MEMORANDUM

TO: **UTILITIES ADVISORY COMMISSION**

FROM: **UTILTIES DEPARTMENT**

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DATE: **August 2, 2017**

SUBJECT: **Discussion of Developing a Flexible Distributed Energy Resource Plan and Forecasting Long Term Customer Electrical Loads in Palo Alto**

REQUEST

This report provides the Utilities Advisory Commission (UAC) an overview of Distributed Energy Resources (DERs) in Palo Alto and a proposed approach to integrating these resources into the electric utility distribution system, including a set of proposed strategic principles to guide operational decision making. Staff is seeking feedback on the proposed approach, and will bring a fully developed DER Work Plan for UAC review and recommendation in late 2017 / early 2018. These strategic principles will also help inform aspects of the Utilities Strategic Planning process. While these strategic principles are primarily focused on the impacts and opportunities for DERs in utility operations, staff intends to integrate them into other Citywide efforts (such as the Sustainability and Climate Action Plan, the S/CAP) to promote or enable DERs for other reasons, such as carbon reduction.

This report also discusses the approach staff takes in forecasting customer electrical loads and how forecasts of DER adoption will be incorporated into these load forecasts to comply with the integrated resource planning requirements of SB 350.

No UAC action is requested at this time.

EXECUTIVE SUMMARY

DERs in Palo Alto are electrical energy resources connected to the CPAU electric distribution grid that can significantly change the character, timing, and magnitude of electric loads and that can potentially be used to replace or complement services traditionally provided by utility-scale generating resources. DERs tend to be smaller than typical utility-scale resources (less than 1MW in Palo Alto). DERs include resources such as solar photovoltaics (PV), electric vehicles (EV), energy efficiency (EE) measures, customer demand response (DR), energy storage (ES) systems, smart thermostats, and high-efficiency electric heat-pumps (HP) for water and space heating of building loads.[1] DERs could be deployed by customers at their premises, behind the utility electricity meter, or by CPAU within the distribution system network. Except for a handful,

[1] PUC §769 defines "distributed resources" as distributed renewable generation resources, energy efficiency, energy storage, electric vehicles, and demand response. Palo Alto definition of DER is slightly boarder, including smart thermostats and heat pump technologies.

all current DERs in Palo Alto are customer-sited behind-the-meter resources. Well managed and integrated DERs with built-in sensing, controlling, and communicating controls could be leveraged to provide distribution and transmission systems services, potentially lowering costs to the DER owner and all CPAU customers.

Currently customer decisions to adopt DERs are based on a variety of factors, including customer preferences, incentives available to customers, and availability of programs to facilitate adoption. However, unmanaged DER adoption could increase costs for CPAU by increasing uncertainty in balancing loads and resources, as well as causing adverse impacts on the distribution system. The third section of this report proposes broad strategic principles to ensure pragmatic and cost-effective integration of DERs in Palo Alto. A DER Plan based on the strategic principles discussed here will guide operational decision making and can help CPAU mitigate risks and facilitate customer adoption of these technologies to the benefit of the entire Palo Alto community.

This report discusses these preliminary strategic principles and a roadmap to develop the DER Plan. Staff will bring a fully developed DER Plan for UAC review and action in late 2017 / early 2018. The adoption of these strategic principles and the increased penetration of DERs will also have implications for the staffing, resources, and priorities for the entire utility, and this will be discussed as part of the Utilities Strategic Planning process.

DISCUSSION

CPAU's current annual electrical energy load (950 GWh) and annual peak demand (180 MW) are approximately 15% lower than in the year 2000. The exit of electricity-intensive commercial customers from Palo Alto, increases in energy-efficient appliances and building codes, changes in customer behavior, and the installation of solar PV on rooftops are some of the reasons for the decreased electricity load. The City's per capita average annual residential customer electrical energy use has declined by 16% over the past decade.[2]

The discussion below is organized in three sections: Section A gives an overview of the impact of DERs on Palo Alto's electric load to-date, while Section B discusses the load forecasting approach and uncertainties in CPAU's 2030 load due to DERs. Section C discusses how staff will develop a DER Plan to facilitate DER integration in Palo Alto.

