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Berkeley Lab Comments - RFI and Feedback Expanding Flexible Demand in CA (24-FDAS-02)

Berkeley Lab Comments on Expanding Flexible Demand in CA through Statewide MIDAS Data Delivery A Comparison of Signaling Options (24-FDAS-02) are attached.

Additional submitted attachment is included below.

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July 3rd, 2024
Jonah Steinbuck
Director of the Energy Research and Development Division
California Energy Commission
Docket Unit
Re: Docket 24-FDAS-02
715 P Street
Sacramento, California 95814

Re: Lawrence Berkeley National Laboratory Comments on Request for Information and Feedback Expanding Flexible Demand in California (Docket # 24-FDAS-02)

Director Jonah Steinbuck,

Commission staff released the following Request For Information and Feedback: Expanding Flexible Demand in California through Statewide MIDAS Data Delivery: A Comparison of Signaling Options (Docket # 24-FDAS-02). Berkeley Lab is pleased to present our response below:

Question #1: In regard to communication standards, what reliable alternative communication technologies exist to communicate directly to or with appliances?

Two aspects of communications that are necessary to consider are wide area (WAN) and local area (LAN) communications. Both LAN and WAN systems have physical and application layers.

In the past half century, we have seen a migration of many applications from application-specific mechanisms (e.g. analog TV broadcast, AM/FM radio, landline telephony, telegrams, etc.) to use of Internet Protocol technology (e.g. streaming TV, streaming audio, phone calls over IP (Internet Protocol), etc.). Similarly, demand flexibility can benefit from using IP communications.

Every year, the availability of IP communications increases, the number of alternative mechanisms increases, and costs decline. The number of uses that buildings and their occupants have for IP communications increases. It is no surprise that when appliance manufacturers add communication to their products, it is almost always IP-based. IP technology is globally harmonized, enabling products to be shipped to and used in any market with high interoperability globally. This drives up product availability and drives down costs.

While we do want to be able to communicate directly from the grid to individual devices (e.g. to distribute prices), we should be mindful that that will not be the dominant mechanism in the future. For a variety of reasons we will see infrastructure devices (call them a ‘gateway’ for purposes of this discussion) deployed in buildings that serve a variety of useful and necessary purposes, to increase capability and reduce costs. This is not a surprise as we have seen the same trend many times in recent decades. For IP communication, we started out with dial-up modems, when only a single computer was used in a building, then moved to infrastructure devices (modems, routers, switches, Wi-Fi APs) when more than one was involved. For cable TV, originally the connection was directly to the TV, but then moved to adding set-top boxes to increase capabilities. That we will see the same for grid coordination would be reasonable.

Even if FM were to be used, a more plausible deployment path would be FM to a central gateway device and then Wi-Fi from that gateway to appliances. Although California has been successful in the past influencing markets for appliance standards, we have concerns that the market is already moving too quickly to adopt alternate strategies for communication protocols, including those mentioned throughout these comments. Appliance manufacturers routinely add Wi-Fi to devices for reasons other than energy purposes since it is low cost to do so and adds great functionality. Wi-Fi could be leveraged even if no general broadband service to the building is used.

For WAN communication, there is much innovation underway for reasons unrelated to energy, such as the emerging technology of 5G-based fixed wireless for cases in which running wires is more expensive.

Another form of technology we recently evaluated is the use of TV signals, which may be more cost-effective than FM. See BitPath (https://bitpath.com/). One advantage of BitPath is that a single organization does the marketing of the digital subcarrier for many markets (realistically spanning all parts of California that TV signals reach), so that contracting could be simpler and longer term to reduce risks of escalating costs for renting the data space.

Globally and in California, it is IP communications that is central to demand flexibility today, and every indication is that that will maintain into the foreseeable future. Elsewhere in the US and globally there is very little discussion of non-IP solutions.

Question #3: Given the report's conclusion that broadcast delivery of MIDAS data is more cost-effective than point-to-point delivery for the volume of appliances envisioned under FDAS, what are the main concerns with a statewide FDAS signaling system that relies on a broadcast, and what cost-effective solutions might mitigate these concerns?

LBNL perspectives differ with the premise of the question and its framing. We don't think that FM broadcast delivery, as described in the report, is more cost-effective for the state. What is needed is delivery of accurate price (and other) information to customers so that all customers can have their devices respond to reduce energy costs and GHG. The FM broadcast approach imposes a low ceiling of functionality, not even meeting today's needs for some customers, and certainly not adequate for future needs.

