MEMORANDUM

TO: **UTILITIES ADVISORY COMMISSION**

FROM: **UTILTIES DEPARTMENT**

DATE: **September 6, 2017**

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SUBJECT: **Update on Smart Grid Pilot Projects and Development of the Utility Technology Implementation Roadmap**

REQUEST

This report is provided to the Utilities Advisory Commission (UAC) for information and discussion. No action is needed at this time.

EXECUTIVE SUMMARY

In 2012, City of Palo Alto Utilities (CPAU) completed an assessment of smart grid applications based on Advanced Metering Infrastructure (AMI) for Palo Alto. The study estimated the capital cost associated with AMI implementation for electric, natural gas and water utility services at $15 to $20 million, and the cost-benefit assessments found the costs outweighed benefits over a 15- to 20-year life of such an investment. Based on these findings, the study recommended, and City Council approved, deferring major investments in smart grid for several years until technologies mature and implementation costs decline, along with implementation of a number of smaller pilot scale smart grid projects (Staff Report 3330, 12/10/2012).

This report outlines the pilot projects undertaken over the past 5 years and discusses the experiences gained and lessons learned. The report also discusses the process currently underway to evaluate the pilots and experience gained, and to develop an actionable technology implementation roadmap over the next 5-10 years. This effort is being coordinated with the update of the Utilities Strategic Plan. A draft technology implementation roadmap with associated resource needs will be brought to the UAC for discussion early next year, and for final Council approval in the spring of 2018.

DISCUSSION

Based on the 2012 evaluation and associated recommendations, staff implemented a number of pilots of smart grid applications and evaluated a number potential integration issues over the past 5-years as outlined below:

1. Implemented Residential CustomerConnect advanced meter pilot program whereby 300 single family residents[1] were provided advanced electric, natural gas and water meters and given access to their hourly utility consumption information with the expectation of enabling residents to better understand their energy and water consumption patterns and improve their utilization or to undertake conservation efforts .

   The $450,000, 5-year pilot helped increase participant awareness of their utility consumption pattern, but no noticeable change in consumption was observed. The water leakage detection

[1] Of the 300 residents, 200 were selected and volunteered to participate on a first-come first-served basis. An additional 100 were recruited by soliciting a group of 400 residents selected based on a stratified sampling technique. In addition to the 300 residents who received advanced meters for all three utility services, 106 additional residents were recruited at strategic locations in town to receive advanced electric meters only, in order to strengthen the meter communication mesh network throughout Palo Alto.

notification feature helped detect and fix a large number of water leakages occurred at participants' homes and was well received by the participants.

Useful customer energy consumption hourly profiles were obtained to further aid customer program development and distribution system planning. The program also facilitated a number of other pilots as outlined below.

2. Implemented Residential Time-of-Use (TOU) electricity retail rates to provide different pricing depending on the hour when electricity was consumed. The TOU rate is designed to encourage the use of electricity during off-peak hours. About 117 customers who participated in the CustomerConnect program were introduced to this rate plan.

   Only a small shift in consumption towards off-peak hours was observed among households with EVs, mostly because EV owners already tended to charge at night, even before they started on the TOU rate. Customers with EVs under this rate on average saved $1 per month. Customers without an EV or high electricity users did not benefit from the TOU rate. EV owners' electricity consumption on average was about 35% or 180 kWh higher per month than an average household in Palo Alto. EV charging profiles obtained through the AMI meters will help better plan distribution system transformer sizing in the future.

3. Enabled the monitoring of electricity consumption through In-Home-Displays (IHD), devices that connect to the AMI electric meter, via a Zigbee radio in the meter, to display consumption in real time to the homeowner. The IHD's ability to send this information through a customer's wifi network to an online platform was utilized in a novel research project through a partnership with the Palo Alto Medical Foundation (PAMF).

   The research projects was designed to explore if near real time utility consumption information could be utilized by care-givers to monitor seniors' activity at home in a unobtrusive manner to provide timely homecare as needed. Twenty such seniors were identified by PAMF and were enrolled in the pilot by providing AMI electric meter and IHD. PAMF and Robert Wood Johnson foundation funded this research project and the results will be published by the end of this year.

