based on Sunspec DNP3 Application Note 2018 helpful but some gaps Developed fiber communication specifications for developer make-ready work	Deploying DERMS without awareness to as-operated network model can generally manage constraints at substation but challenging to address downstream feeder constraints	Successfully integrated utility DERMS with secure field communications and third-party systems New functions for enduring support need long-term resource commitments	Developed a design to directly integrate DER gateway directly with utility PCC recloser with potential to be scalable
What needs to be refined	Standardized data mapping may still not be ready; further work on data standards may be needed Monitor ability for developer community to implement make-ready work specifications for DER communications	Integration of as-operated network awareness to constraint mgmt and the value of mitigate downstream feeder constraints using DERMS rather than infrastructure solutions	Roles within multiple departments to provide on-going configuration, operational and troubleshooting support of DERMS that facilitates flexible connection service Enduring support plan to manage new and growing number of IT/OT devices, networks and systems	None at the moment, continue to monitor behavior during post go-live operations

Flexible Connections | Learning objectives of additional locations

Principles of access

Looking to get additional feedback and willingness from the developer community to adopt a pro-rata curtailment allocation scheme

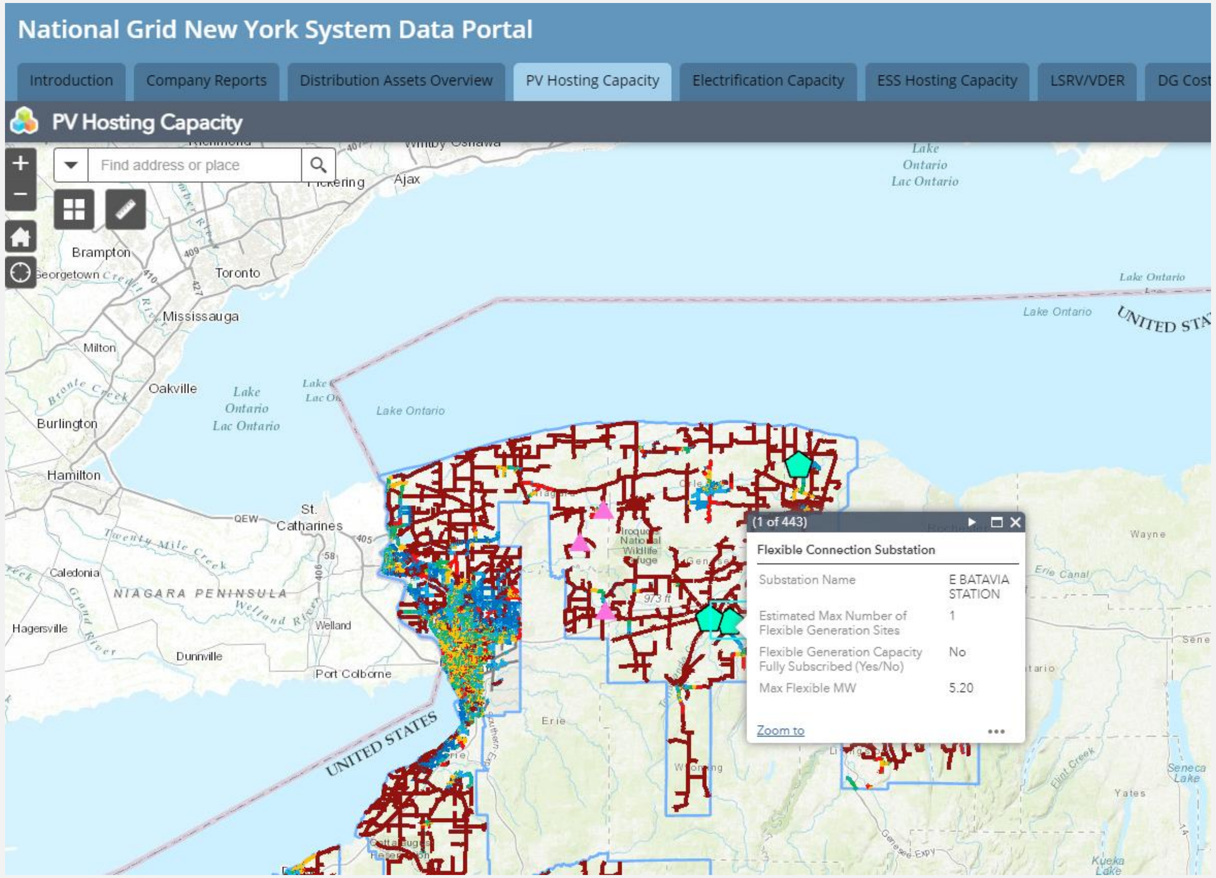
Standardization

To the extent possible, begin to refine and standardize components of the process, design, specification and requirements for integration of flexible interconnection to foster consistency and efficiency

Scalability

How to more efficiently deploy additional flexible interconnection schemes and decrease lead time and costs for future deployments

Further understand scenarios suitable and not suitable for flex IX



Discussion Questions

Some of your companies were a part of these initial projects in NY. Do you have any experiences or feedback you would like to share?

How do the results from the initial Flexible Interconnections compare to your expectations?

Do you agree with the Lessons Learned so far?

Defining Flexible Interconnections

Why is this important?

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Over time, different sources have utilized many different definitions for “Flexible” Interconnection. These different definitions have the potential to cause confusion as we move forward with this initiative

Applicability

A common definition starts to build a clear understanding of what sites and scenarios are potentially affected by a Flexible Interconnection option

Expectations

A common definition builds expectations for what Flexibly Interconnected DERs can expect once operational

Exclusions

A common definition focuses our discussions by excluding certain scenarios and approaches which might otherwise complicate the Framework development process

Definition of Flexible Interconnection

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*Arrangements enabling **more DER capacity to interconnect to the electric grid** by utilizing utility-owned and operated real-time DER **control schemes** to automatically manage Distributed Generation and/or Distributed Storage outputs to stay within grid constraints*

Flexible Interconnection
DER are allowed to operate to operational capacity thresholds based by utilizing DER Management technology and real-time grid constraint monitoring

Scheduled Interconnection
DER are allowed to operate to pre-determined time-varying planned capacity thresholds based on the forecasted minimum hosting capacity available in each time window

Firm Interconnection
DER capacity is limited to the amount that can be safely accommodated year-round under worst case scenario conditions

Distinguishing Characteristics of a Flexible Interconnection

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Dynamic

- Capacity limits are updated at least daily
- Limits are based on observed and/or short-term forecasted system conditions

Layers of Protection

- If monitoring or control is lost clear fail-safe protocols are enforced locally by a utility DER Gateway
- Non-Compliance with operating limits may be subject to automatic disconnection

Alternative to Grid Upgrades

- Project fails one or more CESIR screens triggering a significant eligible grid upgrade
- Triggering projects are not monetarily compensated for quantity of curtailment

Which of the following is a Flexible Interconnection?

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Solar PV site agrees to utilize Volt-Watt mode on their UL 1741 SB-certified inverters to avoid a required reconductoring upgrade

Not Flexible (Firm)

Hybrid Export-Only Solar PV and BESS site agrees to follow max power export limits provided by a utility DER Gateway to shift energy generated into hours when grid is less constrained to avoid substation transformer upgrade

Flexible

Stand-alone BESS site agrees to follow a pre-defined export limit schedule to avoid a required substation transformer upgrade

Not Flexible (Scheduled)

Technical Requirements of Flexible Interconnection Sites

Enabling Flexible Interconnections – General Technical Requirements

General Eligibility

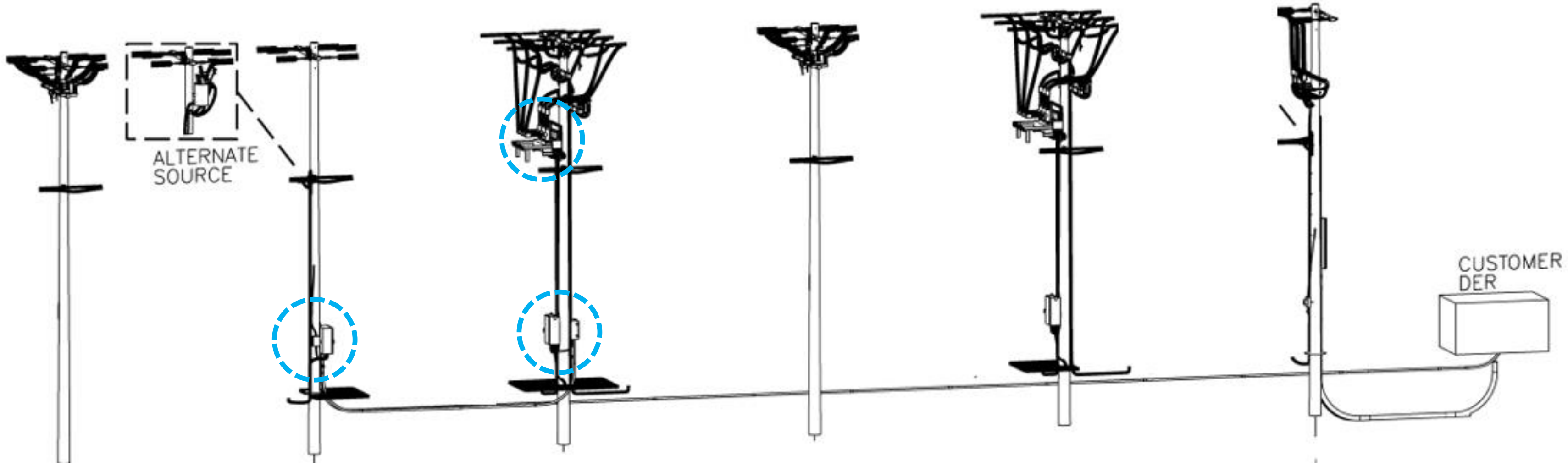
Distributed generators with a flexible interconnection service generally need to meet the same technical requirements of any other DG site but with the ability to curtail its generation when instructed by the utility at any moment.

