

FLEXIBLE GRID CONNECTIONS IMPLEMENTATION GUIDE

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The views contained in this document do not represent the views of any of the CHARGED Participant's organizations and cannot be attributed to any single Participant.

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PREFACE

OVERVIEW OF THE CHARGED INITIATIVE

The CHARGED initiative supports states as they electrify their transportation and building sectors, ensuring that the electricity distribution system is ready for this new era, while strengthening affordability and reliability for customers. CHARGED engages multiple stakeholders to develop technical solutions that support utility planning and operations for electrification. While CHARGED does not aim to identify a single “standard,” it aims to help the industry move beyond the current state-by-state piecemeal approach to utility planning and operations for electrification. The underlying principle is that processes that bring utilities, technology providers, and public interest groups together in collaborative ways can generate creative and effective solutions that will help utilities and states across the country to learn from each other and accelerate the adoption of effective practices.

CHARGED was launched by GridLab, RMI and Advanced Energy United with a convening in 2024 (“Inaugural Convening”) that brought 60 representatives from a diverse set of organizations together to develop solutions using collaborative problem solving across several technical and regulatory themes. Since the Inaugural Convening, CHARGED has initiated three broad sets of workstreams that traverse solution development to implementation—“ideation”, “implementation”, and “education”:

- ▶ Ideation engages multiple stakeholders across the industry through a collaborative approach to develop innovative solutions with broad applicability;
- ▶ Implementation works with specific organizations at the state level such as utilities to deploy solutions through pro-bono subject matter expertise and facilitation support;
- ▶ Education builds on ideation and implementation to socialize learnings across a wider set of actors, including regulators.

Under the ideation workstream, CHARGED initiated three working groups that directly follow from recommendations developed in the Inaugural Convening—proactive investment framework, flexible grid connection, and GIS best practices. This report contains the final finding and recommendations from an ideation working group that addressed the topic of proactive investment

CHARGED AND FLEXIBLE GRID CONNECTION

At the 2024 CHARGED Inaugural Convening, stakeholders were organized into groups to analyze distribution system challenges from various perspectives. The distribution operations group identified several solutions that could be readily adopted by utilities, which we called “least-regrets” solutions. Flexible Grid Connection emerged as a least-regrets solution that needed further exploration and refinement to support implementation efforts. A key motivation for this project was that utilities lacked (at the time) a clear implementation guide for flexible grid connection that went down to the engineering details level. A working group was formed to tackle this subject.

GLOSSARY OF TERMS

TERM	DEFINITION
PCS (Power Control System)	On-site system that limits import/export based on configured settings.
DERMS	Distributed Energy Resource Management System, management infrastructure used to control and monitor DER and flexible loads.
Hosting Capacity	The amount of additional load or generation a part of the grid can support without requiring upgrades.
Firm Capacity	Guaranteed capacity available to a customer at all times.
Operating Schedule	Time-varying set of limits governing when and how much a customer may import/export power.
Staggered Connection	Partial energization of a planned connection that is allowed to fully operate after system upgrades are completed.
Dynamic Operating Envelope (DOE)	A real-time or scheduled operating boundary based on current and forecasted grid constraints, used for dynamic connection management.

PURPOSE AND SCOPE

This implementation guide is intended to facilitate understanding of flexible grid connection concepts and methods, providing a step-by-step pathway for utilities to explore, evaluate, prioritize, and implement flexible connections to reduce the need for grid upgrades and the associated costs and timeline delays. This includes the full connection journey:

- ▶ **From** customer intent and application
- ▶ **Through** screening, study, and capacity profiling
- ▶ **To** energization, ongoing operations, and eventual refinement

While flexible grid connections methods and technologies can be used by customers of all sizes and types for different purposes, this implementation guide will focus primarily on larger distribution-connected commercial and industrial customers and loads (on the order of 1-20 MW), as large load additions are most likely to be able to utilize flexible connection methods to avoid triggering costly upgrades to distribution infrastructure. Methods discussed will similarly apply to other categories, including distributed solar, but this is not the focus of the examples provided.

FLEXIBLE GRID CONNECTION

OVERVIEW

WHAT IS A FLEXIBLE GRID CONNECTION?

Flexible Grid Connection (FlexGC)¹ is the process of modifying the performance or timing of loads or DERs connecting to the grid to expedite connection timelines and avoid creating grid constraints. The load connection process, historically, has assessed system impacts and upgrade needs by assuming that all new customer demand must be served firmly² at all times. To meet this requirement, the magnitude of the new load addition has typically been estimated using equipment nameplate values (or a percentage of such values, referred to as “demand factor”, which is often derived from historical impacts from similar loads).

As electrification accelerates, this business-as-usual method will result in the grid being built assuming all loads will at some point be used at maximum capacity, simultaneously, resulting in a grid that is built for the most unlikely of extreme scenarios. These assumptions and estimates therefore create unnecessary delays and costly upgrades that could be avoided by aligning actual load operating characteristics, grid needs, and study assumptions. FlexGC facilitates this alignment by defining specific methods with supporting processes and infrastructure to modify load operating characteristics in order to avoid the need for grid upgrades. FlexGC empowers customers with options to connect new loads³ quickly even in areas with capacity limitations.

FLEXIBLE GRID CONNECTION — MODERNIZING THE RULES

Current utility connection processes for new loads may be more adaptable to flexibility than commonly assumed—especially compared to those for power-injecting DERs. Some approaches to FlexGC can be applied today at almost any utility with only minor tweaks to the study and contracting process. While each utility and jurisdiction approaches grid connection differently, common themes are emerging:

- ▶ **Pain points:** Rigid assumptions, single time point “worst-case” load studies at peak load, and lack of options for applicants create challenges for new/expanding load customers.
- ▶ **Opportunity:** Customer flexibility in the timing and magnitude of their load can be leveraged to enable faster, cheaper, low-risk connection pathways.
- ▶ **Scope:** FlexGC is about modifying the amount of power consumed at a specific time (i.e., the shape of consumption), not the total energy consumed over a broad period (i.e., the total energy consumption).

¹ This guide will focus primarily on load connections, but the same general methods can be applied to other distributed energy resource (DER) types such as solar PV and battery energy storage, either on their own or in combination with flexible loads. Where practical, this guide will incorporate considerations for combinations of load and other DERs. The term “Connection” is used in lieu of “interconnection” to refer to both load and other types of DERs, as “interconnection” is more commonly associated with additions of DERs that inject power onto the grid.

² In this context, firm service refers to the customer’s ability to operate their load at all times without utility restriction except during emergency or outage restoration conditions.

³ “New Loads” is used throughout this document to refer to both the construction of new metered delivery points and increases in load occurring at existing utility customer locations.

Flexible connections can:

- ▶ Replace conservative assumptions (e.g., demand factor) with more realistic operating limits.
- ▶ Enable pre-defined operating schedules and limits designed to meet customer needs while addressing grid needs during periods of grid constraint, including during the build of upgrades.
- ▶ Dynamically modify operating limits to maximize access to grid capacity based on actual, real-time grid conditions.

Static FlexGC methods, which have specific operating restrictions set at the time of connection, can be implemented without the need to stand up new operational communications and control infrastructure (e.g., DER Management Systems, or DERMS). This makes such methods an ideal place to start for any utility looking to improve the efficiency and cost-effectiveness of the grid connection process. **Dynamic FlexGC methods**, which can have operating restrictions adjusted during operations in response to changing capacity availability, can achieve a higher degree of operational freedom, but are significantly more complex in their design, implementation, and execution and are more costly in terms of enabling technologies (DERMS or otherwise). Both Static and Dynamic FlexGC approaches can be used as either a means to buy time while traditional upgrades are made (“bridge-to-wires” solutions) or avoid them altogether (permanent solutions), depending on the specific needs of the customer.

The “bridge-to-wires” concept, which arose in the context of connecting electric fleet customers, allows customers to operate under temporary restrictions while the grid upgrade needed to support their full site build-out is completed. The complexity of “bridge-to-wires” varies by the methods employed to set the temporary restrictions. In the simplest implementation, only a portion of the full customer site is constructed and energized. More complex implementations incorporate temporary use of the above static and dynamic FlexGC methods or temporary limits that will increase after the upgrade is complete. The utility’s approach to “bridge-to-wires” offerings should be derived from their approaches and capabilities to implement each method.

Flexible grid connection is not a nascent concept. In fact, it has been an integral part of cost-effective utilization of the distribution system for integrating load and distributed generation in Australia and Great Britain for several years. For example, in GB, they have three tiers of flexible grid connection⁴ which include (1) Ramped (2) Timed/Profiled (3) Real-Time Dynamic. These have been offered in a “flex-first” approach and have been part of business as usual since 2020.

Mapping these concepts to U.S. terminology, methods 1 and 2 are “static” or non-DERMS based approaches (ramped is sometimes called “staggered” and timed/profiled is sometimes called “scheduled”), while method 3 is often referred to as dynamic flexible grid connection.

4 UKPN Connections products overview: <https://www.ukpowernetworks.co.uk/low-carbon-technology-commercial/connections-products>

FLEXIBLE GRID CONNECTION

PROCESS AND METHODS

Utilities have historically relied on a standardized set of assumptions when evaluating the impact of new load connection requests and any resulting need for system upgrades. When customers submit requests for new load additions, they are generally required to submit site plans detailing the types of loads being added as well as equipment nameplate demand and motor operating characteristics. This information is then converted to an estimated demand using utility calculation tools derived from historical data from similar loads or customer types.

Once the estimated demand has been determined, the new load is modelled to assess capacity impacts to upstream distribution equipment and to size on-site equipment or line extensions to serve the new load addition.

FIGURE 1. *Traditional Load Connection Process Flowchart*

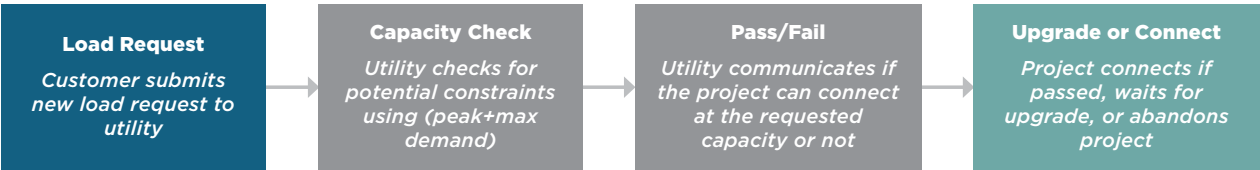


Figure 1 overviews the traditional model of load impact assessment which can result in large costs or long wait times for new connections due to several factors:

- ▶ Conservative demand factor assumptions - Utility calculations estimating the peak load impact of new load types may not be reflective of actual impacts due to lack of comparable historical data, variations between different sites, or the conservative nature of distribution planning and study processes.
- ▶ Peak time alignment - Traditional utility capacity impact assessments only consider the peak load time point (i.e., the “non-coincident” peak load⁵). Actual customer operations and the associated loads may not actually result in maximum customer capacity impact at the same time as the grid capacity constraint (i.e., “coincident” peak load will be less than the non-coincident peak load).

IMPORT/EXPORT LIMITS — ESTABLISHING THE FOUNDATION FOR FLEXGC

Flexible grid connection shifts the paradigm by replacing traditional nameplate assumptions with realistic performance limits while preventing the customer resources from exceeding such limits using a variety of techniques. **Import/Export Limits is a foundational concept that FlexGC relies**

5 Non-coincident peak (NCP) load is an electrical term for a customer's or group's highest electricity demand during a specific period (like a month), regardless of when the overall system peak occurs, differing from coincident peak (CP) which aligns with the system's maximum load

on for successful implementation. Import/export limits simply require utilities and customers to agree on a maximum capacity limit (which can be applied at any time scale) lower than the equipment nameplate (or the otherwise assumed capacity impact of the new load) on which the connection and energization or interconnection will be based.

At present, the majority of U.S. utilities are not utilizing Import/Export Limits in their standard grid connection processes, creating a misalignment between actual customer capacity needs and utility models and served capacity. This leads to under-utilized grid infrastructure and longer connection wait times for customers. Import/Export Limits and the associated agreements and customer compliance requirements are the basis for success for all FlexGC methods. These modifications can take multiple forms, with varying implications for study methodology, operational monitoring, and contractual structure. The table below provides an overview of FlexGC methods, which are explored in more detail later in the report.

UNDERSTANDING FLEXGC METHODS

Once the necessary foundation has been established or incorporated into the plan for FlexGC deployment, the three methods for FlexGC can be further explored. Table 1 below provides a summary of these methods with more detailed explanations provided in the sections below and the Appendix.

TABLE 1. *FlexGC Methods Overview*

FLEXGC METHODS	METHOD SUMMARY
Staggered	Utility and customer agree to allow the customer’s proposed facilities to operate with restrictions prior to the completion of system upgrades needed to support their full intended operation. This allows customers to connect sooner, but at a temporarily reduced maximum capacity.
Scheduled	Customer agrees to operate under a utility-defined capacity schedule (i.e., seasonal variations, time-of-day variations, or both) based on infrastructure capacity availability and customer operating profile.
Dynamically Managed	Customer agrees to utilize software and hardware infrastructure to actively respond to utility requests to ramp up or down depending on real-time, dynamically changing localized infrastructure constraints.

Within the traditional grid connection process, the applicant is generally only responsible for providing information about the planned load addition and, after the study process is completed, deciding whether to move forward with the project once the associated costs and timeline, as provided by the utility, are known. Incorporating flexibility into this process can add an additional layer of customer engagement to determine whether and which flexible options are viable for the customer’s needs. This engagement could occur prior to the start of the study (in, for example, areas of known constraint) or to discuss mitigation options after the study is completed and the corresponding system upgrade needs have been identified using online tools or active personnel engagements to advise customers interested in connecting to the grid. Regardless of the timing, **it is critical that the resulting FlexGC solution is capable of meeting the customer’s operational needs while also avoiding exacerbating grid constraints.**

IMPLEMENTING FLEXIBLE GRID CONNECTION

A STRUCTURED PROCESS FOR UTILITIES AND STAKEHOLDERS

Developing new FlexGC offerings can be a complex endeavor, depending on the selected method, with wide-ranging impacts both within the utility as well as to utility customers, new load applicants, and other stakeholders. Consequently, a clear, structured approach can help navigate the complexity and decisions to arrive at a solution optimized for specific local needs.

This implementation guide outlines a ten-step process, outlined below, to guide utility action and stakeholder engagement. The adoption process begins with reviewing local goals and constraints, followed by a scan of current practices to identify opportunities for improvement. Based on this foundation, utilities can select which FlexGC methods to evaluate, and then assess feasibility and impact with input from customers and regulators. The final step is to develop the offering, ensuring that it aligns with the region’s specific grid conditions, customer types, and planning capabilities. Throughout, stakeholder input is key, not just for gathering feedback, but for co-designing solutions that are implementable, equitable, and aligned with long-term electrification goals.

While there may be some regulatory approvals needed for certain aspects of FlexGC implementation, the core element of the load connection process that FlexGC addresses is the utility’s assumptions and study approach for capacity impact, which has historically been left for utilities to define, design, and manage themselves. As a result, utilities can take concrete steps forward by exploring and potentially even implementing FlexGC approaches within existing processes.

HIGH-LEVEL 10 STEP PROCESS FOR UTILITIES IMPLEMENTING FLEXIBLE GRID CONNECTION

Adoption Process Guide Steps 1-5

1. Review local goals and drivers
2. Review current practices
3. Prioritize methods for investigation
4. Investigate feasibility and impact
5. Develop offering

Rollout and Management Guide Steps 6-10

6. Integrate into all processes
7. Manage existing assets and queues
8. Publish technical requirements
9. Share data and methods
10. Define change process

ADOPTION PROCESS GUIDE

The adoption process guide focuses on the first half of the ten implementation steps where utilities and stakeholders are investigating the internal and external landscapes to inform how to prioritize implementation of each method. Successful implementation requires utilities to first take stock of what customers are needing and assess what can be implemented and when.

Review Local Goals and Drivers

Before exploring specific process changes or new capabilities, utilities should start with a grounded understanding of the existing system constraints, emerging load types, and policy drivers that are straining conventional connection processes. This step ensures the investigation's focus and resulting recommendations are rooted in local realities, not generic industry trends.

QUESTIONS TO CONSIDER

CONSIDERATIONS	POTENTIAL SOLUTIONS
Which technologies or resources are driving growth and new connections in your territory?	➤ Considering whether load or generation is driving grid connection demand in your territory will help prioritize which methods to pursue first.
How much capacity is currently available on the distribution system? Is that capacity located in areas expected to experience growth?	➤ Targeted deployment of FlexGC in areas with existing capacity limitations or in specific areas of interest for new connectors, will ensure FlexGC offerings are reaching customers and areas that need it most.

Review Current Practices

Before considering any changes, it is recommended to first clearly articulate how the existing load connection process functions, including dimensions such as:

- ▶ Queue management
- ▶ Study criteria
- ▶ Customer load and demand factor assumptions
- ▶ Capacity solution selection
- ▶ Customer cost share responsibility for system modifications

Often, information about how utilities estimate the capacity impact of new load additions is not accessible to stakeholders outside of utility planning or grid connection departments. Avenues such as Integrated Distribution Plans or utility “new business” webpages are great places to document these process elements to improve public understanding and help customers navigate the existing processes more effectively. Improving information sharing on existing practices also helps facilitate informed stakeholder engagement and provides a consistent location for future flexible offerings to be documented as well.

