Jurisdictional Scan on DER-Provided Grid Services

Key Takeaways

TDWG Meeting #16 – November 25th, 2024

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Study Objectives

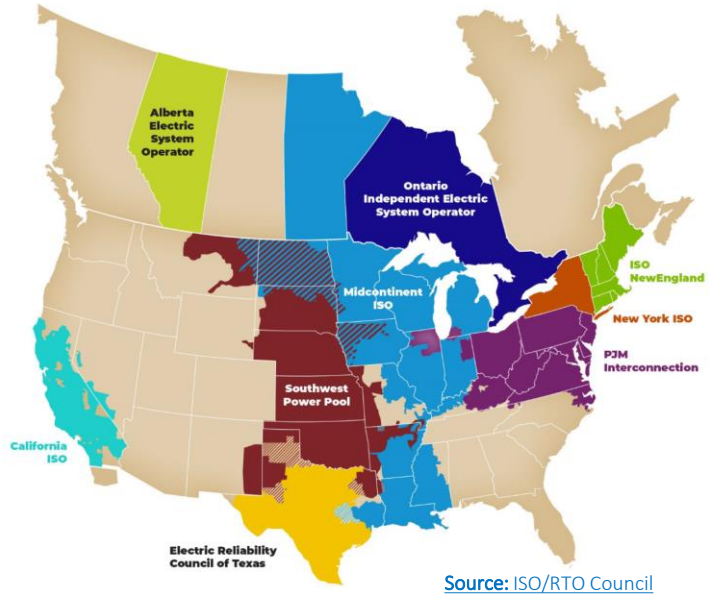
- Research the status of DER-provided grid services in several jurisdictions in the US and Europe:
  - *California, New York, UK, France, Sweden, Germany, Netherland.*

- Distribution services
  - *Services provided by DER to the distribution utility.*
- Bulk power services (=wholesale market)
  - *Services provided by DER to the wholesale market operator.*
- Terminology
  - grid services (US) ~ flexibility services (Europe)
- Value stacking strategies cutting across grid domains

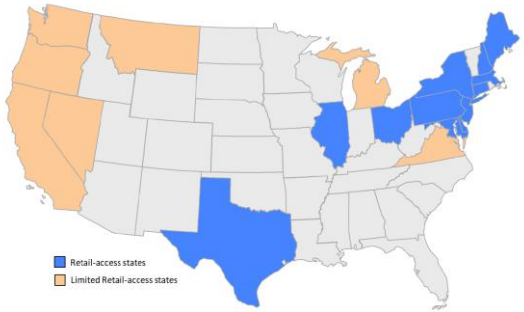
- Today's agenda:
  - Takeaways: US, Europe.
  - Q&A

Structure of Electricity Sector in the US

- Bulk System
  - Wholesale markets
    - 7 Regional Transmission Organizations (RTOs)/Independent System Operators (ISOs)
    - Energy, ancillary services (AS), and capacity markets
    - Day-ahead (DA) and other granularity *forward* markets and Real-time (RT) *spot* markets
    - Focus on CAISO and NYISO
  - Vertically-integrated utilities
    - Investor-owned, state-owned or cooperatives
  - Energy Imbalance and other markets
    - Include a subset of ISO market functionality
    - Examples include Western Energy Imbalance Market (WEIM), Western Energy Imbalance Service (WEIS) and Southeast Energy Exchange Market (SEEM)
- Distribution
  - Vertically integrated utilities
  - Retail choice with the option to choose provider in some states
    - NY has full retail-access (unbundling of delivery and energy sales for all customer types)
    - CA has limited retail-access (programs are capped or not available to all customer types)



Source: ISO/RTO Council

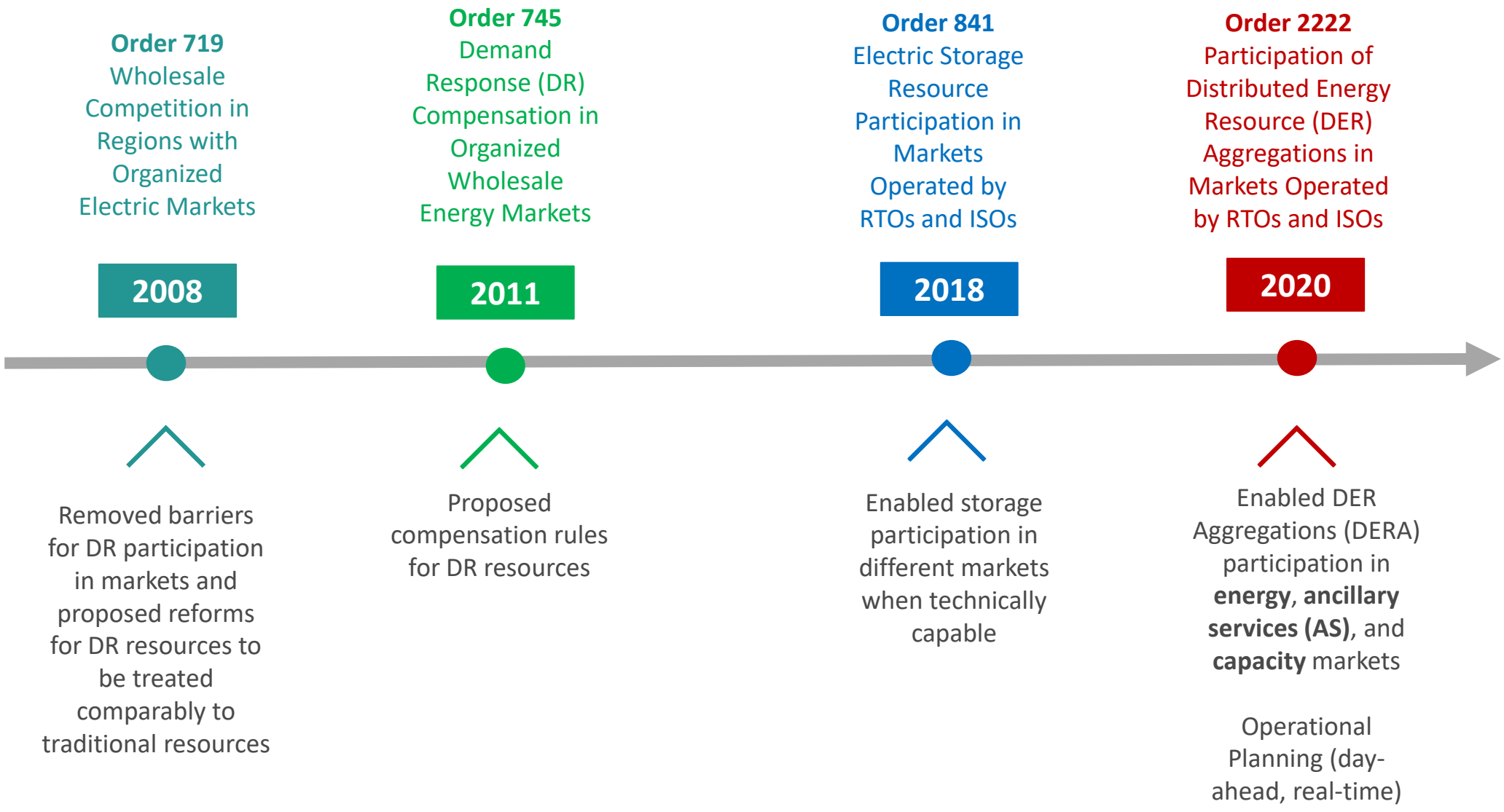


Source: Wholesale Electricity Market Design in North America: Reference Guide Volume I (EPRI)

Grid Actors in the US

- ISO/RTO
- Distribution Utility/Distribution System Operator (DSO)
- Resource Owners
  - Conventional Generators, Storage, Demand Response, Variable Energy Resources
- Regulators
  - Federal Energy Regulatory Commission (FERC)
  - State's Public Service/Utility Commissions and Planning Agencies (CEC, CPUC, NY PSC)
- Distributed Energy Resource Aggregators (DERA) or Virtual Power Plants (VPPs)
- Load Serving Entities (LSEs)
- Other
  - Transmission Owners
  - Communication and Metering Entities
  - Data Repository/Management Vendors
  - Software vendors
  - Financial entities
  - Market Monitors

U.S. Federal Regulation shaping DER and DERA participation in wholesale electricity markets



Current Participation Models (Wholesale Market Participation)

- DER aggregation can comprise of **Variable Energy Resources**, **Demand Response** and **Electric Storage Resources**

Participation Models in CAISO

	Participation Model	Description
	DER Provider (DERP)	Enables *Aggregation* of DERs to meet minimum capacity requirements and act as one 'virtual' resource (homogeneous or heterogeneous)
PDR	**Proxy Demand Response (PDR)**	Enables 3rd parties to bid DR for *load curtailment* (independent of LSE)
PDR	**PDR – Load Shift Resource (PDR-LSR)**	Allows for *bi-directional* dispatch product (rewards increasing consumption during negative prices)
PDR	**Reliability Demand Response (RDRR)**	Allows reliability-based *load curtailment* triggered under certain emergency conditions
NGR	**Limited Energy Storage Resource (LESR)**	Resources with continuous *positive to negative* operating range, constrained by *state-of-charge* limits (e.g., batteries)
NGR	**Dispatchable Demand Response (DDR)**	Resources with *non-positive* operating range, constrained by curtailable *energy* limit
NGR	**Generic Non-Generating Resource (NGR)**	Resource with continuous *positive to negative* operating range

