NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

NERC Inverter-Based Resource (IBR) Webinar:

Session 8: Interconnection Process

June 29, 2023

RELIABILITY | RESILIENCE | SECURITY

SCE Interconnection Process – Current Challenges and Pain Points While Managing the Interconnection Process

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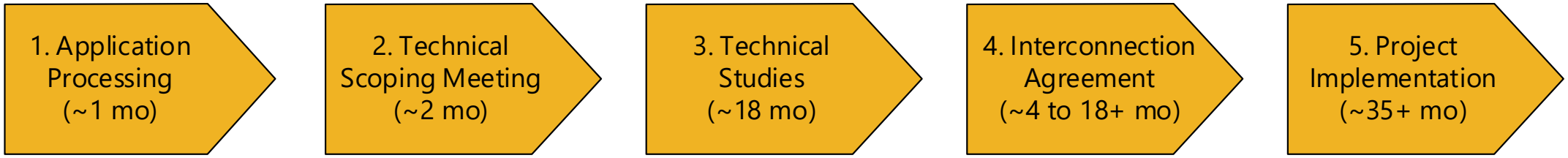
Interconnection Process Overview



1. Application Processing

- Customer submits Interconnection Request to CAISO (TOT) or SCE (WDAT) including technical data, study deposit, and Request for Distribution Service (WDAT only)
- SCE reviews submission and iterates with Customer on any issues until it is "deemed complete"

2. Technical Scoping Meeting

- SCE/CAISO and Customer meet to ensure a common understanding of the process (typ. within 30-60 days of application deemed complete)
- SCE provides technical system details and limitations known from past studies
- After scoping meeting, Customer confirms Point of Interconnection and size (MW)

3. Technical Studies

- SCE/CAISO complete technical studies to understand the impact of the project on SCE Distribution System and CAISO grid:
  - System reliability impact
  - Plan of interconnection
  - Estimated scope with cost/duration of upgrades
- Study outcome is provided in reports to the customer and at a results meeting

4. Interconnection Agreement

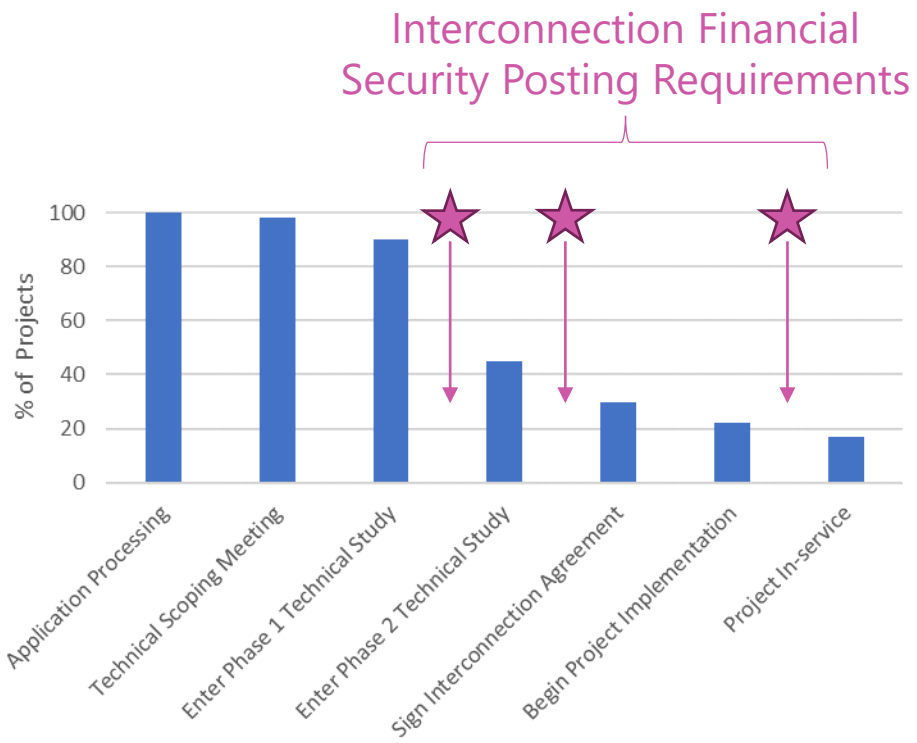
- The Interconnection Agreement is a contract that defines the requirements for interconnection including scope of facilities, operational requirements, financial responsibility, and milestones, payment, etc.
- Negotiations begin after completion of studies and results meeting and end when executed by all parties

5. Project Implementation

- SCE initiates a project to complete the work, conducts a kick-off meeting with the customer, and holds regular execution team meetings with the customer
- SCE and Customer complete their respective scopes of work and coordinate necessary interfaces