QUESTIONS TO CONSIDER

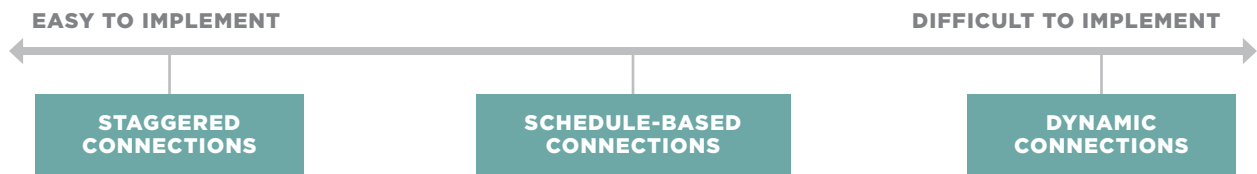
CONSIDERATIONS	POTENTIAL SOLUTIONS
<p>What assumptions are used today when studying the capacity impact of new load connections?</p>	<p>➤ Demand factor assumptions may be unnecessarily conservative. Improving import/export limits will help to avoid upgrades by reducing the anticipated demand without significantly altering customer operational capabilities and establish a foundation for other FlexGC approaches.</p>
<p>How are customer cost contributions towards system upgrades to support load additions determined and recovered? What portion of the associated costs are recovered through rates?</p>	<p>➤ If costs of system upgrades are not borne directly by the customer requesting connection, the value of flexible connection may not be accurately valued in the ratemaking/cost recovery process. Assess where this cost recovery occurs to accurately calculate the anticipated savings of FlexGC deployment, in addition to the time savings for customers.</p>

Prioritize Methods for Investigation

Once the existing baseline needs and practices are firmly established and the import/export limitation foundations for flexible connections are in place, utilities should next determine which FlexGC methods to investigate. When making this determination, it is useful to consider both the potential benefits that can be achieved as well as the feasibility of implementation. To maximize the benefits achieved through FlexGC, methods should be selected based on the specific drivers of growth and the likelihood of new connectors to successfully utilize the method to avoid triggering the need for system upgrades. For instance, winter-peaking loads that connect to summer-peaking distribution systems may be much more likely to benefit from seasonal static schedules.

When it comes to feasibility, it can be useful to start with the simplest FlexGC method, determine what actions and support infrastructure are necessary to enable that method, then consider what additional steps would need to be taken to enable the more complex methods. A flexible interconnection effort scale is shown in Figure 2.

FIGURE 2. *Flex XI Implementation Effort Scale*



- ▶ **Staggered connections** utilize the foundation of import/export limits to design and agree to a ramped capacity connection schedule as infrastructure is built, allowing customers to connect sooner, at a reduced capacity maximum. It is the simplest method to implement and provides a natural starting point. These connections can be studied effectively in existing power flow software and do not require advanced operational controls or time-series planning capabilities. Enabling staggered connections is primarily achieved through connection process updates and the establishment of customer performance requirements for compliance.

- ▶ **Schedule-based connections** utilize many of the same process and performance requirements as staggered connections, but add an additional layer of complexity to the connection study and compliance verification processes. The granularity of the schedule (i.e., seasonal variations, time-of-day variations, or both) is a key factor driving the degree of additional study complexity and the need for time-series data processing, study tools, and additional engineering resources to implement static schedule-based connections.
- ▶ **Dynamically managed connections** are the most complex type of FlexGC because they communicate limits in a dynamic manner, rather than at the time the grid connection contract is established. As with static-based FlexGC, in theory, there are a few variations, such as conveying limits on a seasonal, monthly, daily, hourly, or “real-time” basis. As the method approaches real-time, more sophisticated utility communications and control infrastructure may be required. Dynamically managed connections can employ contractual agreements that establish a minimum base capacity or ramping limits, ensuring customer operations are not unreasonably disturbed during grid constraint events. This approach provides the customer with a reasonable baseline for capacity expectations, but allows limits to be relaxed in real-time when there is additional capacity available. Implementing dynamically managed connections adds new requirements to the study process (beyond those needed for static schedules) and also requires the utility to be able to communicate updated operating limits in real-time to the customer’s equipment.

QUESTIONS TO CONSIDER

CONSIDERATIONS	POTENTIAL SOLUTIONS
<p>Is your utility incorporating time-series data and time-varying capacity considerations into the planning and study process?</p>	<p>▶ Integrating capacity and operation time-series data into the grid connection process is critical to ensure utilities are accurately modeling customer operating profiles and, in turn, effectively utilizing existing grid capacity, not just planning for the worst-case scenario. Temporal modeling also opens up options to utilize the more complex approaches to FlexGC. As a result, utilities should strongly consider adopting time-series capabilities for planning and connection studies.</p>
<p>Is your utility already operating or pursuing deployment of infrastructure to communicate with customer grid-edge technologies? Examples may include DER Management Systems, IEEE 2030.5 communications infrastructure, OpenADR, or similar technologies.</p>	<p>▶ If so, exploring how existing or planned infrastructure can enable dynamic FlexGC can further improve customers’ access to available capacity. DERMS can support the implementation of all FlexGC approaches for generation and load, but are often not needed depending on the desired monitoring, communications and controls capabilities.</p>

Investigate Feasibility and Impact

Once FlexGC methods are prioritized, utilities must analyze their technical, operational, and regulatory feasibility. This includes assessing:

- ▶ Customer site requirements
- ▶ Utility communications, monitoring and control systems (for dynamically managed)
- ▶ Customer readiness
- ▶ Stakeholder alignment

It also includes estimating the effort and time to roll out each FlexGC method, whether through prioritized and phased deployment or full integration. This step ensures a realistic, de-risked path forward.

QUESTIONS TO CONSIDER

CONSIDERATIONS	POTENTIAL SOLUTIONS
Which utility departments will be impacted by changes to the connection process? What process elements, technologies, or other infrastructure are needed to support such changes?	Impacts will not be isolated to just distribution planning engineers performing connection studies. Utilities should follow the complete lifecycle of a new connection to identify each department impacted and discuss potential changes with them to understand their needs.
How will customers' election to use FlexGC be documented? Can additional requirements be appended to existing agreements, or will a new agreement be required?	Review existing documents and agreements used within the connection process for applicability to FlexGC connections and share resources with customers to encourage them to self-assess. Ensure that language covering non-performance or failure to maintain required systems includes FlexGC connections.
What regulatory steps are necessary to enable FlexGC connections?	Because load connection processes tend to be less rigidly defined than similar DER connection processes, they may be easier to modify without lengthy regulatory processes. Adoption of Static FlexGC methods may be more practical without major modifications, as they primarily impact utility study assumptions.

Develop Offering



With feasibility clarified, utilities can design the actual offering, that is, the customer-facing product, service, or tariff that defines how a flexible grid connection will work.

This step includes defining:

- ▶ **Enrollment mechanisms** - How do applicants apply for or become considered for flexible connections?
- ▶ **Internal workflows** - How do flexible applications move through the utility process?
- ▶ **Data and scheduling processes**
- ▶ **Customer support plans** - How can customers ensure their sites comply with requirements and that flexible connections meet their needs?
- ▶ **Agreements and contracting** - How are flexible operating requirements documented and agreed upon?

The final design should clearly connect back to the original goals and grid needs, closing the loop from drivers to delivery.

QUESTIONS TO CONSIDER

CONSIDERATIONS	POTENTIAL SOLUTIONS
How will customers be made aware of flexible connection options available to them?	 Update customer-facing documentation and online information. Train utility representatives to discuss new options with customers that are most likely to utilize them.
What information do customers need in order to make decisions related to FlexGC options? How will that information be provided?	 Review all sources of customer information and identify changes or updates that would support the method(s) being investigated. Examples include new business webpages, connection application portals, hosting capacity maps, and sample agreements.

ROLLOUT AND MANAGEMENT GUIDE

The rollout and management guide is the second half of the ten step implementation guide which focuses on the processes after methods have been prioritized and overall approach has been clearly defined. This section outlines key steps for utilities to operationalize flexible grid connection methods across their systems. Successful deployment of flexible grid connection offerings at scale requires more than just technical design; it demands coordinated rollout, organizational alignment, and procedural integration. **To implement these offerings, utilities must embed flexible connection pathways into existing planning, grid connection, operations, and regulatory workflows.** This includes establishing new roles and responsibilities, refining data and modeling practices, updating customer-facing materials, and training internal teams. Importantly, rollout must not be treated as a one-time initiative, it is an evolving capability that requires thoughtful prioritization of where to start, transparency around how decisions are made, and continuous improvement as grid conditions and customer needs change. By embedding these activities into utility processes with clear stakeholder roles, documented decision-making frameworks, and aligned customer engagement practices, utilities can ensure rollout is practical, equitable, and achieves the desired outcomes.

Integrate Into All Processes

For flexible load connections to succeed at scale, utilities must embed these offerings into their everyday business processes.

This means:

- ▶ Clearly defining internal utility roles and responsibilities
- ▶ Aligning across utility departments
- ▶ Integrating new connection types into planning, interconnection, service connection, IT, regulatory, and operations workflows

The rollout should be guided by a clear understanding of who owns what, at what stage, and with what authority. Ideally, necessary process changes were explored during the “investigation” phase of FlexGC adoption, which allows for a focus on successful change management before and during the transition to offering FlexGC options.

TABLE 2. *Potential Changes to Roles and Responsibilities*

UTILITY DEPARTMENT	POTENTIAL CHANGES
Customer Service, New Business, and Key Account Representatives	<ul style="list-style-type: none"> • Communicate FlexGC options and information to interested customers • Recommend FlexGC options where they may be practical and beneficial to the customer
Distribution Planning & Connection Studies	<ul style="list-style-type: none"> • Perform connection studies using FlexGC capabilities where requested • Recommend FlexGC options where practical when connection studies identify the need for system upgrades • Incorporate FlexGC connections and capacity impacts into capacity planning and forecasting processes
Mapping & GIS Integration	<ul style="list-style-type: none"> • Maintain appropriate records of FlexGC connections in relevant information systems for use by other departments and software tools
Information Technology	<ul style="list-style-type: none"> • Update impacted information systems and software to enable new capabilities and integrations necessary for FlexGC • Procure, deploy, and maintain communications and management systems necessary for Dynamic FlexGC, where applicable
Legal and Regulatory	<ul style="list-style-type: none"> • Identify and navigate appropriate regulatory pathways to implementing FlexGC • Update connection documents and legal language, where applicable, to address FlexGC requirements
Operations	<ul style="list-style-type: none"> • Be aware of FlexGC offerings and capabilities to enable effective troubleshooting, switching, and outage restoration. • For Dynamic FlexGC, oversee capacity management efforts and incorporate dynamic management capabilities into operational processes.
Multi-Stakeholder Elements	<ul style="list-style-type: none"> • Develop and publish customer-facing documentation of FlexGC options, their benefits, and additional requirements • Expand Hosting Capacity information to support design of FlexGC options by applicants, where needed

Manage Existing Assets and Queues

This section focuses on how to handle existing and future load connection requests, clarifying whether flexible connections apply only to new applicants or also to those already waiting. Key decisions must be made around policy triggers, eligibility, and tiering of offerings based on available capacity or investment needs.

Historically, load connection queue management has been largely an internal utility process, with little to no public-facing queue information. Because FlexGC is attempting to avoid triggering the need for upgrades, it is important that the impacts of any queued load additions be considered, since they will impact the amount of available capacity. At the same time, customer privacy is an important consideration, as the magnitude and timing of large load additions can be sensitive customer information with business impacts from its publication. Stakeholder engagement, especially related to process design, is a key element of navigating these challenges effectively.

For some implementations of flexible connection methods (e.g., dynamically managed), there may be logistical or technical limitations on the number of substations that can be enabled in a given amount of time. Where such limitations exist, **utilities should also identify priority locations** based on grid needs. These may be feeders or substations with high congestion risk, clustered electric

vehicle (EV) load growth, or strategic electrification importance. Hosting capacity, asset age, and operational complexity should all factor into this prioritization, allowing utilities to stage their rollout in a way that delivers the most benefit with the least risk.

QUESTIONS TO CONSIDER

CONSIDERATIONS	POTENTIAL SOLUTIONS
<p>What information is available to potential applicants about queued load connections in an area? What information would be beneficial to provide?</p>	<p>Public-facing queue information can be valuable, but may require modifications to or deployments of new software and systems. Public queues also come with the potential for customer privacy concerns for customers adding large loads. Striking the right balance is essential for an initial FlexGC rollout, with potential enhancements added over time or as application volume or capacity congestion increases.</p>
<p>Should applicants that submitted connection requests prior to the rollout of FlexGC be eligible to use new FlexGC methods, or should the rollout be limited to new applicants?</p>	<p>For existing applicants that have not yet been studied, access to FlexGC can provide significant benefits and does not result in additional study work for the utility. Those that have been studied and determined to require system upgrades may now be able to avoid costs using FlexGC methods, but would require re-study. Also, upgrades may already be in progress, which would need to be addressed.</p>
<p>Is there a need to limit some FlexGC offerings to only certain locations? How should priority rollout locations be identified?</p>	<p>FlexGC is most valuable where available capacity is relatively limited and where there is interest in new connections. Consider prioritizing locations where both conditions overlap.</p>

Publish Technical Requirements

Customers need clear, accessible requirements that explain how to participate in flexible grid connection programs, what additional equipment they may need, and how performance requirements will be applied. These technical documents should specify the data requirements, performance constraints, and interface expectations associated with each type of FlexGC offering and be designed and developed in collaboration with what is feasible for customers and stakeholders. Publishing requirements builds customer confidence and reduces back-and-forth during connection application reviews. Stakeholder input during the technical requirements phase is highly beneficial, as it can help ensure that the technical recommendations are feasible and that the information is communicated clearly in a manner that enables customers to effectively design and construct their facilities.

Most utilities already publish similar documents for available customer service voltages and sizes to enable customers to build compliant facilities that can be connected and operated safely. Adding FlexGC configurations to existing standards will help increase visibility to potential applicants and provide a “one-stop shop” for construction requirements. Including baseline requirements for scheduling, data granularity, and customer-side equipment capabilities (where applicable) will also prevent confusion and inconsistent implementation.

QUESTIONS TO CONSIDER

CONSIDERATIONS	POTENTIAL SOLUTIONS
What information do customers need in order to comply with utility requirements for Flexible Connections options?	➤ Requirements should include equipment certifications, approved equipment lists, design drawings that demonstrate example implementations, and other relevant requirements.
How can inefficient customer iterations and interactions be minimized?	➤ Make requirements publicly available in an easy to access manner.

Share Data and Methods

Providing transparent utility data and clear methodologies are essential to ensure customers understand where flexible grid connection is viable for their business operations while also avoiding grid constraints and lower system costs for all customers. While some utilities may already have the capability to publish detailed hosting capacity maps or feeder-level availability, others may need to start with summary metrics and work with regulators and other stakeholders to define acceptable assumptions and calculation methods.

Across the pond, in Great Britain, UKPN has launched The Connections Lab⁶. This web application allows users to model potential connections to the distribution system and see what happens with different asset configurations and explore existing grid constraints and their potential impacts to the project. UKPN does the work of compiling all of the network model information, connections queue, background powerflows, constraint associations, and active network management schemes to produce a report that illustrates if there is enough capacity for the user’s scenario.

The more visibility existing and prospective customers have into the viability of flexible grid connection options, the more likely they are to successfully utilize those options. **Data-sharing platforms, such as maps, APIs, or planning portals should be structured to help customers (or their designated 3rd party advisors) explore options, develop viable flexible grid connection performance parameters, and align with utility expectations.** Internally, utilities must align on who owns and maintains these tools, and how frequently updates are made.

6 UKPN Connections Lab: <https://ukpowernetworks.opendatasoft.com/pages/connections-lab/>

QUESTIONS TO CONSIDER



CONSIDERATIONS	POTENTIAL SOLUTIONS
<p>What information do customers need to effectively utilize flexible grid connection options?</p>	<p>➤ Identifying locations with limited capacity on large, costly equipment (e.g., substation or feeder constraints) is an easy first step that generally does not require a lot of additional analysis. Expanding to more locational data and providing time-varying information are key enhancements, especially if scheduled flexible connection options are offered.</p>
<p>In what format will that information be best communicated?</p>	<p>➤ Geospatial maps are useful for showing where existing electrical infrastructure is located and what constraints may impact potential projects, but can be difficult to use for site assessment for customers evaluating many different potential sites. Tabular data views can be very useful for prospecting unconstrained areas and may be less intensive to develop, but may not have the same degree of specificity. API accessible data is the gold standard for companies and customers operating in this space and can be implemented with standardized authentication and security processes. New York utility hosting capacity maps, which allow for data access via REST API, provides an example implementation.</p>
<p>How will the information be maintained so that customers can use it to make decisions?</p>	<p>➤ Keeping information up-to-date is key, as it impacts the accuracy and trustworthiness of the information for customers. Updating application and queue information is most critical, as those elements are likely to change more often and more quickly than peak load or load profile information. In some countries, this data is updated in near-real-time.</p>

Define Change Process

Flexible grid connection offerings should evolve alongside utility capabilities and customer needs. Pathways for enhancements or changes to existing FlexGC offerings should be considered as part of the adoption process. As utilities gain more experience with FlexGC options, changes to standards, assumptions, or study and operating practices can help refine offerings, improve the customer experience, and further ensure system reliability.

Change processes should be clearly discussed and defined for customers that choose to participate in FlexGC options. Major unexpected changes to operating capabilities or operating schedule are likely to have significant business impacts. As such, customer utilization of FlexGC options will require clear definition for whether and when changes may occur. Where initial FlexGC assumptions or restrictions were too conservative, both customers and the utility may benefit from relaxing constraints (to enable more customer equipment operation) or increasing capabilities during some time periods within the operating schedule. Defining this pathway is critical during the rollout, as it will have important consequences to commercial risk for customers if the conditions change materially and impact future queue management efforts.

QUESTIONS TO CONSIDER

CONSIDERATIONS	POTENTIAL SOLUTIONS
Can the utility unilaterally modify the connection parameters due to changes in grid conditions? If so, under what conditions?	 Increasing the degree of operating restriction on FlexGC customers (outside of temporary emergency conditions) may have serious negative impacts on their business. Clear processes and recourse for modifications that increase the degree of restriction should be defined as part of the contracting requirements.
Can customer FlexGC operating requirements be relaxed if more capacity becomes available in the future?	 If customers can increase their utilization of the distribution system without requiring additional upgrades, this benefits the customer, the utility, and other customers. Providing a pathway to increase utilization in this manner in the future is highly recommended for FlexGC offerings.

TYPOLGY OF FLEXIBLE GRID CONNECTION METHODS

Below is a high-level typology (Table 3) of the foundation —import/export limitations⁷ and the three flexible connection methods of FlexGC. These represent a spectrum, from the simplest foundational static caps to more operationally integrated, dynamic methods. Selection of methods may vary by geography, customer class, technology type, and utility readiness.