- Flexibly interconnected DG sites must still comply with IEEE 1547 SB and comply with existing SIR and utility requirements (for National Grid: Electric Service Bulletin ESB 756)
- Pass all voltage, flicker, protection and anti-islanding requirements
- Meet all system thermal requirements except for ones that the utility can manage via generation curtailment through a flexible interconnection scheme

Initial target segment of eligible DER (may be expandable to other DER types in the future)

- 50 kVA and above
- Electric distribution-connected only
- Three-phase, EPS interconnection voltage at 12kV or above (mitigate voltage imbalance and circuits with lower light load conditions)
- Eligible DER types specified by utility (may vary across utilities)
- PCC recloser requirement (typically DG sites 300-500 kW and greater) to support utility monitoring and curtailment non-compliance

Enabling Flexible Interconnections – General Technical Requirements



Telemetry Make-Ready Work

To establish live telemetry via utility-approved protocols (ex. DNP3) between the utility and the DG site for the dispatch communication of dynamic operating limits, private wireless communications has been used from utility SCADA networks to on-site utility DER gateway and serial fiber communications from utility DER gateway to developer plant control system (PCS)

Utility Scope:

- Installation of utility-owned DER gateway and backend communications (localized fail-safe logic including loss of communications to backend utility mgmt systems or DERMS)
- Integration to utility PCC recloser on or near utility pole lineup

Developer Scope:

- Fiber conduit and cable (subject to utility requirements) between utility-owned DER gateway and developer PCS and utility DER gateway to utility PCC recloser
- Integration at developer PCS

Enabling Flexible Interconnections – M&C Field Integration

Monitoring Parameters	Description
Active Power - Phase A (kW)	Phase A active power
Active Power - Phase B (kW)	Phase B active power
Active Power - Phase C (kW)	Phase C active power
Active Power - Three-Phase (kW)	Three-phase active power
Reactive Power - Phase A (kVAR)	Phase A reactive power
Reactive Power - Phase B (kVAR)	Phase B reactive power
Reactive Power - Phase C (kVAR)	Phase C reactive power
Reactive Power - Three-Phase (kVAR)	Three-phase reactive power
Apparent Power - Three-Phase (kVA)	Three-phase apparent power
Voltage - Phase A (V)	Phase A voltage
Voltage - Phase B (V)	Phase B voltage
Voltage - Phase C (V)	Phase C voltage
Amperes – Phase A (A)	Phase A Amps
Amperes – Phase B (A)	Phase B Amps
Amperes – Phase C (A)	Phase C Amps
Battery Operational State of Charge (%)	0% to 100% of operational energy storage capacity

Monitoring Parameters	Description
Heartbeat Counter	Customer site controller increments value to show online status
Permit Service	Able to enter or stay in service. Utility verifies whether setting is enabled or disabled
Active Power Limit Enabled	Active Power Limit mode enabled/active in PCS
Maximum Active Generation Power (kW)	Maximum active power export limit configured in PCS
Maximum Active Charging Power (kW)	Maximum active power import limit configured in PCS
Active Power Limit Generation Setpoint Feedback (%)	Feedback setpoint to confirm DER has received the last utility active power generation/export limit
Active Power Limit Charging Setpoint Feedback (%)	Feedback setpoint to confirm DER has received the last utility active power charging/import limit

* Note: Specific detailed point list and approved telemetry protocols still under development and may vary across utilities.

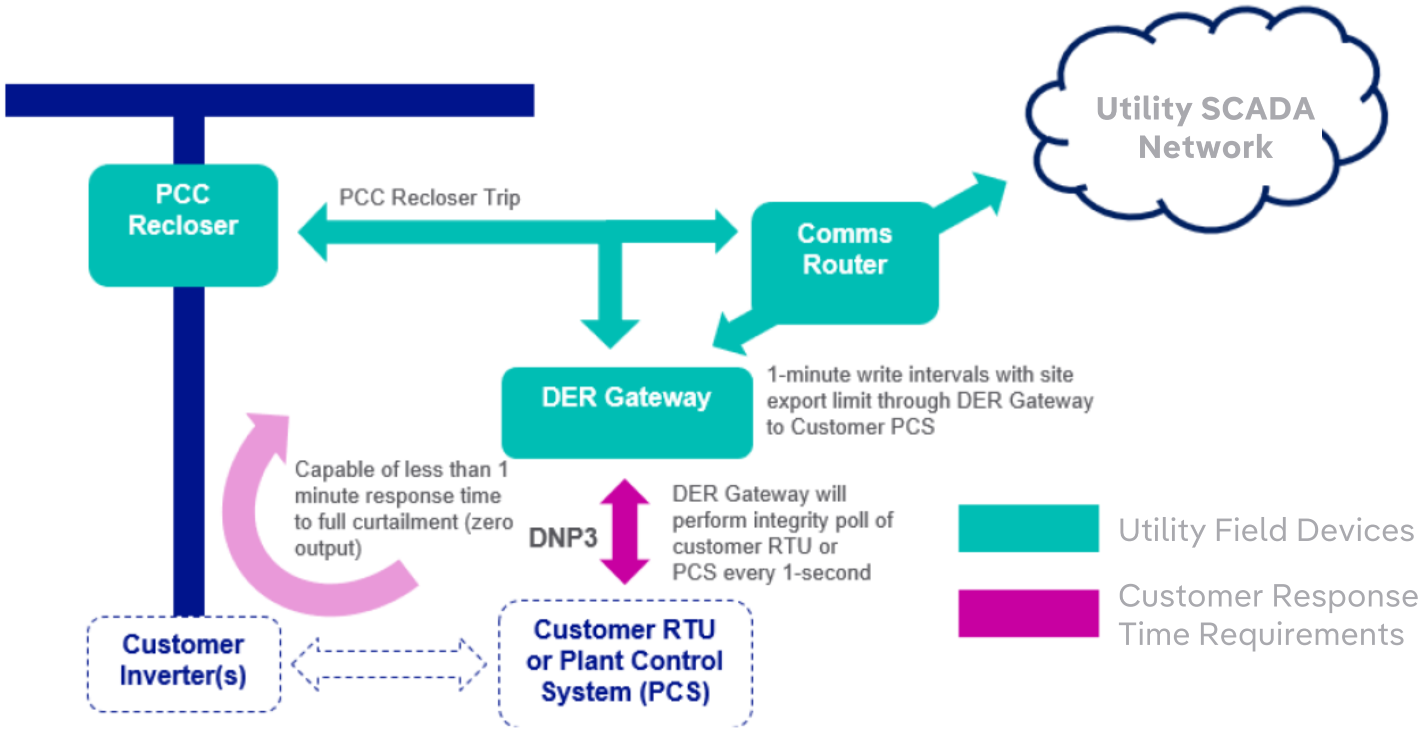
Enabling Flexible Interconnections – M&C Field Integration

Control Parameters	Description
Permit Service	Able to enter or stay in service
Limit Maximum Active Power Export (%)	Limit maximum real power export to grid
Limit Maximum Active Power Import (%)	Limit maximum real power import from grid
Limit Active Power Enable	Enable or disable limit active power mode
Fail Safe Limit Maximum Active Power Export (%)	Limit maximum real power export to grid during fail safe operation
Fail Safe Limit Maximum Active Power Import (%)	Limit maximum real power import to grid during fail safe operation

* Note: Specific detailed point list and approved telemetry protocols may vary across utilities.

