Electric Energy Storage:
An Assessment of Potential Barriers and Opportunities

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CALIFORNIA PUBLIC UTILITIES COMMISSION

Matthew Deal

Susannah Churchill

Larry Chaset

Christopher Villarreal
Principal Authors

Paul Clanon
Executive Director

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1 INTRODUCTION

California has the most aggressive suite of environmental polices in the nation, if not the world. California law currently requires that 20 percent of retail electricity sales come from qualified renewable resources.[1] The California Global Warming Solutions Act of 2006 ("AB32") requires that California reduce statewide greenhouse gas ("GHG") emissions to 1990 levels by 2020.[2] Additionally, an Executive Order issued by California Governor Arnold Schwarzenegger calls for an eighty percent reduction in emissions from 1990 levels by 2050.[3] The California PUC has established the most comprehensive set of energy efficiency policies and programs ever seen – appropriately named "California's Big Bold Energy Efficiency goals." California is currently undertaking an effort to retire, repower, or replace several thousand megawatts of aging, inefficient fossil fuel generation facilities in order to mitigate the environmental impacts of once-through cooling and to comply with the Clean Water Act.[4] Additionally, efforts are currently underway in the California Legislature to place into California law a separate requirement, independent of AB32, which would require load serving entities to meet 33% of retail electric sales from qualified renewable resources.[5] Thus, California policymakers face substantial challenges as they work to ensure reliable, efficient and environmentally sustainable energy for consumers at reasonable costs.

While California's energy and environmental goals are numerous and aggressive, the challenges presented by these various, and at times competing, initiatives are not insurmountable. However, the challenge of meeting all of these various goals requires policymakers, utilities and market participants to have a new approach and a new way of thinking about how to plan the state's electric energy system. In the past, planners relied chiefly upon large dispatchable fossil fuel generators to provide electric energy. The energy from these facilities was transmitted over the bulk transmission system and ultimately consumed by end-use customers. However, this model is changing. California's current energy policies mandate the development of new types of renewable and distributed generation resources, such as wind and solar. These resources by their nature are intermittent and cannot be directly dispatched by system operators to meet customer load. Thus, if the state wants to properly plan for these new types of resources, the historic model of electric system planning must be re-thought. Since operators of the electricity grid must constantly match electricity supply and demand, intermittent renewable resources are more challenging to incorporate into the electricity grid than traditional generation technologies. Intermittent renewable technologies cannot be scheduled to produce power in specific amounts at specific times, creating additional challenges and costs to resource procurement. Moreover, as more intermittent resources are deployed to meet increasing Renewable Portfolio Standards ("RPS") requirements, the operational challenges will become greater. Specifically, since planners cannot control when renewable generation will occur, the generation can often occur at times when there is little need

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[1] California's Renewable Portfolio Standard (RPS) was established in 2002 under Senate Bill 1078 (Stats. 2002, Ch. 516, Sec. 3) and accelerated in 2006 under Senate Bill 107 (Stats. 2006, Ch. 464, Sec. 13,).

[2] AB 32 (Stats. 2006, ch. 488, effective September 27, 2006)

[3] Governor Arnold Schwarzenegger, Executive Order S-3-05, June 1, 2005. Available at: http://gov.ca.gov/executive-order/1861/

[4] *See*, Statewide Water Quality Control Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling. Adopted May 4, 2010. Available at: http://www.waterboards.ca.gov/water_issues/programs/npdes/docs/cwa316may2010/otcpolicy_final050410.pdf.

[5] California's energy agencies have already established a 33% RPS as a policy goal, but currently lack statutory authority to enforce penalties for non-compliance.

for that power. However, a promising new set of Electric Energy Storage ("EES") technologies appear to provide an effective means for addressing the growing problem of reliance on an increasing percentage of intermittent renewable generation resources.

In the past, it was difficult, if not impossible, to store large amounts of electricity. There were two main barriers: economic (too expensive) and technological (inefficient, impractical). Recent advancements have been achieved and certain storage technologies have progressed through successful pilot and demonstration phases. As such, these technologies are poised to become commercially viable. EES offers California multiple economic and environmental benefits. By utilizing EES technologies to store intermittent renewable power, the state may reduce greenhouse gas emissions from carbon-based electricity production, avoid the need to build expensive new transmission lines and power plants to meet peak energy demand, increase system reliability and generate economic activity through the manufacturing and operation of these EES technologies.