A. Overview of Past DER Adoption

A variety of DERs have been installed in Palo Alto to-date. An overview of various technologies and their adoption in Palo Alto is provided below. CPAU's practice to-date has been to support and facilitate customer adoption of DER in accordance with Council-approved plans or State mandates.[3] However, when such systems are cost-effective from a societal perspective,[4] CPAU

[2] The corresponding per capita residential natural gas and water consumption has declined by 25% and 45% respectively over the past 10-years.

[3] Existing CPAU goals/ programs related to DERs include: 2014 Local Solar Plan, 2015 Electrification Work Plan, 2016 Use of Low Carbon Fuel Standard Revenue to benefit EV customers, and the 2017 Updated Ten-Year Electric Energy Efficiency Goals. DERs are also addressed in the Sustainability and Climate Action Plan (S/CAP) and goals related to DERs were included in the first proposed Sustainability Implementation Plan (SIP). Other City mandates address DERs as well, such as Building Code regulations mandating EV charger installation in new buildings.

actively promotes technologies using electric rate-payer funds such as Public Benefits funding.[5] CPAU also funds DERs as required by state law.

- **Solar PV Systems**: Since 1998, over 1,000 PV systems with a total capacity of 10 MW have been installed in the community at an estimated nominal investment of $55 million.[6] These systems received $13 million in rebates funded by electric rate-payers as required by state law SB-1 and additional support through the City's Net Energy Metering (NEM) rate, which was also mandated.[7] These systems currently meet approximately 1% the community's overall energy needs and lower the City's system peak capacity by 5%. Palo Alto has a Local Solar Plan goal to provide 4% of its electricity from local solar resources by 2023.

- **Energy Efficiency**: Since 2007 CPAU has supported and provided incentives for $23 million in EE projects.[8] The EE investments over the past ten years have lowered the community's electrical loads by 6.5% (a cumulative savings of 62,800 MWh). In addition to CPAU programs, stricter State and Federal standards for high-efficiency appliance and building energy use have also lowered community electrical loads substantially. CPAU's recently-approved ten-year electric energy efficiency goals set a cumulative savings goal of 5.7% for 2018 through 2027.[9] Between 2018 and 2027, State building codes and standards are projected to save another 2.8% of CPAU's total projected 2027 electricity load.

- **Electric Vehicles**: Since 2010, there has been rapid growth in EVs in Palo Alto, for both resident-owned and commuter vehicles. With an estimated 2,500 EVs expected to be registered in Palo Alto by the end of Calendar Year (CY) 2017 and 1,000 commuter EVs, CPAU estimates the total EV charging load in Palo Alto in CY 2017 to be 6,400 MWh or 0.7% of expected load. In accordance with Council directives as well as state law, CPAU is facilitating greater adoption of EVs by providing information on EV charging costs, simplifying the process for installing EV chargers at home, and by providing $0.4 million per year in rebates for installing new EV chargers at multi-user sites.[10]

- **Demand Response:** CPAU has had a pilot Demand Response program available since 2012. The current pilot program provides about 0.5 MW reduction in peak capacity (or 0.3% reduction in CPAU's coincident peak).

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[4] "Societal cost-effectiveness" is based on a Societal Cost Test (SCT) used in the utility industry. SCT is a broader measure of societal net benefit, as oppose to Participants Cost Test (PCT), which looks at only a single customer's cost and benefits.

[5] PUC § 385: The public benefits charge (for electric utilities in California) is a state mandated requirement to collect a separate surcharge to be used for "public benefits" programs such as cost-effective energy efficiency and low income programs.

[6] These solar systems are made up of 975 residential and 78 commercial systems. Nominal investment is estimated using declining cost of the solar PV system over time (1998 to 2017; $24/Watt to $3.5/Watt).

[7] NEM is a billing mechanism to compensate onsite renewables at the retail rates. CPAU's NEM cap is 10.8 MW. Once CPAU reaches the NEM cap, customers with newly approved solar PV systems will be served by the NEM Successor rate.