4. Implemented large commercial customer summer peak demand response (DR) program to lower Palo Alto's overall annual summer peak load and associated electricity capacity purchase cost, and to reduce the need for the state to turn on inefficient fossil fuel peaker plants. Customers who signed up for the program were required to lower consumption by a minimum of 50kW when called upon and were compensated for energy consumption reduction during those periods at a rate of 50 cents/kWh, Palo Alto's avoided energy/capacity cost for such peak load periods in the summer. The program was open to only large commercial customers who were eligible to receive communicating interval meters under an existing Meterlinks program.

   The program has attracted six to eight large commercial customers (including City facilities) and customers collectively reduced loads by 400 to 800 kW (in a 4-hour period between noon to 6pm) on such demand response days in the summer. The benefit of this program is about $10,000 per year, and is equal to the cost of program administration and customer compensation.

5. Assessed Conservation Voltage Reduction (CVR) potential, by utilizing voltage sensors in the AMI meter and transformer load tap changers, to more optimally manage voltage levels along the electric distribution system. A lowering of system voltage along distribution feeder lines, while maintaining the voltage within the industry standard range of 114 to 126 volts for all customers, tends to lower the energy consumption by customers. This strategy was successfully tested on a single distribution feeder. Citywide AMI meters need to be installed to harness this benefit on all 68 distribution feeders in Palo Alto.

   An assessment for Palo Alto was undertaken with a grant from American Public Power Association (APPA). The assessment found an energy conservation potential of 0.5% to 1% across all distribution feeders that could lower overall energy supply cost by $0.4 to $0.8 million per year.

6. Evaluated ways to lower overall AMI system integration cost with the Customer Information and Billing systems (CIS). The 2012 cost-benefit assessment estimated the cost of the AMI meter data management (MDM) system and its integration with Palo Alto's SAP CIS system at $5 million.

   In 2016 CPAU decided to explore migrating to a utility best-of-breed CIS system, and expects to decide on this system in 2018. In developing the system specification for the new CIS system, the need to integrate with MDM/AMI system was considered. This coordinated CIS/MDM system procurement and implementation plan is expected to result in more successful integration at lower cost. If found merited, the MDM/AMI system implementation is currently planned for the 2020-21 timeline, after the CIS system implementation currently planned for 2018-19.

7. Evaluated ways to integrate AMI into the distribution system outage management system (OMS) currently in place.

   The vendor of the OMS system, NISC, has a proven record of successfully integrating the 'outage last gasp signal' from many AMI meter systems into their OMS. This signal notifies the OMS system that an AMI meter has lost power, indicating that an outage may have occurred. An AMI/OMS system integration will enable speedier response by CPAU crews in the event of electrical outages. Such integration, after full AMI implementation, is now thought to be a valuable operational tool and relatively straightforward to implement.

8. Evaluating ways to optimally integrate Distributed Energy Resources (DERs) installed by customers and to leverage these system for the benefit of the entire Palo Alto Community. DERs such as solar photovoltaics (PV), electric vehicles (EVs), Energy Efficiency (EE), Demand Response (DR), Energy storage (ES), and heat pump based water and space heaters (HP units) are expected to proliferate in the coming decades. The ability to communicate and control these DER systems to optimally utilize them will become more important in the coming years. Examples include the ability to: 1) inject capacitive energy from PVs using smart inverters, 2) use storage systems at customer premises to provide service to lower the customer utility bill and create savings for the utility in the process, and 3) explore the capability for DERs to provide transmission-related services. These efforts to optimally utilize customer DER system will require customer AMI metering to measure/impute the output of these systems and compensate customers for the services provided when warranted. The City's plan for integrating and optimizing DERs will be developed through the DER Plan development process commencing in August 2017 and will be a topic discussed as part of the Utilities Strategic Plan.