As valuable as adding storage could be for California's power grid, many EES technologies are still early in their development, and existing commercial projects are in relatively short supply worldwide. As a result, EES faces several regulatory obstacles because of the lack of familiarity that regulators have with the various EES technologies. Regulators are uncertain how EES technologies should fit into the electric system, in part because EES provides multiple services such as generation, transmission and distribution. Furthermore, regulators do not yet know how EES costs and benefits should be allocated among these three main elements of the electric system.

California policymakers support the development of EES because it can provide an advantageous strategy for meeting the state's long-term clean energy goals while maintaining system reliability. However, relatively little information about EES costs and benefits is available to form a rational basis for policy action. The purpose of this paper is to identify for policymakers the opportunities for and barriers to the development and deployment of EES technologies throughout California's electricity system.

2 DEFINITION OF ELECTRIC ENERGY STORAGE

EES uses forms of energy such as chemical, kinetic, or potential energy to store energy that will later be converted to electricity. Such storage can provide several basic services: supplying peak electricity demand by using electricity generated during periods of lower demand, balancing electricity supply and demand fluctuations over a period of seconds and minutes, and deferring expansions of electric grid capacity (including generation, transmission and distribution elements).[6] One of the major conundrums facing policymakers and industry is the lack of a single, authoritative definition of electric storage. This lack of definition hampers efforts to overcome barriers to the widespread development and deployment of storage on the grid.

For the purposes of this paper, storage can be defined as: a set of technologies capable of storing previously generated electric energy and releasing that energy at a later time. EES technologies may store electrical

[6] Pew Center on Global Climate Change, *Energy Storage*. Available at: http://www.pewclimate.org/technology/factsheet/EnergyStorage

energy as potential, kinetic, chemical, or thermal energy, and include various types of batteries, flywheels, electrochemical capacitors, compressed air storage, thermal storage devices and pumped hydroelectric power.

3 DESCRIPTION OF ELECTRIC ENERGY STORAGE TECHNOLOGIES

EES technologies come in many forms. Some technologies have existed for decades (batteries, pumped hydro), so the concept of electric energy storage is not new. Advances in materials, electronics, chemistry and information technology have resulted in a number of newly emerging storage technologies; these new technologies have the potential to significantly reduce the overall costs on a broader scale.

EES can encompass a diverse range of categories, including – mechanical, thermal and chemical storage. Each of these broad categories has a unique set of parameters to measure cost and performance. This section describes some of the technologies currently available or under development; it is not intended to be an exhaustive list of existing or potential EES technologies.[7]

Pumped Hydro:[8] Pumped hydro storage uses low-cost electricity generated during periods of low demand to pump water from a lower-level reservoir (e.g., a lake) to a higher-elevation reservoir. The water is released to flow back down to the lower reservoir while turning turbines to generate electricity, similar to conventional hydropower plants. Pumped hydro storage can be constructed on a large scale with capacities of 100-1000s of megawatts ("MWs") and discharged over long periods of time (4 to 10 hours).

Compressed Air:[9] Compressed air energy storage ("CAES") plants use electricity to compress air into a reservoir. The high pressure air is released from underground and used to help power natural gas-fired turbines. The pressurized air allows the turbines to generate electricity using significantly less natural gas. The compressed air can be stored in several types of underground media (*i.e.*, reservoirs) including porous rock formations, depleted natural gas/oil fields, and caverns in salt or rock formations.

Batteries:[10] Several different types of large-scale rechargeable batteries can be used for EES including sodium sulfur ("NaS"), lithium ion, and flow batteries. Batteries have the potential to span a broad range of energy storage applications. Battery systems for electricity storage use the same principles as batteries used,

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[7] For each technology listed, we presume that the energy is stored at times when demand (and therefore price) is low and released at a time when demand (and prices) are relatively higher. This assumption is not intended to preclude a situation where EES is used to store energy for reliability purposes that might be diconnected from price/demand considerations.

[8] "The Potential of Wind Power and Energy Storage in California," Diana Schwyzer, Masters Thesis for Energy and Resources Group at UC Berkeley. November 2006. p. 33.

[9] "New Utility Scale CAES Technology: Performance and Benefits (Including CO2 Benefits)," by Robert B. Schainker (EPRI), Michael Nakhamkin (ESPC), Pramod Kulkarni (CEC) and Tom Key (EPRI). Available at http://www.energystorageandpower.com/pdf/epri_paper.pdf

[10] Descriptions of batteries, flywheels, SMES and electrochemical capacitors from "Challenges of Electricity Storage Technologies: A Report from the APS Panel on Public Affairs Committee on Energy and Environment," May 2007. http://www.aps.org/policy/reports/popa-reports/upload/Energy-2007-Report-ElectricityStorageReport.pdf.

for example, in automobiles, but in much larger and higher power configurations. EES systems based upon batteries can be portable; since batteries are a known technology, the utility industry is generally familiar with them.