TABLE 3. Flexibility in Equipment Operation and Performance

FOUNDATION	STATIC METHODS		ADVANCED METHODS
IMPORT/EXPORT LIMITATIONS	STAGGERED CONNECTIONS	SCHEDULE-BASED CONNECTIONS	DYNAMICALLY MANAGED CONNECTIONS
Customers are assigned a single import or export cap (e.g., 250 kW max demand), fixed at time of interconnection. No variation with time.	Customer’s import/export limits are fixed at time of connection and ramp up per the staggered connection timeline and capacity amount agreed to in the contracting process.	Customer’s import/export limits vary by time (e.g., hourly, seasonal), according to a pre-defined and contractually approved schedule. Enables alignment with known system constraints.	Customer’s import/export limits are set in real-time or via forecast (e.g., day-ahead), based on current or projected system constraints. May require DERMS, AMI, or other systems.

Use Cases for Flexible Grid Connections

- ▶ Bridge-to-Wires Solution: Customers wish to connect their full proposed site (which may or may not utilize FlexGC methods on a permanent basis), but full site operation requires one or more grid upgrades. Customers may temporarily utilize FlexGC methods while the grid upgrade is constructed to enable serving the entire proposed facilities.
- ▶ Permanent FlexGC Utilization: Customers incorporate FlexGC methods into their site design for long-term operation as part of their connection requirements.

IMPORT/EXPORT LIMITATIONS

Import/Export limitations are the foundation upon which all flexible grid connections can build. They work by setting a firm upper bound on how much power a customer can import from or export to the grid at any time. These limits are agreed upon in advance and can be hard-coded into the site’s equipment or operating parameters.

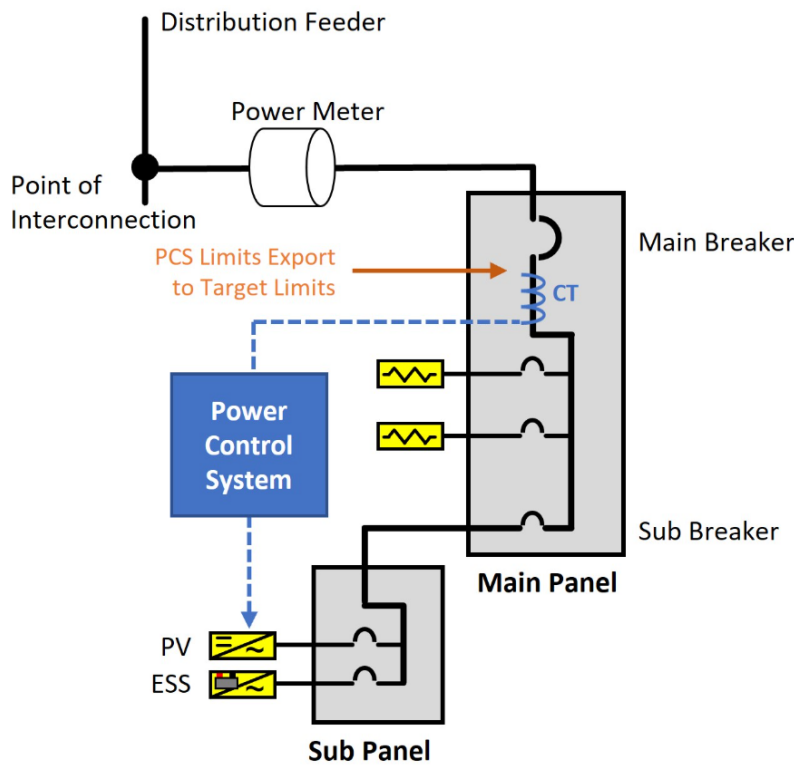
This approach differs from current U.S. grid connection practices, which typically assume that the customer’s estimated demand or full equipment nameplate capacity will be drawn or injected during peak periods. For many electrification use cases, especially those with controllable or non-

⁷ The foundation here—Import/Export Limitations—involves setting a one-time reduced capacity limit until full capacity becomes available. This differs from staggered connections, where the utility gradually increases available capacity as system upgrades are completed. Import/Export Limitation is the most commonly used approach today.

coincident loads, this assumption leads to unnecessary delays and upgrade costs. Import/export limits help bridge that gap by aligning the connection study process with realistic operational expectations — not just at the grid level, but also at the site level, where smaller customers may use the same technologies (e.g., Power Control Systems - see more below about these systems) to avoid costly upgrades to their own electrical panels, transformers, or service equipment.

This mechanism has already been widely used in solar-plus-storage projects. In these cases, a customer may install solar panels and batteries behind the meter but operate in a “non-export” mode, meaning that power is never purposefully injected into the grid. Instead, solar charges the battery, and the battery discharges to meet onsite load. The utility studies and approves the system under the assumption that the site will not export during steady-state operation.

FIGURE 3. Residential PCS Example with PV and BESS⁸



Application to Electrification Use Cases:

This same approach can be applied to load-only connections, such as electric vehicle (EV) charging depots, commercial electrification, or industrial electrified processes. For example, an EV fleet depot may install 5 MW of chargers but only expect a maximum concurrent demand of 3 MW due to natural demand diversity or their on-site operational requirements. Rather than size grid upgrades for the full 5 MW, the utility can approve a static import limit of 3 MW, which reduces the capacity requirements and allows for improved utilization of distribution equipment.

⁸ Residential PCS Example with PV and BESS – EPRI: This shows how a Power Control System (PCS) enforces export limits by coordinating the behavior of solar, storage, and the building load.

This method reduces:

- ▶ **Time to connect**, since fewer upgrades may be required.
- ▶ **Customer cost**, especially for transformers, switchgear, and service panel sizing⁹.
- ▶ **System-wide costs**, by deferring upgrades until they're actually needed, and getting more out of investments that have already been made.

Implementation Tools

To ensure the import or export limits are honored in practice, several implementation tools are available:

- ▶ **Power Control Systems (PCS):** These devices monitor real-time power flows and actively control site equipment (e.g., EV chargers, batteries) to stay within agreed-upon limits. PCS units certified under the legacy **UL 1741 CRD** or the **UL 3141** standard have undergone rigorous validation to prove their reliability in enforcing these limits.
- ▶ **Relay-Based Protections:** Some utilities may allow or require relays or circuit breakers to **disconnect the site or equipment** if the import/export cap is exceeded. This solution is relatively robust but comes at significantly higher upfront cost, especially for load customers that, unlike large DERs, generally do not require on-site utility reclosers where the associated relaying can be easily incorporated.
- ▶ **Other Custom Controls:** Where appropriate, utilities and customers may agree to **customized enforcement strategies**. This may include the use of non-certified, customer-programmable power control systems.

Utility Responsibilities

For utilities, enabling this mechanism at scale involves:

- ▶ **Publishing acceptable methods** for complying with FlexGC requirements (e.g., UL-certified PCS, PCS performance requirements, relay schemes)
- ▶ **Defining technical requirements**, such as response time, telemetry needs, and testing procedures
- ▶ **Training internal reviewers and inspectors** to assess compliance during design review and field inspection
- ▶ **Clearly documenting roles and accountability** in customer agreements

Reference Examples

- ▶ **New Mexico Interconnection Rules:** Explicitly allow non-exporting systems and define implementation paths using PCS.¹⁰
- ▶ **California¹¹ and Hawaii¹²:** Allow export-limited interconnection for DERs, models that could be adapted for flexible load management.

⁹ Customer cost—especially for on-site infrastructure such as transformers, switchgear, and service panel sizing—is often a key barrier to electrification, particularly for smaller or mid-sized customers. While utility connection processes typically focus on upstream grid constraints, flexible connection methods can also help customers avoid unnecessary over-sizing of their own electrical systems. For example, static import limits or pre-defined schedules can allow customers to downsize costly site equipment without compromising their operational needs, aligning both utility and customer incentives for right-sized, cost-effective connections.

¹⁰ New Mexico PUC Interconnection Rules: <https://www.srca.nm.gov/parts/title17/17.009.0568.pdf>

¹¹ California Electric Rule 21: Generating Facility Interconnections: <https://www.cpuc.ca.gov/rule21/>

¹² Hawaii Electric Rule 14H: https://www.hawaiianelectric.com/documents/billing_and_payment/rates/hawaiian_electric_rules/14.pdf

- ▶ **Emerging load-side examples:** Certain fleet operators have requested capped EV charging agreements in constrained urban feeders¹³.

Summary

Import/export limits represent a low-cost, high-impact step to enable flexible grid connections. They do not require complex utility-side systems or real-time coordination; only upfront planning, reliable on-site enforcement, and clear guidelines from the utility.

They are especially well-suited for:

- ▶ Customers with predictable or manageable loads
- ▶ Utilities looking for fast, scalable rollout options
- ▶ Prioritization to test flexible connection frameworks where they are most effective before layering on dynamic or scheduled features

Key Takeaway

This practice creates a safe, technically feasible, and cost-effective solution that can help avoid grid upgrades by reducing the need for conservative assumptions about coincident demand.

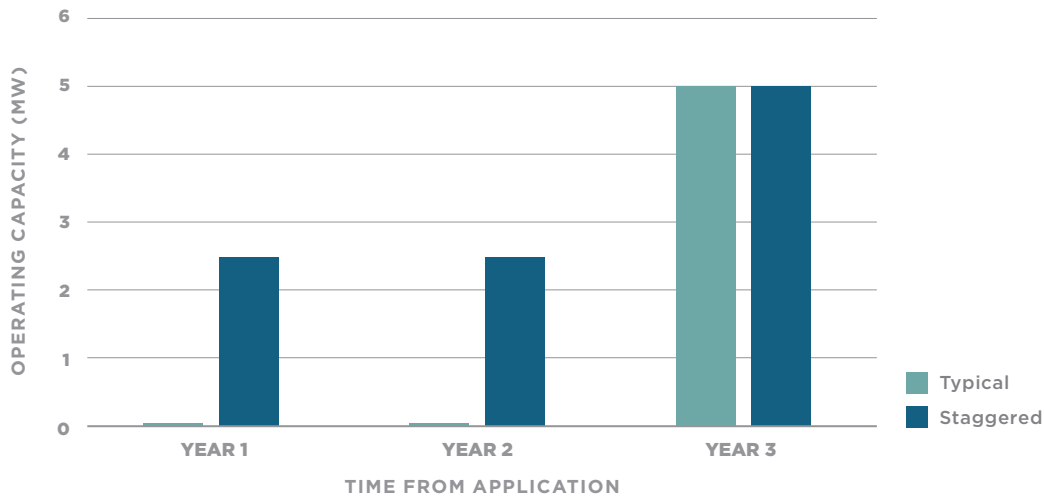
STATIC FLEXGC: STAGGERED CONNECTIONS

Staggered connections create an opportunity to change the structure of the connection process to allow for temporarily restricted operation of the new facilities while necessary supporting grid upgrades are being constructed, serving effectively as a “bridge to wires”. This approach focuses entirely on connection speed, attempting to connect and operate new resources as quickly as possible while maximizing utilization of the existing system and still maintaining system reliability. These restrictions are designed to last only as long as necessary, typically until a line, transformer, or substation upgrade is completed. Temporary operating restrictions may include temporary import/export limits, temporary operating schedules, or temporary dynamic management. Once the upgrade is completed, a staggered connection effectively transitions into either a traditional connection or permanent use of one of the other FlexGC methods.

Staggered connections offer a practical way for utilities and customers to connect resources quickly without requiring any additional customer control systems. Rather than forcing a project to delay energization until all utility reinforcements are complete, staggered connections allow the customer to energize only a portion of their equipment until full system capacity is available. Utilizing staggered connections requires changing the connection process philosophy to match customer deployment capabilities. A visual comparison of Typical vs Staggered connections is shown in Figure 4.

13 National Grid, National Grid Petition Seeking Certain Modifications to EV Managed Charging Program, New York Public Service Commission, Case 18-E-0138, 2024. Available online: <https://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7BF0D6798D-0000-CC11-BE20-7BC34F9C0DB1%7D>

FIGURE 4. *Typical vs. Staggered Connections*



[Simple example - partial connection of 5 MW system]

Key Idea: *Do not wait years to energize, start now with what the grid can support.*

Why It Matters

- ▶ **Faster customer activation:** Reduces the waiting time for customers, especially in areas or for loads where upgrades take 3-5+ years.
- ▶ **Makes best use of what is available:** If there is spare capacity today, use it.
- ▶ **Supports phased development:** Especially helpful for large sites (fleets, campuses, industrial) where load often ramps up over time.

In practice, some utilities already do this informally, especially for large commercial or industrial loads, by staging new load additions while feeder upgrades are underway. Nevertheless, formalizing temporary operating restrictions as an official offering, with clear rules, tracking, and safety guardrails, allows broader and more consistent use.

Implementation Considerations

- ▶ **Customer Equipment Controls:** If the customer builds all their systems up front, controls must prevent operation beyond the temporary limits. This could include:
 - Pre-programmed Power Control Systems (PCS)
 - Visible open disconnects
 - Software- or hardware-based limiters
- ▶ **Utility Process Changes:** Most existing study processes are designed to identify if system modifications are necessary to accommodate the full customer addition. While this is still necessary, utilizing temporary operating restrictions requires additional study work to identify how much can be accommodated under existing constraints. Utilities will need to:
 - Modify study templates to allow partial/staged evaluation
 - Add “temporary condition” tracking in work orders
 - Create signposts in internal systems for when full capacity becomes available

Operational Safety First: Any staged energization must include safeguards to ensure temporary limits are not accidentally exceeded. This is essential to avoid grid reliability risks.

Program Design Elements

To formally offer temporary operating restrictions, utilities should clarify:

- ▶ Eligibility criteria: What customer types, sizes, or locations qualify?
- ▶ Temporary conditions: What form will restrictions take? How are they communicated?
- ▶ Exit criteria: When and how will the full connection be granted?
- ▶ Customer education: Make sure customers understand both the benefits and limitations of temporary operating restrictions.

Reference Example

- ▶ **UK Power Networks (UKPN) Ramped Connections¹⁴:** Connections that will supply a metered connection with an initial capacity, and a commitment to increase the available capacity in line with the customers agreed Profile Plan, up to the maximum capacity applied for.
- ▶ **PG&E Flex Connect¹⁵:** Allows limited DER operation (e.g., export caps) until upgrades are complete.

Summary

Staggered connections allow utilities and customers to say “yes, but not all at once.” In a time when electrification goals are outpacing grid upgrade timelines, temporary operating restrictions provide a flexible, scalable tool to keep projects moving without compromising safety or reliability.

Key Takeaway

Do not let the need for upgrades block progress. Temporary operating restrictions unlock partial value today, and full value tomorrow.

STATIC FLEXGC: SCHEDULE-BASED CONNECTIONS

Static schedule-based connections offer a practical evolution of FlexGC by adding a variable aspect to the concept of import or export limits. Rather than applying a single limit year-round, these connections allow limits to vary across time dimensions like seasons, months, days, or even hours, enabling more efficient, schedule-driven use of available grid capacity without compromising reliability. Other dimensions of variability such as ambient temperature may also be considered, but may be more challenging to evaluate and implement in a grid connection study context.

Instead of planning grid upgrades around a customer’s single highest possible load, utilities and customers can collaborate to establish operating schedules that reflect when grid capacity is available and when the customer truly needs additional power from what otherwise could be accommodated in constrained conditions. For example, higher import limits could be granted in spring and fall when overall grid loads are lower, while summer afternoon constraints might trigger tighter limits.

¹⁴ UK Power Networks Ramped Connections Slide Deck: <https://media.umbraco.io/uk-power-networks/rc5cmeun/ramped-capacity-connection-guide.pdf>

¹⁵ PG&E Flex Connect Pilot One Pager: <https://www.pge.com/assets/pge/docs/clean-energy/electric-vehicles/flexible-service-connection-pilot-overview.pdf>

Key Idea: Maximize flexibility without overbuilding the system, implementing new utility control systems, or constraining customers.

Illustration: How Schedules Can Vary:

Figure 5 and 6 below shows different levels of schedule granularity for a hypothetical connection. These range from a single-limit schedule (flat year-round import or export limit based on system peak) to more refined peak/off-peak, seasonal, and combination schedules, with higher imports allowed during uncongested periods.

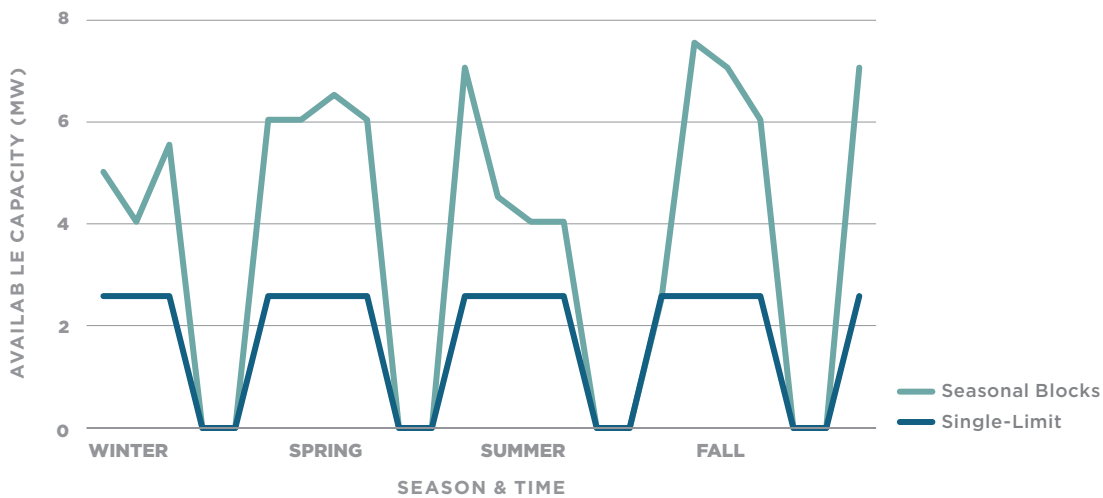
FIGURE 5. Typical vs. Staggered Connections 4-Point Seasonal

SCHEDULED GRANULARITY ILLUSTRATION
1 to 4 Points



FIGURE 6. Typical vs. Staggered Connections 24-Point Seasonal Time Blocks

SCHEDULED GRANULARITY ILLUSTRATION
24-Point Seasonal Time Blocks



Enabling Technology and Enforcement

To ensure the customer adheres to the agreed-upon time-varying limits, a **Power Control System (PCS)** or automation logic must be implemented at the site. Two primary implementation paths are emerging:

- ▶ **UL 3141-Certified Power Control Systems:** The UL 3141 standard, still in finalization, outlines how a PCS can enforce pre-programmed time-based import/export schedules. Hardware that has been tested against the draft standard is already commercially available.
- ▶ **Custom Automation Systems:** Some customers, especially large commercial or fleet operators, may choose to implement Programmable Logic Controllers (PLCs) or energy management systems that can follow complex schedules and integrate with building or fleet operations.