Considerations for Participation Models

- Technology Type
- Size Limits
- Eligible Services
- Homogeneous vs Heterogeneous Aggregation

Requirements and Aspects of DERA Wholesale Market Participation under FERC Order No. 2222

- DERA can comprise of **Variable Energy Resources**, **Demand Response** and **Electric Storage Resources**

FERC Order 2222 Aspect	NYISO	CAISO
Participation Model	DER and Aggregation	DER Provider (DERP)
Eligible Wholesale Market Services	Energy, Ancillary Services (AS), Installed Capacity Market (ICAP)	Energy, AS, Flexible Ramping Product
Locational Requirements	Single Transmission Pricing Node	Multiple Transmission Pricing Nodes (but within a sub-LAP, 23 sub-LAPs in CAISO)
Metering Requirements	Aggregated Revenue Quality, Individual DER data could be measured or calculated	Aggregated Settlement Quality, Individual DER data must be directly metered
Telemetry Requirements	Aggregated Real-Time Telemetry, 6 seconds scan rate	Aggregated Real-Time Telemetry, 4 seconds scan rate
Maximum Size (individual)	20 MW	1 MW
Maximum Size (DERA)	-	20 MW (if aggregated across multiple pricing nodes)

Summary: DER-Provided Wholesale Services (US)

- On-going Compliance
- Pilots and/or commercial procurement projects
  - Most are providing services at the distribution level
  - Plans and approval processes for wholesale market participation in the future
  - DERA data from CAISO and NYISO is not readily available
    - **ERCOT ADER**: ~9 participants (2 qualified, others at various points of registration), 9.1MW energy, 3.1MW AS
    - CA and NY have similar participation anecdotally
- Limited DERA participation in wholesale markets
  - Prolonged interconnection process
  - Stringent metering, telemetry, data and coordination requirements
  - Distribution or retail programs may offer better incentives
  - Distribution reliability services take precedence over wholesale services
  - Competing with various other initiatives in the list of ISO priorities

DER-provided distribution services (US): Status and Maturity

NY

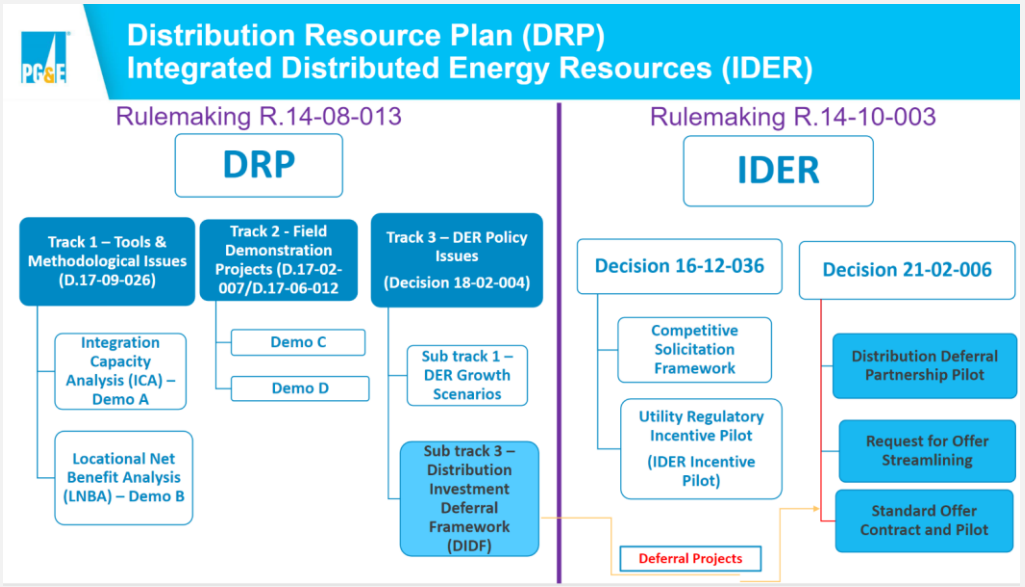
New York

- **Commercial procurement of assets implementing DER-provided grid services for stand-alone NWA**
- **Aggregated DER model not yet open to customers**[1]
  - NYISO proposed revisions applicable to aggregations participation in wholesale markets on June 1, 2023
    - Acceptance would have allowed aggregations to participate in 2023, but FERC issued 2 deficiency letters
    - NYISO responded to 2nd deficiency letter on Feb. 13, 2024, requesting approval of revised tariff for potential implementation beginning Apr. 16, 2024
    - Effective date for NYISO's compliance with Order No. 2222 is anticipated to be **no later than December 31, 2026**.
  - NYISO working with joint utilities of New York to develop a services compatibility document to prevent double counting

CA

California

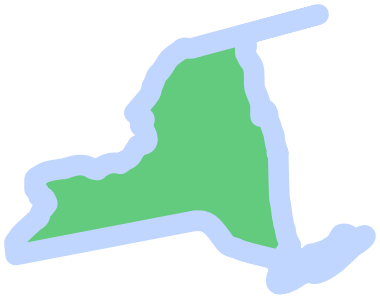
- Commercial procurement for any type of project (tech neutral procurement program – Distribution Investment Deferral Framework (DIDF)). Also an ongoing pilot for aggregated DERs (Partnership Pilot Program).



Source: PG&E, in 2023 EPRI NWA Workshop proceedings

[1] See 02/13/2024 Filing in Docket No. er23-2040-003, NYISO 2nd Deficiency Response re: DER and Aggregation Market Rule Changes.

Cost Recovery



New York

- ConEd has filed a Wholesale Distribution Service (WDS) tariff with FERC to prepare for FERC 2222.
- Allows ConEd to recover network delivery costs from DER connected to ConEd's grid and providing services to NYISO.
- Settlement performed by ISO, during process DSO can perform audits and confirm/deny outages as presented by aggregators
- **DER Aggregations**
- Open question as to how costs are recovered for additional costs associated with DER aggregations
  - E.g., costs for time and resources to study DER aggregations
  - Notably, aggregations are allowed to change on a monthly basis[1], so it makes sense to study load "pockets" with all potential resources for a given aggregation, but cost allocation is unclear

California

- Ongoing conversations with utilities on whether costs for using distribution infrastructure to participate in wholesale markets is recovered
  - Including "other" costs such as increased staffing and/or time for dispatching and customer service
  - Looking into whether these costs are baked into savings when calculating deferred upgrades

Overview of NWA Selection/Deployment

New York

- Orange & Rockland has 1 NWA providing peak load reduction and reliability to distribution system, also has bid into wholesale markets
- National Grid has 1 NWA providing local reliability support that also bids into the NYISO wholesale markets

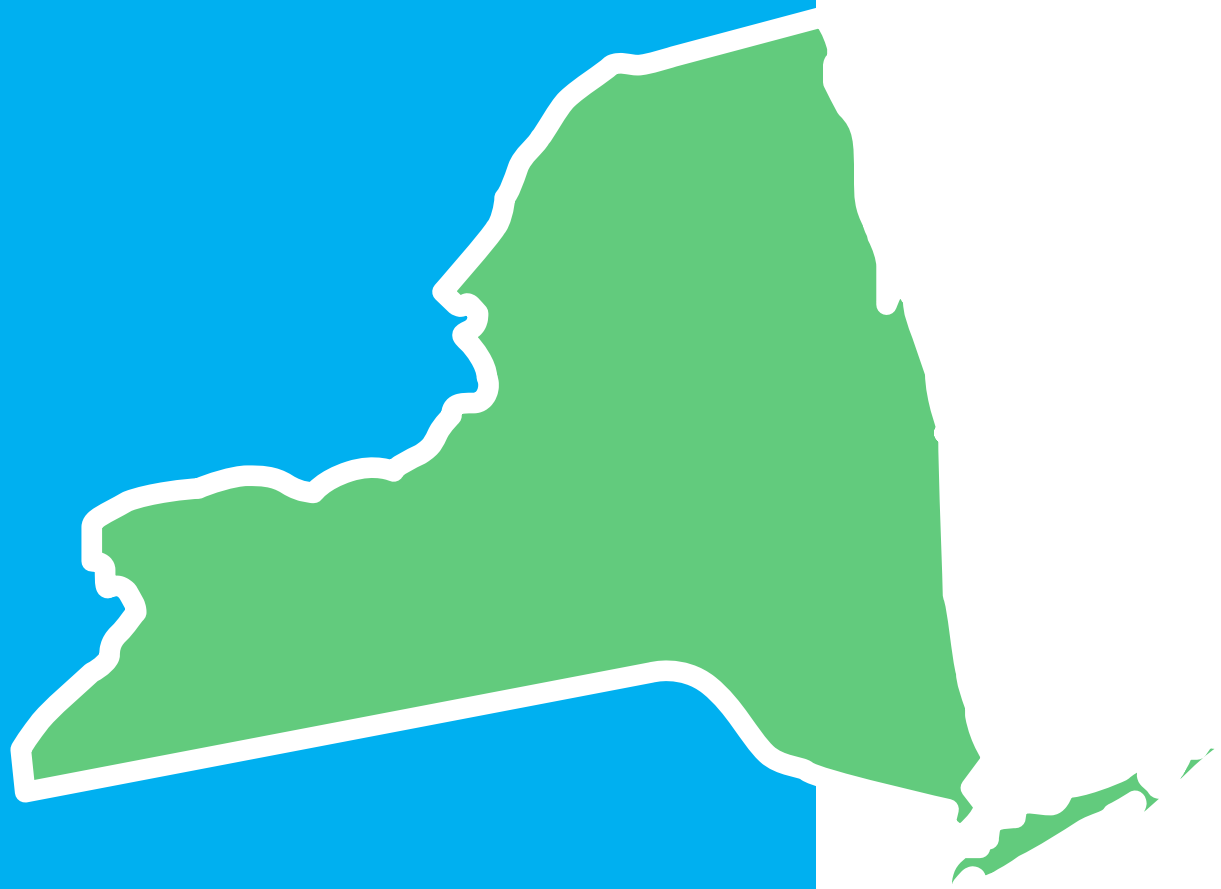
California

- PG&E has 1 DIDF project online as of May 1, 2024
- Data for table from PG&E's 2023 DDOR and SCE's Second Amended 2023 DDOR

