ELECTRIC GRID FUNDAMENTALS

OR, *"CAN THE GRID HANDLE BUILDING, VEHICLE AND INDUSTRIAL ELECTRIFICATION?"*

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SHORT ANSWER: YES, BUT WITH A FEW CAVEATS

- Adequate planning is the key—but let's keep in mind that "planning" covers a lot of ground

- A large number of policy-making bodies are involved with differing policy objectives and they will need to cooperate and collaborate to avoid "unintended consequences".

AGENCIES INVOLVED (NOT AN EXHAUSTIVE LIST)

- CPUC: jurisdiction over IOU rates and service rules
- CEC: jurisdiction over power plant siting, resource adequacy forecasting, codes and standards
- CAISO: operates the transmission system (including planning and infrastructure); supports a competitive market for wholesale (non-profit public benefit corporation)
- CARB: protects public health and welfare by regulating emissions
- FERC: regulates interstate transmission of electricity and natural gas
- Cities, counties, CCAs, regional networks . . .

WHY DO I SAY, "YES, THE GRID CAN HANDLE IT"

- I started in 1981: Let's look at California from 1981-2000
- CA population in 1981: 24.3 million
- CA population in 2000: 34.0 million (40% increase)
- Current population of Michigan: 10.0 million (tenth largest state)
- One way to look at it: over 20 years, the equivalent of the entire state of Michigan moved to CA. In addition to energy, all of the new residents need jobs, housing, roads and bridges, airports, mass transit, schools, etc., etc. etc.
- There were numerous cases of the grid getting close to the limit, especially during the summer peaks, but the grid never collapsed: lots of mitigations.

MITIGATIONS: AN "ALL OF THE ABOVE" APPROACH

- Numerous efforts on the demand side:
  - Large Interruptible/Curtailable rate plans for industry; direct control programs for A/C units and swimming pool pumps
  - Time-of-use rate plans starting with commercial and industrial customers
  - Huge investments in energy efficiency programs—transactional (CPUC) and research (CEC)
  - Building and appliance codes and standards (CEC and DOE)
- All kinds of efforts on the supply side
  - Generation (lots of activity from Diablo Canyon to small power plants)
  - T&D (ongoing)

RATEMAKING 101 FOR LOCAL GOVERNMENT AND REGIONAL ORGANIZATIONS

- IOUs (~75-80% of CA market) earn money from infrastructure, not from the actual kWhs and Therms. However, residential rates (especially) are commoditiy-based (kWhs and Therms).
- Rates are fundamentally based on a revenue requirement (RR)and a throughput (sales) forecast. Filed and adjudicated periodically with the CPUC
- RR = Capital investment + Expenses + Earnings (rate of return on CI)
  - Capital: The cost to build out and maintain the system (AKA "pipes and wires)
  - Expenses: Personnel costs, equipment, taxes, purchased energy
- Electric Rate = RR / Forecasted sales (in kWh)
  - Dozens of rate schedules with combinations of fixed and variable costs
  - Bottom line: the sum total of all revenue from all rates must equal the RR
  - Annual gas and electricity sales can be modeled quite accurately relative to other commodities

SOME KEY IMPLICATIONS TO RATEMAKING MODELS

Core idea: collect cost of service fairly including a "reasonable" rate of return

Balancing Accounts: sales forecast won't be perfect: what if the RR = $1.0 billion but rate/forecast model leads to $1.02 billion? Over-collections refunded in subsequent year(s). (Same in reverse with under-collections).

Rates and Rate Features: designed to effect cost minimization. For example, the top 1% of peak kWh sales might cost 20x average cost therefore high peak charges are designed to reduce peak usage.

"Subsidies" or "discounts" to any given customer group or segment (i.e. under-collect the RR to that group) must be "made up" by some other set of customers: the RR does NOT change

- Low income rates, economic development rates
- Special technical incentive rates (e.g., NEM rates)

WHAT DOES THIS MEAN FOR DEMAND-SIDE DECARB?

- Gas rates (esp. residential) are collected based mainly on how many therms are used (a "volumetric" rate)
- However, the RR for gas rates is dominated by the infrastructure cost (pipes, compressors, etc.)—all you have to do is look at PG&E's G-1 gas rate
  - 2022 "Procurement" (the gas itself PG&E acquires) = $0.75/Th (a pass-through cost)
  - 2022 "Transport" (the infrastructure to deliver the gas) = $1.62/Th (68% of the bill)
  - 2023 full year forecast: Transport is 75% of the bill
- Very important: the cost of the infrastructure does not change (much) based on the amount of gas put through the system.
- Reducing "Transport" by, say, 50% wouldn't reduce the RR of the Transport cost very much, but it would need to be collected with half as many Therms: a huge impact on the total customer gas bill (for customers staying on gas).

THE GOOD NEWS . . .

- As buildings, industry and transportation electrifies, there should be downward pressure on electric infrastructure costs, at least in a relative sense
- Over the past 40-50 years, the utilization rate of electric infrastructure (i.e., total usage as a percentage of peak) has fallen.
- 1960, 12% of homes had A/C, today 91%--grid usage (compared to peak) has declined
- Electrification, especially with storage (commercial level plus individual customers) can increase overall grid utilization—roughly the opposite impact as on the gas system

THANK YOU!

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