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Response to Energy Commission RFI

Additional submitted attachment is included below.

CALIFORNIA
Efficiency + Demand Management
COUNCIL

Response to Energy Commission RFI: Clean Energy Resources for Reliability; 21-ESR-01

About the Council + This Response

The California Efficiency + Demand Management Council (Council) is the premier, statewide non-utility trade association representing an industry that employs tens of thousands of people. The Council's Members design, implement, maintain, and evaluate energy efficiency (EE), demand response (DR), and data analytics services and products.

The Council firmly believes demand side resources, particularly EE, DR, and distributed energy resources (DERs) generally are essential to resolving California's energy and climate challenges equitably, reliably, and effectively.

Background + Context

Over the 2022 Legislative Session, the Council worked with California's policy leaders (Governor's Office, Legislature, California Public Utilities Commission ("PUC"), California Independent System Operator ("CAISO"), and California Energy Commission ("Energy Commission")) to help advance the State's goals of decarbonization and clean, affordable, and reliable energy. The Legislature's passage and Governor's signing of SB 846 (Dodd) is of critical importance towards meeting California's reliability goals.

SB 846, in part, establishes the Clean Energy Reliability Investment Plan ("CERIP"), to be developed by the Energy Commission in coordination with the PUC and California Air Resources Board ("CARB"), that supports programs and projects that accelerate the deployment of clean energy resources, support demand response, assist ratepayers, and increase energy reliability. The Energy Commission, other State agencies, and stakeholders have an exciting opportunity to expand the adoption and utilization of EE, DR and DERs to advance the State's energy and climate goals and accelerate the modern grid.

In the development of CERIP, the Energy Commission has filed a Request for Information (RFI) seeking stakeholder feedback on the CERIP's framework, CERIP investment recommendations, and the Distributed Energy Backup Assets Program ("DEBA"). **The Council offers this response with a particular emphasis on demand-side investments that can deliver real and tangible benefits in the short, medium, and long-term time horizons. The Council also offers an extensive list of informative resources in Appendix A to supplement the further analysis that can and should be conducted.** The Council appreciates the opportunity to put forward these recommendations which are drawn from Council Members' experience and expertise.

November 30, 2022

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The Benefits of Load Shifting

Effective load shifting can shift customer demand from periods of particular strain on the grid and/or energy resources to times of the day where that strain is significantly reduced. Load shifting can deliver direct and ancillary benefits across the state in emergency-response scenarios (e.g. peak demand crises like that observed on September 7, 2022) as well as year-round (e.g. evening ramping and peak demand generally experienced from 4 - 9 p.m.).

In January of 2019, the PUC's Working Group on Load Shift ("Working Group") published their Final Report where the Working Group compiled a thorough, yet succinct, list of benefits load shifting provides to the grid and California's customers. The following list of benefits capture, at a high level, key reasons why DR is essential to resolving California's energy and climate challenges equitably, reliably, and effectively:

- **Avoided renewable generator curtailment**: Load shift can reduce oversupply of generation in the middle of the day, which contributes to curtailment of renewable generation, and address significant ramps in the morning and evening;
- **Energy Cost Reductions**: By reducing the need to dispatch conventional generators, Load Shift has the potential to lower the marginal cost of generation in both day-ahead and real-time energy markets;
- **Emission Reductions**: Where conventional generator dispatch is avoided, Load Shift also reduces both GHG emissions and local particulates, contributing to the mitigation of climate change, improving local air quality, encouraging environmental justice;
- **System, Local and Flexible Resource Adequacy**: Load shifting can reduce peak and ramping needs, at both the system and local level;
- **Transmission Capacity**: Like the impact on Resource Adequacy demands, Load Shift may contribute to a reduced need for high-voltage transmission;
- **Distribution System Services**: Load Shift may reduce the cost of distribution systems while easing operations by giving operators new flexibility to shift load off circuit peaks, increase load in locations where distributed generation currently exceeds demand, and where the resource is inverter based, support voltage regulation;
- **Customer Bill Savings**: Load Shift provides customers the opportunity to reduce both volumetric and demand charges, shifting their consumption to periods of relatively low costs.

Current DR Efforts Aimed at Grid Resilience and Reliability

Stemming from the August 2020 extreme heat events and subsequent rolling blackouts resulting from insufficient grid resources, the State has embarked on a monumental effort to address grid resilience and improve reliability. This includes a significant emphasis on enhancing and expanding a variety of demand-side resources. Many of these efforts have built on the State's significant capabilities and long expertise in the DR and EE spaces. At present, there are four general categories of demand-side resources that are aimed at addressing grid resilience and reliability while at the same time furthering the State's carbon reduction ambitions:

- **IOU-based Efforts**: Under the authority of the PUC, the State's investor-owned utilities (IOUs) offer a variety of DR and EE programs targeting all customer classes. Over the past few years, these programs have been expanded in terms of broadening customer eligibility, enhancing customer participation incentives, and removing regulatory barriers such as outdated cost-effectiveness requirements. Further, the PUC and the IOUs have developed additional offerings that are aimed at resiliency including the Market Access Program (MAP) and the Emergency Load Reduction Program (ELRP).

- **POU-based Efforts**: Nearly all of the state's publicly-owned utilities (POUs) offer a number of EE and DR programs. While the two largest POUs (Los Angeles Department of Water and Power - LADWP and Sacramento Municipal Utility District - SMUD) are not within the control area of the CAISO they have heeded the state's calls for expanding demand-side programs in the face of grid resilience challenges.

- **Market-based Efforts**: There are a number of market-based initiatives overseen by the PUC and CAISO that address resource adequacy (RA) needs. A number of DR resources are contained within this category including RA contracts, proxy demand resources (PDR), and the demand-response auction mechanism (DRAM) pilot.

- **Energy Commission-based Efforts**: Resulting from recent budget allocations, the Energy Commission has been given the authority to develop and operate the Demand Side Grid Support Program ("DSGS"). The DSGS is aimed at incrementally expanding on the various efforts described above by expanding DR customer eligibility and enhancing customer participation incentives. DSGS was rolled out during the summer 2022 and is expected to be fully operational by summer 2023.