Year	PG&E			SCE		
	DIDF RFO	Partnership Pilot	SOC Pilot	DIDF RFO	Partnership Pilot	SOC Pilot
2020-2021	7 projects, 0 contracts	N/A	N/A	2 projects, 0 contracts	N/A	N/A
2021-2022	6 projects, 3 contracts	6 projects, 0 contracts, 1 open	1 project, 0 contracts	0 projects	3 projects, 0 contracts, 1 open	1 project, 0 contracts
2022-2023	3 projects, 0 contracts	3 projects, 0 contracts, 1 open	1 project, 1 contract	1 project, 0 contracts	4 projects, 0 contracts, 1 open	1 project, 0 contracts
2023-2024	3 proposed	3 proposed	N/A	6 proposed	1 proposed	N/A

Orange & Rockland Ponoma Project

New York



Details

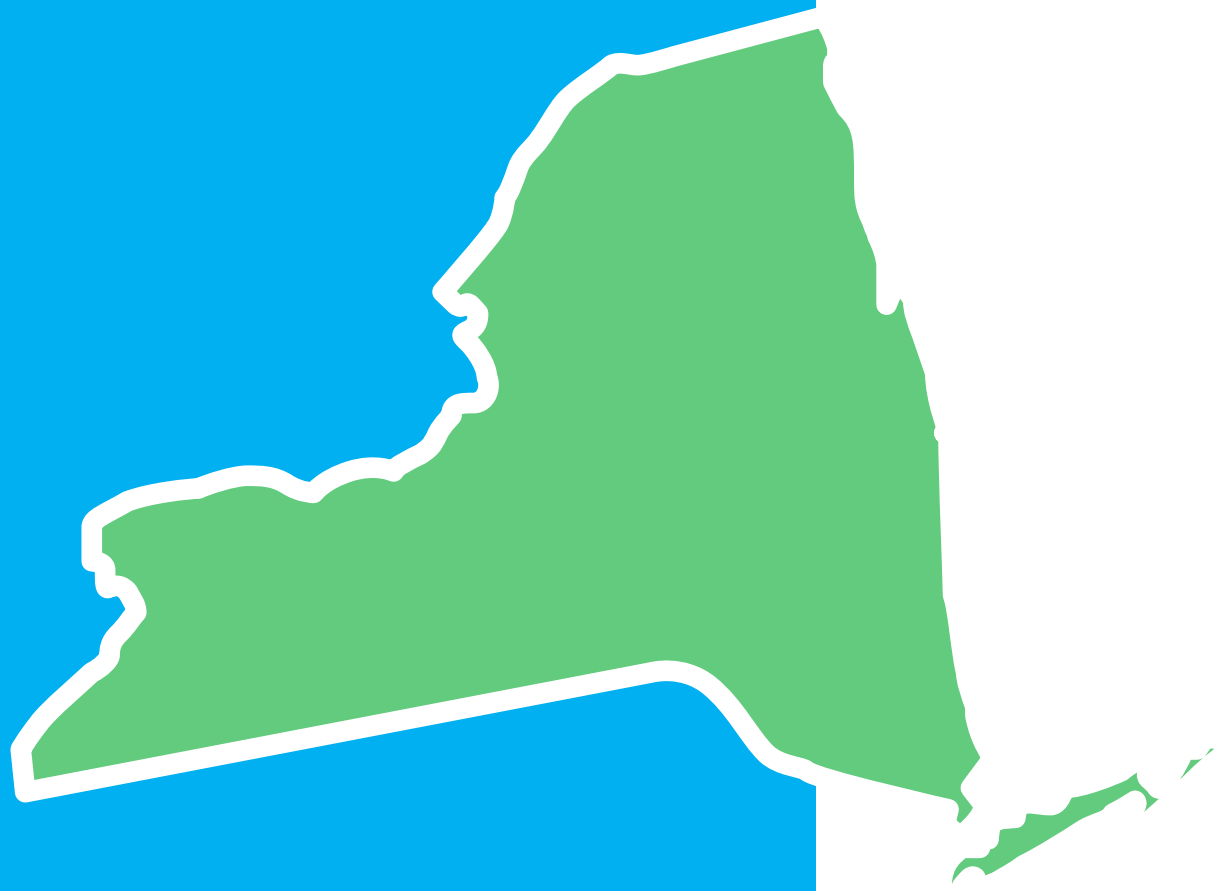
- 3 MW/ 12 MWh BESS
- Provided 37 dispatches totaling 444 MWh of energy during peak season to provide relief during times of peak load from 2021-2023
- Between August 2023 and December 2023 also provided over 307 MWh to local distribution system as part of wholesale markets and NYISO dispatch

Lessons Learned

- NYISO requested back-to-back dispatches of 12 MWh and 13.83 MWh without allowing time to charge
- After 1 month, system had to be taken offline for a day to rebalance battery cells. Expected to continue monthly.
- NYISO dispatches are often sporadic for small time increments, which will negatively impact BESS longevity
    - Working with NYISO to find solutions

National Grid Pulaski Project

New York



Details

- 2 MW/ 3 MWh BESS to provide peak load reduction to prevent thermal overload during normal peak system conditions
- Has been providing reduction since 2018 in June-Sept
- Participating in wholesale markets, balancing participation with recommended annual cycling from vendor

Lessons Learned

- Analysis determined filing with FERC was required to ensure the company had authority to participate in wholesale ancillary markets under its market-based rate tariff
- Uses 3rd party power marketer to do bidding in wholesale markets and recommend strategies
- Additional metering was needed to meet the NYISO Energy Storage Resource market metering requirements (auxiliary load separate from storage system)
- Energy Management System changes were needed to facilitate 2 modes of operation
- Needed to convert data from NYISO at ESS (mega to kilo)
- Required changes to the company billing and settlement systems
- Some technical challenges encountered during end-to-end testing

PG&E Lakeview Project

California

Details

- DIDF project online as of May 1, 2024. It was scheduled for 2023 but was deferred due to lack of need (change in forecast, as well as lack of help during the interconnection process)[2]
- Contract for 1.056 MW of in-front-of-the-meter capacity via battery storage[1]
- Project to serve 1 grid need and participate in wholesale markets

Lessons Learned

- Limited or no supplemental help was provided to the customer through the interconnection process despite it being first DIDF project to come online
- Potentially slowed ability of getting the project online
- Utility initially providing many limitations of the DER implicitly
  - E.g., compatibility of services evaluated by customer
  - Only explicit requirement is DSO dispatch schedule, provided day ahead
  - May need to be changed as distribution connected systems providing wholesale services scales

[1] ELEC_6755-E.pdf (pge.com), p. 20.

[2] Binder1 (003).pdf (ca.gov), Appendix K, p. 1

Distribution/Bulk Value Stacking in the US

New York

- Distribution reliability is to be prioritized per NYPSC direction
- Ongoing outreach into penalties for non-performance
  - Older tariffs don't have penalty for non-performance
  - Newer, such as dynamic load management, has penalties for non-performance

California

- Projects must be fully or partially incremental to PG&E's programs, tariffs, and solicitations
- Compensation dependent on delivery of services
  - $/kW-month
  - Contract Capacity * Contract Price * Ratio Delivered Services when called *Delivered Services Adjustment
- Assets can sell excess "product" to 3rd parties
- Able to sell other attributes of projects to 3rd parties
- Free to monetize other revenue streams outside of specified days/times

Resources can be:		Examples
Fully Incremental	Not already sourced through another program, tariff, solicitation	• Add-ons to existing DERs, such as the addition of dispatchable storage to an existing PV resource • New programs; • EE Technology not included in Portfolio
Partially Incremental	Partially sourced through another program, tariff, solicitation	Enhanced uptake of DER over base
Not Incremental	Wholly sourced through another program, tariff, solicitation	Rooftop PV compensated under NEM without enhancement; Existing DG or ES compensated under SGIP without enhancement; EE or DR portfolio resources without enhancement

Delivered Services	Delivered services adjustment
≥0.90 and ≤ 1.00	1.0
≥0.75 and < 0.90	0.5
< 0.75	0

