TO: Danielle Osborn Mills, Director, AWEA California Caucus
FROM: Caitlin Liotiris, Partner, Energy Strategies
DATE: March 2018
SUBJECT: Additional Analysis on the Relative Value of the Production Tax Credit for Wind Resources

In August of 2017, Energy Strategies delivered a memo to the AWEA California Caucus (ACC) which outlined the relative value of the federal Production Tax Credit (PTC) for wind energy.1 The PTC is currently scheduled to phase out over the next several years; though, if timely procurement decisions are made, opportunities remain for California’s load-serving entities (LSEs) and, ultimately, ratepayers to capture the benefits associated with these federal tax credits.

Energy Strategies previous analysis focused on the impacts on the levelized cost of energy (LCOE) for wind facilities that obtained the full (100%) PTC, compared to wind projects that did not receive these federal tax incentives. This subsequent analysis focuses on the relative cost savings of wind facilities that capture 80% of the federal PTC, compared to those facilities built at a later date which do not receive the PTC (though the relative cost of 100% PTC wind is also shown for illustrative purposes). The results of the analysis, described in more detail below, demonstrate the continued value of wind energy that receives 80% of the PTC. This analysis also evaluates cases with significant declines in capital costs and other technological advancements in wind and finds that projects with the 80% PTC are still expected to deliver significant savings to ratepayers compared to wind resources built at a later date that do not receive the PTC.

The PTC is currently scheduled to phase out over the next several years, with varying deadlines for resources to achieve 100%, 80%, 60% and 40% PTC. We point readers to the previous memo which explains, in more detail, how wind generation built in the coming years can capture the PTCs under Internal Revenue Service (IRS) guidelines.

The previous analysis focused on wind projects that achieve commercial operation in two timeframes: 2020 and 2026. As some wind projects achieving commercial operation in 2020 will be able to capture 100% of the PTC, while projects reaching commercial operation in 2026 are

1 The memo was subsequently updated with additional information on potential ratepayer savings in October 2017.
unlikely to be eligible for any amount of PTC. Similarly, certain projects reaching commercial operation in 2021 will be eligible to receive 80% of the federal PTC. This analysis focuses on comparing the costs of wind projects coming online in 2021, and receiving 80% of the PTC, and wind projects coming online in 2026, without PTCs.\(^2\)

A number of both 100% and 80% PTC-eligible projects are expected to be available to California ratepayers, though they will require near-term contracting in order to achieve 100% or 80% PTC eligibility.

The analysis summarized below compares the relative LCOEs associated with procuring 80%-tax benefit eligible wind to procuring wind at a time when these tax benefits have expired, demonstrating the economics of the tax-eligible resources, even at a reduced level. Since the cost of renewable resources has been falling for many years now, several parties have suggested that decreasing capital costs and technological advancements will continue to decrease the costs of renewable resources, which may more than make up for any federal tax benefits that are currently available. To help illustrate the relative value of the PTCs, we added additional scenarios, including a more extreme capital cost decline scenario and a case with both further capital cost declines and higher capacity factors (which could result from further technological advancements).

As with the prior assessment, this assessment focuses on high-capacity-factor wind from New Mexico and Wyoming. In order to perform this analysis, Energy Strategies utilized version 6.2 of the California Public Utilities Commission (CPUC) Renewable Portfolio Standard (RPS) Calculator\(^3\) with updated assumptions on capital cost and capacity factor taken from the July 2017 RESOLVE documentation of the inputs and assumptions for the CPUC 2017 Integrated Resource Plan (IRP).\(^4\) Specifically, the RPS Calculator’s pro forma cash tool was used to calculate the LCOE of wind resources in several scenarios, while using the average capital cost of Wyoming and New Mexico wind from the RESOLVE IRP inputs and assumptions. Although the LCOE values produced by the RPS Calculator may not reflect actual, confidential prices contained in PPAs, the RPS Calculator has been widely vetted in various CPUC proceedings and provides a sound platform for analyzing the relative change in the cost of wind energy with and without federal tax incentives.\(^5\)

\(^2\) 2026 also aligns with the procurement timeframes being evaluated in RESOLVE and would, almost certainly, be past the time wind resources might qualify for reduced PTCs (such as 60% or 40%).

\(^3\) Version 6.2 of the RPS Calculator was used, as version 6.3 has not been made available on the CPUC’s website.

\(^4\) RESOLVE documentation for capital cost and capacity factors used in the analysis is available here: http://www.cpuc.ca.gov/uploadedFiles/CPUCEnergy/IRP/17/RESOLVE_CPUC_IRP_Inputs_Assumptions_2017-07-19_redline.pdf

\(^5\) Note that while interconnection costs were assumed for these wind projects, no additional transmission costs were added for any of the wind projects evaluated. While transmission costs would likely be necessary for delivery
The analysis considered several scenarios. Each scenario is designed to compare the relative changes in LCOE between a wind project that can achieve commercial operation in 2021, and obtains 80% PTCs, and a wind project that achieves commercial operation with no PTCs. For illustration purposes, we have also included the costs of wind projects that achieve the 100% PTC (which have been assumed to come online in 2020). The wind project scenarios are described below and summarized in Table 1.

1. **Scenario 1A (Default RESOLVE/RPS Calculator Inputs):** This scenario uses the default assumptions from the RPS Calculator, including updated capacity factors and capital cost assumptions from the RESOLVE documentation for inputs and assumptions used in the 2017 CPUC IRP. Capital costs reflect the simple average between Wyoming and New Mexico costs, which were sourced from RESOLVE inputs.

2. **Scenario 2A (Higher Capacity Factor):** Scenario 2A uses the same inputs and assumptions as Scenario 1A, except that a higher capacity factor (52%) is used to align with the capacity factor of recent a wind project in New Mexico.

3. **Scenario 3A (Higher Capacity Factor and Cost Reductions):** Scenario 3A uses the same inputs and assumptions as Scenario 2A, except the project that comes online in 2026 has a lower capital cost to reflect potential cost reductions. The capital cost has been reduced from the 2020 value by 7.7%, which is in line with the largest proportional capital cost reductions seen between 2020 and 2030 under a single “case” in the U.S. Department of Energy’s Wind Vision analysis.

4. **Scenario 4A (Further Capital Cost Reductions in 2026):** Scenario 4A uses the same inputs and assumptions as Scenario 2A & 3A, except the project that comes online in 2026 is assumed to experience even greater reductions in capital costs, even more than are anticipated in any case in Wind Vision. In this scenario, the wind coming online in 2026 experiences roughly a 22% reduction in capital costs compared to the 2020 case. This cost decline represents the greatest percentage decline from one of Wind Vision’s “high” cost cases in 2020 to a “low” cost case in 2030.

5. **Scenario 5A (Further Capital Cost Reductions and Higher Capacity Factor in 2026):** Scenario 5A uses the same inputs and assumptions as Scenario 4A, except the project that comes online in 2026 not only experiences significantly lower capital costs, but also experiences increased capacity factors due to technological advancement. For this scenario, wind coming online in 2026 was assumed to have a 61% net capacity factor.

---


A 61% net capacity factor is the highest net capacity factor modeled under Wind Vision’s 2030 assumptions.

### TABLE 1: SCENARIO SUMMARY

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Commercial Operational Date (COD)</th>
<th>PTC Eligible?</th>
<th>Capacity Factor</th>
<th>Capital Cost (2016 $/kW)</th>
<th>Other Financial Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scenario 1A: Default RESOLVE/RPS Calculator Inputs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Based on RESOLVE (July ‘17)</td>
</tr>
<tr>
<td></td>
<td>2020</td>
<td>100%</td>
<td></td>
<td>44%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2021</td>
<td>80%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2026</td>
<td>NO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Scenario 2A: Higher Capacity Factor</strong></td>
<td></td>
<td></td>
<td></td>
<td>52%</td>
<td>Based on RESOLVE (July ‘17)</td>
</tr>
<tr>
<td></td>
<td>2020</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2021</td>
<td>80%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2026</td>
<td>NO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Scenario 3A: Higher Capacity Factor and Cost Reductions</strong></td>
<td></td>
<td></td>
<td></td>
<td>52%</td>
<td>2026 only reduced 7.7% from 2021 RESOLVE value</td>
</tr>
<tr>
<td></td>
<td>2020</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2021</td>
<td>80%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2026</td>
<td>NO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Scenario 4A: Further Capital Cost Reduction in 2026</strong></td>
<td></td>
<td></td>
<td></td>
<td>52%</td>
<td>2026 only reduced 22% from 2021 RESOLVE value</td>
</tr>
<tr>
<td></td>
<td>2020</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2021</td>
<td>80%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2026</td>
<td>NO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Scenario 5A: Further Capital Cost Reduction and Higher Capacity Factor in 2026</strong></td>
<td></td>
<td></td>
<td></td>
<td>52%</td>
<td>2026 only reduced 22% from 2021 RESOLVE value</td>
</tr>
<tr>
<td></td>
<td>2020</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2021</td>
<td>80%</td>
<td></td>
<td>52%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2026</td>
<td>NO</td>
<td></td>
<td>61%</td>
<td></td>
</tr>
</tbody>
</table>

8 The RPS Calculator includes functionality to optimize the debt-equity ratio. Because the goal of this assessment was to isolate the relative value of the PTC, the debt-equity ratio for each project was held constant at 50/50.
The relative impact on the LCOEs in each scenario were compared. Table 2 summarizes the results of the assessment. Figure 1 illustrates the savings that can be achieved by securing the full benefit of the PTC.

**TABLE 2: LEVELIZED COST OF ENERGY (2016 $/MWH) AND RELATIVE SAVINGS ACROSS SCENARIOS**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>$31.61</td>
<td>$23.27</td>
<td>$23.27</td>
<td>$23.27</td>
<td>$23.27</td>
</tr>
<tr>
<td>2021</td>
<td>$36.48</td>
<td>$28.18</td>
<td>$28.18</td>
<td>$28.18</td>
<td>$28.18</td>
</tr>
<tr>
<td>2026</td>
<td>$56.41</td>
<td>$48.19</td>
<td>$46.07</td>
<td>$40.94</td>
<td>$35.34</td>
</tr>
<tr>
<td>Delta (2026-2021)</td>
<td>$19.92</td>
<td>$20.01</td>
<td>$17.89</td>
<td>$12.75</td>
<td>$7.16</td>
</tr>
<tr>
<td>Relative savings (%)</td>
<td>35%</td>
<td>42%</td>
<td>39%</td>
<td>31%</td>
<td>20%</td>
</tr>
</tbody>
</table>

*Relative savings (%) 80% PTC vs. no PTC*

**FIGURE 1: LEVELIZED COST OF ENERGY (2016 $/MWH) COMPARISON**

---

9 The delta in the LCOE in Table 2 results from comparing LCOEs, as calculated by the RPS Calculator, of the two projects in each scenario. The RPS Calculator calculates LCOE using the net present value of the cash flows and the net present value of the energy and, among various other assumptions, the LCOE is grossed up for taxes. Note that the LCOE from the RPS Calculator may differ from actual PPA prices.
This analysis demonstrates that the LCOE savings of the wind resources that receive 80% of the PTC can be between $7-20/MWh or 20-42% lower than the LCOE of wind energy that comes online in 2026, even when significant cost savings and increased capacity factors are assumed for wind coming online in 2026. While these values may not be reflective of actual, confidential PPA prices, they demonstrate the relative value of securing the 80% PTC.

The total value that can accumulate to ratepayers will vary depending on the specifics of the PPAs that might be signed. But if the LCOE values in this analysis are used as a proxy for relative and levelized PPA prices, then the total ratepayer savings associated with 1,000 MW of wind that receives 80% of the PTC over twenty-years can be estimated to be between $1.5 and $1.8B for scenarios 1A-3A. And, even if by 2026 there are significant reductions in capital costs and/or increases in capacity factors over the coming years, securing wind with 80% of the PTC would still result in relative LCOE savings of $650M - $1.2B over twenty-years. These results demonstrate the substantial value of the PTC and the potential cost savings ratepayers could see by securing wind that receives the 80% PTC compared to purchasing wind energy at a later date.
INFORMAL COMMENTS OF THE CALIFORNIA WIND ENERGY ASSOCIATION
ON THE DRAFT SOURCES FOR 2019-20 IRP SUPPLY-SIDE RESOURCES

Nancy Rader
Executive Director
California Wind Energy Association
1700 Shattuck Ave., #17
Berkeley, CA 94709
Telephone: 510-845-5077 x1
E-mail: nrader@calwea.org

Dariush Shirmohammadi
Technical Director
California Wind Energy Association
1700 Shattuck Ave., #17
Berkeley, CA 94709
Telephone: (310) 858-1174
E-mail: dariush@gridbright.com

On behalf of the California Wind Energy Association

April 23, 2018
INFORMAL COMMENTS OF THE CALIFORNIA WIND ENERGY ASSOCIATION
ON THE DRAFT SOURCES FOR 2019-20 IRP SUPPLY-SIDE RESOURCES

Pursuant to the March 27, 2018, email from Patrick Young, Energy Division, and the April 13, 2018, email of Karolina Maslanka, Energy Division, the California Wind Energy Association (“CalWEA”) submits these informal comments on the Draft Sources for 2019-20 IRP Supply-Side Resources, addressing a subset of the questions posed by staff. We also comment on available transmission capacity, although none of the questions were directed at this topic, and reiterate two important issues that we have raised in the past.

Question 7: How should high- and low-cost trajectories for future battery costs be developed?

CalWEA encourages staff to ensure that the cost of battery disposal is properly accounted for, given the potentially hazardous materials involved.

Questions 10/11: Are there any new resource types … that Energy Division should prioritize including as a candidate resource in the 2019 IRP? Are there data sources … that should be considered for modifying the candidate resource potential assumed in IRP?

In CalWEA’s initial IRP comments, we urged staff not to assume (as it did) that existing renewable resources will continue to operate indefinitely. This is a particular concern for renewable energy projects installed in the 1980s, including approximately 1,100 MW of wind energy projects that have not recently been repowered with new technology. See Attachment A
for a list of these projects. Further, the model should consider that repowering these resources with new technology can dramatically improve capacity factors and extend project life.

CalWEA is not aware of any publicly available data sources for the operating costs of these existing, aging wind projects. Moreover, costs will vary depending on turbine type, age, and wind regime (e.g., wind turbulence) of the project, among other factors. However, in general, essentially all turbines installed in the 1980s that remain operational are mechanically sound, although their electronic control systems are dated. Most of these turbines continue to operate past 30 years of age, albeit with relatively high operations and maintenance costs, relative to modern turbines, and capacity factors ranging from the high teens to 30%-range. These “work horse” turbines are generally continually repairable to the extent that replacement parts can be found or fabricated. However, it would be unreasonable to assume more than a 45-year life.

In contrast, beginning in the 1990s, turbines began to be designed with lifetimes to match expected contract lengths of 20-25 years with a five-year margin beyond that (25-30 years in total). These variable-pitch machines, with smaller gears and bearings, are more difficult to repair. Against this backdrop, based on input from CalWEA member companies that own and operate many of these vintage resources, CalWEA believes that the following average figures would be reasonable for use in the RESOLVE model:

- A reasonable assumption for the average cost of operating a 1980s-vintage wind project is $0.05/kWh (with a range of $0.04-$0.065/kWh). Costs would be lower where capital costs have been paid off and/or capacity factors are higher, and higher where debt remains (many projects have been purchased from their original or later owners within the past decade) and capacity factors are lower.
- A reasonable assumption for the average cost of operating 1990s-vintage wind projects is perhaps 25% less than that above, given higher capacity factors.

The cost of repowering pre-2000-vintage California wind projects should be presumed to be the same as the cost of building new, greenfield wind projects. On the one hand, these projects do not incur the early-stage risk-capital outlays associated with a new project, including siting,

1 CalWEA submitted this same list as part of its October 26, 2017, IRP comments.
2 These are Danish-made turbines; nearly all, if not all, U.S. Windpower machines installed in the 1980s are no longer operating.
3 CalWEA is supporting a UC Davis/DNV-GL project funded by the Energy Commission (EPC-16-019) to research, develop and demonstrate cost-effective communications and control systems for aged turbines that will enable these turbines to be remotely dispatched and controlled in response to real-time and forecasted market prices, curtailment orders, forecasted wind production and other factors.
permitting and interconnection-deposit costs. On the other hand, the very small size of these projects, as indicated in Attachment A, creates a lack of economies of scale.\(^4\) Therefore, many fixed costs (e.g., re-permitting, transactions, certain construction costs and, potentially, interconnection costs) must be spread over many fewer megawatts. While there are many site/project-specific factors that create variability in the costs of both greenfield and repower projects,\(^5\) in general, the model should assume the same cost for small repowers as assumed for new greenfield projects. A reasonable assumption for the average operating cost of a repowered project would be 105% of the operating cost of a new, larger greenfield wind project. This, again, is due to fixed and non-scalable costs associated with small projects, such as service trucks, buildings and personnel.

**Comment on Available Transmission Capacity**

The staff document describes the source for available transmission capacity as “CAISO supplemental analysis based on the current year’s TPP work.” This analysis needs to be updated to reflect the ELCC-based RA values for wind and solar that have been adopted by the Commission.

CAISO’s analysis estimates the amount of full capacity deliverability service (“FCDS”) that is available from each CREZ. In very broad terms, this estimation consists of three steps:

1. Calculate total FCDS transmission capacity from the CREZ;
2. Calculate, based on CAISO’s exceedance methodology, FCDS transmission capacity reserved to transmit the RA capacity of CREZ resources that are either operating or contracted; and
3. Calculate remaining available FCDS transmission capacity from the CREZ by subtracting the reserved FCDS transmission capacity calculated in Step 2 from total FCDS transmission capacity calculated in Step 1 plus any FCDS transmission capacity that may become available from planned retirement of resources in the CREZ.

\(^4\) A large majority of these wind projects (representing about half of the total capacity) is under 30 MW in size. Some 20 projects are under 10 MW in size.

\(^5\) For repowers, these factors include substation conditions and interconnection requirements, terrain, project size, and impacts on neighboring projects.
For example, if CAISO determines that the total FCDS transmission capacity from CREZ-1 is 12,000 MW and the amount of reserved FCDS transmission capacity for existing and contracted resources in CREZ-1 is 8,000 MW (say, 100 solar projects with nameplate capacities of 100 MW and RA capacities of 80 MW each), the available FCDS transmission capacity from CREZ-1 should be 4,000 MW (=12,000-8,000). For reasons CalWEA cannot explain, CAISO adds a margin on the RA capacity – for example, for solar resources whose RA capacity is about 80% of their nameplate based on the exceedance method, CAISO reserves FCDS transmission capacity for 100% of nameplate capacity. In the simple example noted above, the reserved FCDS transmission capacity for CREZ-1 is calculated to be 10,000 MW, rather than 8,000 MW, and thus the available FCDS transmission capacity from CREZ-1 is calculated to be 2,000 MW (=12,000-10,000).

With the advent of the ELCC methodology for calculating the RA capacity value of wind and solar resources, Step 2 in the above calculation will be heavily impacted since the RA capacity of existing and contracted resources under the ELCC methodology is significantly different than the RA capacity under the exceedance method. For example, the Commission-approved RA capacity of a solar resource is now about 40% of its nameplate capacity. This means that the reserved FCDS transmission capacity from a solar-heavy CREZ will be significantly smaller than the value calculated under the exceedance method. In the above example for CREZ-1, the reserved FCDS transmission capacity calculated in Step 2 under ELCC should be 4,000 MW (100 solar resources with 100 MW nameplate capacity each and 40 MW RA capacity each). Even with the CAISO adjustment of RA capacity, the reserved capacity from CREZ-1 would be 5,000 MW (100 solar resources with 100 MW nameplate capacity each and 50 MW RA capacity each). That means that the available FCDS transmission capacity under ELCC will be 7,000 MW (=12,000-5,000) which is significantly higher than the 2,000 MW calculated under the exceedance method.

Therefore, the Commission should work with the CAISO to update its analysis of available transmission capacity in order to account for the Commission’s adopted ELCC values.

**Comments on Additional Issues**

We are not clear whether or not reiterating some of our past comments is appropriate at this juncture, but just in case, we want to flag the following:
• **BTM PV** – The IRP model should have behind-the-meter (“BTM”) PV compete with other resources in developing the IRP reference plan, as opposed to being placed as an input number. (The same is true for energy efficiency.) If this is not possible, then, for BTM-PV, the baseline should not assume levels of BTM PV that the IRP results clearly show to be grossly non-cost-effective. The RESOLVE results for the initial IRP cycle showed that reducing BTM PV to 9 GW would save ratepayers $682 million/year in the 42 MMT case. While location-specific transmission and distribution (“T&D”) deferral benefits (net of specialized distribution upgrades needed to accommodate high BTM penetrations) are not considered in RESOLVE, the RESOLVE model also does not consider the ratepayer impact of NEM, since the assumed cost of BTM PV was the estimated installation cost only; the ratepayer impact is likely to be far higher than any T&D net benefits associated with BTM PV. Therefore, no more than 9 GW of incremental BTM PV should be included in the baseline for 2030 in the Reference case until the Commission determines the successor NEM tariff in view of any location-specific values determined in the Distributed Resources Plan proceeding, and the full ratepayer impact of NEM should be reflected.

• **Import-Export Limits.** The limit on import and export resources should be based on either historical figures or west-wide production simulation studies. The assumptions used in Staff’s 42 MMT Reference case arbitrarily assumed a net export level of 5,000 MW out of the CAISO footprint, which is nearly 5,000 MW over the highest amount that has ever occurred. The “low export” sensitivity assumes 2,000 MW of exports. However, the current figure is near-zero even though there are no institutional, regulatory, or technical barriers to exporting energy out of the CAISO. If there are limits, they are economic limits resulting from neighboring Balancing Authorities’ valuation of energy from the CAISO footprint (due to cost of the energy, the wheeling-out cost, or the neighboring area’s own minimum generation limits or other operating considerations).

For future studies, a more appropriate limit should be established using WECC-wide production simulation studies. Meanwhile, the Commission should use CAISO’s recommended level of 2,000 MW for the base case and should use zero exports for the “low-export” sensitivity. As CalWEA has shown in its own runs of the RESOLVE model, a lower and more realistic export level will show that wind resources further reduce ratepayer costs.

Respectfully submitted,

/s/ Nancy Rader

---

6 As stated in CalWEA’s January 13, 2017, informal comments in this proceeding, these limits could be reasonably established by performing a WECC-wide study with proper hurdle rates for inter-BA transactions to determine maximum expected export values from California to neighboring BAs. One such value should be established for each study year and interpolation could be used to determine the maximum expected export value for non-study years. The maximum expected export values, thus determined, would then become export limits for the IRP studies.

7 See CalWEA’s October 26, 2017, IRP comments --Question 5, part (b).
On behalf of the California Wind Energy Association

April 23, 2018
Projects Already Re-Contracted/Repowered/New (Assumed based on CPUC RPS Contract Database, public info or industry knowledge)

Buena Vista Energy
PG&E Wind
2017
43
Byron, CA
RPS

Diablo Winds
PG&E Wind
2016
18
Altamont Pass, CA
RPS

EDP Renewable Windpower
PG&E Wind
2017
10
Montezuma Hills
Qualifying Facility (QF)

EDP Renewable Windpower, Inc.
PG&E Wind
2018
6.5
Bencia, CA
Qualifying Facility (QF)

Edom Hills Project I, LLC
SCE Wind
2015
20
Palm Springs, CA
PCC 0

Green Ridge Power LLC
PG&E Wind
2015
43.1
Tracy, CA
Qualifying Facility (QF)

Green Ridge Power LLC
PG&E Wind
2018
15
Tracy, CA
Qualifying Facility (QF)

Green Ridge Power LLC
PG&E Wind
2015
144.1
Livermore, CA
Qualifying Facility (QF)

Green Ridge Power LLC
PG&E Wind
2016
10.8
Tracy, CA
Qualifying Facility (QF)

Green Ridge Power LLC
PG&E Wind
2018
5.9
Tracy, CA
Qualifying Facility (QF)

Green Ridge Power LLC
PG&E Wind
2015
54
Tracy, CA
Qualifying Facility (QF)

Mountain View Power Partners, LLC
SCE Wind
2021
66.6
North Palm Springs, CA
PCC 0

San Gorgonio Westwinds II, LLC (partial)
SCE Wind
2015
10
Palm Springs, CA
PCC 0

Sha4 Cabazon-Whitewater
SDG&E Wind
2013
102.4
Palm Springs, CA

Shikish Wind
PG&E Wind
2021
75
Birds Landing, CA
RPS

Windland Inc. (Boxcar II) (Partial)
SCE Wind
2015
3
Tehachapi, CA
PCC 0

Total Assumed Repowered (MW)
227.4

TOTAL REPOWER CANDIDATES (MW)
1130

Note: A small fraction of these projects were repowered in 1998, before the federal tax credit was amended to discourage repowers. Even these facilities would be over 30 years old by 2030.

Projects Already Re-Contracted/Repowered/New (Assumed based on CPUC RPS Contract Database, public info or industry knowledge)
BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking to Develop an Electricity Integrated Resource Planning Framework and to Coordinate and Refine Long-Term Procurement Planning Requirements. Rulemaking R.16-02-007

INFORMAL COMMENTS OF CALIFORNIA BIOMASS ENERGY ALLIANCE ON THE DRAFT SOURCES FOR 2019-20 IRP SUPPLY-SIDE RESOURCES

April 17, 2018

Julee Malinowski Ball, Ex. Director
California Biomass Energy Alliance
1015 K Street
Sacramento, CA 95814
ph: (916) 441-0702
Julee@ppallc.com
INFORMAL COMMENTS OF CALIFORNIA BIOMASS ENERGY ALLIANCE
ON THE DRAFT SOURCES FOR 2019-20 IRP SUPPLY-SIDE RESOURCES

Pursuant to the March 27, 2018, email from Patrick Young, with attached documents, in Proceeding R-16-02-007, the Order Instituting Rulemaking to Develop an Electricity Integrated Resource Planning Framework and to Coordinate and Refine Long-Term Procurement Planning Requirements, the California Biomass Energy Alliance (CBEA), the trade organization of California’s biomass energy industry provides: Informal Comments of California Biomass Energy Alliance on the Draft Sources for 2019-20 IRP Supply-Side Resources. CBEA’s Comments are focused on the treatment of biomass in the IRP modeling process, including in the model’s database.

The CBEA’s June 28, 2017, Comments in this proceeding, made the case that some of the data in the Resolve database pertaining to biomass were inaccurate, with the result that biomass was not adequately represented in the modeling that led to the determination of the Reference System Plan, which was memorialized in D.18-02-018. We reiterated and reinforced our case for updating the biomass specifications in the Resolve database in our October 26, 2017, Comments on the Proposed Reference System Plan. With respect to renewable resources, the Draft Sources for 2019-20 IRP Supply-Side Resources (Draft Sources) document is clearly focused on solar and wind resources. Nevertheless, the time is now to update and correct the biomass data in the Resolve model database, in addition to updating solar and wind data.

We address below questions 10 and 11 in the Draft Sources document.

10. Are there any new resource types (not described in your responses to Questions 1 – 9) that Energy Division should prioritize including as a candidate resource in the 2019 IRP?

As the CBEA pointed out in our June 28, 2017, and October 26, 2017 Comments, there are approximately 200 MW of idled but operable biomass facilities in the state that could be brought back into service at considerably lower cost than the development of a new,
greenfield plant. We are unaware of a public source of information that contains cost data on refurbishing and restarting idled power plants, but we believe that reasonable estimates can be added to the model’s database based on discounting from the cost of new facilities (see answer to question 11 below re cost of new facilities).

The capital cost for the restart of an existing biomass facility can be assumed to be at least fifty percent lower than the cost of developing a new facility. As discussed below in our answer to question no. 11, the CBEA believes that publicly-available cost data from the EIA should be used in place of the data currently in the Resolve model’s database for biomass power production. Using the EIA data, and adding in property taxes, which are in the Resolve database but not in the EIA data, produces a total levelized cost for new biomass power of $105 /MWh. If the capital cost factor used by EIA is cut in half in order to represent the cost of a restart of a idled facility, the total levelized cost of biomass from a restart of a idled facility would be $83 /MWh, a reduction of more than twenty percent. These “opportunity” facilities should be added to the Resolve model database. We repeat below the table of idled but operable biomass facilities in the state from our June 28, 2017, Comments.

<table>
<thead>
<tr>
<th>Facility</th>
<th>MW</th>
<th>Non-Op after 2014?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue Lake</td>
<td>10</td>
<td>Yes</td>
</tr>
<tr>
<td>Buena Vista Biomass Power</td>
<td>18</td>
<td>Yes</td>
</tr>
<tr>
<td>Covanta Burney</td>
<td>10</td>
<td>No</td>
</tr>
<tr>
<td>Covanta Delano</td>
<td>48</td>
<td>Yes</td>
</tr>
<tr>
<td>Covanta Mendota</td>
<td>25</td>
<td>Yes</td>
</tr>
<tr>
<td>Covanta Westwood</td>
<td>11</td>
<td>No</td>
</tr>
<tr>
<td>Dinuba Biomass</td>
<td>12</td>
<td>Yes</td>
</tr>
<tr>
<td>Madera Biomass</td>
<td>25</td>
<td>No</td>
</tr>
<tr>
<td>Shasta Renewable Energy</td>
<td>6</td>
<td>No</td>
</tr>
<tr>
<td>Tracy Biomass</td>
<td>20</td>
<td>No</td>
</tr>
</tbody>
</table>
11: Are there data sources (not described in your responses to Questions 1 – 9) that should be considered for modifying the candidate resource potential assumed in IRP?