For equity purposes, all Californians should have access to the same quality of signals - that is, the correct price. Providing something similar to the price for low-income customers and the correct price to high income is not equitable.

An increasing number of Californians have asymmetric retail prices with the export price being much lower than the import. This requires a 'local price' that can be determined by a gateway device (by monitoring the power flow at the meter, either directly from the meter or with current transducers). A broadcast solution is fundamentally incapable of fulfilling this. It is likely that the number of customers with asymmetric tariffs will increase as more people adopt PV, stationary batteries, or bi-directional charging. It is not equitable if low-income customers cannot have their devices correctly optimized while higher income customers can.

Any device with Wi-Fi can in principle get a firmware update and add price-based optimization (not all can but for cybersecurity reasons the ability to get firmware updates is becoming the norm). Last fall for example, Apple put out a new version of iOS that optimizes phone charging to a 5-minute GHG signal (a true GHG signal, not the SGIP signal); this could just as easily have been a price signal or a hybrid of the two. This was done for free and by default. This shows the power of such IP-based solutions.

Question #4: How should the CEC prioritize broadcast options presented in Chapter 3 (FM, AM, Cellular) and why? Are there more appropriate and cost-effective broadcast options not listed here?

As noted above, TV signals might be more cost effective (LBNL has not compared reception characteristics between FM and TV). As noted, any broadcast signal should be received by a central gateway device, which could incorporate a better antenna than would be feasible for installing such a receiver in individual appliances.

LBNL analysis suggests that broadband supplemented with cellular as needed is the least expensive option to provide equitable access to needed grid signals. The FM solution does not do this. As broadband increases in penetration in availability and subscription each year, the non-broadband population of customers decreases each year.

Question #5: What message content options (e.g. GHG, price, or some combination) do you suggest being sent using the default FDAS Rate Identification Numbers discussed in Chapter 2, and why?

The RIN concept is not in any existing technology standard nor used in any other geography. The relevant technology standards in wide use today organize tariffs by the combination of a retailer ID and a tariff ID (and location can be part of the tariff ID). The goal that we should be aiming for for all devices is to respond to the correct grid signals for that site. Effort spent on other solutions would be better directed to providing devices with the right information. Making such behavior the default for devices, and coordinating with other states and countries can make this the norm in the future.

For content, price, GHG, and alerts are the core information. There is an increasing need to manage distribution system capacity, which requires 2-way communication, so that will be a needed function of building gateway devices.

Question #6: Voluntary utility and third-party programs for load flexibility (shifting) have typically had very low participation from end users. What alternate Load Flexibility program(s) would you recommend that maximize participation while being ubiquitous, cost-effective, equitable, and technically feasible without requiring or precluding participation from third parties?

One important design decision is whether to have a program be opt-in, opt-out, or mandatory. A recent Berkeley Lab study – Carvallo and Schwartz (2023) “The use of price-based demand response as a resource in electricity system planning” – that analyzed price-based DR as part of state requirements for Integrated Resource Plans and 12 plans by filed U.S. electric utilities in the West, Midwest, and Southeast provides useful definitions:

Opt-In (Customers can choose to participate but are otherwise not enrolled); Opt-Out (Customers are enrolled by default but have the option to switch to another rate); and Mandatory (All customers in the designated rate class, or meeting certain criteria (e.g., above a set consumption level), must take service on the rate).

Regarding expected participation rates, utilities that "disclosed their assumed enrollment rates by recruitment strategy reported a 3%–30% range for opt-in recruitment. Only one utility reported its assumed enrollment rate for opt-out recruitment, at 74%." The study authors assumed from this that low reported values "represent opt-in recruitment and high values represent opt-out recruitment." The following table shows the expected participation rate across 8 utilities for different price-based DR approaches (Time of Use (TOU), Critical Peak Pricing(CPP, Virtual Peak Pricing (VPP) for Residential and Commercial & Industrial (C&I) Customers)

Utility ID	Res-TOU	Res-CPP	Res-VPP	C&I-TOU	C&I-CPP	C&I-RTP
1	13% opt-in; 74% opt-out	-	25%	13% opt-in; 74% opt-out	-	-
2	-	15% eligible load	-	10% eligible load	-	-
3	28% opt-in	17% opt-in	-	13% opt-in	18% opt-in	3-5% opt-in
4	-	-	-	-	~10% (ind)	-
5	30% (low); 75% (high)	-	7% (low); 24% (high)	10% (low); 22% (high)	-	5% (low); 10% (high)
6	27%	-	-	14% (comm); 22% (ind)	-	-
7	~70%	-	-	-	-	-
8	36%-64%	-	-	-	23%-50%	-