In addition, a number of implementation and logistical lessons were learned through these pilot projects and assessments as outlined below:

a) A few participants in the CustomerConnect pilot expressed concerns regarding the potential adverse impacts of Radiofrequency (RF) radiation from AMI meters. Staff provided scientific industry information to allay their concerns, but two customers chose to opt-out of the AMI pilot due to such concerns. At the time of full deployment, a communication plan to address customer's concerns of having an AMI radio at their homes and a policy to exempt concerned customers from receiving AMI meters would have to be developed.

b) The implementation of AMI will touch CPAU's customer segments in different ways (e.g. CustomerConnect pilot for single family homes and DR program for large commercial customers).[2] In addition, since the AMI pilot and DR program have a limited and self-selected

[2] Single family homes account for 15,000 customers, while multi-family homes account for 10,000 customers in Palo Alto. CPAU has 4,500 commercial customers, out of a total of 29,000 customers, and this segment of customers consume 85% of Palo Alto community's total electricity use and approximately 50% of natural gas and water consumption.

group of participants, additional issues and opportunities will be discovered as these programs are expanded. Further analysis will be undertaken to evaluate ways to harness value from AMI for additional customer segments.[3]

c) Adoption of aggressive greenhouse gas reduction goals by the community in 2016 will likely increase the rate of DER systems adoption, increasing the need of AMI system deployment to facilitate customer adoption of such systems.

d) Staff spent more time than anticipated providing QA/QC related to smart meter data displayed in the customer portal. At the time of full deployment, vendor and Palo Alto staff responsibility for QA/QC will be more clarified, and additional performance benchmarks with non-performance penalties may be included.

e) Meter installation for the CustomerConnect pilot for the 300 homes was undertaken by staff, and this was a good learning experience for CPAU. However, it is apparent that third party installers would be needed at the time of full deployment due to the large workload this would entail.

f) Greater understanding of the cost and value drivers related to AMI deployment was achieved.[4]

g) A number of risks related to full deployment of AMI pilot systems and post-implementation operations were identified.[5]

After learning from lessons and experiences gained by implementing pilots and evaluations over the past 4-5 years, CPAU is now gearing up to re-evaluate the merits of full-scale smart grid investments. In May 2017, CPAU retained Utiliworks Corporation (UWC) as consultants to assist with the evaluation and develop an overarching technology roadmap and implementation plan. Over the next 9 to 12 months, UWC has been tasked to:

1. Assess the smart grid pilot projects, the evaluations undertaken, and the lessons learned
2. Evaluate the progress of other ongoing technology projects and planned new projects
3. Update the cost-benefit assessment for AMI based smart grid investments
4. Develop a utility technology roadmap and actionable implementation plans with associated organizational resourcing needs for the next 5-10 years

Upon completion of this work (Phase I), a recommendation on whether to move forward with the AMI investment would be made to Council. If the recommendation is to move forward, the recommendation would be accompanied by a draft implementation plan that will include a customer communication plan, resource needs, and timelines. If the Council makes a decision to proceed with the investment, Phase II work will commence to develop AMI system specification, solicit vendor proposals, and develop

[3] CPAU's Customer Programs are designed to serve every segment of the customer base. For example, residential customer segments include, single and multi-family homes, extent of energy/water consumption, customer income levels, adoption of DER systems such as PV/EVs, etc.

[4] The cost of installing a communication network for AMI meter communication is now projected to be lower by more than 50% from the initial estimates made by the cost-benefit assessment conducted in 2012. The energy conservation potential via implementing CVR scheme in the distribution system was assumed to be zero in the 2012 assessment, but it is now expected to be in the 0.5% to 1% range, increasing the value of AMI deployment.

[5] These risks include the need for proper planning of resources to implement and operate an AMI based smart grid system including plans related to organizational change management and stakeholder communication, maintenance and cybersecurity issues related to the new technology, public perception, reliability of metering technology and communication network, vendor selection and technology obsolescence, etc. These factors will be closely analyzed with industry experts with operational experience to successfully manage these risks.

a detailed implementation plan. Tasks in the implementation phase (Phase III) will encompass vendor contract execution, detailed implementation plan (including alpha and beta phase of scaling up), project implementation, and testing/acceptance. Phase II and III collectively could span 3-5 years, but it will be prudent to complete phase III in the shortest possible time to begin gaining value associated with the investments.

Due to the imminent work to replace the CPAU's current Customer Information and Billing System (CIS), AMI Implementation (Phase III) work is not expected to commence until 2019-2020. Full implementation of AMI is currently projected for 2021-22 period. Upon full implementation, the work to fully operationalize the investment and to build upon this enabling technology to provide improved customer service will be an ongoing process.