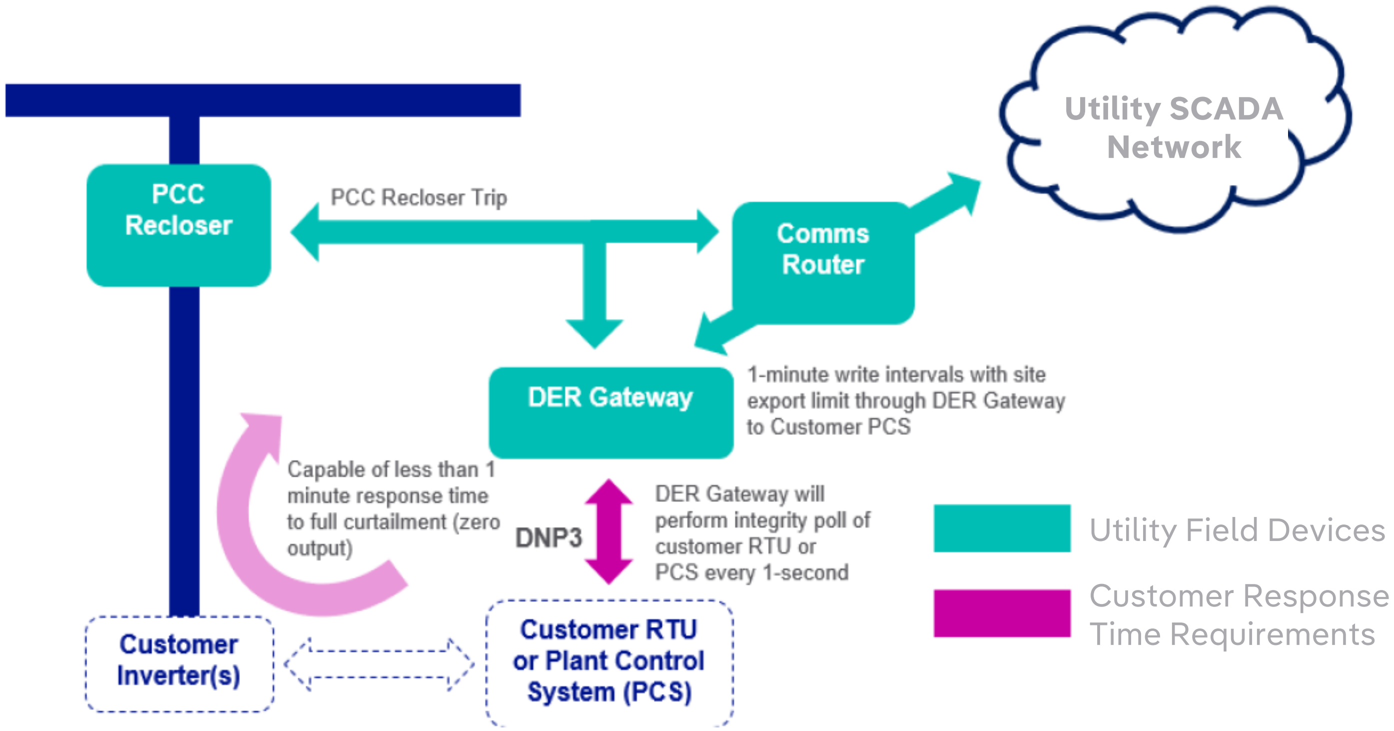
Enabling Flexible Interconnections – Performance Requirements

- **Response times**
  - Time interval of telemetry scans between Utility DER gateway and DER PCS
  - Time between retrieval of new limit setpoints to site complying with the limit
- **Adherence to fail safe scheme(s)**
  - If site loses communications with utility's DERMS and no longer receives live operating limit setpoints, DER gateway will instruct the site to limit its output to fail-safe levels (e.g. zero) until communications with the utility is re-established
  - Time delays are used to minimize fail-safe scheme from acting on short temporary communication loss
  - Fail safe scheme will also apply in the event of any major component of the flexible interconnection solution is compromised



Enabling Flexible Interconnections – Performance Requirements

- **Non-compliance disconnection**
  - Live monitoring and value comparison done by DER gateway between utility PCC recloser measurements and limit setpoints from DERMS
  - An output tolerance and time delay will be configured to allow momentary deviation or time delays/latency in telemetry
  - If site continues to exceed the limit beyond the allowed tolerance and time delay, an automatic trip will be issued to the utility PCC recloser, which must be reset
- **Support model**
  - DER owner to maintain supporting equipment owned by the DER such as PCS and conduit/fiber between PCS and utility DER gateway
  - The utility to maintain supporting equipment and software (e.g. DERMS, telecommunications, O&M of field devices)
    - Utility may apply a recurring support fee for continued O&M support of the flexible interconnection solution



Flexible Interconnection Planning Criteria

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Utility Comparison

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Criteria	National Grid	NYSEG/RG&E
Voltage	• Distribution Circuits 15 kV-Class and Above	• Distribution Circuits 15 kV Class and Above
Violation Type	• Normal system thermal violation • Contingency(N-1) thermal	• Normal system thermal violation • Contingency (N-1) thermal
Impacted System Assets	• Distribution substation transformers	• Distribution substation transformers • Feeder Conductor
DER Types	• Photovoltaic (PV) • Coupled PV and Energy Storage Systems (ESS) (Export-Only)	• Photovoltaic (PV) • Coupled PV and Energy Storage Systems (ESS) • Stand-Alone Energy Storage Systems (ESS)
Distribution Circuit Applicability	• Substation and feeders listed on Company System Data Portal	• Feeders highlighted on Company PV Hosting Capacity Portal

Flexible Interconnection Planning Criteria

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Flexible Vs Firm

- Once a project chooses to become a flexible Interconnection project, for that same project to become a firm interconnection requires a new application and a new position in the Firm queue

System Area Planning

- Flexible Interconnection is studied at max output but flex scheme to be assumed functional in mitigating eligible constraint(s).
- Minimum level of import/export used for planning study violations under flexible operation.

Cost Sharing

- Cost sharing for Firm upgrades becomes non-applicable where flexible interconnection is pursued
- Avoidance of cost share obligations is not all inclusive. I.e. 3V0 Cost Share.

Bulk Transmission Planning

- Engagement with Transmission Planning to identify impacts of multiple flex IX schemes in the same region
- Flexible Interconnection not to be used to mitigate transmission constraints

Flexible Interconnection Operating Criteria

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Normal System Curtailment

- Subject to disconnection for failure to respond to Utility dispatch signal
- Prior to dispatch response under thermal violation, asset loading shall not exceed asset rating based on asset operating conditions

Abnormal Condition Curtailment

- Subject to disconnection for failure to respond to Utility dispatch signal
- Prior to dispatch response under N-1 thermal violation, asset loading shalll not exceed asset rating based on asset operating conditions
- Dispatch to be done post contingency event

Abnormal Feeder Or Station Configuration

- Subject to SIR and Company criteria for Emergency and Non-Emergency Disconnection.
- Flexible Facility studied under the assumption to be operational under normal circuit configuration as identified in impact study

Allocation of Flexible Capacity & When Additional Capacity is Gained

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Firm Capacity Determination

Utility derived values dependant on asset operating conditions, safe carry loading limits, and aggregate DER connected and in queue.

Flexible Capacity Determination

Utility derived values dependant on asset operating conditions, safe carry loading limits, and short-term operating conditions,

Project withdraws

+

Capital improvement project

+

Equipment rating increase

→

Gained additional hosting capacity

Short term selection of flexible interconnection locations

- **How were the initial 5 substations for flexible connection eligibility selected (National Grid):**

Reviewed substation transformer capacity (N-0 and N-1) against existing connected and queued DG project capacity based on recent queue data, then filtered for:

- Distribution (low-side station bus) voltage 13.2kV only
- Substation transformers above a certain bank capacity size (>25 MVA)
- Double bank substations prioritized first, then single bank substations
- No planned capital upgrades on substation bank
- No planning violations (load demand not DG/backfeed violations) on substation bank forecasted in the next 5 years
- No concerns from Transmission Planning on amount of DG in area
- Technology integration readiness of the substation and the area
    - Has EMS/SCADA at the substation RTU already
    - Has good cellular communication coverage
    - No anticipated issues integrating cell comms between Orion/Verizon cell network and substation RTU

Principles of Access

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Considerations for Principles of Access

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Economic Efficiency

Technical/Grid Efficiency

Curtailment Risk/Certainty

Ease of Implementation

Last-In/First-Out (LIFO)