Combined, these four efforts contributed what the Council estimates could have been around 1,000-1,500 MWs or 2-2.5% of the State's peak load at the most grid constrained time periods (between the hours of 4-9 p.m.) during the September 5-9, 2022 extreme heat event. The Council estimates that once the effects of these stepped-up demand-side efforts are fully realized the state could experience peak load reductions of up to 2,500-3,000 MWs or 4-5% of California's peak load during the coming years (2023-24). Unfortunately, this significant reduction is still not enough to address the State's anticipated capacity shortfalls projected for future years. According to a wide variety of DR experts ranging from evaluators to implementers to academics, there is a common viewpoint that California could realize peak load reductions of up to 8% of peak load (roughly 5,000 MW) through yet more aggressive implementation of additional demand-side programs and initiatives. And that is why efforts, such as SB 846, are essential towards creating a pathway to identify and invest in additional carbon-free demand-side resources that will result in additional peak load reduction capacity and meet California's grid reliability needs for decades to come.

Response: List of Resource types and Evaluation Attributes

The Council offers the following responses to each correlating question:

1. **Are the categories (indicated in Tables 1, 2 and 3) appropriately representing how the CEC should be evaluating resources?**
   The Council finds the capacity thresholds listed for the resource types in Table 1: Supply Resources may be unintentionally limiting. This appears true for the 30 MW minimum threshold for "Pumped Hydro" under the Storage category. 30 MW is too high of a threshold does not reflect or portray current and future pumped hydro resource opportunities or regulations. The Council recommends lowering that threshold substantially. Otherwise, the Council generally finds the Energy Commission has thoughtfully and appropriately represented how resources should be evaluated within CERIP.

2. **Are there resources that should be added to or removed from the preliminary list under each of the categories (shown in Tables 1, 2, and 3)?**
   The Council finds the Energy Commission has offered a reasonably thoughtful and flexible list of resources under each category, including the resource types listed in Table 2: Demand Resources.

3. **Are there other attributes that should be considered, in addition to the ones listed in Table 4? If so, should those be considered for the qualitative and/or quantitative evaluation?**
   The Council incorporated and suggests the Energy Commission consider the following attributes for resource analysis: expected useful life, lifetime emissions, land impacts, and financial opportunities (e.g. stackable funding streams) in addition to financial barriers. The Council explicitly distinguishes between qualitative and quantitative evaluations for each resource recommendation.

4. **How should the attributes be weighted relative to each other? Should some attributes be weighted more than others?**
   The Council acknowledges each attribute is valuable in guiding effective resource investments, however, some attributes should take priority over others. The Council suggests the following attributes, in no particular order, are prioritized over the remaining attributes but do not offer what that specific weighting scale should be: cleanliness, dispatchability, levelized cost ($/MW-yr), equity, permitting, and policy alignment.

5. **What data/information sources can help inform characterization and evaluation (both qualitative and quantitative) of the different resources?**
   The Council offers an extensive list of resources in Appendix A in addition to the information and references included in our recommendations below.

Response: Resource Characterization

Based on Council and Member expertise, the Council is confident that a number of additional demand-side measures can be taken to increase the amount of peak load reduction that could be realized during critical periods and future extreme heat events. The Council's intent is to outline a number of EE, DR and DER solutions that could be put forward by the Energy Commission in the CERIP.

In compiling the following list of recommendations, the Council considered a number of factors **in addition to** the qualitative and quantitative attributes analyzed throughout as being of critical importance in identifying and right-sizing resource recommendations (note: the Council does not incorporate these factors into our individual resource recommendation analyses):

- Duration of peak load impacts: Identify solutions that would have duration of impact in the most critical time periods – 4-5 hours during the peak periods of 4-9 p.m.
- Automation functionality: Identify solutions that leverage automation and that can be seamlessly integrated into existing grid management systems.
- Large impact: Identify solutions that may be scalable or beneficial to customers well beyond those actively participating in a program.

The following suggested solutions are organized according to the following four sector-based categories:

Sector	Recommendation
Residential	Distributed energy storage fleets
	Vehicle to building deployment
Commercial	Advanced energy storage
Agricultural	Advanced pumping for small and medium agricultural facilities
Water/Wastewater Systems	Flow equalizer basins for wastewater facilities
	Grid Responsive Energy + Water Storage Systems

Residential

Enabling statewide distributed energy storage fleets

Demand Resource | Energy Storage | Distributed

With the possibility of PUC-mandated reductions to current net energy metering (NEM) incentives, commercial and residential customers with existing rooftop solar systems but with no energy storage (battery) capability may have limited incentive to respond during grid-related emergencies. However, if those customers were enabled with battery storage systems, along with customers without solar, they could be connected through a virtual aggregator and in effect be "islanded" during peak load emergencies by only relying on their battery to supply their electricity needs.

A program that allows third-party ownership and control of storage technologies subject to certain performance obligations and sited on private property – with or without solar PV – could offer new market opportunities. Storage could be managed in support of the grid generally, with a share of the savings and/or monthly rental costs associated with storage space rental. This may represent an attractive value proposition for certain homeowners who would benefit from additional grid stability with protection from occasional local outages. This model is compatible with the proposed CalFUSE approach currently being piloted by Southern California Electric.

Quantitative Attributes:

ATTRIBUTE	DETAIL	RESPONSE
Capacity	How many new MWs and MWhs can the resource provide per year, taking into account resource characteristics and known barriers between now and 2035?	Currently, approximately 600 MWs of storage capacity is installed in California households.[1] Good estimates of residential storage growth potential are not immediately available. According to the Energy Commission's 2018 DR Potential study, residential storage can provide close to 10 GWh-year of load shift potential and over 4 GW of load shed capacity through 2025.[2] Note that the load shift and shed potential of residential storage depends on cost. The capacity figure cited above represents a levelized cost of $200-$400/kW-yr. Realized (deployed) capacity is likely to be lower.
	How is that different if used	N/A