Customer Segment Considerations & Meter Roll-out Sequence when Implementing an AMI System

The pilot programs listed above focused on single-family homeowners and a few large commercial customers. It is worth noting that the AMI system is anticipated to impact CPAU's 15,000 single family homes, 10,000 multi-family homes, and 4,500 commercial customers in different ways, and there will be additional lessons learned during implementation beyond those learned during the pilot program. An AMI system will assist all customer segments with more accurate billing, more granular usage information, and enable water leakage detection. However, some customers may see higher or lower value from AMI. For example, master-metered multi-family customers may not be able to use AMI to understand their water usage because of the lack of individual metering, which AMI will not solve. AMI will enable new customer programs to encourage efficiency and conservation to be rolled out to all customers (e.g. smart thermostats, demand response, TOU rates), but some customers will be able to use these more effectively than others. For example, higher usage customers or EV customers will have a greater potential to conserve or to shift usage from one time period to another to lower utility bills under time-of-use (TOU) retail rates. Commercial customers with flexible air conditioning loads or automated lighting controls could participate in an expanded demand response program.

From a CPAU engineering and operations perspective, having visibility into hourly electricity consumption and customer voltage profiles will assist in detecting or replacing highly loaded distribution transformers and implementing a CVR program as discussed earlier. By knowing hourly customer consumption in different water pressure zones and natural gas distribution areas, better natural gas and water distribution system modeling is possible. An AMI system will also enable automated reading of hard-to-access customer meters and reduce injuries to meter readers.

The industry norm for deploying AMI is to first deploy a few meters in the lab for testing meters, communication, and integration with the CIS system (alpha-phase). Upon successful completion of the alpha-phase, a few hundred to a thousand meters would then be deployed to customers who value AMI capabilities highly and/or a geographic spread of customers (for example, customers on a single meter reading route) to further test the system (beta-phase). The mass installation of meters with third party installers will be triggered only upon successful completion of the beta-phase testing. A sequenced approach, while more costly, may provide some value by rolling out AMI earlier to customers who will get the most benefit from it, or to customers whose use of AMI will enable CPAU to derive the most educational value from the project. During full implementation, for example, CPAU may want to first change out meters from multi-family family dwellings or locations were meters are hard to access. However, this must be balanced against the cost impacts of a less efficient deployment. Typically AMI deployments are done according to meter-reading routes to minimize logistical complexity, impact to normal operations, and to reduce costs.

Though full implementation could be limited to certain customer segments who garner the highest value, staff is unlikely to recommend this for Palo Alto due the relative economics and operational issues

related to doing so. Of the total investment in the AMI system, approximately 50% would be fixed costs related to IT systems and integration costs, hence savings related to a partial deployment would be relatively small. Also savings related to discontinuing manual meter reading cannot be achieved unless all three meters are automated in a meter reading route. In addition, carrying a wider variety of customer meters in stock results in higher inventory carrying cost and introduces operational risks related to meter replacements. Programs such as CVR and distribution system modeling also cannot be undertaken without AMI meters in vast majority of customer premises.

NEXT STEPS

This is an update to the UAC on pilot programs and assessments performed to-date to gain experience with smart grid and advanced metering technologies and their applications in Palo Alto. Staff has begun working with UWC on updates to the smart grid cost-benefit assessment, the business case for implementing such system for different customer segments, and technology implementation strategies.[6] Staff anticipates providing an update on UWC's evaluations and findings at the November/December UAC meeting, and will coordinate the evaluation with the Utilities Strategic Plan development process.

RESOURCE IMPACT

There are no new proposals presented as part of this item, and therefore no additional cost impacts. The ongoing cost for the existing pilot programs is roughly 0.3FTE of effort annually and $20,000 in annual costs. In addition, approximately 0.5 FTE of effort will be expended to support the UWC assessment through the end of the year.

POLICY IMPLICATIONS

The UWC findings and recommendations, along with the Utility Strategic Plan findings may have impact on policies under which CPAU currently operates. All policy-level findings and recommendations will be brought to the UAC and Council for review and action.

ENVIRONMENTAL REVIEW

The Utilities Advisory Commission's discussion of the Smart grid pilot projects and evaluations 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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[6] If Council decides to proceed with AMI investments, detailed implementation planning would include staff/contractor resource needs, budgets, logistics of software and hardware procurement/installation, integration with existing systems, testing and operationalizing new systems, etc.