Biomass cost data in the Resolve model database are in strong need of updating. The current data are based on a 2013 study performed by Black & Veatch (B&V) for the Commission in the RPS proceeding. The B&V study produced design and cost data for a small (3 MW) and a large (20 MW) biomass generator. The table below shows the capital cost data ($/kW) in the B&V study for the two unit sizes, inflated to 2018 values.

<table>
<thead>
<tr>
<th>Size</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 MW</td>
<td>5,650</td>
<td>6,780</td>
<td>8,475</td>
</tr>
<tr>
<td>20 MW</td>
<td>5,810</td>
<td>6,520</td>
<td>7,695</td>
</tr>
</tbody>
</table>

These numbers show almost no difference in cost between a 3 MW biomass generator and a 20 MW biomass generator, whereas it is well known that there are very significant economies of scale to be had in this size range. Based on the experience of CBEA members, it is our opinion that the cost data for the 3 MW facility are reasonable, while the cost data for the 20 MW facility are much too high. The problem is that the too-high capital-cost numbers for the 20 MW facility form the basis for the cost specifications in the Resolve database for large biomass generators.

The Resolve database is populated with levelized cost data for candidate generators, with levelized fixed costs expressed in $/kW-yrs, and levelized variable costs expressed in $/MWh. The RPS Calculator V6.3 Data Updates document, which is cited as a source document for Resolve, includes a capital cost for biomass of $5,869/kW, and a capacity factor of 85 percent. Assuming that this is the source for the capital cost specification for biomass in the Resolve database, this translates into a levelized capital cost for biomass of $556/kW-yr.

The most authoritative source of public information that we know of on the cost of electricity production is the Dept. of Energy’s Energy Information Administration (EIA).
In March, 2018, the EIA published, Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2018.\footnote{https://www.eia.gov/outlooks/aeo/pdf/electricity_generation.pdf} Tables 1a and 1b (pgs. 5, 6) of the document present the levelized capital cost of biomass at $39.2-40.3 /MWh, which translates into a range of $295-300/kW-yr, assuming a capacity factor of 85 percent. The table below compares the full set of costs between the Resolve database and the EIA:

<table>
<thead>
<tr>
<th>Levelized Fixed Costs ($/kW-yr)</th>
<th>Resolve</th>
<th>EIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital</td>
<td>556</td>
<td>300</td>
</tr>
<tr>
<td>Interconnection</td>
<td>19</td>
<td>11</td>
</tr>
<tr>
<td>Property Tax</td>
<td>37</td>
<td>0</td>
</tr>
<tr>
<td>Fixed O&amp;M</td>
<td>186</td>
<td>115</td>
</tr>
<tr>
<td>Total Fixed</td>
<td>798</td>
<td>426</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Levelized Variable Costs ($/MWh)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable O&amp;M</td>
<td>9</td>
<td>45</td>
</tr>
<tr>
<td>Fuel</td>
<td>34</td>
<td>inc. above</td>
</tr>
<tr>
<td>Prod. Tax Credit</td>
<td>-28</td>
<td>0</td>
</tr>
<tr>
<td>Total Variable</td>
<td>15</td>
<td>45</td>
</tr>
</tbody>
</table>

| Total Levelized Cost ($/MWh)    | 122      | 102 |

\textbf{Corrected TLC (see disc. below)} \hspace{1cm} \textbf{150} \hspace{1cm} \textbf{105}

As the raw data in the table show, there are two inconsistencies between the Resolve and the EIA datasets. First, the Resolve dataset includes a $28/MWh production tax credit for biomass, which, as we pointed out in our June 28, 2017, Comments, has long-since expired. Second, the EIA dataset does not include an estimate of property taxes. Removing the production tax credit from the Resolve dataset, and adding property taxes to the EIA dataset at the same rate as in the Resolve dataset, leads to the corrected values for total levelized cost shown on the last line of the table above in red.
The CBEA urges the Commission to update the Resolve model database’s biomass specifications with publicly-available information from the EIA.

**Conclusion**

CBEA requests that the biomass dataset being used for the IRP analysis be updated in time for the next round of the IRP, both with regards to the cost of new biomass generators, and with respect to including operable but currently idle biomass generators in the state as candidates for satisfying future resource needs.

Dated April 17, 2018

Respectfully Submitted,

Julee Malinowski Ball, Ex. Director
California Biomass Energy Alliance
1015 K Street
Sacramento, CA 95814
ph: (916) 441-0702
Julee@ppallc.com
INFORMAL COMMENTS OF THE CALIFORNIA ENERGY STORAGE ALLIANCE ON THE DRAFT SOURCES FOR 2019-2020 IRP SUPPLY-SIDE RESOURCES DOCUMENT

Alex J. Morris  
Sr. Director, Policy & Regulatory Affairs

Jin Noh  
Policy Manager

**CALIFORNIA ENERGY STORAGE ALLIANCE**  
2150 Allston Way, Suite 210  
Berkeley, California 94704  
Telephone: (310) 617-3441  
Email: amorris@storagealliance.org

April 23, 2018
Order Instituting Rulemaking to Develop an Electricity Integrated Resource Planning Framework and to Coordinate and Refine Long-Term Procurement Planning Requirements.

Rulemaking 16-02-007
(Filed February 11, 2016)

INFORMAL COMMENTS OF THE CALIFORNIA ENERGY STORAGE ALLIANCE ON THE DRAFT SOURCES FOR 2019-2020 IRP SUPPLY-SIDE RESOURCES DOCUMENT

As follow-up to the Modeling Advisory Group ("MAG") webinar on March 1, 2018 and in response to the March 27, 2018 email from the California Public Utilities Commission ("Commission") staff soliciting comment on the draft Sources for 2019-2020 IRP Supply-side Resources ("Draft Sources") document, the California Energy Storage Alliance ("CESA")\(^1\) hereby submits these informal comments.

---

I. **INTRODUCTION.**

CESA appreciates the opportunity to provide informal input to the MAG as it works in parallel tracks to enhance the production cost modeling in the 2017-2018 Integrated Resource Planning (“IRP”) cycle and to update assumptions for initial modeling for the 2019-2020 IRP cycle. CESA agrees that this is a prudent and wise use of the Commission’s time to prepare for the next round of RESOLVE modeling beginning in January 2019 while the load-serving entities (“LSEs”) prepare their IRP filings for the 2017-2018 IRP cycle based on Decision (“D.”) 18-02-018. CESA plans to continue its active participation in this important proceeding.

In these informal comments, CESA provides responses to the questions posed in the Draft Sources document but first offers its comments on the data source criteria, which requires that data sources to be used in IRP modeling must be publicly available, technically credible, reflective of future costs, usable to develop all-in technology costs, and geographically specific, if needed.\(^2\) CESA generally agrees with this criteria, but adds that certain credible proprietary data and actual cost data from real-world competitive solicitations may be used to inform which publicly-available data sources and ranges to use. CESA understands the challenge for any public proceeding is around the ability to use publicly available data, which eliminates the use of perhaps more informative confidential data from competitive solicitations and/or the use of proprietary data due to licensing barriers. However, such datasets that are unusable for citing in public proceedings may still be useful to benchmark the publicly available data sources and inform the adoption of low-end or high-end cost ranges from the publicly available data source for different resources. Overall, we should not use inaccurate data knowingly, and should find a way to use realistic going-forward cost data.

---

\(^2\) Draft Sources document, p. 11.
Furthermore, CESA believes that there should be some criteria around the process or triggers for updating resource cost inputs. Especially for energy storage, where costs are on a rapid downward trajectory, the use of one primary data source at this stage of the IRP modeling process may soon become stale by the time that the actual modeling efforts are underway in early 2019 and the modeling results are completed by late 2019, possibly early 2020. In instances where the primary data source is not updated annually or frequently enough, it may be reasonable to utilize certain proprietary data sources and/or actual costs from recent competitive solicitations to inform whether the high-, mid-, or low-end costs of the resource is reasonable for adoption in the 2019 or 2020 Reference System Plan. The Commission already proposes a criteria to justify changes to model functionality and run-time, where the magnitude of potential impact on future portfolio costs and composition must be sufficient. However, in this case, CESA believes that cost assumption updates as CESA proposes above do not require a significant re-work of the model functionality or create extra run-time, and thus a consideration of some threshold criteria or a streamlined process by which to update cost assumptions may be reasonable and prudent to ensure more accurate model outputs.

II. RESPONSE TO QUESTIONS.

Below, CESA provides our select responses to the questions posed by Commission staff from the Draft Sources document.

**Question 4:** Do parties have recommendations on how to distinguish between specific battery technologies in an emerging market?

CESA appreciates the Commission’s consideration of emerging battery storage technologies. There are a number of battery storage technologies on the market today or are in the early stages of commercialization that each offer its own unique advantages and disadvantages in
terms of power/energy density, lifetime, performance, safety, recyclability, among other traits. New advancements are frequently occurring, but rather than modeling every specific battery technology, CESA believes it may be more reasonable to model and price the different capabilities of battery (and other energy storage) technologies, with some differentiation across the major sub-classes of battery storage technologies – *i.e.*, lithium-ion, flow, advanced lead-acid, and flywheel battery storage – as it has been done in the IRP modeling to date and as it is usually reported in publicly-available industry sources. Ultimately, CESA views the role of the procurement process to select the specific battery technology, whereas the IRP modeling should identify the higher-level capabilities needed from energy storage resources to meet identified grid needs. For example, energy storage costs can be differentiated by duration levels to guide the authorization of procurement for specific energy storage capabilities.

**Question 5:** What sources should be considered in developing recommended battery costs for use in IRP?

CESA supports the Commission’s approach of using Lazard’s *Levelized Cost of Storage 3.0* (or whatever subsequent version of the study comes out)\(^3\) as a primary data source that can be benchmarked or revised with a literature review of other proprietary industry market research from

---

sources such as Bloomberg New Energy Finance (“BNEF”),
GTM Research, Navigant Research, IHS, and potentially others. CESA finds Lazard to be a generally credible and technically sound public industry data source that breaks out the various cost drivers of different energy storage technologies and takes a use-case perspective to determine costs that take into account the operational parameters of different energy storage technologies.

Lazard as a primary data source also has the advantage of representing a broader range of technologies, which many other data sources lack. In addition to Lazard’s study, CESA points to

---

4 BNEF conducts an annual Lithium-Ion Battery Price Survey that provides valuable insights into the trajectory of lithium-ion cell and pack prices, primarily those used for electric vehicles and stationary storage. This proprietary resource is limited for focusing on the storage module costs and not incorporating the balance of system, power conversion, or engineering, procurement, and construction costs of a grid-connected energy storage system. However, this resource is useful in tracking recent cell/pack capital cost trajectories as well as forward trajectories based on their calculated learning rates, though this is only useful for lithium-ion-based batteries. https://data.bloomberglp.com/bnef/sites/14/2017/07/BNEF-Lithium-ion-battery-costs-and-market.pdf


GTM Research conducts battery hardware and balance of system costs over a three- to four-year look-ahead period and is thus limited to its applications when looking out to 2030. Furthermore, GTM Research does not provide a cost model for alternative energy storage technologies, limiting its application to short-term lithium-ion battery prices and forecasts, but given its more project-by-project tracking of energy storage costs, it may serve as a useful benchmark for current and short-term cost assumptions for lithium-ion battery storage projects. https://www.greentechmedia.com/research/storage

6 Navigant is a major industry market research firm, but this source may be less reliable for IRP modeling purposes given the lack of detail and infrequency of its energy storage cost reports. When these reports do come out, it may be useful to at least benchmark and review.

7 The same points for Navigant apply to IHS as a data source. The latest IHS report that CESA could find was limited in scope to lithium-ion battery projects of a specific configuration with short-term look-aheads. https://www.utilitydive.com/news/ihis-grid-scale-lithium-ion-battery-storage-prices-will-decline-by-half-by/409822/

8 There are a number of other services firms that may produce energy storage cost reports, including one from McKinsey. However, these reports are usually one-off reports and may not track industry cost trends as closely, though it may still be informative as part of the literature review. https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/the-new-economics-of-energy-storage
a peer-reviewed, publicly-available analysis of current energy storage costs as well as projections through 2030 from the International Renewable Energy Agency (“IRENA”).

Using a methodology that identified economic and materials-based factors that could drive down costs with scale and innovation, the IRENA report provided a comprehensive report on not just classes of energy storage technologies (e.g., lithium-ion, flow batteries) but also specific chemistries and sub-classes of each type of technology. The report also covers a range of alternative energy storage technologies such as compressed air energy storage (“CAES”) and flywheel energy storage that many industry data sources do not provide. The IRENA report may be helpful in benchmarking the Lazard’s current and forecasted cost estimates.

Additionally, CESA recommends that the Commission consider the approach used by the New York State Energy Research and Development Authority (“NYSERA”) in developing its NYS Energy Storage Roadmap, which aims to conduct an energy storage study to determine the energy storage deployment potential that would deliver net positive ratepayer benefits for the state of New York. As part of that study, NYSERDA generated 2018-2030 energy storage cost projections as inputs into their modeling runs by conducting a literature review of data from Lazard, GTM Research, Navigant Research, BNEF, and energy storage developers and creating a ‘blended’ cost number to calculate the installed cost per kW and per kWh of different durations of energy storage (see below table). This is an approach that could be explored in lieu of modeling each and every energy storage technology (see response to Question 4) and that could be replicated in some manner here in California. It may be useful to coordinate between NYSERDA and the

---


Commission to share their approach to using industry data sources. If this approach is used, it will also be important to make transparent to stakeholders how the Commission determined these blended cost numbers.

Furthermore, in addition to Lazard and other industry data sources, CESA encourages the Commission to, with appropriate controls and protections for confidentiality, also look at confidential cost numbers reported as part of rate proceedings and applications for contract/project approval.\(^\text{11}\) The use of actual cost data can serve as a very useful benchmark on the current or near-term costs used for energy storage assumptions, which can then be extrapolated using forecasts from industry data and forecasting reports. While CESA does not have access to these numbers, the Commission does have access and has the ability to adjust and adopt high-, mid-, or low-end cost estimates based on this actual cost data. The Commission has the discretion to select among the cost ranges from the publicly-available data sources, which can be guided by solicitation data from any number of energy storage applications in California – e.g., biennial....

\(^{11}\) Comparative projects should be used. Importantly, CESA recommends not using projects that may not be reflective of normal development times, such as, for example, the 2016 Aliso Canyon Energy Storage (ACES) RFO projects. Such projects were needed and procured due to an emergency order stemming from the Aliso Canyon natural gas facility leak and subsequent moratorium on injections and withdrawals.
energy storage applications, local capacity requirement ("LCR") applications that selected energy storage contracts, etc. As an example, CESA points to Xcel Energy’s all-source solicitation report that aggregated bid information by resource type and found surprisingly low cost data for standalone and paired energy storage resources.\(^\text{12}\) A similar approach could be used to aggregate cost data across actual solicitations in California if possible – i.e., sufficient number of bids to be able to aggregate bid prices and protect confidentiality – and be reported into the IRP. CESA encourages the Commission to explore this possibility given that we have seen reports of hundreds of bids submitted into energy-storage-related solicitations that could be used for IRP purposes.\(^\text{13}\) In sum, this actual cost data can serve as a baseline against cost forecasts for energy storage resources as well as for other supply-side resources.

Another important consideration for supply-side energy storage assumptions is to reflect the investment costs for energy storage resources paired with generation assets. Hybrid energy storage resources have a significant advantage in potentially reducing the balance of plant and engineering, procurement, and construction ("EPC") costs, which factor into the capital costs reported by Lazard and will be used for supply-side cost assumptions of energy storage in the IRP modeling. One of the serious limitations of the 2017-2018 IRP modeling is that RESOLVE did not factor in the reduced cost impacts of coupling energy storage with solar resources, generating potential cost savings in terms of shared land, shared inverters (in the case of DC-coupled solar-plus-storage systems), and the Federal Investment Tax Credit ("ITC") when charging the energy storage resource by at least 75% from the paired ITC-eligible solar generator. In the next IRP


cycle, CESA believes it is important to properly model these potential capital cost savings as well as to get this functionality into RESOLVE where energy storage resources are not just selected independently but also coupled with either existing or new resources.

Understandably, this added functionality will require modeling generation and energy storage charge/discharge correctly, but robust modeling that accurately reflects the tools available for the grid should be the backbone to the IRP process. The National Renewable Energy Laboratory (“NREL”) produced a study that could be referenced by the Commission on how pairing energy storage resources with solar plants can impact the costs and benefits of these hybrid assets, depending on the configuration and the charge profile of the resource. Notably, the study found significant balance of system and inverter cost savings as well as a major benefit in the ITC that boosted the viability of DC-coupled solar-plus-storage systems.\(^\text{14}\) Similar type of work can be conducted in this IRP cycle, and in many ways, CESA believes that this functionality must be done since the Reference System Plan results demonstrated how the ITC has significant impacts on the resulting optimal resource portfolio, as evidenced by the more than 9,000 MW of utility-scale solar selected before 2026. To simplify modeling efforts, CESA suggests that the Commission consider modeling energy storage resources that can either charge 75% or 100% from the on-site solar resource as separate candidate resources, which can claim 75% or 100% of the ITC, respectively, against its investment costs.\(^\text{15}\) For the 75% energy storage case, it may require further discussion on how the energy storage charging from the grid should be modeled, including


\(^{15}\) Though there is a range of energy storage charging cases between 75% and 100%, testing these two polar ends of ITC-eligible paired energy storage may be informative on the types of paired energy storage selected as well as the potential grid impacts of PV-only versus PV-majority charging.
how it should be sized in terms of capacity and durations and how it may be operationally constrained due to the 75% charge requirement.

In addition to storage paired with solar, CESA also recommends that the Commission consider other hybrid configurations where energy storage resources are paired with gas generation projects. For example, gas-plus-storage projects may also have similar capital cost benefits while providing the added benefit of reducing gas turbine starts and run time, thereby reducing the GHG emissions profile of the otherwise standalone gas plant. In both of these cases, adjustments to the capital and investment costs of the energy storage resource is needed when added to an existing or new generation resource in addition to adjustments to the modeled operating profile of the generation asset. Likewise, wind-plus-storage projects may have similar capital cost benefits as solar-plus-storage projects but have a different benefit where energy storage can firm generation, which reduces forecast uncertainty and/or load following requirements, generating cost and potential indirect greenhouse (“GHG”) emission savings from not have to have other resources on standby to address those issues.

Understandably, the modeling of hybrid energy storage resources is a complex task, but CESA believes this is reasonable, if not essential, for the Commission to adapt its models to incorporate this functionality because of the potential ratepayer savings that could be generated by investing in new energy storage resources that can be paired with new or existing generation assets, rather than having the model make separate and potentially costlier investment decisions of generation and energy storage assets. Gas-hybrid resources may also have special applicability to address longer-term contingency conditions or local conditions, so they especially warrant representation in IRP models in this period of gas-plant attrition.
**Question 6:** How should Multiple Use Applications of battery storage be modeled?

CESA appreciates the Commission’s consideration of multiple-use applications ("MUAs") of energy storage resources to be modeled in the IRP. In line with R.15-03-011 and ongoing work to effectuate MUAs in energy storage contracts and operations, CESA recommends exploration of MUA cost models that could be both prudent and reflective of real-word MUA capabilities. These resources can be modeled as new MUA storage resources into RESOLVE or other tools. Controls are needed to ensure MUAs are appropriately incremental to other resources, but the general concept here would be to model MUAs as resources that can be dispatched but that may have lower costs. Ultimately, modeling results should highlight system or grid needs and should be able to direct competitive solicitations wherein MUAs may be best evaluated via a procurement process using bids by third-party energy storage operators, who have the project- or fleet-specific optimization model for the energy storage resource to optimize revenues while managing financial risk, and by the distribution utility and the California Independent System Operator ("CAISO"), who have the visibility to key grid constraints and needs to ensure whether MUAs are viable from a single resource.

Additionally or alternatively, CESA recommends that the Commission adopt low-end cost assumptions for energy storage resources as an input into the model. CESA believes this is a minimally reasonable proxy for the MUA capabilities, which measures the added benefits of energy storage resources when evaluated for cost-effectiveness. In other words, if cost-effectiveness is a measurement of benefits over costs and the benefits are difficult to model in the context of MUAs, it is reasonable to assume lower costs for energy storage resources, with the intent to eventually tap into the MUA benefits of energy storage when these resources are procured and contracted.
**Question 7:** How should high- and low-cost trajectories for future battery costs be developed?

See CESA’s response to Question 5-6. In general, CESA believes that it is reasonable to use low-end energy storage cost numbers from Lazard, supported by benchmarking from other industry resources. If actual cost data can be used as a baseline for the current year, the aggregate average of the actual cost information should be used as the mid-point estimate. If actual aggregated and anonymized cost data cannot be reported publicly in the model, it could inform whether the Commission should use the high-, mid-, or low-end estimates from public industry data sources for use as the mid-point estimate in 2020-2030. Low- and high-cost trajectories for battery costs can be informed by literature reviews as well as learning rate estimates of cost reductions based on the scale of MW deployment.

**Question 8:** How should pumped storage costs be represented given that they are highly site-specific and difficult to estimate on a generic basis?

Given that pumped storage projects are site specific and fewer in number and are thus difficult to estimate on a generic basis, CESA recommends that differentiated categories of pumped storage projects could be used to model their costs. For example, “PHS 1” could represent pumped storage sites on brownfield sites while “PHS 2” could represent pumped storage projects on greenfield sites. Due to the confidentiality of site-specific information, CESA believes that a PHS 1, PHS 2, PHS 3, etc. type of approach is needed, similar to how the 2017-2018 RESOLVE model represented different gas generation units. Categories of specific capabilities, size, and project characteristics may be used to model pumped storage in this way.

CESA also suggests IRP staff have conversations with pumped storage developers to explore cost structures for specific sites. The goal of these conversations would be to have a more accurate and informed IRP outcome. Large pumped storage solutions should be available to the
IRP model for selection. IRP should also recommend how cost-sharing for resources larger than any single LSE’s procurement appetites can be supported, if it is in the interests of ratepayers.

**Question 9:** To what extent are new pumped hydroelectric facilities able to contribute to primary frequency response?

In addition to having significant total inertia, ternary pumped storage facilities have the ability to contribute to primary frequency response (“PFR”) due to the ability of the pumped storage plant to pump and generate at the same time. In other words, ternary pumped storage facilities are capable of acting like a fast-acting system that can transition quickly from pumping to generating in response to frequency deviations. There are a number of studies highlighting the capabilities of ternary pumped storage units, including one from Argonne National Laboratory on how these systems should be modeled in production cost and revenue analyses.\(^\text{16}\)

CESA recommends the RESOLVE model or alternative IRP model also solve for grid needs such as PFR. A constraint such as this may highlight how resources with actual or synthetic inertia and PFR capability are needed in the grid of the future. The provision of PFR from any resource requires headroom, so model inputs should reflect this real-world operational requirement.

**Question 10:** Are there any new resource types (not described in Questions 1-9) that Energy Division should prioritize including as a candidate resource in the 2019 IRP? Describe how the new resource type satisfies the new candidate resource criteria listed above. List the data sources available for quantifying the cost and potential of the proposed resource type and describe how the data sources satisfy the data source criteria listed above.

Yes, CESA believes that there are several new resource types that should be prioritized for inclusion in the 2019-2020 RESOLVE model as candidate resources. Using the criteria set forth by the Commission to justify their inclusion as well as some recommended data sources, CESA has outlined the case for each in the below table.

<table>
<thead>
<tr>
<th>Resource</th>
<th>CAES</th>
<th>Gas + Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria 1:</td>
<td>Resource must have plausible trajectory to commercial availability</td>
<td>Yes, SCE contracted with Wellhead Electric and GE to procure energy storage</td>
</tr>
<tr>
<td></td>
<td>within planning time horizon</td>
<td>integrated with a simple-cycle combustion turbine – i.e., the new Hybrid EGT</td>
</tr>
<tr>
<td></td>
<td>Yes, there are two CAES plants in operation today in Germany(^17) and</td>
<td>technology.(^19)</td>
</tr>
<tr>
<td></td>
<td>one CAES plant in Alabama(^18) that has been in operation for</td>
<td></td>
</tr>
<tr>
<td></td>
<td>decades.</td>
<td></td>
</tr>
<tr>
<td>Criteria 2:</td>
<td>Magnitude of potential impact on future portfolio costs and</td>
<td>Yes, RESOLVE model economically selected approximately 1,200 MW of PHS as</td>
</tr>
<tr>
<td></td>
<td>composition must be sufficient to justify changes to model functiona-</td>
<td>being optimal in the 30 MMT scenario and economically selected significant</td>
</tr>
<tr>
<td></td>
<td>lity and run-time</td>
<td>levels of PHS in 2034 to achieve the 2038 GHG emissions target in the limited</td>
</tr>
<tr>
<td></td>
<td>Yes, RESOLVE model</td>
<td>post-2030 sensitivity for the 42 MMT scenario. D.18-02-018 then added</td>
</tr>
<tr>
<td></td>
<td>economically selected</td>
<td>that PHS benefits can be generalized to other bulk storage types, which</td>
</tr>
<tr>
<td></td>
<td>approximately 1,200 MW of PHS as being optimal in the 30 MMT scenario</td>
<td>includes CAES.</td>
</tr>
<tr>
<td></td>
<td>and economically selected significant levels of PHS in 2034 to</td>
<td></td>
</tr>
<tr>
<td></td>
<td>achieve the 2038 GHG emissions target in the limited post-2030</td>
<td></td>
</tr>
<tr>
<td></td>
<td>sensitivity for the 42 MMT scenario. D.18-02-018 then added</td>
<td></td>
</tr>
<tr>
<td></td>
<td>that PHS benefits can be</td>
<td></td>
</tr>
<tr>
<td></td>
<td>generalized to other bulk storage types, which includes CAES.</td>
<td></td>
</tr>
<tr>
<td>Potential Public Data Sources</td>
<td>Lazard’s LCOS 2.0(^21) and PacifiCorp’s 2017 IRP Study Report(^22)</td>
<td>Informed estimates based on informational interviews and data reported from</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SCE’s procurement with GE and Wellhead</td>
</tr>
</tbody>
</table>

\(^{17}\) See E.ON’s Huntorf CAES Plant: [http://www.solarplan.org/Research/BBC_Huntorf_engl.pdf](http://www.solarplan.org/Research/BBC_Huntorf_engl.pdf)


For each of the above, CESA believes that they are already commercially available and present significant potential to support the state’s renewable and GHG goals at least cost. CESA recommends the Commission explore these candidate resources.

III. CONCLUSION.

CESA appreciates the opportunity to submit these comments to the Ruling and looks forward to working with the Commission going forward in this proceeding.

Respectfully submitted,

Alex J. Morris
Sr. Director, Policy & Regulatory Affairs
CALIFORNIA ENERGY STORAGE ALLIANCE
2150 Allston Way, Suite 210
Berkeley, California 94704
Telephone: (310) 617-3441
Email: amorris@storeagealliance.org

Date: April 23, 2018
ORDER INSTITUTING RULEMAKING TO DEVELOP AN ELECTRICITY INTEGRATED RESOURCE PLANNING FRAMEWORK AND TO COORDINATE AND REFINE LONG-TERM PROCUREMENT PLANNING REQUIREMENTS.

Rulemaking 16-02-007

COMMENTS OF CONSERVATION PARTIES ON THE 2019-2020 IRP
SUPPLY-SIDE RESOURCES

Erica Brand
California Energy Program Director
The Nature Conservancy
201 Mission St #4
San Francisco, California 94105
415-281-0451
ebrand@tnc.org

Representing The Nature Conservancy

Kim Delfino
California Program Director
Defenders of Wildlife
980 9th St, Suite 1730
Sacramento, CA 95814
916-313-5800
kdelfino@defenders.org

Representing Defenders of Wildlife

Nina Robertson
Earthjustice
Email: nrobertson@earthjustice.org
50 California St., Suite 500
San Francisco, CA 94111
(415) 217-2000

Representing Sierra Club

April 23, 2018
COMMENTS OF CONSERVATION PARTIES ON THE 2019-2020 IRP
SUPPLY-SIDE RESOURCES

Defenders of Wildlife, The Nature Conservancy, and Sierra Club ("Conservation Parties") respectfully submit these comments pursuant to the California Public Utilities Commission ("Commission") Energy Division request for stakeholder input dated March 27, 2018, in the Integrated Resource Plan ("IRP") proceeding (R.16-02-007), requesting review and comment on the document called “Draft Sources for 2019-20 Supply-Side Data Sources.”

In the “Draft Sources” document, the Energy Division outlines the proposed data sources to be used in an update of the supply curve. The supply curve is the list of candidate renewable resources that are used as inputs to the RESOLVE model, for the statewide Integrated Resource Plan proceeding. These updates to the supply curve are to be incorporated into the modeling for the 2019-20 IRP planning cycle. With these comments, the Conservation Parties address Question 11 from the Draft Sources document, recommending additional environmental data sources for incorporation into the candidate resource potential.

Overall, we recommend that the Commission seek opportunities and methods to encourage and support renewable energy development in least-conflict zones which have been identified in stakeholder processes. This includes low-impact areas such as brownfields and the built environment.