[1] https://www.californiadgstats.ca.gov/charts/

[2] https://escholarship.org/content/qt2m68c4xh/qt2m68c4xh_noSplash_51f431240d9b89dd188c6afbde16bc58.pdf

	incrementally as an emergency asset during an extreme heat event?	
Levelized Cost	What is the levelized cost for the resource in $/MW-yr. and $/MWh-yr. from 2023 to 2035?	The levelized cost of standalone behind-the-meter ("BTM") storage systems range from $150-$300/kW-yr or $50-$150/MWh.[3] The levelized cost of storage+PV system is estimated at $545-$785/kW-yr or $416-621/MWh.[4] Costs through the 2030s are highly uncertain. Although the cost of installing BTM storage systems is expected to drop in the long term, post-pandemic supply chain disruptions, coupled with inflationary pressures, could push costs up in the short-term.
Expected Useful Life	What is the expected useful life for: A. Current technologies? B. Emerging technology?	Most consumer BTM systems have an expected useful life of 10 years.[5] Upcoming technologies, like vanadium flow batteries have a longer expected useful life in the range of 20 to 100 years.[6]

Qualitative Attributes:

ATTRIBUTE	DETAIL	RESPONSE
GHGe and Environmental Impacts	Comparison to conventional generation	BTM storage that charges from on-premise solar or from the grid during peak solar hours is a clean resource.
	Lifetime emissions	The lifecycle emissions of residential battery systems is variable and highly dependent on the location, applicable tariff structure and the timing of battery charging/discharging. One recent study of the lifecycle GHG emissions from solar and solar-plus-storage systems in 52 representative households

[3] https://eta-publications.lbl.gov/sites/default/files/lbnl-2001113.pdf (p. 7-14)
[4] https://www.lazard.com/media/451882/lazards-levelized-cost-of-storage-version-70-vf.pdf (p. 5-6)
[5] https://www.nrel.gov/docs/fy21osti/79393.pdf (p. 9)
[6] https://www.sciencedirect.com/science/article/pii/S2352484719305967

		across California found that the lifecycle emissions of solar+storage systems are sometimes lower and sometimes higher than pv-only systems (−20% to 24%).[7] An evaluation of the Self-Generation Incentive Program (SGIP) found that residential storage contributed to an overall reduction of GHG emissions in 2020 of approximately 11.0 kg/kWh (or 7%), though this study did not consider lifecycle emissions.[8]
	Land impacts	This resource can be installed directly within consumer homes.
Reliability	How does the resource support reliability (e.g., supply, permanent load reduction, net peak reduction, or emergency asset?) (List all that apply.)	BTM storage can provide permanent load reduction and net peak reduction. It can also be used as a back-up asset in an emergency.
	How can the resource be used as an incremental on-call resource during emergencies?	See above.
Dispatchability	Certainty and firmness of an option, including number of events, frequency of events, and event duration	Solar+storage is a dispatchable resource that can handle frequent events. The barriers to realizing its full potential are not technological, but rather regulatory and market design in nature. Solar+storage systems must be able to earn capacity revues in order to yield a reasonable return on investment. The only way that BTM battery owners/aggregators can do so is by participating in the CAISO wholesale market as a proxy demand resource (PDR). Importantly, PDR "floors" performance at 0, thereby not permitting batteries to earn revenue for exports.
Readiness	Current technology:	Although the process can take several weeks, the timeline to deployment has been lengthened substantially post-pandemic due to

[7] https://www.sciencedirect.com/science/article/pii/S2589004221014632

[8] https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/self-generation-incentive-program/sgip-2020-energy-storage-impact-evaluation.pdf (p. 109)

		supply chain disruptions, permitting delays, labor shortages, etc. A residential electrician is required for permitting, installation and potential electrical system upgrades.
	Emerging tech:	N/A
Non-Financial Barriers or Opportunities	Permitting	N/A
	Interconnection	The requirements around interconnecting BTM storage to the distribution grid, including the high cost of telemetry, have been an important barrier for bringing these resources to market.
	Supply Chain	Current supply chain challenges persist. Investments by the federal government, including through the Infrastructure Investment and Jobs Act and the Defense Production Act intend to mitigate some of those challenges.
	Customer Acceptance	BTM storage has high desirability among consumers; cost remains a significant barrier.
	Policy Goal Alignment	Clean energy requirements (SB 100, SB 1020) and load shifting targets (SB 846).
Financial Barriers or Opportunities		SGIP offers rebates to households for installing energy storage technology. A customer of California's three large utilities is eligible to receive a rebate of $250/kWh, which covers approximately a quarter of the cost of average storage systems. Low income customers may be eligible for a higher incentive ($850/kWh or 85% of system cost), while those living in high fire threat districts or experiencing frequent public safety power shutoffs may receive as much as $1000/kWh, equivalent to nearly 100% of system cost. Residential standalone battery storage systems >3kW are also eligible for the 30% investment tax credit under IRA.
Low-Income and Disadvantaged Communities Impacts		N/A

Vehicle to building deployments

Demand Resource | Electric Vehicle to Building ("V2B") | Distributed

A typical electric vehicle ("EV") has more than sufficient battery capacity to meet the power needs of a home. With the addition of in-home inverters, these EVs can be connected to the home's power system through a virtual aggregator and in effect be "islanded" during peak load emergencies as the EV would supply their electricity needs. The EVs would be charged during peak solar hours (10 a.m. to 3 p.m.) using existing rooftop solar systems or charging could be accomplished during these same hours at the workplace.

Quantitative Attributes:

ATTRIBUTE	DETAIL	RESPONSE
Capacity	How many new MWs and MWhs can the resource provide per year, taking into account resource characteristics and known barriers between now and 2035?	Currently: 100kW of capacity storage/vehicle, 12kWhs - 82 kWhs/EV (depending on the type of EV (including plug-in or hybrid as well as line limitations). 2030+ projections: 246kWhs/BEV and 36 kWhs/PHEV[9]
	How is that different if used incrementally as an emergency asset during an extreme heat event?	Limited to battery charge at time of event and discharge capacity (including line limitations). Likely 10kW for average home.
Levelized Cost	What is the levelized cost for the resource in $/MW-yr. and $/MWh-yr. from 2023 to 2035?	Disregarding potential upfront costs for the EV (which range drastically between new and used and between models), potential customer costs include[10]: - $100 - $900/year electric vehicle supply equipment subscription(s) - ~$500 - $6,500 home EV Supply Equipment ("EVSE") - Wide range of costs for battery degradation
Expected Useful Life	What is the expected useful life for: A. Current technologies? B. Emerging technology?	10 - 20 years for batteries, the useful life for EVSE is currently unclear.