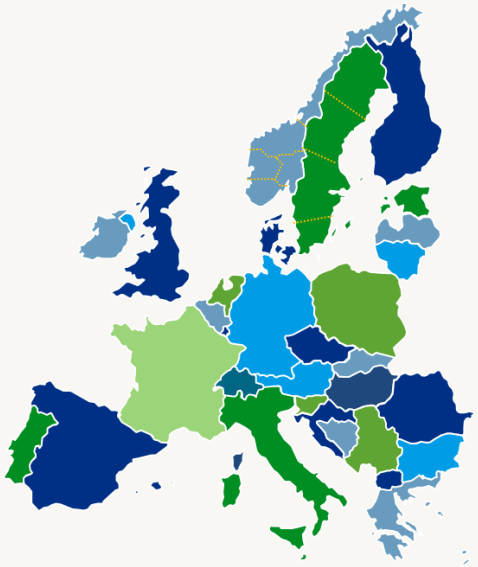
European Focus

Great Britain, France, the Netherlands, Germany, and Sweden

European Harmonised Wholesale Electricity Sector

Wholesale markets- **Zonal** market structure (not nodal)

- Common legislation
- Common pan European trading platforms for all 27 member states
- Common timeframes
  - Forward capacity trading
  - Day ahead trading; SDAC
  - Intraday trading; SIDC
  - Balancing energy trading; - Freq response and shared procurement platforms
    - IGCC, Picasso, MARI, TERRE



Source: Tennet, congestion management overview

- Roles and responsibilities
  - **TSOs – Transmission System Operators-mostly self-dispatch markets (central dispatch in 4** countries**; Ireland, Italy, Poland, Greece)**
    - Balancing market operation and balancing services procurement, non-freq ancillary services,
    - Capacity markets- National Government role , delivery depending on region
    - New responsibility to determine flexibility requirements
      - Flexibility needs on a seasonal/ daily/ hourly basis to integrate electricity generated from renewable sources in the electricity system
      - Consideration of the potential of non-fossil flexibility resources. demand side response and energy storage to fulfil this need at all levels
      - Evaluation of the barriers to enabling flexibility provision and proposed mitigatory measures
  - **NEMOS- Nominated Electricity Market Operators**- market exchanges
    - Market coupled trading - Pan EU Day ahead markets (SDAC) and intraday markets (SIDC)
  - **RCC- Regional Coordination Centres** – capacity allocation between zones

Great Britain Electricity Market structures

Wholesale markets- **currently one single zone – exploring additional zones** (not nodal)

- UK legislation (somewhat based on EU legislation)
- Markets for DER
  - Day ahead trading; EPEX/N2EX
  - Intraday trading; 2 daily auctions, and continuos auction
  - Balancing energy trading; Elexon, NESO
  - Ancillary services – complexity and innovation
  - Capacity market
  - Self-dispatch market - although exploring central dispatch due to congestion and re-dispatch frequency

Source: EPEXSPOT https://www.epexspot.com/en/gb-market-post-brexit

TSO/DSO flexibility markets

Flexibility services – mix of DSO and TSO requirements

EU Requirements driving DER participation

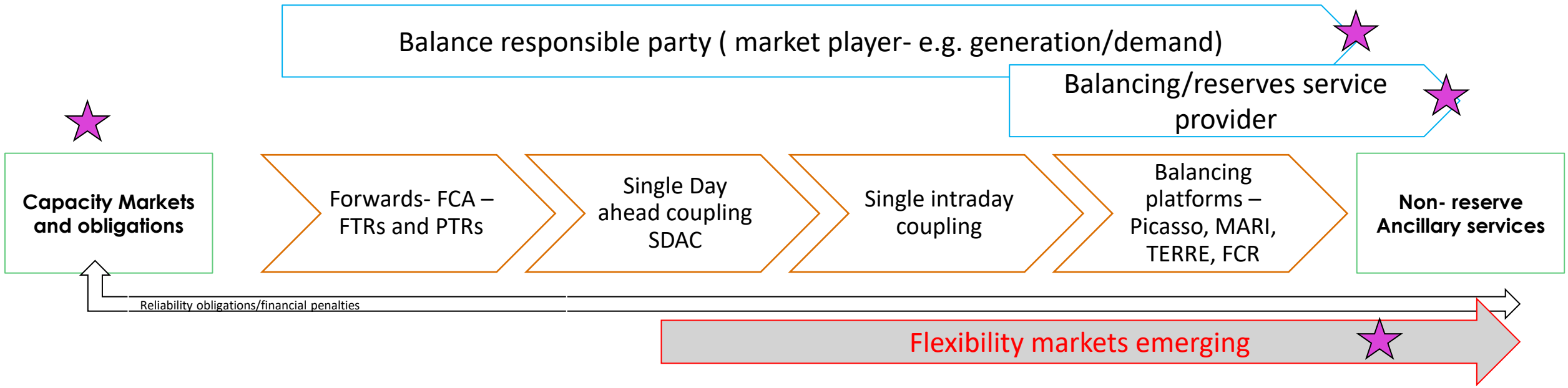
EU Regulation 2019/943,2024/1747, EU Directive 2019/944 and 2024/1711

"well-functioning, integrated electricity markets, which **allow all resource providers and electricity customers non-discriminatory market access**,... **enhance security of supply and flexibility through demand response, energy storage and other non-fossil flexibility solutions, ensure energy efficiency, facilitate aggregation of distributed demand and supply, and enable market and sectoral integration and market-based remuneration of electricity generated from renewable energy**"

- 'ancillary service' means a service necessary for the operation of a transmission or distribution system, including balancing and non-frequency ancillary services, but not including congestion management;
- 'non-frequency ancillary service' means a service used by a transmission system operator or distribution system operator for steady state voltage control, fast reactive current injections, inertia for local grid stability, short-circuit current, black start capability and island operation capability
- Member States shall ensure that transmission system operators and distribution system operators, when procuring ancillary services, treat market participants engaged in the aggregation of demand response in a non-discriminatory manner (and storage) alongside producers on the basis of their technical capabilities.
- Transmission system operators shall procure balancing services subject to the following:
  a) transparent, non-discriminatory and market-based procedures;
  b) the participation of all qualified electricity undertakings and market participants, including market participants offering energy from renewable sources, market participants engaged in demand response, operators of energy storage facilities and market participants engaged in aggregation.

Non-discriminatory approach to market participation for DER

Market timeframes – DER opportunities



DER participation Possible

- Year ahead
  - Financial transmission rights
  - Physical transmission rights
  - Balancing capacity products can also be long term
- Day ahead
  - 10.00 CET available capacities on ICS are published
  - 12:00 D-1CET gate closure
  - 12:45-12:57 hourly clearing prices announced
- Intraday
  - Continuous
  - 15:00 on D-1,
  - 22:00 D-1, and
  - 10:00 on D – intraday
- Balancing markets
  - Frequency containment reserve
  - Frequency restoration reserve (automatic or manual)
  - Replacement reserve

Wholesale markets and emerging market timeframes

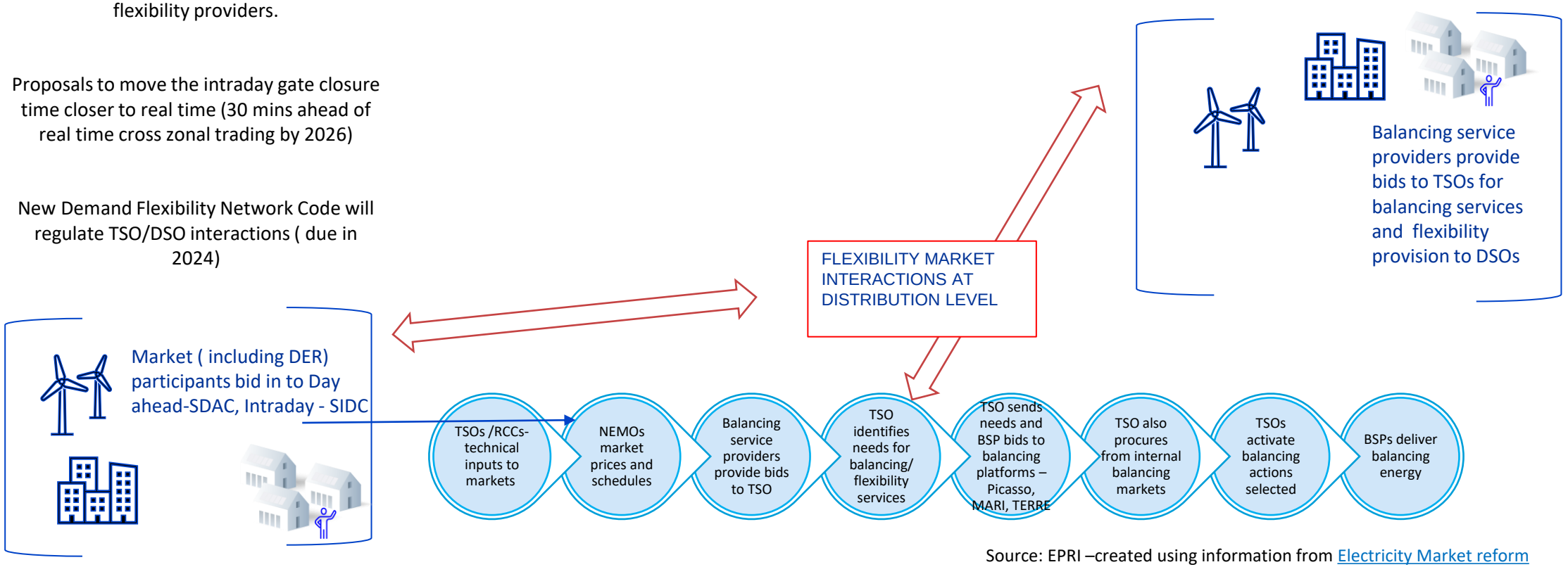
EU wholesale market/flexibility market developments

New regulations

- The minimum bid size for day-ahead and intraday markets should be lowered to 100kW (currently at 500kW) to facilitate greater participation by small scale flexibility providers.