1 See CPUC Document “Draft Sources for 2019-20 Supply-Side Data Sources”
Question 11: Data Sources on Candidate Resource Potential

In the IRP supply curve, the potential capacity for candidate wind and solar resource is characterized in zones. These zones are called Super Competitive Renewable Energy Zone (Super CREZ) within California, and Western Renewable Energy Zone Qualified Resource Areas (QRAs) outside of California.²

Pursuant to the Commission’s request for stakeholder input, the Conservation Parties recommend updates to the renewable energy resource potential estimates (i.e. zones) that are used in the RESOLVE model. The candidate renewable resource potential for each zone (i.e. estimated MW per zone) should be updated to incorporate the latest ecological information. The Commission has periodically updated the ecological information in the supply curve in the past, every one or two years, since the creation of the original zones in 2008-2012.³

We recommend that the update for 2019-20 planning cycle should incorporate newly-available environmental information, which has not yet been incorporated into the planning process. The list below includes a description of each information source, and a recommendation for how the Commission should incorporate each source into the modeling:

- Bureau of Land Management Solar Energy Program (SEP)
  - Description: “As part of the Solar Energy Program, the BLM has categorized lands that are excluded from utility-scale solar energy development (about and has identified specific locations that are well suited for utility-scale production of solar energy (solar energy zones, or SEZs) where the BLM proposes to prioritize development. The program emphasizes and incentivizes development within SEZs and outlines a collaborative process for identifying additional SEZs.”⁴
  - Recommendation: update renewable resource polygon boundaries (QRA boundaries) to capture SEP solar energy zones and exclusions per state, in AZ, NV, CO, NM, UT (note DRECP Development Focus Areas supersede in CA)

- BLM West-Wide Wind Mapping Project
  - Description: “Regional and state wind energy development exclusions and resource sensitivities maps and associated geospatial data developed as part of the West-Wide Wind Mapping Project are

² For background historic information on how these zones were developed, see the series of documents summarized in the appendix to this document.
³ See appendix to this document for overview and timeline.
⁴ [http://blmsolar.anl.gov/program/](http://blmsolar.anl.gov/program/)
available... These maps depict areas on BLM-administered lands excluded from wind energy development, as well as areas with potentially developable wind energy resources where proposed wind energy projects would be expected to have a high level of siting considerations, a moderate level of siting considerations, or where there are no known environmental resources or land use restrictions that are likely to require more extensive consideration in siting reviews.”

○ Recommendation: Update or modify QRA boundaries to capture exclusions and wind energy zones per state
  ▪ See geodatabase called Consol_BLM_wind_dev_sens
  ▪ The following shape files are relevant:
    • Combined_exclusions_public.shp
    • Combined_high_level_siting_considerations_public.shp
    • Combined_moderate_level_siting_considerations_public.shp
    • The summary table in the WWMP report describes what is included in each of these consolidated layers

• U.S. Department of Energy Section 368 West-wide Energy Corridors
  ○ Description: “Section 368 of EPAct directed the Secretaries of Agriculture, Commerce, Defense, Energy, and the Interior to designate corridors for oil, gas, and hydrogen pipelines and electricity transmission and distribution facilities on federal lands in the 11 contiguous western states. Congress also directed the Agencies to perform any environmental reviews that may be required to complete the designation of the corridors and incorporate the corridors into land use plans.”

  ○ Recommendation: In particular note the Corridors of Concern identified in the 2012 Settlement Agreement. We recommend applying a risk factor to proposed transmission routes that fall into these Corridors of Concern.

• California desert area information
  ○ Description of information source: “The Desert Renewable Energy Conservation Plan (DRECP) is a landscape-level plan that streamlines renewable energy development while conserving unique and valuable

---

5 http://wwmp.anl.gov/
6 http://wwmp.anl.gov/downloads/WWMP_Exclusions_Sensitivities_Table.pdf
7 http://corridoreis.anl.gov/
8 http://corridoreis.anl.gov/documents/docs/Settlement_Agreement_Package.pdf#page=29
desert ecosystems and providing outdoor recreation opportunities. It was a collaborative effort between the California Energy Commission, California Department of Fish and Wildlife, the U.S. Bureau of Land Management, and the U.S. Fish and Wildlife Service, also known as the Renewable Energy Action Team.”

- **Recommendation:** No update needed. The DRECP has already been incorporated into supply curve updates as of 2016.
- **Recommendation for lands within the DRECP boundary, but not under the jurisdiction of the BLM LUPA (mostly private, City, or County lands):** incorporate most recent County-level planning information.
- **Recommendation that extends beyond DRECP boundary:** incorporate latest NatureServe Desert Tortoise Species Distribution Model.

- **San Joaquin Valley (SJV) information**
  - **Description:** “The main objective of the [2015] Solar and the SJV [stakeholder] process was to identify least-conflict areas in the Valley for solar PV development. The solar industry, agricultural farmland conservation, and environmental conservation stakeholder groups generated spatially explicit data to answer this single question.”
  - **Recommendation:** Update solar resource potential to include information from San Joaquin Valley Solar Convening.

- **Environmental Information for Energy Planning from California Energy Commission**
  - The CEC has made a significant investment into developing environmental information for energy planning. This information should be made available for use in the IRP proceeding. The following tools are especially well-suited to help inform renewable energy portfolio selection.
    - **CEC Energy Gateway**
      - **Description:** “The California Energy Gateway is an online, interactive platform that can support state and local planning by offering increased transparency and enabling users to”

---

9 https://www.drecp.org/
10 https://databasin.org/datasets/4b146a46c4d84a959ba4d2a58ba736ff
11 https://databasin.org/datasets/b64959db3e694254818d97e5e2e6f42
12 See August 2 2017 workshop: IEPR Staff Workshop on Environmental Information for Energy Planning http://www.energy.ca.gov/2017_energypolicy/documents/#08022017
collaborate through assembling, displaying, integrating, analyzing, and sharing data.”\textsuperscript{14}

- Environmental Report Writer\textsuperscript{15}
  - Description: This is an “interactive environmental report writer tool that could be used in future energy planning to identify and evaluate locations to site renewable energy generation and transmission, as well the environmental context of that location.”\textsuperscript{16}
    - Recommendation: continue working with CEC staff to identify methods to incorporate these tools into the IRP process.

- Brownfields and other low-impact areas
  - EPA Brownfields study
    - Description: “Through its RE-Powering America’s Land Initiative, the U.S. Environmental Protection Agency (EPA) encourages renewable energy development on current and formerly contaminated lands, landfills, and mine sites when aligned with the community’s vision for the site... EPA’s RE-Powering Mapper, an online interactive web application, allows users to visualize EPA’s information about renewable energy potential on contaminated lands, landfills and mine sites.”\textsuperscript{17}
    - Recommendation: prioritize candidate renewable resources on sites which have been identified for encouragement by the EPA, in a policy-preferred portfolio.

- CEC Offshore Wind Energy Gateway\textsuperscript{18}
  - Description: “The Offshore Renewable Wind Energy Gateway assembles geospatial information on ocean wind resources, ecological and natural resources, ocean commercial and recreational uses and community values. This information will help identify areas off of California that are potentially suitable for wind energy generation.”
  - Recommendation: Update the offshore wind resource potential to incorporate ecological and natural resource information. In particular

\textsuperscript{15} http://docketpublic.energy.ca.gov/PublicDocuments/17-MISC-03/TN220483_20170801T111642_Presentation_by_Scott_Flint_8217.pdf
\textsuperscript{17} https://www.epa.gov/re-powering/re-powering-mapper
\textsuperscript{18} https://caoffshorewind.databasin.org/
Each of the information sources in the above list is publicly available, technically credible, and geographically specific at the level of transmission zones used in RESOLVE. In addition, the magnitude of potential impact on future portfolio costs and composition is sufficient to justify changes to model functionality and run-time.

Independent studies have shown that “many undeveloped landscapes with high renewable resource potential also have high conservation value, creating the potential for conflict between renewable energy development and conservation goals. These potential conflicts matter. If renewable energy projects proceed in environmentally sensitive areas, they can unnecessarily degrade the habitat, biodiversity and other values of natural landscapes. Conversely, environmental concerns can seriously impede renewable energy development by subjecting projects to multi-year delays, major cost increases and in some cases abandonment.”

Applying the recommended updates will help develop a better “understanding of the environmental impacts and economic costs of potential renewable energy siting decisions to achieve ambitious renewable energy targets.” This understanding is needed to minimize potential conflicts between conservation and development, and to better quantify potential cost impacts of doing so. The 2015 ORB study estimated potential cost impacts of the environmentally preferred portfolio as minimal (within 1 or 2 percent of the base case). Continual incorporation of the latest available information is necessary to investigate and confirm these initial results.

Methods

For the spatial data sources recommended above, the recommended method to incorporate this information is simple. The steps are as follows.

1. Start with the spatial data currently underlying the supply curve in the RESOLVE model.

---

19 https://caoffshorewind.databasin.org/
21 Spatial data for the supply curve which is used as an input to the RESOLVE model is available online here: http://www.cpuc.ca.gov/General.aspx?id=6442453965
The specific links are as follows: Renewable Resources Cost and Potential Update:
2. Modify the polygons in this existing spatial data, to reflect additional exclusions and sensitivities represented in the data sources listed above. The geoprocessing term is called "clipping" the polygon. This modifies the amount of available resource per zone (MW) in proportion to the number of acres removed or added.

We describe above an easy way to update the estimates of available candidate renewable energy resource potential per zone. This will help produce more appropriate, informed, and relevant portfolios of future resources for transmission planning. In addition to updating the candidate resource list, we also recommend that the IRP proceeding seek further methods to encourage and support renewable energy development in least-conflict zones which have been identified in stakeholder processes, including other low-impact areas such as brownfields and the built environment.

Development of policy-preferred low-environmental risk portfolios can be done in multiple ways. The IRP team should investigate methods to favor or prioritize these least-conflict zones and other low-impact areas in the RESOLVE model portfolio selection process, in order to produce policy-preferred portfolios for consideration in directed procurement or transmission investment.

In the IRP proceeding, the Commission should consider whether to incorporate a land use or conservation metric for evaluating selected portfolios in the 2018-19 planning cycle. This has been done before, in the RPS proceeding. For an example approach, we recommend the Commission consult the methodologies presented in August 2015 Land Use Ruling and Staff Paper. In particular, Tracks 2a and 2b provide helpful illustrations. The following excerpt describes Tracks 2a and 2b:

Track 2a was intended to develop portfolios for use in the 2016 LTPP and policy-preferred portfolios for the 2016-2017 CAISO TPP. Track 2b was intended to consider in greater detail several additional issues.

Ruling http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/Mi154/K287/154287797.PDF
Energy Division Staff Paper: Incorporating Land Use and Environmental Information into the RPS Calculator and Developing and Selecting RPS Calculator Portfolios http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=5684
including how best to incorporate environmental information into the RPS Calculator... There are two primary issues to be resolved in Track 2b: 1) how best to represent land use information in the RPS Calculator and whether; and 2) how to align generation and transmission planning with renewable procurement... Issue 2 of Track 2b, the alignment of planning and procurement, is not addressed here and will be visited at a later date.

The 2019-2020 IRP planning cycle is an ideal time to revisit this thinking. The 2017-18 planning cycle was necessarily kept simple, because it was the first instance of a new planning cycle, and it was necessary to design basic structures and a replicable path forward for implementing statewide IRP in California. Now that several decisions have been made and the planning cycle structure has been established, it is appropriate to re-introduce some of the nuance that had been lost when the RESOLVE model replaced the RPS Calculator functionality, designing plausible portfolios of renewable resources needed to meet the state’s renewable energy and climate goals in future years for the purpose of generation and transmission planning.

The completion of these updates will enable the informed decision-making needed for California to meet its renewable energy and climate goals while balancing the protection of our natural and cultural resources.

We look forward to further collaboration with the Commission on this important topic. We are available to support the process of updating the supply side inputs and assumptions as needed, between now and the beginning of the IRP planning cycle in early 2019. We expect more detailed ecological information to become available over the coming months, and we will keep Commission Staff apprised of updates as information arises.
Conclusion

The Conservation Parties appreciate this opportunity to submit comments on supply-side resources for the 2019-2020 IRP. We applaud your leadership in this process, and we look forward to our continued work with you on this important effort.

Respectfully submitted,

/s/ Kim Delfino
Kim Delfino
California Program Director
Defenders of Wildlife
980 9th St, Suite 1730
Sacramento, CA 95814
916-313-5800
kdelfino@defenders.org
Representing Defenders of Wildlife

/s/ Erica Brand
Erica Brand
California Energy Program Director
The Nature Conservancy
201 Mission St #4
San Francisco, California 94105
415-281-0451
ebrand@tnc.org
Representing The Nature Conservancy

/s/ Nina Robertson
Nina Robertson
Earthjustice
Email: nrobertson@earthjustice.org
50 California St., Suite 500
San Francisco, CA 94111
(415) 217-2000
Representing Sierra Club

April 23, 2018
Appendix

This Appendix provides background and historic overview of the development of renewable energy “zones” currently being used in the RESOLVE model.

2008-2010: Renewable Energy Transmission Initiative (RETI)
In the Renewable Energy Transmission Initiative (RETI), lands were identified through a rigorous stakeholder process, and protected lands were organized into Category 1 (development prohibited) and Category 2 (development limited) (see the Final RETI Phase 1B report, beginning on page 333 at:

See also 2009 RETI report

It was through the elimination of protected and sensitive lands, as well as through the application of additional spatial and technical criteria, that the Competitive Renewable Energy Zones (CREZs) and Super CREZs (larger than the original CREZs) were identified.

Spatial (GIS) information for the RETI initiative is available online here:
http://www.energy.ca.gov/reti/documents/index.html
See GIS data for phase 2B, posted April 8, 2010

2010-2012: Western Renewable Energy Zones Initiative
Out of state candidate renewable resources were characterized through a similar screening process, under the WREZ initiative, facilitated by the Western Governors’ Association. Protected and sensitive lands were identified through a similar method as was used in RETI. Category 1 and 2 lands were identified and screened out. The remaining renewable resource zones were called Qualified Resource Areas (QRAs).
https://westernenergyboard.org/crepc-spsc/wrez-3/

2010 - 2016: Renewable Portfolio Standard Calculator
The list of candidate resources identified in the RETI and WREZ studies took the form of a supply curve. A supply curve is a list of resources, with unique identifiers tying the each resource to a spatial polygon, along with resource characteristics of that polygon (cost, estimated annual energy production, transmission cost, etc).
The RPS calculator was developed to use the supply curves from RETI (in California) and WREZ (out of state resources) as inputs. The supply curve is the list of candidate renewable resources from which the model selects the portfolio to meet future RPS targets. The selected portfolio (the output from the model) was submitted by the CPUC to the CAISO for use in the Transmission Planning Process.

The supply curve for the RPS calculator has been periodically updated over time, to incorporate new cost and environmental information as it became available. Documentation for these updates is provided below.

RPS Calculator v 6.0
http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=9366
RPS_CalcV60_ResourcePotentialandCost.pptx

RPS Calculator Version 6.2 release notes
http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=10346

CPUC Land Use Ruling and Staff Paper
http://www.cpuc.ca.gov/RPS_Calculator/
8/28/15
• Ruling
• Energy Division Staff Paper: Incorporating Land Use and Environmental Information into the RPS Calculator and Developing and Selecting RPS Calculator Portfolios

RPS Calculator v 6.3
Cost and Resource Potential Update
http://www.cpuc.ca.gov/General.aspx?id=6442453965

2016: RESOLVE Model for Integrated Resource Plan
The RESOLVE model has replaced the function of the RPS calculator in renewable energy planning at the CPUC. It continues to use the same input supply curve as its predecessors. This supply curve continues to need periodic updates to incorporate new information.
http://www.cpuc.ca.gov/irp/prelimresults2017/

Spatial data for the supply curve which is used as an input to the RESOLVE model is available online here:
http://www.cpuc.ca.gov/General.aspx?id=6442453965
The specific links are:
Renewable Resources Cost and Potential Update
Renewable Resources GIS Data
ftp://ftp.cpuc.ca.gov/resources/electric/zip/
April 17, 2018

To: Patrick Young

From: Noman Williams

Subject: 2019 - 2020 IRP Assumptions Input; Southern Nevada Solar Tracking Capacity Factor Update

GridLiance West appreciates the opportunity to provide comments on the CPUC’s 2019 - 2020 IRP Assumptions. GridLiance West offers input at this time on one set of assumptions—that pertaining to the solar capacity factors in Southern Nevada captured in the RESOLVE modeling tool input files.

GridLiance West and its partner Valley Electric Association have participated actively in vetting the RESOLVE assumptions in the prior IRP cycle, primarily through our consultant representatives at Resero Consulting. We appreciate the efforts of the staff in the 2017 – 2018 IRP cycle to resolve significant aspects of the RESOLVE representation of the Southern Nevada CREZ areas.

At this time, GridLiance West requests only that the staff consider updating its assumption regarding the capacity factor of Southern Nevada solar resources. Currently the RESOLVE inputs show Tehachapi utility scale tracking solar facilities at approximately 35% and Southern Nevada-area resources at approximately 32%. Among the RESOLVE and RPS Calculator assumptions documentation, there is extensive documentation of the source(s) of the in-state (California) capacity factor values. For example, the 2017 RESOLVE Documentation: CPUC 2017 IRP Input and Assumption (DRAFT) dated July 2017, includes Table 21, California renewable resource cost & performance data, and it sources the data to Black and Veatch for the RPS Calculator v.6.3 as supplemented by additional analysis conducted by E3 on the cost and performance of new generation resources for the WECC (p. 34). The out-of-state capacity factors in the same July 2017 assumption document were included in Table 22. In this table, the Southern Nevada solar capacity factor is shown as 32%. For this table, however, there is no indication of the source of data. Release notes for RPS Calculator v6.1 and v6.2 do not indicate the source of the out-of-state solar capacity factor data. Similarly, while the RPS Calculator v6.3 Data Updates¹ provided updates to a lot of renewable cost and performance variables, no data or sources were noted regarding out-of-state solar capacity factors. In short, the source of data for the Southern Nevada region is unclear.

GridLiance West believes that the capacity factor for the Southern Nevada CREZ region should be the same as that used for the Tehachapi region. The National Renewable Energy Laboratory (NREL) shows comparable normal irradiance data for both the Tehachapi area of California and for Southern Nevada as shown below.²

---

¹http://www.cpuc.ca.gov/uploadedfiles/cpuc_website/content/utilities_and_industries/energy/energy_programs/electric_power_procurement_and_generation/ltp/rpscalc_costpotentialupdate_2016.pdf
²https://www.nrel.gov/gis/solar.html
Gridliance West is not aware of any solar data source that shows differences in solar intensity or solar facility capacity factors between these two geographic regions.

The relative differences in net cost for renewable alternatives can be small. Ensuring the data does not artificially create a distinction in net cost per MWh of production will ensure the most economical selection of resources by Load Serving Entities. Gridliance West respectfully requests that the CPUC update the Southern and Western Nevada solar capacities to be equivalent to those of the Tehachapi area, currently set to 35.25%.

Thank you for your consideration.

Sincerely,

Noman L. Williams
Chief Operating Officer
(972) 476-0110
(785) 259-5110 (M)
BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking to
Develop an Electricity Integrated
Resource Planning Framework and to
Coordinate and Refine Long-Term
Procurement Planning Requirements.

Rulemaking 16-02-007
(Filed February 11, 2016)

THE OFFICE OF RATEPAYER ADVOCATES’ INFORMAL COMMENTS ON
DRAFT SOURCES FOR 2019-20 IRP SUPPLY-SIDE RESOURCES

XIAN MING (CINDY) LI
CHRISTIAN KNIERIM
Staffs for
Office of Ratepayer Advocates
California Public Utilities Commission
505 Van Ness Avenue
San Francisco, CA 94102
Telephone: (415) 703-1546
E-mail: Xian.Li@cpuc.ca.gov

April 23, 2018
SUBJECT INDEX

I. INTRODUCTION ..................................................................................................................... 1

II. DISCUSSION .......................................................................................................................... 1

1. SOLAR PHOTOVOLTAIC QUESTION 2: CURRENT ASSUMPTIONS OF TECHNOLOGY MIX FOR SOLAR PV ARE 25% FIXED TILT AND 75% SINGLE AXIS TRACKING, BOTH WITH INVERTER LOADING RATIO OF 1.3. WHAT ASSUMPTIONS SHOULD BE MADE FOR THE CONFIGURATION AND INVERTER LOADING RATIO (ILR) OF FUTURE SOLAR PV FACILITIES? ....................................................................................................................... 1

2. RESOURCE POTENTIAL: ARE THERE ANY NEW RESOURCE TYPES (NOT DESCRIBED IN YOUR RESPONSES TO QUESTIONS 1 – 9) THAT ENERGY DIVISION SHOULD PRIORITIZE INCLUDING AS A CANDIDATE RESOURCE IN THE 2019 IRP? DESCRIBE HOW THE NEW RESOURCE TYPE SATISFIES THE NEW CANDIDATE RESOURCE CRITERIA LISTED ABOVE. LIST THE DATA SOURCES AVAILABLE FOR QUANTIFYING THE COST AND POTENTIAL OF THE PROPOSED RESOURCE TYPE AND DESCRIBE HOW THE DATA SOURCES SATISFY THE DATA SOURCE CRITERIA LISTED ABOVE. ......................................................................................................................... 1

3. RESOURCE COSTS QUESTION 13: HOW SHOULD IMPORT TARIFFS ON SOLAR PV MODULES BE REPRESENTED? ................................................................................................................................. 2

III. CONCLUSION .......................................................................................................................... 2
I. INTRODUCTION


II. DISCUSSION

A. Solar Photovoltaic Question 2: Current assumptions of technology mix for solar PV are 25% fixed tilt and 75% single axis tracking, both with inverter loading ratio of 1.3. What assumptions should be made for the configuration and Inverter Loading Ratio (ILR) of future solar PV facilities?

Assumptions for the mounting-type and inverter load ratio of solar PV should continue to be based on the latest solar project development trends. For example, since 2015, what type of solar projects have the investor-owned utilities (IOUs) contracted with, fixed tilt and/or tracking? What is the ratio between fixed tilt and tracking? What are the latest trends in inverter load ratios?

B. Resource Potential Question 10: Are there any new resource types (not described in your responses to Questions 1 – 9) that Energy Division should prioritize including as a candidate resource in the 2019 IRP? Describe how the new resource type satisfies the new candidate resource criteria listed above. List the data sources available for quantifying the cost and potential of the proposed resource type and describe how the data sources satisfy the data source criteria listed above.

The Draft Sources for 2019-20 IRP Supply-Side Resources document\(^1\) includes solar thermal as an “existing & planned resource” (along with biomass, geothermal, small hydro, solar PV, and wind). However, the document does not include solar thermal as a “candidate resource” that could be “potentially used to meet policy constraints and system needs, as well as resources identified as economic investments.”\(^2\) The candidate renewables are listed as biomass and biogas, geothermal, small hydro, solar PV, and

\(^1\) Draft Sources for 2019-20 IRP Supply-Side Resources, p. 3.
\(^2\) Draft Sources for 2019-20 IRP Supply-Side Resources, p. 5.
wind. Is there an explanation for the omission of solar thermal as a “candidate resource?”

C. Resource Costs Question 13: How should import tariffs on solar PV modules be represented?

As the modeling staff develops a methodology to account for solar PV module import tariffs and their effects on future solar PV project development costs in California, the staff should consider the following questions:

- Approximately how many future solar projects in California, for the years that the solar PV module import tariffs are in place, would continue to use imported materials as components for their projects? For example, Bloomberg reports that more than 80% of solar installations in the U.S. use imported materials. Would a similar trend continue in California while the tariffs are in place? Since 2015, what percentage of California solar projects have used imported components, and how would the tariffs impact this trend?

- The solar PV module import tariffs last four years. How do typical solar PV project development timelines affect the likelihood that a project in development would face, or avoid, these import tariffs? For example, if a solar project started development in year 2 of the import tariffs, could the project delay its procurement of PV modules until after the tariffs expire so that the tariffs do not increase ratepayer costs for that project?

III. CONCLUSION

ORA looks forward to further discussion about inputs and assumptions for the 2019-20 IRP.

---

3 Draft Sources for 2019-20 IRP Supply-Side Resources, pp. 6-8.

April 23, 2018

Mr. Paul Douglas
Supervisor, Energy Division
California Public Utilities Commission
505 Van Ness Avenue
San Francisco, CA  94102

Re: Informal Comments on Draft Sources for 2019-2020 Integrated Resource Plan
Supply Side Resources Presented on March 27, 2018 (Rulemaking 16-02-007)

Dear Mr. Douglas:

In accordance with the direction provided by Energy Division of the California Public Utilities Commission (Commission or CPUC) on March 27, 2018, Pacific Gas and Electric Company (PG&E) respectfully submits these informal comments concerning the categories and sources of assumptions discussed during the March 1, 2018 Modeling Advisory Group (MAG), which Energy Division staff proposes to use in Integrated Resource Planning (IRP) capacity expansion modeling activities in 2019. PG&E’s informal comments address three broad categories (data sources, resource potential, and resource costs) in the identical structure as the request presented by Staff in its document titled “Draft Sources for 2019-20 IRP Supply-Side Resources”, which was served to parties in the R.16-02-007 CPUC docket.¹

The following summarizes PG&E’s comments:

A. PG&E provides specific recommendations for the CPUC for developing costs of

   (1) retrofitting a power plant, which should be based on inputs from manufacturers for retrofitting an existing combined cycled (CC) or combustion turbine (CT), or converting an existing CC or CT;

   (2) future solar photovoltaic (PV) projects, for high- and low-cost trajectories, that are based on a range of fundamental inputs that drive uncertainty around the levelized cost of energy (LCOE) for such projects; and,

   (3) installed battery costs, financing costs, and operations and maintenance (O&M) costs should be consistent with the California Energy Commission’s (CEC) cost of generation reports;

¹ Included on page 10 of the “Draft Sources for 2019-20 IRP Supply-Side Resources” document is a request for comments on Demand Response (DR) related data sources, even though this candidate resource type was inadvertently omitted from “Questions for Stakeholders” section on pages 12-13. PG&E provides a response as an addendum to the Data Sources section.
B. PG&E recommends the California Demand Response Potential Study should not serve as a formal forecast of the future of advance DR models (i.e., shift, shimmy, shape); and,

C. PG&E recommends how import tariffs on solar PV modules should be represented.

I. Data Sources

1. Do parties have recommendations on public data sources that capture the costs and operational characteristics of retrofitted power plants?

   Response: PG&E recommends CPUC develops costs of retrofitting a power plant based on inputs from manufacturers and power plant operators for retrofitting:
   
   • An existing CC or CT
   • Converting an existing CC to a CT

   Several factors impact the type and cost of retrofit for a power plant including its age and operational characteristics (e.g. number of starts). While retrofit cost is unique for a power plant, a reasonable assumption can be developed using typical cost for extending the life of a power plant and operational characteristics.

2. Current assumptions of technology mix for solar PV are 25% fixed tilt and 75% single axis tracking, both with inverter loading ratio of 1.3. What assumptions should be made for the configuration and Inverter Loading Ratio (ILR) of future solar PV facilities?

   Response: PG&E believes these values are roughly appropriate. Regarding the technology mix, PG&E notes that recent trends and projections have shifted more weight to single-axis trackers as part of the technology mix in recent years and may continue to do so. As a higher bound, up to 90 percent of new ground-mount installations could be single-axis trackers by the 2021 timeframe.

3. How should high- and low-cost trajectories for future PV costs be developed?

   Response: PG&E recommends developing high/low cost trajectories based on a range of fundamental inputs that drive uncertainty around the levelized cost of energy (LCOE) for solar PV projects. These include, but are not limited to: the extension and availability of tax credits, import tariffs, panel costs, balance of system cost, financing structures, etc. Benchmarking and supplementing these forecasts with public and/or private cost forecasts could also be beneficial.

4. Do parties have recommendations on how to distinguish between specific battery technologies in an emerging market?

   Response: PG&E does not have any comments at this time.
5. What sources should be considered in developing recommended battery costs for use in IRP?

Response: PG&E recommends the CPUC develop installed battery costs, financing costs, and O&M costs using a methodology consistent with that deployed by the CEC’s cost of generation reports for other technologies.

Specifically, the installed cost of battery system cost can be obtained as the sum of battery pack costs and Balance of System costs for specified sizes. Battery pack costs can be developed by applying a specific learning rate and a forecasted demand for battery packs. The forecast demand for battery packs should recognize the forecasted demand for electric vehicles, as well as stationary batteries. For historical battery pack costs, PG&E recommends referencing the surveys done by BNEF and surveyed costs from battery pack vendors for specific sizes. PG&E also recommends the CPUC consider price differences between battery packs for stationary battery and electric vehicles due to order volume differences and economies of scale.

PG&E recommends the CPUC break down Balance of System costs into four cost components: inverters (power control systems); balance of plants; installation (shipping and assembly), and Engineering, Procurement and Construction (EPC); and development costs (developer overheads, developer margin, interconnection and permitting). PG&E recommends breaking down the components of battery system and individually developing the cost of each component to be based on its underlying cost driver (whether size-independent, kW-dependent, or kWh dependent).

The source of such costs for individual component can be obtained from survey and industry report, such as BNEF and GTM Research. However, most sources lack thorough forecasts of battery system cost estimates up to the IRP horizon. Therefore, the CPUC needs to develop cost trajectory for individual component based on historical and projected cost estimate of individual component, and assuming certain observed (or assumed) learning rates, and/or inflation, and make it vary by kW or kWh of the assumed size of battery systems.

6. How should Multiple Use Applications of battery storage be modeled?

Response: PG&E recommends the CPUC first determine an assumed description of common types of Multi Use Applications (MUA) of battery storage. For example, the CPUC could assume that a certain MW or percentage of battery storage will be for dual-use between distribution/transmission grid reliability and market services in which capacity during summer months is reserved for grid reliability and capacity during non-summer months can be used for market. Once such use cases for MUA of battery storage are specified, how to model such MUA battery systems follow.

7. How should high- and low-cost trajectories for future battery costs be developed?

Response: PG&E recommends the CPUC develop low- and high-cost trajectories for future battery system costs by combining low- and high-cost trajectories for each component (battery pack, inverters, balance of plants, development, and installation) of battery system costs. PG&E recommends the CPUC use different learning rates and
Informal Comments on 2019 IRP Supply Side Sources  
April 23, 2018  
Page 4

different battery pack volume growth trajectory in order to develop the low- and high-cost trajectories for battery pack costs. Since a significant cost decline for battery pack cost is anticipated (mainly driven from uncertain amounts of large growth in electric vehicles (EV)), it is necessary to assume different EV growth trajectories in order to develop high, mid and low trajectories for battery pack demand.