Thermal Energy Storage:[11] There are two types of thermal energy storage ("TES"): TES applicable to solar thermal power plants and end-use TES. TES for solar thermal power plants consists of a synthetic oil or molten salt that stores solar energy in the form of heat collected by solar thermal power plants to enable smooth power output during daytime cloudy periods and to extend power production for 1-10 hours past sunset. End-use TES stores electricity through the use of hot or cold storage in underground aquifers, water or ice tanks, or other materials and uses this energy to reduce the electricity consumption of building heating or air conditioning systems when needed.

Flywheels: A conventional flywheel stores energy as the kinetic energy of a massive disk spinning on a metal shaft. To retrieve stored energy from the flywheel, the process is reversed with the motor acting as a generator powered by the braking of the rotating disc. The amount of energy stored depends upon the linear speed of rotation and the mass of the disk. Short discharge time flywheels are suitable for stabilizing voltage and frequency, while longer duration flywheels may be suitable for damping load fluctuations.

Ultracapacitors: Ultracapacitors are electrical devices that consist of two oppositely charged metal plates separated by an insulator. The ultracapacitor stores energy by increasing the electric charge accumulation on the metal plates and discharges energy when the electric charges are released by the metal plates. Generally, capacitors are suitable for short-duration applications like providing backup power during brief interruptions. Advanced capacitors are useful for stabilizing voltage and frequency.

Superconducting Magnetic Energy Storage: Superconducting magnetic energy storage ("SMES") consists of a coil with many windings of superconducting wire that stores and releases energy with increases or decreases in the current flowing through the wire. Energy is added or extracted from the magnetic field of the inductor by increasing or decreasing the current in the windings. At steady state, the superconducting windings dissipate no energy, and energy may be stored indefinitely with low loss. The main parts in a SMES are motionless, which results in high reliability and low maintenance. However, superconductors also require refrigeration systems that introduce energy losses and do contain moving parts. Power can be discharged almost instantaneously with high power output for a brief period of time with less loss of power than for other technologies.

4 COSTS OF ELECTRIC ENERGY STORAGE TECHNOLOGIES

There are a number of factors that influence the cost of an EES technology. Storage tends to be an application-specific resource and therefore the costs (and benefits) can vary greatly. One of the complications in developing detailed cost estimates of EES technologies is that the costs of a given technology are greatly influenced by the particular application in which that technology is deployed. Thus, any generalized cost estimates are of questionable value. While a detailed analysis of the costs of specific EES technologies is

[11] Pew Center on Global Climate Change, *Energy Storage*. Available at: http://www.pewclimate.org/technology/factsheet/EnergyStorage

beyond the scope of this paper, included below is a brief overview of some of the main cost drivers of EES technologies.

Estimating the total installed cost of a given EES technology cannot be accomplished without advance knowledge of a number of key factors. An EES system's size varies on two dimensions: power (how much electricity can be discharged at one time) and energy (how many hours can be discharged continuously). EES system costs are impacted by system efficiency (how many useable kWh can be discharged compared to the amount charged). The frequency of how often and deeply the system is discharged also impacts costs. All of these factors (size, efficiency, and frequency) mean that an EES technology's cost cannot be meaningfully estimated independently of the way in which it is used.

The lifecycle cost of an EES system is made up of two basic components: capital costs and operating and maintenance ("O&M") costs. The most commonly used metric to estimate the lifecycle costs that incorporates these two factors is $/kW-yr, or how much a kW of capacity costs to own and operate for one year. Public analyses have estimated capital costs to a certain extent, while O&M cost estimates are more difficult to find. EES O&M costs include the cost of buying the energy used to charge the system, fixed costs that do not depend on how much or often the system is used, and variable costs, the bulk of which are replacement costs.

Ultimately, however, the actual cost of a given EES application is not as important a metric as a well formulated cost effectiveness measure that appropriately accounts for the full range and types of costs and benefits that EES can provide to the overall system. The challenge for policymakers is how to develop a cost-effectiveness evaluation for EES that does not favor one technology over another while recognizing the various costs and benefits that EES provides.