[9] https://deepblue.lib.umich.edu/bitstream/handle/2027.42/167344/Wang_Meiye_thesis.pdf
[10] https://www.nrel.gov/docs/fy17osti/69017.pdf

Qualitative Attributes:

ATTRIBUTE	DETAIL	RESPONSE
GHGe and Environmental Impacts	Comparison to conventional generation	The emissions associated with EV and V2B usage largely depends on electricity resource mix[11] used to charge the EV as well as EV maintenance.
	Lifetime emissions	There are widely varying emissions associated with the extraction and manufacturing processes for EVs.[12]
	Land impacts	Negligible
Reliability	How does the resource support reliability (e.g., supply, permanent load reduction, net peak reduction, or emergency asset?) (List all that apply.)	Potential for load shift, net peak reduction, and emergency asset
	How can the resource be used as an incremental on-call resource during emergencies?	If participating EVs are able to communicate with aggregators/3rd party entities, LSEs, etc., they can be discharged to help mitigate surging demand during the evening ramp or peak.[13][14][15]
Dispatchability	Certainty and firmness of an option, including number of events, frequency of events, and event duration	Battery EVs are, on average, estimated to be available for up to 18 hours/day for dispatch. This depends on their location during those 18 hours and if they are plugged in.
Readiness	Current technology:	EV: <1 month - 12 months+ EVSE: Weeks to months for delivery, install, and coordination Clearer programs led by aggregators can help accelerate program success. Education, technical, and installation assistance can accelerate deployment of EVSE equipment. Coordination with load serving entity may help

[11] https://www.epa.gov/sites/default/files/2015-07/documents/emission-factors_2014.pdf
[12] https://energy.mit.edu/wp-content/uploads/2019/11/Insights-into-Future-Mobility.pdf
[13] https://www.sciencedirect.com/science/article/pii/S0378775318303720?via%3Dihub
[14] https://iea.blob.core.windows.net/assets/e018e1f6-a2b3-4ddd-81d7-87e3e627ecfb/load_shifting.pdf
[15] https://www.nature.com/articles/s41560-022-01105-7/figures/3

		with any infrastructure upgrades needed. Upfront capital costs in addition to those of the EV pose substantial barriers. Greater potential challenges include dynamic tariffs, utility programs, and timely data access.
	Emerging tech:	N/A
Non-Financial Barriers or Opportunities	Permitting	N/A
	Interconnection	Interconnection is less of a barrier as-is the general limitations of connections (line limitations) and potential upfront capital costs associated with infrastructure (line, panel, EVSE, etc.) investments.
	Supply Chain	Current supply chain challenges persist particularly for EV materials, including for critical mineral supply chains. Investments by the federal government, including through the Infrastructure Investment and Jobs Act and the Defense Production Act intend to mitigate at least some of those challenges.
	Customer Acceptance	N/A
	Policy Goal Alignment	Clean energy requirements (SB 100, SB 1020), load shifting targets (SB 846), and 2030 EV requirements (CARB and Executive Order)
Financial Barriers or Opportunities		There are a myriad of additive funding opportunities at the regional, state, and federal level (including Inflation Reduction Act).
Low-Income and Disadvantaged Communities Impacts		As used EVs become more available and as upfront capital costs of EVSE and other investments fall, this option becomes more attainable for a broader customer base. Upfront capital costs continue to range from burdensome to prohibitive for Low-Income and Disadvantaged Communities. This is also true for accessibility of public EVSE.

Commercial

Advanced energy storage

Demand Resource | Thermal Energy Storage | Distributed

There have been significant technology advances in packaged cooling systems that serve small and medium commercial buildings. The range of options include self-contained ice units that produce ice during off-peak hours when net loads are low and use that ice as a coolant during on peak periods to systems that combine dew-point-style sensible cooling with liquid desiccant dehumidification to significantly reduce non-fan electricity usage. With aggressive enablement incentives and effective tariff designs, these systems could potentially offset half of a building's electrical demand during peak periods.

Quantitative Attributes[16] [17] [18]:

ATTRIBUTE	DETAIL	RESPONSE
Capacity	How many new MWs and MWhs can the resource provide per year, taking into account resource characteristics and known barriers between now and 2035?	Up to 100 MW 4x365x100 MWh Industry 200 MW 300 MW (four to eight hour discharge)
	How is that different if used incrementally as an emergency asset during an extreme heat event?	Thermal energy storage is generally a permanent load shifting product, but some products may also be designed to respond to emergency events or deploy during peak load events.
Levelized Cost	What is the levelized cost for the resource in \$/MW-yr. and \$/MWh-yr. from 2023 to 2035?	Costs vary significantly.
Expected Useful Life	What is the expected useful life for: A. Current technologies? B. Emerging technology?	20+ years

[16] https://pubs.rsc.org/en/content/articlelanding/2021/ee/d1ee01992a
[17] https://info.ornl.gov/sites/publications/Files/Pub164102.pdf
[18] https://heatpumpingtechnologies.org/magazine-2-2021/topical-article-the-state-of-art-of-heat-pump-integrated-thermal-energy-storage-for-demand-response/

Qualitative Attributes:

ATTRIBUTE	DETAIL	RESPONSE
GHGe and Environmental Impacts	Comparison to conventional generation	This resource does not generate energy, but rather stores it in the form of ice. Therefore, emissions associated with the dispatch of that stored thermal energy are dependent on the electricity mix used to charge the resource.
	Lifetime emissions	N/A
	Land impacts	Negligible; units are usually installed on commercial building rooftops or in replacement to or near existing HVAC units.
Reliability	How does the resource support reliability (e.g., supply, permanent load reduction, net peak reduction, or emergency asset?) (List all that apply.)	Provides permanent load shift away from peak-demand, which can contribute to mitigating demand impacts during summer heat events. Thermal charging can be flexible to meet cost, environmental, and/or structural needs.
	How can the resource be used as an incremental on-call resource during emergencies?	See above.
Dispatchability	Certainty and firmness of an option, including number of events, frequency of events, and event duration	This resource is largely intended to provide permanent load shifting, which can mitigate impacts from peak demand on a daily basis.
Readiness	Current technology:	3+ months from initial order to installation and commissioning.
	Emerging tech:	N/A
Non-Financial Barriers or Opportunities	Permitting	Permitting is similar to installing an HVAC unit. CEQA not required.