[8] CPAU has been promoting EE investments since the 1970s, but highly regulated efficiency savings accounting has only been in place for the past 10 years. CPAU provides an annual update on EE/demand side management programs each fiscal year.

[9] March 2017 Updated Ten-year Electric Energy Efficiency Goals

[10] CPAU provides EV charger rebates by leveraging funds from CA state Low Carbon Fuel Standard (LCFS) program - EV charger rebates for multi-user sites

- **Energy Storage, Heat Pump Water Heaters, and Smart Thermostats:** These technologies are still in early stages of deployment and their impact on the CPAU electrical system is yet to be determined. CPAU assessed the cost-effectiveness of energy storage systems earlier this year and found they are not yet cost-effective from a societal perspective[11]. CPAU is facilitating customers' adoption of energy storage systems by clearly communicating interconnection and building permitting requirements. High-efficiency heat pumps for water and space heating currently both have very low penetration rates in Palo Alto. For heat-pump water heaters, CPAU is facilitating customer adoption by providing education to customers and installers, communicating the City's permitting requirements, and by providing a pilot program rebate of $1,500 per unit.

B. Load Forecasting Approach, Use of Forecasts and Uncertainty in 2030 Loads

CPAU currently plans for the impact of DERs by incorporating projections of DER adoption rates into the load forecasting process. CPAU, in collaboration with NCPA, uses an econometric load forecasting model for the long-term forecast.[12] The output for the long-term econometric model is then exogenously adjusted for factors that are not adequately captured in the model – such as the addition or exit of large loads, or accelerated adoption of DER technologies. These monthly and annual forecasts are generated for up to 10 years, and are submitted to the California Independent System Operator (CAISO), the California Energy Commission (CEC), and Pacific Gas and Electric Company (PG&E) for transmission and supply resource planning purposes at the state level. Internally, CPAU utilizes the same forecast for energy and capacity procurement decisions, monthly load-resource balancing, distribution system planning, developing and promoting customer programs and for financial planning of rates and reserves. Long-term forecasts for the period of 2019 – 2030, along with DER forecasts and the supply portfolio will be developed for the purpose of long-term supply planning and will be submitted to the CEC to meet regulatory requirements under SB 350.

- **Uncertainty in 2030 Loads due to DERs**

DER technology adoption forecasts remain uncertain as past customer adoption rates provide limited foresight into future adoption trends. Dynamic factors such as decreasing technology cost trends, policy directives, and rebate availability play a large role in DER adoption rates.

Staff has made some preliminary and highly uncertain estimates. Under a high-adoption scenario, staff estimates that solar PV and EE investments might lower CPAU's electric load by 20% in 2030. A high-adoption scenario for EV adoption and building electrification, on the other hand, could increase the electric load by 10% in 2030. These individually-owned DERs will impact CPAU's load profile (both seasonal and hourly), and if integrated optimally they could have the potential to lower CPAU costs to serve the entire Palo Alto community. CPAU is currently assessing the locational impacts of DER adoption.

[11] May 2017 Energy Storage Report to the UAC

[12] The forecasts provide long-term trends and are sensitive to the adoption of DERs in the long term. NCPA utilizes a separate short-term neutral network based day-ahead model to forecast hourly loads on a day-ahead basis.

C. Framework to Develop a Long Term DER Plan

- **Guiding Principles to Develop a DER Plan**

Staff expects that the adoption of DER technologies will remain uncertain as cost-effectiveness and customer preferences evolve in the coming decade. To effectively plan for the impacts of DERs, staff proposes the following set of strategic principles for discussion by the UAC in August 2017.

CPAU proposes to integrate DERs in a cost-effective and reliable manner by the adhering to the following principles:

1) Ensure that both the electric distribution system and electric utility financial and pricing structures can accommodate DER growth,

2) Facilitate the operation of DERs in ways that enhance the value to the DER owner as well as to the rest of the Palo Alto community, and

3) Staff will act as a facilitator of DERs. This means that:
   i. Where DERs are cost-effective as an alternative to traditional generating sources or distribution system upgrades, CPAU will create incentives for adoption of DERs;
   ii. Where DER technologies are not yet cost-effective alternatives to traditional generating sources or distribution system upgrades, CPAU will facilitate voluntary customer adoption.