The low and high case for each component of balance of system can also be developed based on the range of the values observed and projected by different sources.

8. How should pumped storage costs be represented given that they are highly site-specific and difficult to estimate on a generic basis?

Response: PG&E does not have any comments at this time.

9. To what extent are new pumped hydroelectric facilities able to contribute to primary frequency response?

Response: PG&E does not have any comments at this time.

9A. Are there other data sources that should be considered for additional DR cost and potential, beyond the latest version of the California Demand Response Potential Study?

Response: PG&E observes that the 2025 California Demand Response (DR) Potential Study dated March 1, 2017, may not be ripe for use as an input to the IRP. Consistent with PG&E’s comments filed in this proceeding on the 2017 Reference System Plan, we believe the DR Potential Study should not serve as a formal forecast of the future of advance DR models (i.e., shift, shimmy, shape) because core assumptions underlying the model include market and regulatory policy changes that have not been fully analyzed or realized, much less implemented and operationalized.

On the other hand, as it relates to conventional DR (i.e., shed), PG&E’s latest Load Impact showing, filed on April 2, 2018, provides a reasonable projection of DR load reduction (impact) associated with DR programs administered at this time (these include Critical Peak Pricing (CBP), Base Interruptible Program (BIP), SmartAC). The load impacts associated with PG&E’s DR (and CBP) programs are provided through a rolling 10-year projection (2018-2028). PG&E cautions that these projections effectively assume status quo in the 10-year forecast cycle.

There are several uncertainties that could materially impact these projections. First, PG&E, along with SCE and SDG&E, currently have a DR program funding cycle that is

---


Informal Comments on 2019 IRP Supply Side Sources
April 23, 2018
Page 5

five-years (2018-2022), with an expected mid-cycle review occurring in 2020. Program
offerings could be modified in 2020 with even greater changes possible beyond 2022.
Second, the potential conversion of the DR Auction Mechanism (DRAM) from a pilot to
a permanent program could impact the overall level of DR offered by third-parties, which
may directly or indirectly affect IOU programs. Third, significant load migration to
Community Choice Aggregators (CCA) combined with Competitive Neutrality Cost
Causation rules, will most likely impact the level of DR capable of being offered by
LSEs.

II. Resource Potential

10. Are there any new resource types (not described in your responses to Questions 1 – 9) that
Energy Division should prioritize including as a candidate resource in the 2019 IRP?
Describe how the new resource type satisfies the new candidate resource criteria listed above.
List the data sources available for quantifying the cost and potential of the proposed resource
type and describe how the data sources satisfy the data source criteria listed above.

   Response: PG&E does not have any comments at this time.

11. Are there data sources (not described in your responses to Questions 1 – 9) that should be
considered for modifying the candidate resource potential assumed in IRP? Please describe
and provide a link for any suggested data sources. Explain how the data source meets the
data source criteria listed above.

   Response: PG&E does not have any comments at this time.

III. Resource Costs

12. Are there any additional sources of capital cost, operating cost, and performance projections
(not described in your responses to Questions 1 – 9) that should be considered for solar PV or
wind? Please describe and provide a link for any suggested sources. Explain how the data
source meets the data source criteria listed above.

   Response: PG&E does not have any comments at this time.

13. How should import tariffs on solar PV modules be represented?

   Response: Imported solar modules represent the vast majority of solar PV installations.
   Therefore, it is critical to update RESOLVE’s modeled prices. Import tariffs on solar PV
   modules can be represented in cost assumptions for solar PV between February 2018 and
   February 2022. The 30 percent import tariff, which begins in 2018 and phases down
   
---

5 D. 16-09-056 called for a Resolution to be issued by June 1, 2018 regarding the future of DRAM.
6 D. 17-10-017 set forth a path for the development of a mechanism for IOUs to unwind their DR program
offerings to CCA and ESP customers when a Direct Access provider establishes a “similar” DR program.
7 First 2.5 gigawatts of imported modules are excluded from the tariff.
five percent annually over the four-year period, will increase the cost of modules and therefore the cost of solar PV development overall.

To best reflect this cost increase, a dollar ($) per watt (W) adder can be incorporated into solar PV cost assumptions. For example, if the average price of an imported PV module is $0.33/W, in 2018 this adder would apply approximately $0.10/W to total module costs, stepping down to approximately $0.04/W in the final tariff year.\footnote{8}{https://www.greentechmedia.com/articles/read/breaking-trump-admin-issues-a-30-solar-tariff} \footnote{9}{https://news.energysage.com/2018-us-solar-tariff-impact-prices/}

<table>
<thead>
<tr>
<th>Tariff Level (Cost)</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Premium</td>
<td>$0.10/W</td>
<td>$0.08/W</td>
<td>$0.06/W</td>
<td>$0.04/W</td>
</tr>
</tbody>
</table>

14. Should any of the cost and financing assumptions in RESOLVE’s LCOE calculations be modified, for example assumptions related to state and federal tax incentives, the cost of capital, and financing lifetime? Explain and support any recommended changes using publicly available information, to the greatest extent possible.

Response: PG&E does not have any comments at this time.

IV. Conclusion

PG&E appreciates Energy Division Staff’s leadership to ensure that IRP modeling produces high quality analysis for the next IRP cycle, and thanks Staff for its efforts to ensure a transparent stakeholder process. We look forward to learning about Staff’s findings resulting from these informal comments during future MAG sessions, and how party input on the supply-side resources will ultimately be used in IRP modeling.

cc: Service List R.16-02-007
Patrick Young, CPUC
Karolina Maslanka, CPUC
BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking to Develop an Electricity Integrated Resource Planning Framework and to Coordinate and Refine Long-Term Procurement Planning Requirements. Rulemaking R.16-02-007

INFORMAL COMMENTS OF PACIFIC OCEAN ENERGY TRUST ON THE DRAFT SOURCES FOR 2019-20 IRP SUPPLY-SIDE RESOURCES

April 23, 2018

Jason Busch, Executive Director
Pacific Ocean Energy Trust
240 N. Broadway, Suite 102
Portland, Oregon 97227
ph: (503) 729-2253
JBusch@PacificOceanEnergy.org
INFORMAL COMMENTS OF PACIFIC OCEAN ENERGY TRUST
ON THE DRAFT SOURCES FOR 2019-20 IRP SUPPLY-SIDE RESOURCES

Pursuant to the March 27, 2018, email from Patrick Young, with attached documents, in Proceeding R-16-02-007, the Order Instituting Rulemaking to Develop an Electricity Integrated Resource Planning Framework and to Coordinate and Refine Long-Term Procurement Planning Requirements, the Pacific Ocean Energy Trust (POET), a representative of California’s floating offshore wind (OSW) sector, provides the following informal comments on the Draft Sources for 2019-20 IRP Supply-Side Resources. POET’s Comments are focused on the treatment of offshore wind energy in the IRP modeling process, including in the model’s database.

POET appreciates the opportunity to submit these informal comments in this proceeding in response to the March 27, 2018 letter from Patrick Young, and it is our position that the IRP process in California should include floating OSW, a new but promising source of clean energy for California. However, we must also emphasize that existing data regarding the current and projected cost of floating OSW is incomplete, and it is not possible to provide accurate and up-to-date data on the sector at this time. Nevertheless, the sector is committed to developing the data, and we agree the time is now to begin adding OSW data to the RESOLVE model database.

We address below question 10 in the Draft Sources document.

10. Are there any new resource types (not described in your responses to Questions 1 – 9) that Energy Division should prioritize including as a candidate resource in the 2019 IRP?

POET supports the preliminary investigation of floating OSW as a new supply-side resource. Due to the age of publicly-available cost data, however, formal consideration of floating OSW as a candidate resource should be deferred until the 2021-2022 IRP.

With 112 gigawatts of technical resource capacity in California from safe, reliable, clean, and locally available renewable generation, the opportunity for floating OSW in California is significant. Worldwide, the offshore wind sector has matured, the supply chain is competitive, and costs continue to fall. The installed capacity of offshore wind in Europe exceeds 15 gigawatts, and the strike prices
for the most recent projects did not include subsidies; in other words, OSW in Europe is approximately at price parity with other sources of conventional and renewable energy generation.

While the United States has only recently brought online its first offshore wind project in Rhode Island, fifteen projects are now underway on the east coast, and two floating OSW projects have been proposed in California. Largely as a result of the maturation of bottom-mounted OSW technology, a growing and competitive supply chain, and efficiencies of scale, the cost of OSW has declined by sixty-five percent over the past ten years. While those cost reductions pertain to bottom-mounted OSW, several of the factors that have contributed to that decline also apply to the floating OSW sector.

In light of California’s outstanding offshore wind resource and the progress of the offshore wind industry overseas, Governor Brown in May 2016 asked then Secretary of the Interior Sally Jewell to form an intergovernmental task force to evaluate opportunities for offshore renewable energy development off the California coast. Governor Brown stated that California will need to “dramatically increase our share of renewable energy to meet long term climate objectives,” and that offshore renewable energy resources “present important future opportunities.” He also stated that there “are significant offshore wind resources along most of California’s coast that complement the profile of onshore solar resources,” and that “new developments in offshore wind technology – such as large facilities that are not visible from land and present little to no avian impacts – will likely make projects more viable.”

A recent report by the National Renewable Energy Laboratory (NREL) has provided new insights into the cost and benefits of floating offshore wind in California. In 2016, NREL published a report called Potential Offshore Wind Energy Areas in California: An Assessment of Locations, Technology, and Costs. NREL was commissioned by the Bureau of Ocean Energy Management


(BOEM) in 2016 to conduct a cost and feasibility study for floating offshore wind in California. The study assessed possible siting options and cost trajectories for floating offshore wind in California out to a 2030 timeframe. The study indicated that the cost of floating offshore wind could drop below $100/MWh by 2030 at most viable sites in California, which now appears high relative to recent market trends. It also indicated that large-scale (up to 15 GW) deployment of offshore wind was possible in California. Finally, it showed that the corresponding day/night wind patterns along the coast could be complementary to the solar production curves, which sharply ramp down in the early evening just before peak demand. The study was conducted using the existing NREL spatial cost model, which is a detailed bottom-up cost estimator that takes into account geo-spatial siting differences and breaks down the wind plant into sub-cost elements that are aggregated over different years, from present day out to 2027 commercial operations date.

However, this study was conducted without the benefit of current market data which show a 65% drop in fixed bottom offshore wind winning auction prices in several European countries, and without a formal analysis to understand how much of the recent cost reductions can be attributed to floating wind systems. In addition, NREL based its 2016 floating foundation cost estimates and projections on specifications for one thoroughly studied design, even while recognizing that there are numerous other floating foundation designs at various stages of development, some of which show considerable promise for steeper cost reductions. A recent NREL presentation on floating foundation technology surveyed active and recently concluded demonstration projects and research efforts relating to floating offshore wind with budgets totaling nearly $500 million. Floating wind has been modeled by NREL to have the potential for cost parity with fixed bottom systems by 2030 by exploiting the key advantages of offshore wind including higher wind speeds, fewer siting conflicts, less work at sea, potential for quayside assembly and commissioning, and multiple opportunities for mass production and site independence.

In addition, the initial study showed that diurnal wind characteristics may have some synergies with solar energy resources that may be beneficial to smoothing out the duck curve, but the analysis was not comprehensive enough to quantify the value of this effect to the grid under realistic deployment.

scenarios. This aspect of offshore wind could also be investigated and the sensitivities of offshore wind deployment to the mitigation of large scale renewable energy deployment can be investigated to help further capture the costs and benefits of OSW.

We look forward to continuing to engage with NREL, CPUC, BOEM, CEC and other California industry experts to continue this cost analysis to develop more accurate cost data that can be used to inform California’s IRP process, evaluate the economic potential of offshore wind, and improve upon the initial floating wind cost estimates.

**Conclusion**

POET requests that the California Public Utilities Commission continue its investigation of the costs and benefits of floating OSW energy for the California energy market. Over the course of the next year, POET and the floating wind sector will ensure that updated data will be developed that will more accurately reflect the current and projected costs of OSW. In addition, POET will seek to work with its regional and national partners to help develop the value proposition of floating OSW, reflecting the myriad facets of OSW that provide benefits to the state of California including, among others: lower grid integration costs relative to existing and available renewables; the effect of geographically western generation that will utilize existing but stranded grid assets and strengthen the state’s grid with geographically balanced energy generation; and the potential to help address the “duck curve” problem.

Dated April 23, 2018

Respectfully Submitted,

Jason Busch, Executive Director

Pacific Ocean Energy Trust
240 N. Broadway, Suite 102
Portland, Oregon 97227
503-729-2253
JBusch@PacificOceanEnergy.org
BEFORE THE PUBLIC UTILITIES COMMISSION OF THE

STATE OF CALIFORNIA

Order Instituting Rulemaking to Develop an Electricity Integrated Resource Planning Framework and to Coordinate and Refine Long-Term Procurement Planning Requirements.

) )

Rulemaking 16-02-007 (Filed April 23, 2018)

CERTIFICATE OF SERVICE

I hereby certify that I have this day served a copy of the accompanying INFORMAL COMMENTS OF PACIFIC OCEAN ENERGY TRUST ON THE DRAFT SOURCES FOR 2019-20 IRP SUPPLY-SIDE RESOURCES on all parties of record to R.16-02-007 by transmitting a true and correct copy to the persons at the electronic notification addresses shown on the accompanying Service List.

Executed this 23rd day of April, 2018, in San Diego, California.

/s/ Jason Busch

Jason Busch
CALIFORNIA PUBLIC UTILITIES COMMISSION
Service Lists

PROCEEDING: R1602007 - CPUC - OIR TO DEVELO
FILER: CPUC
LIST NAME: LIST
LAST CHANGED: APRIL 23, 2018

Download the Comma-delimited File
About Comma-delimited Files

Back to Service Lists Index

Parties

DAVID LYONS                               JEFFREY KEHNE
ATTORNEY                                  CHIEF DEVELOPMENT OFFICE / GEN.COUNSEL
PAUL HASTINGS LLP                         MEGELLAN WIND LLC
EMAIL ONLY                                EMAIL ONLY
EMAIL ONLY, CA  00000                      EMAIL ONLY, DC  00000
FOR: LA PALOMA GENERATING COMPANY,LLC     FOR: MAGELLAN WIND LLC

JOHN W. LESLIE, ESQ.                      MATTHEW FREEDMAN
ATTORNEY                                  STAFF ATTORNEY
DENTONS US LLP                            THE UTILITY REFORM NETWORK
EMAIL ONLY                                EMAIL ONLY
EMAIL ONLY, CA  00000                      EMAIL ONLY, CA  00000
FOR: SHELL ENERGY NORTH AMERICA (U.S.),   FOR: THE UTILITY REFORM NETWORK (TURN)
L.P.

MERRIAN BORGESON                          TIM MASON
SR. SCIENTIST                             POLICY DIRECTOR
NATURAL RESOURCES DEFENSE COUNCIL         LARGE-SCALE SOLAR ASSOCIATION
EMAIL ONLY                                EMAIL ONLY
EMAIL ONLY, CA  00000                      EMAIL ONLY, CA  00000
FOR: NATURAL RESOURCES DEFENSE COUNCIL    FOR: LARG-SCALE SOLAR ASSOCIATION
(NRDC)

KENNETH SAHM WHITE                        MIKE LEVIN
DIRECTOR, ECONOMIC & POLICY ANALYSIS      DIR - GOVN’T AFFAIRS
CLEAN COALITION                           FUELCELL ENERGY, INC.
EMAIL ONLY                                3 GREAT PASTURE ROAD
EMAIL ONLY, CA  00000-0000                 DANBURY, CT  06810
AMY H. FISHER
MANAGING DIR. - REGULATORY AFFAIRS
GE ENERGY FINANCIAL SVC'S, INC.
800 LONG RIDGE ROAD
STAMFORD, CT 06927
FOR: INLAND EMPIRE ENERGY CENTER, LLC

DENISE GRAB
SR. ATTORNEY
INSTITUTE FOR POLICY INTEGRITY
139 MACDOUGAL STREET, 3RD FL.
NEW YORK, NY 10012
FOR: INSTITUTE FOR POLICY INTEGRITY

KATHRYN PERRY
AGERA ENERGY, LLC
555 PLEASANTVILLE ROAD, S-107
MANOR, NY 10510
FOR: AGERA ENERGY, LLC

ERIKA DIAMOND
ENERGYHUB
232 3RD STREET, SUITE 201
BROOKLYN, NY 11215
FOR: ENERGYHUB

LAURA SALVESEN
PALMCO POWER CA
1350 - 60TH STREET
BROOKLYN, NY 11219
FOR: PALMCO POWER CA

JEFFREY LEAHEY
DEPUTY EXECUTIVE DIR.
NATIONAL HYDROPOWER ASSOCIATION
25 MASSACHUSETTS AVE. NW, STE. 450
WASHINGTON, DC 20001
FOR: NATIONAL HYDROPOWER ASSOCIATION

WILLIAM D. DEGRANDIS
ATTORNEY AT LAW
PAUL HASTING, LLP
875 15TH STREET, N.W.
WASHINGTON, DC 20005
FOR: GRIDLIANCE WEST TRANSCO, LLC

PARDEEP GILL
CONSTELLATION NEWENERGY, INC.
100 CONSTELLATION WAY, STE 600
Baltimore, MD 21202
FOR: CONSTELLATION NEWENERGY, INC.

JEFFREY S. SPURGEON
GENTRIX ENERGY POWER MGMT., LLC
9405 ARROWPOINT BOULEVARD
CHARLOTTE, NC 28273
FOR: COGENTRIX ENERGY POWER MANAGEMENT, LLC (COGENTRIX)

TABITHA CANTY
LIBERTY POWER DELAWARE, LLC
1901 W. Cypress Creek Road, Ste. 600
FT. LAUDERDALE, FL 33309
FOR: LIBERTY POWER DELAWARE, LLC / LIBERTY POWER HOLDINGS, LLC

CURRY ALDRIDGE
TENASKA CALIFORNIA ENERGY MARKETING, LLC
14302 FNB PARKWAY, STE 100
OMAHA, NE 68154
FOR: TENASKA CALIFORNIA ENERGY MARKETING, LLC

BETHANY SOLER
REPRESENTATIVE
TIGER NATURAL GAS, INC.
EMAIL ONLY
TULSA, OK 74136
FOR: TIGER NATURAL GAS, INC.

CURRY ALDRIDGE
TENASKA POWER SERVICES CO.
1701 E. LAMAR BLVD., STE 100
ARLINGTON, TX 76006
FOR: TENASKA POWER SERVICES CO.

JASON ARMENTA
CALPINE POWERAMERICA-CA, LLC
717 TEXAS AVENUE, SUITE 1000
HOUSTON, TX 77002
FOR: CALPINE POWERAMERICA-CA, LLC

BYRON POLLARD
EDF INDUSTRIAL POWER SERVICES (CA), LLC
4700 W. SAM HOUSTON PKWY, N., STE. 250
HOUSTON, TX 77041
FOR: EDF INDUSTRIAL POWER SERVICES (CA), LLC

KEVIN BOUDREAU
ENERCAL USA, LLC YEP ENERGY
7660 WOODWAY DRIVE, STE. 471A
HoustoN, TX 77063
FOR: ENERCAL USA, LLC YEP ENERGY

JOHN H. RITCH
GEXA ENERGY CALIFORNIA, LLC
20455 STATE HIGHWAY 249, STE. 200
HOUSTON, TX 77070
FOR: GEXA ENERGY CALIFORNIA, LLC

DAVID P. LOWREY
DIRECTOR, REGULATORY STRATEGY
CONVERGE, INC.
999 18TH STREET, SUITE 2300
DENVER, CO 80202
FOR: CONVERGE, INC.

ROXANE J. PERRUSO
FOR: CLEAN COALITION

JASON R. SMITH
FOR: FUELCELL ENERGY, INC.
VP / GENERAL COUNSEL                      PRESIDENT
TRANSWEST EXPRESS LLC                     TRANSCANYON, LLC
555 SEVENTEENTH STREET, STE 2400          ONE ARIZONA CENTER
DENVER, CO  80202                         400 EAST VAN BUREN ST., STE. 350
FOR: TRANSWEST EXPRESS, LLC               FOR: TRANSCANYON, LLC

DAVID GETTS                               JOSHUA A. NORDQUIST
GEN. MGR.                                 DIR. - BUSINESS DEVELOPMENT
SOUTHWESTERN POWER GROUP II, LLC          ORMAT TECHNOLOGIES, INC.
3610 N. 44TH ST., STE. 250                6225 NEIL ROAD
PHOENIX, AZ  85018                        RENO, NV  89511
FOR: SOUTH WESTER POWER GROUP (SWPG)      FOR: ORMAT TECHNOLOGIES, INC.

EDWARD L. HSU                             STEVE ZURETTI
SR COUNSEL                                DIRECTOR, REGULATORY AFFAIRS
SOUTHERN CALIFORNIA GAS COMPANY            BROOKFIELD RENEWABLE ENERGY PARTNERS
555 WEST 5TH STREET, GT14E7                WEST COAST
LOS ANGELES, CA  90013                    601 S. FIGUEROA STREET, SUITE 2200
FOR: SOUTHERN CALIFORNIA GAS COMPANY      LOS ANGELES, CA  90017
(SOCAL)                                   FOR: (BROOKFIELD RENEWABLE ENERGY PARTNERS)

HOWARD CHOI                               JERRY R. BLOOM
GENERAL MGR.                              ATTORNEY AT LAW
COUNTY OF LOS ANGELES                     WINSTON & STRAWN LLP
OFFICE OF SUSTAINABILITY                  333 SOUTH GRAND AVENUE, 38TH FL.
1100 NORTH EASTERN AVENUE                 LOS ANGELES, CA  90071
LOS ANGELES, CA  90063                    FOR: CALIFORNIA COGENERATION COUNCIL
FOR: COUNTY OF LOS ANGELES

LISA BOND                                 DAN MARSH
RICHARDS WATSON GERSHON                    MGR, RATES AND REGULATORY AFFAIRS
355 SOUTH GRAND AVE., 40TH FLOOR           LIBERTY UTILITIES (CALIFORNIA)
LOS ANGELES, CA  90071                    9750 WASHBURN ROAD
FOR: CITY OF REDONDO BEACH                DOWNNEY, CA  90241-7002
FOR: LIBERTY UTILITIES (CALPECO ELECTRIC) LLC

MICHAEL MAZUR                             J. DOUGLAS DIVINE
3 PHASES RENEWABLES, LLC                  CHIEF EXECUTIVE OFFICER
1228 E. GRAND AVENUE                      EAGLE CREST ENERGY COMPANY
EL SEGUNDO, CA  90245                     3000 OCEAN PARK BLVD., STE. 1020
FOR: 3 PHASES RENEWABLES, LLC             SANTA MONICA, CA  90405
FOR: EAGLE CREST ENERGY COMPANY

INGER GOODMAN                             DANIEL W. DOUGLASS
JUST ENERGY SOLUTIONS INC.                ATTORNEY
6 CENTERPOINTE DRIVE, SUITE 750           DOUGLASS & LIDDELL
LA PALMA, CA  90623-2520                   4766 PARK GRANADA, SUITE 209
FOR: JUST ENERGY SOLUTIONS, INC. F/K/A    CALABASAS, CA  91302
COMMERCIE ENERGY, INC.                    FOR: WESTERN POWER TRADING FORUM
FOR: WESTERN POWER TRADING FORUM          (WPTF)/ ALLIANCE FOR RETAIL ENERGY
(WPTF)/ ALLIANCE FOR RETAIL ENERGY MARKETS (AREM) / DIRECT ACCESS CUSTOMER
MARKETS (AREM) / DIRECT ACCESS CUSTOMER COALITION (DACC) / NEST LABS, INC.

JONATHAN WORD                             C.C. SONG
DIR OF STRATEGIC OPERATIONS               SR. POLICY ANALYST
BISON PEAK PUMPED STORAGE, LLC            MARIN CLEAN ENERGY
9795 CABRINI DR., STE. 206                1125 TAMALPAIS AVE
BURBANK, CA  91504                        SAN RAFAEL, CA  91901
FOR: BISON PEAK PUMPED STORAGE, LLC       FOR: MARIN CLEAN ENERGY (MCE)
FOR: MARIN CLEAN ENERGY (MCE)

RAYN HARWELL                              JEFF MALONE
DIRECT ENERGY BUSINESS                    VP
7220 AVENIDA ENCINAS, STE 120             HIGH DESERT POWER PROJECT, LLC
CARLSBAD, CA  92009                       888 PROSPECT STREET, STE. 200
FOR: CALIFORNIA COGENERATION COUNCIL

CHRISTIAN LENCI                           SANDEEP ARORA
PRAXAIR PLAINFIELD, INC.                  VICE PRESIDENT, TRANSMISSION
2430 CAMINO RAMON DR.                     LS POWER DEVELOPMENT, LLC
SAN RAMON, CA  94583                     5000 HOPYARD, ROAD, SUIT E480
FOR: PRAXAIR PLAINFIELD, INC.             FOR: LS POWER DEVELOPMENT (LS POWER)
PLEASANTON, CA  94588

APRIL ROSE SOMMER                         LAURA WISLAND
EXE DIR - LEAD COUNSEL                   SR. ENERGY ANALYST
PROTECT OUR COMMUNITIES FOUNDATION       UNION OF CONCERNED SCIENTISTS
1547 PALOS VERDES MALL NO. 196           500 12TH ST., STE. 340
WALNUT CREEK, CA  94598                  OAKLAND, CA  94607
FOR: PROTECT OUR COMMUNITIES FOUNDATION  FOR: UNION OF CONCERNED SCIENTISTS (UCS)
1547 PALOS VERDES MALL NO. 196

MARK BYRON                                MELISSA BRANDT
WHOLESALE ELECTRICITY PROGRAM MGR.       DIR - REGULATORY AFFAIRS
UNIV. OF CALIF. OFFICE OF THE PRESIDENT   EAST BAY COMMUNITY ENERGY
1111 FRANKLIN ST., 6TH FL.               1111 BROADWAY, SUITE 3000
OAKLAND, CA  94607                      OAKLAND, CA  94607
FOR: THE REGENTS OF THE UNIVERSITY OF    FOR: EAST BAY COMMUNITY ENERGY
CALIFORNIA

ADAM BORISON                              CATHLEEN MONAHAN
MANAGING DIRECTOR                         SR. PROGRAMS DIR.
BERKELEY RESEARCH GROUP, LLC              GRID ALTERNATIVES
2200 POWELL STREET, SUITE 1200            1117 OCEAN AVENUE, SUITE 200
EMERYVILLE, CA  94608                    OAKLAND, CA  94608
FOR: BERKELEY RESEARCH GROUP, LLC (BRG)   FOR: GRID ALTERNATIVES

GRETCHEN DUMAS                            JASON B. KEYES
PILOT TEAM                                KEYES & FOX LLP
1749 PLEASANT VALLEY AVENUE               436 14TH STREET, SUITE 1305
OAKLAND, CA  94611                       OAKLAND, CA  94612
FOR: IHM COMMUNITY                        FOR: TESLA

JASON B. KEYES                            LAURENCE G. CHASET
PARTNER                                  COUNSEL
KEYES & FOX LLP                           KEYES & FOX LLP
436 14TH ST., STE.1305                   436 14TH STREET, STE. 1305
OAKLAND, CA  94612                       OAKLAND, CA  94612
FOR: SOLARCITY CORPORATION               FOR: WORLD BUSINESS ACADEMY

LISA BELENKY                              PATRICK VANBEEK
SR. ATTY                                  DIR - CUSTOMER SUPPORT
CENTER FOR BIOLOGICAL DIVERSITY           COMMERCIAL ENERGY OF CALIFORNIA
1212 BROADWAY, STE. 800                  7677 OAKPORT STREET, STE. 525
OAKLAND, CA  94612                      OAKLAND, CA  94621
FOR: CENTER FOR BIOLOGICAL DIVERSITY     FOR: COMMERCIAL ENERGY OF CALIFORNIA

ALEX MORRIS                               GREGG MORRIS
SR. DIR., POLICY & REGULATORY AFFAIRS     DIRECTOR
CALIFORNIA ENERGY STORAGE ALLIANCE        THE GREEN POWER INSTITUTE
2150 ALLSTON WAY, SUITE 210              2039 SHATTUCK AVE., SUITE 420
BERKELEY, CA  94704                     BERKELEY, CA  94704
FOR: CALIFORNIA ENERGY STORAGE ALLIANCE   FOR: GREEN POWER INSTITUTE
(CESA)

NANCY RADER                               SHANA LAZEROW
EXECUTIVE DIRECTOR                       ATTORNEY
CALIFORNIA WIND ENERGY ASSOCIATION       COMMUNITIES FOR A BETTER ENVIRONMENT
1700 SHATTUCK AVENUE, SUITE 17           120 BROADWAY, SUITE 2
BERKELEY, CA  94709                    RICHMOND, CA  94804
FOR: CALIFORNIA WIND ENERGY ASSOCIATION  FOR: CALIFORNIA ENVIRONMENTAL JUSTICE
(CALWEA)                                  ALLIANCE (CEJA)
Information Only