		Permitting is a relatively short process taking 4 to 8 weeks depending on the local building department backlog.
	Interconnection	Generally, no interconnection permit is required, especially as the stored energy of thermal energy storage units is not returned to the grid in the form of electrons.
	Supply Chain	Outside of the general supply chain challenges faced during the COVID-19 pandemic, many of the materials needed for this resource can be sourced domestically and avoid additional supply chain barriers/challenges.
	Customer Acceptance	N/A
	Policy Goal Alignment	Clean energy requirements (SB 100, SB 1020) and load shifting targets (SB 846)
Financial Barriers or Opportunities		SGIP and stackable benefits through the federal Inflation Reduction Act.
Low-Income and Disadvantaged Communities Impacts		N/A

Agricultural

Advanced pumping for small and medium agricultural facilities

Demand Resource | Water Pumping Controls | Distributed

While larger agricultural interests have been able to invest the capital needed to improve water pumping efficiencies, small and medium agricultural facilities generally have not been able to keep pace with their larger counterparts. As a result, their operating costs have increased due to pumping and irrigation inefficiencies. The purpose of this program would be to target underserved agricultural customers with incentives and technical assistance that would lead to efficiency improvements in pumping. This would effectively lead to significant load reductions during peak periods.

Quantitative Attributes[19]:

<table>
<tr><th>ATTRIBUTE</th><th>DETAIL</th><th>RESPONSE</th></tr>
<tr><td rowspan="2">Capacity</td><td>How many new MWs and MWhs can the resource provide per year, taking into account resource characteristics and known barriers between now and 2035?</td><td>Small (8 horsepower, “hp”): 133 kWh/year/unit
Medium (32 hp):152 kWh/year/unit
Large (150 hp): 108 kWh/year/unit</td></tr>
<tr><td>How is that different if used incrementally as an emergency asset during an extreme heat event?</td><td>N/A</td></tr>
<tr><td>Levelized Cost</td><td>What is the levelized cost for the resource in $/MW-yr. and $/MWh-yr. from 2023 to 2035?</td><td>Costs are variable.</td></tr>
<tr><td>Expected Useful Life</td><td>What is the expected useful life for:
A. Current technologies?
B. Emerging technology?</td><td>Small (8 hp): 15-33 years
Medium (32 hp): 26 years
Large (150 hp): 26 years</td></tr>
</table>

[19] https://www.caetrm.com/login/?next=/measure/SWWP004/02/

Qualitative Attributes:

ATTRIBUTE	DETAIL	RESPONSE
GHGe and Environmental Impacts	Comparison to conventional generation	This resource does not generate energy and therefore emissions associated with operating these pumps is dependent on the electricity fuel mix used to power them.
	Lifetime emissions	N/A
	Land impacts	Minimal landscape needed, likely to be placed at or near current/existing pumps. Water usage impacts vary.
Reliability	How does the resource support reliability (e.g., supply, permanent load reduction, net peak reduction, or emergency asset?) (List all that apply.)	Permanent load reduction Load shift Potential for emergency demand response
	How can the resource be used as an incremental on-call resource during emergencies?	Potential for emergency load reduction outside of permanent load reduction in the case of emergencies.
Dispatchability	Certainty and firmness of an option, including number of events, frequency of events, and event duration	See response to reliability.
Readiness	Current technology:	From order to install, several months, however, some of the complications noted in the permitting section below may be relevant here as well.
	Emerging tech:	N/A
Non-Financial Barriers or Opportunities	Permitting	Permitting, and/or other related necessary processes, can pose challenges if they conflict with certain agricultural seasons.
	Interconnection	N/A
	Supply Chain	Outside of the general supply chain challenges faced during the COVID-19 pandemic, many of

		the materials needed for this resource can be sourced domestically and avoid additional supply chain barriers/challenges.
	Customer Acceptance	Largely dependent on cost and potential interruptions to business operations. Barriers can become opportunities depending on useful life of existing pumps and timing of kickstarting the process to acquire (a) new pump(s).
	Policy Goal Alignment	Net Zero emissions target, load shifting targets (SB 846), and EE targets (SB 350, 2015).
Financial Barriers or Opportunities		- California Dept. of Food & Agriculture's State Water Efficiency & Enhancement Program (SWEEP) - Various utility advanced pumping efficiency programs - EPIC
Low-Income and Disadvantaged Communities Impacts		This option reduces grid impacts and energy consumption, contributing to energy and infrastructure cost mitigation in likely rural and lower income regions of the state.

Water/Wastewater

Flow equalizer basins for wastewater facilities

Demand Resource | Wastewater Treatment & Pumping | Distributed

Build flow equalization basins ("EQ basins") that can store incoming sewage during peak periods by not sending the sewage flow into the plant for treatment during those times. This effort would advance energy and cost savings by withholding raw sewage and delaying required treatment. Existing controls would allow the plant's equipment downstream of the EQ basins to modulate down to their lowest position, reducing energy demand.

