



# **WORKSHOP REPORT ON PUMPED STORAGE WORKSHOP**

REPORT PREPARED BY POLICY & PLANNING DIVISION

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## Introduction

On January 16, 2014, California Public Utilities Commission (Commission) held a workshop to discuss the current state of pumped storage in California. The workshop was led by staff from the Commission's Policy and Planning Division. This workshop was held pursuant to Commission directive in Decision (D) 13-10-040, Ordering Paragraph 9,<sup>1</sup> which directed Commission Staff to hold a technical workshop to "further explore the operational characteristics and uses for pumped storage projects."

D.13-10-040 ordered electric utilities of Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE) and San Diego Gas and Electric Company (SDG&E) to procure 1,325 megawatts (MW) of energy storage by 2020. The decision allowed PG&E, SCE and SDG&E to include any pumped storage resources up to 50 MW to count towards the storage procurement targets, but excluded pumped storage resources over 50 MW from the procurement requirement. The reason being that the sheer size of pumped storage projects (often 500 MW and over) would dwarf smaller, emerging storage technologies and potentially inhibit market transformation goals. The decision did recognize the potential benefits of large-scale pumped storage. In order to gain a greater understanding of the current landscape for pumped storage in California, the Commission directed the convening of a workshop to discuss these matters.

Specifically, the workshop sought to gain an understanding of the variety of issues that face pumped storage today and in the future, including barriers to the development of pumped hydro, the potential regulatory steps to address barriers, and the potential uses and benefits of pumped hydro. In order to better understand the totality of these issues, the workshop explored a range of the issues facing pumped storage in California, including those barriers outside of the Commission's jurisdiction.<sup>2</sup> Pumped storage has a long history in California, notably the Helms facility operated by PG&E. To a great extent, pumped storage has often been overlooked by utility and grid planners in favor of other resources. Indeed, its size and geographical requirements lends itself to being discounted in comparison to smaller resources that can be located closer to load or constraints. The workshop provided interested parties an opportunity to offer their perspective on the current and future state of pumped storage, an identification of the barriers and benefits of pumped storage, and offered suggestions for enhancing the future role of pumped storage in California.

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<sup>1</sup> *Order Instituting Rulemaking Pursuant to Assembly Bill 2514 to Consider the Adoption of Procurement Targets for Viable and Cost-Effective Energy Storage Systems*, "Decision Adopting Energy Storage Procurement Framework and Design Program," D.13-10-040 (October 17, 2013) (available at <http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M079/K533/79533378.PDF>).

<sup>2</sup> The full agenda, list of panelists, and presentations are included as an attachment.

The workshop featured presentations from representatives from academia, utilities, and pumped storage owners. In addition, attendees were afforded the opportunity to ask the panelists questions, provide short discussions of their own projects, and opine on pumped storage issues generally. There were several themes that were very clearly discussed in varying levels of detail throughout the afternoon. These themes are discussed below in more detail.

## **The Workshop**

During the workshop, several main themes were expressed throughout the afternoon. These themes ranged from topics directly under Commission jurisdiction to issues unassociated with the Commission. As noted in the agenda, it was the intent of the workshop to capture the variety of issues associated with pumped storage in California regardless of which state or federal agency was responsible. Beyond these identified themes, there were several other topics associated with pumped storage that were also discussed, and these will also be identified below.

### **A. Permitting**

We learned during the workshop that one of the initial challenges with pumped storage is acquiring a permit to construct the project. The permitting process can be quite arduous and involve multiple state and federal agencies, depending on location. Several panelists and workshop participants representing the pumped storage industry discussed their multi-year efforts to obtain permits to construct their project. A secondary challenge associated with permitting is the ability to transmit the electricity generated on-site to the transmission grid. Many of these projects are located far from transmission lines and need new lines to connect their project with the grid. This may also delay the final construction of the project should the transmission permitting process be delayed.

### **B. Location**

Along with permitting, workshop participants agreed that identifying an appropriate location for a pumped storage project comes with its own set of challenges for construction. Many pumped storage projects rely on a unique set of geographical conditions, a water supply (either a river and a hill top or a series of lakes or reservoirs) and a difference in elevations. In one instance, water from one reservoir is pumped up hill to the elevated reservoir at night, when electricity prices are lower, and then water is released downhill during the day to provide generation or ancillary services to the grid. A second option is a “closed loop” facility completely separated from an already available source of water. In this instance, water is again housed in two different reservoirs and water is moved between the two reservoirs based on time and electricity prices. In both situations, there are unique geographical requirements needed for these projects to operate.