Challenges and Considerations

Designing and implementing schedule-based limits introduces complexity that both utilities and customers must be prepared to manage:

For Utilities

- ▶ **Schedule Creation Requires Time-Series Planning:** Unlike traditional studies that assess a single peak hour, static scheduling requires utilities to assess system conditions across time. This may require enhanced modeling tools, high-quality time-series data, process upgrades, and additional study labor.
- ▶ **Internal Readiness Varies:** Not all utilities have the tools, data, or comfort to confidently approve hour-by-hour schedules, especially for constrained feeders. A practical approach could be to begin with simpler schedules (e.g., seasonal or peak/off-peak windows) and progressively expand to more granular time slices as analytical capabilities, operational data, and staff confidence improve.

For Customers

- ▶ **Schedules Must Align with Operational Needs:** Customers are not just adding load, they are adding **business equipment with a customer or commercial purpose** (e.g., EV charging, industrial processes). An engineered schedule that avoids grid constraints but does not meet their operational needs is a non-starter.
- ▶ **Need for Engagement and Iteration:** Successful implementation of static schedules requires an iterative planning process involving utility engineers, customer facility operators, and often, third-party integrators (e.g., electricians, fleet managers, energy consultants). This collaboration is essential to design a load schedule that aligns with both grid constraints and customer operational needs; ensuring, for example, that fleet vehicles can be fully charged by morning while still avoiding feeder overloads during local peaks.

Implementation Pathways

To support broad adoption of static schedule-based connections, utilities must first determine how schedules are proposed and by whom. There are multiple viable models:

- ▶ **Customer-Proposed Schedules** — where applicants suggest load profiles based on their operational needs
- ▶ **Utility-Proposed Schedules (per applicant)** — developed collaboratively based on feeder

constraints and load characteristics

- ▶ **Utility-Published Standard Schedules** — pre-defined by location, technology type, or constraint severity (e.g., EV fleet charging on urban feeders)

Each approach has tradeoffs in terms of complexity, feasibility, and customer empowerment. Utilities should:

- ▶ publish **standard schedule templates** as a starting point, especially for common use cases (e.g., EV hubs, heat pumps);
- ▶ establish **clear criteria** for what constitutes a feasible schedule and how compliance will be enforced;
- ▶ develop **planning methodologies** that move beyond peak-only assumptions to incorporate seasonal and hourly grid variability; and
- ▶ support **iterative processes** to help refine schedule design practices and data needs over time.

Reference Examples

- ▶ **PG&E Flex Connect Pilot:**¹⁶ Load customers are able to connect on a schedule-based limit (or real-time capacity limit) agreement.
- ▶ **PG&E Load Limit Letters:**¹⁷ PG&E has issued formal approvals specifying daily import schedules for large EV fleet connections based on local grid conditions.

Summary

Static schedule-based connections provide a powerful mechanism to optimize both **grid efficiency** and **customer flexibility**. They represent a middle ground between rigid system planning and real-time management, enabling more projects to proceed **quickly and cost-effectively**, maximizing the use of existing infrastructure while maintaining safe grid operation.

Key Takeaway

Schedule-based connections can significantly improve available operating capacity for some resources, but require both utility and customer planning teams to be equipped to engage in coordinated, time-aware decision-making.

DYNAMICALLY MANAGED CONNECTIONS

Dynamically Managed Connections take flexibility one step further by moving away from fixed or pre-studied limits and instead applying real-time or day-ahead control to manage a customer's import or export based on actual (real time) or anticipated (day-ahead) grid conditions. These connections allow utilities to make the best possible use of existing infrastructure, serving more load, enabling more energy imports, and deferring costly upgrades, without compromising grid reliability.

Traditional grid connection studies are based on peak-hour assumptions, scenarios that might only occur a few dozen hours per year. Even static flexible grid connection methods like single limits or

¹⁶ See footnote 10

¹⁷ PG&E's CA PUC Load Limit Letter Filing: <https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M569/K525/569525911.PDF>

time-based schedules can be conservative, as they are built around worst-case planning conditions in each time interval being studied. In contrast, dynamic connections allow customers to access more capacity when it is available and limit capacity only when truly needed.

Dynamic management may be more difficult for load customers to accommodate if capacity availability is unpredictable. Because these loads are, fundamentally, business equipment with a purpose, the sudden inability to fully operate that equipment may be a non-starter for many businesses. Operational restrictions are even more critical to address with dynamically managed connections, as customers are likely to be even more concerned if the utility can, without much notice, effectively set their available capacity to zero during constrained periods.

To manage uncertainty and enable adoption, many dynamic flexible connection programs pair dynamic operating limits with a static fallback schedule that defines a guaranteed minimum level of capacity. This hybrid model provides customers with a predictable baseline of access, even during communication loss or constrained conditions, while still allowing utilities to dynamically increase capacity availability when system headroom permits.

This approach is used in several real-world pilots. In Australia, Dynamic Operating Envelopes (DOEs) as implemented by Western Power and Horizon Power include “floor” export levels that are always available to customers, even if dynamic signals are unavailable¹⁸. Similarly, UK Power Networks’ (UKPN) Active Response and Flexible Connections pilots include default static limits for flexible generators and loads, which are only overridden by dynamic signals when additional capacity is available¹⁹. This blend of minimum guaranteed service with opportunistic capacity enhancements offers the dual benefits of business certainty and infrastructure optimization, and may be especially critical for loads like fleets and industrial facilities, which depend on predictable uptime.

***Key idea:** Dynamic FlexGC becomes a live relationship between the utility and the customer, grounded in a minimum capacity guarantee, but designed to deliver greater capacity and value when system conditions allow.*

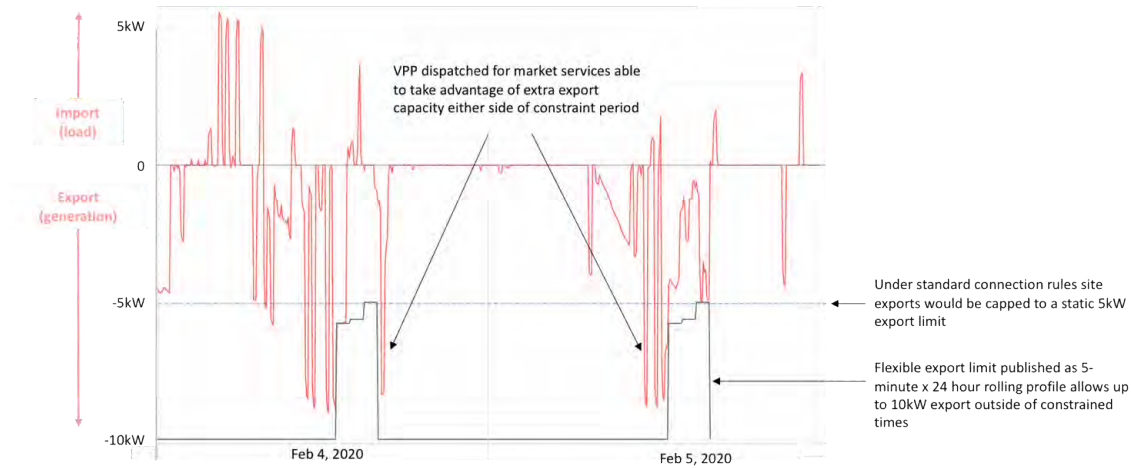
Visualizing the Opportunity:

Figure 7 below shows how a dynamic flexible grid connection approach outperforms fixed capacity for a solar+battery installation. While standard connection rules would have capped the export capacity at 5 kW for all time periods, allowing for flexible export capacity limits enables a higher degree of operation (up to 10 kW for this example system) outside of constrained periods than the fixed 5 kW static limit.

18 Distributed Energy Resources Roadmap Third Progress Report: https://www.wa.gov.au/system/files/2024-07/248948epwaderrroadmap26_july.pdf

19 UK Power Networks (UKPN) Active Response and Flexible Connections pilots: <https://www.ukpowernetworks.co.uk/new-electricity-connections/distributed-energy-resources-der-generation/flexible-connections>

FIGURE 7. SA Power Networks - Advanced VPP Grid Integration²⁰



1. U.S. Examples: Utility-Driven Control

In the U.S., Dynamic FlexGC pilots like those at New York Utilities, RG&E, NYSEG, and ComEd, use **DER Management Systems (DERMS)**²¹ to manage connections. These systems:

- ▶ Monitor feeder-level conditions (like voltage, capacity, or reverse power flow)
- ▶ Send direct commands to customer systems (e.g., battery storage, smart inverters, flexible EV chargers)
- ▶ Curtail or ramp loads/exports as needed in real-time

This model is most feasible for **larger applications**, where the cost of adding communications/control is relatively small compared to the overall project.

2. Great Britain Examples: Market Driven Control

Great Britain’s approach to flexibility has significantly increased the flexibility of energy demand in their system. **Utilities offer all three methods of FlexGC to load and generation customers** as the standard menu of options during the grid connection process. This has been standard practice in the region since 2020.

Great Britain has gone beyond flexible grid connections to fully integrating flexibility services into every aspect of electricity management including:

- ▶ Considering flexibility as a viable non-wires-alternative solution to address grid upgrade requests, using a **“flex-first” mindset**
- ▶ Contracting **flexible capacity to meet resource adequacy** needs
- ▶ Securing **localized flexible capacity** to respond to real-time operating constraints
- ▶ Utilizing **flexibility as a rampable resource** in electricity markets

²⁰ South Australia Power Networks — Advanced VPP Grid Integration: <https://arena.gov.au/assets/2021/05/advanced-vpp-grid-integration-final-report.pdf>

²¹ Different types of DERMS systems exist (Grid Centric and Grid Edge DERMS) <https://www.renewableenergyworld.com/news/coordinating-grid-centric-and-grid-edge-derms-a-journey-towards-platform-convergence/>

This increased use of flexibility in the system has significantly **improved grid infrastructure utilization** and the market-based components have served to introduce new competition to help keep energy costs competitive. For dynamic FlexGC, the regulator required all utilities to standardize connections agreement and use a common methodology to determine and share curtailment limits as part of a grid connection offer. All FlexGC offers are also required to share the date at which the grid will be upgraded and therefore the end of the FlexGC agreement, unless the customer wishes to remain on a FlexGC.²² The GB approach uses a modular DERMS approach in which DERMS are applied incrementally at feeders as they approach constraints²³.

3. Australia Example: Publishing Dynamic Limits

Australia's approach flips the script: Instead of commanding devices directly, utilities **publish "operating envelopes"**, which define the specific amount of allowed export capacity for each interval of a rolling schedule, to a server. These envelopes are **retrieved** using a secure protocol (IEEE 2030.5), and used to adjust resource performance.

- ▶ A **rolling 24-hour schedule** sets limits for each hour of the day for the next 24-hour period.
- ▶ Customers retrieve these limits using public internet infrastructure.
- ▶ Compliance is managed through equipment standards and use of default limits if communications with the server are not maintained, reducing the utility's direct control burden.

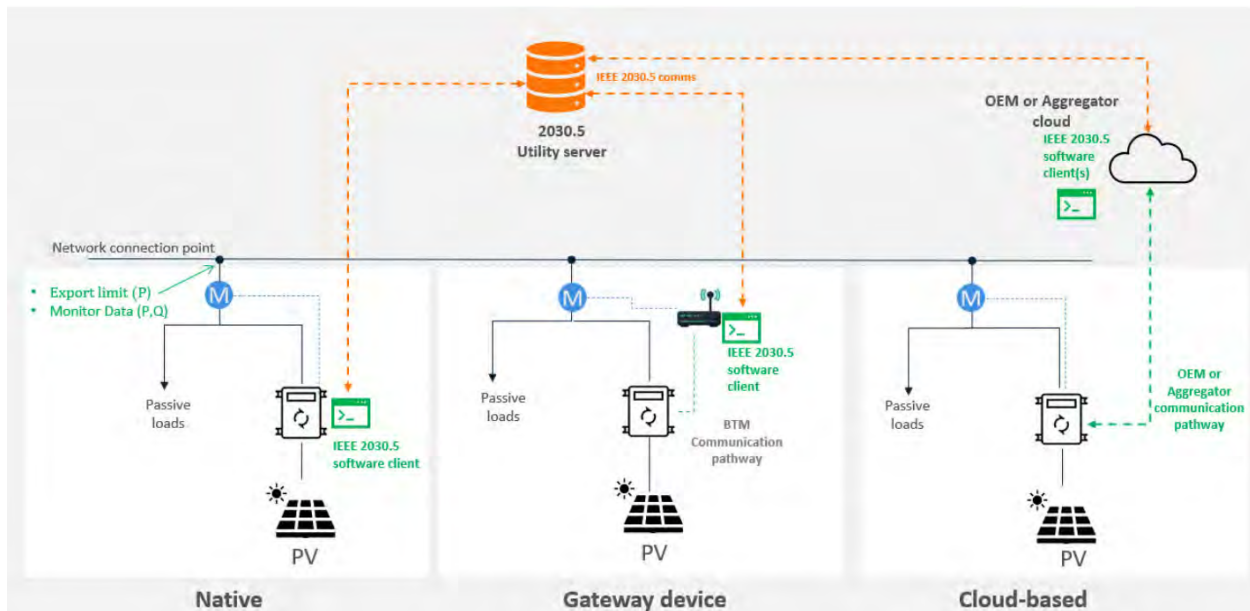
This approach scales well to **tens of thousands of small systems** (like rooftop solar or EV chargers) and has the added benefit of maintaining customer autonomy. Notably, the Australia approach does not require enterprise DERMS, rather DOEs define time varying upper and lower bounds on DER/Load import and export as shown in Figure 8, typically delivered to the DERs/Loads ahead of time (e.g., day ahead or further). DOEs are then communicated to resources directly or through aggregators via standardized protocols (such as IEEE 2030.5 or OpenADR), with each DER, load, or combined delivery point (e.g., site PCS) following the prescribed schedule.²⁴

²² Ofgem Access and Forward-Looking Charges Significant Code Review: Decision and Direction: <https://www.ofgem.gov.uk/decision/access-and-forward-looking-charges-significant-code-review-decision-and-direction>

²³ GridLab Blog - London Calling by Ric O'Connell: https://gridlab.org/london_calling/

²⁴ Ameren Illinois Flexible Interconnection DER Orchestration Plan: <https://www.ameren.com/-/media/files/account/service-options/renewables/illinois/resources/flexible-interconnection-orchestration-report-phase-1.ashx>

FIGURE 8. DOE Architecture Illustration²⁵



Key Considerations

For Loads (e.g., EVs, fleets, industry)

- ▶ **Curtailment must be predictable.** Because real-time curtailment can introduce uncertainty into business operations, many load customers may prefer day-ahead signals or predefined curtailment schedules or limits. These provide operators with a clear planning window to adjust activities accordingly. This is especially important for fleet charging, industrial loads, or temperature-sensitive operations²⁶ where advance notice is crucial for maintaining service quality.
- ▶ **Minimum firm capacity is needed for dynamically managed loads.** A minimum level of firm (non-flexible) capacity will be required to ensure baseline functionality for customer equipment. Above this guaranteed threshold, dynamic flexibility can be layered on top to create additional value for both the customer and the utility. This tiered approach can build trust, enable more predictable planning for customers, and still support greater system efficiency for the grid.

For Utilities

- ▶ Utilities must have **visibility into local conditions** (e.g., AMI, SCADA, sensors).
- ▶ Utilities must have a method to communicate limits to the customer, which can be as simple as “publishing” schedules or conveying these to devices.
- ▶ DERMS or communications platforms must be **interoperable with customer systems** (inverters, controllers, PCS).
- ▶ Need clear governance, fallback rules, and customer engagement plans.

25 DOE Architecture Illustration (pg. 23): <https://arena.gov.au/assets/2022/03/dynamic-operating-envelope-working-group-outcomes-report.pdf>

26 **Temperature-sensitive operations** refer to industrial or commercial processes where environmental temperature plays a critical role in performance, safety, or quality. Examples include cold storage facilities, food processing plants, semiconductor manufacturing, and HVAC systems in healthcare or laboratory settings, where even short curtailments without notice can compromise equipment, products, or regulatory compliance

Implementation Readiness

To scale this method, utilities should adopt the following steps.

Start with priority infrastructure for large, controllable resources.

Launching dynamic flexibility programs with large, well-instrumented customers—such as EV fleet depots, industrial facilities, or battery storage systems—provides an ideal proving ground. These customers often have robust technical capabilities, on-site energy management systems, and clear operational profiles, making them better suited to test and refine dynamic curtailment signals. Their scale also ensures meaningful system benefits during peak conditions or constrained operations. By starting with simple approaches for the most constrained infrastructure, utilities can see large benefits quickly while also testing the process with loads that can see benefits fast before rolling it out to the full system.

Standardize communication protocols.

To scale dynamic flexibility programs, interoperability matters. Utilities and third-party platforms need to speak the same language as customer systems. Leveraging standardized protocols like IEEE 2030.5 (commonly used for DER communications) or OpenADR (historically utilized for demand response) allows integration with a broad set of devices and vendors. Choosing and committing to specific standard protocols early helps avoid vendor lock-in, streamlines implementation, and simplifies customer onboarding.

Clarify customer incentives.

Customers will not opt into dynamic programs without a clear value proposition. Beyond faster interconnection or lower upgrade costs, utilities can offer recurring incentives, demand flexibility credits, or participation bonuses for allowing real-time adjustment. Importantly, utilities should also provide transparency into risk management—such as minimum guaranteed load delivery or compensation for curtailments—so customers can confidently weigh the tradeoffs and benefits of dynamic participation.