Typical Interconnection Process Delays and Hurdles

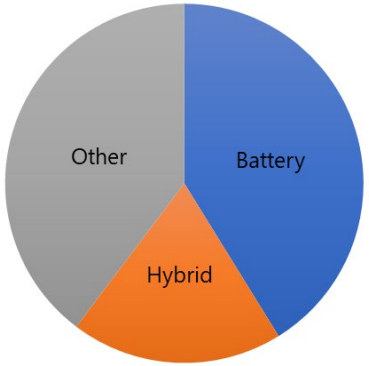
- Application Processing
  - High volume of applications leads to review delays; applications may need several rounds of review to remove all deficiencies
  - Application indicates the wrong tariff, utility, or Point of Interconnection
- Technical Studies
  - Estimated upgrade cost/duration considered too high
  - Project does not receive adequate eligibility to provide resource adequacy (deliverability allocation)
- Interconnection Agreement
  - Delays can occur because project is waiting on a Power Purchase Agreement, not ready to proceed (suspension), waiting for deliverability (parked), and/or has contract disputes
- Project Implementation
  - Supply chain delays (e.g., 100 weeks for a 220 kV circuit breaker)
  - Outages to complete construction must be coordinated with other projects
  - Skilled workforce shortages; testing for remedial action scheme (RAS) and centralized RAS is a particular challenge
  - Permitting and project line routing into substation



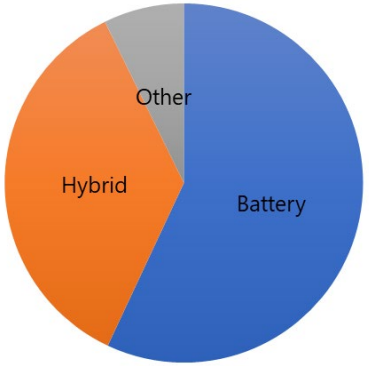
Typical attrition of projects in a cluster study process

Recent Interconnection Trends (SCE)

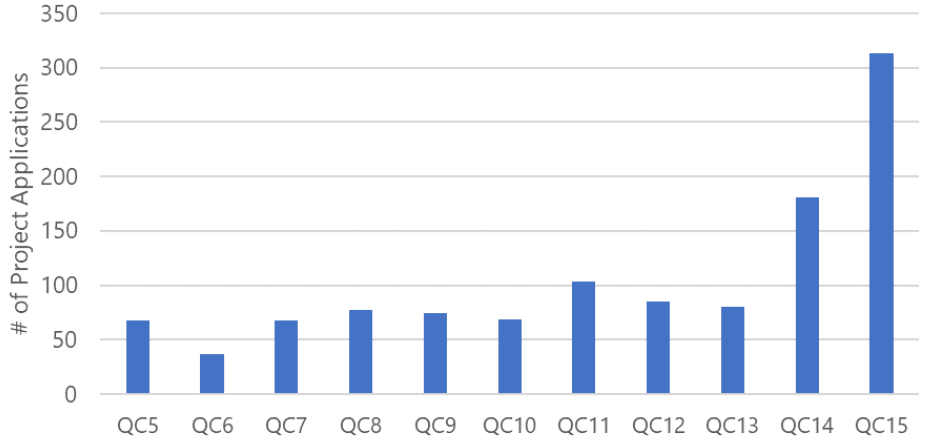
- Recent significant increase in the number of project applications (includes affected systems studies) by queue cluster (QC)
- Generation project sizes have been increasing on average—graphs show a combination of SCE wholesale distribution access tariff (WDAT) and transmission owner tariff (TOT)
- Battery projects and projects with batteries (hybrid) have become increasingly common
- Consistent lack of generation projects electing to finance area deliverability upgrades (Option B)
- Representative median time from application to in-service (recent):
  - Transmission (TOT/CAISO) = 6.1 years
  - Distribution (WDAT) = 4.8 years

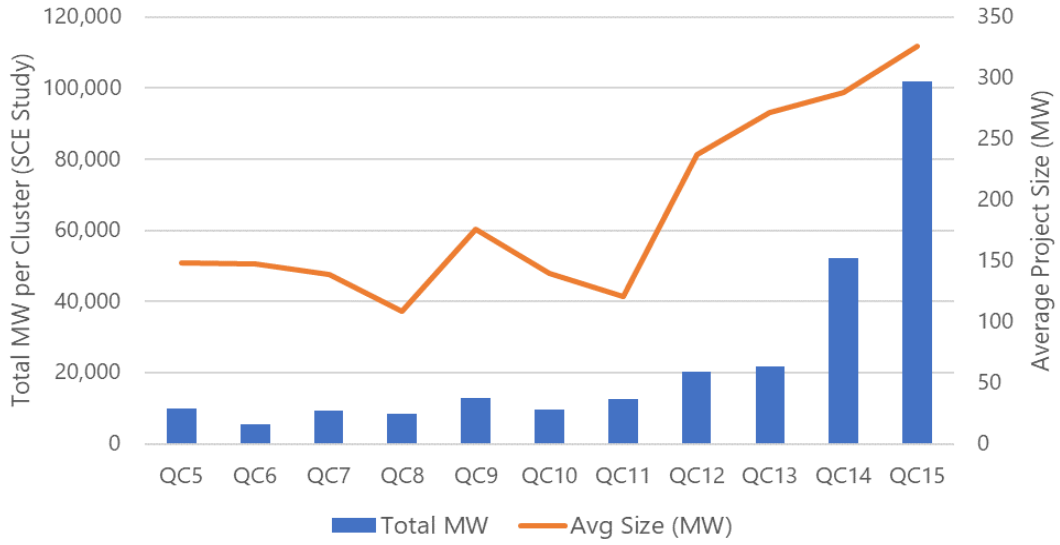


QC10 (2017)