5 BENEFITS OF ELECTRIC ENERGY STORAGE TECHNOLOGIES

The benefits of EES often cross the traditional boundaries of generation, transmission, distribution, and at times, load which make analysis difficult. As noted above, the ability of EES technologies to provide multiple services, and thus, varying benefits leads to confusion and uncertainty about how energy storage should be regulated and valued. For the purposes of this paper, the benefits are categorized as economic and operational.[12]

One complicating factor is that oftentimes the quantification of benefits will depend upon the particular application of storage. This means that there is no "one-size-fits-all" approach to valuing the benefits that EES will provide. Another complicating factor is that the value of a single EES installation is often divided between the owner of the EES system, utility shareholders, and utility ratepayers, such that it is difficult for one set of stakeholders to capture enough of this value to outweigh the technology's costs, even if all these value streams are properly priced in the relevant markets.

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[12] These two categories are not necessarily mutually exclusive. Therefore, several of the operational benefits also will provide a certain amount of economic benefits.

5.1 ECONOMIC BENEFITS

Energy bill savings from shifting demand to off-peak times: EES enables customers to change when they draw power from the grid to meet their demand. For customers on dynamic rates (*i.e.*, those who pay more for power during times of higher demand on the grid), EES allows energy arbitrage opportunities whereby the EES system charges when the cost of energy is low and discharges when the cost of energy is high.

The economic value of this load-shifting varies depending on the customers' load shape and tariff, as well as the timing and frequency of when the load is shifted. Many commercial and industrial power customers in California have tariffs that consist of an energy charge, which is based on how many kilowatt-hours of energy have been used in a given time period, and a demand charge, which is based on the size of maximum demand within one month. Use of EES can reduce energy charges if the spread between on-peak and off-peak time of use rates is large enough. Even larger savings could come from reduced demand charges, if EES reliably reduces the size of the customer's maximum demand peak in a given month. Customers with photovoltaic ("PV") systems can use an EES system to mitigate the intermittency of their PV panels' power production, thereby acting as a back-up to the PV system's output and ultimately reducing the customer's demand charge.

Profits from selling EES resources into ancillary services and/or energy markets: If market rules enable EES owners to sell into ancillary services markets or wholesale energy markets, they can profit from these services.[13] For example, third-party owners of flywheels are currently seeking to sell into CAISO regulation markets.

Lower future EES costs as market matures: The EES market is currently an emerging market. Costs will be lowered in the future as a result of learning-by-doing, developing economies of scale and conducting additional research and development. Increased demand will spur EES manufacturers, integrators and installers to become more efficient which should further reduce future costs. Policymakers will need to consider these market transformations when determining the value, if any, of public investment.

Employment and other economic growth if industry locates in California: As more storage is deployed, new jobs could be created in manufacturing and installation, boosting the state's economy and providing a new source of tax revenue.

5.2 OPERATIONAL BENEFITS

Improved power quality: Some commercial and industrial customers' manufacturing or other processes are harmed if their power varies in frequency and voltage. EES can serve to eliminate these power quality inconsistencies.

Reliable and cleaner back-up power: EES technologies can provide customers with electricity for a period of hours when utility power is not available. While economics prevent EES being used as a long-term back-up (*i.e.*, for multiple days at once), EES can provide a source of back-up power for shorter outages.

Reduced need for peak generation capacity: By allowing customers, utilities or power generators to store energy off-peak and discharge on-peak, storage provides an alternative to the construction and operation of

[13] The ability to sell into ancillary services markets is discussed in more detail in the section on societal benefits

new generation and reserve capacity. Peak demand growth is a major concern for California electricity planners, exacerbated by the fact that populations in the hotter central and southern parts of the state are growing fastest. The value of the avoided cost of peak generation capacity will continue to increase as peak demand grows and as carbon emissions become more expensive.

More efficient use of renewable and other off-peak generation: California's clean energy and GHG emissions reduction goals require a large increase in wind and other renewable electricity generation in coming decades. Wind in California tends to blow most strongly at night, and the CAISO predicts a serious mismatch of load and generation in the off-peak hours of 11 pm to 6 am, including as much as 3000 to 5000 MW of excess off-peak capacity. Rather than forcing renewable generators to curtail off-peak production, EES can allow excess wind and other off-peak energy to be stored and used during high demand times.

Reduced need for transmission and distribution capacity upgrades: EES can be used to maximize existing transmission and distribution ("T&D") resources. EES can shift demand off-peak, delaying the need for new T&D upgrades that would have been needed to accommodate growth. EES located at the transmission substation level can be dispatched by the utility to meet peak demand in a transmission-constrained region with power charged off-peak. The value of T&D upgrade deferral varies greatly by location and is driven by the population density of the area, terrain, geology, weather, and the type and amount of T&D equipment involved.