Source: LBNL webinar February 22, 2024 by Juan Pablo Carvallo and Lisa Schwarz, "Price-Based Demand Response as a Resource in Electricity System Planning"

It is worth noting that the study authors find that the residential opt-out recruitment values provided by utilities are slightly lower than those in the literature (although comparable for opt-in). “A 2016 DOE-sponsored study” found enrollment in TOU for opt-out recruitment at 92% (vs. 15% for opt-in). Todd et al (2013) found enrollment in TOU for opt-out recruitment at 84% (vs. 11% for opt-in). A Brattle Group study (Faruqui et al. 2014) found enrollment in TOU for opt-out recruitment at 85% (vs. 28% for opt-in), and “similar results across various dynamic price options including CPP, VPP, and RTP.” The authors also suggest in a footnote – citing John Howat and Jennifer Bosco, National Consumer Law Center, in Advancing Equity in Utility Regulation, Future Electric Utility Regulation Report No. 12, 2021, Cappers, et al., 2016, and Sergici et al., 2020 – that despite the advantages of opt-out designs for higher enrollment, it is worth considering opt-in for low-income customers. The authors state that this:

> *would be more protective by allowing each family to assess whether they can shift a significant amount of electrical load and whether it makes financial sense for the household to try a time-varying rate structure.*

Given the importance of participation rates to the economics of the system, one suggestion is to conduct future social science research to advance knowledge of the likelihood of participation given different designs. There are a number of ways to do this, including using survey experiments to provide coefficients that can inform modeling and simulation.

While pricing is the preferred solution, Virtual Power Plants (VPPs including aggregators) will be around for the foreseeable future, so a good approach is to ensure that devices can work with either - in a simple and universal way. This will require adoption of key technology standards and defined ways to use those standards. Standard functional control capabilities for devices can be leveraged by both pricing and VPPs. Native price response is an important approach for new devices.

Question #7: Assuming a statewide broadcast signal were to be deployed, would a default appliance setting that automatically initiates response to MIDAS signals at installation allow for ease in initiating flexibility of the appliance? What issues or concerns would you anticipate with such a plug-and-play functionality?

Such default behaviors are certainly possible, but are a distraction from connecting devices to the correct price signal that they should respond to.

As stated in our response to question 6, past studies have suggested that low-income customers participate in an opt-in program design while other customers participate in opt-out. This topic should probably be incorporated into the discussion on pages 39-40 around Economic Impacts and Equity with respect to default operation, as it argues against setting defaults for automatic MIDAS responsiveness because these defaults will be most likely to be in place in low income settings including rental properties.

Question #8: The report proposes a hybrid communication architecture that incorporates both plug-and-play MIDAS response and third-party program enabling technology, represented by the Plug-and-Play Port scenario, as the most cost-effective solution to enable demand flexibility for an appliance. What do you think are some pros/cons of this approach?

This approach is more expensive and lower performing than one that is rooted in standard IP technology that can be realistically adopted across the country and globally. Standards-based approaches also have the ability to grow in capability which the broadcast mechanism cannot.

Question #9: The consultant report suggests that a gateway architecture cannot support plug-and-play flexibility. Is this accurate from your perspective? If not, describe how a gateway solution could enable both intrabuilding load optimization and plug-and-play flexibility for appliances without sacrificing cybersecurity.

Systems based on LAN infrastructure devices are the norm, as noted in the response to question 1. A standard mechanism for an appliance to discover the local price server can be defined so that devices can initiate automatic price response once standards-based gateway devices are deployed. As such, the consultant report does not accurately reflect our relevant experience with technology development. Device self-optimization based on prices received from the gateway, or gateway optimization of devices can both be performed without sending any customer data up to the grid or to a third party and do not compromise cyber security.

Question #10: Are there equity issues related to a MIDAS plug-and-play architecture that remain unaddressed by the report?

We note several outstanding equity issues. First, the report suggests that customer access to grid signals that are not the prices that the customer is paying is adequate. Customers with broadband can access the MIDAS server today and get their prices, and such customers can have gateway devices that determine the correct local price and rebroadcast it locally. CalFlexHub has demonstrated such a gateway device and is currently creating a second such demonstration device. This provides superior functionality than the broadcast-based approach described in the report. Providing substandard access to lower income customers is not equitable. The principle of equality suggests providing access to the same capabilities to all customers. This includes both capabilities needed today, and those that can be reasonably expected to be needed in the near future, particularly for capacity management.