QC14 (2021)





Interconnection Improvement Efforts

California Statewide Efforts

- Dec 2022 Memorandum of Understanding (MOU)
  - Established to create better coordination between California Public Utilities Commission (CPUC), California Energy Commission (CEC) and California Independent System Operator (CAISO) to meet California renewable energy goals
  - Latest 2022-2023 CAISO Transmission Plan approved $7.3 B in new transmission, with a focus on aligning state resource portfolios with necessary transmission investment to meet state clean energy goals; identifies new resources by geographic zones with intent to direct new procurement to those zones
- CAISO Interconnection Process Enhancements (IPE) 2023 Initiative
  - Triggered by a combination of the 2022 MOU, record-low withdrawal rate of QC14 requests between Phase I and Phase II studies, and record-high interest in QC15 applications: 541 transmission interconnection requests (total of 354 GW)
  - Track 1: Pause the processing of cluster 15 applications one year to April 2024 (ER23-2058 filed on 6/2/2023)
  - Track 2: Discuss and implement transformative changes to the interconnection process

SCE-Specific Efforts

- Overall Efforts
  - Increasing headcount in critical staff roles for generator interconnections and focusing on hiring and training activities
  - Incorporate interconnection forecasts into company resource plans
  - Generator interconnection dashboard for tracking process performance and current project status, expedited project initiation process, and additional risk tracking that starts at the Interconnection Agreement execution phase

CAISO Track 2 Draft Problem Statements (as of 6/23/23)[1]

- Problem Statement #1: Interconnection
  - The massive increase in interconnection requests seeking to meet the accelerated cadence of resource development now needed by the state on a sustained basis has overwhelmed critical planning and engineering resources across the industry. Both the volume of capacity and individual interconnection requests in Clusters 14 and 15 compromise the ISO's ability to produce meaningful study results within necessary commercial timeframes, making it challenging to bring resources online in time to meet state policy and reliability needs. The current generator interconnection processes simply cannot efficiently accommodate the latest level of interconnection requests received. More publicly-accessible information on the location and amounts of available interconnection and deliverability capacity is needed help developers to decrease the numbers and increase the viability of applications. In addition, clearly defined measures of project viability and clear expectations around when viability should be tested and determined are needed.
- Problem Statement #2: Managing the Queue
  - Following the study process, a number of projects in the interconnection queue do not proceed to commercial operations as expected (e.g. delay executing a GIA, meet contract milestones, etc.) and remain in the queue without indication of their intent to proceed to contracting or construction. The current processes for managing the queue presents certain challenges for projects proceeding to commercial operation (e.g. modifications, limited operation study, commercial viability criteria, etc.) and challenges for the ISO's enforcement of projects that are not. Lastly, there is a lack of common understanding of what it means for a project to maintain 'viability' as it moves through the stages to achieve commercial operation.

1: California ISO 2023 Interconnection Process Enhancements: Summary of June 20 & 21 Track 2 Working Group Meeting Revised Principles and Problem Statements 1 and 2, available at http://www.caiso.com/InitiativeDocuments/Revised-Principles-and-Problem-Statements-Interconnection-Process-Enhancements-2023-Track%202-Jun%2020-212023.pdf as of 6/26/2023.

Questions and Answers After All Presentations

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Challenges with Interconnection Analysis & Enforcement

Evan R. Wilcox
Director – Advanced Transmission Studies& Modeling
American Electric Power

NERC IBR Webinar Series: Webinar 8 – Interconnection Process

June 29, 2023

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Examples of Challenges with IBRs Today

- **Stability and voltage ride-through capability**
  - Concern: If actual performance does not match the interconnection study, who is responsible?
- **SSO/SSCI interactions**
  - Concern: If issues are discovered after interconnection, what actions should be taken?
- **Islanding with load**
  - Concern: If there is a failure to disconnect and customers are negatively impacted, who is at fault?

Analysis Gaps

- **Interconnection Studies**
  - PSS/E models are used to assess system stability and not generally expected to uncover ride-through deficiencies.
  - Proper evaluation necessitates PSCAD study, however system-level PSCAD studies require significant expertise, computer resources, and modeling details often not required or readily available.
  - PSCAD ride-through evaluations are not an established interconnection study in any of the RTOs AEP operates in (PJM, SPP, ERCOT).
    - May not be practical with respect to generator interconnection process and timelines.