Transmission support and congestion relief: EES can be used to improve T&D system performance by alleviating problems like voltage sag and unstable voltage. In addition, EES can help to avoid transmission congestion by discharging in congested areas at times of peak demand. For this purpose EES can be located either at the customer location or at an appropriate location on the transmission or distribution system. As noted just above in connection with T&D upgrade deferral, the range of values for T&D congestion relief between locations will be large.

Increased and improved availability of ancillary services: Ancillary services are services necessary to support the transmission of energy from generation resources to consumers, while maintaining the reliable operation of the transmission system. There are two primary types of ancillary services sold in California, both of which could be provided by EES: frequency regulation, which ensure the grid operates within an allowable range of interconnection frequencies, and operating reserves, which ensure that more energy can be added to the system within a short period of time to meet unexpected increases in demand or reductions in supply. EES technologies are capable of providing regulation services as well as operating reserves.

Lower GHG and other emissions: EES can reduce emissions by shifting on-peak energy use to off-peak periods. In California, relatively little baseload power comes from coal and much comes from hydroelectric and nuclear power, such that off-peak generation generally has a cleaner emissions profile than largely gas-fired peak power. However, as renewables like wind increase as a percentage of the off-peak power mix, the emissions benefits of EES will continue to grow.

EES is also a lower-emissions alternative for providing ancillary services. A study by KEMA found that regulation provided by a 20 MW flywheel EES system created less than half the GHG emissions of equivalent regulation from a combined cycle gas turbine and less than three quarters of the emissions of a pumped hydro plant providing equivalent regulation.[14]

6 RECOMMENDATIONS

EES represents a valuable potential addition to the resource mix available to meet California's various energy and environmental goals. While EES has many different applications and benefits, widespread deployment and utilization of EES technologies face numerous commercial and regulatory barriers. As a result, if policymakers want to increase the amount of EES in operation throughout California's electricity system they must take action. The following policy recommendations highlight potential actions that California's regulatory authorities could undertake to facilitate the deployment of EES into California's electricity system.

Prior to opening a formal rulemaking the CPUC should consider convening a symposium to explore the best options for EES deployment. The symposium would help the Commission narrow the focus of a potential rulemaking by helping to define the ultimate goal(s) of EES deployment.

The CPUC should conduct a rulemaking to develop a comprehensive set of policies to remove barriers to the deployment of EES technology in California. The deployment of EES technologies will create a variety of benefits and costs for California ratepayers that reach across the Commission's traditional program silos, such as energy generation, demand response, resource adequacy, renewables development, etc. A centralized, coordinated rulemaking addressing storage will avoid unnecessary duplication and potentially conflicting policy development. Top priorities in the rulemaking should be:

1. Define the goals of increased deployment of EES within California's electrical energy system.
2. Determine what the potential operational uses are for EES.
3. Develop a cost-benefit methodology for EES and use it to define, quantify and monetize the full range of EES costs and benefits.[15]
4. Compare the costs and benefits of various types of EES with those of other load-shifting and emissions reduction strategies (including energy efficiency, demand response, and renewable energy procurement), in order to determine how ratepayer funds can be optimally committed.
5. Determine the mechanism(s) by which an EES facility can recover its costs, including when the facility is being used for multiple purposes.
6. Develop a methodology to determine a Resource Adequacy ("RA") value for EES, thus enabling load serving entities to meet part of the requirements under the RA program with storage resources.
7. Streamline the siting and interconnection rules for both distributed and utility scale EES projects.
8. Explore whether the natural gas industry, which has relied upon storage products and services for decades, could provide some insight as to how best to incorporate EES into the electric system.
9. Consider developing incentives for EES, which could include:

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[14] Richard Fioravanti and Johan Enslin. "Emissions Comparison for a 20 MW Flywheel-Based Regulation Plant." KEMA, January 2007.

[15] A cost benefit analysis for energy storage may need to consider costs and benefits that may be outside the jurisdiction of the CPUC.

a. An EES procurement standard and/or feed-in tariff(s).[16]
b. Increased utility rates of return for EES investment *(i.e.*, utility ownership).
c. Develop a methodology to allow utilities to earn an incentive rate of return on power purchase agreements signed with EES developers.[17]
d. Increased and coordinated research, development and deployment programs with appropriate levels of funding for EES technologies.