ALIA SCHOEN  
PUBLIC POLICY MGR.  
BLOOM ENERGY  
EMAIL ONLY  
EMAIL ONLY, CA  00000

ANDREW LUSCZ  
GLACIAL ENERGY OF CALIFORNIA  
EMAIL ONLY  
EMAIL ONLY, CA  00000

BARBARA BARKOVICH  
BARKOVICH & YAP  
EMAIL ONLY  
EMAIL ONLY, CA  00000

BILL POWERS  
PROTECT OUR COMMUNITIES FOUNDATION  
EMAIL ONLY  
EMAIL ONLY, CA  00000

COLEY GIROUARD  
ASSOCIATE, PUC PROGRAM  
ADVANCED ENERGY ECONOMY  
EMAIL ONLY  
EMAIL ONLY, CA  00000

DAMON FRANZ  
DIRECTOR - POLICY & ELECTRICITY MARKETS  
TESLA, INC.  
EMAIL ONLY  
EMAIL ONLY, CA  00000

DAVID MCCOARD  
EMAIL ONLY  
EMAIL ONLY, CA  00000

DONALD LIDDELL  
DOUGLASS & LIDDELL  
EMAIL ONLY  
EMAIL ONLY, CA  00000

DONALD LIDDELL  
DOUGLASS & LIDDELL  
EMAIL ONLY  
EMAIL ONLY, CA  00000

DONALD LIDDELL  
DOUGLASS & LIDDELL  
EMAIL ONLY  
EMAIL ONLY, CA  00000

DUSTIN TILL  
ATTORNEY  
PACIFICORP  
825 NE MULTNOMAH ST., STE. 1800  
PORTLAND, OR  97232  
FOR: PACIFICORP

ALLA WEINSTEIN  
FOUNDER  
TRIDENT WINDS, LLC  
113 CHERRY STREET, SUITE 34912  
SEATTLE, WA  98104-2205  
FOR: TRIDENT WINDS, LLC (TRIDENT)

ANNA MILEVA  
ICE ONE H  
EES CONSULTING, INC.  
EMAIL ONLY  
EMAIL ONLY, WA  00000

ANNE FALCON  
EEG CONSULTING, INC.  
EMAIL ONLY  
EMAIL ONLY, WA  00000

BENYAMIN MORADZADEH  
PACIFIC GAS AND ELECTRIC COMPANY  
EMAIL ONLY  
EMAIL ONLY, CA  00000

CEDRIC O. CHRISTENSEN  
DIR - OPER & DEVELOPMENT  
STRATEGEN CONSULTING LLC  
EMAIL ONLY  
EMAIL ONLY, CA  00000

CURT BARRY  
SENIOR WRITER  
INSIDE WASHINGTON PUBLISHERS  
EMAIL ONLY  
EMAIL ONLY, CA  00000

DANIELLE O. MILLS  
SR. POLICY ADVISOR  
LARGE-SCALE SOLAR ASSOCIATION  
EMAIL ONLY  
EMAIL ONLY, CA  00000

Despina Niehaus  
CALIFORNIA REGULATORY AFFAIRS  
SAN DIEGO GAS & ELECTRIC COMPANY  
EMAIL ONLY  
EMAIL ONLY, CA  00000

EBCE REGULATORY  
EAST BAY COMMUNITY ENERGY  
EMAIL ONLY  
EMAIL ONLY, CA  00000
<table>
<thead>
<tr>
<th>Name</th>
<th>Title/Position</th>
<th>Company/Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eric Weiner</td>
<td>Analyst</td>
<td>Peninsula Clean Energy, CA 00000</td>
</tr>
<tr>
<td>Erin Grizard</td>
<td>Bloom Energy</td>
<td>Email Only, CA 00000</td>
</tr>
<tr>
<td>George Wiltsee</td>
<td>Clean Power House, LLC</td>
<td>Email Only, AA 00000</td>
</tr>
<tr>
<td>Gregory S.G. Klatt</td>
<td>Attorney at Law</td>
<td>Email Only, CA 00000</td>
</tr>
<tr>
<td>James A. Ross</td>
<td>Regulatory &amp; Cogeneration Services Inc</td>
<td>SCE State Regulatory Operations, CA 00000</td>
</tr>
<tr>
<td>Jeanette Melgar</td>
<td>Residential Tariiffs &amp; Advice Ltrs</td>
<td>Email Only, CA 00000</td>
</tr>
<tr>
<td>Jennifer W. Summers</td>
<td>California Regulatory Affairs</td>
<td>Email Only, CA 00000</td>
</tr>
<tr>
<td>Jessica Hilgart</td>
<td>Pacific Gas &amp; Electric Company</td>
<td>Email Only, CA 00000</td>
</tr>
<tr>
<td>Jessica Nelson</td>
<td>General Manager</td>
<td>Golden State Power Cooperative, CA 00000</td>
</tr>
<tr>
<td>Jimmy Nelson, Ph.D</td>
<td>Kendall Science Fellow in Electricity</td>
<td>Email Only, CA 00000</td>
</tr>
<tr>
<td>Jordan Decker</td>
<td>Utility Specialist, Clean Power SF</td>
<td>California Energy Markets, CA 00000</td>
</tr>
<tr>
<td>Kevin Fallon</td>
<td>Sir Capital Management</td>
<td>Email Only, NY 00000</td>
</tr>
<tr>
<td>Maggie Chan</td>
<td>Pacific Gas and Electric Company</td>
<td>Email Only, CA 00000</td>
</tr>
<tr>
<td>Matthew Tisdale</td>
<td>Science Engineer</td>
<td>Wireless Glue Networks, Inc., Roseville, CA 00000</td>
</tr>
<tr>
<td>Meghan Cox</td>
<td>California Power Law Group</td>
<td>Email Only, CA 00000</td>
</tr>
<tr>
<td>Mohit Chhabra</td>
<td>Scientist</td>
<td>Natural Resources Defense Council, CA 00000</td>
</tr>
<tr>
<td>Nellie Tong</td>
<td>Senior Consultant, DNV Kema Energy &amp; Sustainability</td>
<td>DNV Kema Energy &amp; Sustainability, CA 00000</td>
</tr>
<tr>
<td>Paul Nelson</td>
<td>Analyst</td>
<td>Barkovich &amp; Yap, Email Only, CA 00000</td>
</tr>
<tr>
<td>Paul Nelson</td>
<td>Senior Consultant, Barkovich &amp; Yap</td>
<td>Email Only, CA 00000</td>
</tr>
<tr>
<td>Paul Nelson</td>
<td>Senior Consultant, California Large Energy Consumers Association</td>
<td>Email Only, CA 00000</td>
</tr>
</tbody>
</table>
PETER T. PEARSON  RACHEL A. GOLDS  
ENERGY SUPPLY SPECIALIST  CALIFORNIA AIR RESOURCES BOARD 
BEAR VALLEY ELECTRIC SERVICE  EMAIL ONLY 
EMAIL ONLY  EMAIL ONLY, CA  00000 

RHONDA MILLS  RICK UMOFF
WESTERN ISSUES REP  COUNSEL & DIR - STATE AFFAIRS 
GEOTHERMAL ENERGY ASSOCIATION  SOLAR ENERGY INDUSTRIES ASSOCIATION 
EMAIL ONLY  EMAIL ONLY 
EMAIL ONLY  EMAIL ONLY, CA  00000 

ROBERT GEX  SARAH M. KEANE
DAVIS WRIGHT TREMAINE LLP  MORGAN LEWIS & BOCKIUS, LLP 
EMAIL ONLY  EMAIL ONLY 
EMAIL ONLY  EMAIL ONLY, CA  00000 

SARITA SARVATE  SHARON YANG
EMAIL ONLY  DIRECTOR OF LEGAL SERVICES 
EMAIL ONLY  LIBERTY UTILITIES (WEST REGION) 
EMAIL ONLY  EMAIL ONLY, CA  00000 

SIOBHAN DOHERTY  STEPHEN COURY
ANALYST  EUCI 
EMAIL ONLY  EMAIL ONLY, CA  00000 
EMAIL ONLY  EMAIL ONLY, CA  00000 

STEPHEN ST. MARIE  STEVE CULBERTSON
CPC  BKI CONSULTING 
EMAIL ONLY  EMAIL ONLY 
EMAIL ONLY  EMAIL ONLY, CA  00000 

SUSANNAH CHURCHILL  TOM JARMAN
SOLAR POLICY ADVOCATE  PACIFIC GAS & ELECTRIC COMPANY 
VOTE SOLAR  EMAIL ONLY 
EMAIL ONLY  EMAIL ONLY, CA  00000 

UDI HELMAN  WILL MITCHELL
HELMAN ANALYTICS  MANAGER, REGULATORY AFFAIRS 
EMAIL ONLY  RECURRENT ENERGY 
EMAIL ONLY  EMAIL ONLY, CA  00000 

WILLIAM DIETRICH  XIAOBO WANG, PH.D
SENIOR CONSULTANT  SR. ADVISOR, MKT & INTEGRATION STUDIES 
DIETRICH CONSULTING  CALIFORNIA ISO 
EMAIL ONLY  EMAIL ONLY 
EMAIL ONLY  EMAIL ONLY, CA  00000 

REGULATORY CLERK  MRW & ASSOCIATES, LLC 
BRAUN BLAISING SMITH WYNNE, PC  EMAIL ONLY 
EMAIL ONLY  EMAIL ONLY, CA  00000 

PILOT POWER GROUP, INC.  DAVIS WRIGHT TREMAINE LLP 
EMAIL ONLY  EMAIL ONLY 
EMAIL ONLY  EMAIL ONLY, CA  00000 

DAVID MARCUS  MICHAEL BERLINSKI
ALTON ENERGY, INC.
6201 SHELLEY DRIVE
HUNTINGTON BEACH, CA 92647

RICHARD ROBERTS
KINETIC ENERGY RESOURCES
25282 DERBYHILL DR.
LAGUNA HILLS, CA 92653

DONALD DAME
ENERGY CONSULTANT
2022 PEIRPONT BLVD
VENTURA, CA 93001

JERRY B. BROWN, PH.D
DIRECTOR - SAFE ENERGY PROJECT
WORLD BUSINESS ACADEMY
2020 ALAMEDA PADRE SERRA, STE. 135
SANTA BARBARA, CA 93103

HEATHER SWAN
LANCASTER POWER AUTHORITY
CITY OF LANCASTER
44933 FERN AVE.
LANCASTER, CA 93534

JIM BAAK
SR. MGR. - REGULATORY AFFAIRS WEST
STEM, INC.
100 ROLLING ROAD
MILLBRAE, CA 94030

EMILY LESLIE
ENERGY REFLECTIONS
1028 MONTE VERDE DR
PACIFICA, CA 94044

JOSEPH F. WIEDMAN
SR. REGULATORY & LEGISLATIVE ANALYST
PENINSULA CLEAN ENERGY AUTHORITY
400 COUNTY CENTER, SIXTH FL.
REDWOOD CITY, CA 94063

MILA A. BUCKNER
ATTORNEY
ADAMS BROADWELL JOSEPH & CARDOZO
601 GATEWAY BLVD., STE. 1000
SOUTH SAN FRANCISCO, CA 94080

NICOLAI SCHLAG
SR. MANAGING CONSULTANT
ENERGY & ENVIRONMENTAL ECONOMICS, INC.
101 MONTGOMERY ST., STE 1600
SAN FRANCISCO, CA 94101

SUIY HONG
DEPUTY CITY ATTORNEY
CITY AND COUNTY OF SAN FRANCISCO
CITY HALL
1 DR. CARLTON B. GOODLETT PLACE, RM 234
SAN FRANCISCO, CA 94102

SIEMENS ENERGY INC.
2441 RIDGE ROUTE DRIVE, STE. 230
LAGUNA HILLS, CA 92653

EMANUEL WAGNER
ASSISTANT DIRECTOR
CALIFORNIA HYDROGEN BUSINESS COUNCIL
18847 VIA SERENO
YORBA LINDA, CA 92886
FOR: CALIFORNIA HYDROGEN BUSINESS COUNCIL (CNBC)

JEFF HIRSCH
JAMES J. HIRSCH & ASSOCIATES
12185 PRESILLA ROAD
SANTA ROSA VALLEY, CA 93012-9243

RINALDO BRUTUCO
WORLD BUSINESS ACADEMY
2020 ALAMEDA PADRE SERRA, STE. 135
SANTA BARBARA, CA 93103

DEEANN TOILIEN
STRATEGIC PLANNING RESEARCH MGR
RICHARD HEATH & ASSOCIATES, INC.
590 W LOCUST AVENUE, SUITE 103
FRESNO, CA 93650

TED KO
DIRECTOR OF POLICY
STEM, INC.
100 ROLLING ROAD
MILLBRAE, CA 94030

JEREMY WAEN
SR. REGULATORY ANALYST
PENINSULA CLEAN ENERGY
2075 WOODSIDE RD.
REDWOOD CITY, CA 94061

MARC D. JOSEPH
ATTORNEY AT LAW
ADAMS, BROADWELL, JOSEPH & CARDOZO
601 GATEWAY BLVD., STE. 1000
SOUTH SAN FRANCISCO, CA 94080

HILARY STAVER
REGULATORY & LEGISLATIVE ANALYST
SILICON VALLEY CLEAN ENERGY AUTHORITY
333 W. EL CAMINO REAL, STE. 290
SUNNYVALE, CA 94087

DAN WILLIS
PLANNING AND REGULATORY COMPLIANCE
SFPUC
525 GOLDEN GATE AVENUE, 7TH FLOOR
SAN FRANCISCO, CA 94102

CLEANPOWERSF REGULARTORY
SFPUC
525 GOLDEN GATE AVE.
SAN FRANCISCO, CA 94102
<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Organization/Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOREST KASER</td>
<td>President Picker</td>
<td>CALIF PUBLIC UTILITIES COMMISSION 505 Van Ness Avenue, 94102-3214</td>
</tr>
<tr>
<td>ERIC BORDEN</td>
<td>Energy Policy Analyst</td>
<td>THE UTILITY REFORM NETWORK 785 Market Street, Suite 1400, 94103</td>
</tr>
<tr>
<td>JAMES H. NELSON Ph.D</td>
<td>Consultant</td>
<td>ENERGY AND ENVIRONMENTAL ECONOMICS, INC. 101 Montgomery St., 16th Fl., 94105</td>
</tr>
<tr>
<td>AMISHA RAI</td>
<td>Senior Dir. - Calif. Policy</td>
<td>ADVANCED ENERGY ECONOMY 135 Main St., Suite 1320, 94105</td>
</tr>
<tr>
<td>BRUCE PERLSTEIN</td>
<td>Director, Advisory</td>
<td>KPMG LLP 55 Second St., Suite 1700, 94105</td>
</tr>
<tr>
<td>CASE ADMINISTRATION</td>
<td></td>
<td>PACIFIC GAS AND ELECTRIC COMPANY 77 Beale Street, 94105</td>
</tr>
<tr>
<td>DON BROOKHYSER</td>
<td></td>
<td>BUCHALTER, A PROFESSIONAL CORPORATION 55 Second Street, Suite 1700, 94105</td>
</tr>
<tr>
<td>KATHERINE MORSONY</td>
<td>Attorney</td>
<td>BUCHALTER, A PROFESSIONAL CORPORATION 55 Second Street, Suite 1700, 94105</td>
</tr>
<tr>
<td>MIKE CADE</td>
<td></td>
<td>MORGAN, LEWIS &amp; BOCKIUS, LLP ONE MARKET ST., SPEAR STREET TOWER, 94105</td>
</tr>
<tr>
<td>SENIOR VICE PRESIDENT</td>
<td></td>
<td>PERKINS COIE LLP 555 Howard Street Suite 1000, 94105</td>
</tr>
<tr>
<td>RENAE STEICHEN</td>
<td></td>
<td>MORGAN, LEWIS &amp; BOCKIUS, LLP ONE MARKET ST., SPEAR STREET TOWER, 94105</td>
</tr>
</tbody>
</table>

**FOR: TURN**

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Organization/Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>BREWSTER BIRDSALL</td>
<td></td>
<td>ASPEN ENVIRONMENTAL GROUP 235 Montgomery Street, Suite 935, 94104</td>
</tr>
<tr>
<td>AARON BURDICK</td>
<td></td>
<td>PACIFIC GAS AND ELECTRIC COMPANY 77 Beale Street, 94105</td>
</tr>
<tr>
<td>BARNEY SPECKMAN</td>
<td></td>
<td>NEXANT 101 Second Street, 11th Floor, 94105</td>
</tr>
<tr>
<td>CARL NOLEN</td>
<td></td>
<td>PACIFIC GAS AND ELECTRIC COMPANY 77 Beale Street, 94105</td>
</tr>
<tr>
<td>CHRISTOPHER G PARKER</td>
<td></td>
<td>PERKINS COIE LLP 555 Howard Street Suite 1000, 94105</td>
</tr>
<tr>
<td>MIKE CADE</td>
<td></td>
<td>MORGAN, LEWIS &amp; BOCKIUS, LLP ONE MARKET ST., SPEAR STREET TOWER, 94105</td>
</tr>
<tr>
<td>KATHERINE MORSONY</td>
<td></td>
<td>BUCHALTER, A PROFESSIONAL CORPORATION 55 Second Street, Suite 1700, 94105</td>
</tr>
<tr>
<td>MIKE CADE</td>
<td></td>
<td>MORGAN, LEWIS &amp; BOCKIUS, LLP ONE MARKET ST., SPEAR STREET TOWER, 94105</td>
</tr>
<tr>
<td>RENAE STEICHEN</td>
<td></td>
<td>MORGAN, LEWIS &amp; BOCKIUS, LLP ONE MARKET ST., SPEAR STREET TOWER, 94105</td>
</tr>
</tbody>
</table>

**FOR: PACIFIC GAS & ELECTRIC COMPANY**

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Organization/Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>RACHEL PETERSON</td>
<td>Commissioner Randolph</td>
<td>CALIF PUBLIC UTILITIES COMMISSION 505 Van Ness Avenue, 94102-3214</td>
</tr>
<tr>
<td>MARCEL HAWIGER</td>
<td>Energy Attorney</td>
<td>THE UTILITY REFORM NETWORK 785 Market Street, Suite 1400, 94103</td>
</tr>
<tr>
<td>THOMAS J. LONG</td>
<td>Legal Dir.</td>
<td>THE UTILITY REFORM NETWORK 785 Market Street, Suite 1400, 94103</td>
</tr>
<tr>
<td>AARON BURDICK</td>
<td></td>
<td>PACIFIC GAS AND ELECTRIC COMPANY 77 Beale Street, 94105</td>
</tr>
<tr>
<td>BARNEY SPECKMAN</td>
<td></td>
<td>NEXANT 101 Second Street, 11th Floor, 94105</td>
</tr>
<tr>
<td>JAMES H. NELSON Ph.D</td>
<td></td>
<td>ENERGY AND ENVIRONMENTAL ECONOMICS, INC. 101 Montgomery St., 16th Fl., 94105</td>
</tr>
<tr>
<td>AMISHA RAI</td>
<td></td>
<td>ADVANCED ENERGY ECONOMY 135 Main St., Suite 1320, 94105</td>
</tr>
<tr>
<td>BRUCE PERLSTEIN</td>
<td></td>
<td>KPMG LLP 55 Second St., Suite 1700, 94105</td>
</tr>
<tr>
<td>CASE ADMINISTRATION</td>
<td></td>
<td>PACIFIC GAS AND ELECTRIC COMPANY 77 Beale Street, 94105</td>
</tr>
<tr>
<td>DON BROOKHYSER</td>
<td></td>
<td>BUCHALTER, A PROFESSIONAL CORPORATION 55 Second Street, Suite 1700, 94105</td>
</tr>
<tr>
<td>EMILIE OLSON</td>
<td></td>
<td>ADVANCED ENERGY ECONOMY 135 Main Street, Suite 1320, 94105</td>
</tr>
<tr>
<td>MARK R. HUFFMAN</td>
<td></td>
<td>PACIFIC GAS AND ELECTRIC COMPANY 77 Beale Street, B30A, 94105</td>
</tr>
<tr>
<td>PATTY COOK</td>
<td></td>
<td>PACIFIC GAS &amp; ELECTRIC COMPANY 55 Second Street, Suite 1700, 94105</td>
</tr>
<tr>
<td>MIKE CADE</td>
<td></td>
<td>MORGAN, LEWIS &amp; BOCKIUS, LLP ONE MARKET ST., SPEAR STREET TOWER, 94105</td>
</tr>
<tr>
<td>KATHERINE MORSONY</td>
<td></td>
<td>BUCHALTER, A PROFESSIONAL CORPORATION 55 Second Street, Suite 1700, 94105</td>
</tr>
<tr>
<td>RENAE STEICHEN</td>
<td></td>
<td>MORGAN, LEWIS &amp; BOCKIUS, LLP ONE MARKET ST., SPEAR STREET TOWER, 94105</td>
</tr>
</tbody>
</table>

**FOR: TURN**

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Organization/Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>THOMAS J. LONG</td>
<td></td>
<td>ASPEN ENVIRONMENTAL GROUP 235 Montgomery Street, Suite 935, 94104</td>
</tr>
<tr>
<td>BREWSTER BIRDSALL</td>
<td></td>
<td>PACIFIC GAS AND ELECTRIC COMPANY 77 Beale Street, 94105</td>
</tr>
<tr>
<td>AARON BURDICK</td>
<td></td>
<td>NEXANT 101 Second Street, 11th Floor, 94105</td>
</tr>
<tr>
<td>JAMES H. NELSON Ph.D</td>
<td></td>
<td>ENERGY AND ENVIRONMENTAL ECONOMICS, INC. 101 Montgomery St., 16th Fl., 94105</td>
</tr>
<tr>
<td>AMISHA RAI</td>
<td></td>
<td>ADVANCED ENERGY ECONOMY 135 Main St., Suite 1320, 94105</td>
</tr>
<tr>
<td>BRUCE PERLSTEIN</td>
<td></td>
<td>KPMG LLP 55 Second St., Suite 1700, 94105</td>
</tr>
<tr>
<td>CASE ADMINISTRATION</td>
<td></td>
<td>PACIFIC GAS AND ELECTRIC COMPANY 77 Beale Street, 94105</td>
</tr>
<tr>
<td>DON BROOKHYSER</td>
<td></td>
<td>BUCHALTER, A PROFESSIONAL CORPORATION 55 Second Street, Suite 1700, 94105</td>
</tr>
<tr>
<td>EMILIE OLSON</td>
<td></td>
<td>ADVANCED ENERGY ECONOMY 135 Main Street, Suite 1320, 94105</td>
</tr>
<tr>
<td>MARK R. HUFFMAN</td>
<td></td>
<td>PACIFIC GAS AND ELECTRIC COMPANY 77 Beale Street, B30A, 94105</td>
</tr>
<tr>
<td>PATTY COOK</td>
<td></td>
<td>PACIFIC GAS &amp; ELECTRIC COMPANY 55 Second Street, Suite 1700, 94105</td>
</tr>
</tbody>
</table>

**FOR: PACIFIC GAS & ELECTRIC COMPANY**

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Organization/Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>RACHEL PETERSON</td>
<td>Commissioner Randolph</td>
<td>CALIF PUBLIC UTILITIES COMMISSION 505 Van Ness Avenue, 94102-3214</td>
</tr>
<tr>
<td>MARCEL HAWIGER</td>
<td>Energy Attorney</td>
<td>THE UTILITY REFORM NETWORK 785 Market Street, Suite 1400, 94103</td>
</tr>
<tr>
<td>THOMAS J. LONG</td>
<td>Legal Dir.</td>
<td>THE UTILITY REFORM NETWORK 785 Market Street, Suite 1400, 94103</td>
</tr>
<tr>
<td>AARON BURDICK</td>
<td></td>
<td>PACIFIC GAS AND ELECTRIC COMPANY 77 Beale Street, 94105</td>
</tr>
<tr>
<td>BARNEY SPECKMAN</td>
<td></td>
<td>NEXANT 101 Second Street, 11th Floor, 94105</td>
</tr>
<tr>
<td>JAMES H. NELSON Ph.D</td>
<td></td>
<td>ENERGY AND ENVIRONMENTAL ECONOMICS, INC. 101 Montgomery St., 16th Fl., 94105</td>
</tr>
<tr>
<td>AMISHA RAI</td>
<td></td>
<td>ADVANCED ENERGY ECONOMY 135 Main St., Suite 1320, 94105</td>
</tr>
<tr>
<td>BRUCE PERLSTEIN</td>
<td></td>
<td>KPMG LLP 55 Second St., Suite 1700, 94105</td>
</tr>
<tr>
<td>CASE ADMINISTRATION</td>
<td></td>
<td>PACIFIC GAS AND ELECTRIC COMPANY 77 Beale Street, 94105</td>
</tr>
<tr>
<td>DON BROOKHYSER</td>
<td></td>
<td>BUCHALTER, A PROFESSIONAL CORPORATION 55 Second Street, Suite 1700, 94105</td>
</tr>
<tr>
<td>EMILIE OLSON</td>
<td></td>
<td>ADVANCED ENERGY ECONOMY 135 Main Street, Suite 1320, 94105</td>
</tr>
<tr>
<td>MARK R. HUFFMAN</td>
<td></td>
<td>PACIFIC GAS AND ELECTRIC COMPANY 77 Beale Street, B30A, 94105</td>
</tr>
<tr>
<td>PATTY COOK</td>
<td></td>
<td>PACIFIC GAS &amp; ELECTRIC COMPANY 55 Second Street, Suite 1700, 94105</td>
</tr>
<tr>
<td>Name</td>
<td>Position</td>
<td>Address</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>ICF International</td>
<td>SMART WIRES</td>
<td>620 FOLSOM STREET, STE. 200</td>
</tr>
<tr>
<td>SHOSHAN LUCICH</td>
<td>ATTORNEY AT LAW</td>
<td>201 SPEAR STREET, STE. 1350</td>
</tr>
<tr>
<td>Morgan, Lewis &amp; Bockius, LLP</td>
<td>ONE MARKET, SPEAR STREET TOWER</td>
<td>620 FOLSOM STREET, STE. 200</td>
</tr>
<tr>
<td>SHOSHANA LUCICH</td>
<td>ATTORNEY AT LAW</td>
<td>201 SPEAR STREET, STE. 1350</td>
</tr>
<tr>
<td>Tovah Trimming</td>
<td>BUCHALTER, A PROFESSIONAL CORPORATION</td>
<td>55 SECOND STREET, SUITE 1700</td>
</tr>
<tr>
<td>Environmental Law &amp; Justice Clinic</td>
<td>GOLDEN GATE UNIVERSITY SCHOOL OF LAW</td>
<td>536 MISSION STREET</td>
</tr>
<tr>
<td>Perkins Coie LLP</td>
<td>ATTORNEY</td>
<td>505 HOWARD STREET, STE. 1000</td>
</tr>
<tr>
<td>F. Jackson Stoddard</td>
<td>ATTORNEY</td>
<td>505 HOWARD STREET, STE. 1000</td>
</tr>
<tr>
<td>Monica A. Schwebs</td>
<td>ATTORNEY AT LAW</td>
<td>505 HOWARD STREET, STE. 1000</td>
</tr>
<tr>
<td>Morgan Lewis Bockius LLP</td>
<td>ONE MARKET, SPEAR STREET TOWER</td>
<td>505 HOWARD STREET, STE. 1000</td>
</tr>
<tr>
<td>Monica A. Schwebs</td>
<td>ATTORNEY AT LAW</td>
<td>505 HOWARD STREET, STE. 1000</td>
</tr>
<tr>
<td>Tovah Trimming</td>
<td>ATTORNEY</td>
<td>505 HOWARD STREET, STE. 1000</td>
</tr>
<tr>
<td>Morgan Lewis Bockius LLP</td>
<td>ONE MARKET, SPEAR STREET TOWER</td>
<td>505 HOWARD STREET, STE. 1000</td>
</tr>
<tr>
<td>Brian Kooiman</td>
<td>OHMCONNECT, INC.</td>
<td>350 TOWNSEND ST., STE. 210</td>
</tr>
<tr>
<td>Francesca Wahl</td>
<td>SR. ASSOCIATE, BUS. DEVELOPMENT</td>
<td>350 TOWNSEND ST., STE. 210</td>
</tr>
<tr>
<td>John W. Anderson</td>
<td>DIR - ENERGY MARKETS</td>
<td>350 TOWNSEND ST., SUITE 210</td>
</tr>
<tr>
<td>Buck Endemann</td>
<td>OHMCONNECT, INC.</td>
<td>350 TOWNSEND ST., SUITE 210</td>
</tr>
<tr>
<td>John McIntyre</td>
<td>ATTORNEY</td>
<td>350 TOWNSEND ST., SUITE 210</td>
</tr>
<tr>
<td>Katie Jorrie</td>
<td>ATTORNEY</td>
<td>423 WASHINGTON ST.</td>
</tr>
<tr>
<td>Molly Deringer Croll</td>
<td>CALIFORNIA ENVIRONMENTAL ASSOCIATES</td>
<td>423 WASHINGTON ST.</td>
</tr>
<tr>
<td>Rikki Weber</td>
<td>CALIFORNIA ENVIRONMENTAL ASSOCIATES</td>
<td>423 WASHINGTON ST.</td>
</tr>
<tr>
<td>Litigation Assistant</td>
<td>WEST REGION GEN. COUNSEL</td>
<td>423 WASHINGTON ST.</td>
</tr>
<tr>
<td>Earthjustice</td>
<td>NRG ENERGY, INC.</td>
<td>423 WASHINGTON ST.</td>
</tr>
<tr>
<td>50 California Street, Suite 500</td>
<td>EARTHJUSTICE</td>
<td>50 California Street, Suite 500</td>
</tr>
</tbody>
</table>
ED SMELLOFF  
MANAGING DIRECTOR, REGULATORY TEAM  
VOTE SOLAR  
360 22ND STREET, SUITE 730  
OAKLAND, CA  94612