Enforcement Gaps

- **FAC-001-3 (Facility Interconnection Requirements)**
  - Applies only to Transmission Owners (TOs) or entities serving in a “TO” role regarding third party interconnections to their facilities.
  - Does not explicitly require the GO to comply with a TO Interconnection Requirements (IR) document.
  - Unlike a NERC-ERO or a Reliability Coordinator (RC), a TO has no practical enforcement mechanisms for any <u>performance</u> requirements within an IR document, such as disturbance ride-through or islanding detection.

Energy Delivery

Requirements for Connection of New Facilities or Changes to Existing Facilities Connected to the AEP Transmission System

Revision: 4

Effective Date: 12/31/2022

Supersedes *AEP Interconnection Requirements Rev 3*
Description: Requirements for interconnection to the AEP Transmission System

	Requirements for Connection of New Facilities or Changes to Existing Facilities Connected to the AEP Transmission System	Rev. 4	TP-0001
	CAUTION: Printed copies of this document are uncontrolled and may be obsolete. Always check for the latest revision prior to use.		Page 1

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Standards Gaps

- **Presently, IEEE 2800 is the only industry-wide standard that contains IBR ride-through performance capability requirements covering:**
  - RMS voltage excursions.
  - Frequency excursions.
  - Transient overvoltage.
  - Current injection performance while in RT mode.
  - Specifications regarding measurement data for performance monitoring.

- **However, IEEE 2800 is voluntary until made enforceable by government jurisdictional entities or RC.**

- **IEEE 2800 is not currently required or enforced in AEP's IR document.**
  - One RTO-RC currently proposing to enforce certain 2800 requirements.

Conclusions

- Rules are being developed to mitigate many concerns with IBRs, but are reactionary in nature.
- The desire of policies and markets for interconnection speed conflicts with the physical realities of grid planning and operations.
  - Reliability concerns in the dynamics/stability realm are complex, requiring advances in tools, methods, and expertise to analyze.
- TOs as the customer interface and often get the questions, but do not necessarily control the rules, process, or enforcement.

Questions and Answers After All Presentations

Presentation for NERC Webinar
Interconnection Process
ERCOT Technical and Process Challenges When Managing the Interconnection ~~Queue~~ Process

June 29, 2023

Jay Teixeira
Manager, Resource Integration

ERCOT Interconnection Process

ERCOT Interconnection process slightly different than most of the country

- Not a Queue, each project moves on its own, but may seem like a queue at crunch points where staff limitations are pronounced
- Deliverability not guaranteed. Only “Driveway” is built during Interconnection Process, “Highway” determined through Planning Process
- “Connect and Manage” process where generation is connected and managed by congestion management during real time operations
- Studies are done to ensure reliability, but not to build transmission

Ercot process is 18 to 30 months for Large Generation (>=10 MW) and 8 to 12 months for Small Generation (<10 MW) not including construction/supply delays

Resource Interconnection Process – Large Generation

- GINR Application and Fees
- Security Screening Study
- Full Interconnection Studies
- Subsynchronous Resonance Study
- Standard Gen. Interconnection Agreement
- Resource Integration and On-Going Operations data submittal
- Compliance with Operational Standards
- Reactive Study
- Quarterly Stability Assessment

- RE Registration
- Resource Integration and On-Going Operations data submittal
- ERCOT Polled-Settlement Meters and ESI ID Requirements
- Telemetry and ICCP Requirements

- TSP: 1: Request to Energize POI
- Commissioning Plan Template
- New Generator Commissioning Checklist
- Part 1: Request to Energize
- Part 2: Request for Initial Synchronization
  - Curtailment, AVR, Reactive, PFR tests
- Part 3: Request to Commission a Resource

Quarterly Stability Assessment (QSA)

