Major Evolution of the Utility Paradigm

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1. Introduction

The electric utility industry has operated under the paradigm that big generators are sufficiently more efficient than small generators to justify the considerable expense of the T&D network required to get their energy to widely distributed loads. This has been the case since Tesla and Westinghouse invented the modern electric utility industry (to a lesser extent Edison, who actually invented DC microgrids). But what if this was not true, at least in some cases?

The answer to the above question appears to be: this assumption is no longer true in limited cases, and this will start an evolution of the grid's structure.

The title evolution will not be rapid, nor will it initially be universally applicable, but it will start in the next year or two, and it will progress relentlessly for the next few decades. I am fortunate to have a front seat for this evolution because I have two homes. One in the suburban San Francisco Bay Area and the other is 120 miles away in eastern Calaveras County's Sierra Nevada Mountains. The former will not participate in this initial evolution and the latter probably will.

For areas with widely dispersed small communities that are susceptible to wildfires and thus public safety power shutoffs (and other widespread outages), the California Utility organizations appear to have made the determination that these would be better served by microgrids rather than the traditional grid. This post is about this evolution and its implications.

Since I have written on this subject before, I am referencing two earlier posts that have additional information on this subject.

Microberg: This post from January covers three subjects related to using microgrids to mitigate Public Safety Power Shutoffs (PSPS): (1) a bill on its way through California's Senate that hopes to help achieve this, (2) a recent ruling by the California PUC that "facilitates commercialization of microgrids across California, and strategies for procurement of backup power in advance of the wildfire season…", and (3) how microgrids and distributed power might operate cost-effectively.

https://energycentral.com/c/cp/microberg

The Five Dimensions of Microgrids: In June 2020 I posted a two part series on PG&E's likely reorganization details. One of these details is how they intend to mitigate the Public Safety Power Shutoffs (PSPS) used to reduce the chances of sparking additional wildfires. Although there were multiple actions to do this, the primary strategy for remote parts of their service territory was a series of 20 microgrids. These will allow long stretches of transmission line to be de-energized while keeping the remote consumers powered. This posts explores how this might be done.

https://energycentral.com/c/cp/five-dimensions-microgrids

2. This Evolution is best for everyone

As I pointed out above, I have a home in Eastern Calaveras County. Going up the hill on Highway 4 from Angels Camp, there are two communities with a population of about 4,000 (Angel's Camp and Arnold), one community with a population of around 2,000 (Murphys), maybe seven communities with populations in the low hundreds plus additional scattered smaller groupings of homes. The distance (as the crow flies) from Angels Camp to the eastern-most community (Bear Valley) is about 40 miles.

As I'm starting to write this paper in mid-February, this area has just recovered from an extended outage. This outage impacted Bear Valley first. I was up there then and drove to Bear Valley for some XC skiing. It was a real slog because PG&E had trucks all over the place restringing downed power lines. They must have had 50 trucks with at least 30 being their largest bucket trucks.

Then another wintery blast hit and took out power down to Arnold (where my house is). It took them more than a week to completely restore power to everyone in Arnold.

Yes, this was very inconvenient for the utility customers in the impacted areas, but what about the massive expense for PG&E. Hello microgrids.

3. PG&E's Plans

The primary sources for this section are referenced at the end of this paragraph. As the older post referenced in the intro indicated, PG&E has been planning (at least) 20 microgrids for over a year. An August, 2020 CPUC workshop provided sample microgrid solutions from vendors including Tesla, Sunrun, Bloom Energy, FuelCell Energy and Enchanted Rock, as well as presentations from two Northern California community-choice aggregators building renewable energy microgrids.[1]

In response to the workshop PG&E filed a report it commissioned from ADL Ventures to evaluate possible courses of action and that report was submitted to the CPUC in September, 2020. The following text is mainly from this report and is linked in reference 1.

The initial suggested solutions in this report were either:

- Large diesel generators initially used by PG&E to mitigate the effects of public safety power shutoffs
- Natural Gas, biomethane- or hydrogen-fueled reciprocating engine generator sets (which I assume includes propane-fueled or bio-propane units). Note that biomethane is, sometimes called renewable natural gas or RNG.

[1] Three references were initially used, two articles by Jeff St. John of Greentech Media (GTM): "PG&E Plans Utility-Owned 'Remote Grids' for Isolated Communities", Feb 2, 2021, https://www.greentechmedia.com/articles/read/pge-plans-utility-owned-remote-grids-for-isolated-communities?utm_medium=email&utm_source=Storage&utm_campaign=GTMStorage , and "California Faces Big Challenges to Microgrid Plans for Wildfires and Outages", Dec 10, 2020, https://www.greentechmedia.com/articles/read/californias-microgrid-plans-for-wildfires-and-outages-face-major-challenges , and a Report filed by PG&E with the CPUC on Sep 25, 2020, https://adlventures.com/casestudies/clean-energy-and-energy-resilience/

- Natural Gas, biomethane- or hydrogen-fueled combustion turbine generator sets (I assume microturbines).
- HVO fuel (Hydrotreated Vegetable Oils) used in diesel generator sets. HVO is basically a second generation biodiesel fuel.

The reason for the initial preference for these solutions is that a reciprocating engine-generator set or combustion turbine gen set are the only solutions that have both the compact size necessary to be placed adjacent to most small substations, the spinning mass required for microgrid stability, and the ability to black-start.

Another initial conclusion was that a generation resource that was only used during PSPS events (especially one of the options described above) is not viable going forward: the cost of installing and fueling this could not be economically justified by the few times per year it would be needed.