- Proposals to move the intraday gate closure time closer to real time (30 mins ahead of real time cross zonal trading by 2026)

- New Demand Flexibility Network Code will regulate TSO/DSO interactions (due in 2024)

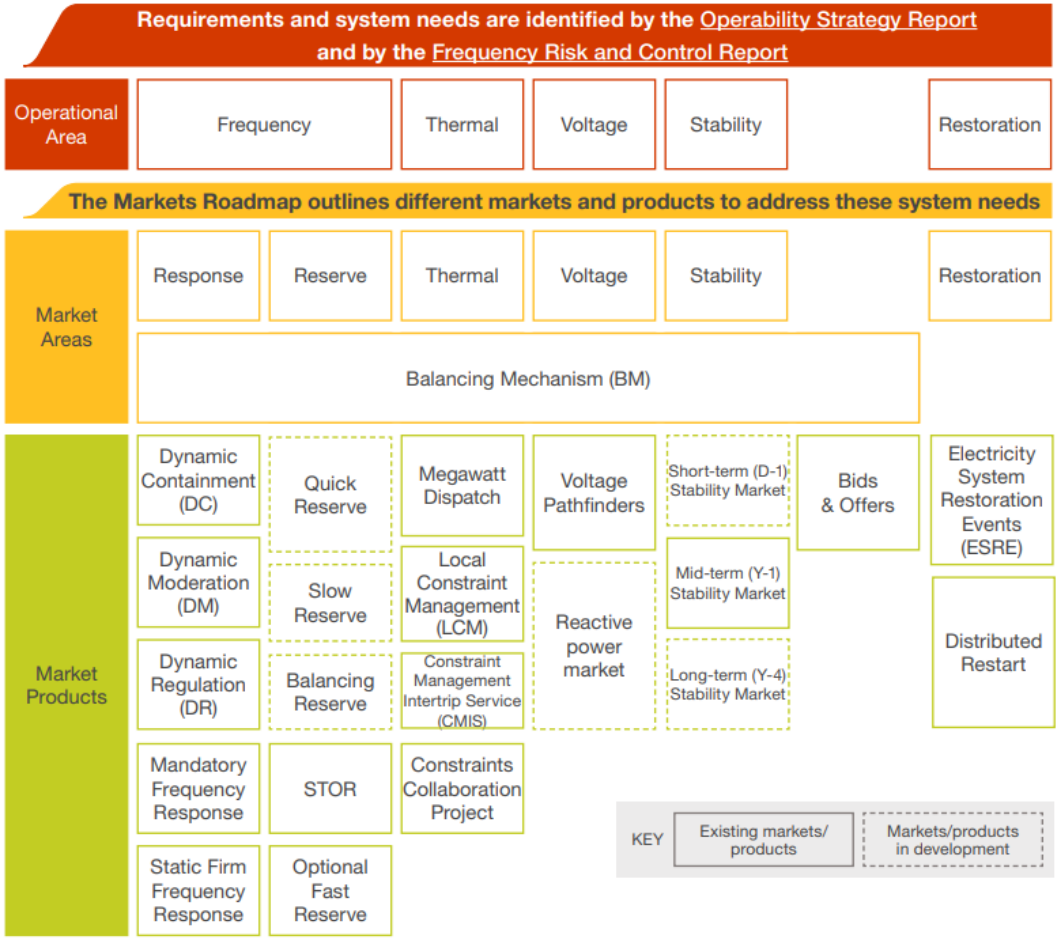


Source: EPRI –created using information from Electricity Market reform legislation and Network Code on Demand Flexibility

TSOs & DSOs have more autonomy in areas outside wholesale market design – flexibility markets, ancillary services

Great Britain Transmission system services

- Multiple markets, and constant change
- Multiple markets open to DER participation
- DNO/TSO innovation
- Joint market trials e.g. Power Potential for reactive power
- DSO flexibility markets interaction



Source: NESO Market Roadmap 2024

GB services open to DER participation

Transmission (Bulk) services available for DER participation	Dynamic response services	MW Dispatch service	Demand Flexibility service	Restoration services	Capacity Market
Service requirements	Respond to frequency deviations (within set point)	Reduce export to zero upon notification	Demand Flexibility service- turn down demand	System restoration post partial or total shutdown under instruction from the ESO	Contracted capacity to be delivered during stress events.
Use case for wholesale market operator.	Frequency containment and recovery - pre fault (Dynamic moderation, Dynamic regulation) and post fault (Dynamic containment)	Reduce export to zero to manage transmission pre fault thermal constraints	Demand response to manage peak load events	Restoration of system using distributed energy resources (solar, wind, storage, hydro)	Resource adequacy management
Eligibility criteria to provide service (e.g., min participation MW)	1MW min, automatic activation. Open to all distributed generation and demand response, and storage. DSO connected assets are eligible- can be aggregated behind a transmission/ distribution interface location	1MW - with plans to reduce	From domestic consumers (through aggregation) to large energy consumers eligible - minimum aggregated quantity 1MW	10/15MW minimum block size - multiple technology types from distribution network connections	1MW
Prices/ payments/ incentives. Are these tied to any technical parameters?	Availability only- pay as clear	Utilization payment (no availability) Prices submitted day ahead- pay as bid	Price floor for Winter 2022/2023 and first half Winter 2023/2024. Competitive tendering for early 2024.	Availability payment (£/settlement period) + possible Contribution sums – these payments are available to new or refurbishing plant only. NGESO may choose to contribute towards the provider's costs.	Recent auction T-1 2024/2025 had a clearing price of 35.79 GBP. DSR is derated at approximately 75%
Procurement process (e.g., auction, program, RFP, etc.), including market timeframes (day-ahead, real time) as relevant.	Auction day ahead	Day ahead price submission	Competitive tender for winter periods	Tenders - contract length 5 year	Auction T-1 and T-4

DER-provided wholesale services in the EU (1/2)

Country	Aspect	Standard/Trial /Support	Network Operators Involved	High Level Description
Netherlands	FFR, FCR, mFRR, aFRR	Standard	Tennet (TSO working with Dutch DSOs)	• Successful integration of storage, wind and solar participants, and aggregated assets into several reserve segments- via Crowd Balancing Platform • Specific requirements for DSO interaction if assets participating are located on DSO network • Specific requirements for data protection for Household asset participation
Netherlands	GOPACS congestion management	Now standard	Tennet(TSO), Alliander , Coteq, Enexis, Liander, Rendo, Stedin, Westland Infra	• Address a lack of network capacity and increase resilience • Enables trading by TSO and DSO and partipation by multiple resources • Enables trading via EPET and EPEX (existing wholesale trading platforms) • Aims to enhance both TSO/DSO and DSO/DSO coordination • Redispatch intraday (via trading platforms), Congestion bid obligation contract – Grid operator/CSP, Capacity limitation contract with day ahead
Sweden	FCR- N, FCRD, aFRR mFRR	Trial and now minmum bid size is 100kW for participation		Successful trial enabled the provision of reserve services from multiple DERs. Has led to reduction in minimum bid sizes for standardised procurement

Table 1. Overview of participation in the pilot study by technology and ancillary service.

Technology	Ancillary service	Prequalified capacity (MW)
Consumption	FCR-N	0.2
Solar power	FCR-D down	10
Wind power	FCR-N	150
	FCR-D up	167
	FCR-D down	324
	aFRR up	150
	aFRR down	200
	mFRR up	150
	mFRR down	150

DER-provided wholesale services in the EU (2/2)

Country	Aspect	Standard/Trial /Support	Network Operators Involved	High Level Description
Germany	FFR, FCR, mFRR, aFRR	Standard	TSOs- Tennet, 50Hertz , Amprion, Transnet BW,	• Standard requirements as per EU regulations • Minimum bid size of 1MW for FCR , 5MW for aFRR, mFRR
Germany	Redispatch 2.0	Due to be come standard but stalled	TSOs- Tennet, 50Hertz , Amprion, Transnet BW, DSOs (870)	• Every asset greater than 100kW must participate- 100,000 assets interacting with 870DSOs • TSO and DSO oversight • Greater responsibility for all participants
France	FCR, aFRR, mFRR	Standard	RTE and DSOs	Open to all providers on distribution networks- however minimum bid size is 10MW for mFRR Aggregation model is in place – multiple sites/ BRP and 1 metering point
France	Capacity mechanism (resource adequacy to meet peak demand days)	Standard	RTE	Decentralized mechanism – suppliers obliged to buy sufficient certified generation to meet peak demand days. DER must meet contracted volume (generation/demand response) on 15 peak days for consumption & 25 days for generation during November-March. Peak days notified D-1 by RTE. 1MW min (aggregation possible for sites under 1MW) Annual auction 4 years ahead Marginal pricing - pay as clear . Penalties if non-delivery/not enough capacity maintained (assessed in Year Y+3 for year Y)