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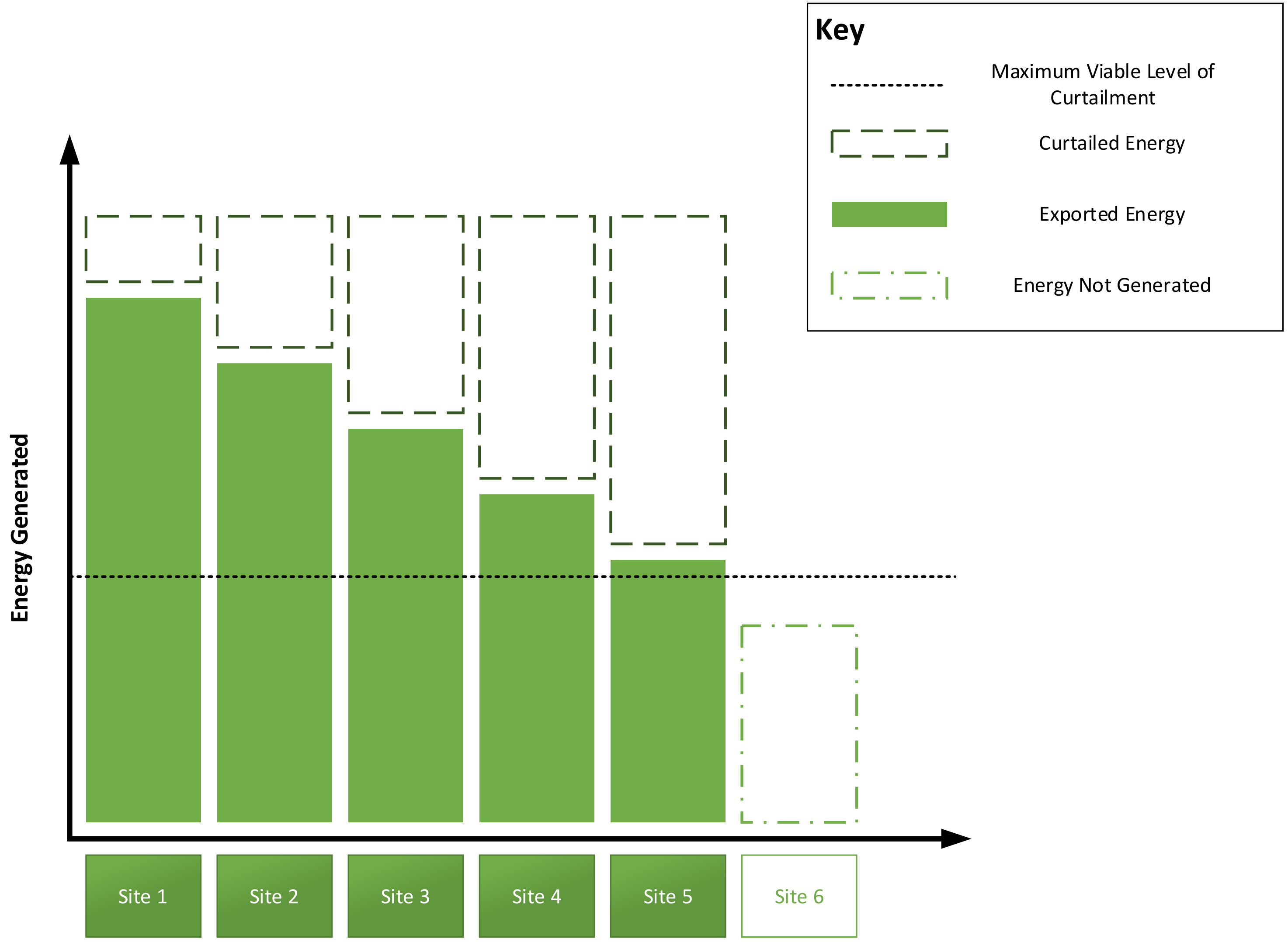
- First to be interconnected, last to be curtailed/Last to be interconnected, first to be curtailed
- Tried, Tested, and Simple
- Curtailment risk is based purely on changes to the load profile of the circuit from year-to-year, which reduces the risk of the curtailment becoming uneconomical
- Curtailment burden falls disproportionately on the DER that connect later, which can limit the total amount of capacity that can interconnect under this approach
- Even within DER owned by the same entity, the unequal distribution of curtailment across multiple sites can cause issues
- Ignores the sensitivity of the constraint to the DER's output



Pro-Rata

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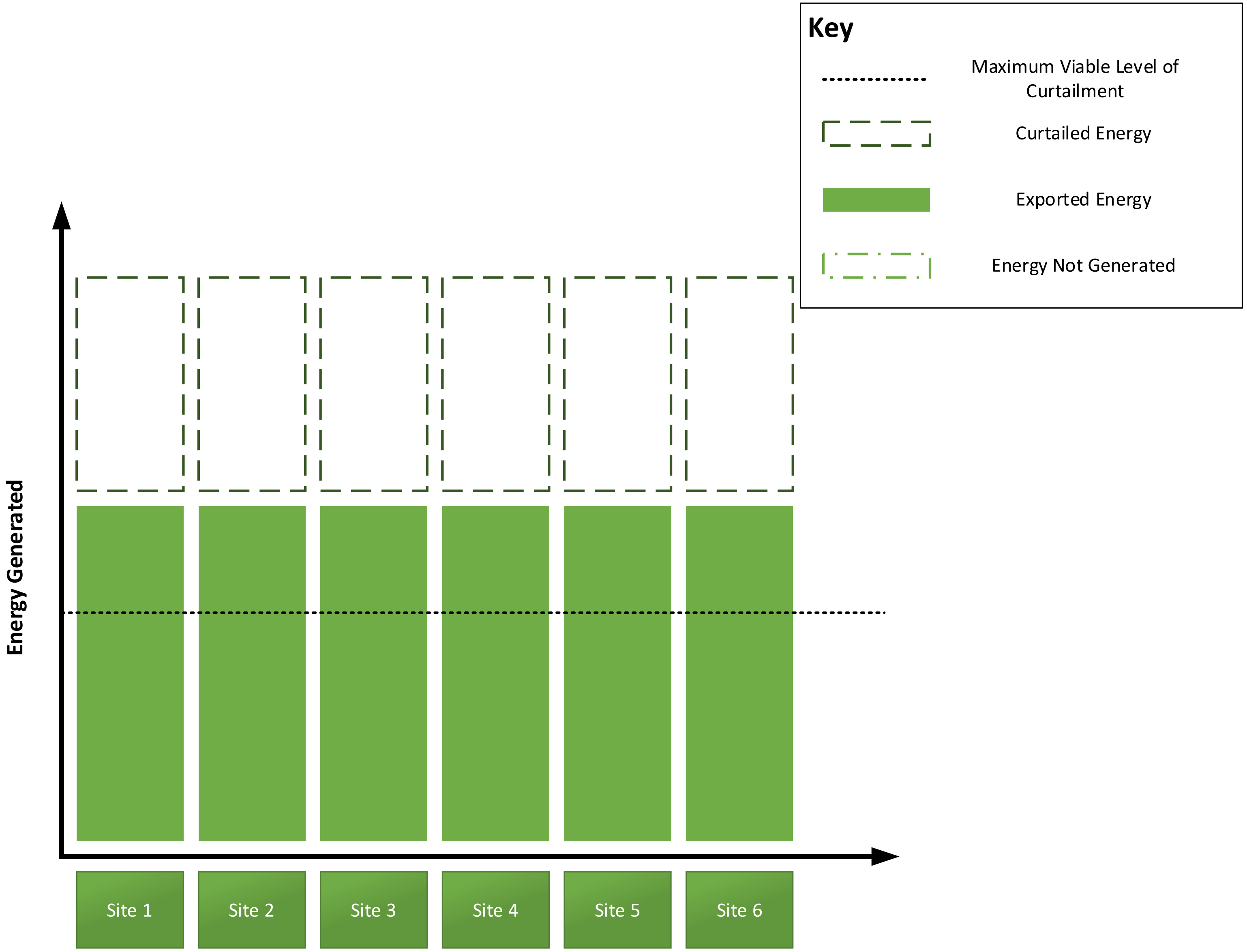
- Curtailment is assigned equally across all generators with the goal of having all sites bear the same curtailment burden
- Can be more difficult to trace curtailment than LIFO but also a simple, proven approach
- Curtailment risk is significant as curtailment experienced affected by additional flexible capacity interconnected as well as changes to load profile
- Because each MW interconnected theoretically experiences the same amount of curtailment, Pro-rata enables higher levels of flexible capacity to interconnect
- Ignores the sensitivity of the constraint to each DER's output