Reference Examples

- ▶ **RG&E/NYSEG Flex IX Pilot:**²⁷ Demonstrated utility-controlled flexible connections with DERMS.
- ▶ **ComEd Flex IX Pilot:** Includes dynamic flexibility for managed loads.
- ▶ **Australia's Dynamic Operating Envelopes (DOEs):**²⁸ IEEE 2030.5-based publishing of day-ahead limits.
- ▶ **Emerging Load Use Cases:** Several EV fleet operators have begun testing day-ahead dynamic limits as a bridge to full system upgrades.²⁹

Summary

Dynamically managed connections represent the **most sophisticated level of flexibility**, offering customers the highest grid utilization potential, and utilities a powerful tool to manage local

²⁷ RG&E and NYSEG Flexible Interconnection Capacity Solution: <https://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7B80ED4B91-0000-C839-A43C-A68BB37C01D6%7D>

²⁸ Australian Governments Dynamic Operating Envelopes Workstream: <https://arena.gov.au/knowledge-innovation/distributed-energy-integration-program/dynamic-operating-envelopes-workstream/>

²⁹ PG&E's EV Service Offering Updates: <https://investor.pgecorp.com/news-events/press-releases/press-release-details/2025/New-PGE-Service-Offering-Makes-It-Easier-and-Faster-to-Connect-EV-Chargers-EV-Fleets-and-Big-Batteries-to-the-Grid/default.aspx>

constraints in real time. While not every customer will be ready for this level of interaction, the potential benefits for high-value sites (e.g., fleets, campuses, commercial DER) are significant, and growing.

Key Takeaway

Dynamic FlexGC isn't just a method, it is a mindset shift towards **real-time coordination between the utility and the customer.**

COMPARISON OF FLEXIBLE CONNECTION METHODS

Table 4 provides details comparing each Flex GC method across definitions, use cases, utility implementation requirements, pros, and challenges.

TABLE 4. *Comparison of Flexible Connection Methods*

METHOD	DEFINITION	CUSTOMER USE CASE	UTILITY IMPLEMENTATION REQUIREMENTS	PROS	CHALLENGES / CONSIDERATIONS
Foundation: Import/Export Limits	A fixed power cap on site's import or export.	Sites with oversized equipment (e.g., EV depots, solar + storage) but limited coincident peak demand.	<ul style="list-style-type: none"> Update study practices to accept lower import/export assumptions. Acceptable PCS or relaying methods must be defined. 	<ul style="list-style-type: none"> Simple to understand No comms needed Reduces grid upgrade needs 	<ul style="list-style-type: none"> Conservative: no variation over time May still require on-site controls to enforce limits
Static: Staggered	Pre-defined capacity cap staggered based on infrastructure build timeline	Sites that can energize in stages, but would benefit from immediate energization at a lower capacity	<ul style="list-style-type: none"> Modify study templates to allow partial/staged evaluation Add "temporary condition" tracking in work orders 	<ul style="list-style-type: none"> Simple to understand Faster energization Increases grid utilization 	<ul style="list-style-type: none"> Still relatively conservative Requires reliable contractual agreements
Static: Schedule-Based	Pre-defined schedule of varying limits (e.g., higher limits off-peak).	Loads that can operate flexibly in time (e.g., fleets with overnight charging).	<ul style="list-style-type: none"> Schedule development process. Standard to validate PCS programming (e.g., UL 3141). 	<ul style="list-style-type: none"> Increases grid utilization Aligns with feeder load and generation profiles 	<ul style="list-style-type: none"> Complex schedule design Customer operations may not always align

METHOD	DEFINITION	CUSTOMER USE CASE	UTILITY IMPLEMENTATION REQUIREMENTS	PROS	CHALLENGES / CONSIDERATIONS
Dynamically Managed	Import/export limits updated in real time or day-ahead based on actual grid conditions.	Large or controllable resources (e.g., big fleets, campuses, industrial).	<ul style="list-style-type: none"> Utility visibility into local grid conditions Method to convey signals to customer (via DERMS or communication protocol) and the necessary communication infrastructure Integration with utility forecasting and operations 	<ul style="list-style-type: none"> Maximizes infrastructure use Precise constraint avoidance 	<ul style="list-style-type: none"> High technical complexity May be hard to scale for small customers <p>(Potential for unacceptable customer business impact without proper incentives)</p>

OTHER USE CASES FOR FLEXIBLE GRID CONNECTION METHODS

While the primary goal of flexible connection methods has been to reduce delays and minimize grid upgrade costs, the same underlying approaches and technologies could also be applied for other purposes. Designing utility programs or rate offerings that provide lower electric rates or additional incentives for customers that use flexibility to reduce their impact on peak load could extend the value well beyond just those customers trying to avoid triggering specific grid upgrades. As utilities face increasing pressure to accommodate electrification, decarbonize operations, and defer costly infrastructure investments, flexible connections can be powerful tools for ongoing system optimization with an eye towards affordability and reliability.

1. Rate Design and Program Innovation

Currently, customers only have a strong incentive to pursue flexible connections when doing so avoids specific connection costs or delays. Utilities can expand adoption by offering ongoing operational incentives that motivate customers to utilize flexibility when doing so would result in lower overall costs for other customers, not just specific avoided interconnection costs for themselves. This could be achieved using rate and incentive mechanisms such as:

- ▶ **Reduced demand charges** for customers who agree to operate under static or dynamic import limits, reflecting their lower contribution to peak system demand.
- ▶ **Time-varying rates aligned with static schedules**, rewarding customers for shifting consumption to hours with more available grid capacity (e.g., off-peak pricing, shoulder-hour discounts).
- ▶ **Performance-based bill credits** or rebates for successful adherence to curtailment schedules or for responding to utility dispatch (e.g., day-ahead or real-time signals).
- ▶ **Capacity reservation discounts** for customers who accept pre-defined limits below their nameplate and commit to operating within flexible connection tiers.
- ▶ **Queue prioritization** for applicants that opt into flexibility-based solutions that reduce the need for grid reinforcements.

2. Strategic Electrification Deployment

Flexible connection methods can enable more targeted and efficient rollout of electrification across different parts of the grid. Rather than delaying service until upgrades are fully built, utilities can offer pathways that allow electrified loads to connect in the near term, even in constrained areas, using temporary operating restrictions.

This is particularly valuable in locations experiencing rapid electrification demand, such as EV fleet hubs or dense commercial corridors. By using location-specific schedules tied to available headroom, utilities can accelerate connections in these high-impact areas and maximize use of existing infrastructure. While not inherently equity-driven, these tools offer a way to proactively manage grid congestion and prioritize service in zones where faster connections align with electrification or policy goals.

3. Enhanced Planning and Forecasting

Widespread adoption of flexible connections gives utilities access to more granular usage and capacity data, which can improve load forecasting, hosting capacity modeling, and investment planning. It allows planners to move away from binary assumptions about peak demand or worst-case loading and instead leverage realistic, time-dependent profiles that reflect actual system behavior. In other words, over time, flexible connection portfolios can become a grid intelligence asset, helping utilities better predict and manage future load growth and infrastructure needs.

Summary

Flexible connection methods are not just a workaround for capacity constraints, they can be the foundation for a smarter, more adaptable distribution system. By aligning technical flexibility with policy, pricing, and planning tools, utilities can transform flexible grid connection into a strategic asset for grid modernization. The next step is to think beyond grid connection and begin designing comprehensive programs that turn flexible capacity into shared value for customers and the grid.

DESIGN IMPLICATION: ONE SIZE DOES NOT FIT ALL

Flexible connection methods offer different types of value to different types of customers, and their effectiveness depends on the size, operating profile, and flexibility of the resource being connected. To successfully implement and scale these approaches, it is critical to consider customer-specific goals, constraints, and participation readiness. When designing flexible connection offerings, utilities should:

- ▶ Segment customers based on size, technical capacity, and flexibility
- ▶ Simplify options and automate participation for smaller loads
- ▶ Support customized implementation negotiation and configuration for large, sophisticated customers
- ▶ Ensure fairness in terms of access, visibility into options, and dispute resolution

While the primary focus of this report to date has been on large load customers, the table below is meant to consider a broader set of customer types.

TABLE 5. *Design Implications by Customer Type*

CUSTOMER TYPE	PRIMARY NEEDS & PRIORITIES	MOST SUITABLE FLEXIBLE METHODS	UTILITY SUPPORT REQUIREMENTS
Residential	<ul style="list-style-type: none"> • Fast, low-cost connections • Minimal complexity • Predictable operation 	<ul style="list-style-type: none"> • Static Limited Import-Static Schedule (simple peak/off-peak) 	<ul style="list-style-type: none"> • Plug-and-play options • Pre-certified equipment lists • Integration with TOU/managed charging programs
Fleet Operators	<ul style="list-style-type: none"> • Scheduled charging for operations • Cost-effective infrastructure • Reliability 	<ul style="list-style-type: none"> • Static Schedule-Based-Temporary Operating Restrictions • Dynamic (if coordinated day-ahead) 	<ul style="list-style-type: none"> • Fleet-specific enrollment pathways • Templates for operational schedules • Utility-fleet engagement processes
Charging Hubs / Depots	<ul style="list-style-type: none"> • Maximize utilization- Avoid upgrade delays • Willingness to manage complexity 	<ul style="list-style-type: none"> • Temporary Operating Restrictions (ramp-in to full build) • Static Import Limit • Dynamically managed • Layered methods 	<ul style="list-style-type: none"> • Negotiated agreements • Detailed telemetry integration • Multi-method layering guides
Commercial Campuses / Mixed Use	<ul style="list-style-type: none"> • Ability to phase development • Serve multiple tenants/resources 	<ul style="list-style-type: none"> • Static Schedule-Temporary Operating Restrictions • Dynamic (aggregator control) 	<ul style="list-style-type: none"> • Aggregator pathways-Campus-level load allocation rules • Site-based planning support
Public Sector / Transit	<ul style="list-style-type: none"> • Reliability & mission-critical load • Electrification mandates • Phased buildout 	<ul style="list-style-type: none"> • Temporary Operating Restrictions • Static Schedule coupled with • Dynamic 	<ul style="list-style-type: none"> • Guaranteed upgrade timelines • Policy alignment (e.g., government mandates) • Dedicated utility liaisons
Industrial / Manufacturing	<ul style="list-style-type: none"> • High power quality • Predictable load • Backup systems 	<ul style="list-style-type: none"> • Static Import Limit • Temporary Operating Restrictions as contingency 	<ul style="list-style-type: none"> • Firm capacity guarantees • Redundancy planning • Custom load control integration

Key Takeaways:

- ▶ **No single method works for everyone.** Tailoring offerings by customer type is essential for both adoption and system impact.
- ▶ **Smaller customers need simplicity.** Static methods and embedded flexibility in rates/programs are best suited.
- ▶ **Larger or fleet-based customers need customization.** They benefit from negotiations, hybrid approaches, and performance-based incentives.
- ▶ **Temporary operating restrictions and layered connections are universally valuable** for improving timelines and phasing infrastructure investments.

REGULATORY AND DECISION-MAKING GUIDANCE

As utilities and commissions consider enabling flexible load connection methods, regulatory clarity and alignment can support in scaling adoption and ensuring equitable treatment of customers. Flexible connections challenge legacy assumptions around grid capacity, cost responsibility, and connection rights, and thus require thoughtful interpretation of existing policies and regulations or development of new regulatory frameworks.

Regulators and decision-makers can play a central role in creating the environment where flexible connection methods can succeed, as has been demonstrated by the regulatory environments in the international examples cited in this document. This does not necessarily require overhauling existing rules. Significant progress can be made by making changes within the utility study process, with regulators motivating utilities to explore such options. Additional enhancements requiring more regulatory action, such as approving tariffs for flexible connections, defining fair queue management policies, or establishing data-sharing expectations, can further improve utility offerings and customer outcomes. Below are several key regulatory questions and pathways for action.

TABLE 6. *Regulatory Considerations by Topic Area*

AREA	REGULATORY QUESTIONS	POTENTIAL ACTIONS
Tariffs and Eligibility	Should flexible load connection be codified as a tariffed service? What types of customers qualify?	Approve priority areas and tariffs for static, scheduled, or dynamic connections.
Selecting the FlexGC method	Should investments for utility enabling infrastructure of FlexGC be approved?	Ensure FlexGC investments are appropriately selected and designed for the respective use case — in some cases, lower tech solutions may be sufficient (e.g., static FlexGC rather than dynamic FlexGC)
Cost Allocation	Who bears the cost for enabling flexibility (e.g., utility integration)?	Provide cost recovery for enabling infrastructure; clarify customer vs. utility investment expectations.
Queue Management	How should flexible applicants be treated in existing queues? Can flexible requests bypass rigid upgrade requests?	Allow flexible requests to proceed where non-flexible requests would be delayed. Establish queue fast-tracks.
Data and Transparency	What types of capacity or hosting data must be published, and how frequently?	Require feeder-level hosting or EV capacity data at defined update intervals.

AREA	REGULATORY QUESTIONS	POTENTIAL ACTIONS
Reliability and Enforcement	<p>How should utilities enforce flexible agreements?</p> <p>What's the recourse for violations or misperformance?</p>	Require minimum technical standards (e.g., UL 3141). Define enforcement and dispute resolution pathways.
Rate Design & Incentives	<p>How can utilities, customers, and aggregators be incentivized to prioritize flexibility where practical for achieving faster, cheaper connections?</p> <p>What economic signals reach customers?</p>	Allow performance-based rebates, flexible connection rate classes, or deferral credits.

REGULATORY PATHWAYS TO CONSIDER

1. Start with priority infrastructure + tariff templates:

Encourage utilities to propose FlexGC priority tariffs, with learnings shared via working groups or filings. Tariff templates (e.g., coming up with a “Flex Schedule Rider”) can provide consistency across utilities.

2. Incorporate into grid planning filings:

Flexible connections should be addressed in integrated grid planning, distribution plans, or electrification strategies, not just interconnection rulemakings.

3. Allow interim policy changes:

For time-sensitive load connections (e.g., fleets), allow utilities to pursue temporary, commission-noticed solutions using flexible methods without full formal proceedings.

4. Support hosting capacity + planning tool modernization

Where costs and benefits are proven, consider cost effective measures to support modernization of hosting capacity analysis, and time-varying planning tools to enable dynamic or scheduled flexibility.

Ultimately, flexible connection methods offer a powerful toolkit to improve grid efficiency, reduce connection delays, and enable electrification at scale, but only if supported by enabling policy and aligned incentives. By providing regulatory space for utilities and customers to innovate together, commissions can ensure that electrification occurs not only faster, but smarter.

CONCLUSION

The electrification of transportation, buildings, and industry presents an urgent and growing challenge for utility distribution systems. Traditional grid connection processes, built for a different era, often rely on conservative assumptions and static capacity thresholds, which can lead to costly upgrades, long delays, and underutilized infrastructure. Flexible connection methods provide a promising path forward by allowing customers and utilities to collaboratively manage capacity, improve connection timelines, and defer or reduce grid investments, all while maintaining system reliability and customer satisfaction.

This guide offers a practical roadmap for utilities and regulators to explore, prioritize, and implement flexible load connections through a combination of static, scheduled, dynamic methods for both permanent and temporary utilization. It emphasizes not only the technical and procedural considerations, but also the customer experience, regulatory alignment, and organizational readiness required for success. As the grid evolves, flexible connections can serve as a cornerstone strategy, enabling smarter, faster, and more equitable electrification.

APPENDIX A

FLEXIBLE CONNECTION TECHNICAL METHODS EXPLORATION

APPROACH AND TERMINOLOGY

This Appendix examines each static flexible connection method with the goal of identifying and discussing key implementation details, process impacts, and change management activities necessary for utilities to implement each method. Focusing on the utility implementation perspective is intended to build utility confidence and address specific challenges anticipated during the development of flexible connection offerings. Customers, regulators, and other industry stakeholders also play a key role in successful implementation. Approaching each method from the perspective of utility implementation will also provide key information and recommendations that can help empower these key stakeholders to constructively engage with specific design decisions for flexible connection offerings.

Throughout this Appendix, the terms “applicant” or “customer” will be used to refer to new or existing utility customers who are connecting a new site, adding load to an existing site, adding DER to an existing site, or any combination thereof, and may wish to utilize flexible connection methods to do so. Where applicable, impacts to utility customers other than those directly engaged in the connection process will be noted as such and may be referred to as “other customers”.

FOUNDATION	STATIC METHODS		ADVANCED METHODS
IMPORT/EXPORT LIMITATIONS	STAGGERED CONNECTIONS	SCHEDULE-BASED CONNECTIONS	DYNAMICALLY MANAGED CONNECTIONS
Customers are assigned a single import or export cap (e.g., 250 kW max demand), fixed at time of interconnection. No variation with time.	Customer’s import/export limits are fixed at time of connection and ramp up per the staggered connection timeline and capacity amount agreed to in the contracting process.	Customer’s import/export limits vary by time (e.g., hourly, seasonal), according to a pre-defined and contractually approved schedule. Enables alignment with known system constraints.	Customer’s import/export limits are set in real-time or via forecast (e.g., day-ahead), based on current or projected system constraints. May require DERMS, AMI, or other systems.

COMMON ELEMENTS ACROSS FLEXIBLE METHODS

When considering how to implement the different flexible connection options, some aspects of the connection process and impacts on other utility processes are common across all of the methods. While there are specific details that may be method-specific, it is useful to start from these shared considerations.

From a utility operations perspective, the central concern for designing flexible connection offerings is ensuring compliance with the relevant operating limitations. For limited import/export

and schedule-based connections, this means adhering to the prescribed single-point or time-varying import or export limits. For staggered connections, this means complying with temporary limitations until the system upgrade is completed. Because these methods intentionally attempt to push the system to operate at or near its design limits more often, it compliance with operational requirements is critical. Violations of these conditions by the customer may result in equipment overloads, loss of life of utility equipment, or negative reliability impacts to other utility customers.

At the same time, overly strict compliance mechanisms may negatively impact customer costs, process, or the overall experience when attempting to utilize flexible connections. While there is a potential for intentional non-compliance by the applicant (e.g., they connect additional load in a manner that exceeds the relevant import limit), that risk is already present within existing connection processes. Comparing compliance costs and risks under flexible connection approaches to those already present within existing connection processes can help ensure that any additional compliance mechanisms implemented to support flexible connections are reasonable and necessary. Specific design options for compliance assurance may vary across the different flexible connection methods, by customer or resource size, or other factors.

Ensuring that load and DER connection processes can support flexible connection is another critical element for successful deployment. Because these methods can be used as a solution for avoiding or working around grid reinforcements, it is essential that customers are able to modify their proposed equipment during the connection process if significant reinforcements are prescribed as a result of the customer's original application. For DER connections, where the interconnection process is much more likely to be explicitly defined within state regulations, it may be more difficult to make such modifications.

