Grid Modernization and DER:

Resilient, Complex, and Affordable; Pick Any Three

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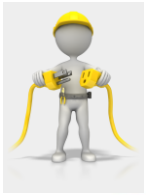
BLUF (Bottom Line Up Front)

The primary barrier to Grid modernization is the tension between:

- Utility capitalization and control/ security/ e-protection of assets
- Recognizing customer Behind-the-Meter (BTM) assets as Grid assets, ultimately with equal (but different) signaling/control/security

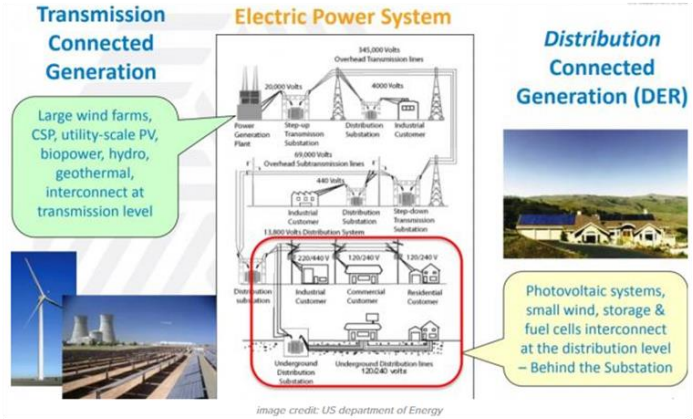
... Compounded by the fact that the system-level merger of these assets is not a Utility-owned and incented issue

- Indeed, this includes barriers that are implicit in viewing 'The Grid' as a Transmission-dominant domain
  - Transmission is a capital-intensive (and profitable) domain that has been engineered over many decades to address reliability and resilience, as opposed to the more 'messy' emerging Grid Edge and Distribution complexities, with millions of market actors and vulnerabilities, and yet-to-be engineered system-of-systems (SoS) solutions



Definitions (mostly as 'What I DON'T mean...')

Distributed Energy Resources (DER; [DOE image])



The word "connected" is essential
... although DER is not just generation

Any power not connected to Transmission, nor (for this briefing) Utility-Owned, nor an unknown/dumb load (i.e., not a "Resource")

Grid Modernization (aka Grid 2.0, Smart Grid; [IEEE image])

A parallel image? ... No. All examples just 'connect everything' and add a 'central control' asset (... which needn't exist)

NOT included is ongoing Grid evolution via AMI, advanced Sychrophasor (etc.) enabled switchgear, dynamic rating, autoclosers, etc.

Some More Definitions, Trends, & Assumptions

The Grid is typically defined to 'end' at the load (i.e., consumers' meters)

Consumer assets, both active (whether as generation or controllable load/PQ) and passive (as potentially designed-to 'known behaviors'), **are not viewed as Grid components**

- This view is common, in most cases, to both the Utility and the Consumer
- **Control of Behind the Meter (BTM) assets is infrequent** (generally as pilots), **and typically owner-initiated upon review of market signals**

The scale at which these BTM assets are being deployed is accelerating

- With regard to Distributed Energy Resources (DER), **D-connected small/medium powerplants** (~ 1-20 MW) are increasing (both BTM and FTM), and **are the focus of Industry activity** (e.g., 'Distribution System Operator' market actors/definitions) ... **BUT**
- **<u>This briefing focusses on smaller and seemingly 'market incidental' DER</u>**: consumer and prosumer (i.e., producing consumer) assets

These 'Incidental' DER Assets Dwarf Many Utility Assets

... or will soon, and the utlities won't be paying for them

The Utility industry has accommodated, even embraced, certain DER and DER functions, largely per existing markets or regulatory direction

- DER Resource Planning (initially C-PUC, now elsewhere)
- Non-Wires Alternatives (NWA), dominantly per legislated pilots and on-ramps
- Distribution-connected Utility power, proximal to loads (even as microgrids)

... My belief is that <u>this</u> type of DER is not the largest influence on Grid modernization

There is a MUCH larger set of 'unused', marginally accommodated DER (mostly as an irritant to Grid operations), or viewed as load impacts (e.g., PQ, forecasting)

- Residential solar (also as 'millions of networked inverters'), electric vehicles & chargers (ditto), smart homes/buildings, and other emerging energy commodities

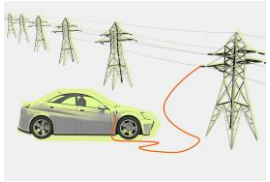
But just how much larger ...?