One of the presenters did a simple Google maps analysis regarding potential geographic areas suitable for pumped storage along the coast of California and identified 300 locations capable of providing 572 gigawatt hours, or nearly the total daily consumption of electricity in California.<sup>3</sup> The geographical requirements are further limited by proximity to available interconnection points on the transmission grid. The ability to easily access these interconnection points have the potential to both streamline the identification of geographical needs as well as reduce the burden of permitting for any needed transmission line construction. Additionally, addressing the land use challenges for any project can be equally daunting, especially if the project is located close to parks or other protected land.<sup>4</sup>

### C. Agency Coordination

Participants in the workshop identified the extensive list of agencies at the state and federal level that need to coordinate at different points in the process. On the state side, it was noted that the Commission needs to coordinate policy development with the California Energy Commission and the Air Resources Board as it applies to meeting the state's greenhouse reduction goals. In another instance, for example, when addressing the situation when a project potentially impacts a state park or other protected lands, approval from the appropriate state agency would also be required, either for the construction of the project or any needed transmission lines. On the federal side, the Federal Energy Regulatory Commission is responsible for the federal licensing of a project. Again, to the extent the project impacts lands under the responsibility of the Bureau of Land Management, National Park Service, or even Native American lands would all need to coordinate with one another. The ability, or inability, to coordinate between agencies on either permitting or policy development may have the ability to delay the construction of a project, or negatively impact the feasibility and benefits of a project.

### D. Technology

Participants discussed the variety of technologies for pumped storage projects, including closed loop storage technologies and more advanced generation options for pumped storage, such as adjustable speed layout. During the workshop, it was discussed that adjustable speed layout allowed for greater benefits to the project, greater efficiencies in operation, and more flexibility in responding to grid needs around frequency support, and firming renewables.<sup>5</sup> Furthermore, it was noted that adjustable speed pumped storage projects can reduce market costs by over

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<sup>3</sup> Presentation by Charles Barnhart and Sally Benson at 18-19. Dr. Barnhart noted, however, that many of those sites may be currently used for other purposes, like housing, or are too remote to be feasible.

<sup>4</sup> In the storage rulemaking, Sierra Club advocated for excluding large pumped storage from the procurement target precisely due to these land use implications. The impact on the local environment, *i.e.*, cutting down trees, changing water flows or pressure, impact on fisheries, can also negatively impact the feasibility of a project.

<sup>5</sup> See presentation by Vladimir Koritarov.

9%, and can significantly reduce renewable curtailments; how these values are accounted for remains an open question, as described more generally below. Fixed speed projects also provide benefits to the grid and integrating renewables, but not to the extent as adjustable speed layouts.

The above themes apply across the industry, whereas the themes below are more specific to the Commission. The Commission has little impact on the themes identified above, but the true ability of a pumped storage project to compete, participate, and be operational rely on the discussion of the last two themes. Indeed, these last two themes are not unexpected as they were the two dominant themes in the Commission's energy storage rulemaking.

## E. Value

In some respects, this was the primary theme of the workshop: how can pumped storage projects be appropriately valued for the variety of services they can provide? As noted at the start of the workshop by Argonne National Labs, there are 20 services that pumped storage projects can provide to the grid.<sup>6</sup> Much like the discussion in the energy storage rulemaking, how to divide these benefits from one project can be challenging for operators and utilities. Furthermore, it was discussed that many of these services are not valued or under-valued by the market, such as inertia and voltage support.<sup>7</sup> In his presentation, Dr. Barnhart noted the superior ability of pumped storage projects to effectively support renewable generation integration over other energy storage technologies.<sup>8</sup> The workshop identified several areas where Value needs to be further developed.

### 1. Procurement

Participants were extremely vocal in the need for utility procurement plans to appropriately account for pumped storage services in their Long Term Procurement Plans (LTPP). While this is part of determining overall Value of a particular Service, participants at the workshop supported the need to identify this as a separate theme of the day.

Pumped storage operators expressed frustration at the lack of a specific forum to discuss the real operational needs of utilities in the LTPP that pumped storage can provide. Many expressed the difficulty in participating in multiple proceedings at once, *i.e.*, LTPP, Resource Adequacy, Renewable Portfolio Standard, and Energy Storage proceedings. One presenter noted that LTPP is too narrowly scoped, does not look longer term (30 years or more), and does

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<sup>6</sup> *Id.* at 7. This corresponds to the list identified by the Commission in the energy storage rulemaking.

<sup>7</sup> Presentation of Scott Flake.