In addition to impacts within the connection process and technical requirements, flexible connection methods (especially for load additions) can impact existing utility processes related to load addition cost calculations such as Contribution in Aid of Construction (CIAC) and associated revenue offset calculations. Many utilities have provisions for the customer's contribution to line extension or system upgrade costs (which are necessary to serve their new load) to be reduced by considering the anticipated increase in the customer's bill as a result of the load addition. Where flexible connection methods are utilized to connect new loads, complex changes to the operating profile may also require changes to bill impact calculations within this process in order to accurately determine the resulting offset to connection costs.

FOUNDATION FOR FLEXIBLE GRID CONNECTIONS:

LIMITED IMPORT/EXPORT CONNECTIONS

Static Limited Import/Export connections set a specific level of maximum power import or export to be followed in perpetuity once the new resources are connected. Import or export limits can be set either at the whole site (i.e., the amount of power imported or exported through the utility meter) or for a subset of equipment on the site (i.e., a set of EV chargers being added to an existing customer's other loads). This limit-based approach shifts the focus away from the equipment nameplate values (historically used to estimate performance directly or via a calculated demand factor) and toward the actual capabilities and performance of the impacted resources.

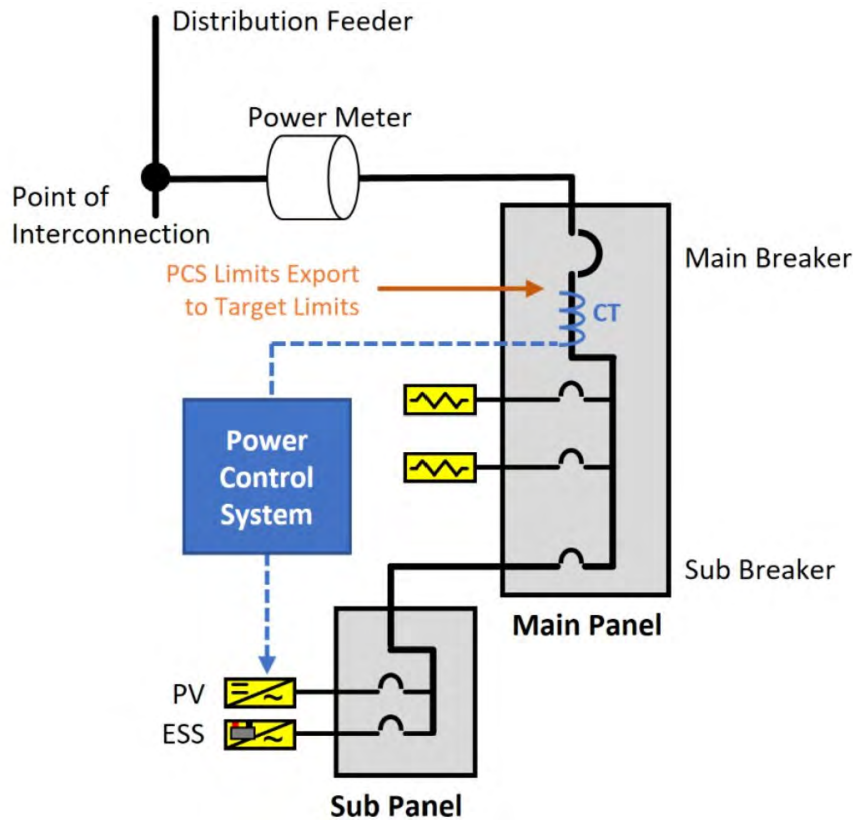
Static import/export limited connections can be useful for many different goals. Much of the initial momentum and technical development underpinning this approach was established to support battery storage interconnections (especially when combined with solar PV). The use of import/

export limits allowed for battery storage to be connected, studied, and operated as a complement to the solar PV (in, for example, non-export mode where all on-site generation is self-consumed by the customer) rather than as a separate resource studied at its maximum nameplate operating capability.

Controllable electrification-related loads such as EV charging equipment can also utilize this approach for similar purposes. For instance, consider a customer electrifying their fleet vehicles by adding ten 300kW DC fast chargers. While the total nameplate equipment size is 3,000 kW, natural diversity and varying demand within charging cycles make it very unlikely that this new load will ever draw 3,000 kW at once. However, it still needs to be studied when applying for its capacity impact on the distribution system, so some assumed level of impact must be determined. The fleet customer or their project developer may have their own modeling or estimated coincident demand (e.g., 1,000kW maximum coincident demand), which may differ from the assumptions used by the utility to assess the capacity impact within the connection study (e.g., 2,000 kW maximum coincident demand). Where the utility's assumed demand impact is higher than the customer actually anticipates, limited import/export connections can allow for the utility study assumption to be safely reduced by using import/export limiting mechanisms to ensure the lower capacity impact is reasonable and maintained at the customer's site. Utilizing static limited import/export connections in this manner can reduce the likelihood of system upgrades or allow for faster connection without waiting for the construction of distribution system reinforcements.

Implementation Methods:

Power control systems (PCS) are perhaps the most direct method of implementing limited import/export connections. PCS technologies monitor power import and export at specific points and adjust the performance of specific resources to ensure that pre-set import or export limits are not violated. PCS can be used for site-level import/export limits as well as limits applied to a specific subset of on-site controllable loads or DER. Because of the nature of the technology, there can be a time lag between deviations in import/export amounts and PCS control actions to return the site to compliance. These "inadvertent exports" are very short in duration (generally on the order of a seconds), but may need to be considered in addition to the normal, steady-state import/export limit.



Example Residential PCS (EPRI)

On-site protective relaying can provide another option for implementing import or export limitations. Under this approach, rather than directly controlling resources to prevent violations of import or export limitations, the protective relaying equipment waits until a violation is detected and then trips the associated recloser or disconnecting means, de-energizing the affected equipment. Effectively, the relay serves as a backstop against the violation of the import/export limit condition, and it is not intended to trip during normal operations. Consequently, some other means of avoiding the import/export limit and associated relay tripping is necessary. Relaying may be used, for instance, in conjunction with power control systems to provide additional protection against PCS misoperation or intentional customer non-compliance. Relaying could also be used as an assurance mechanism for customer site design and maximum demand calculations, rather than using separate, more conservative utility demand assumptions. When considering using relaying for implementing limited import/export connections, the cost and operational impacts must be considered. For installations that would not otherwise require relay-controlled protective equipment, the additional cost and complexity can be unacceptably high from the customer perspective. For sites that would already require relay-controlled protective equipment (e.g., large DER with a dedicated on-site utility recloser) relaying may be more feasible for use in limited import/export connections.

Utility Process Impacts:

To enable static limited import/export connections, changes to utility study practices and process flows are necessary. The biggest change is shifting from equipment nameplate-based assessments and study assumptions to using import and export values for steady-state studies instead. Within

distribution power flow modeling software, this change can be effectively modelled and studied using existing tools. In addition, modifications may be needed to account for the impacts of inadvertent export, especially for system protection and fault response considerations (which deal with very short time scales on the order of cycles or seconds). Protection studies, to capture the actual behavior of the new resources during fault conditions, may still need to consider equipment nameplate values, rather than PCS-limited steady-state import or export limits.

Incorporating limited import/export connections into utility recordkeeping may also require some changes to existing tools, processes, and capabilities. Accurately capturing both the import/export limits and the nameplate information from the impacted equipment is critical to accurate modeling for utility planning and operations. Many existing utility systems of record (e.g., Geographic Information Systems or utility interconnection portals) or documentation processes may not be configured to capture both import/export limits and the individual load and DER components that make them up. Updating these systems and processes to enable full documentation is necessary for long-term model and study accuracy.

The other key focus area of utility focus is customer compliance with import or export restrictions. In particular, because PCS-based implementations rely on customer equipment utilities may be hesitant to rely on them as the sole means of preventing equipment overloads or negative reliability impacts. Fortunately, there are tools available that can mitigate this concern. For site-level import or export restrictions, AMI meter data (for smaller customers) or SCADA data (where available at larger customer sites) can provide visibility of import and export power values, which can be monitored for non-compliance using utility back-office data analytics capabilities or directly via SCADA alarms where available. For applications that already require an on-site recloser or other relay-based protective equipment, incorporating import or export limitations into the protection design can provide layered protection at minimal additional cost.

PCS capabilities have also evolved over time to provide additional safety mechanisms to ensure continued compliance and address utility non-compliance concerns. The UL 3141 PCS standard, for instance, allows for vendor password-protected access for modifying import and export limits, which prevents customers from modifying on-site limits (inadvertently or otherwise). PCS also include fail-safe design elements to prevent PCS equipment failure from violating import/export restrictions. Acceptance of PCS-based methods within the National Electric Code for conductor sizing (and, consequently, fire prevention) provides a compelling signal that the technology is mature enough to be used effectively for this purpose within the distribution connection processes.

Finally, it is recommended for utilities to publish specific technical standards and requirements for customers wishing to utilize limited import/export connections. This may include specific site requirements, technology performance requirements (i.e., for PCS operation), relevant standards and equipment certification, or other relevant items. Publishing the requirements allows customers to design their sites accordingly and procure any relevant equipment, minimizing process friction.

Impacts to Customers and Project Developers:

From the lens of the utility connection process, customers can primarily utilize limited import/export connections to reduce the impact to the utility system, which can reduce the time to connect or the cost to connect by avoiding utility system upgrades. For smaller customers, this may mean avoiding service transformer upgrades or improving the speed of progress through the DER connection screening process. For larger customers, limited import/export connections may avoid larger-cost upgrades by setting a demand factor less conservative than the utility-assumed

demand factor (reducing utility capacity impact) or by incorporating DER such as battery storage to reduce the overall demand impact.

Customers with flexible loads or with both load and DER may also wish to utilize techniques for limited import or export as part of their own site design to avoid or reduce the cost of upgrades to their on-site electrical facilities or to reduce their overall demand (and associated utility bill impacts from demand charges). Revisions to the National Electrical Code, where adopted, have allowed for mechanisms such as power control systems to be used for this purpose by controlling equipment (such as EV chargers, solar PV, or battery storage systems) to prevent overloads of customer electrical equipment.

Regulatory, Tariff, and Contract Considerations:

Modifications to existing connection rules and processes may be necessary to accommodate limited import/export connections, especially when involving DER, as DER connection processes are generally more directly specified and regulated. In particular, migrating from nameplate-based criteria to import and export-based criteria may be necessary in screening processes to reflect the actual performance of the resources. Since load connection processes are generally less rigorously defined and likely already incorporate demand factor assessments, there may be more latitude to incorporate limited import connections for loads without major process modifications.

Because flexible connections can be used to avoid utility upgrades, it is critical that the connection process allows for applications to be modified after the initial study is completed. That way, if system upgrades are triggered, import/export limits could be established to avoid the upgrade that would otherwise be necessary.

Because this type of connection requires ongoing compliance with specific import or export restrictions, it is important that the relevant operating limits and requirements are formally documented during the connection process. This may include modifying existing interconnection agreements or adding addendums to such agreements. Specific modifications will vary by state and utility and may differ for load and DER connections even within the same utility. Because existing agreements almost all already include language and actions related to customer non-compliance (in, for instance, utility Terms of Service documents), incorporating import/export limits into these documents can extend existing policies and practices to cover these connections.

Technology Considerations:

The key technology consideration for limited import/export connections is the PCS. Because the UL 3141 standard has not yet completed development, there may be some hesitancy to incorporate it into utility standards and operations. However, the UL 3141 standard builds on a strong foundation from the UL 1741 PCS Certification Requirements Decision (CRD), so there are already robust requirements in-place for equipment performance. Hardware certified as compliant with initial outlines of UL 3141 is also already available. Until the full standard is completed, utilities may wish to allow for certifications from either the UL 1741 PCS CRD or UL 3141.

While certified PCS are one of the primary mechanisms for implementing limited import/export connections, they are not the only option. Some customers may wish to utilize customized implementations via non-certified control equipment (using, for example, an SEL RTAC Real-Time Automation Controller) or through other operational means. Using a performance-based approach to design requirements and compliance (rather than solely certification-based) can enable a higher degree of customer design flexibility. For non-certified equipment, utilities may wish to establish

additional testing requirements or witness test provisions in order to ensure the successful operation of the control scheme and verify compliance with stated requirements.

Key Focus Areas:

When considering implementing limited import/export connections, designing specific approaches, technologies, and compliance assurance mechanisms for different sizes and types of customers is critical for success. Setting overly stringent requirements is likely to create additional customer costs and significantly deter utilization of limited import/export connections.

STATIC METHODS

Staggered Connections

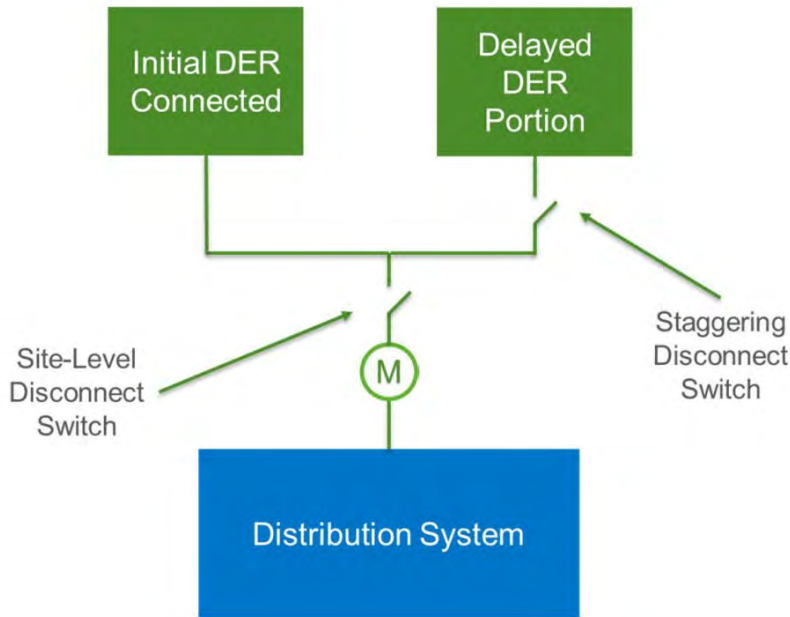
Staggered connections can be utilized where an applicant's full planned load or DER addition requires system upgrades by the utility in order to fully interconnect and operate. Using the staggered connection approach, an applicant could energize a portion of their planned new facilities or operate under temporary operating restrictions while system reinforcements are constructed to meet the full capacity needs of the applicant. For instance, if a 5 MW EV charging depot applies to connect in an area with 3 MW of existing distribution capacity, the depot can connect and operate up to 3 MW immediately (less any safety or operating margin), with the remaining 2 MW connected after the completion of the system upgrade needed to support its operation.

Staggered connections can also encompass the temporary use of other flexible connection methods such as limited import/export, operating schedules, or dynamic management to temporarily restrict their operations to fit within existing capacity while a system upgrade is constructed. Using this “bridge to wires” approach, staggered connections would transition to unrestricted connections or other flexible connection options on a permanent basis once the applicable system upgrade has been completed.

Using staggered connection methods can reduce the wait time for customers in areas where there is limited capacity available and long construction timelines for system reinforcements would delay customer additions or expansions.

Implementation Methods:

One option for implementing staggered connections is for customers to delay construction or energization of a portion of their planned facilities, energizing only that portion of the facility that is allowed prior to the completion of the grid upgrade. This approach is relatively straightforward to implement. Once the customer begins construction of the delayed portion of their facilities, it is important that they take steps to prevent such facilities from being inadvertently energized before the utility completes the upgrade because inadvertent violation of the temporary limit could result in damage to utility equipment. Leaving a visible air gap in the form of a lockable disconnect switch, an unconstructed span of conductors, or leaving a set of jumper wires uninstalled can prevent on-site personnel unfamiliar with the capacity limitation from inadvertently energizing the additional facilities.



Example Staggered Connection using a Lockable Disconnect Switch³⁰

Alternatively, customers can also implement staggered connections by utilizing other flexible connection methods such as limited import/export, operating schedules, or dynamic management on a temporary basis while system upgrades are constructed to support the full site build-out. This approach can allow the customer to construct their entire planned facilities up-front while still ensuring compliance with capacity limitations prior to the completion of the system upgrade. Once construction is completed, any temporary operating limits can be lifted or otherwise modified to enable the full planned site operation. Specific implementation details for this type of staggered connection will vary based on the method employed.

Utility Process Impacts

In order for customers to utilize staggered connections, some changes are necessary within the utility study process. First, whenever a system upgrade is moving forward in support of a connection request, the utility would need to identify how much capacity is available and what portion of the applicant's facilities can be constructed (or what temporary restrictions may need to be in place) prior to the completion of the system upgrade. This may require additional engineering labor within the study process to test various system sizes or operating restrictions for feasibility. In addition, allowing customers to connect facilities until the limiting criteria is reached would not leave any remaining capacity to connect even small new loads or absorb any unexpected load increase from temperature variations or year-to-year fluctuations. An appropriate safety margin will need to be determined to ensure that unexpected violations do not materialize while the system upgrade is being constructed.

In addition, the utility will need to add an additional layer of communication with the applicant to determine whether they wish to pursue a staggered connection and the type and magnitude of

30 From Ameren Illinois' [Flexible Interconnection and DER Orchestration Report](#)

temporary restrictions to be considered. To minimize the additional communication time and study labor, it may be optimal to offer staggered connections to an applicant if their application triggers the need for a system upgrade and they are still considering moving forward.

Utility recordkeeping and tracking of partial energizations or temporary operating restrictions is necessary and may require modifications to existing practices. For most utilities, recordkeeping processes are designed to map new connections and update systems of record such as GIS once the facility has been completed and energized. Failure to update systems of record after the initial partial energization may cause operational and planning models to not have visibility of the facility. On the other hand, erroneously mapping the full system build-out when only a portion has been energized may cause operational and planning models to overestimate the impact of the facility and identify problems that are not actually present. Incorporating staggered connections effectively into systems of record should be part of change management activities to enable staggered connections.