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Other Approaches

Sensitivity/Value-Based

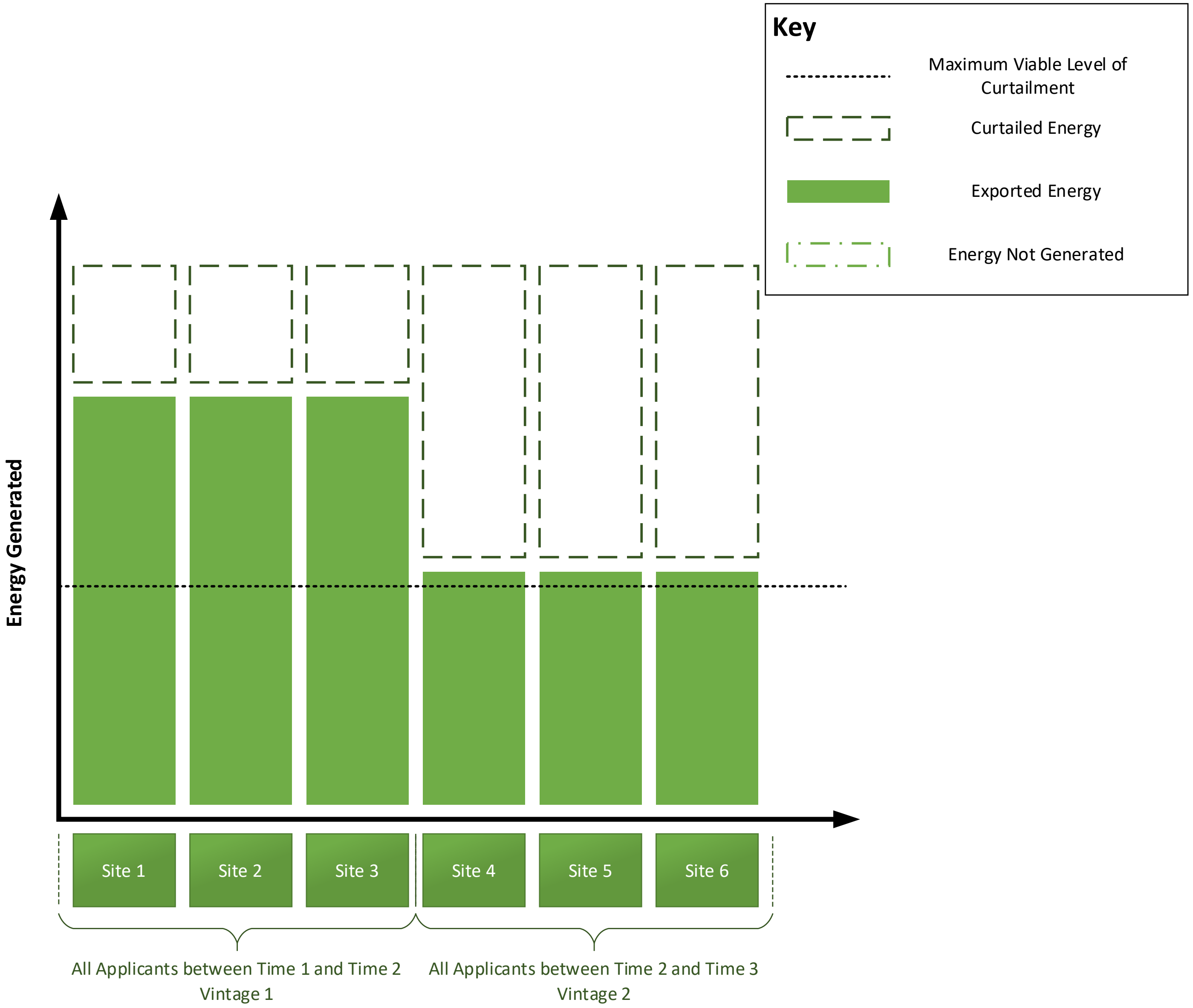
- Curtailment is assigned based on the sensitivity of the DER to the constraint and/or the economic value assigned to the DER’s output
- The most complex and difficult to trace Principle of Access
- Achieves the most “optimal” solution for curtailment from a technical and/or economic perspective

Vintaging

- Combines LIFO and Pro-Rata approaches by creating “vintages” based on when the DER applied for interconnection and curtailing all DER within the same vintage as pro-rata and curtailing the different vintages in LIFO order
- Achieves some of the optimization of Pro-Rata while simultaneously also providing LIFO levels of curtailment risk

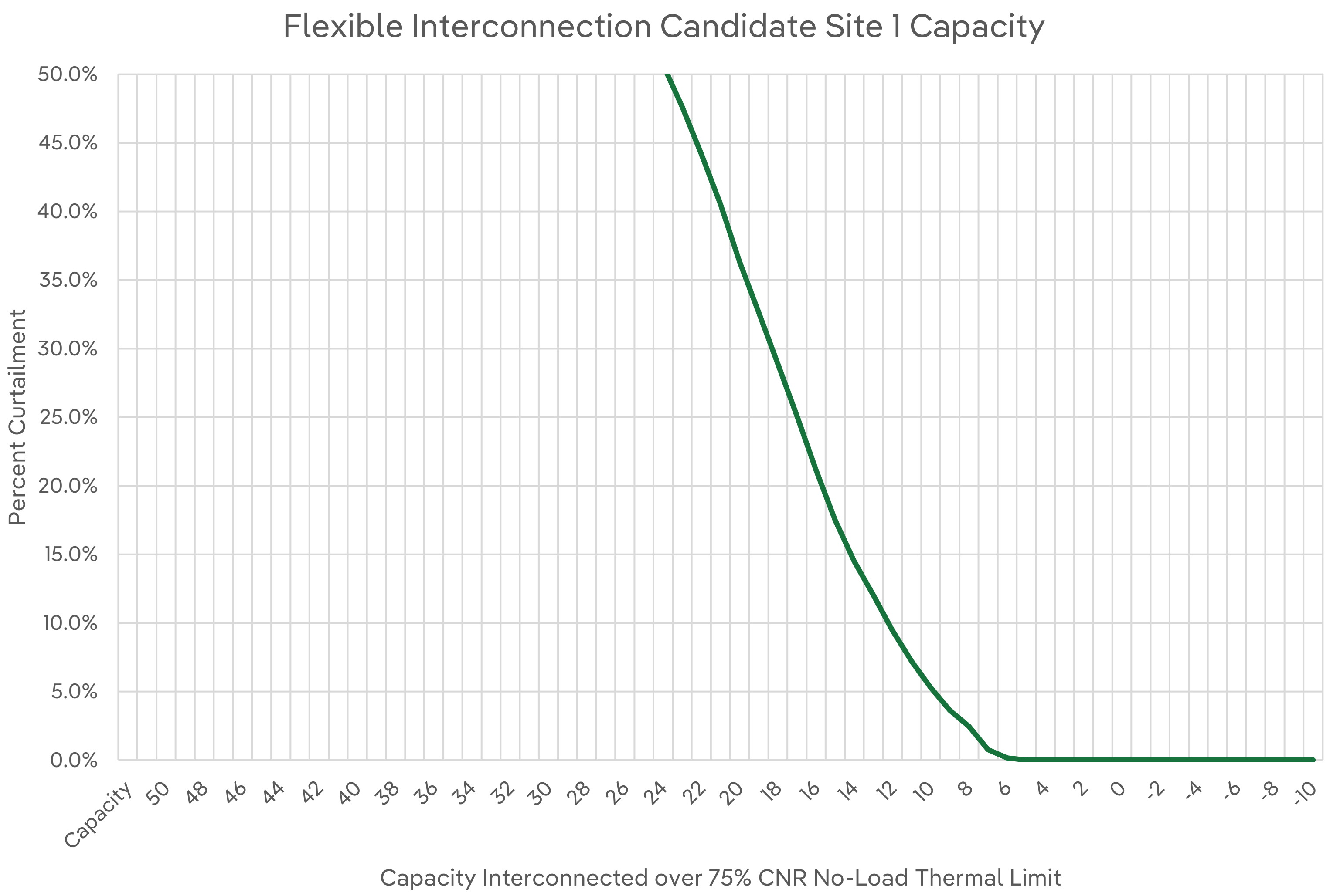
Capacity Quotas

- Pro-Rata curtailment with the addition of a maximum flexible capacity quota that is established for each constraint. Once the quota is reached no additional flexible capacity is allowed to interconnect to that constraint.
- Assumes all DERs have the same curtailment risk tolerance which is unlikely to be the case



Curtailment Guarantees

- A utility **must** curtail a Flexible DER if a grid constraint violation is imminent to maintain grid reliability
  - Non-Network Curtailment adds additional curtailment risk
- Any limit or guarantee of the maximum curtailment a DER would experience would come with a potentially significant cost to cover the risk that it was violated
  - **This risk should not be born by ratepayers**
- Actual curtailment risk is limited by the grid conditions in the majority of cases
- A curtailment guarantee would limit competition and arbitrarily cap Flexible Hosting Capacity
- Utilities and DER owners and developers have other tools at their disposal when it comes to reducing or providing certainty of the curtailment risk for a specific project
  - Curtailment Analysis study techniques
  - Principles of Access
  - Energy Storage



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Curtailment Analysis Outputs