EU & GB Distribution services

DER Flexibility Programs in European Countries

	France (Enedis Tenders)	Germany (enera)	Netherlands (GOPACS)	Sweden (sthlmflex)	UK (DSO Tenders)
Market-Based Procurement of Flexibility (Maturity)	**Commercial Procurement (Early Stages)**	**Hybrid model under discussion** (cost-based for generation + voluntary market-based for load)	**Advanced Trial Phase**	**Trial Phase**	**Commercial Procurement**
Targeted DER Flexibility Services					
Network Deferral	✓			✓	✓
Congestion Management	✓	✓	✓	✓	✓
Reliability Enhancement	✓			✓	✓
Network Re-energization					✓
System Balancing				✓	
Buying Parties					
DSO	✓	✓	✓	✓	✓
TSO		✓(Congestion)	✓(congestion)	✓ (Balancing and congestion)	
Network operators' coordination					
Procurement Rule	N/A	DSO over TSO	Separate Procurement	DSO over TSO	N/A
Security Coordination	None	Cascading Top-Down	TSO/DSO analysis	Subscription Rights	None
Metering					
Connection Meter	✓	✓	✓	✓	✓
Sub-meters				✓	

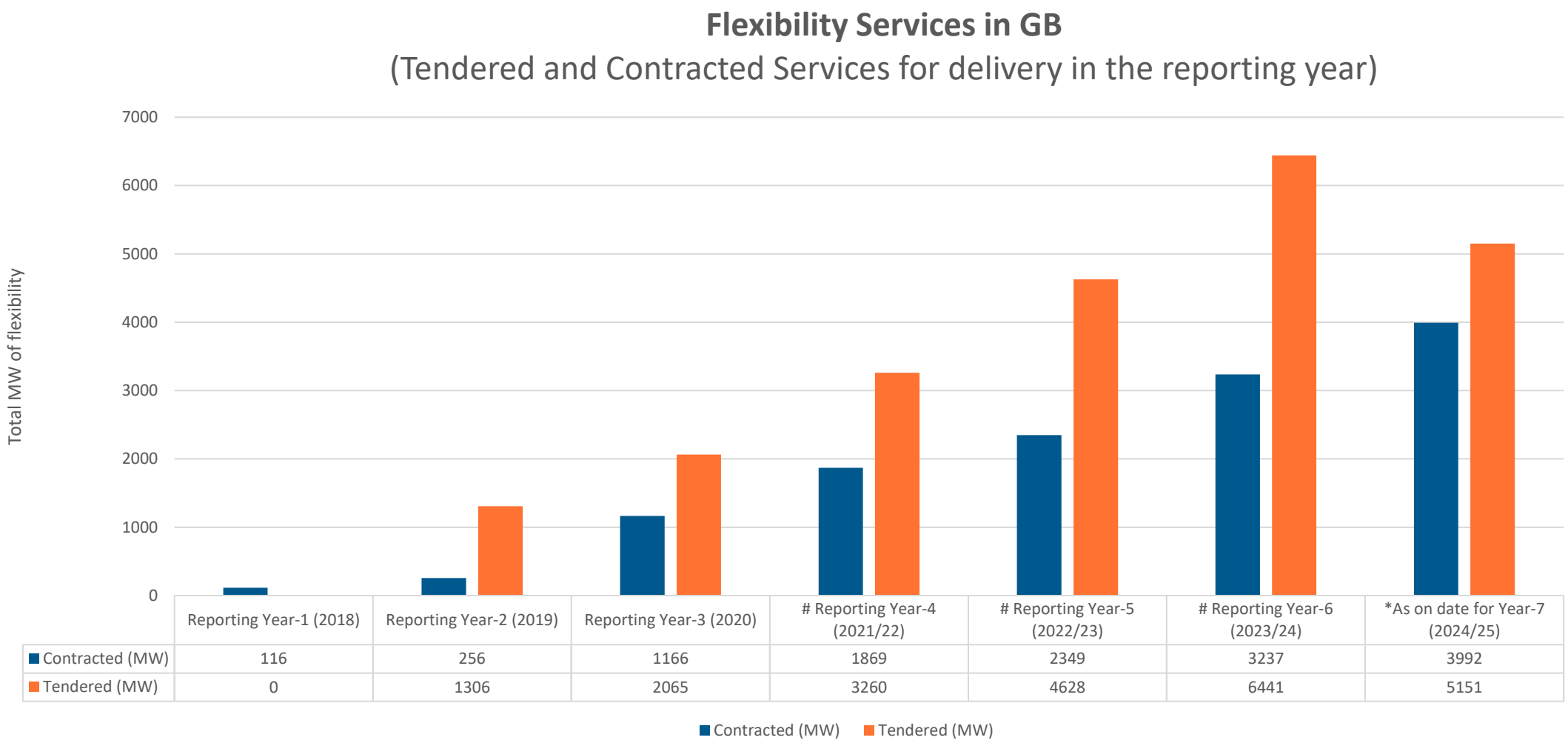
UK – The Four Flexibility Products *(Distribution Services)*

Product / Service	Sustain	Secure	Dynamic	Restore
Description	DERs pre-emptively reduce peak demand at point of contract by flexing supply up-down per a schedule.	DERs provide a scheduled response to manage peak loads and prevent system violations.	DERs provide immediate response following a fault (often during summer maintenance work) or during unplanned network event.	DERs provide immediate response to restore electricity following an unplanned network event.
Case	Scheduled Constraint Management	Pre-Fault Constraint Management	Post-Fault Constraint Management	Post-fault Network Restoration
Availability Payment	Yes, for scheduled availability pre-agreed within contract	Yes, arming payment for availability at week-ahead	Yes, arming payment for availability at week-ahead	No
Utilization Payment	Yes	Yes	Yes	Yes
Availability Declarations	Week-ahead. By midnight every Wednesday for the following week (Mon-Sun)			
Availability Acceptance	Week ahead. By midday every Thurs for the following week (Mon-Sun)			
Dispatch Notice	Fixed within contract; notice sent 15 min. ahead of requirements	Fixed week-ahead on acceptance of availability; notice sent 15 min. ahead of requirements	Notice sent 15 min. ahead of requirements	

Source: DER-Provided Distribution Services: Field Experiences. EPRI, Palo Alto, CA: 2021. 3002021411.

UK – Flexibility Services Tendered and Contracted (1/2)

- **By June 2024** - The figures for the the past 12 months show that the utilities have tendered for 6.4 GW of flexibility, of which 3.2 were contracted.

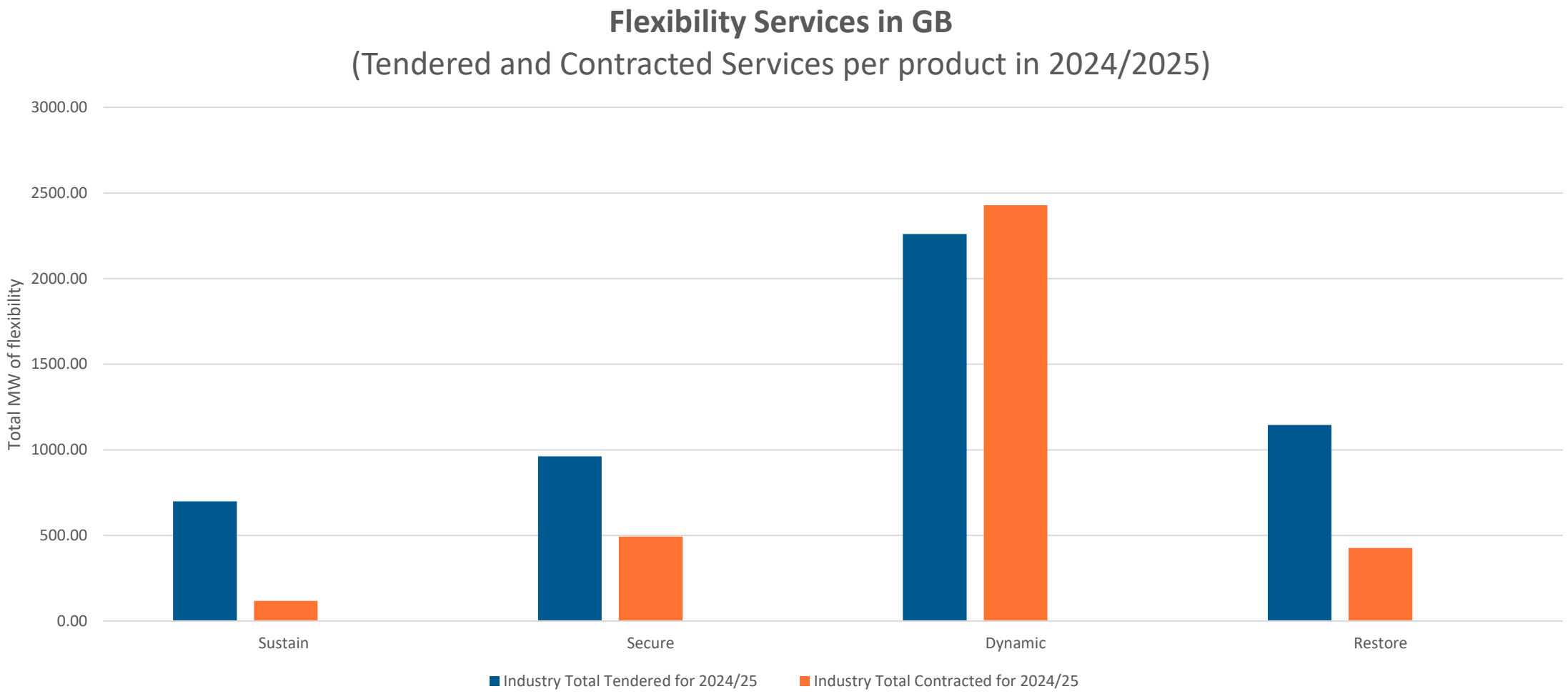


	Reporting Year-1 (2018)	Reporting Year-2 (2019)	Reporting Year-3 (2020)	# Reporting Year-4 (2021/22)	# Reporting Year-5 (2022/23)	# Reporting Year-6 (2023/24)	*As on date for Year-7 (2024/25)
Contracted (MW)	116	256	1166	1869	2349	3237	3992
Tendered (MW)	0	1306	2065	3260	4628	6441	5151