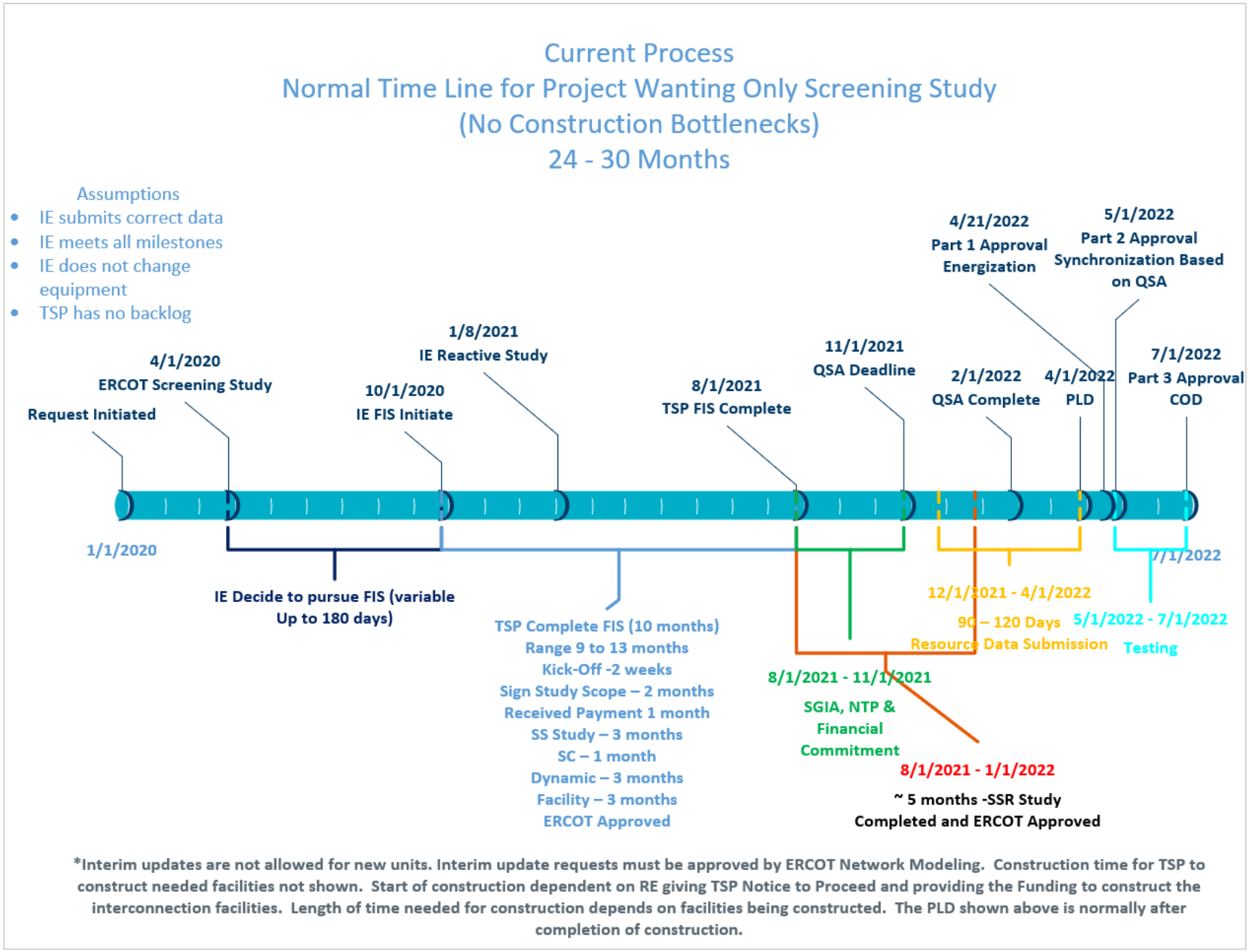
Generation not included in the quarter shown in the Initial Synchronization Quarter column in the table below will not be eligible for Initial Synchronization during that three-month period:

Generation Resource Initial Synchronization Quarter	Last Day for an IE to meet prerequisites as listed below	Completion of Quarterly Stability Assessment
Upcoming January, February, March	Prior August 1	End of October
Upcoming April, May, June	Prior November 1	End of January
Upcoming July, August, September	Prior February 1	End of April
Upcoming October, November, December	Prior May 1	End of July

To qualify for the QSA, the IE must have met the following requirements (Large Gen):