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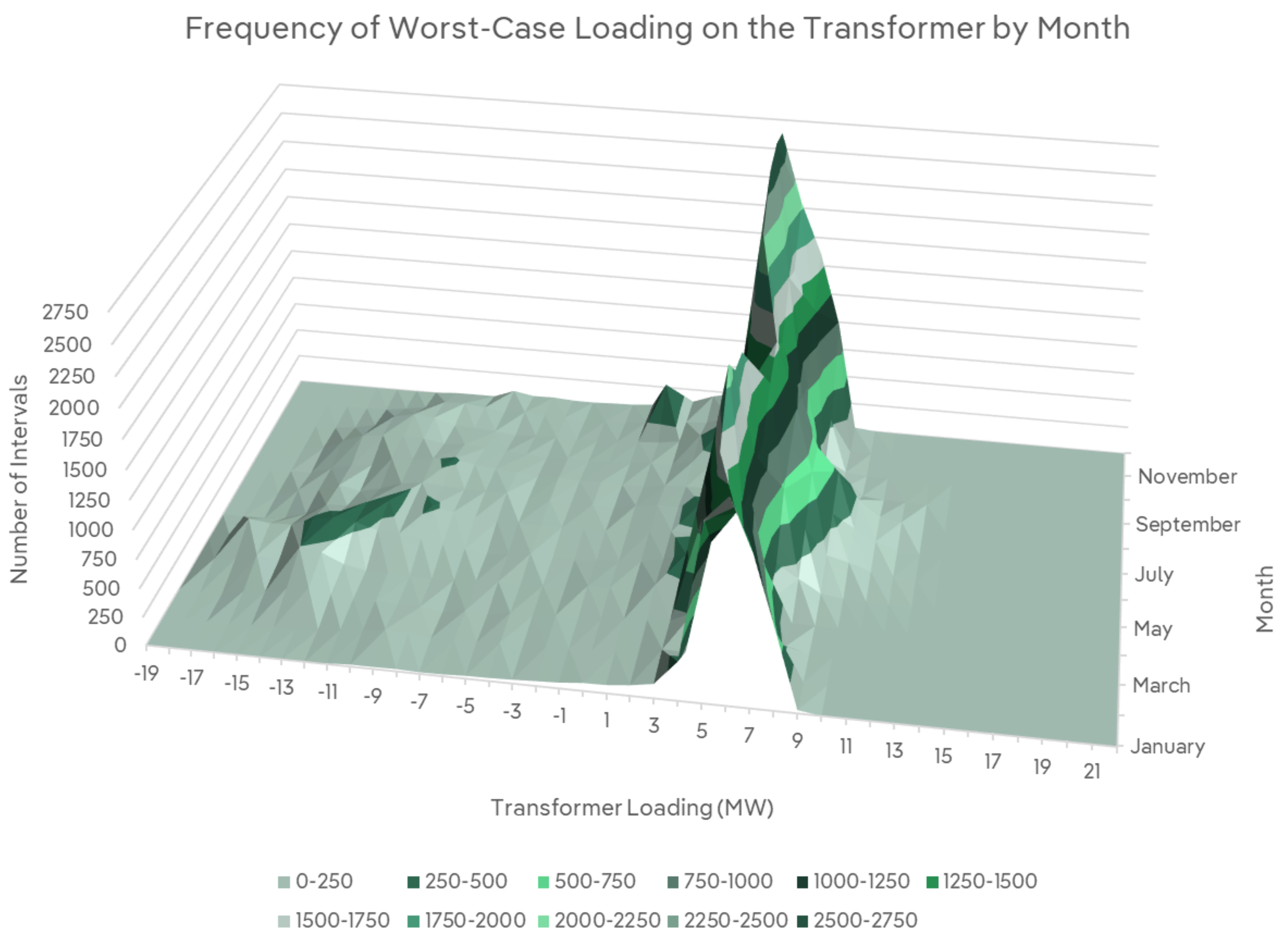
- The purpose of a Curtailment Analysis is to provide adequate data on the curtailment risk at a proposed DG site to inform a developer's decision to move forward or not
- Not all data can be shared with developers:
  - 8760 data is available publicly, but utility policy prevents sharing higher resolution loading data
  - We must be careful to avoid sharing data that might enable market manipulation or a competitive advantage
- We recognize that the time when curtailment occurs is as important as the quantity of curtailment projected to occur
  - NYSEG/RG&E have begun experimenting with different ways of graphically representing both the loading and the curtailment projections
- We also recognize that changes to the quantity of load (LIFO) or load and generation (Pro-Rata) can affect the total curtailment experienced
  - NYSEG and RG&E provide a sensitivity analysis of the total curtailment as standard in all Curtailment Analysis Reports



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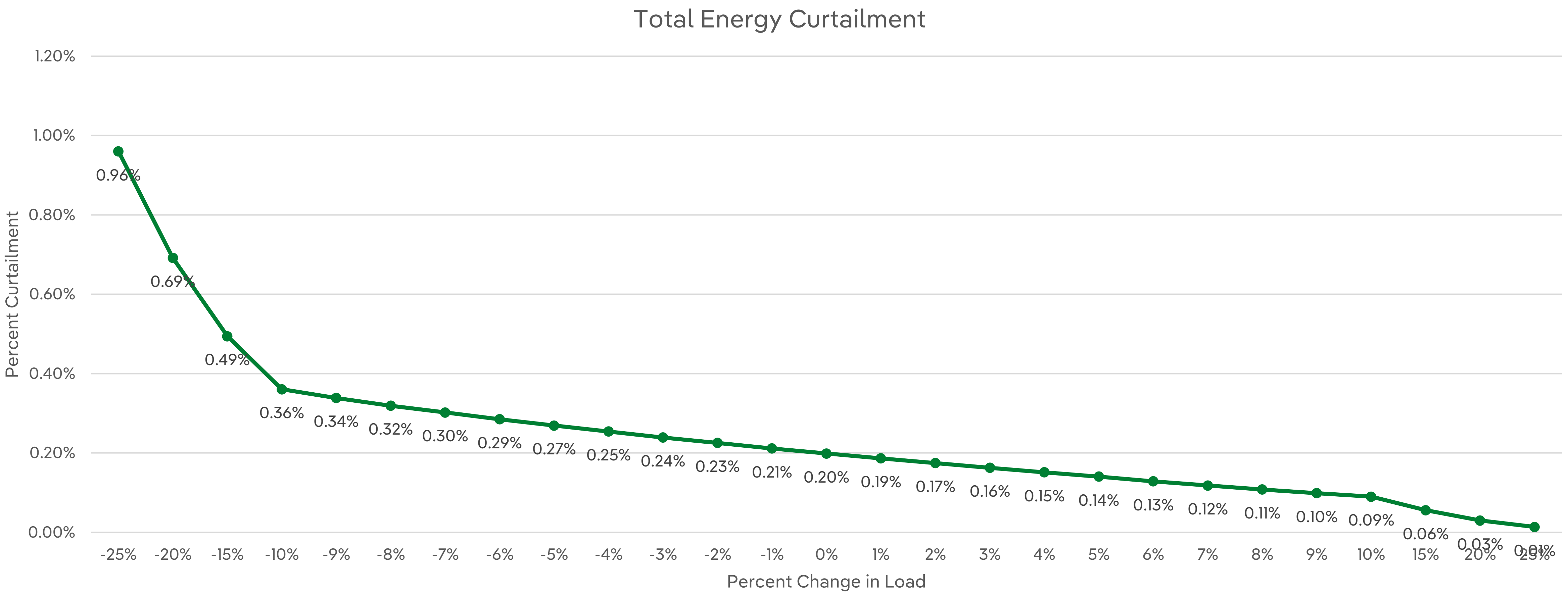
Curtailment Sensitivity Analysis



A curtailment sensitivity analysis like the one above can be used to help quantify the risk of curtailment

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Flexible Capacity Heatmapping

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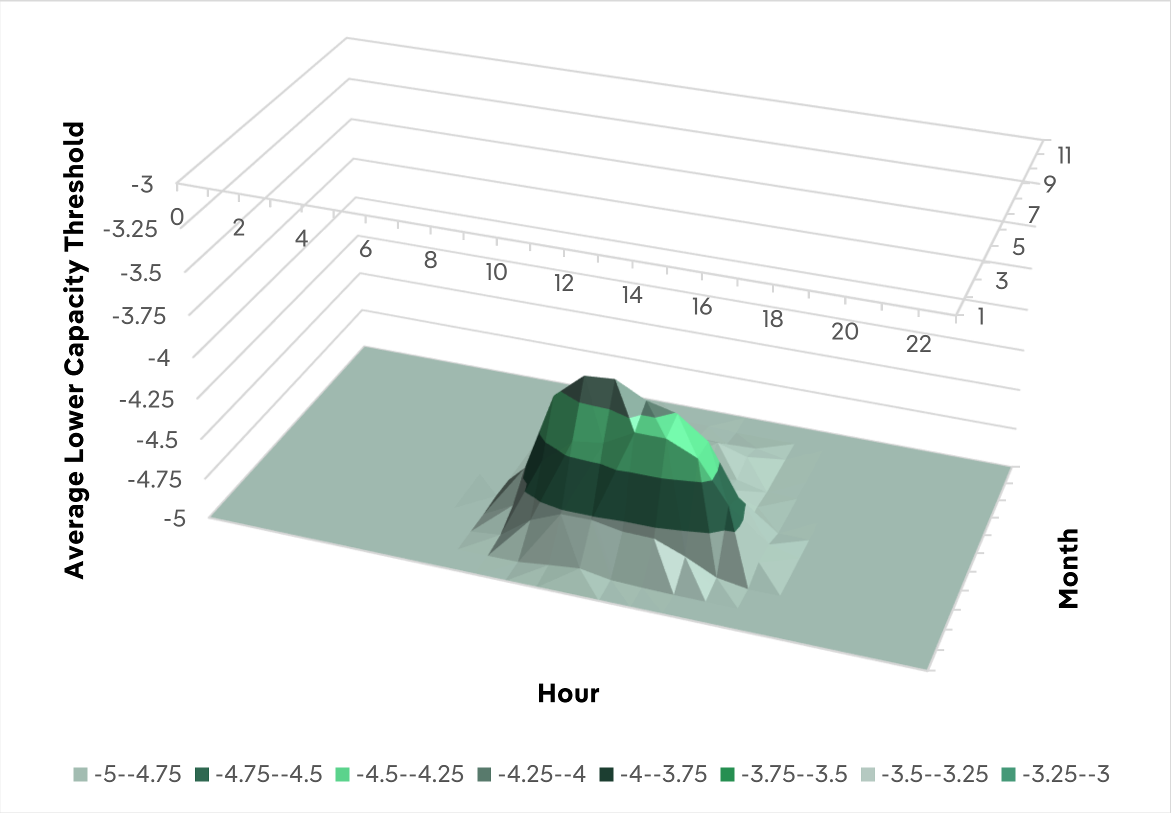
Capacity Threshold Heatmap Table