Quantitative Attributes[20] [21] [22]:

ATTRIBUTE	DETAIL	RESPONSE
Capacity	How many new MWs and MWhs can the resource provide per year, taking into account resource characteristics and known barriers between now and 2035?	Varies significantly. See qualitative attributes for more.
	How is that different if used incrementally as an emergency asset during an extreme heat event?	During emergency events, EQ Basins can be used to hold flow which will result in less flow being sent to the plant for treatment. When loading on process equipment is reduced, their modulation devices will allow them to operate at the minimum output necessary which will reduce energy demand. In this scenario, process equipment may see higher load after

20 https://nepis.epa.gov/Exe/ZyNET.exe/2000QTKP.TXT?ZyActionD=ZyDocument&Client=EPA&Index=Prior+to+1976&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C70thru75%5CTxt%5C00000002%5C2000QTKP.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL

21 https://nepis.epa.gov/Exe/ZyNET.exe/300007H3.TXT?ZyActionD=ZyDocument&Client=EPA&Index=1976+Thru+1980&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C76thru80%5CTxt%5C00000001%5C300007H3.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL

22 http://www.commerce.wa.gov/wp-content/uploads/2016/11/hfu-expected-useful-life-2011.pdf

		the peak event has passed. Given that peak power has higher emissions associated with it, such shifting of process operations should in principle result in lower emissions overall.
Levelized Cost	What is the levelized cost for the resource in $/MW-yr. and $/MWh-yr. from 2023 to 2035?	Costs are based on 2021$. Costs beyond this are certain due to various external factors such as supply chain constraints, product lead times, and estimated engineering cost burden. The cost over the estimated 40 year life of the solution is estimated to be in the range of $44-$79 per MWh-yr. The same cost represented as demand is in the range $32,920-$228,951 per MW-yr.
Expected Useful Life	What is the expected useful life for: A. Current technologies? B. Emerging technology?	EQ Basins typically can be in service for a long time. Depending on how they are deployed, these basins can be: 1) Earthen basins with protective lining to prevent infiltration below ground to prevent groundwater contamination (Estimated to be 40 years. Limited by life of liner which is estimated to be 15 years. Liner is a low-cost item that can be replaced.) 2) Concrete basins (Estimated to be 40 years) 3) Steel (Estimated to be 40 years. Limited by life of liner which is estimated to be 15 years. Liner is a low-cost item that can be replaced.)

Qualitative Attributes:

ATTRIBUTE	DETAIL	RESPONSE
GHGe and Environmental Impacts	Comparison to conventional generation	EQ Basins do not generate energy and therefore emissions associated with operations depend on the electricity fuel mix used to power them. EQ Basins may be used to shift process operations to earlier in the day. Since peak grid supply tends to be more carbon-intensive, shifting operations to earlier in the day should result in reduced GHG emissions.
	Lifetime emissions	N/A
	Land impacts	Project can be hosted where land is available.

Reliability	How does the resource support reliability (e.g., supply, permanent load reduction, net peak reduction, or emergency asset?) (List all that apply.)	Typical wastewater treatment flow peaks are coincident with grid peaks. The diurnal flow profile also shows pronounced peaks and valleys. By equalizing flow, equipment that are typically designed to meet peak flow conditions can be modulated down which reduces their energy consumption and results in permanent load reduction during peak grid conditions.
	How can the resource be used as an incremental on-call resource during emergencies?	If additional flexibility is needed, EQ Basins can be decided to hold more flow than necessary so that process equipment may be allowed to modulate down further.
Dispatchability	Certainty and firmness of an option, including number of events, frequency of events, and event duration	WWTP flows are very predictable in a given season. Therefore, dispatchable loads can be easily predicted unless there are process upsets within the plant. In addition, during storm events with wet weather that occur during gird peak events, these basins can be used to ensure that plant electric load does not increase significantly as more influent flow is delivered to the plant. This is especially true for cities that have combined storm and sewer systems.
Readiness	Current technology:	3-5 years for deploying new storage. Would require expedited study of storage feasibility. If program funds can be expended to help pay for feasibility studies, that will help to speed up customer approval processes for the first phase of the evaluation.
	Emerging tech:	Technology is available right now and can be scaled linearly depending on demand.
Non-Financial Barriers or Opportunities	Permitting	Permitting varies significantly. Permitting would need to meet codes necessary to install new storage assets. Environmental studies to evaluate impacts will also need to be conducted for wastewater treatment plants.
	Interconnection	None. The basins would integrate into the plant's process. Additional interconnection is not necessary. Additional support equipment such as pumps, blower or aerators will be needed. Those will be additional loads that can be integrated into an existing utility service

		delivery.
	Supply Chain	Equipment lead times have increased from weeks to months. If additional modulation devices are needed due to site specific conditions, the supply chain issues are more prevalent. Due to current supply chain challenges, delays of up to 40 weeks are currently being observed in procuring variable frequency drives.
	Customer Acceptance	Operators would be open to the solution as it allows tighter control of the process. It does introduce new equipment and processes that they will need to track. For most customers, this added inconvenience will be countered by the benefits of the enhanced process.
	Policy Goal Alignment	SB 350 (2015) - EE targets, SB 846 (2022) - Load shift targets, GHGe reductions targets
Financial Barriers or Opportunities		EQ Basins can be used to improve the efficiency of process operations which can potentially dip into energy efficiency program incentives. On-bill Financing (OBF) and low interest rate loans from California State Clean Water State Revolving Fund may be tapped as additional funding sources.
Low-Income and Disadvantaged Communities Impacts		For capacity constrained areas, EQ Basins can provide demand flexibility which will ensure grid resilience. Grid resiliency is especially critical for Low-Income and Disadvantaged Community customers since access to additional resources to mitigate grid outage conditions are likely to be more constrained than other communities. Implementing EQ Basins require capital expenditure that are typically recovered through rate increases. Such rate increases are generally distributed equitably across customer types that are serviced by the wastewater treatment plant. This ensures that the cost of the solution is not borne by Low-Income and Disadvantaged Community customers alone or inequitably.

Grid Responsive Energy + Water Storage Systems (GREWSS)

Supply Resource | Closed-Loop, Small/Modular Pumped Storage Hydropower | Utility Scale

Pumped storage hydropower ("PSH") uses pumps to convey water from a lower reservoir to an upper reservoir for energy storage and releases water back to the lower reservoir via a powerhouse for hydropower generation. PSH facility pump and generation cycling often follows economic and energy demand conditions.

PSH systems are characterized as either open-loop (continuously connected to a naturally flowing water feature) or closed-loop (not continuously connected to a naturally flowing water feature). Most PSH development has involved the construction of facilities that provide large energy storage and capacity. For multiple reasons, large-scale, open-loop PSH development has been virtually non-existent in the United States in recent decades.