JAMES HANSELL  
DVN GL GROUP  
1505 JACKSON STREET  
OAKLAND, CA  94612

JIM BAAK  
PROGRAM DIR - GRID INTEGRATION  
VOTE SOLAR  
360 22ND FLOOR, SUITE 730  
OAKLAND, CA  94612

KATHERINE RAMSEY  
STAFF ATTORNEY  
SIERRA CLUB ENVIRONMENTAL LAW PROGRAM  
2101 WEBSTER STREET, SUITE 1300  
OAKLAND, CA  94612

RACHEL BIRD  
DIR - POLICY & BUS. DEVELOPMENT, WEST  
BORREGO SOLAR SYSTEMS, INC.  
360 22ND STREET, SUITE 600  
OAKLAND, CA  94612

TIM LINDL  
COUNSEL  
KEYES & FOX LLP  
436 14TH STREET, STE. 1305  
OAKLAND, CA  94612

CLAIRE V. BROOME  
26 NORTHGATE AVE  
BERKELEY, CA  94708

R. THOMAS BEACH  
PRINCIPAL CONSULTANT  
CROSSBORDER ENERGY  
2560 NINTH STREET, SUITE 213A  
BERKELEY, CA  94710

MCE REGULATORY  
MARIN CLEAN ENERGY  
1125 TAMALPAIS AVENUE  
SAN RAFAEL, CA  94901

SHALINI SWAROOP  
REGULATORY & LEGISLATIVE COUNSEL  
MARIN CLEAN ENERGY  
1125 TAMALPAIS AVENUE  
SAN RAFAEL, CA  94901

PHILLIP MULLER  
PRESIDENT  
SCD ENERGY SOLUTIONS  
436 NOVA ALBION WAY  
SAN RAFAEL, CA  94903

JOHN NIMMONS  
COUNSEL  
JOHN NIMMONS & ASSOCIATES, INC.  
175 ELINOR AVE., STE. G  
MILL VALLEY, CA  94941

DAVID REYNOLDS  
REGIONAL DIRECTOR  
ERS  
152 N. 3RD STREET, SUITE 520  
SAN JOSE, CA  95112

C. SUSIE BERLIN  
LAW OFFICES OF SUSIE BERLIN  
1346 THE ALAMEDA, STE. 7, NO. 141  
SAN JOSE, CA  95126

CB HALL  
SONOMA CLEAN POWER  
50 SANTA ROSA AVENUE, 5TH FLOOR  
SANTA ROSA, CA  95404

DEB EMERSON  
DIR - POWER SERVICES  
SONOMA CLEAN POWER  
50 SANTA ROSA AVENUE, 5TH FLR.  
SANTA ROSA, CA  95404

JACK TIBBETTS  
CALIFORNIA CLEAN POWER  
50 SANTA ROSA AVENUE, SUITE 420  
SANTA ROSA, CA  95404

JAN MCFARLAND  
SONOMA CLEAN POWER  
50 SANTA ROSA AVENUE 5TH FLR  
SANTA ROSA, CA  95404

PETER RUMBLE  
CALIFORNIA CLEAN POWER  
50 SANTA ROSA AVENUE, SUITE 420  
SANTA ROSA, CA  95404

MARGIE GARDNER  
EXECUTIVE DIRECTOR  
CAL. ENERGY EFFICIENCY INDUSTRY COUNCIL  
1535 FARMERS LANE, SUITE 312  
SANTA ROSA, CA  95405

JAMES H. CALDWELL, JR.  
JAN MCFARLAND
<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Organization</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALLISON CAMPBELL</td>
<td>MGR - POWER RESOURCES</td>
<td>REDWOOD COAST ENERGY AUTHORITY</td>
<td>633 3RD STREET, EUREKA, CA 95501</td>
</tr>
<tr>
<td>CHRISTOPHER DEVON</td>
<td></td>
<td>CALIFORNIA INDEPENDENT SYSTEM OPERATOR</td>
<td>250 OUTCROPPING WAY, SONOMA, CA 95476</td>
</tr>
<tr>
<td>JILL POWERS</td>
<td></td>
<td>CALIFORNIA INDEPENDENT SYSTEM OPERATOR</td>
<td>250 OUTCROPPING WAY, SONOMA, CA 95476</td>
</tr>
<tr>
<td>KARL MEEUSEN, PH.D</td>
<td></td>
<td>CALIFORNIA INDEPENDENT SYSTEM OPERATOR</td>
<td>250 OUTCROPPING WAY, SONOMA, CA 95476</td>
</tr>
<tr>
<td>KIM PEREZ</td>
<td></td>
<td>CALIFORNIA ISO</td>
<td>250 OUTCROPPING WAY, SONOMA, CA 95476</td>
</tr>
<tr>
<td>PAUL D. MAXWELL</td>
<td></td>
<td>NAVIGANT CONSULTING, INC.</td>
<td>35 IRON POINT CIRCLE, STE. 225, FOLSOM, CA 95630</td>
</tr>
<tr>
<td>TIM MASON</td>
<td></td>
<td>GRID SUBJECT MATTER EXPERTS, LLC</td>
<td>1847 IRON POINT RD., STE. 140, FOLSOM, CA 95630</td>
</tr>
<tr>
<td>LORENZO KRISTOV</td>
<td></td>
<td>CALIFORNIA ISO</td>
<td>250 OUTCROPPING WAY, SONOMA, CA 95476</td>
</tr>
<tr>
<td>TIM MASON</td>
<td></td>
<td>GRID SUBJECT MATTER EXPERTS, LLC</td>
<td>1847 IRON POINT RD., STE. 140, FOLSOM, CA 95630</td>
</tr>
<tr>
<td>ROBIN SMUTNY-JONES</td>
<td>DIR., CALIFORNIA POLICY &amp; REGULATION</td>
<td>IBERDROLA RENEWABLES, LLC</td>
<td>3009 E. PINTAIL WAY, ELK GROVE, CA 95757</td>
</tr>
<tr>
<td>MATTHEW SWINDLE</td>
<td>CEO &amp; FOUNDER</td>
<td>NLINE ENERGY, INC.</td>
<td>5170 GOLDEN FOOTHILL PARKWAY, EL DORADO HILLS, CA 95762</td>
</tr>
<tr>
<td>ROBIN SMUTNY-JONES</td>
<td>DIR., CALIFORNIA POLICY &amp; REGULATION</td>
<td>IBERDROLA RENEWABLES, LLC</td>
<td>3009 E. PINTAIL WAY, ELK GROVE, CA 95757</td>
</tr>
<tr>
<td>ROBIN SMUTNY-JONES</td>
<td>DIR., CALIFORNIA POLICY &amp; REGULATION</td>
<td>IBERDROLA RENEWABLES, LLC</td>
<td>3009 E. PINTAIL WAY, ELK GROVE, CA 95757</td>
</tr>
<tr>
<td>GWENN O’HARA</td>
<td>ATTORNEY</td>
<td>CALIFORNIA POWER LAW GROUP</td>
<td>1325 19TH STREET, SACRAMENTO, CA 95811</td>
</tr>
<tr>
<td>CATHERINE BESTLEY</td>
<td></td>
<td>RESERO CONSULTING</td>
<td>9289 SHADOW BROOK PLACE, GRANITE BAY, CA 95746</td>
</tr>
<tr>
<td>WENXIONG HUANG</td>
<td></td>
<td>WH ENERGY SOLUTIONS LLC</td>
<td>5014 CHELSHIRE DWNS ROAD, GRANITE BAY, CA 95746</td>
</tr>
<tr>
<td>ROBIN SMUTNY-JONES</td>
<td>DIR., CALIFORNIA POLICY &amp; REGULATION</td>
<td>IBERDROLA RENEWABLES, LLC</td>
<td>3009 E. PINTAIL WAY, ELK GROVE, CA 95757</td>
</tr>
<tr>
<td>GWENN O’HARA</td>
<td>ATTORNEY</td>
<td>CALIFORNIA POWER LAW GROUP</td>
<td>1325 19TH STREET, SACRAMENTO, CA 95811</td>
</tr>
<tr>
<td>CATHERINE BESTLEY</td>
<td></td>
<td>RESERO CONSULTING</td>
<td>9289 SHADOW BROOK PLACE, GRANITE BAY, CA 95746</td>
</tr>
<tr>
<td>WENXIONG HUANG</td>
<td></td>
<td>WH ENERGY SOLUTIONS LLC</td>
<td>5014 CHELSHIRE DWNS ROAD, GRANITE BAY, CA 95746</td>
</tr>
<tr>
<td>ROBIN SMUTNY-JONES</td>
<td>DIR., CALIFORNIA POLICY &amp; REGULATION</td>
<td>IBERDROLA RENEWABLES, LLC</td>
<td>3009 E. PINTAIL WAY, ELK GROVE, CA 95757</td>
</tr>
<tr>
<td>GWENN O’HARA</td>
<td>ATTORNEY</td>
<td>CALIFORNIA POWER LAW GROUP</td>
<td>1325 19TH STREET, SACRAMENTO, CA 95811</td>
</tr>
<tr>
<td>CATHERINE BESTLEY</td>
<td></td>
<td>RESERO CONSULTING</td>
<td>9289 SHADOW BROOK PLACE, GRANITE BAY, CA 95746</td>
</tr>
<tr>
<td>WENXIONG HUANG</td>
<td></td>
<td>WH ENERGY SOLUTIONS LLC</td>
<td>5014 CHELSHIRE DWNS ROAD, GRANITE BAY, CA 95746</td>
</tr>
<tr>
<td>ROBIN SMUTNY-JONES</td>
<td>DIR., CALIFORNIA POLICY &amp; REGULATION</td>
<td>IBERDROLA RENEWABLES, LLC</td>
<td>3009 E. PINTAIL WAY, ELK GROVE, CA 95757</td>
</tr>
<tr>
<td>GWENN O’HARA</td>
<td>ATTORNEY</td>
<td>CALIFORNIA POWER LAW GROUP</td>
<td>1325 19TH STREET, SACRAMENTO, CA 95811</td>
</tr>
<tr>
<td>CATHERINE BESTLEY</td>
<td></td>
<td>RESERO CONSULTING</td>
<td>9289 SHADOW BROOK PLACE, GRANITE BAY, CA 95746</td>
</tr>
<tr>
<td>WENXIONG HUANG</td>
<td></td>
<td>WH ENERGY SOLUTIONS LLC</td>
<td>5014 CHELSHIRE DWNS ROAD, GRANITE BAY, CA 95746</td>
</tr>
<tr>
<td>ROBIN SMUTNY-JONES</td>
<td>DIR., CALIFORNIA POLICY &amp; REGULATION</td>
<td>IBERDROLA RENEWABLES, LLC</td>
<td>3009 E. PINTAIL WAY, ELK GROVE, CA 95757</td>
</tr>
<tr>
<td>GWENN O’HARA</td>
<td>ATTORNEY</td>
<td>CALIFORNIA POWER LAW GROUP</td>
<td>1325 19TH STREET, SACRAMENTO, CA 95811</td>
</tr>
<tr>
<td>CATHERINE BESTLEY</td>
<td></td>
<td>RESERO CONSULTING</td>
<td>9289 SHADOW BROOK PLACE, GRANITE BAY, CA 95746</td>
</tr>
<tr>
<td>WENXIONG HUANG</td>
<td></td>
<td>WH ENERGY SOLUTIONS LLC</td>
<td>5014 CHELSHIRE DWNS ROAD, GRANITE BAY, CA 95746</td>
</tr>
<tr>
<td>ROBIN SMUTNY-JONES</td>
<td>DIR., CALIFORNIA POLICY &amp; REGULATION</td>
<td>IBERDROLA RENEWABLES, LLC</td>
<td>3009 E. PINTAIL WAY, ELK GROVE, CA 95757</td>
</tr>
<tr>
<td>GWENN O’HARA</td>
<td>ATTORNEY</td>
<td>CALIFORNIA POWER LAW GROUP</td>
<td>1325 19TH STREET, SACRAMENTO, CA 95811</td>
</tr>
<tr>
<td>CATHERINE BESTLEY</td>
<td></td>
<td>RESERO CONSULTING</td>
<td>9289 SHADOW BROOK PLACE, GRANITE BAY, CA 95746</td>
</tr>
<tr>
<td>WENXIONG HUANG</td>
<td></td>
<td>WH ENERGY SOLUTIONS LLC</td>
<td>5014 CHELSHIRE DWNS ROAD, GRANITE BAY, CA 95746</td>
</tr>
</tbody>
</table>

OLOF BYSTROM

AUDRA HARTMANN
BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking to
Develop an Electricity Integrated Resource Planning Framework and to Coordinate and Refine Long-Term Procurement Planning Requirements

Rulemaking 16-02-007

RANGE ENERGY STORAGE SYSTEMS COMMENTS ON MODELING ADVISORY GROUP DRAFT SOURCES FOR 2019-2020 IRP SUPPLY-SIDE RESOURCE MODELING

April 23, 2018

In accordance with the March 27, 2018 Energy Division request for comment, Range Energy Storage Solutions (“Range”) respectfully submits the following comments on the Energy Division’s Draft Sources for the 2019-2020 IRP Supply Side Resources (“Draft Sources”).

I. INTRODUCTION

Range has been an active participant in the Integrated Resource Planning process since its inception in 2016. In January 2017, we discussed including supply side information specific to Compressed Air Energy Storage (CAES) in the first iteration of the IRP model. We have continued to advocate that diverse technologies, including multiple bulk storage technologies, should be made available as candidate resources in this model because CAES has a different cost profile, operational profile and is more scalable than pumped hydro storage.

We are encouraged that staff has taken the opportunity to consider updating assumptions and inputs in the model, including incorporating new types of resources. The next IRP cycle will commence in a matter of months and this is the right opportunity to incorporate new resource types into the model which were absent in the first iteration.
II. RESPONSE TO QUESTIONS

Question 10: Are there any new resource types (not described in your responses to Questions 1 – 9) that Energy Division should prioritize including as a candidate resource in the 2019 IRP? Describe how the new resource type satisfies the new candidate resource criteria listed above. List the data sources available for quantifying the cost and potential of the proposed resource type and describe how the data sources satisfy the data source criteria listed above.

Compressed Air Energy Storage (CAES) should be included as a candidate resource in the 2019 IRP. Decision 18-02-018 Conclusion of Law (COL) 18 directed the Commission to “continue to evaluate the need for long lead-time resources, including out-of-state wind (and other renewables), geothermal, and pumped hydro storage (and other bulk storage) resources in subsequent IRP” (emphasis added). The Decision also suggests that CAES could be a new resource to include in the next IRP. As discussed below, CAES is a commercially available technology today which could significantly impact and improve the next portfolio selected for the 2019-2020 Reference System Plan, especially as other variables (e.g., availability of gas resources, carbon reduction targets/ranges, etc.) change.

CAES is commercially available today. Two CAES plants have been in commercial operation for decades. E.ON Kraftwerke operates a 290 MW CAES plant in Huntorf, Germany, commissioned in 1978. The PowerSouth Energy Cooperative has had a 240 MW CAES plant in McIntosh, Alabama, commissioned in 1991. Lazard calls CAES, “a mature technology with a well-developed design and a proven track record which leverages existing gas turbine technologies.”

There are multiple companies actively pursuing new CAES projects today, including Range ESS, Magnum CAES, and Apex CAES. Finally, the Southern California Public Power Authority is currently evaluating CAES proposals submitted in response to their January 2018 CAES

---

1 Decision 18-02-018, http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M209/K771/209771632.PDF, p. 166.
2 Decision 18-02-018, p. 51.
The absence of a recently completed CAES facility should not be viewed as an indication of technology readiness. There is no question about the commercial availability of CAES.

**CAES could substantially impact future portfolio costs and composition.** Given other changes in resource assumptions and targets which the Commission could implement for the 2019 IRP, it is much more likely that the model will select a bulk storage resource for the next Reference System Plan. First, the next IRP may implement a more stringent carbon target. While the Commission selected the 42 MMT reference system plan for the 2017 IRP, at higher RPS levels and carbon reduction levels (the 30 MMT scenario), bulk storage (PHS) was selected by the model as a cost-effective resource. Second, the value of bulk storage in the development of the Reference System Portfolio also hinges on assumptions about other resources in the portfolio, such as the existing gas fleet. As the Commission revises the model’s assumption about which gas resources will be available in the future, allowing some to retire and some to compete, energy storage resources of all kinds are likely to become more competitive. The addition of CAES creates a more diverse set of bulk energy storage candidate resources (just as there are multiple forms of short-duration storage resources available) and will make the model more robust and useful to both the Commission and Load Serving Entities (LSEs).

Compared to other storage resources, CAES has the operating profile closest to that of a natural gas plant (while being much cleaner, more efficient, and more flexible than a simple cycle or combined cycle facility). CAES could therefore serve as the most suitable alternative to re-contracting gas-fired units in certain locations. By including all the best alternatives to natural gas resources in the model, the Commission will be well equipped to judge whether any new or re-contracted natural gas resources proposed in an LSE IRP are, in fact, justified, as required by Order number 8 in D 18-02-018. CAES is also less expensive than batteries and PHS on a levelized cost of storage basis and could therefore affect the cost effectiveness of the next resource portfolio.  

---


5 Lazard LCOS v. 2 p. 11.
Despite the Commission’s suggestion in D 18-02-018 that one bulk storage resource can act as a proxy for other bulk storage resources and that “pumped hydro storage can be generalized to include bulk storage of other types,”6 there are in fact significant differences in the cost, scale, and operating characteristics between different technologies. Range understands that for the first IRP, including one bulk storage technology was a way to begin evaluating this type of long-lead time resource. However, PHS is not an appropriate proxy for CAES. No other resources in the model appropriately represent CAES’s cost, performance, scalability and operating characteristics.

There are credible, public data sources available on CAES. Range recommends that Energy Division Staff examine and incorporate into the model data on CAES provided by the following sources:

1. **Lazard’s Levelized Cost of Storage Version 2.**7 Note that while staff stated a preference for Lazard LCOS Version 3 or later, Version 2 is the latest report which includes information on CAES.

2. **PacifiCorp IRP Storage Studies, by Black & Veatch (2017 and 2015).**8 See especially data in Table 11 (pg. 26) of the 2017 Bulk Storage Study.9

3. **Western Electricity Coordinating Council (WECC) Transmission Expansion Planning Policy Committee (TEPPC) 2015 Priority Study Inputs,** prepared with Burbank Water and Power and Duke American Transmission Company.10 Data inputs are provided in Attachment 1 of this comment letter.11

Each of these three data sources has been prepared and vetted by credible entities and in combination provide sufficient data on CAES capital costs, operating costs, and operating characteristics. Range has summarized the information in the following table, which generally

---

6 Decision 18-02-018 p. 78.
10 See study results: [https://www.wecc.biz/Administrative/160208_PC26_Study_Results_IPP-Swap.pptx](https://www.wecc.biz/Administrative/160208_PC26_Study_Results_IPP-Swap.pptx).
11 OEM can also provide updated information to CPUC staff.
aligns with the data inputs used in the model for other storage inputs. Range team members also worked closely with WECC over several months to determine the right approach for modeling CAES and would be happy to work with staff and E3 to determine how to appropriately model CAES in RESOLVE.

We also recommend the Commission utilize the aggregate data received by SCPPA in their very recent solicitation to validate or improve upon CAES assumptions in the model.

Table 1: CAES Data Sources & Values

<table>
<thead>
<tr>
<th>Data Need</th>
<th>Data Source</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available potential capacity (MW)</td>
<td>WECC TEPPC inputs</td>
<td>150 MW (single train)</td>
</tr>
<tr>
<td>Storage duration (hrs.)</td>
<td>Lazard 2.0</td>
<td>8 hours average daily discharge</td>
</tr>
<tr>
<td>Round-trip efficiency (%)</td>
<td>a) WECC TEPPC inputs</td>
<td>a) 83%</td>
</tr>
<tr>
<td></td>
<td>b) Lazard 2.0</td>
<td>b) 75-79%</td>
</tr>
<tr>
<td>Point of interconnection</td>
<td>Active proposals</td>
<td>Intermountain Power Project (IPP) at Delta, UT. Multiple pathways from IPP to CAISO.</td>
</tr>
<tr>
<td>Ramping limitations, if applicable (MW/min)</td>
<td>a) WECC TEPPC inputs</td>
<td>a) 20% of full load per minute; 30 MW/min generation (per single train); 25 MW/min compression (per single train);</td>
</tr>
<tr>
<td></td>
<td>b) PacifiCorp IRP Study</td>
<td>b) 32 MW/min</td>
</tr>
<tr>
<td>Other operational limits such as minimum time to switch from charge to discharge.</td>
<td>OEM Dresser-Rand</td>
<td>None, can operate concurrently.</td>
</tr>
<tr>
<td>Spinning reserves</td>
<td>a) WECC TEPPC Inputs</td>
<td>a) Full capacity spinning reserve (150 MW of 150 MW facility)</td>
</tr>
<tr>
<td></td>
<td>b) PacifiCorp IRP Study</td>
<td>b) 156.7 MW on 320 MW net capacity facility</td>
</tr>
<tr>
<td>Ability to contribute to other reserve requirements</td>
<td>PacifiCorp IRP Study</td>
<td>Expected use-cases include: Energy, capacity, spinning, regulation, non-spinning, black start</td>
</tr>
</tbody>
</table>
### Data Need

<table>
<thead>
<tr>
<th>Data Need</th>
<th>Data Source</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current and future projections of cost, performance, and financing</td>
<td>Lazard 2.0</td>
<td>CAGR 1%; 5 years = 5%</td>
</tr>
<tr>
<td>assumptions (used to develop forward-looking projections of PPA prices, $/MWh)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital cost, $/kW and $/kWh</td>
<td>a) Lazard 2.0</td>
<td>a) $146-$210/kWh</td>
</tr>
<tr>
<td></td>
<td>b) PacifiCorp IRP Study</td>
<td>b) $1,740/kW base capital</td>
</tr>
<tr>
<td>Fixed O&amp;M, $/kW-yr.</td>
<td>a) Lazard 2.0</td>
<td>a) $1-2/kWh</td>
</tr>
<tr>
<td></td>
<td>b) PacifiCorp IRP Study</td>
<td>b) $18.9/kW-yr.</td>
</tr>
<tr>
<td>Financing inputs (WACC, capital structure, etc.)</td>
<td></td>
<td>Suggest using similar financing inputs to those used for CCGT or CTs.</td>
</tr>
<tr>
<td>Tax credits (PTC, ITC)</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Heat Rate @Pmin/PMax</td>
<td>a) WECC TEPPC Inputs</td>
<td>a) 4.375 mmbtu/MWh (HHV) @Pmax</td>
</tr>
<tr>
<td></td>
<td>b) PacifiCorp IRP Study</td>
<td>b) 4.227 mmbtu/MWh (HHV) @Pmax</td>
</tr>
<tr>
<td></td>
<td>c) OEM Dresser-Rand</td>
<td>c) 5.210 mmbtu/MWh (HHV) @Pmin</td>
</tr>
<tr>
<td>Information12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**III. SUMMARY AND CONCLUSION**

CAES is a commercially available technology today which could significantly impact and improve the next portfolio selected for the 2019-2020 Reference System Plan, especially as other variables (available gas resources, carbon reduction targets) change.

The IRP is the state’s central procurement vehicle in the electricity sector. Excluding a low-GHG, flexible resource like CAES essentially bars it from the consideration and restricts resource competition and portfolio optimization (both in terms of costs and flexibility). It is critical that the Commission include CAES in the model today so that the Commission, the

---

CAISO, and LSEs can begin evaluating the potential for this resource to meet system needs and achieve 2030 GHG goals. If the Commission delays incorporating CAES into the model for another IRP cycle, it may not be possible for developers and LSEs to carry out the necessary evaluations, procurement processes, and construction activities to bring a facility on line by the time it is needed.

Respectfully,

/s/

____________________________

Molly Deringer Croll
California Environmental Associates

*On behalf of Range Energy Storage Systems*
Gridview CAES Entries

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generator Name:</td>
<td>CAES Unit 1</td>
<td>Single CAES unit train. Total 1200 MW would be comprised of eight-150 MW units like this.</td>
</tr>
<tr>
<td>Long Name:</td>
<td>-</td>
<td>To be provided by modeler.</td>
</tr>
<tr>
<td>Long ID:</td>
<td>-</td>
<td>To be provided by modeler.</td>
</tr>
<tr>
<td>Bus ID:</td>
<td>-</td>
<td>To be provided by modeler.</td>
</tr>
<tr>
<td>Generator ID:</td>
<td>-</td>
<td>To be provided by modeler.</td>
</tr>
<tr>
<td>Initial Dispatch:</td>
<td>0</td>
<td>To be provided by modeler. Usually zero.</td>
</tr>
</tbody>
</table>
| Maximum Storage (MWh):           | 5976  | Maximum MWh of energy input to storage for each CAES unit, to support two days of generation at full, 150 MW output.  
150 MW * 48 hours * (0.83 storage input to generation output ratio) = 5976 MWh. |
| Minimum Storage (MWh):           | 0     | Minimum level of working air available. Cavern would always contain additional cushion air. |
| Minimum Generation Capacity (MW):| 17    | Minimum generation of an eight-unit, 1200 MW facility in total would be that for only a single unit = 17 MW. |
| Maximum Pumping Capacity (MW):   | 150   | Assumes multi-unit pumping MW for 1200 MW generation is 1200 MW (Same as generation MW). |
| Minimum Pumping Capacity (MW):   | 50    | When pumping, maximum turndown of compressors is 67%. Two-50% (i.e., 75 MW) compressors per CAES unit.  
0.5* 67% * 150 = 50 MW. |
| Maximum Pumping Price ($/MWh):   | See Comments | May need to be input as "IF-THEN" nomogram or formula to represent changing prices per then-current market pricing conditions.  
Example: 90% of average look-ahead price in next 24 hours? |
| Cost Benefit Ratio (%):          | 100   | Establishes whether CAES will generate based on cost/price ratio in that hour. |
| Spinning Reserve Contribution (MW)| 150   | For fast-ramping resources like CAES, full capacity can spin within time requirement to qualify. |
| Pumping Requirement:             | 0.83  | Ratio of (Storage MWh in)/(Net CAES Generation MWh out). |
| Heat Rate (MMBTU/MWh):           | 4.375 | For natural gas input to CAES generator (Higher heating value, HHV).  
Gridview entry page currently erroneously specifies units as MWh/MMBTU. |
| Fuel Name                        | NGAS  | Natural gas. |
| Ramping Rate for Generation (MW/hour): | 1800 | Ramp rate for generation: 20% of full load per minute = 150*0.2 = 30 MW/minute = 1800 MW/hour for each 150 MW CAES unit.  
In the future, Gridview entry page may be revised to use units in MW/minute. |
| Ramping Rate for Pumping (MW/hour): |       |  |
| Ramping Up or Down               | 3000  | 25 MW/minute for each 50% (75 MW) compressor in each 150 MW CAES unit. Two compressors can ramp 50 MW/minute.  
2 compressors * 25 MW/minute = 50 MW/minute * 60 minutes/hour = 3000 MW/hour. Same rate ramp for ramping up or down.  
Compressors in eight-150 MW CAES units (1200 MW) working together can ramp 8*50 MW/minute = 400 MW/minute, which is  
60 * 400 = 24,000 MW/hour. |
| Startup Cost ($)                 | 0     | Unlike a conventional CT, very little startup cost for CAES. |
| Emission:                        | See Comments | Coal: 0.9 metric tons CO$_2$/MWh.  
CCGT: 0.36 metric tons CO$_2$/MWh.  
CAES: 0.23 metric tons CO$_2$/MWh. |
| Scheduling Mode:                 | -     | To be provided by modeler. |
| Schedule Area/Region             | -     | To be provided by modeler. |

by: SA/RHS
Southern California Edison Company’s Informal Comments on Draft Sources for 2019-20
IRP Supply-Side Resources
April 23, 2018

On Tuesday, March 27, 2018, Staff issued a request for informal input on the sources for supply-side technology costs and potential to be used in 2019 Integrated Resource Planning (“IRP”) modeling. In the document, Staff outlined the various sources it currently considers when determining input assumptions in IRP modeling and listed several questions on which it invited parties to comment.

Southern California Edison Company (“SCE”) appreciates Staff’s willingness to update, improve, and gather party input on the supply-side resources used in IRP modeling and thanks Staff for its efforts to maintain and improve transparency. In their comments on the proposed Reference System Plan in the fall of 2017, several parties, including SCE, identified assumptions and inputs to the model that were inconsistent with observed market data or other industry-respected projections. In addition to those issues, technology and commodity costs change, sometimes rapidly. New use cases are also developing for selected technologies. It is essential that the IRP process incorporate updated assumptions as market conditions change.

SCE’s comments on Staff questions are focused on two key themes. First, as valuable as publicly available sources can be for their transparency and accessibility, they sometimes lag behind observed market conditions. Supplementing these sources with selected proprietary information would improve IRP modeling and portfolio outcomes. Fuel prices are a good example of input assumptions to which the modeling outcome is highly sensitive, but the publicly available sources Staff uses do not well reflect observed market realities. SCE’s previous comments have shown that the Reference System Portfolio’s timeline for resource buildout changes significantly when natural gas prices are adjusted to reflect observed market prices. Staff should be willing to make these adjustments using proprietary sources, especially where respected industry reports suggest public forecasts are not accurate, and where the model is highly sensitive to those inputs.

Second, it is important that Staff recognizes the impact of key inputs to the financial modeling in RESOLVE, and that steps are taken to improve transparency and accuracy of those inputs. The goal of IRP modeling should be to reflect underlying market conditions in the most accurate way possible and then let resources compete for placement into an optimal portfolio that reaches the greenhouse gas (“GHG”) emissions goals. There are several assumptions in the financial modeling engine that are unclear and others that are subject to policy change or uncertainty. These inputs can significantly affect the mix and amount of resources selected to fill the portfolio need. SCE further outlines these issues in its answer to question 14 below.

SCE thanks Staff for this opportunity to provide input and includes its comments on specific questions herein.