From an operations and compliance perspective, compliance mechanisms, where needed, can help identify violations or otherwise prevent the customer from energizing additional facilities too early or otherwise not complying with their temporary restrictions. Non-compliance may be identified using available meter data (where AMI data is available) or SCADA data where telemetry is available for larger systems. A visible disconnect (discussed previously) may be used to prevent inadvertent non-compliance. Some utilities may wish to lock this disconnect with their lock for additional protection against unplanned energization. Where other flexible connection approaches such as limited import/export or schedules are used as temporary restrictions, the appropriate technical standards and compliance mechanisms would apply to such systems. Since staggered connections involve two separate energizations, utilities may also wish to perform two separate on-site witness tests (one for the initial energization and one for the full site energization) to ensure on-site facilities meeting temporary and permanent design and operational requirements.

Impacts to Customers and Project Developers

Staggered connections would primarily be utilized where system upgrade costs themselves are not a blocker, but construction timelines to support new growth are long. Large load customers (or large DER, where applicable), which are mostly likely to trigger specific system upgrades in response to their planned facilities, would be most likely to utilize staggered connections to expedite operation of the facilities. For instance, fleet electrification service providers, many of which are smaller firms or in the early stages of growth, may benefit from accelerating a portion of the ultimate facility to demonstrate progress, ensure contract stability, and build investor confidence by providing a bridge to full energization.

Temporary operating restrictions may also be utilized, as part of specific programs, to enable connections of smaller systems in constrained areas. Southern California Edison's Automated Load Control Management System (LCMS) pilot³¹ is one such example. Under this program, customers can install power control systems which limit power import to a specified value (either specified in advance or updated dynamically based on distribution system conditions) while waiting for additional capacity to become available.

31 DOE Flexible DER and EV Connections (July 2024) Pg. 11-13: <https://www.energy.gov/sites/default/files/2024-08/Flexible%20DER%20%20EV%20Connections%20July%202024.pdf>

Regulatory, Contract, and Tariff Considerations

Temporary limitations intended to facilitate staggered connections should be enshrined within the associated load or DER interconnection agreement to ensure clarity for both parties and ensure full application of relevant terms and conditions such as liability and non-performance resolution. Additional exhibits, addendums, or modifications to agreements or terms of service may be necessary if existing language or structures support the inclusion of temporary restrictions.

In order to implement staggered connections, existing interconnection rules and process requirements (particularly for DER) may need to be modified to allow for applications to be modified during the interconnection process. For instance, many state DER interconnection rules prevent applicants from modifying site facilities during the study process by requiring the DER to re-submit a new application, forfeiting their queue position. Modifying rules and processes to allow for some design changes (such as those that do not increase import or export capacity) may be necessary.

Implementation of staggered connections may also create ambiguity within processes or programs that consider the time of connection. For load additions, for example, applicants may receive credit towards interconnection costs based on their anticipated additional revenue contribution to the utility over a certain period of years. If that period starts upon the full energization, it may not include the portion energized during the construction of the system upgrade. If that period starts when the initial portion is energized, the result would tend to underestimate the actual anticipated revenue if the customer could energize their entire system as applied for. Consequently, it may be beneficial to include potential revenue during the temporary restriction as well as the full time period after the temporary restrictions are lifted.

Technology Considerations:

Utility visibility of site conditions and performance for customers utilizing staggered connections may vary by the size of the customer facilities and the available utility equipment. AMI meter data can provide a relatively high degree of visibility without additional costs, especially for site-level operating restrictions, but may be more challenging to use for real-time monitoring due to time lags in AMI data collection. Utilities may also install on-site SCADA telemetry to large customer meters or through site reclosers for larger DER sites to ensure the availability of real-time monitoring. For load or DER additions at existing customer locations with other equipment already operating, site-level meter or SCADA telemetry may not provide full visibility of the operation of new load or DER. Separate communications pathways may be desirable for such facilities in some cases, especially if temporary operating restrictions are applied to the collection of new load or DER additions directly, rather than at the customer site level.

Because staggered connections can temporarily utilize other flexible connection methods such as limited import/export, operating schedules, or dynamic management, the specific technology considerations for those methods (explored within the relevant sections of this Appendix) will apply.

Key Focus Areas:

The primary utility risk when considering implementing staggered connections is customer non-compliance, which can be mitigated using a variety of options (described previously) with varying impacts to the customer. At the same time, overly strict compliance mechanisms may negatively impact customer costs, process, or the overall experience when attempting to utilize staggered

connections. Structurally, the risk of customers energizing more load or DER than approved on their application already exists within current utility processes. Consequently, comparing proposed mitigation measures within staggered connection approaches to risks and compliance measures already present within existing connection processes can help ensure that any additional compliance mechanisms implemented to support staggered connections are reasonable.

From the customer perspective, delays to utility system upgrade construction and, subsequently, the customer's full site energization, still present a risk. However, utility construction delays are relatively less impactful for staggered connections when compared to traditional "all or nothing" connections because at least a portion of the site is able to operate during the additional delay period. Still, it may be worthwhile to solidify proposed utility timelines and understand how construction delays are handled within existing processes.

SCHEDULED CONNECTIONS

Scheduled connections build off the foundation provided by limited import/export connections, expanding from a single limiting value to multiple limits that vary with time. Consequently, implementation decision-making for scheduled connections will require considering additional needs, uses, and benefits from adding a time-varying schedule for import or export limits. The simplest operating schedules may be just two points (i.e., peak and off-peak limits), while more complex schedules expand to seasonal, monthly, and time-of-day variations up to 288 points (one 24-hour day per month) or more.

Moving from single-value, worst-case limitations to more granular schedule-based constraints allows for a higher degree of customer operating freedom while still avoiding utility constraints (and any associated system reinforcements). In addition, because static schedule-based connections can be implemented without the need for ongoing communications or complex utility control systems (i.e., DER Management Systems), they have significant potential to improve customer outcomes on a shorter implementation timeline.

Implementation Methods:

As with limited import/export connections, schedule-based connections can also utilize power control systems (PCS) with schedule capabilities. The UL 3141 PCS standard includes verification of functionality for different levels of schedule granularity up to 288 values, enabling a wide range of potential schedules. Custom implementations using other hardware or control approaches may also be viable options, especially for customers with more sophisticated operations such as those participating in bulk power market services.

Utility Process Impacts

As a flexible connection option, an operating schedule with corresponding import/export limits can be used as a mitigation to avoid a system upgrade during the connection study process. Customized schedules may be developed by the utility, after a costly system modification has been identified, by identifying the highest degree of available operation in each time interval. Because the utility can directly determine the maximum allowable operating limit, they can offer an accurate schedule based on available capacity. However, the timing and magnitude of that available capacity may not be acceptable to the customer if it has a significant negative impact on their operation.

Perhaps the most challenging aspect of schedule-based connections, from the utility perspective,

is choosing the time granularity of the operating limit schedule and determining the import/export limits associated with each time period within the interconnection study process. Traditional planning and study processes focus on the worst case (i.e., the highest peak load hour for load additions), which can be used to set single-point import/export limits. To add additional schedule intervals, it is necessary to establish the “worst case” within each time interval and then perform a similar study to assess the impact of the new customer facilities.

For instance, to develop a two-point seasonal “peak” and “off-peak” schedule, the worst case during the “peak” time interval (i.e., summer) and the “off-peak” time interval (i.e., the rest of the year) must be established and studied separately, with a less restrictive operating limit during the “off-peak” period. Similarly, a two-point time-based “peak” and “off-peak” schedule may place the peak period during certain hours (i.e., 2 PM to 8 PM) and generate corresponding operational limits during the associated time windows. Expanding the schedule by incorporating additional time points requires identifying the most constrained time point within each time interval and repeating the study process to identify the appropriate import and export limits during that period. In order for more complex time-varying schedules (i.e., 288-point hourly by month) to be practical to produce, time-series planning capabilities such as hourly interval load and generation data, time-series power flow modeling, and study automation tools are likely to be necessary.

It is also possible for applicant customers to propose their own operating schedule based on their actual anticipated operational needs, either as part of the initial connection application or as a response to attempt to avoid the need for grid upgrades. Empowering customers to propose their own schedules has several benefits. First, rather than generating operating limits, the utility only has to evaluate whether there are study criteria violations requiring mitigation with each time interval, which is easier to execute directly within existing planning tools. In addition, customer-proposed schedules reduce the amount of capacity and the number of hours in which capacity is unnecessarily reserved when compared to utility-proposed schedules, which can negatively impact available capacity for future applicants. This is because the utility attempts to identify the maximum allowable operation within each interval, which may be higher in many intervals than the customer would actually need or utilize.

Ideally, customers proposing their own operating schedules would also have information about the distribution infrastructure and the relevant capacity limitations at their proposed site. In practice, access to grid constraint data is often too limited for this to be practical today. Many utilities do not publish hosting capacity maps for new loads, and for many of those that do, the information is too simplistic or too unreliable to be used in developing a detailed, time-varying schedule. There is also an incentive issue - if the utility is already performing a schedule-based study to identify an operating schedule that can work for the site, the customer has no reason to develop or propose a schedule themselves (especially since it is likely to be more constraining than the resulting utility-provided schedule).

For utilities, effectively navigating the schedule design is critical to efficient use of schedule-based connections. Finding middle ground by engaging customers on their operational needs and schedule preferences may provide a more efficient path to implementation than either the utility or the customer proposing a schedule independently.

In addition to applicant-specific schedules, utilities can develop and offer schedule-based connections to groups of new applicants connecting a specific technology. For instance, in capacity-constraints areas, a utility study may identify the total size of residential EV charging that can connect under a particular charging schedule without exacerbating capacity constraints, then

offer that schedule to new applicants up to that total size. This could also be performed for DER such as solar PV by determining, for example, the total amount of solar PV that could be connected and experience less than a certain percentage of curtailment on a substation with existing hosting capacity limits.

Once a schedule is determined and the application is completed, record retention of the operating limit schedule and access for impacted utility stakeholders is critical. Because the operating schedule defines the performance of the customer's resources, recordkeeping is necessary for modeling for distribution planning studies, interconnection studies, operational models, and compliance monitoring activities.

When it comes to verifying schedule compliance for schedule-based connections, there are additional challenges that reduce the effectiveness of methods used within static fixed limited import/export connections. For instance, protective relays are generally programmed with trip settings that do not vary with time of day or season. This makes relaying a poor option for ensuring schedule compliance. Using live or historical measurements (from, for instance, SCADA), requires more sophisticated methods, as historical data must be compared by schedule time block rather than against a fixed limit. In addition, operational monitoring via SCADA is also less straightforward for the same reason, as SCADA systems may not have the ability to adjust alarm thresholds based on a varying schedule. These challenges put even more emphasis on PCS equipment to implement and adhere to the operating schedule.

Impacts to Customers and Project Developers

A customer's interest in scheduled connections and willingness to participate are strongly tied to the impact of the scheduled limits on their operational plans. Large customers with controllable loads (e.g., fleets) are more likely to have strict operational requirements, and would thus be highly dependent on the specific timing and magnitude of operational limits. Where the scheduled limits are not significantly impactful to their operations, such customers may be interested in scheduled connections as a means of avoiding interconnection costs or avoiding interconnection delays. Smaller customers are less likely to utilize scheduled connections unless there are specific utility offerings to allow for connections that would otherwise have to wait for a system upgrade.

Regulatory, Contract, and Tariff Considerations

Similar to limited import/export connections, scheduled connections may also require modifications to existing connection processes and documentation in order for scheduled connections to be utilized. In addition, depending on the granularity of the operating schedule, the studies used to develop operating schedules can be significantly more complex than traditional peak load snapshot-based studies. For load customers, who generally do not pay application fees for new connections or load additions, the impact of additional study labor may need to be considered, as it may impact utility staffing.

Technology Considerations

The UL 3141 Power Control System standard is a key enabling technology for widespread adoption of scheduled connections. The standard includes provisions for schedules for specific months and hours, up to a 288-point schedule covering 24-hour time periods for each month. Other more custom implementations may also be viable technical solutions, but may require additional verification testing or ongoing compliance measures.

Key Focus Areas

The primary focus area for adopting scheduled connections is determining the granularity of the schedule. Highly granular, time-varying schedules (e.g., 288-point) provide the highest degree of available capacity, but they come with significant challenges. First, the cost and complexity of developing such schedules within the connection process is significant, particularly for utilities that have not made meaningful progress towards time-series planning capabilities to date. Development of reliable time-series load and generation data and corresponding tools within the modeling and study process are key enablers for scaling schedule-based connection offerings with high schedule granularity. For initial offerings, relatively less complex schedules (e.g., peak/offpeak or daytime/non-daytime) are much more practical to develop with existing data and snapshot-based study capabilities. While these less complex schedules leave some potential operational capacity on the table, the additional capacity enabled by moving from a single import/export limit to even a relatively basic schedule is significant and can appreciably improve the integration of new connections and the total energy throughput of the distribution system.

In addition, month-to-month and hour-by-hour variations from recent historical data may not actually be representative of anticipated conditions in the future. For instance, year-to-year summer peaks may occur in June, July, or August, depending on weather and temperature variations. Directly developing monthly schedule limitations based on a single previous year may not provide appropriate schedule limits for the other Summer months in future years. Consequently, segmenting schedules into highly granular blocks may provide a false sense of precision. Considering seasonal limitations, rather than monthly limits, may be a more appropriate means of capturing the potential for such variations. The same effect can occur with hourly variations. Providing schedules for blocks of hours, rather than individual hours, can help account for such variations.

Because the operating schedules used in this method are much more granular than typical single-point limits, future changes on the circuit may allow for operating schedules to be relaxed in the future. For instance, if a feeder experiences significant solar adoption, loads with schedule-based connections may be able to operate more extensively during daylight hours than their initial operating schedule allows. Incorporating a mechanism to expand the customer's allowable operating schedule may allow for improved utilization by the customer (and, subsequently, increased grid utilization).

In contrast, revisiting customer operational schedules to further restrict operation is much less straightforward. Once the schedule is enshrined within the agreement, the customer's expectation (similar to existing connection applications) is that the capacity described by that schedule will be available in perpetuity. Consequently, reductions in available scheduled capacity may have significant negative business impacts for the customer. Permanent modifications that further restrict the operating schedule should be approved by the customer.

DYNAMICALLY MANAGED CONNECTIONS & DYNAMIC OPERATING ENVELOPES

In contrast to the “static” methods described previously, which are generally set at the time of grid connection, dynamic limits can be adjusted operationally, whether in real-time or day(s) ahead. Within this Appendix, dynamically managed connections will refer to the use of real-time commands to set resource performance or maximum import or export values. Dynamic Operating Envelopes, rather than single-point real-time values, will refer to the use of a schedule for resource performance or import/export limits over a relatively short time, operational time horizon such as a

rolling 24-hour ahead schedule.

When considering dynamic connections for flexible loads, it is critical to remember that flexible loads are more than just loads — they are equipment, intended to perform a task as part of customer home or business operations. As a result, feasibility for flexible connections is fundamentally tied to whether dynamic management can meet the customer’s operational needs. This is a stark contrast to most DER implementations, which are most frequently evaluating the financial viability rather than specific operational needs. As a result, examining the suitability of dynamic connections starts with understanding when customers have flexibility and when they do not. In addition, uncertainty around the timing and magnitude of curtailment may negatively impact customer perception of dynamic connections due to the potential for curtailment beyond acceptable levels for their operations. Utilizing dynamically managed connections in conjunction with static schedules can help solve this challenge and build customer confidence. When used in combination, a static pre-set schedule can define minimum expected available capacity, giving the customer operational certainty, with dynamic methods used to increase the available capacity above the minimum when additional capacity is available (due to conservative assumptions within the static schedule development process). This can help relieve customer concerns related to unexpected curtailment.

Currently, many U.S.-based pilots for dynamically managed connections involve utility-directed communications, where commands are pushed from utility control systems such as DERMS to customer load, DER, or site controllers over utility-controlled communications channels. Australia’s Dynamic Operating Envelopes, in contrast, are implemented by having customer endpoint devices pull their operating schedule on a regular basis from a utility server, which can be performed over public internet infrastructure. It is important to recognize that, conceptually, these are two approaches to achieving the same dynamic management objectives. Differences between existing U.S.-based and Australian approaches are thus differences in architecture and communications chosen for implementation, not differences in end goals.

One of the key design decisions when developing dynamic flexible connection offerings is how capacity access will be allocated to participants. The proportional (or pro-rata) approach allocates capacity equally across multiple participants based on the relative size of each installation, regardless of the order in which the resources are interconnected to the distribution system. Conversely, the Last In, First Out (LIFO) method gives capacity priority to earlier connectors, curtailing first those resources who connected most recently. Other methods or prioritization such as economic efficiency or greenhouse gas emissions may be considered, but have not been primary drivers of existing pilot deployments. Combinations of methods may also be considered, such as a tranche of pro-rata connections up to a predetermined curtailment percentage, with LIFO utilized for any subsequent connectors.

Implementation Methods

To implement dynamic flexible connection, it is first necessary for utilities to be able to identify violations of operational constraints and develop optimized dispatches. For dynamic operating envelopes, this requires the additional step of developing future-looking forecasts of constraints, with the optimization developing operating limits within each time interval. This may be achieved via power flow and optimization capabilities within utility ADMS or DERMS systems, or may be developed and deployed separately. Southern Australia’s Dynamic Operating Envelopes, for instance, utilizes separate statistical modeling and forecasting tools without a DERMS to develop the operating envelopes for each participant DER.

Once an operating limit or schedule is developed, it must be communicated to the impacted customer facilities. There are two primary approaches to achieve this communication. Within the U.S., the most common implementation is a “utility push” approach, where utility-directed communications are sent over dedicated communication channels (which may also be utility owned). For example, a DERMS-based approach may leverage utility cellular or fiber communications to allow for the utility to send export limit commands to participant sites and poll the DER for relevant operational data.

Southern Australia’s deployment of Dynamic Operating Envelopes, in contrast, uses an “endpoint pull” approach where the operating schedule is retrieved by the customer’s DER from a central utility server. This is achieved using a standardized implementation of IEEE 2030.5 infrastructure, allowing customer DER (directly or indirectly via on-site gateway or vendor cloud infrastructure) to securely connect and retrieve their operating schedule over public internet infrastructure, rather than separate dedicated communications channels. If communications is disrupted, customer DER default back to a pre-set maximum safe export level, which incentivizes customers to maintain internet connectivity and protects against potential negative impacts of lost connections or non-compliance.