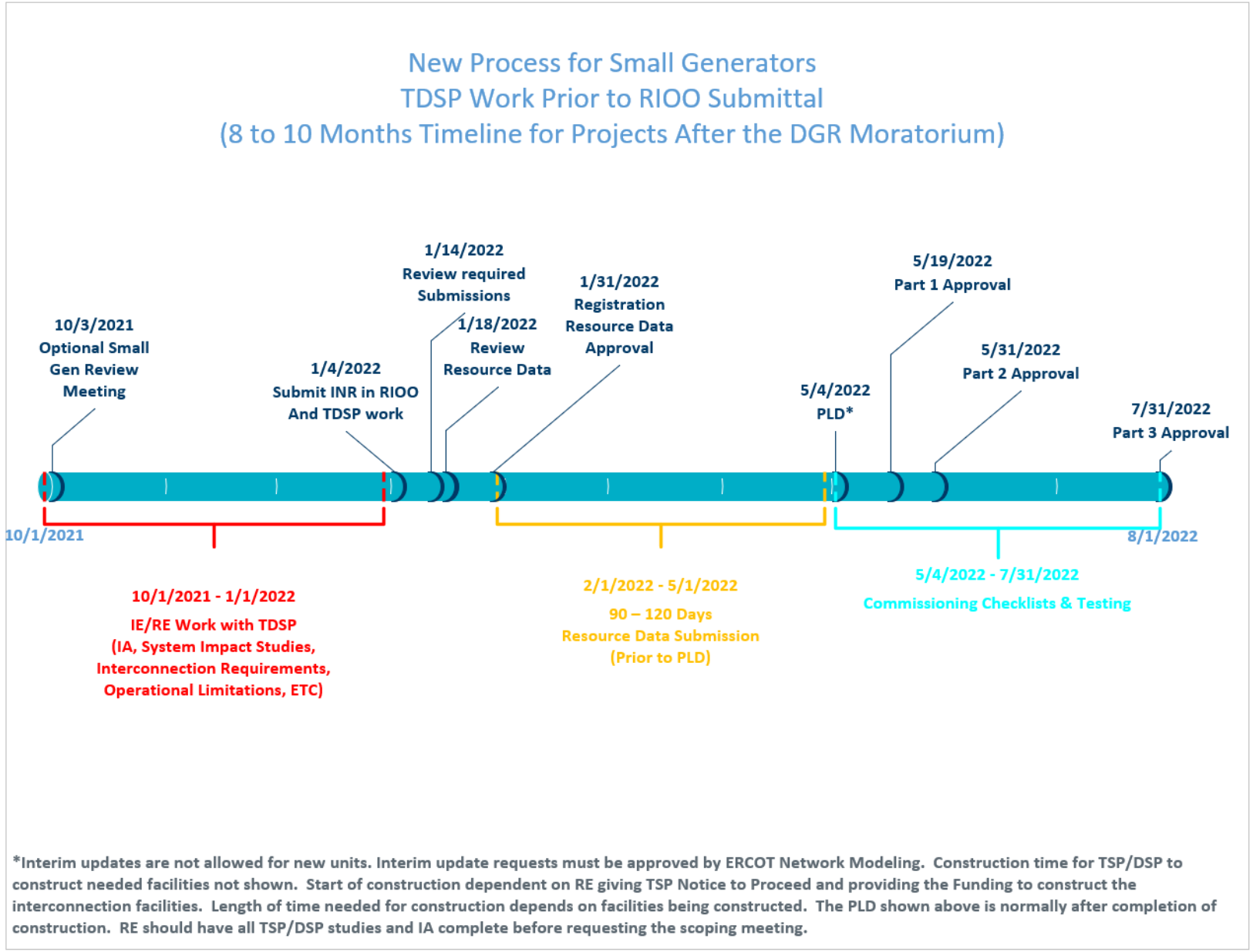
- Completed the requirements of Planning Guide Section 6.9, Addition of Proposed Generation to the Planning Models. (SGIA, Air/Water Permits, NTP, $ to fund interconnection (refunded after Part 3 commissioning); and
- FIS studies; and
- Reactive Power Study; and
- System improvements or mitigation plans that were identified in studies; and
- Initial Compliance with Operational Standards review.

Large Generation Timeline for Screening Study only



*Interim updates are not allowed for new units. Interim update requests must be approved by ERCOT Network Modeling. Construction time for TSP to construct needed facilities not shown. Start of construction dependent on RE giving TSP Notice to Proceed and providing the Funding to construct the interconnection facilities. Length of time needed for construction depends on facilities being constructed. The PLD shown above is normally after completion of construction.