These principles are discussed in greater detail below:

1) Ensure that both the electric distribution system and electric utility financial and pricing structures can accommodate DER growth

As discussed above, long-term DER adoption rates remain uncertain. Establishing scenarios and stress test cases could help CPAU to plan for these load uncertainties. Staff plans to undertake DERs scenario assessments as part of developing the DER Plan and EIRP.

CPAU currently has a relatively robust distribution system network in place and does not anticipate having to make significant investments on the distribution system side to integrate DERs in next few years.[13] However, this could change if there are specific neighborhoods of concentrated EV and electrification adoption. Staff is undertaking a closer review of the distribution system, and is assessing if there are any locational hot spots which could prove challenging for integrating DERs in longer term. Staff plans to share these findings with the UAC in early 2018.

Staff will also evaluate the current electrical rate structure and DER connection fee structures to ensure that they can accommodate customer driven DER adoption, within overall rate

[13] CPAU has 9 substations with availability of back-up substation transformers, 62 feeder lines and about 3,000 distribution transformers.

making principles. The Utility Strategic Planning process is an appropriate venue to discuss the relative priorities of these initiatives.

2) Facilitate operation of DERs in a way that enhances value to the DER owner as well as for the overall Palo Alto community

Time-varying retail price signals could create incentives for customers to operate DERs in a manner that is optimal for both the customer and the overall Palo Alto community. For example, unmanaged EV charging in residential areas could stress the local distribution transformer in evening time periods and may require unplanned upgrades. This impact could be mitigated if there are price signals to encourage EV charging in less impactful hours in the day.

CPAU currently does not have Advanced Meter Infrastructure (AMI) to implement time varying pricing.[14] CPAU's planned investments in Customer Information System (CIS) and AMI systems by 2021 will prepare the utility to send appropriate price signals and to ensure DER electricity consumption (or self-generation) patterns are in sync with the distribution system and CAISO market needs.

As part of its series of AMI pilot programs, staff is considering a pilot program to test capabilities of new sensing, controlling, and communications systems which could enable DER systems to respond to transmission and distribution system needs on a day-ahead or real-time basis.[15] Smart inverters integrated with solar PV and battery storage, automated DR capability for Building Management Systems, sensing and communication for EVs, and controllable heat-pump water heaters, are some of the technologies that could be included for this assessment.

3) Staff will act as a facilitator of DERs. This means that:

iii. Where DERs are cost-effective as an alternative to traditional generating sources or distribution system upgrades, CPAU will create incentives for adoption of DERs

iv. Where DER technologies are not yet cost-effective alternatives to traditional generating sources or distribution system upgrades, CPAU will facilitate voluntary customer adoption.

Staff proposes that CPAU's role be to facilitate customer DER adoption rather than to take a 'do-nothing' approach,[16] or to actively encourage adoption regardless of the cost,[17] or to try to be involved in the business of installing and owning DER technologies.[18] A facilitative approach

[14] CPAU has successfully tested the AMI technology with 300 customers CustomerConnect Advance Meter Pilot

[15] The pilot scale project could include leveraging the PV and energy storage systems' smart inverters capabilities to provide capacitive energy for enhancing the distribution system power factor and to provide ancillary services to the transmission system

[16] This approach would not include streamlining of DER adoption requirements, devoting staff to other priorities, and addressing distribution system issues in a reactive manner, as they arise.

[17] This would involve actively attempting to reshape the way the distribution system operates using advanced control technologies and incentives to encourage sophisticated DER integration. This approach could involve significant costs and risks by moving more quickly than most small utilities.