<sup>8</sup> Presentation of Charles Barnhart. As discussed in the workshop, the variety of energy storage technologies also provides a variety of services and benefits; specific values for specific energy storage technologies are highly dependent on need and location.

not factor in pumped storage in the planning assumptions and scenarios.<sup>9</sup> Another presenter also identified the need for longer term contracting and planning to support the longevity that pumped storage projects can provide.<sup>10</sup> At its most basic, supporters of pumped storage expressed a frustration that current programs and planning models do not adequately value the flexibility and variety of services that pumped storage projects can provide, as well as the ability of pumped storage to meet other California policies, such as greenhouse gas reduction, integration of renewables, and reliability.<sup>11</sup>

## 2. Services

There was substantial discussion around the variety of services that pumped storage can provide to the grid, CAISO, and utilities. Pumped storage operators clearly expressed their belief that those benefits are not be appropriately valued in existing models. The presenters all noted the ability of pumped storage to lower total electricity costs, provide additional services to the grid, and reliably support renewable generation integration. As noted by several participants, there are impending reliability challenges facing California regarding large and quick ramping times from over-generation to under-generation as renewables can reduce generation production quickly. The flexibility, response times, and power needed to maintain reliability of the grid during these events will challenge grid operators, and are areas where pumped storage can effectively support grid operators.<sup>12</sup> These challenges are further exacerbated by the long lead times for construction as well as the large sizes of these projects.<sup>13</sup>

## 3. California Independent System Operator

Several presenters expressed limitations with market products offered by the California Independent System Operator (CAISO). Notably, the CAISO ancillary services markets do not have products that last long enough or are procured enough in advance to effectively entice long-term investments in pumped storage project, development of incentives pursuant to Federal Energy Regulatory Commission (FERC) Order 784<sup>14</sup> not progressing fast enough,<sup>15</sup> and the CAISO interconnection process not sufficient to enable pumped storage projects.<sup>16</sup> Finally,

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<sup>9</sup> See presentation of Doug Divine.

<sup>10</sup> See presentation of Greg Probst.

<sup>11</sup> Many of these same arguments were made in the energy storage proceeding.

<sup>12</sup> See presentation of Doug Divine.

<sup>13</sup> See presentation of Michael Jones.

<sup>14</sup> *Third-Party Provision of Ancillary Services; Accounting and Financial Reporting for New Electric Storage Technologies*, Order No. 784, 144 FERC ¶ 61,056 (July 18, 2013), *order granting clarification in part and denying rehearing in part*, Order No. 784-A, 146 FERC ¶ 61,114 (February 20, 2014). FERC Order 784 allows transmission providers to take into account the speed and accuracy of Regulation and Frequency Response ancillary services, which can benefit fast-acting resources, like energy storage technologies.

<sup>15</sup> Presentation of Greg Probst.

<sup>16</sup> Presentation of Doug Divine.

participants discussed challenges with CAISO long-term planning needs noting that planning horizons are too short to effectively capture pumped storage benefits; pumped storage projects can be operational for over 40 years, and current planning models end at 2020, discounting the long-term benefits of pumped storage.

## Recommendations

During the workshop, several parties provided some specific comments on next steps regarding pumped storage. The California Energy Storage Alliance (CESA) offered that it may be worthwhile to undertake a study identifying the potential of pumped storage in California, both in evaluating the potential benefits of pumped storage but also the potential needs that pumped storage can provide. CESA noted that a similar exercise was conducted in the energy storage proceeding that helped to develop the final recommendations. Many parties expressed strong support for a greater role for pumped storage in the LTPP proceedings. Indeed, this was the clearest “ask” by the proponents of pumped storage at the workshop, that there be one proceeding to discuss the needs and benefits of pumped storage. Many expressed a frustration with being bounced around proceedings, only to end up back in LTPP, but returning too late to have any effective discussion of pumped storage in LTPP.

In summary, the recommendations from workshop participants are identified as follows:

- The Commission needs one avenue where pumped storage issues can be discussed, and that should be LTPP;
- Statewide planning processes should look farther into the future in order to adequately value pumped storage services;
- Commission and CAISO need to better reflect the benefits and services provided by pumped storage in planning and market products and development; and,
- The Commission should support alternative arrangements for testing and proving benefits of pumped storage that can be used to develop future policies regarding quantification of pumped storage benefits and services.

## Attachments

Workshop Agenda; List of Panelists; Presentations

[http://www.cpuc.ca.gov/PUC/energy/electric/Technical Workshop Understanding Current State of Pumped Storage.htm](http://www.cpuc.ca.gov/PUC/energy/electric/Technical%20Workshop%20Understanding%20Current%20State%20of%20Pumped%20Storage.htm)