Advantages of Closed-Loop, Small/Modular PSH:

- Compared with conventional, large PSH development, small and modular PSH development requires much smaller up-front capital investment, reducing perceived financial risk for investment. **By using modular concepts, designs can be replicated at multiple sites and reduce site specificity, project costs, and development timelines.**

- Environmental effects of closed-loop projects are generally lower than those of open-loop projects because they: (1) are located "off-stream," potentially mitigating aquatic and terrestrial impacts, and; (2) often have greater siting flexibility than open-loop projects.[23]

Regulatory Status of Closed-Loop PSH in the United States:

- In response to increased interest in PSH by project developers, regulators, resource agencies, and others, FERC reevaluated its hydropower licensing review process for qualifying closed-loop PSH projects and its hydropower licensing jurisdiction for certain types of closed-loop PSH projects.

  As a result, in October 2018, Congress passed the America's Water Infrastructure Act of 2018[24] requiring FERC to establish "an expedited process for issuing and amending licenses for closed-loop pumped storage projects." FERC issued the final rule in April 2019 (FERC 2019a), establishing the criteria for expedited license processing, requiring PSH projects:

  - cause little to no change to existing surface and groundwater flows and uses;
  - is unlikely to adversely affect species listed as a threatened species or endangered species, or designated critical habitat of such species, under the Endangered Species Act of 1973;
  - utilize only reservoirs situated at locations other than natural waterways, lakes, wetlands,

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[23] https://www.energy.gov/sites/prod/files/2020/04/f73/comparison-of-environmental-effects-open-loop-closed-loop-psh-1.pdf

[24] https://www.congress.gov/bill/115th-congress/senate-bill/3021/text#:~:text=3765%5D%5D%20Public%20Law%20115,activities%2C%20and%20for%20other%20purposes.

  and other natural surface water features; and
  - rely only on temporary withdrawals from surface waters or groundwater for the sole purposes of initial fill and periodic recharge needed for project operation.

- In addition to expedited licensing review, FERC decisions re: closed-loop PSH projects "**confirm that, for purposes of establishing the mandatory licensing requirements under the FPA, groundwater is not a non-navigable Commerce Clause stream**" (Gerard and Hites 2018). This means a project "that uses only groundwater as its water source **will not require** FERC licensing if the project does not trigger other jurisdictional tests" under FPA Section 23(b) (Gerard and Hites 2018).

- **This decision allows some closed loop projects to avoid the FERC licensing process altogether**. However, the projects are still subject to environmental review and permitting approval by other federal, state, and local resource agencies.

The Administration and DOE support closed-loop PSH projects

- In 2019, the U.S. Department of Energy Water Power Technologies Office launched the **HydroWIRES** (Water Innovation for a Resilient Electricity System) **Initiative** to understand, enable, and improve hydropower and pumped storage hydropower's (PSH's) contributions to reliability, resilience, and integration in the rapidly evolving U.S. electric system. **The unique characteristics of hydropower, including PSH, make it well suited to provide a range of storage, generation flexibility, and other grid services to support the cost-effective integration of variable renewable resources.**

California is ideally positioned to benefit from recent advances in small, modular storage systems, in both the near-and mid term:

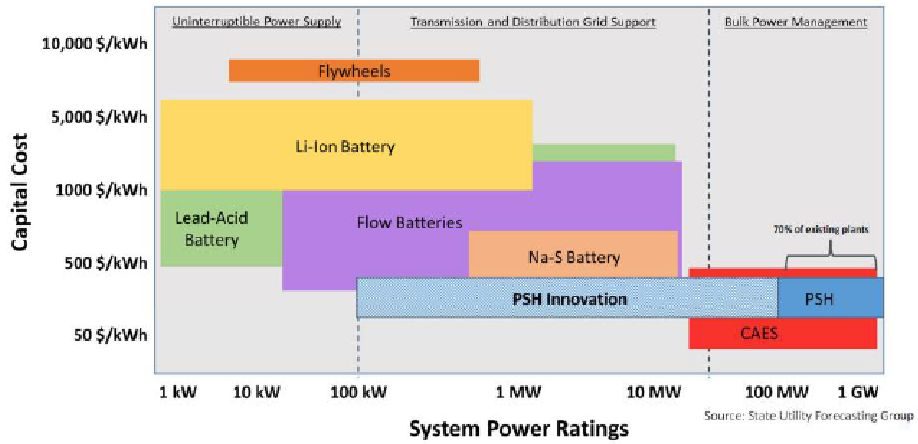
- Small, modular PSH systems (< 30MWs) powered by on-site renewables can be designed as a multi-benefit platform that operates in different modes, depending on grid needs. On a daily basis, stored energy can help the grid operate more efficiently and cost-effectively. During emergency conditions, those same systems can deliver resiliency for communities and critical infrastructure by switching to microgrid operation mode. With stored water from the tanks, they provide enhanced firefighting capabilities. These resources are otherwise known as Grid Responsive Energy + Water Storage Systems ("GREWSS"). There are several companies actively working to develop these types of projects in California today.

  A typical GREWSS system consists of two above ground water storage tanks located at different elevations, a pumping system, a hydroelectric plant, and a solar array. Each day, water is pumped from the lower tank to the upper tank drawing on power produced by the onsite solar system during the 10 a.m. to 3 p.m. time period. During the hours of 4 p.m. to 9 p.m., water is released from the upper tank, sent through the hydroelectric plant where power is produced and sent to the electrical grid to meet peak load needs. The water that flows through the hydro plant is stored in the lower tank. The process is repeated the next day. Each system has the potential to supply up to 30 MW of firm dispatchable capacity. GREWSS provide significant ancillary benefits beyond peak load services and are well equipped to serve drought-stricken regions by mitigating concerns over evaporation.