Small Generation Timeline

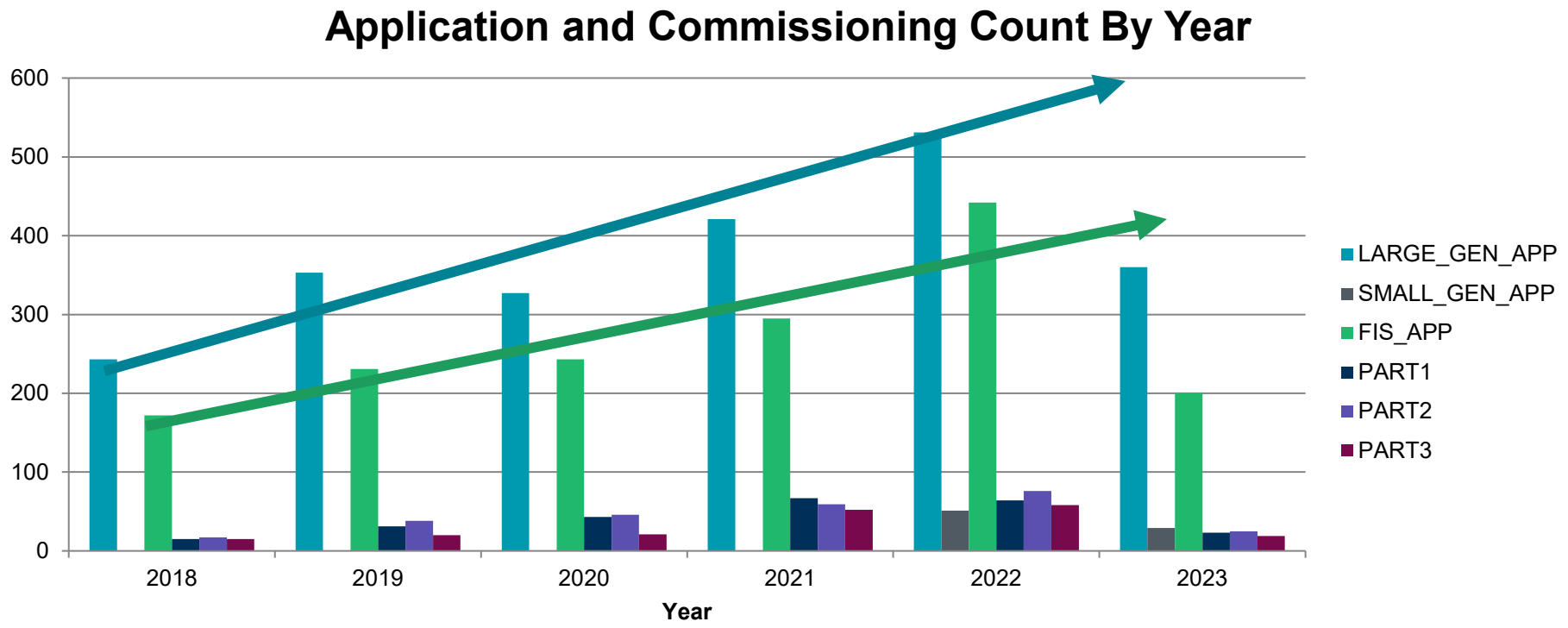


*Interim updates are not allowed for new units. Interim update requests must be approved by ERCOT Network Modeling. Construction time for TSP/DSP to construct needed facilities not shown. Start of construction dependent on RE giving TSP Notice to Proceed and providing the Funding to construct the interconnection facilities. Length of time needed for construction depends on facilities being constructed. The PLD shown above is normally after completion of construction. RE should have all TSP/DSP studies and IA complete before requesting the scoping meeting.

Interconnection Application Counts

As of 06/12/2023

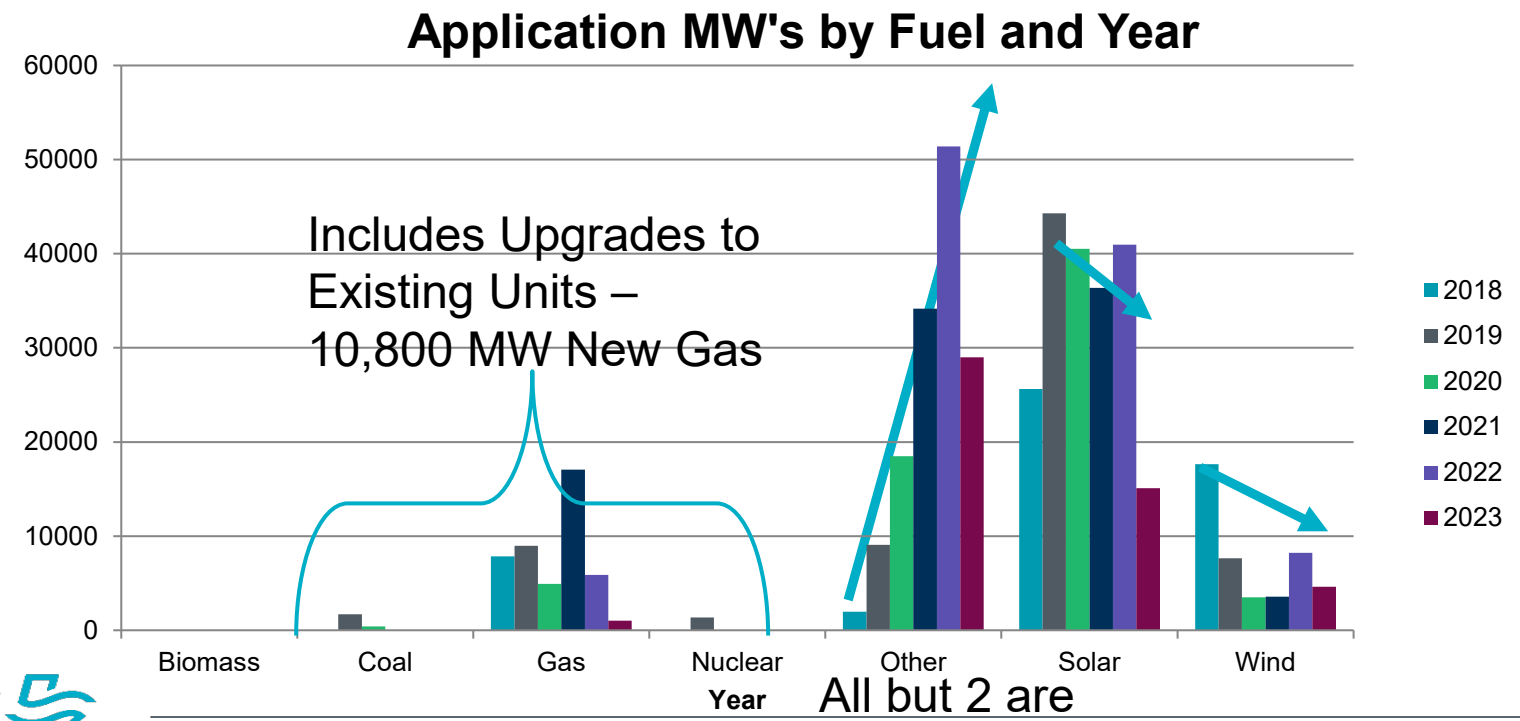
YEAR1	LARGE_GEN_APP	SMALL_GEN_APP	FIS_APP	PART1	PART2	PART3
2018	243	0	172	15	17	15
2019	353	0	231	31	38	20
2020	327	0	243	43	46	21
2021	421	0	295	67	59	52
2022	531	51	442	64	76	58
2023	360	29	201	23	25	19