Hour	Month 1	2	3	4	5	6	7	8	9	10	11	12
0	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00
1	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00
2	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00
3	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00
4	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00
5	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00
6	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00
7	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00
8	-5.00	-5.00	-5.00	-5.00	-4.99	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00
9	-5.00	-5.00	-4.98	-4.90	-4.77	-4.98	-4.98	-5.00	-5.00	-5.00	-5.00	-5.00
10	-5.00	-5.00	-4.85	-4.59	-4.28	-4.93	-4.90	-4.98	-4.94	-4.99	-5.00	-5.00
11	-5.00	-4.98	-4.77	-4.43	-4.13	-4.89	-4.79	-4.91	-4.85	-4.97	-5.00	-5.00
12	-5.00	-4.96	-4.77	-4.40	-4.11	-4.85	-4.82	-4.93	-4.80	-4.97	-4.99	-5.00
13	-5.00	-4.99	-4.80	-4.30	-4.21	-4.85	-4.85	-4.91	-4.85	-4.96	-4.99	-5.00
14	-5.00	-5.00	-4.81	-4.30	-4.25	-4.92	-4.88	-4.94	-4.85	-4.97	-5.00	-5.00
15	-5.00	-5.00	-4.88	-4.38	-4.39	-4.94	-4.91	-4.95	-4.91	-4.96	-5.00	-5.00
16	-5.00	-5.00	-4.97	-4.63	-4.70	-4.99	-4.98	-5.00	-5.00	-5.00	-5.00	-5.00
17	-5.00	-5.00	-5.00	-4.95	-4.95	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00
18	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00
19	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00
20	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00
21	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00
22	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00
23	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00	-5.00

Capacity Threshold Heatmap Graph



For Distributed Storage Assets which have a greater reliance on being able to output their maximum capacity at times of its greatest value there are alternative approaches to a standard capacity analysis that can provide the necessary information to quantify curtailment risk

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Discussion Questions

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Based on the descriptions provided and your experiences, do you have a preferred Principles of Access Approach?

How do we maintain competition and maximize Flexible Hosting Capacity while providing adequate certainty to the financing community?

What kinds of analysis in the Curtailment Analysis Report would help you quantify the risk of curtailment for your projects?

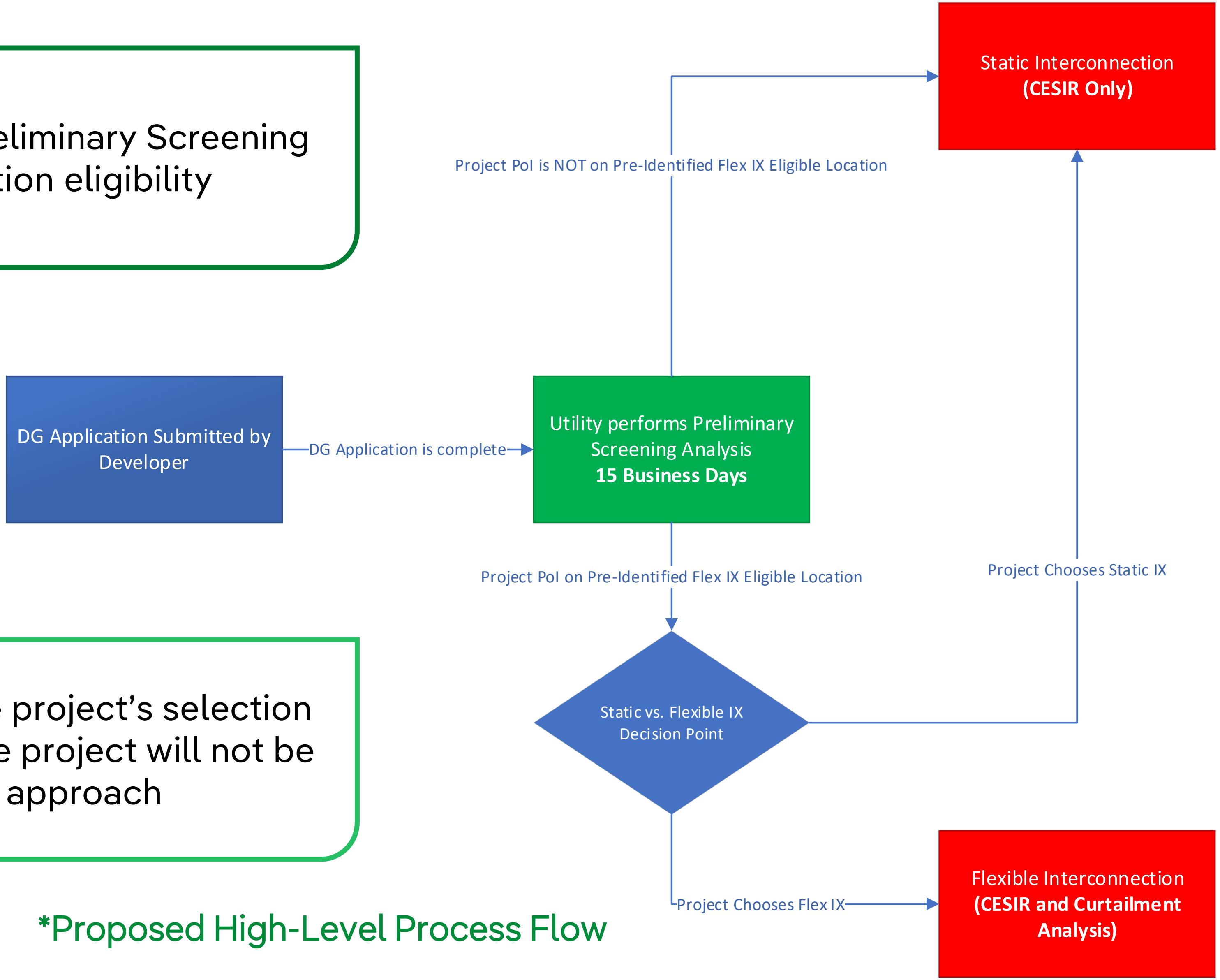
Flexible vs. Firm Processes and Timelines

The Interconnection Decision Point

Projects will be screened during the Preliminary Screening Analysis for Flexible Interconnection eligibility

After being notified of their eligibility, projects will be given the opportunity to select whether to pursue Static or Flexible Interconnection

Once the utility has been notified of the project's selection of Flexible or Static Interconnection, the project will not be allowed to switch to the other approach



*Proposed High-Level Process Flow

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The Flexible Interconnection Process