Questions from Energy Division Staff

1. Do parties have recommendations on public data sources that capture the costs and operational characteristics of retrofitted [gas] power plants?

SCE supports the idea of including a plant improvement adder to represent natural gas plant retrofits and upgrades. The set of retrofits and upgrades would be modeled with a capital cost, just like other candidate resources. The IRP modeling results could then select a retrofit or upgrade if, for example, it could improve the existing power plant performance or operating characteristics, and it was more cost-effective than other candidate resources. Plant retrofits and upgrades can include physical or programming improvements that: reduce $P_{\text{min}}$, increase operational flexibility, including ramping; improve heat rate; or institute other performance enhancing or emissions reduction modifications.

SCE is not aware of any publicly available source that specifically addresses the costs or generic characteristics of various forms of power plant retrofits and upgrades that may apply. This is partially because each natural gas plant is unique, and depending on the types of upgrades and improvements to each unique plant, these costs and characteristics could vary widely on a case-by-case basis. However, one possible alternative is to use a proxy value that represents the cost of generic upgrades and improvements. While there does not appear to be a pre-developed industry standard on a broadly applicable proxy
value, one approach could be to use a percentage of the capital cost of a new plant. The capital cost of a new plant can be obtained from a public source\(^2\) and then apply a factor of 10\% of the cost of a new plant to represent the cost of a retrofit. Alternatively, a study could be performed to develop a more engineered proxy algorithm. In either case, SCE agrees that including retrofitted gas plants as a candidate resource represents an important potential enhancement to IRP modeling.

2. **Current assumptions of technology mix for solar PV are 25\% fixed tilt and 75\% single axis tracking, both with inverter loading ratios (ILR) of 1.3. What assumptions should be made for the configuration and ILR of future solar PV facilities?**

SCE recognizes the challenges of modeling resources that can be developed using multiple configurations and appreciates Staff attempts to acknowledge and model both the fixed and tracking configurations that may be utilized going forward. However, SCE’s preferred method to identify the mix of these configurations is to let the model endogenously choose, based on the cost and performance of each type of plant. These assumptions are readily available for both fixed and tracking solar configurations of utility-scale solar plants. Therefore, the capacity expansion model should be able to evaluate each separately, so that the share of total additions for which each configuration accounts is an output of the model rather than a forced value. Market activity over recent years shows a shift toward single-axis tracking as the dominant configuration. However, as market conditions evolve and change, modeling both fixed and tracking solar as distinct resource types would eliminate the need for Staff to continually revise this assumption exogenously.

Regarding ILR parameters, SCE has observed ratios closer to 1.5 in recent years. We expect this ratio may continue to trend upward as solar paired with energy storage

---

\(^2\) One example of a publicly available source is the Energy Information Administration’s *Cost and Performance Characteristics of New Generating Technologies*, included in the 2018 Annual Energy Outlook. This source includes broad estimates of capital costs in the U.S. electric sector, as well as regional adjustments that provide California-specific estimates. Available at: [https://www.eia.gov/outlooks/aeo/assumptions/pdf/table_8.2.pdf](https://www.eia.gov/outlooks/aeo/assumptions/pdf/table_8.2.pdf).
becomes more prevalent, therefore reducing the effects of inverter constraints on the solar installation’s DC capacity.

3. **How should high- and low-cost trajectories for future PV costs be developed?**

SCE suggests that the high- and low-cost trajectories should represent a reasonable range of conservative and ambitious technology improvement projections and the cost reduction associated with those developments. SCE’s recommended method to develop these trajectories is to establish the current year’s cost from a source or sources and extrapolate high and low trajectories using different learning curves. SCE suggests validating publicly available cost estimates with proprietary sources which utilize specific expertise and resources to develop more targeted projections. SCE’s preferred source for this purpose is the IHS *US Solar PV Capital Cost and Required Price Outlook*. It provides a reasonable estimate of current costs and defines a future cost trajectory on a regionally specific basis.

4. **Do parties have recommendations on how to distinguish between specific battery technologies in an emerging market?**

Future planning models should have the flexibility to identify the best battery technologies to use for various purposes. For example, one type of battery may be useful in replacing peaker plants by responding quickly to system needs, while other batteries may be more effective for shifting generation in low demand hours to high demand hours. Battery storage characteristics, from ramping limitations to the number of cycles per day to upfront costs, may change significantly between these different technologies used for different purposes. In addition to different characteristics, batteries may receive revenues from differing value streams, such as Resource Adequacy or distribution deferral. Resource optimization in planning models will be improved by including the characteristics and, eventually, value streams that distinguish different battery storage products used for specific purposes.
5. **What sources should be considered in developing recommended battery costs for use in IRP?**

SCE agrees that Lazard’s *Levelized Cost of Storage Analysis*, which Staff has indicated is already an input to the RESOLVE model, is a valuable, publicly available source to use in modeling storage technology cost and operational parameters. SCE uses this source in conjunction with proprietary sources, such as the IHS *US Battery Storage Costs, Drivers, and Market Outlook* report, to develop its internal perspectives on the state of the storage market and how it may evolve in the near- to mid-term.

SCE recognizes and appreciates the challenge Staff faces, balancing a publicly available source’s accessibility and transparency against a proprietary source that may provide more detailed or up-to-date information. However, SCE recommends that Staff considers utilizing proprietary sources where appropriate to validate, adjust, or supplement publicly available cost and operational data. This is particularly relevant for newer technologies where costs and technological improvements, and projections of future improvements, are not always adequately captured by publicly available research.

6. **How should Multiple Use Applications of battery storage be modeled?**

SCE supports efforts to appropriately value and realize the multiple functions energy storage can provide to the grid. In the future, IRP modeling should be able to account for “value stacking” opportunities in modeling potential energy storage capacity expansion and SCE looks forward to continued engagement in IRP, the Multiple-Use Application (“MUA”) Working Group, and other venues as the market develops. However, it would be premature to attempt to include MUAs in the current version of capacity expansion modeling in IRP, both because the market and rules governing it remain early-stage, and because the model requires additional work on single-use storage modeling before multiple uses are considered.

Generally, SCE agrees that appropriately valuing MUA storage is a priority goal and that capacity expansion modeling will underestimate the optimal level, and contributions, of
grid-connected storage as long as these uses are not modeled. The MUA Decision\(^3\) provides interim rules that outline the benefits storage can provide at a given level of grid connection; however, more work is required to define the value of these benefits. Neither the market, nor the rules governing it, are well enough developed to provide substantial insight into appropriate modeling parameters or approaches at this time.

Further, the RESOLVE model, as a system-level model without deep geographic granularity, currently models only medium-duration load shifting and cannot account for all the various single-use applications in which a given battery can participate. For all these reasons, SCE supports continuing work within the MUA Working Group and with the Commission, California Independent System Operator (“CAISO”), and other stakeholders in other venues to define storage use cases and values. However, this work is ongoing, and SCE recommends continued monitoring rather than attempting to model MUA values at this time.

7. **How should high- and low-cost trajectories for future battery costs be developed?**

As previously stated, SCE agrees that Lazard’s *Levelized Cost of Storage Analysis – Version 3.0* report is a valuable publicly available source that estimates energy storage technology costs and future projections. This report also provides low and high cost ranges. These ranges should be used in conjunction with proprietary sources to guide Staff in developing high and low battery storage ranges.

8. **How should pumped storage costs be represented given that they are highly site-specific and difficult to estimate on a generic basis?**

SCE agrees that pumped storage’s cost is highly site-specific, and is difficult to represent on a generic basis. There are also relatively few observed, recent data points on which to build a reasonable forecast of pumped storage capital and operating costs. SCE does not have an existing, well-developed methodology to recommend for determining new pumped storage cost estimates. Instead, SCE offers one suggestion for a proxy method and two more general guiding principles.

\(^3\) D.18-01-003, Appendix A.
In terms of a proxy method, Staff could consider collecting observed capital costs from existing plants and using them as a guidepost for new development costs. In particular, if new sites are in close proximity to proposed capacity additions, these estimates may capture some of the site-specific cost drivers a new unit would face.

Regarding guiding principles, SCE recommends Staff takes into consideration two key aspects of pumped storage plants when developing estimates. First, internal analysis suggests that scale effects are particularly relevant for pumped storage. In other words, there is a theoretical minimum unit size below which pumped storage additions would not be considered economic or practical. Second, new pumped storage projects require long project development cycles, in many cases upward of ten years. Staff should consider this in the event IRP modeling selects any new pumped storage capacity, in particular if capacity is projected to be added within this ten-year window.

9. **To what extent are new pumped hydroelectric facilities able to contribute to primary frequency response?**

IRP modeling should consider pumped hydroelectric facilities as bulk storage assets and not frequency response assets, given the scale and operational profile of these projects. According to industry research presented by the Electric Power Research Institute (“EPRI”) to the Commission in R.10-12-007, pumped hydro storage facilities have an optimal scale of many hundreds of megawatts and it is more financially beneficial for those assets to provide bulk shifting services than ancillary services. In the study, EPRI states that “[r]egulation service has lower priority than system electric supply capacity. To provide this service, the storage system must have at least 15 minutes of capacity available. Its dispatch is on the same priority level and co-optimized with other ancillary services and electric energy time-shift to maximize market profit.”[^4] Pumped hydro’s scale and operational profile make it much better suited to providing higher priority system electric supply capacity services rather than frequency response.

10. Are there any new resource types (not described in responses to Q1-9) that Energy Division should prioritize including as a candidate resource in the 2019 IRP? Describe how the new resource type satisfies the new candidate resource criteria listed above. List the data sources available for quantifying the cost and potential of the proposed resource type and describe how the data sources satisfy the data source criteria listed above.

The current set of supply-side candidate resources is reasonable for the 2019 IRP cycle.

11. Are there data sources (not described in responses to Q1-9) that should be considered for modifying the candidate resource potential assumed in IRP? Please describe and provide a link for any suggested data sources. Explain how the data source meets the data source criteria listed above.

SCE has no further comment on sources for candidate resource potential, other than the sources discussed in responses 1-9. However, SCE also provides its response to the question related to demand response (“DR”) resources from the “Draft Sources for 2019-2020 IRP Supply-side Resources” document, per Staff’s request in the March 30 Modeling Advisory Group webinar. The question is as follows:

Are there other data sources that should be considered for additional DR cost and potential, beyond the latest version of the California Demand Response Potential Study?

SCE recommends using programmatic, market, and/or pilot data, where available, to ensure that reasonable and achievable DR potential is reflected for IRP planning purposes. For offerings being defined as “Shed,” current DR programs will best serve to inform costs, availability, and other attributes. SCE can provide program data to Staff, which would help better define appropriate cost parameters for Shed offerings. SCE also recommends Staff supplements its analysis with the 2017 Load Impact Study5 and SCE’s

---

prospective portfolio submitted as part of the approved 2018-2022 Demand Response Application.⁶

SCE recognizes there are limited sources of publicly available data, outside of the most recent DR Potential Study, for offerings that are defined as “Shift,” “Shape,” and “Shimmy.” These offerings are currently being considered for new models of DR and are largely in the development phase. As they remain relatively nascent, with high uncertainty regarding their cost, value, market potential, and adoption rates, SCE recommends Staff refers to timing and sequencing considerations of ongoing activities in DR-specific proceedings that may help inform appropriate modeling parameters. SCE also expects that future updates to the DR Potential Study will capture additional market changes that affect appropriate values for these products.

Currently, Staff and stakeholders are developing a means of enabling new products and models for DR through the Load Shift Working Group. This Working Group is required to submit a final report to the Commission on January 31, 2019, outlining recommendations and positions on the parameters around a new load shifting product. Over the next few months, stakeholders will be work to clarify different product types, determine how to integrate the resources in the wholesale market, and address the necessary policy/operational barriers to enable the market to offer products such as Load Shift. Concurrently, CAISO’s ESDER Phase III pilot will help inform these efforts, albeit limited to a specific technology during the first stage of development. The earliest these products could “go-live” in the market would be sometime in 2020 (i.e., following CAISO and Federal Energy Regulatory Commission approvals and CAISO systems updates to enable “go-live”). Until these offerings are better understood and clearly defined, SCE recommends limiting reliance on lesser known products and their values.

As these new products are integrated into the market, lessons learned from their early adoption can inform the next DR Potential Study and future IRP efforts.

12. Are there any additional sources of capital cost, operating cost, and performance projections (not described in your responses to Q1-9) that should be considered for

---

⁶ Per D.17-12-003.
solar PV or wind? Explain how the data source meets the data source criteria listed above.

SCE recommends Staff considers two additional sources not discussed in previous questions, to further validate technology cost assumptions entered into RESOLVE.

The first is the NREL Annual Technology Baseline. Staff documented utilizing this source only for conventional gas generators and did not look to this study for current and projected technology costs for wind, solar, and various other technologies. This data is both technically credible and publicly available, the two most important criteria for the assumptions used in RESOLVE.

Second, Staff should consider utilizing proprietary data to supplement its publicly available sources. SCE recommends using research from IHS, including the US Wind and Capital Cost and Required Price Outlook, and the US Solar PV Capital Cost and Required Price Outlook. IHS develops its current and projected cost analyses using proprietary models and input from industry participants. The reports are considered technically credible and are widely respected among industry professionals. They also include regional level data, which is another key criterion for assumptions used in IRP modeling.

13. **How should import tariffs on solar PV modules be represented?**

SCE appreciates that Staff is considering how to account for Section 201 import tariffs on solar crystalline silicon photovoltaic modules in IRP modeling given recent Federal policy changes. Given the ad valorem structure of the tariff, SCE recommends that Staff models an adjusted solar installed cost projection as a function of baseline (pre-tariff) installed costs, the share of installed cost accounted for by the modules, and the applicable tariff rate on modules for a given model year. Mathematically, this method would be calculated in the following way, where \( m \) represents the portion of total installed cost attributable to modules and \( t \) represents the tariff rate:

---

2 Available at: https://atb.nrel.gov/.
New Solar Installed Cost

\[
= \text{Old Solar Installed Cost} \times (1 - m) + \text{Old Solar Installed Cost} \times m \\
\times (1 + \text{tariff rate})
\]

\[
= \text{Old Solar Installed Cost} \times (1 + mt)
\]

To complete this analysis, Staff would need to develop a perspective on the percent of a given solar installation’s price attributable to modules and recognize that this value varies by the type of installation considered (i.e., distinct \( m \) values exist for utility-scale, commercial, and residential solar PV installed costs). Various public and proprietary sources can provide this perspective. SCE recommends estimated values of approximately 33% for utility-scale, 20% for commercial distributed, and 15% for residential distributed.\(^8\)

The tariff rate is established by the Presidential Proclamation 9693\(^2\) and shown in the table below.

<table>
<thead>
<tr>
<th>Year (Feb-Feb)</th>
<th>1 (2018-19)</th>
<th>2 (2019-20)</th>
<th>3 (2020-21)</th>
<th>4 (2021-22)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module tariff rate ((t))</td>
<td>30%</td>
<td>25%</td>
<td>20%</td>
<td>15%</td>
</tr>
</tbody>
</table>

This simplified methodology does not account for all the potential nuances of the Section 201 tariff administration. For example, it assumes all modules are imported and subject to the tariff, while in fact there are several countries producing small volumes of modules that may be exempt. While the simplification is directionally correct, given the broad nature of industry protection tariffs, some small quantity of crystalline silicon modules would likely be exempt from the duty. It should also be noted that thin-film solar modules are exempt from these tariffs, and the model does not provide a clear method of

---

\(^8\) These ratios are approximated, and derived from public reports estimating the impact of solar tariffs on the cost of installations, and average system cost estimates.

accounting for the type of solar module chosen for a given project. One way to account for this issue could be to make a simplifying assumption that most fixed-tilt systems will use thin film technology and most single-axis tracking systems will use crystalline silicon modules. When combined with SCE’s recommendation to model fixed and tracking system costs separately and let the capacity expansion model choose between them, Staff could allocate the tariff costs only to tracking systems for the purposes of planning.

The nature of this policy also raises the importance of utilizing opportunities to improve the time granularity of IRP modeling. Given RESOLVE currently only models every fourth year in the planning period, impactful policies that are instituted and/or expire in between those time periods are inherently obscured. Rather than attempting to capacity weight the tariff to account for this issue in specific modeled year, Staff should consider improving the model’s time granularity to an annual or biennial period.

14. Should any of the cost and financing assumptions in RESOLVE’s LCOE calculations be modified, for example: assumptions related to state and federal tax incentives, the cost of capital, and financing lifetime? Explain and support any recommended changes using publicly available information, to the greatest extent possible.

SCE appreciates Staff raising this question, given the sensitivity of the optimal portfolio to these assumptions. Testing has shown that it is possible to substantially alter the optimal portfolio’s mix and timing by making reasonable changes to the financial model without changing any underlying technology or fuel cost data. This is particularly relevant for certain technology types, such as geothermal. SCE submits the following comments on factors related to capital structure, tax rates, tax incentives, and out-of-state transmission cost adders.

**Capital structure**

With regard to the capital structure, SCE suggests several key assumption adjustments or clarifications. First, SCE recommends either that all resources be modeled using the same capital structure, or that Staff conducts research and provide documentation with regard to differences in capital structure by technology type. In RESOLVE’s current method,
resources can differ not only in variable cost, fixed cost, construction cost, and incentives, but also equity share and discount rates. Without keeping the capital structure the same, different technology costs are not evaluated on a level playing field. For example, solar developers are assumed to use 52% equity whereas geothermal and battery developers are assumed to use 20-30% equity. In a model where only the cost data drives financial differences, rather than the financial modeling, the valuation would be more directly related to the information at hand rather than assumed calculations that may not bear out in future deployments. If these assumptions should vary by technology, Staff should consider reporting more thoroughly on the genesis of these assumptions. For example, developer capital structures might be studied using data on public companies.

SCE also suggests additional vetting and documentation around the discount rates used to levelize costs in worksheet “COSTS_Pro_Forma.” With the current range of discount rates ranging from 12% to 23%, it is difficult for SCE to determine how these values were selected and how they compare to discount rates used in independent power producers’ (“IPP”) financial models or other similar financial modeling on future capacity expansion estimates. Excessively high discount rates serve to underestimate renewable power purchase agreement prices as a seller would, in reality, be recovering investment costs at a faster rate than assumed in RESOLVE.

Further, the RESOLVE model’s use of cost of equity measures lacks transparency and SCE suggests two changes. First, as the model makes certain assumptions about the equity and debt shares for project finance, it may better reflect financial market conditions to use the Weighted Average Cost of Capital (“WACC”) as the discount rate for this purpose. WACC is a more accurate reflection of the opportunity cost of capital and therefore a more reasonable measure to include in investment calculations. Second, the cost levelization uses Cost of Equity in the numerator (net present value of payments) while the denominator (net present value of capacity) uses another rate (called “Discount Rate” in cell Costs_Pro_Forma C51). SCE believes that the two rates should be equal in order for future payments and future capacity to be valued in the same present value terms. It seems that the difference between Cost of Equity and Discount Rate may reflect some cost escalation; however, SCE notes that the escalation seems to be captured in the
payment streams of Fixed Operations & Maintenance, Production Tax Credit, and Fuel. In this case, modifying Discount Rate to reflect escalation may result in double counting the escalation.

Finally, SCE requests Staff validates the use of a cost escalation calculation in Fixed Operations & Maintenance, Production Tax Credit, and Fuel. Costs are reported in constant 2016 dollars, and cost escalations typically reflect monetary, rather than real, changes in contracts. In general, no monetary effects should be modeled if the costs are stated in real terms. However, if a monetary effect were being captured, the exponent in the escalation should reflect the distance from the constant dollar year rather than only the lifetime year of the project.

**Tax rates**

With regard to tax rates assumed in RESOLVE, SCE makes two recommendations to bring modeling more in line with current policy. First, the California state corporate tax rate in RESOLVE should be set to the actual current rate of 8.84%, rather than the 7% figure currently used in RESOLVE. Differences in tax rates can result in different revenue requirements and total resource costs, but also affect the resources selected in the optimal portfolio.

Further, changes in Federal corporate tax policy should be reflected in the next cycle of IRP modeling. The “Tax Cuts and Jobs Act of 2017” (H.R. 1, 115th Congress) institutes a much lower corporate tax rate, at 21%, than the 35% currently modeled in RESOLVE. According to SCE’s sensitivity testing in RESOLVE, reducing the corporate tax rate to 21% over the full planning horizon increases modeled optimal geothermal additions by over 50%. As capacity additions are capital intensive and the tax rates affect capital costs through deductions for interest and depreciation, it also would be prudent to consider sensitivities around future uncertainty in Federal tax policy (for example, one in which the corporate tax rate starts at 21% in the base year, but returns to the previous 35% later in the planning horizon).
**Tax incentives**

SCE makes two recommendations with regard to how investment and production tax credits are modeled. First, the Investment Tax Credit (“ITC”) and Production Tax Credit (“PTC”) are modeled assuming developers/sellers can monetize the entire ITC benefit one-for-one, and that the full value is passed through to customers. In reality, these tax credits are generally distributed as a negative value in the company’s future taxes. In order to harness the ITC as working capital, IPPs have historically entered into agreements known as tax equity financing wherein the future ITC value is sold to other, typically non-IPP companies. These agreements inherently put the ITC at a discount, and the full value is not passed through to customers in the form of cost savings. This should be better captured in the RESOLVE modeling.

Second, the RESOLVE model’s current version assumes unlimited tax deductibility of interest payments on construction and interconnection. However, federal law places a cap on the level of the deduction based on a company’s earnings before interest, taxes, and amortization (“EBITA”).\(^\text{10}\) Testing suggests that the interest deduction significantly affects the optimal portfolio and the path to 2030. In test scenarios SCE ran to adjust this assumption, geothermal capacity quadrupled, solar declined nearly 50%, and no wind was procured until the 2030 model year.

**Out-of-state transmission cost adders**

Finally, SCE asks that Staff provides additional transparency regarding the out-of-state transmission cost adders applied to relevant resource options in the RESOLVE model. Staff’s Inputs and Assumptions document released in September 2017 notes that these values are “derived” from CAISO data. It is, however, unclear whether or not these values were included as reported by CAISO and if so, which reports produced them. Without additional transparency, it is difficult for parties to validate that the assumed

---

\(^\text{10}\) For additional context, please see the following sources:

costs reasonably reflect future cost of transmission additions required to deliver out-of-
state renewables into the California market.

15. Other issues not addressed in questions.

There are several issues on which Staff did not specifically request input, but are
important to mention in a thorough review of supply-side input assumptions. SCE
addresses issues related to natural gas generating facilities and fuel costs, and
recommends an additional source for transmission data.

Existing natural gas facilities

As SCE stated in its previous comments on the Reference System Plan, it is important
that IRP modeling be able to identify natural gas plant economic shutdown conditions. To
create this functionality, Staff should strongly consider integrating annual fixed costs
along with the current profile of variable operating and maintenance costs for existing
natural gas facilities. Without this information, there will potentially be errors in the
planning reserve margin, and other important metrics.

Fuel prices

The RESOLVE model currently relies on gas price forecasts reported in the state’s
Integrated Energy Policy Report (“IEPR”), but as SCE previously noted, the gas prices
provided by this report differ from both available data on gas prices in California, and
from proprietary forecasts. As SCE highlighted in previous comments, the Reference
System Portfolio’s timeline for resource buildout changes significantly when natural gas
prices are adjusted to reflect observed market prices. Given this sensitivity, and the
inaccuracy of publicly available data, Staff should strongly consider supplementing and
validating existing publicly available sources with one or more additional proprietary
sources that better reflect market realities.

11 Comments of Southern California Edison Company (U 338-E) on Administrative Law Judge’s Ruling
Seeking Comment on Proposed Reference system Plan and Related Commission Policy Actions,
October 26, 2017, at 25.
Further, the method IEPR uses to extrapolate seasonal changes in gas price may no longer be appropriate. The current methodology assumes all gas price hubs will have the same monthly shape as the Henry Hub. However, various fundamental market changes have occurred since this methodology originated that invalidate this assumption. For example, the significant diminution of gas storage capacity at Aliso Canyon makes California gas prices more seasonal than other North American hubs. The ascendance of Appalachia and Permian Basin as the two fastest growing gas production hubs also affects this assumption. Permian Basin is the nearest supply basin to California, and its gas is largely produced in conjunction with oil. This means the proximate supply to California has less supply elasticity than the drier gas plays of the Gulf Coast region. Until the IEPR’s model is refined to reflect these changes, seasonality depicted in IEPR and transferred to RESOLVE will remain unreliable.

**Transmission capacity and cost**

When considering appropriate transmission capacity and cost assumptions, SCE recommends Staff considers the RETI 2.0 reports\[12\] in addition to those sources already mentioned in Section 3.3 of Staff’s supply-side source documentation. RETI 2.0 can provide additional information on bulk transmission system capacity for new generation resources. Currently the only primary data source is listed as CAISO supplemental analysis based on the current year’s Transmission Planning Process work. Adding an additional source would help validate Staff’s current assumptions and identify potential opportunities for refinement.

To: California Public Utilities Commission Integrated Resource Plan Staff  
From: Dr. Arne Jacobson, Director, Schatz Energy Research Center  
Re: New Resource Type for IRP- Offshore Wind

Off-shore wind energy can play an important role in helping California meet its medium and long-term renewable energy targets and greenhouse gas emission reduction goals and therefore should be included as a candidate resource in the 2019 Integrated Resource Plan (IRP). Offshore wind has a plausible trajectory to commercial availability within the planning time horizon as evidenced offshore wind technology deployment in Europe1 and early stage activities in California such as a public-private partnership initiated by the Redwood Coast Energy Authority and partners with intent to develop an offshore wind project in the waters near Humboldt Bay.ii

An offshore wind industry along the California coast that has an estimated potential of up to 100 GWiii based on investment of $500 billion.iv At this magnitude, the potential impact on future portfolio costs and composition is sufficient to justify changes to model functionality and run time.

The following publicly available and technically credible data sources are available for quantifying the cost and potential of offshore wind.


D) URL: http://maps.nrel.gov/wind_prospector


The California wind resource data for both of these Musial reports were collected from two sources: 1) AWS Truepower databases and 2) National Aeronautics and Space Administration’s (NASA) Modern-Era Retrospective Analysis (MERRA) data. These data sets were combined into a hybrid
data set. While the MERRA data is freely available from NASA, the AWS Truepower databases are proprietary, and the hybrid data set used by Musial et al (2016a) is not currently available. The MERRA data is based upon satellite observations - a dataset similar to the AWS database will need to be obtained to characterize wind resource.

Furthermore, NREL studies use NOAA buoy data as verification - an important step, as Musial et al (2016b) acknowledge that significant uncertainty still exists within AWS data. Currently, there is one buoy off of Humboldt coasts - the Eel River station - that collects wind speed data. If this dataset cannot serve as a reliable estimate for the project location, an additional buoy will need to be deployed near the target site.

NREL has also created the Wind Integration National Dataset (WIND) that is the largest publically available wind dataset. As described by Draxl et al. (1915), it provides up to seven years of 5-minute interval simulated wind speed data for the lower 48 States and offshore locations. The spatial resolution is on a 2 km x 2 km grid. Access to the dataset is free and facilitated by a convenient web interface (http://maps.nrel.gov/wind_prospector). The data has been validated based on measurements at over 100 locations.

---

iii https://www.boem.gov/2016-074/
iv https://www.nrel.gov/docs/fy17osti/66861.pdf
INFORMAL COMMENTS OF
THE SOLAR ENERGY INDUSTRIES ASSOCIATION
AND THE LARGE-SCALE SOLAR ASSOCIATION
ON DRAFT SOURCES FOR 2019-20 IRP SUPPLY-SIDE RESOURCES

R. Thomas Beach,
Principal, Crossborder Energy
Email: tomb@crossborderenergy.com
Phone: 510-549-6922

Tim Mason,
Policy Director, Large-scale Solar Association
Email: tim@largescalesolar.org
Phone: 510-812-1416

On behalf of
Solar Energy Industries Association

On behalf of
Large-scale Solar Association

Dated: April 23, 2018
INFORMAL COMMENTS OF
THE SOLAR ENERGY INDUSTRIES ASSOCIATION
AND THE LARGE-SCALE SOLAR ASSOCIATION
ON DRAFT SOURCES FOR 2019-20 IRP SUPPLY-SIDE RESOURCES

Pursuant to the March 27, 2018 email from Patrick Young to the parties in Commission
Rulemaking R. 16-02-007, the Solar Energy Industries Association (SEIA) and the Large-scale
Solar Association (LSA) appreciate the chance to present the following informal comments on
the draft sources (Draft Sources) that are proposed to be used for modelling supply-side
resources in the 2019-2020 Integrated Resource Plan (IRP). The comments of SEIA and LSA
are limited to the sources that the Commission should use to develop the costs for utility-scale
solar resources in California. SEIA is the national trade association of the solar industry in the
U.S. LSA is a trade association that represents the developers and operators of utility-scale solar
facilities in California.

The capital costs for solar resources have declined substantially and consistently in recent
years. As a result, it is important to use the most up-to-date information, including public,
reputable forecasts, to develop a reasonable estimate for solar costs. The Draft Sources proposes
to use utility-scale solar costs derived from the current version of the RPS Calculator, updated by
E3 using unspecified “market data.” The Draft Sources also lists as sources the CEC’s Cost of
Generation report, California Solar Initiative (CSI) data, and Lawrence Berkeley National
Laboratory’s (LBNL) most recent reports on actual utility-scale and distributed solar costs in the
SEIA and LSA observe that the CEC’s available Cost of Generation report is dated (2015); we understand that an updated version is planned, but we are not aware that it has been published. CSI data also may be out-of-date given that CSI incentives are no longer available. Further, the CSI data is limited to distributed solar projects no larger than 1 MW. The LBNL report on utility-scale solar costs is an excellent source, but it is important to recognize that the LBNL reports on solar costs are backward-looking. For example, the LBNL reports published in 2017 are based on actual data through 2016.