Application MWs

As of 06/15/2023

FUEL	2018	2019	2020	2021	2022	2023
Biomass				53		
Coal		1710	420			
Gas	7877.5	8994.6	4945.4	17059.8	5884	1017.32
Nuclear		1375				
Other	1991.34	9082.91	18507.92	34176.46	51376.34	28980.01
Solar	25624.12	44293.71	40528.48	36370.39	40956.2	15108.39
Wind	17637.83	7664.93	3522.92	3572.99	8236.02	4628.83

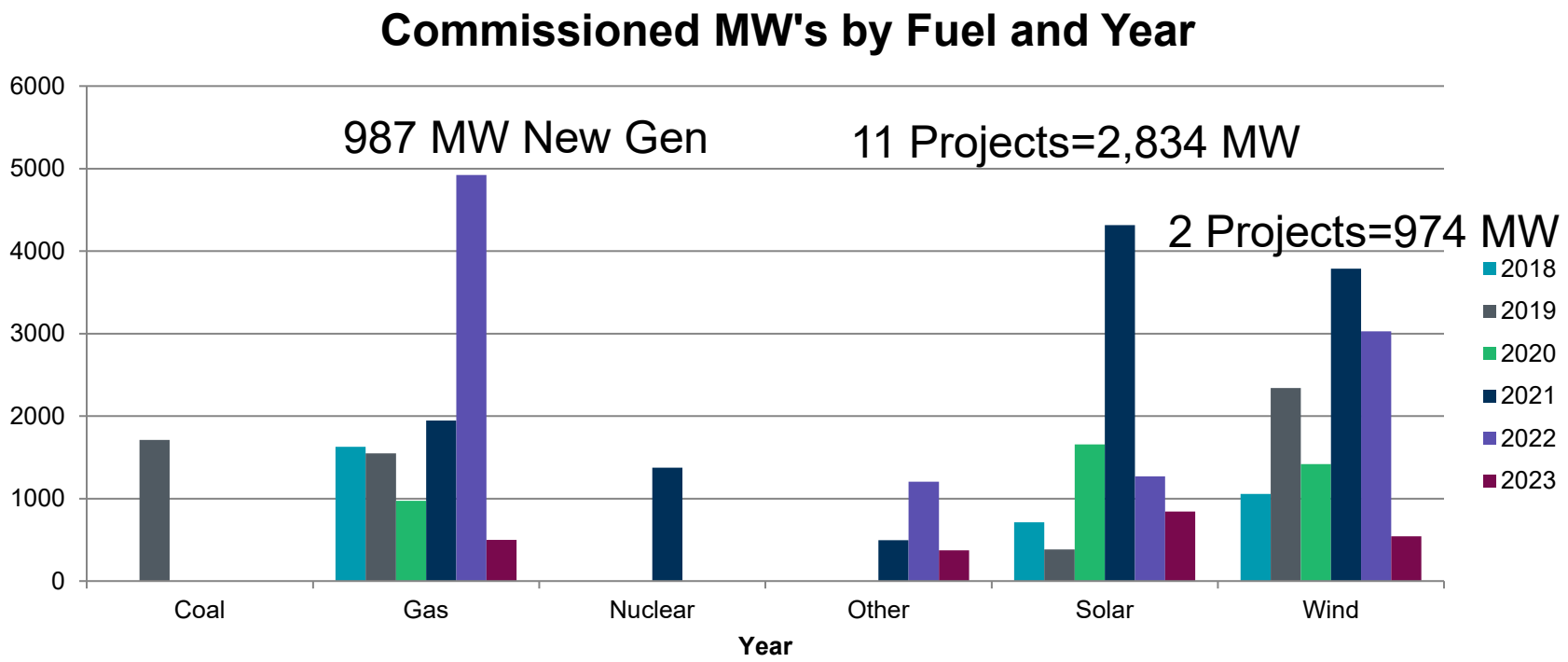


All but 2 are Battery

Commissioned MWs

As of 06/12/2023

FUEL	2018	2019	2020	2021	2022	2023
Coal		1710				
Gas	1629	1550	975	1946	4921.5	499.5
Nuclear				1375		
Other				497.08	1203.84	372.58
Solar	714	383	1656.57	4313.72	1269.82	844.15
Wind	1058	2341.88	1418.2	3786.13	3027.16	542.5



Questions?

Questions and Answers

Feel free to reach out to us if interested in participating in the NERC IRPS or EMTTF!