Another conclusion of the report was that if consideration is given to a generation resource that was only used during PSPS events, the served load should be reduced during these events by some combination of demand response and/or distributed resources. This would primarily be driven by specialized tariffs applied to the affected facilities, although the report thought that these are probably not politically viable for most consumers.

Note that the above paragraph is similar to suggestions that I made in “The Five Dimensions of Microgrids”, which is linked in the introduction to this paper.

An interim conclusion seems to be: *Getting more power out of the substation footprint is one thing, but the real opportunity comes from thinking beyond the substation. If parking lots, rooftops, and garages throughout the load pocket become grid assets, power density no longer becomes the gating constraint. If 1) the non-trivial challenges of integrating a high-penetration of distributed energy resources (DERs) into a distribution-only grid can be overcome and 2) if the T&D upgrade investment required to power the load pocket in a distributed manner is not prohibitive, then PG&E will be able to more confidently and cleanly energize the load pocket during PSPS events while also increasing the resilience of the grid throughout the year.*

In other words, the best approach may be to convert the loads plus distributed resources and dedicated resources into a microgrid.

Other suggestions are made, and some of these have merit for specific communities and/or locations, but the “microgrid” solution appears to have the widest applicability to the author.

A final suggestion is below:

As outlined below, technology teams can be layered in sequentially, prioritizing cleaner and lower-cost options. This framework broadly aligns with the CPUC Integrated Resource Planning guidelines for loading order, which “mandates that energy efficiency and demand response be pursued (procured) first, followed by renewables and lastly clean-fossil generation.”

This loading order is below:

0. Do No Harm: *Ensure that older residential solar installations can be curtailed, if necessary, if generation in the load pocket exceeds demand.*

1. Reduce Net Load by Encouraging Islanding: *Support and encourage islanded BTM (behind the meter) solar + storage wherever possible. While these assets may not actively provide flexibility to the grid, they reduce the net load by allowing customers to island without relying as much on the grid during PSPS.*

2a. Leverage Available BTM DERs as Grid Assets: *For BTM assets with smart inverters, leverage over-built assets to support the grid by exporting power from locations throughout the load pocket (this layer requires a DERMS (distributed energy resources management system) and other enabling technology.*

2b. Deploy Clean IFOM (in front of meter) Solutions (layers 2a and 2b are interchangeable in terms of priority): *Complement some permanent assets such as solar arrays with other clean mobile solutions at or near the substation. Critically, enough space must be reserved at the substation for turbines or reciprocating engines (layer 3a) to provide enough power to serve the remaining load, at least in the near-term.*

3a. Deploy Dirtier IFOM Solutions: *Natural gas turbines or HVO reciprocating engines may be the most logical near-term replacements for diesel, with natural gas being particularly attractive when gas transmission pipelines are within 1,000 feet. Capital equipment can be modified at a relatively low cost to support other fuels such as RNG or hydrogen as they come down in cost.*

3b. Leverage Grid Services Assets: *Grid resources such as demand response, flywheels, batteries, or even diesel locomotives must be layered in to ensure stable distribution grids and provide peak shaving, black start, inertia, etc.*

Author's note: "Diesel locomotives?" Perhaps PG&E and/or their consultants have identified one or more areas where these can be used (not anywhere close to Arnold).

The referenced report the describes: "*critical gaps inhibiting the use of cleaner technology assets are not the generation and storage technologies themselves but rather technology demonstration, policy & incentives, and grid infrastructure."*

It should be noted that the author does not necessarily agree with the gaps identified. Additionally PG&E should <u>not</u> develop a set of recommendations on their own. I was involved in CPUC / CEC working groups in starting in 2002, where all major California Utilities were also involved. These working groups justified the implementation of advanced metering infrastructure (AMI) by all of these utilities. This work is described in section 3 of an earlier post linked below (from 2-1/2 years ago):

Advanced Metering Infrastructure – Part 2, Creating Demand

https://energycentral.com/c/iu/ami-%E2%80%93-part-2-creating-demand

A similar structure is exactly what is required to bootstrap these microgrids (et al) into existence.

Note from the Author: The above-linked post is a part of a four-part series that described the evolution of AMI. I was lucky enough to have (another) front seat to this evolution, and this series describes it in detail. For those that are interested in this subject, it might be worth starting with part 1 and go through all of these, the other parts are linked below.

The first paper in this series, Roots, can be accessed via the link below.

https://www.energycentral.com/c/iu/advanced-metering-infrastructure-ami-part-1-roots

The third paper in the series, AMI Technology Basics, can be found through the link below.

https://www.energycentral.com/c/iu/ami-part-3-technology-basics

Part 4 of this series describes how AMI is evolving into the Internet of Things.

https://www.energycentral.com/c/iu/ami-part-4-%E2%80%93-internet-things

4. Other Issues

Even though I have a home that is impacted by outages (PSPS and otherwise), I really don't have a problem with these, as I can hop in my car and drive back to my other residence if desired. I also have "outage-proofed" my home in Arnold using other methods (wood-burning stove for heat, lots of oil and battery powered lamps. etc.)

However, even if I lived up there full-time, I could cost-effectively outage-proof my home (or business) with behind the meter photovoltaic panels and small battery energy storage systems (like Tesla Powerwalls). This speaks to the fact that these picogrids are already cost effective, and if PG&E doesn't move to provide microgrid as a service, their customers will begin to implement BTM solutions. As described above (2a) these can be used as microgrid assets, but could also be used to (greatly) reduce a given facility's electric consumption / utility cost, complicating the process of developing a tariff that would encourage both applications.

Also there are other even less expensive methods to outage-proof including integrated propane-fueled generators, and inexpensive gasoline-fueled generators. These are not ideal, as described in my recent post "Microberg", linked in the intro.