[18] For example, installing EV chargers, getting into the business of installing rooftop solar, or other competitive business

would involve acknowledging the DERs can sometimes serve a role in providing services traditionally provided by generators (for example, reducing EV charging load during peak hours as an alternative to turning on a gas-fired peaking plant). The cost-effectiveness of DERs as an alternative to central station generation depends on the cost of the DER technology and the value of the service provided. For example, storage could be used to provide a variety of services, including providing operating reserves for the transmission system, providing reactive power, reducing impacts on the distribution system, and other services. However, currently the cost of storage systems exceeds the benefits the storage system can realize, meaning it is not cost-effective for the utility to encourage storage as an alternative to services provided by central station generation or to defer distribution system investments. This may change as storage costs decrease. Still, there are cost-effective DER technologies right now, such as energy efficiency measures. Installing efficient appliances is a well-established cost-effective alternative to building new generation.

Where DER technologies (such as storage) are not yet cost-competitive, staff is proposing that CPAU's focus be on working to ensure that permitting and interconnection processes are made as minimally burdensome as can be reasonably achieved while preserving system safety. In addition, CPAU could implement pilot programs to gain experience with these DERs. This helps those customers who are willing to pay a premium to voluntarily adopt DER technologies that are not yet cost-effective from a societal perspective. One example of how such an approach would work is the City's program to use Low Carbon Fuel Standard (LCFS) funds to provide rebates for installation of EV chargers in underserved multi-use sites (non-profits, schools, multi-family housing) while simultaneously working to safely ease permitting requirements for EV charger installation. This facilitates greater EV adoption by customers who are willing to pay a premium to reduce carbon by purchasing an electric vehicle, but does not significantly impact other electric ratepayers to do so.

This approach would require the utility to devote staff time and resources to work on evaluating cost-effective technologies, launching and managing pilot programs, and working to safely streamline permit and interconnection requirements. The DER Work Plan discussed below would establish a proposed level of staffing for these functions and whether additional staff would be required, and the Utilities Strategic Plan would help establish the priority for these activities relative to other necessary utility functions. Any change in staffing or other funding levels would require discussions as part of the budget and rate setting process. Lastly, any efforts undertaken under the DER Work Plan would need to be coordinated and aligned with other City initiatives involving DERs, particularly the S/CAP.

- **Roadmap to Develop a DER Work Plan for next 5-10 years**

Figure 1, below, outlines at a high level how a DER integration plan could progress over the next decade. There are multiple levels of involvement that CPAU can have in DER integration and partnership, and each requires a higher level of sophistication and resource commitment. The DER Plan will provide a more detailed plan for the potential timing of these stages, the decision criteria for whether to proceed to the next stage, and the variety of different options available

ventures.

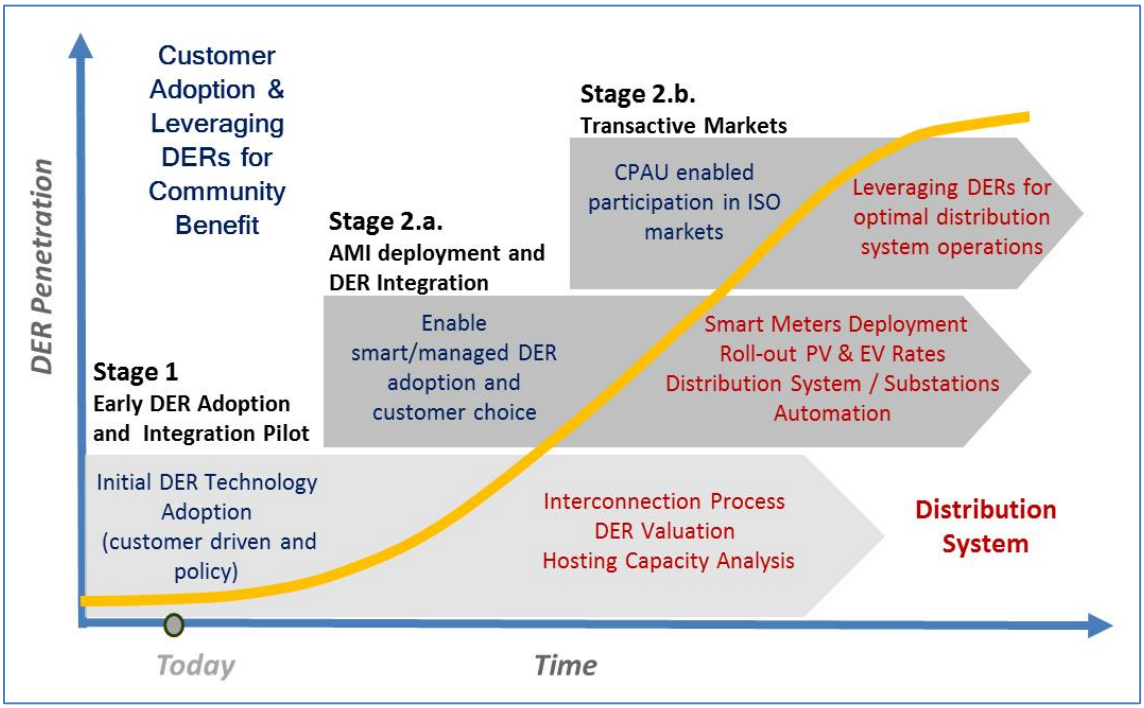
at each stage. The discussion of the DER Plan strategic principles (as listed above) and the Utility Strategic Planning exercise will also provide insights to develop a more robust DER work plan.