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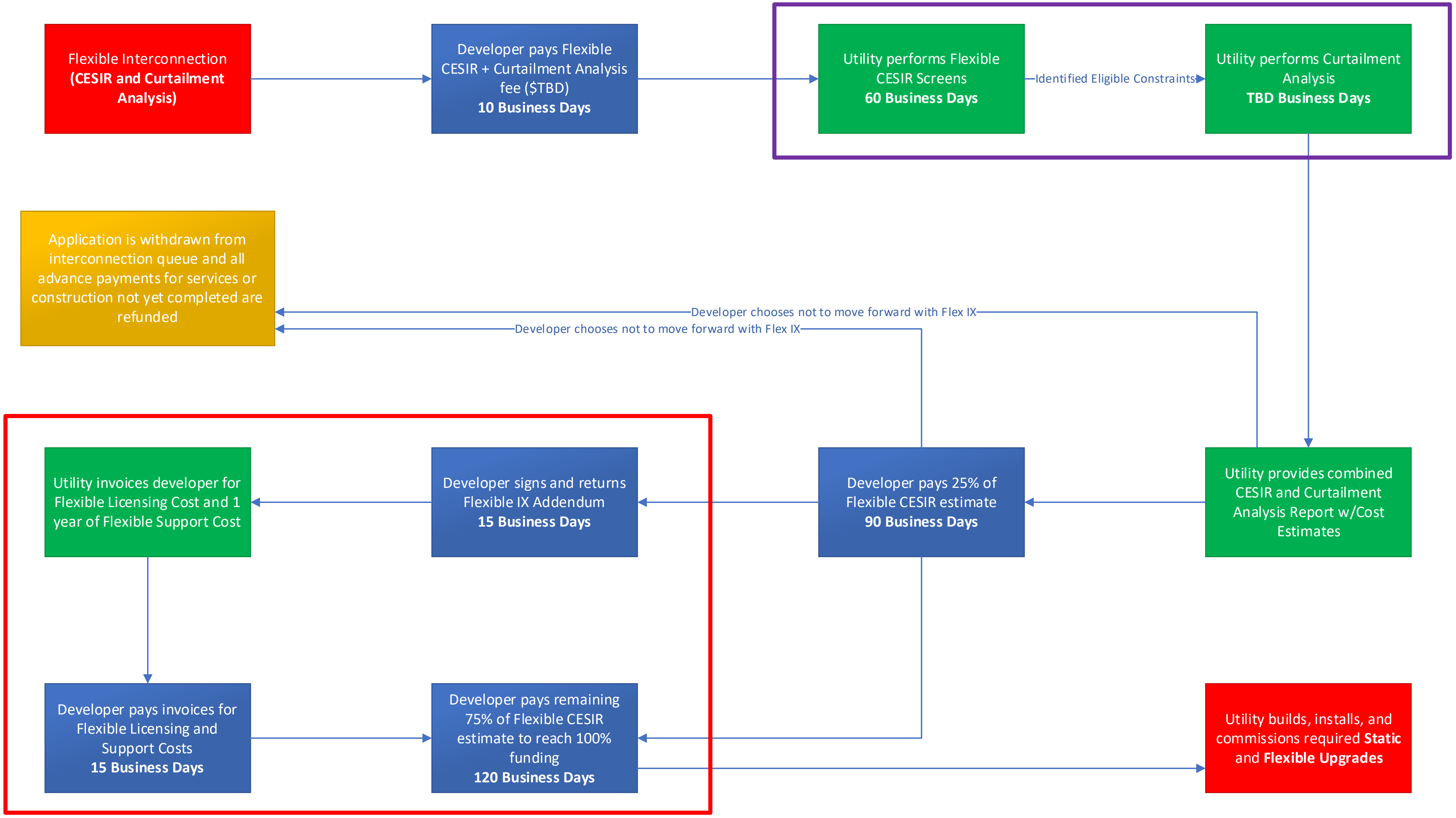

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Flexible Capacity Rights and Queue Management Proposal

Current SIR rules dictate that Firm Capacity is awarded on a First-Come-First-Serve basis

The IX application that is accepted first gets the first rights to the available Firm Capacity and when a project drops out that capacity is passed along to the next project in the queue according to this priority order

To-date, the utilities have applied this same approach to Flexible Interconnection projects

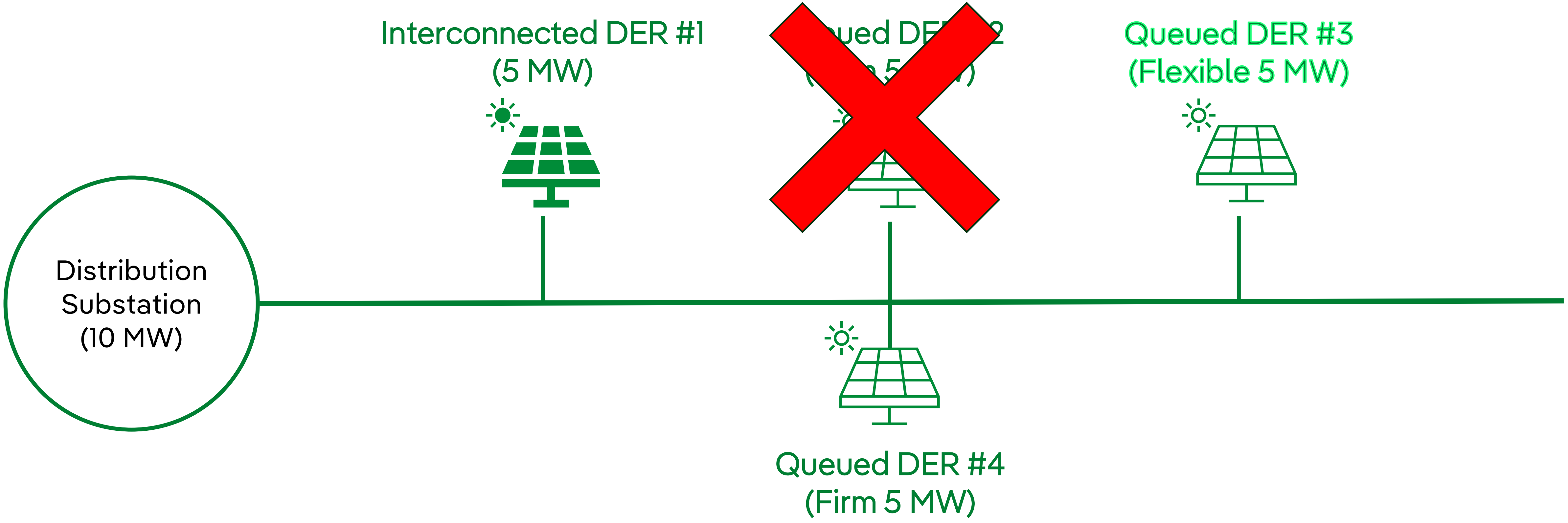
When a Firm Interconnection project drops out in front of a Flexible Interconnection project, the Firm Capacity that was utilized by the prior project passes to the next project in queue regardless of if it is a Flexible Interconnection project or not

Because it will not be possible for a project to move from Flexible to Firm Interconnection in the case of a queue change and the different interconnection types will be studied with different assumptions, **Flexible projects will not be allowed to occupy Firm capacity***

When a Firm Interconnection project drops out in front of a Flexible Interconnection project, the Firm Capacity that was utilized by that prior project will pass to the next Firm Interconnection project if one exists

*The converse is also true

A Simplified Proposed Queue Management Scenario



If DER #2 drops out of the queue, then DER #3 would not automatically receive the 5 MW of Firm capacity that became available. That capacity would go to the next Firm Interconnection project in the queue and if there was not a Firm Interconnection project in the queue it would go to the next Firm Interconnection project that applies, in this case DER #4

What Happens...?

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...to my Curtailment Analysis if a Firm Interconnection project drops out of the queue?	Nothing. All Curtailment Analyses are performed assuming the Firm Capacity on the constraint is fully subscribed. Only the loss of queued Flexible Interconnection projects will affect your Curtailment Analysis
...to a Cost Share payment calculation if there's a Flexible Interconnection project on the Cost Share constraint?	The incremental hosting capacity used to calculate a Firm Interconnection project's share of the qualifying upgrade cost will only factor in the Firm Interconnected capacity on the constraint
...if a Firm capacity upgrade is performed on a Flexible Interconnection constraint (either customer-funded or as part of the utility capital plan)?	The Flexibly Interconnected projects only convert to Firm Interconnections if they fund their pro-rated portion of the upgrade. Otherwise they remain Flexible and the incremental Firm capacity opened by the upgrade goes to the next Firm project to apply

Flexible Interconnection Framework Timeline

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Deployment Schedule

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Q4 2024
- FICS REV Demonstration Revised Implementation Plan Filed

Q1 2025
- Initial Developer Workshop

Q2 2025
- 3 Additional Capacity Auction Locations Released

Q4 2025
- Capacity Auction Awards Announced

Q1 2026
- Post Flexible Capacity Auction Developer Workshop

Q4 2027
- First Capacity Auction Participant Sites Permission to Operate

Q1 2028
- Next Round of Flexible Interconnection Locations Released

nationalgrid

Oct 2024
- Additional Eligible Substations Announced for Flexible Interconnection

Q1 2026
- Assess Potential for Additional Eligible Substations for Flexible Interconnections

Flexible Interconnection Framework Initiative Timeline

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September 2024

- Initial Flexible Interconnection Framework Initiative (FIFI) Workplan Proposed

November 2024

- Initial Stakeholder Workshop

December 2024 – October 2025

- Draft Flex IX Eligibility Criteria, Process Flow, SIR Modifications, Guidance Document, and Addendum Template

November 2025

- FIFI Stakeholder Deliverable Workshop

March 2026

- Flexible Interconnection Guidance Document(s) Released

What does the future hold?

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Flexible Interconnections are a clear driver for and dependent on utility DMS and DERMS adoption

Flexible Interconnections require a fundamental change to the way the grid is planned and operated

Access to distribution grid capacity is valuable

Dynamic Hosting Capacity limits exist for both import and export

As utility DMS and DERMS technology evolves so will the opportunities for Flexible Interconnection

Not all constraints or DER sites will be suitable for Flexible Interconnection

The magnitude of the increase in DER penetration Flexible Interconnections can produce is determined by the risk tolerance of the parties involved

Cost responsibility for mitigating grid constraints remains on the triggering project(s) for all projects