Residential DER, EOY 2020 and 2030

Residential solar (interconnected) 19.2 GW; May quadruple by 2030 (SEIA)

1% of vehicles (1.8M) are plug-in EVs; Projected to increase to 7-21% of 350M vehicles by 2030 (per 9 major indices; Argonne/DOT)

- **100GW / 100GWh TODAY (if as 50kW V2G), on the road only 5% of the time**
- **So, (lowest projection) as 700GW/700GWh by 2030**
- **Total Utility Energy Storage Systems today ... 96% of it as pumped hydro and 3% of it battery ... is 23GW (~1GW/3GWh battery)**



Networked smart thermostats: 40M, CAGR through 2030 as 12-29% (GTM)

- **Independently as new homes construction and efficient 'smart home' refurbs or just HVAC control**
- **Future smart energy foci? (e.g., State Farm DSPs w/ future networking, Utility signaling)**

Reflects declining prices, increased resilience expectations, rising yet controllable energy costs, and social/environmental desirements

Grid efficiency, with an 'unclaimed' SoS pedigree (and complicated by an IoT that will triple in 10 years to 5.5B devices), could meet, as an example, 95% of the forecasted 23% ERCOT 2030 load growth (Statistica, ERCOT 2020 LTLF, ERCOT Market Summit 2020)

So Back to the Briefing Title, and Those Definitions ...

“Grid Modernization and DER:” (You now have an idea of my intended scope)

... “Resilient, Complex, and Affordable; Pick Any Three”

Resilient: Massively redundant; Widely distributed; Flexible/reactive; Real-time decentralized peer-to-peer transactions (assumes increased transparency of same)

Complex: IoT scale of assets (commensurately addressing Utility-quality security/system protection/safety concerns with TBD future Standards); Dynamic market of competing resources; Rapidly evolving tech baseline/standards; Utility and aggregator roles in TBD market management system (e.g., DSO support of clients, also with RTO/ISO influences); **CULTURE of change**/Utility/equity/environmental/market impacts

Affordable: Valuation of Prosumer/Consumer assets and actions (also as massive infusion of customer-provided capital); Higher system efficiencies; Flexible market-based evolution; Massive pairing of storage and increased renewables

All good, but one last problem ... Define who’s doing the “Pick”

- Including differences between regulated/deregulated markets, degree of existing Utility modernization, capacity/power markets, Verticals/Munis/CoOps, etc..

BACKUP:

The Existing/Emerging Utility DER Space

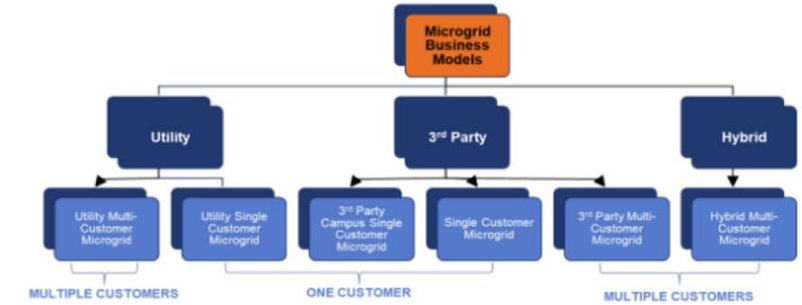
Deregulated Markets: TDU Relationship with BTM Resources

(Applicable to BTM, FTM, and ATM microgrid cases)

TDU control of both BTM and FTM microgrids can be an NWA asset, to be used only under specifically regulated Grid conditions

TDUs routinely engage 3rd parties operating in the competitive market to conduct T&D operations. Constraints such as those to the right (SEPA, 2019) would apply

Across the various microgrid models, these could include:



Source: Smart Electric Power Alliance. 2019.

Grid Interaction:

- *Apply interconnection standards at the point of common coupling*
- *Explore the need to enhance interconnection standards for storage and islanding*
- *Coordinate with non-PSC permitting standards depending on the size of the microgrid and if it crosses public rights-of-way*
- *Consider renewable portfolio standard (RPS) and emission reduction standards and policy goals for distributed generation and electricity imports of the microgrid*

Customer Interaction:

- *Ensure that customers outside of the microgrid are not negatively impacted by the microgrid*
- *Ensure that customers within the microgrid are entitled to the same customer protections and consumer rights as those outside of the microgrid, including customer choice*
- *Ensure that customers within the microgrid are subjected to appropriate PSC and legislative billing surcharges to support the grid and low-income customers*

of higher electricity quality of service. Regulators can determine if microgrids which provide electrical service to multiple customers should be held to stringent reliability and safety metrics standards similar to those for utilities.

Key considerations and best practices for regulators determining appropriate performance standards of microgrids are listed below.