CPAU has already taken some steps supportive of DER integration. Per Council direction (see footnote three), CPAU is already assisting early adopters of some types DERs such as PVs and EVs, and is working to facilitate customer adoption of DERs.[19] CPAU is establishing teams working across Departments and Divisions to achieve these goals. Staff is also working on a DER valuation and distribution system assessment and plans to share these findings with the UAC in coming months. Lastly, CPAU has successfully tested the application of AMI technology and response to the time-varying prices with a 300-customer pilot program, piloting technologies and rate designs that will be important for DER integration. In the absence of widely deployed AMI systems, CPAU is considering performing small scale DER pilots to learn how to integrate a number of DER systems for dispatch into the CAISO day-ahead markets. These activities are outlined as Stage 1 in Figure 1, and are expected to run through 2021 along with CPAU's CIS and AMI system implementation.

By 2021-22, the AMI system is expected to be fully operational. If the UAC and Council direct staff to pursue further DER activities, CPAU would then take on Stage 2a activities related to the deeper integration of DERs, such as DER-specific pricing strategies (including time of use rates) and implementation of other automation at the distribution system level. In Stage 2b, CPAU would be fully prepared to leverage the DER system for the benefit of the California energy markets, transmission and distribution system, and to optimally serve the Palo Alto community. Stage 2 activities could be undertaken over the 2022-2027 time periods. The City can pursue earlier phase activities without proceeding all the way to Phase 2b.

[19] For example, providing unbiased customer information through PV Watt and EV cost calculators and streamlining interconnection and building permit approval processes for heat pump water heaters.

Fig 1: Evolutionary Stages of Customer Adoption of DER & Leveraging DER for Overall Community Benefit[20]



NEXT STEPS

Staff is seeking UAC input on staff's proposed approach to facilitate DER adoption, particularly the three strategic principles intended to guide the development of the DER Plan for UAC review in late 2017 / early 2018.

RESOURCE IMPACT

No additional resources are being sought to develop this plan. Work will be performed with existing staff and with input and support from NCPA.

POLICY IMPLICATIONS

The policies to be adopted in this DER Plan have implications for business practices throughout the Utilities Department and implications for the services provided to customers with respect to DERs. They will be coordinated closely with the Utilities Strategic Plan. The City's DER policies will also need to be consistent with the S/CAP and the Electric Integrated Resource Plan (EIRP) currently under development. Additional staffing or other resources needed, if any, will be discussed as part of the DER Work Plan and formally proposed as part of the annual budget process.

[20] This graphic is adapted from the CAISO's presentation to the NCPA Smart Grid working group , "More than Smart" DER planning paper and SCE whitepaper on grid modernization

ENVIRONMENTAL REVIEW

The Utilities Advisory Commission's discussion of the DER work plan does not meet the definition of a project under Public Resources Code 21065 and is therefore California Environmental Quality Act (CEQA) review is not required.

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