Source: ENA GB Flexibility Figures 2023/2024

UK – Flexibility Services Tendered and Contracted (2/2)

- **Dynamic** is the most tendered and contracted of the flexibility products (2024/2025)

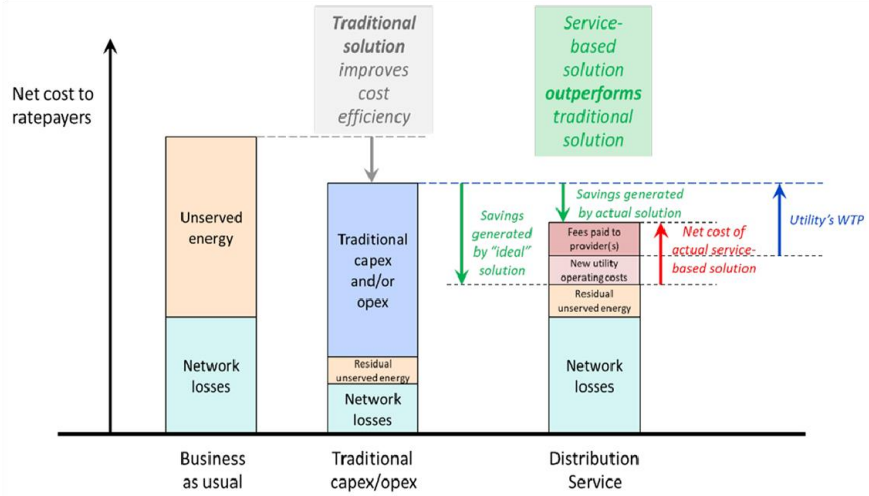


Source: [ENA GB Flexibility Figures 2023/2024]

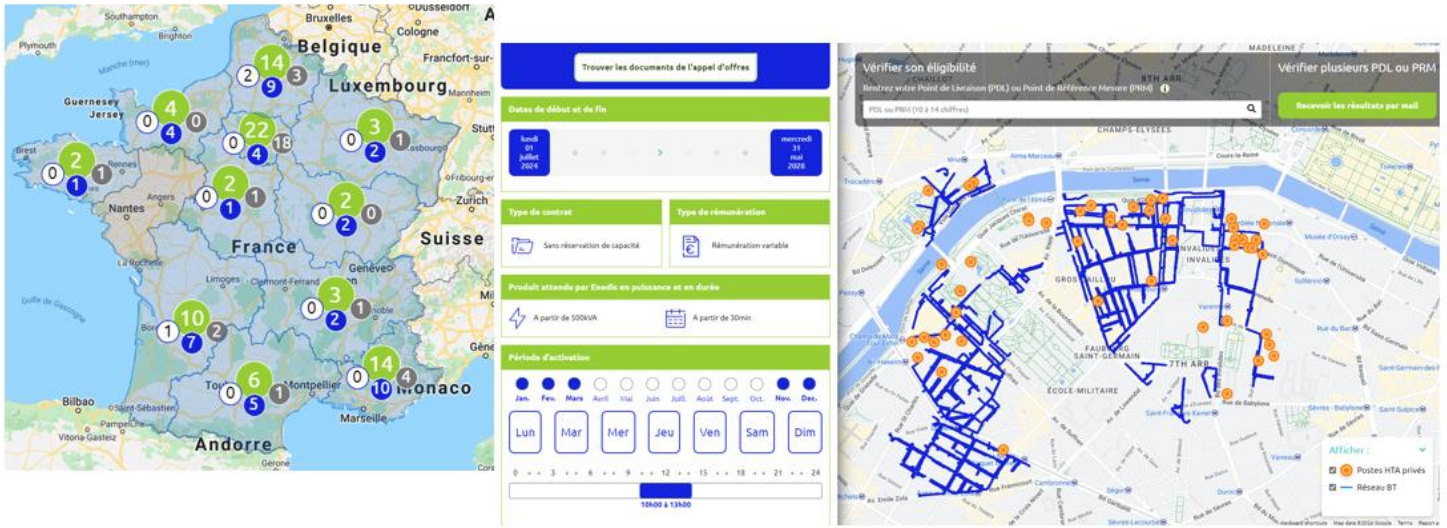
France – Distribution Services Procurement by Enedis (DSO)

- ENEDIS employs a **two-step process to identify and competitively procure distribution service opportunities**
- ENEDIS **also provides an estimation of activated flexibility that will be needed in MWh/annum and the maximum activation period**
- ENEDIS categorizes flexibility products into three types, each based on the system conditions prompting their activation:
  - **I. Abnormal Conditions**
  - **II. Abnormal Conditions due to Maintenance or Construction Work**
  - **III. Normal Work Conditions**
- Service activation is still rudimentary
- **ENEDIS and the French TSO expect minimal operational impacts** in the transmission domain from flexibility activations in the distribution domain, primarily because **there are currently few DERs providing these distribution services**

Final comparison of traditional vs. actual service-based solutions



Source: Procuring Distribution Services From Distributed Energy Resources: Progress Reports from the United Kingdom and France. EPRI, Palo Alto, CA: 2021. 3002024647. Adapted from ENEDIS

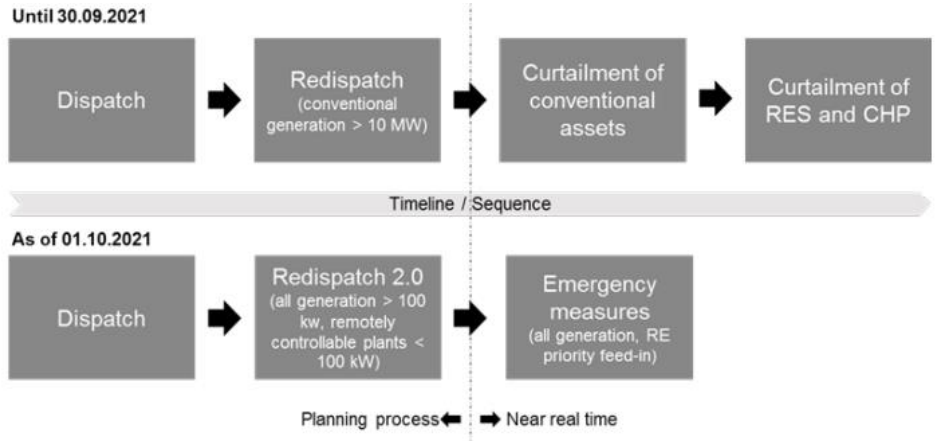


Source: https://flexibilites-enedis.fr/

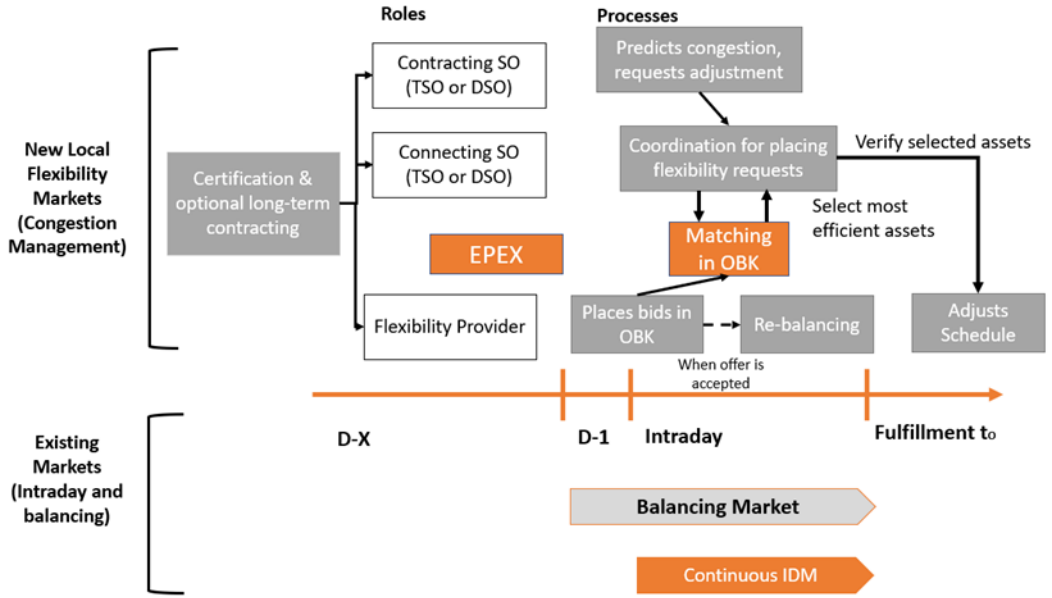
Germany – enera Flexmarkt

- In Germany, **congestion management incurs substantial costs, particularly at the transmission network level**
- **Redispatch 2.0** (3.0 under implementation) **mandates a cost-based approach** to resolving network congestion issues (DERs > 100 kW)
- **Flexibility products for short-term congestion management** (up to TSO level) were traded in the enera marketplace.
- **Trade was organized in 23 different local market areas**, each one corresponding to a local transformer
- **Flexibility trading was starting when a network operator was predicting a congestion**, and a notification was sent to FSPs through the market platform and via email.
- **Coordination between TSO and DSO was made in a cascading top-down direction**: the upstream system operator informed its downstream counterpart about the amount of power to procure via the marketplace and notified its congestions
- **Settlement was based on a comparison of the metered input** (or output) of the flexibility assets
- **Smart Data and Service Platform (SDSP)** served as an overarching collection of information and data for source and target systems