Consider explicitly placing EES within the state's energy resource loading order and require utilities to incorporate EES in their integrated resource planning processes. California's Energy Action Plan established a "loading order" to meet the future energy needs of the state. Specifically including EES in the loading order would demonstrate the importance of deploying cost-effective storage resources throughout the state. In addition, the Commission could consider requiring that all resource procurement processes conducted by utilities explicitly allow EES to participate.[18]

Create and facilitate a California Energy Storage Collaborative. All segments of industry would benefit from a concerted effort to share ideas, data and experiences related to EES. The CPUC should convene an Electricity Storage Working Group to provide an opportunity for representatives from CEC, CAISO, and FERC as well as from the utility, EES manufacturer and installer industries (among others) to meet and collaborate on an ongoing basis. A product of this collaborative could be an established set of "best practices" relating to siting, permitting, safety, and cost allocation.

Require all IOU customers, including residential customers, to move to dynamic retail rates. Current rate structures do not create an incentive for consumers to make efficient decisions about their energy consumption. Unless customers are charged accurate prices for power, these inefficient decisions about how much power to use and when will continue. Dynamic rates will incent more active participation in energy management and consumption by all consumers which could lead to increases in energy efficiency and other demand response strategies as well as greater EES deployment.[19]

Encourage the CAISO to change ancillary service market rules to allow EES systems to more easily bid into regulation markets. Many stakeholders have suggested that the CAISO make two changes to its regulation market rules: (1) to allow EES to bid less than 1 hour of energy in capacity/RA and regulation markets; and (2) to reduce the minimum bid size in the regulation market to less than 1 megawatt.[20] The

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[16] AB 2514 (Skinner), currently pending in the California state senate as of July 1, 2010, would require the CPUC to open a rulemaking to, among other things, consider an appropriate EES procurement mandate for load serving entities.

[17] See, Georgia Code Title 46. Public Utilities and Public Transportation Chapter 3A. Integrated Resource Planning § 46-3A-8.

[18] Alternatively, the Commission may determine that utilities should be required to conduct storage only procurement processes.

[19] AB1X (Water Code Sec. 80110, effective 2001), limited the ability of the PUC to implement dynamic rates for residential customers until the Department of Water Resources "has recovered the costs of power it has procured" to meet retail load on behalf of the Investor-Owned Utilities. SB 695 (Public Utilities Code Sec. 745(b), effective 2009), revised AB1x by setting specific dates as to when the PUC can implement default dynamic rates for residential customers. The statute states that the PUC "shall not ... (1)employ mandatory or default time-variant pricing, with or without bill protection, for any residential customer prior to January 1, 2013; (2) employ mandatory or default time-variant pricing, without bill protection, for residential customers prior to January 1, 2014."

[20] For example, during the CAISO's Market Design Initiatives stakeholder process, the CAISO proposed a 30 minute Ancillary Services product that would, amongst other things, potentially limit the need for the CAISO to use Exceptional Dispatch. In the CAISO's September 18, 2009 "Updated Catalogue of Market Design Initiatives," this was ranked as a "Low" priority with the potential to "reconsider the issue in the future if necessary." Available at

CPUC should consider making these and/or other recommendations to the CAISO with the goal of allowing EES projects to provide valuable regulation and capacity resources to the grid.

Integrate EES in transmission planning. Decisions regarding new transmission lines could be impacted by the deployment of EES and vice versa. Investment in EES could serve to defer or displace the need to build new transmission lines because EES is often less costly than building new transmission facilities. Alternatively, transmission build outs could factor into the location for EES deployment.

7 CONCLUSION

EES has the potential to enhance California's ability to effectively meet its many energy and environmental goals. EES can provide a number of benefits to the grid: it can provide emergency backup, reduce the need for peak generation capacity, provide ancillary services, facilitate demand response, reduce GHG emissions and help to integrate intermittent renewables.

Currently, EES technologies face a number of commercial, economic and regulatory obstacles. The major barrier for deployment of new storage facilities is not necessarily the technology, but the absence of appropriate regulations and market mechanisms that properly recognize the value of the storage resource and financially compensate the owners/operators for the services and benefits they provide. As a result, while many applications of storage are technologically feasible, they struggle to become commercially viable. California policymakers face numerous challenges in developing policies and programs that will facilitate the achievement of its goals. EES may provide policymakers with an additional opportunity to meet the state's long-term clean energy goals and maintain system reliability, while minimizing costs.

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http://www.caiso.com/2433/2433dda16ba10.pdf, at page 37. Such a product could also be used to incent a wider range of storage technologies to provide ancillary services.