Second, we bring attention to the discussion in response to question 7 above, which talks about equity with respect to the default settings in program design (opt-in vs opt-out for low income customers) and in appliances (where default settings are particularly prevalent in low-income housing settings). This topic should be considered more carefully in policy design, and perhaps discussed in the report.

Finally, many non-energy capabilities (and energy capabilities beyond price response) require IP communication. These are part of the value proposition for advanced devices. If low-income customers cannot have access to these, that is not equitable. The need for electricity price response can be another tool to increase the needed increase in broadband access by all Californians. The FM approach encourages the status quo of unequal access.

Question #11: Provide a summary of your support for and/or rejection of any of the recommendations and conclusions offered in the report, along with a brief description of why for each.

The assumptions made by the report ignore the most promising and cost-effective paths resulting in conclusions that lead to recommendations for potentially inequitable pathways. In particular, costs for ordinary IP communication are inflated and costs for the broadcast system are amortized across customers that have no use for it. That is a problem because the value is to a few, but the costs will accrue to all Californians. A more strategic approach is to work on getting broadband to the underserved communities since this is an important utility in today's connected world for education, communication, and integration with modern life.

In addition, it is assumed that IP technology will rarely work, despite the fact that that is how nearly all demand response works today. Standards-based IP technology works today, and with improvement and deployment globally can work even better.

Another challenge is that manufacturers, OEMs and aggregators are investing in IP based communication and are unlikely to support other approaches.

One technical concern aligns with the consultant's report noting that the "primary determinant of economic outcomes is customer enrollment." For this reason, the economic analysis should probably try to use more recent information to inform its participation rate assumptions (discussed beginning on page 24). The consultant report states that "for consistency across scenarios, we estimate a 10 percent opt-in participation rate for voluntary programs without incentives, aligning with real-world observations. Additionally, we conservatively reduce the expected opt-out participation rate for default settings from 90 percent to 80 percent to account for potential uncertainties." As noted above in our response to question 6, there are more recent data in the literature and in assumptions which are contained in recent utility filings which would make a more timely basis of comparison than the "participation rates from treatment groups in the U.S. Department of Energy (DOE) Smart Grid Consumer Behavior Studies completed in the mid-2010s" which the consulting report uses.

We were gratified to see the consultant report discuss the issue of future research around user interfaces. This topic has come up in our CalFlexHub research, where we have performed social science field research with users about what interface elements would increase customer satisfaction with load flexible devices (see Taylor June 20 ETCC webinar in second half of "Watt's Up in DR? Energizing Customer Engagement from In-Home Technologies to Business Models" and upcoming Sanguinetti paper at ACEEE Summer Study, "8-0815_1216_000757 *Load Flexibility: Keeping Users in the Loop with 'Invisible' Technologies* Sanguinetti, A., E. Alston-Stepnitz, D. Outcault, M. Taylor). We think that there is useful human-centered design research that should be performed to help with user interface design, but agree with the consultant report about the general importance of the topic.

Question #12: How do you foresee electricity price, GHG, and grid signals being used in an appliance, e.g., an electric storage water heater's logic command and controls, whether through broadcast or internet connections?

Several CalFlexHub reports have described a system architecture and communication protocols that can enable this to work. The system leverages technologies in wide use today and simplifies and improves them. It works with technologies (e.g. Wi-Fi and OpenADR) that have wide acceptance by industry. It does so in a way that imposes costs on industry that are modest and surgical. It proposes a system that can be deployed anywhere, not just in California.

Modern IT is based on a layered approach, to isolate complexity and enable separate aspects of systems to be interchanged without affecting others. Over time, this approach has enabled devices connected by Ethernet to transition seamlessly to using Wi-Fi by changing the physical layer but leaving application layers unchanged. The report's proposed system ties together the physical layer and application layers in a way that is inconsistent with modern IT technology.

The gateway-based architecture can ensure that devices get the correct local price and also facilitates needed additional capabilities, such as microgrid price distribution capabilities. The consultant report has no path to these additional capabilities. It imposes a ceiling of functionality lower than what is needed today, much less what will be the norm in the future.

Berkeley Lab appreciates the opportunity to provide these comments in response to the CEC's Request for Information and Feedback: Expanding Flexible Demand in California through Statewide MIDAS Data Delivery: A Comparison of Signaling Options (Docket # 24-FDAS-02)

The following individuals contributed comments: Mary Ann Piette, Bruce Nordman, and Margaret Taylor.

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