Performance Standards:

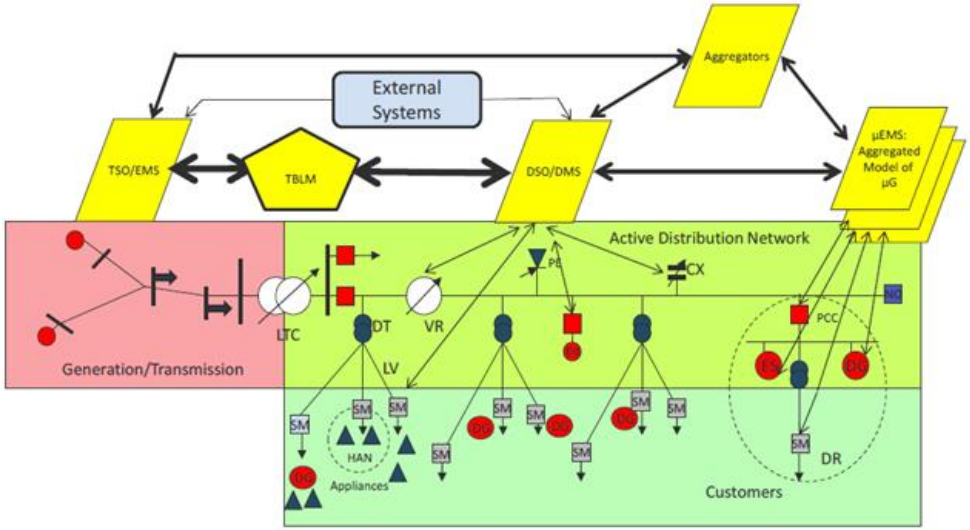
- *Identify jurisdictional safety and electrical performance codes to apply to microgrids depending on the size of the microgrid and/or whether it incorporates utility distribution infrastructure*
- *Determine the appropriate electricity quality of service requirements. If the microgrid serves multiple customers, crosses public rights of way, and/or incorporates utility distribution infrastructure, it may fall into the jurisdiction/oversight of the regulator*

The determination of whether or not microgrids serving multiple customers falls into the realm of a regulated entity is often left to legislators. If legislators decide these types of microgrids should have their own regulatory designation, then the framework.

Potential Utility Interaction with Private Microgrids/Aggregators

Future Distribution System Operator (DSO) functions could include (with regulatory review/change):

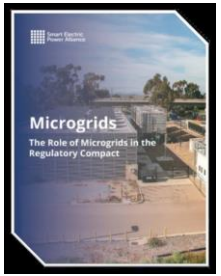
- Information Support for Coordination of EPS and Microgrid Load Shedding Schemes
- Coordination of Volt/Var control in Connected Mode under Normal Operating Conditions
- Update aggregated at PCC real and reactive load-to-voltage dependencies under normal operating conditions
- Updates of capability curves of the microgrid's reactive power sources
- Updating information on microgrid dispatchable load
- Updates of the information on overlaps of different load management means within microgrids
- Updating dependencies of the microgrid operational model on external conditions
- Update aggregated at PCC real and reactive load-to-frequency and load-to-voltage dependencies in the emergency ranges



Source: Smart Electric Power Alliance 2019

Microgrid Regulatory Environment: Incomplete, Evolving

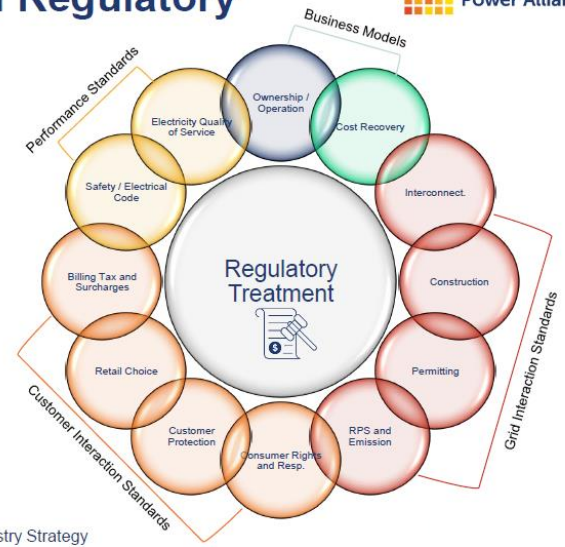
SEPA (2019) assessed the various regulatory treatments of microgrids in U.S. markets



In general, existing regulation allows (although inconsistently) the presence of microgrids … as DER for on-Grid services, and interconnect for islanding …, but:

- Has no consistent means to value resilience
- Undervalues customer, Utility, and Grid benefit
- Is complicated in multi-customer configurations
- Is complicated with regard to impacts and benefits to non-participants (i.e.; rate base)
- CA, HA, IL, and NY have specific microgrid legislative/PUC constructs, some now as Utility tariffs and market rules

Buckets of Microgrid Regulatory Treatment



Source: SEPA Industry Strategy