Quantitative Attributes:

ATTRIBUTE	DETAIL	RESPONSE
Capacity	How many new MWs and MWhs can the resource provide per year, taking into account resource characteristics and known barriers between now and 2035?	Using an existing project as an example, this project can provide up to 70 MW across 3 locations delivering ~300 MWh per year from a mix of (3) 20MW + (1)10MW systems. Assuming an average of 40MW per project, it is reasonable to anticipate these resources could deliver 1 GW or more by 2035.
	How is that different if used incrementally as an emergency asset during an extreme heat event?	Incremental emergency operations would not have a significant impact.
Levelized Cost	What is the levelized cost for the resource in $/MW-yr. and $/MWh-yr. from 2023 to 2035?	The cost model provided by Oak Ridge National Laboratory in 2016[25] detailed insight into the dynamics of m-PSH projects over a variety of scales, topographical and geographical landscapes, and potential deployment. Example finding:There is a potential for smaller scale, cost effective energy storage with m-PSH plants that would operate much different from the conventional fleet. New models and simulations are needed to better understand how m-PSH can be strategically used as an energy storage technology. Analyses should move beyond conventional transmission scale services such as energy arbitrage and ancillary services, and include distributed energy storage benefits, including commercial and industrial use, demand charge reduction, time-of-use management, and renewables integration at small scales.

[25] https://www.osti.gov/biblio/1329154

	 **Figure 3. Capital cost and system power ratings of various energy storage technologies, highlighting the potential for m-PSH innovation (Welch, 2016, as adapted from the State Utility Forecasting Group).**	
Expected Useful Life	What is the expected useful life for: A. Current technologies? B. Emerging technology?	40 - 100 years for hydro/storage system 15 - 30 years for co-located solar PV array

Qualitative Attributes:

ATTRIBUTE	DETAIL	RESPONSE
GHGe and Environmental Impacts	Comparison to conventional generation	The emissions associated with pumping water ("charging") to the upper storage tank depend on the resources used to charge the upper storage tank. As discussed in this recommendation, the intended resource used to generate the power to charge the upper storage tank would be solar - resulting in zero emissions associated with operating the resource.
	Lifetime emissions	There would be zero emissions associated with charging the upper storage tank, and thus all emissions associated with the project would depend on manufacturing, installation, and any potential emissions associated with maintenance.
	Land impacts	Land impacts depend on the size and capacity of each individual project. Considering the resource is a closed loop system, evaporation is negligible and therefore requires relatively

		minimal water recharge and does not require building a reservoir.
Reliability	How does the resource support reliability (e.g., supply, permanent load reduction, net peak reduction, or emergency asset?) (List all that apply.)	The resource can be flexible and serve a variety of needs as frequently as daily. The resource can be used for permanent load shifting or emergency response. Because the resource is a closed loop system it has minimal water loss due to evaporation and thus requires relatively minimal water for recharge - meaning the resource is drought-resistant.
	How can the resource be used as an incremental on-call resource during emergencies?	The resources can participate in various emergency programs.
Dispatchability	Certainty and firmness of an option, including number of events, frequency of events, and event duration	See the response for reliability as well as narrative and context above.
Readiness	Current technology:	Approximately two years, as the technology is proven and well understood. Depending on the size, capacity, and location of the resource, the resource may be ready in 14 months to a couple years from design to operation. This timeframe is shaped largely by permitting and regulatory requirements and construction time. There are several attributes of these projects that lend themselves to quick deployment at scale, as described in the narrative above.
	Emerging tech:	Several projects are in development in California.
Non-Financial Barriers or Opportunities	Permitting	

	Proven Technology Ability to interconnect to the grid at the distribution level (case specific) Non-FERC Jurisdictional (< 40 MW nameplate) Permitted locally; optional Fast Track Approval Process through California Energy Commission Significant Federal and State financial incentives • Ability to sell certain 'products' into CAISO wholesale markets, participate in demand response, flexible load and aggregation programs, and dynamic tariffs • Exempt from Clean Water Act through use of Groundwater • Capacity Range: 5MW, 10MW (2x), 20MW, 30MW • Faster Project Delivery (with Rule 21 Behind-the-meter interconnection)	
	Interconnection	See the response above.
	Supply Chain	For the PSH system, American steel and concrete provide American jobs and lower supply chain risk than other technologies with parts manufactured overseas. The resource would face similar supply chain challenges as any other solar + battery system would. The materials needed for the hydro/storage component of the resource could largely be sourced domestically and would mitigate many of the supply chain challenges currently being experienced.
	Customer Acceptance	Customer acceptance will vary between each community, but it is worth noting the benefits (clean energy, energy resilience, fire resilience, etc.) increase customer acceptance.
	Policy Goal Alignment	Clean energy requirements (SB 100, SB 1020) Load shifting targets (SB 846) California's Wildfire And Forest Resilience Action Plan (2021) Future of Work in California Compact (2021) Water conservation / drought goals
Financial Barriers or Opportunities		Various regional, state, and federal funding stacking opportunities.
Low-Income and		Likely explicit benefits to low-income and

Disadvantaged Communities Impacts		disadvantaged communities as this system could be best suited for being located in fire prone regions which often also face outages due to electricity-related fire risks. There are many benefits these clean energy and resilience projects bring to local communities that are captured by traditional equity-focused tools such as the Cal-Enviro Screening tool that should be considered.

Input on DEBA Program Design

The Council supports the Distributed Electricity Assets Program ("DEBA") and worked towards its passage in the 2022 Legislative Session. The Council is excited by the opportunity to stack incentives under DEBA and the DSGS. Stacking incentives will increase the success of the two programs in providing load reduction and backup generation to support the state's electrical grid during extreme events.

The Council generally has minimal feedback to the Energy Commission's DEBA questions 1, 2, and 4. The Council would like to provide general direction on Question 3 and looks forward to continuing the DEBA discussion with the Energy Commission and stakeholders.

1. What size of resource and what types of customers should the program target?

    The Council does not have a response to this question at this time.

2. What types of incentive structures and amounts are needed to accelerate the development and deployment of this resource?

    The Council does not have a response to this question at this time.

3. What types of conditionalities and measurement and verification requirements should the program include to ensure funded resources participate and deliver during emergency events?

    The Council does not have a response to this question at this time, but points to best practices of existing and current measurement and verification processes appropriate for similar technologies under consideration.

4. In general, please provide any specific proposal or recommendation on the design and implementation of the DEBA program.

    The Council does not have a response to this question at this time.

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APPENDIX A: Annotated Listing of References

Various Resources

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