Both communications architectures are capable of implementing dynamically managed connections and dynamic operating envelopes. The “endpoint pull” approach is well suited to South Australia’s needs, as they communicate schedules to a very large population of small customer solar resources, which makes public internet critical due to its cost-effectiveness and scalability. For larger systems, conventional “utility push” approaches with direct communication are relatively less impacted by the additional costs and are generally preferred by utilities because of the response time and direct nature of the control. Still, there are potential advantages to “endpoint pull” for large systems that merit consideration. Placing the burden of communications uptime on the customer, rather than the utility, can allow for more customer choices, balancing options such as lower costs via single-source public internet against higher costs for redundant on-site providers or dedicated utility-based communications options.

To enable communications with on-site customer resources, there are a few design options to consider. For 2030.5 communications, some customer equipment has the capability to directly interact with utility communications infrastructure. In other cases, manufacturers may use more centralized infrastructure to interact with the utility while maintaining separate communications to on-site customer resources (via, for instance, vendor cloud infrastructure). Gateway devices can also be deployed at the customer site to facilitate communications either via 2030.5 or more directly with utility communications infrastructure. Ultimately, both utility communications architecture and customer site equipment design will inform which approaches are viable for individual sites.

Utility Process Impacts

The utility study process is the primary area where significant modifications are anticipated in order to implement flexible connection offerings. When offered as a standalone connection type, the study process can primarily focus on the timing and magnitude of potential import limits for flexible loads. This analysis requires time-series data and modeling capabilities, rather than single point peak snapshot analysis. During the connection process, curtailment results can be shared with the customer for them to determine whether the use of a dynamic connection can still allow for their operational needs to be met. When offered in conjunction with static schedule-based connections, there is less impact to the study process because the dynamic element provides only additional capacity on top of the existing schedule.

Utility operations will also be impacted by the utilization of dynamically managed connections and dynamic operating envelopes. Because these connection types rely on operational infrastructure, utility operations and dispatch personnel should be prepared to monitor and troubleshoot the performance of the automated control systems that execute dynamic management.

Impacts to Customers and Project Developers

Larger load customers can utilize dynamically managed connections as a means of avoiding otherwise necessary interconnections by reducing the impact during peak load times. They may also utilize dynamic connections in conjunction with static schedules as a way to maximize available capacity. Where these options are offered, customers should be prepared to evaluate whether they are feasible and beneficial for their needs. Due to operational needs related to the underlying equipment, it is anticipated that dynamically managed connections (as a tool for avoiding interconnection costs or triggering upgrades) will be less likely to be adopted relative to similar approaches when used for DER such as solar PV or battery energy storage.

Technology Considerations

The technology stack necessary to implement dynamic connections has been demonstrated through pilot projects and scale deployments for DER, but their utilization for flexible loads is still relatively nascent. Adapting and expanding the necessary foundational capabilities to loads is key to continued progress towards scale implementation.

Establishing appropriate communications with flexible loads to enable dynamic flexible connections is a key enabler. IEEE 2030.5 is one potential option for scaling communications, providing multiple options for communication channels and customer site design. In addition, OpenADR 3.0 provides another means of establishing communication for dynamically managed connections. Historically, OpenADR has been used primarily for demand response implementation, but updates within version 3.0 allow for management of import and export limit functions remotely as a means of dynamic management. Utilities with existing OpenADR deployments for demand response may find it faster or more efficient to integrate OpenADR with their modeling and optimization tools to enable dynamic capabilities.

Key Focus Areas

When considering implementation of dynamically managed flexible connections, the communications and control architecture are critical design decisions, as they have important consequences for both the cost and feasibility of dynamic management. “Endpoint pull” approaches, such as South Australia’s Dynamic Operating Envelope implementation, have distinct advantages to both scalability and customer choice, but may require a different architecture for operational systems than utilities are used to. Consideration should also be given to expanding the use of existing or planned deployments of OpenADR as a communications channel, particularly for dynamic management of flexible loads.

Dynamic flexible connection offerings need to account for the operational needs of potential participant customers. For instance, removal of all import capacity during any period is unlikely to be acceptable to businesses that still need to operate during such periods. Pairing dynamic connections with more defined offerings such as static schedules can help alleviate some of these concerns.

Conceptually, allocating capacity using strategies such as pro-rata is straightforward. In practice,

it is significantly more complicated to manage capacity constraints in real-time when multiple customers are involved. Natural variations in customer load profiles for two different customers are unlikely to align perfectly. In fact, depending on the type of customer and their operational needs, they may not align at all. Equal capacity allocation, in such cases, may lead to effectively no import reduction for one customer but extensive reduction for another. In addition, pro-rata methods for DER are generally based on total system nameplate capability, which may not be a viable comparison for loads with different types of equipment. These potential challenges should be considered when developing dynamic flexible connection options.

FLEXIBLE CONNECTION METHODS – TECHNICAL SUMMARIES

METHOD	DESCRIPTION	TYPICAL TECHNOLOGIES	IMPLEMENTATION NOTES
Static Limited Import/Export	Limits a customer's import/export power to a fixed value at all times.	PCS (UL 1741 CRD), Load Control Relays	Simplest to implement; suitable for DER + load combinations or reducing panel/transformer size.
Static Schedule-Based	Uses time-based import/export limits (e.g., peak/off-peak, seasonal, monthly).	PCS (UL 3141), Programmable Logic Controllers	Requires coordination to align utility constraints with customer schedules; useful for seasonal load patterns.
Dynamically Managed	Uses utility-monitored real-time or day-ahead constraints to actively manage import/export capacity.	DERMS, IEEE 2030.5 (CSIP-AUS), SCADA, Smart Chargers	Higher implementation complexity; ideal for fleets or large flexible sites with real-time visibility.

RELEVANT STANDARDS AND INDUSTRY REFERENCES

STANDARD / DOCUMENT	RELEVANCE	LINK / REFERENCE
UL 1741 CRD	Certification standard for PCS devices (e.g., non-export)	
UL 3141 (in progress)	Future standard covering programmable schedule control	In development; early compliance testing underway
IEEE 2030.5 / CSIP-AUS	Protocol for publishing schedules (used in Australia DOEs)	
BATRIES Toolkit (IREC)	Framework for storage interconnection	
PG&E Flex Connect	Real-world temporary operating restriction implementation	
Avangrid Flex IX Pilot	Dynamic interconnection pilot in NY	Avangrid Filing
New Mexico Interconnection Rules (2023)	Example of rule language enabling non-export connections	

APPENDIX B

QUESTIONS FOR IMPLEMENTATION

QUESTIONS FOR UTILITIES:

1. Integration

The first step is to identify the key utility stakeholders responsible for implementing flexible connection and to establish clear lines of communication and accountability to ensure effective integration into planning and operations.

Section 1: Roles and Responsibilities

1. Who needs to be informed, accountable, responsible, and consulted (RACI) for implementing flexible connection?
2. What does your internal change management structure look like? Who leads flexible connection implementation?
3. What governance structure (e.g., centralized or cross-functional) would best support implementation?
4. What internal processes (e.g., notification for flexible adjustments) need to be created or streamlined?
5. Has your planning team identified initial locations suitable for a flexible connection pilot?

Section 2: Customer Process Impacts

1. What changes are required in the existing interconnection or load service process to support flexible connection?
2. What steps or information should remain unchanged for consistency?
3. How can the flexible connection process be made transparent and user-friendly?

Section 3: Readiness and Constraints

1. What organizational and technical conditions must be met to launch flexible connections at scale?
2. What tools (e.g., DERMS, portals) can be leveraged today? What are the major gaps?
3. What data workflows or automation would need to be developed to support profile generation and agreement management?
4. What kind of pilot could test flexible connection viability (e.g., profile creation, DERMS integration)?
5. What customer education and portal enhancements are needed for success?

2. Existing Assets and Queues

As utilities prepare for flexible connection rollout, they must determine whether the program applies to existing vs. new service requests, and which locations should be prioritized. Key decisions include load queue management practices, siting strategy, and adapting the program over time.

Section 1: Load Queue Management & Policy Design

1. How should load queues be managed, considering the obligation to serve and lack of historical public-facing queue structures?
2. How should flexible connection eligibility be determined for existing vs. new requests?
3. Should flexible connection be offered only for new requests or retroactively applied to those already in queue?
4. What site-level characteristics (e.g., capacity, profile shape) determine flexible connection suitability?
5. Could flexible connection be structured in tiers (e.g., no upgrade, flexible connection, full upgrade)?
6. Should static flexible connection limits be used temporarily until upgrades are complete?
7. Should project viability or likelihood of completion factor into queue prioritization?
8. How can the utility revisit and revise flexible connection commitments as grid conditions evolve?

Section 2: Prioritization of Locations

1. Should specific feeders/substations be prioritized for early flexible connection rollout?
2. What data or conditions (e.g., forecasted congestion, electrification goals) should guide this prioritization?
3. Should available hosting capacity (for load or DER) define where flexible connection is allowed or promoted?
4. Could location-based rules create equity or transparency concerns?
5. Should utilities publish eligibility maps, and how would these differ from standard hosting capacity maps?
6. Should flexible connection schedules be pre-designed for certain common customer profiles (e.g., fast chargers)?
7. How should load forecasts and upgrade costs influence locational rollout?
8. Can utilities use demand/supply modeling to allocate limited flexible connection capacity effectively?

3. Publish Technical Standards

Customers need clear, actionable guidance on how to participate in flexible connection. Utilities must publish technical standards and supporting data that are accessible, usable, and aligned with internal planning tools and processes.

Section 1: Data Requirements & Publication

1. What technical data should be made available to customers (e.g., min/max loads, headroom, seasonal limits)?

2. How frequently should data be updated? What level of granularity is useful?
3. What should a standard technical data page or portal include?
4. What internal tools or models are needed to support accurate and automated profile generation?
5. Should different load sizes be subject to different technical requirements?
6. How can data publication balance transparency with security/privacy concerns?

Section 2: Readiness for Flexible Approaches

1. What are the minimum technical and operational requirements to implement scheduled and dynamic flexible connection connections?
2. Can your AMI and DERMS infrastructure support enforcement and monitoring?
3. What commissioning processes (e.g., RTAC review) need to be included?
4. How should utility readiness account for differences in real-time vs. day-ahead control maturity?

Section 3: Utility Constraints & Considerations

1. What are your key technical and operational constraints when evaluating flexible connection proposals?
2. Should customers be required to submit modeled profiles instead of nameplate capacity?
3. How are system constraints prioritized for flexible connection rollout?
4. Should flexible connection be framed as a bridge-to-upgrades approach or a long-term flexibility strategy?
5. What policies or tariffs are needed to enable long-term cost recovery or incentivize customer flexibility?

4. Share Data and Methods

Sharing relevant, actionable, and periodically updated data helps customers make informed siting and scheduling decisions. When detailed system data cannot be provided, transparency around methodologies and engagement processes builds trust and encourages participation in flexible interconnection.

Section 1: Data Availability & Frequency

1. What system data (e.g., headroom, station limits) can be shared with customers?
2. How frequently can these datasets be updated?
3. What level of temporal and geographic granularity is practical to publish?
4. What role can AMI data play in deferring upgrades or informing flexible capacity?
5. How can privacy concerns be addressed when sharing location-specific grid data?

Section 2: Methodology & Governance

1. Who should define and maintain the methodology for assessing and publishing capacity (e.g., engineers, planners, regulators)?
2. How can you ensure consistency and fairness across circuits and customer types?
3. What are the key assumptions behind capacity values: Is load shape controlled, forecasted, or fixed?

4. Should flexible connection be initiated by customer application or utility invitation? How does this impact transparency?
5. What forecasting or planning tools are needed to model electrification-driven growth?

Section 3: Enabling Customer Participation

1. What specific information must customers provide when submitting a proposed schedule?
2. What platforms or interfaces should be developed to guide customer scheduling decisions (e.g., APIs, portals)?
3. How can the review process be structured to be collaborative and repeatable, not just transactional?
4. How should flexible connection data and review tools be aligned with interconnection and customer service processes?

5. Define Process Changes

Grid conditions are dynamic, feeder capacity and constraints can shift over time due to generation/load variability, infrastructure upgrades, or system events. Both utilities and customers must understand how these changes impact existing flexible connection schedules and agreements, and agree on mechanisms for adjusting commitments fairly and transparently.

Section 1: Managing Change Over Time

1. How frequently should flexible connection capacity assumptions be updated (e.g., quarterly, seasonal)?
2. How can we align flexible connection profiles with evolving hosting capacity results?
3. Should buffering assumptions (e.g., planning margins) be applied to avoid overcommitting capacity?
4. How should change management differ for static vs. dynamic flexible connection agreements?
5. What is the best method to communicate feeder or substation capacity changes to impacted customers?

Section 2 : Schedule Adjustments & Flexibility

1. What process should we follow to review and approve schedule changes after activation?
2. Should we define standard levels of flexibility (e.g., fixed, adjustable, real-time)?
3. Should customers with more flexibility receive priority access or discounted costs?
4. Can we integrate flexible connection schedules with demand-side management programs (e.g., DR, storage)?
5. How should utilities define and enforce minimum firm capacity?

Section 3: Customer Agreements & Accountability

1. Should flexible connection agreements be structured as tariffs, special contracts, or interconnection attachments?
2. What language is needed to define utility-initiated schedule changes and dispute resolution?
3. How do we determine which customers are eligible for flexible connection (e.g., based on telemetry, reliability, type)?

4. What enforcement or performance monitoring should be included in the agreement?

QUESTIONS FOR CUSTOMERS:

1. Integration

The first step is to identify the key utility stakeholders responsible for implementing flexible connection and to establish clear lines of communication and accountability to ensure effective integration into planning and operations.

Section 1: Roles and Responsibilities

1. What governance or communication model would help you interact with the utility most effectively?
2. What internal contact or representative from your side should coordinate on flexible connection?

Section 2: Customer Process Impacts

1. What changes will you need to make in operations to participate in flexible connection (e.g., scheduling tools)?
2. What additional information, support, or approvals will you need to provide a schedule?
3. How early should you be involved in the flexible connection process (e.g., EV fleet planning)?

Section 3: Readiness and Constraints

1. What capabilities do you currently have (e.g., metering, forecasting) to support flexible connection participation?
2. What are your biggest constraints to participation, technical, staffing, financial, or process?
3. What digital tools or portals would help you better manage load growth without costly upgrades?

2. Existing Assets and Queues

As utilities prepare for flexible connection rollout, they must determine whether the program applies to existing vs. new service requests, and which locations should be prioritized. Key decisions include load queue management practices, siting strategy, and adapting the program over time.

Section 1: Load Queue Management & Policy Design

1. What would make flexible connections appealing to your organization (e.g., lower cost, faster connection)?
2. If offered a static limit initially, would your organization still proceed while awaiting upgrades?
3. How do you view your project's likelihood of moving forward when applying for flexible service?

Section 2: Prioritization of Locations

1. How would location-specific rules impact your siting decisions for new load (e.g., fleets, chargers)?

2. What information (maps, capacity profiles) would help you decide where to connect?
3. If your location is unconstrained, would you still participate in a Flex program?
4. Would standardized schedules for your use case simplify the application process?
5. How would access to upgrade costs or forecasts influence your siting decisions?

3. Publish Technical Standards

Customers need clear, actionable guidance on how to participate in flexible connection. Utilities must publish technical standards and supporting data that are accessible, usable, and aligned with internal planning tools and processes.

Section 1: Data Requirements & Publication

1. What data would help you determine if a site is eligible or suitable for flexible connection?
2. How frequently would you need updated system data to support planning?
3. What format (e.g., maps, dashboards, downloadable profiles) is most useful for data access?

Section 2: Readiness for Flexible Approaches

1. What technical capabilities do you anticipate already having (e.g., metering, load forecasting)?
2. How prepared are you to meet operational requirements for flexible connection (e.g., dynamic limits)?

Section 3: Utility Constraints & Considerations

1. Are you able to submit modeled load shapes to inform flexibility assessment? What level of granularity can you provide?
2. What are your expectations around minimum guaranteed capacity?
3. Would you support differentiated tariffs based on your flexibility level or willingness to accept risk?

4. Share Data and Methods

Sharing relevant, actionable, and periodically updated data helps customers make informed siting and scheduling decisions. When detailed system data cannot be provided, transparency around methodologies and engagement processes builds trust and encourages participation in flexible interconnection.

Section 1: Data Availability & Frequency

1. What grid data would help you decide where and when to propose load (e.g., feeder headroom)?
2. How frequently do you need this information updated to plan accurately?
3. Would you be comfortable accessing this data through public maps or portals?
4. Would seasonal or approximate capacity data still be useful to you?

Section 2: Methodology & Governance

1. Do you expect the utility to lead or invite flexible connection participation, or should you apply?

2. What definitions or assumptions about capacity would need to be clarified for you to trust the data?
3. What concerns do you have around fairness, transparency, or consistency in how capacity is calculated?

Section 3: Enabling Customer Participation

1. What information or guidance would help you propose a flexible schedule?
2. Would you want support from vendors or third parties to interpret capacity data or build schedules?
3. Should flexible connection be offered consistently to all customer types across the service area?
4. What tools or processes would make participation easy and low-risk from your side?

5. Define Process Changes

Grid conditions are dynamic, feeder capacity and constraints can shift over time due to generation/load variability, infrastructure upgrades, or system events. Both utilities and customers must understand how these changes impact existing flexible connection schedules and agreements, and agree on mechanisms for adjusting commitments fairly and transparently.

Section 1: Managing Change Over Time

1. How often should customers expect changes to their flexible connection schedule or profile?
2. What kind of notice or lead time is needed when system capacity updates affect operations?
3. Should flexible connection profiles account for safety margins to reduce variability in allocations?
4. How do you interpret utility data about grid constraints, and what support would improve your planning?

Section 2: Schedule Adjustments & Flexibility

1. Would you accept an adjustable schedule in exchange for greater access or lower cost?
2. What is your minimum acceptable capacity under flexible connection to meet your service obligations?
3. Would you opt-in to real-time schedule adjustments if adequate notice or incentives were offered?
4. How would you value capacity made available through flexible connection—per kW, based on reliability, etc.?

Section 3: Customer Agreements & Accountability

1. What kind of agreement (e.g., tariff, attachment, contract) would give you clarity and certainty?
2. What technology or control systems are required on your end to enable flexible connection participation?
3. What type of redress or backup support should be available if the schedule is unexpectedly curtailed?
4. How should risk and responsibility be shared between utility and customer in the agreement?