Redisptach 2.0



enera Flexmarkt



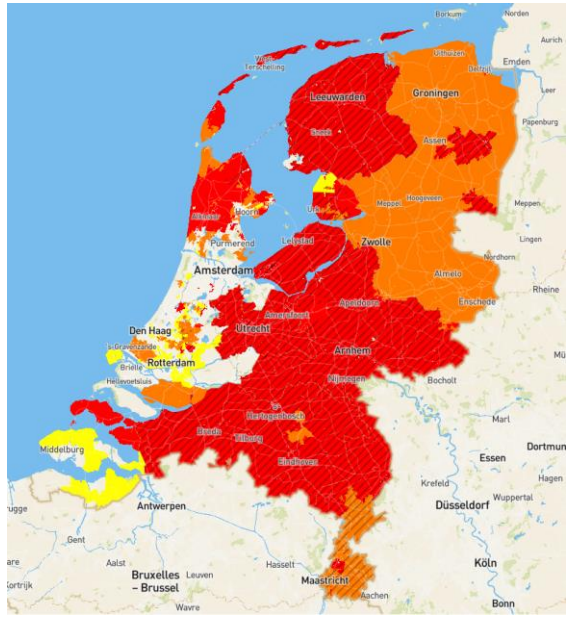
Source: Enera, Using enera's experience to complement the upcoming redispatch regime with flexibility from load& other non-regulated asses

The Netherlands – GOPACS

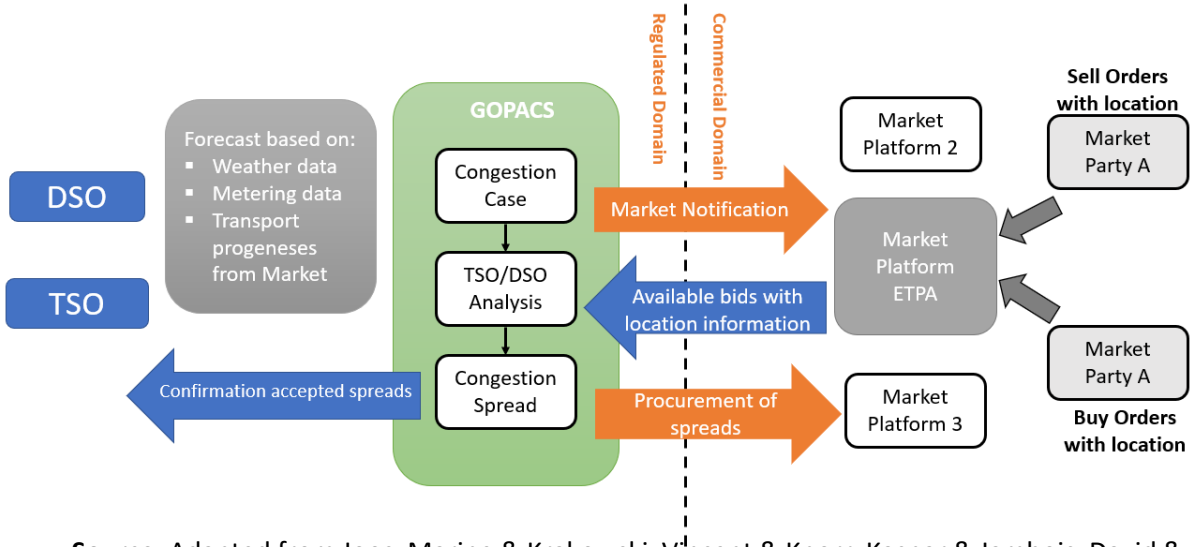
- Dutch power networks **face capacity shortages at the distribution level**, leading to congestions, and also delays by new customers seek to connect to the grid.

- **Dutch DSOs have been developing decision-making tools to understand when to activate DER flexibility**

- **GOPACS (Grid Operators Platform for Congestion Solutions)**
  - One of the first **TSO–DSO coordination platforms implemented for solving network congestions**
  - **Grid operators pre-announce their flexibility needs** (volume, time, duration and direction) to solve congestions **in specific areas** (defined with postal codes and/or regions) less than 24 hours before activation
  - Like the wholesale intraday market, **GOPACS employs pay-as-bid pricing** and acts as a continuous procurement mechanism.
  - Operators procuring flexibility to address congestion issues must also, in parallel, **correct for any potential unbalance** that could result.
  - **Network operators procure a combination of two orders – one addressing the congestion, and another addressing the potential power unbalance** that could result from dispatching a DER to address the congestion



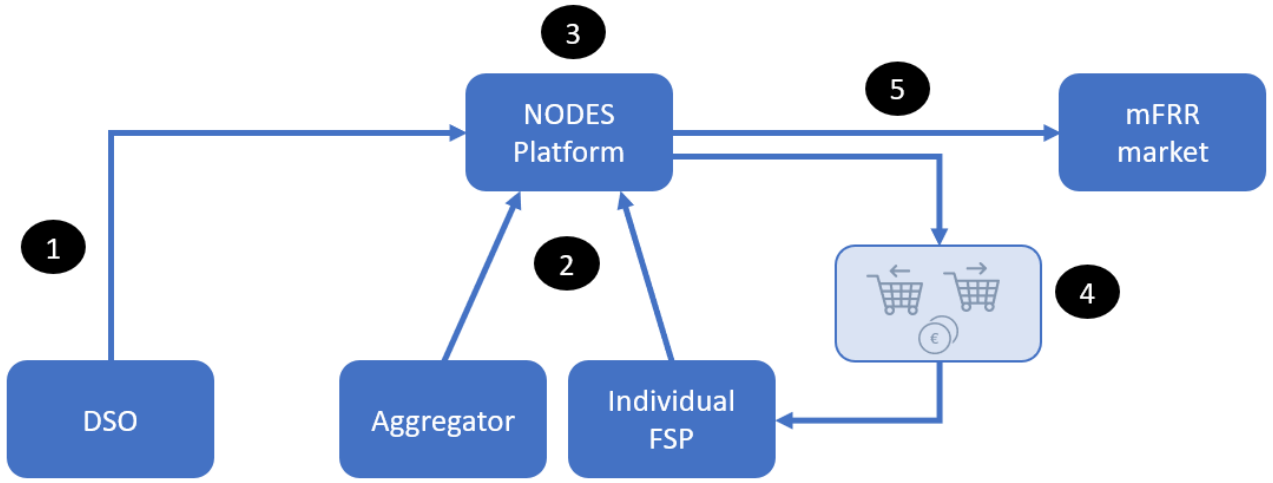
Source: https://capaciteitskaart.netbeheernederland.nl/



Source: Adapted from Joos, Marine & Krakowski, Vincent & Knorr, Kaspar & Jambois, David & Godard, H. & Vandenbergh, M. & Wabbes, A. & Tolstrup, Ksenia. (2020). State-of-the-art of regional markets from the research to the implementation level.

Sweden – sthmflex project

- The sthlmflex flexibility marketplace was introduced in the Stockholm area to **tackle distribution network capacity constraints**
- The platform **seeks to improve coordination between TSOs/DSOs and DSOs/DSOs**
- **DSOs procure congestion management services from FSPs, while the TSO purchases mFRR** (manual Frequency Restoration Reserve) services



Source: Adapted from S.Faregard and M.Miletic, A Swedish Perspective on Aggregators and Local Flexibility Markets, KTH, 2021

1. **DSOs identify upcoming congestion issues**, specifying the location, required flexibility volume, and timing. This information is posted on the NODES market platform.
2. **FSPs and asset owners register their assets** (e.g., heat pumps) on NODES, detailing any constraints and meter points.
3. **Trading occurs on NODES**, with DSOs posting the price they are willing to pay for a specific volume and timeframe. FSPs enter their price, volume, and time, and NODES creates a merit order stack for DSOs to purchase flexibility at the lowest cost.
4. **Once a trade is matched, the FSP manually activates the service**. After delivery, the DSO validates the service, and NODES handles the transaction between both parties.
5. **If an FSP isn't matched on sthlmflex, it can enter the mFRR (wholesale) market**, provided it has registered interest and meets the participation requirements.

Conclusions

1. All regions surveyed have mature wholesale electricity markets
   - Ongoing efforts to enable greater DER/DERA participation
   - Effective participation currently limited
2. Distribution service markets are still emerging
   - Several utilities already conducting competitive procurements (regulatory push)
   - Volumes procured so far remain relatively small
3. Value stacking use cases are being discussed in all regions
   - Some value stacking frameworks defined (e.g., dual participation in NY)
   - Value stacking remains largely anecdotal across regions surveyed
   - Stakeholders universally agree that value stacking should not compromise performance

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