There are publicly-available forecasts of utility-scale solar capital costs, for example, from Wood Mackenzie’s Greentech Media (GTM). Public forecasts also may be available from entities such as Lazard and Bloomberg New Energy Finance. Such forecasts can be used to extend recent historical data from sources such as LBNL on actual utility-scale solar costs, provided that care is taken to make certain that the historical and forecast data are consistent. For example, as discussed in LBNL’s report, Utility-scale Solar 2016, at page 20, LBNL uses a “top down” cost reporting methodology that is more comprehensive than GTM’s “bottom up” approach to costing and forecasting. To compensate for the possible costs that are not captured in GTM’s forecasts, GTM’s forecasts could be increased in all years by the observed ratios of LBNL’s 2016 reported costs to GTM’s 2016 reported costs. Table 1 below shows an example of the application of this approach to forecasting solar capital costs, using the recent forecast from GTM cited above and LBNL’s most recent report on utility-scale solar costs.

---

SEIA and LSA also recommend caution in estimating the impact on solar costs of the new tariff on imported solar cells and modules. The new tariff on solar imports starts at 30% of module costs in 2018 and declines by 5% (500 basis points) in each of the next three years. However, applying the full tariff to forecasts of solar costs will overstate its impact. Some imports are exempt from the tariff (all thin film modules and up to 9% of total imports from certain countries), others may receive exemptions, and there are ongoing activities with the potential to further mitigate the impact of the tariffs. Further, the history of similar tariffs on imports suggests that any adopted tariff may be in place for less than four years, due to retaliation from foreign countries that manufacture panels, retaliation that would be sanctioned as a result of legal action before the World Trade Organization.

The following analysis shows that the import tariffs levied by the U.S. on PV panels imported from select countries will have a minimal impact on the cost of utility-scale PV development. The analysis may be useful to the Commission to the extent that future forecasts of solar cell or module costs do not include tariff impacts. The tariffs, which were imposed in March 2018, will decline annually between 2018 and 2021, expiring completely in March 2022. The first 2.5 GW of panels imported from the specified countries annually are exempt from the tariff.

<table>
<thead>
<tr>
<th>Table 1: Exemplary Solar Cost Forecast</th>
<th>Does not include solar tariff costs.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed - Utility-scale ($/Wdc)</strong></td>
<td></td>
</tr>
<tr>
<td>LBNL Cost</td>
<td>1.55</td>
</tr>
<tr>
<td>GTM Cost</td>
<td>1.17 0.95 0.82 0.78 0.75 0.72 0.70</td>
</tr>
<tr>
<td>Ratio LBNL/GTM Forecast</td>
<td>1.26 1.09 1.04 0.99 0.95 0.93</td>
</tr>
<tr>
<td><strong>Fixed - DG Commercial ($/Wdc) 500 kW - 1 MW</strong></td>
<td></td>
</tr>
<tr>
<td>LBNL Cost</td>
<td>2.50</td>
</tr>
<tr>
<td>GTM Cost</td>
<td>1.74 1.50 1.29 1.20 1.13 1.06 1.03</td>
</tr>
<tr>
<td>Ratio LBNL/GTM Forecast</td>
<td>1.44</td>
</tr>
<tr>
<td><strong>Tracking - Utility-scale ($/Wdc)</strong></td>
<td></td>
</tr>
<tr>
<td>LBNL Cost</td>
<td>1.73</td>
</tr>
<tr>
<td>GTM Cost</td>
<td>1.31 1.08 0.94 0.89 0.85 0.81 0.80</td>
</tr>
<tr>
<td>Ratio LBNL/GTM Forecast</td>
<td>1.32</td>
</tr>
<tr>
<td>Forecast</td>
<td>1.42 1.24 1.17 1.12 1.07 1.05</td>
</tr>
</tbody>
</table>
The tariff will increase panel prices but will have a nominal impact on the total installed costs of utility-scale PV development. There are several factors that mitigate the impact of the tariff on the industry, including:

- Tariffs are only levied on panels from specific countries. American manufactured panels, and panels from exempt countries, will be unaffected by the tariff. We can reasonably expect to see additional imports from exempt nations and there have been several announcements of increased American panel manufacturing, including from Jinko Solar and Sunpower.
- The first 2.5 GW of panels imported annually from the specified countries are exempt from the tariff.3
- Tariffs only apply to silicon-based panels. Thin-film PV technologies, which are a significant portion of utility-scale installations, were not part of the trade case and are exempt from the tariffs, regardless of the location of manufacture.4
- The U.S. Import Trade Commission has received applications for over 20 exemptions from the tariffs, which it is still reviewing. Approval of any of these applications will increase the quantity of imported panels that are exempt from the tariff.

Greentech Media estimates the total U.S. market for solar PV will be approximately 12 GW in 2018, increasing to 14 GW in 2019 – 2022. Adjusting for American production, panels from non-impacted countries, the 2.5 GW per year of exemptions from tariff-subjected countries, and thin film PV, the tariff will impact approximately 42% of all PV panels in 2018, increasing to 50% in years 2019-2021, as shown in Table 2 below.

---

3 2.5 GW of U.S. solar manufactured in 2017: news.energysage.com/u-s-solar-panel-manufacturers-list-american-made-solar-panels
4 See www.eia.gov/todayinenergy/detail.php?id=34112 for information in thin film installations.
Table 2: PV Panels Impacted by U.S. Tariff

<table>
<thead>
<tr>
<th>Tariff Rate</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Panel Demand (GW)</td>
<td>12.0</td>
<td>14.0</td>
<td>14.0</td>
<td>14.0</td>
</tr>
<tr>
<td>Sources exempt from tariff</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tariff-country exemptions (GW)</td>
<td>-2.5</td>
<td>-2.5</td>
<td>-2.5</td>
<td>-2.5</td>
</tr>
<tr>
<td>Exempt-country imports (GW)</td>
<td>-1.0</td>
<td>-1.0</td>
<td>-1.0</td>
<td>-1.0</td>
</tr>
<tr>
<td>Thin-film PV (GW)</td>
<td>-1.0</td>
<td>-1.0</td>
<td>-1.0</td>
<td>-1.0</td>
</tr>
<tr>
<td>U.S.-made panels (GW)</td>
<td>-2.5</td>
<td>-2.5</td>
<td>-2.5</td>
<td>-2.5</td>
</tr>
<tr>
<td>Net: Panels subject to tariff (GW)</td>
<td>5.0</td>
<td>7.0</td>
<td>7.0</td>
<td>7.0</td>
</tr>
<tr>
<td>% of total PV</td>
<td>42%</td>
<td>50%</td>
<td>50%</td>
<td>50%</td>
</tr>
</tbody>
</table>

PV panel costs represent approximately 30% of total installed costs for a utility-scale PV facility. The remainder of the installation – including development costs, site preparation, inverters, racking systems or trackers, and electric interconnection – are not subject to the tariffs.

It is impossible to predict which facilities that will be impacted by import tariffs, making it difficult to assess the impact on the project’s price. Ideally, one could develop a step function
in the supply-cost curve for panels that distinguishes between affected and non-affected panels, but given the national nature of the PV market, it is impossible to determine where that step-function may occur when it comes to large-scale solar development in the western U.S.

In lieu of creating a step function for panel prices, we propose a weighted average tariff cost uplift based on year of installation. Since PV panels are a commodity and can be easily substituted for each other, this assumes that prices will continue to be uniform, and the total cost burden of the tariff apportioned to all panels, whether the individual panels are subject to the tariff or not. The impact on utility-scale facility costs is a function of the tariff rate, the percent of panels affected by the tariff, and the proportional cost of panels to the total facility installed cost. Discussed above and detailed on the table below, the annual impact on the total cost of utility-scale PV facilities will range between 3.8% in 2018 (when tariff rates are highest) to 2.3% in 2021, the last year of the tariff.

| Table 3: Exemplary Impact of U.S. Solar Tariff |
|-----------------|-----------------|-----------------|-----------------|-----------------|
|                 | 2018            | 2019            | 2020            | 2021            |
| Tariff Rate     | 30%             | 25%             | 20%             | 15%             |
| % of total PV   | 42%             | 50%             | 50%             | 50%             |
| % of facility cost | 30%             | 30%             | 30%             | 30%             |
| Tariff Uplift (% facility cost) | 3.8% | 3.8% | 3.0% | 2.3% |

SEIA and LSA appreciate the Commission’s consideration of these informal comments.
INFORMAL COMMENTS OF THE CALIFORNIA ENVIRONMENTAL JUSTICE ALLIANCE AND SIERRA CLUB ON STAFF’S DRAFT SUPPLY-SIDE RESOURCES

INFORMAL COMMENTS OF THE CALIFORNIA ENVIRONMENTAL JUSTICE ALLIANCE AND SIERRA CLUB ON STAFF’S DRAFT SUPPLY-SIDE RESOURCES

INFORMAL COMMENTS OF THE CALIFORNIA ENVIRONMENTAL JUSTICE ALLIANCE AND SIERRA CLUB ON STAFF’S DRAFT SUPPLY-SIDE RESOURCES

Deborah Behles  
Of Counsel for CEJA  
(415) 841-3304  
Email: deborah.behles@gmail.com

Shana Lazerow  
Communities for a Better Environment  
120 Broadway, Suite 2  
Richmond, CA 94804  
(510) 302-0430  
Email: slazerow@cbecal.org

Representing California Environmental Justice Alliance

April 23, 2018
INFORMAL COMMENTS OF THE CALIFORNIA ENVIRONMENTAL JUSTICE ALLIANCE AND SIERRA CLUB ON STAFF’S DRAFT SUPPLY-SIDE RESOURCES

The California Environmental Justice Alliance (“CEJA”) and Sierra Club respectfully submit these informal comments in response to the Energy Division’s Draft Sources for 2019-2020 IRP Supply-Side Resources (“Draft IRP Supply Resources”). CEJA and Sierra Club have some general observations related to this document, and then respond to the document’s questions in the order presented in the document.

GENERAL COMMENTS

Disappointingly, this document leaves out any discussion or consideration of air quality metrics. One of the drawbacks of the RESOLVE methodology in the 2016 IRP was its failure to calculate emissions from cycling and steady-state operations within the model. By failing to include the relevant emissions factors and information, the prior RESOLVE results did not allow users to capture the emission changes from both cycling and steady-state operation at the outset. Instead, the Energy Division conducted an analysis after the fact to attempt to account for the impact of operations on air emissions.¹

¹ See D.18-02-018, p. 60 (describing Staff’s analysis). This analysis, however, did not include consideration of cycling emissions.
To attempt to remedy this, CEJA and Sierra Club request that the RESOLVE model this upcoming round of Integrated Resource Planning (“IRP”) explicitly include and model emission factors for cycling, partial load, and steady-state operations. Potential emission factors for cycling, partial load, and steady-state operations can be developed from real data that is collected by EPA’s Air Market Division\(^2\) or by use of permit conditions for plants throughout California. Another potential starting place for development of emission factors is the SB 350 study conducted for CAISO.\(^3\)

In addition, if possible, the length of time facilities operate at partial load should be estimated within the model. Units that are spinning and operating at partial load generally emit more pollutants per megawatt hour (“MWh”) than units operating at full capacity. For example, a National Renewable Energy Laboratory (“NREL”) analysis estimated that “Gas CCs emit 29% more NOx per megawatt-hour at 50% load compared with full-load.”\(^4\)

The inclusion of air quality metrics should not be optional. SB 350 requires consideration of how to minimize air emissions,\(^5\) and the Commission’s recent decision in this proceeding requires consideration of both cycling and steady-state emissions.\(^6\) Inclusion of air quality metrics will help ensure that this analysis happens at each step during the IRP process.

---

\(^2\) See U.S. EPA, Air Markets Division, [http://www.epa.gov/airmarkets](http://www.epa.gov/airmarkets). Hourly NOx data is collected for some, but not all, of the natural gas power plants within CAISO’s balancing area.

\(^3\) CAISO SB 350 Studies, Volume 9, p. 100, [https://www.caiso.com/Documents/SB350Study-Volume9EnvironmentalStudy.pdf](https://www.caiso.com/Documents/SB350Study-Volume9EnvironmentalStudy.pdf) (showing that one start can emit the equivalent of up to 38 hours of operation). This study’s usefulness, however, is limited because the assumptions do not include shutdown emissions, which are also higher than steady-state operation.


In addition to lacking key air quality metrics, this document does not include consideration of demand-side resources. CEJA and Sierra Club hope to see a set of assumptions developed for consideration in a stakeholder process related to demand-side resources in the near future. The Draft IRP Supply Resources document states that “[d]emand-side resource assumptions and load will largely be based on the 2018 IEPR…We will discuss demand-side updates at a later time in 2018.” More thought should be put into the development of demand-side resources than mere inclusion of the IEPR.

Another significant drawback of using RESOLVE in the 2016 IRP was its inability to optimize demand-side resources. As the Commission noted, the RESOLVE model previously has not optimized “energy efficiency, BTM PV, and some forms of demand response.” Although the optimization of DERs is included in the budget for planned technical support for the next IRP cycle, it is not clear whether this optimization will be prioritized to the extent necessary.

Demand-side resources are first in the loading order, and they must be a critical component of any plan for meeting our greenhouse gas and air quality requirements. Indeed, SB 350 requires that LSEs’ IRPs “[e]nhance distribution systems and demand-side energy management.” Demand reduction products are also a necessary part of a diversified procurement portfolio. To ensure an optimization that best reflects the capabilities of demand-side resources, more work will need to be done than just integrating the IEPR assumptions.

8 D.18-02-018, p. 34.
9 See D.18-02-018, p. 148.
12 See, e.g., Cal. Public Util. Code § 454.52(b)(3)(B) (including “demand reduction products” are part of a diversified portfolio).
CEJA and Sierra Club request that demand-side resource assumptions and plans to optimize demand-side resources be a priority moving forward.

**RESPONSES TO QUESTIONS**

CEJA and Sierra Club respond to the questions in the order presented. CEJA and Sierra Club have chosen not to respond to all the questions presented.13

**Question 1: Gas Retrofits Data:** Although the list of assumptions related to Gas Retrofits includes both fixed and variable O&M costs, it is not clear if there is any consideration of the age of the facility or of how the facility will be operated when considering O&M costs. O&M costs change dramatically for older plants when certain parts of a unit may begin to reach their end of life and if the plant is used to cycle more often than intended. As a report by the National Renewable Energy Laboratory found:

> Cycling of thermal plants can create thermal and pressure stresses in power plant components. This leads to increased O&M costs, more frequent repairs, reduced component life, and more frequent forced outages. Power plants that were designed for baseloaded operation suffer much more wear-and-tear damage from cycling.14

These types of considerations should be included when examining potential retrofits and costs associated with the operation of gas plants. One source of gas retrofit data is regulatory filings such as air permits and applications filed with this Commission. The NREL report cited above also includes some estimates of how O&M costs are impacted by increased cycling.

**Questions 2-3: Solar PV Data:** As related to the proposed breakdown of types of solar (fixed vs. tracking), the Commission should ensure that the percentage best reflects the current

---

13 Sierra Club has also submitted informal comments with Defenders of Wildlife and other conservation parties. Those comments address issues not discussed in these comments.

trends. A Lawrence Berkeley National Laboratory report recently found that 79% of new U.S.
utility-scale solar capacity included tracking systems.\textsuperscript{15} Given this trend, it does not appear that
the 25% tracking and 75% fixed breakdown is consistent with the current market.

As related to cost data, one report that should be considered is the Natural Renewable
This report details recent costs of solar PV and should be included and considered in the IRP’s
development of cost assumptions.

\textbf{Questions 4-7: Battery Storage:} As related to types of batteries, to the extent possible, the
model should assume that the most cost effective battery that can perform the needed services is
chosen. As Lazard’s Levelized Cost of Storage Analysis indicates, the costs of batteries can vary
significantly.\textsuperscript{17} To develop these costs, the most recent literature should be used as the cost of
storage is expected to continue to decrease. Multiple use applications for storage should be
modeled to the extent possible because the value of storage comes in part from its ability to
perform multiple types of different applications. This should necessarily include modeling the
combination of storage and solar facilities to see the impact that this has on the operation of these
facilities. In particular, pairing storage with resources in particular areas is likely to reduce
cycling air pollution from power plants. This possibility should be explored, and the value of
storage to reduce these emissions should be considered.

\textbf{Question 10: New Resource Types:} As discussed above, CEJA and Sierra Club hope
that this process develops ways to consider demand-side resources such as energy efficiency and
distributed generation as candidate resources. In addition to those resources, one related resource

\textsuperscript{15} The report is available here: https://emp.lbl.gov/utility-scale-solar/.
\textsuperscript{16} The report is available here: https://www.nrel.gov/docs/fy17osti/68925.pdf.
\textsuperscript{17} See https://www.lazard.com/media/450350/lcos3executive-summary.pdf.
type that is not being considered is the potential for more microgrids. The University of California San Diego currently operates a 42-MW microgrid,\textsuperscript{18} and the California Energy Commission recently released a draft report discussing the importance of developing microgrids in California.\textsuperscript{19}

In addition, in the Demand Response Proceeding, the Commission is currently considering pilot projects to reduce pollution and provide economic development to disadvantaged communities.\textsuperscript{20} The results of these pilot projects should be integrated into the demand response assumptions to better inform targeted placement of demand response.

**Question 11: Other Data Sources:** In addition to considering the potential cost of GHG allowances, there should also be consideration of the costs of emission reduction credits. Natural gas power plants that emit NOx and PM in certain areas of the state are required to purchase emission reduction credits. These costs can be significant. For example, the South Coast Air Quality Management District estimated that the cost of NOx emission reduction credits for 2014 was an average of $63,014 per ton per year, and the cost of coarse particulate matter (“PM\textsubscript{10}”) emission reduction credits in 2014 per ton per year was $521,868 per ton per year.\textsuperscript{21} The best estimates of these potential costs is from the local air districts. These costs need to be included to best reflect the cost of operating a natural gas facility.

\textsuperscript{18} See https://energycenter.org/self-generation-incentive-program/business/technologies/microgrid.
\textsuperscript{20} See, e.g., A.17-01-012, Assigned Commissioner’s Office Draft Straw Proposal for Pilots Targeting Demand Response to Benefit Disadvantaged Communities (Feb. 7, 2018).
**Question 12: PV Costs**: As related to cost data, one report that is not listed that should be considered is the Natural Renewable Energy Laboratory report entitled *U.S. Solar Photovoltaic System Cost Benchmark: Q1 2017.* This report details recent costs of solar PV and should be included and considered in the IRP’s development of cost assumptions.

**CONCLUSION**

CEJA and Sierra Club appreciate the opportunity to submit these comments.

Dated: April 23, 2018

Respectfully Submitted,

/s/ Deborah Behles
Deborah Behles
Of Counsel for CEJA
(415) 841-3304
Email: deborah.behles@gmail.com

Shana Lazerow
Communities for a Better Environment
120 Broadway, Suite 2
Richmond, CA 94804
(510) 302-0430
Email: slazerow@cbecal.org

*Representing California Environmental Justice Alliance*

/s/ Nina Robertson
Nina Robertson
Earthjustice
50 California St., Suite 500
San Francisco, CA 94111
(415) 217-2000
Email: nrobertson@earthjustice.org

*Representing Sierra Club*

---

22 The report is available here: [https://www.nrel.gov/docs/fy17osti/68925.pdf](https://www.nrel.gov/docs/fy17osti/68925.pdf).
VIA ELECTRONIC MAIL

April 23, 2017

Mr. Paul Douglas
California Public Utilities Commission
505 Van Ness Avenue
San Francisco, CA 94102

Re: Informal Comments on Sources for 2019-2018 Supply-Side Resource Modeling

Dear Mr. Douglas:

The purpose of this letter is to provide the Energy Division with limited comments on the Draft Sources for the 2019-2020 IRP Supply-Side Resources. TransWest Express LLC (TransWest) propose the high priority inclusion of the Wyoming Chokecherry and Sierra Madre Wind Energy Project (CCSM Project) as a new candidate resource due to the commercial availability to procure prior to the expiration of the federal Production Tax Credit (PTC) and the significant positive impacts this resource can provide. While our comments are limited to the CCSM Project, any other wind energy project or resource area that could demonstrate commercial availability prior to the expiration of the PTC should also be considered as new candidate resources.

The comments below focus on questions 10 and question 14 from the list provided in the draft document.

Resource Potential
Question 10: Are there any new resource types (not described in your responses to Questions 1 – 9) that Energy Division should prioritize including as a candidate resource in the 2019 IRP?

Yes, the Energy Division should prioritize the inclusion of the Wyoming wind resources that require transmission expansion and can provide the benefits to ratepayers associated with diverse resources and the federal PTC. These resources were modeled within RESOLVE for the 2017 IRP. However, they were “not made available for selection in the core cases or sensitivities” due to concerns about feasibility and costs of the transmission. As outlined
below these resources should be a high priority resource for inclusion as new candidate resources that can be analyzed and selected if warranted in the 2019 IRP.

Describe how the new resource type satisfies the new candidate resource criteria listed below.

- Resource must have plausible trajectory to commercial availability within planning time horizon.
- Magnitude of potential impact on future portfolio costs and composition must be sufficient to justify changes to model functionality and run-time.

The Energy Division did perform some analysis on out-of-state resources including the transmission upgrades and found the potential for out-of-state wind to represent a significant cost savings if procured prior to the expiration of the federal PTC. This finding is also supported by various publically available studies.¹

The 3,000 MW Chokecherry and Sierra Madre Wind Energy Project located in south central Wyoming is a fully permitted wind energy project that has started a program of continuous construction in 2016 after eight years of permitting. These resources are commercially available to be procured as Portfolio Content Category 1 (PCC 1) in time prior to the expiration of the federal PTC. The recently completed CAISO Special Study on the 50% RPS Out-of-State portfolio found there was a severe lack of Available Transmission Capacity (ATC) to facilitate the procurement and delivery of large scale out-of-state resources as PCC 1 resources. The 3,000 MW TransWest Express Transmission Project (TWE Project) was found to be the only proposed transmission project that could provide the required ATC to connect the CAISO system to these resources without relying on other transmission assets or systems. The TWE Project can be placed in-service in time to provide 3,000 MW of PCC1 wind resources with the PTC into the mid 2020’s.

The magnitude of the potential impact of up to 3,000 MW of PCC1 wind resources net of the increased cost in the transmission expansion is very significant and far exceeds the limited amount of changes required to the model functionality and run time. Given the unique nature of this new candidate resource it may be more efficient and effective to analyze aspects of this

potential candidate resource outside of the model. The required changes in the model apply to altering the timing of the availability of the PTCs for this specific resource and the in-service dates for the transmission solution. All other changes to the model could be handled on the generic basis for the technology with respect to costs and output profiles.

List the data sources available for quantifying the cost and potential of the proposed resource type and describe how the data sources satisfy the data source criteria listed below.

- Publicly available
- Technically credible
- Cost data reflects future costs
- Cost data can be used to develop all-in technology costs
- Resource potential data is geographically specific at level of transmission zones used in RESOLVE

TransWest has provided formal comments throughout the IRP proceeding on the CCSM Project and the TWE Projects and their commercial viability. These comments include citations to various data sources that meet all of these data source criteria.

**Resource Costs**

**Question 14:** Should any of the cost and financing assumptions in RESOLVE’s LCOE calculations be modified, for example assumptions related to state and federal tax incentives, the cost of capital, and financing lifetime? Explain and support any recommended changes using publicly available information, to the greatest extent possible.

The assumptions used for the application of the federal tax incentive for large scale wind energy projects should be extended beyond 2020 through 2025 for the CCSM Project and 2022 in-service date for the TWE Project should be included within the model. TransWest notes that the draft document refers to work being performed this year to inform the cost for capacity expansion solutions will come from the CAISO TPP. The cost for the capacity expansion related to the TWE Project or any other proposed project to access out-of-state resources, or any other analysis by the CAISO on these projects are not included within their 2018-2019 TPP Study Plan. The Energy Division will need to rely on other sources than the CAISO for this vital transmission information.
TransWest appreciates the opportunity to provide these comments.

Sincerely,

/s/

David F. Smith
Director – Engineering and Operations
BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking to Develop an Electricity Integrated Resource Planning Framework and to Coordinate and Refine Long-Term Procurement Planning Requirements.

Rulemaking 16-02-007
(Filed Feb. 11, 2016)

INFORMAL COMMENTS OF TRIDENT WINDS, LLC
ON THE DRAFT SOURCES FOR
2019-2020 IRP SUPPLY-SIDE RESOURCES

Laura G. Zagar
Christopher G. Parker
PERKINS COIE LLP
505 Howard Street, Suite 1000
San Francisco, CA 94105
Tel: (858) 720-5700
Email: LZagar@perkinsoie.com

April 23, 2018

Attorneys for TRIDENT WINDS, LLC
I. PROPOSED RESOURCE DATA

On March 27, 2018, California Public Utilities Commission Energy Division staff released a draft document providing a list of supply-side resources to be used for capacity expansion modeling for the 2019-2020 cycle of the Integrated Resources Planning (IRP) proceeding (Draft Sources Document).\(^1\) The Draft Sources Document requests that the IRP parties comment on twelve questions related to supply-side resource potential and cost. Trident Winds, LLC (Trident) submits the following comments in response to Questions 10 and 11, which ask whether there are any new resource types that Energy Division should prioritize as a candidate resource and what data sources should be used to quantify resource costs and potential.

\(^1\) Energy Division, *Draft Sources for 2019-2020 IRP Supply-Side Resources* (Mar. 27, 2018).
Trident proposes preliminary evaluation of floating offshore wind as a new supply-side resource during the 2019-2020 IRP cycle and anticipates formal consideration of offshore wind as a candidate resource in the 2021-2022 IRP.

A. Background

Offshore wind is an abundant, renewable, zero-emission resource characterized by steady wind speeds and a generation profile that complements solar and onshore wind generation. These uncommon attributes make offshore wind ideally suited to increase resource diversity, decrease curtailment and integration costs, improve reliability and resilience, sustain higher levels of solar penetration, and support cross-sectoral decarbonization.

B. NREL Offshore Wind Data

California’s abundant but untapped offshore wind resources were detailed by a 2016 study prepared by the National Renewable Energy Laboratory (NREL). The 2016 NREL study modeled the site-specific levelized cost of energy (LCOE) for various offshore wind locations in California for the period 2015-2030. This study is the most comprehensive, publicly-available dataset on offshore wind in California. Trident submits the NREL data for Energy Division’s consideration.

The Draft Sources Document sets out five criteria for data on supply-side resources. The data must be publicly available, technically credible, useful for developing all-in technology costs, specified at the level of RESOLVE transmission zones, and reflective of future costs. For new candidate resources, the data must show a “plausible trajectory to commercial availability” within the IRP planning time horizon that justifies changes to model functionality or model run

---

The NREL study data generally satisfy these criteria. The data are accessible online, were developed using detailed methodology that draws upon a large body of research, and show that offshore wind LCOEs will be competitive by the time of deployment in the 2025-2030 timeframe.\(^4\)

Nonetheless, the 2016 NREL data should not be relied upon for future cost projections in the 2019-2020 IRP planning process. The 2016 NREL data were prepared using a conservative methodology that extrapolated future costs based on the performance of single units of offshore wind prototypes and is already arguably outdated. These costs date to 2008-2013 and do not reflect the current state of offshore wind operational knowledge or floating offshore wind technology.\(^5\) For example, the NREL data show a 2030 LCOE as low as $97/MWh.\(^6\) However, strike prices for European offshore wind auctions are already lower than those discussed in the 2016 NREL data.\(^7\) Winning bids have decreased from $200/MWh for projects with a 2017-2019 commercial operation date to $65/MWh for a 2024-2025 commercial operation date.\(^8\) Prices have already reached grid parity in some places,\(^9\) and by 2020, European offshore wind prices may decline by another 70%.\(^10\) Although these prices are not directly translatable to California LCOE, they strongly indicate that the 2016 NREL study significantly overstates the cost of California offshore wind.

\(^4\) See NREL 2016 at vi (“The eventual commercialization of floating offshore wind is supported by market indicators such as accelerating deployment, improving cost, and increasing global research and development spending”).

\(^5\) See id. at 35 (discussing methodology and data from prior studies).

\(^6\) Id. at xii, 56.


\(^8\) Id.

\(^9\) Id. at 54.

Rapid cost declines also reflect technological requirements for offshore wind. There are
two broad categories of foundations used to support offshore wind turbines: fixed-bottom and
floating. Fixed-bottom foundations are fixed to the seabed. The vast majority of California’s
wind resources, however, are located over water too deep for fixed foundations; wind turbine
support structures must float instead.\textsuperscript{11} Floating platforms are a recently-commercialized
technology early in its innovation curve. Rapid cost decreases are occurring and should be
expected to continue. This is supported by the fact that fixed-bottom technology—despite having
been commercialized for decades—continues to experience cost decreases faster than forecasted.
In Europe, for example, fixed-bottom costs have declined by as much as 60\% over the past 10
years.\textsuperscript{12}

Faster-than-anticipated cost declines make it appropriate to adjust the NREL data to
reflect costs more accurately. Trident proposes to work with Energy Division staff over the
course of the current and upcoming IRP cycles to provide reliable cost data on offshore wind.
Both proprietary and publicly-available information should be used for adjustment. Although
proprietary information is confidential because of its competitive sensitivity, Trident and other
members of the offshore wind industry have access to the most recent cost data and financial
projections. Trident hopes to provide Energy Division with the best possible information for the
2021-2022 IRP, which would include both publicly-available and proprietary data,.

Given the decreases in offshore wind auction prices and the expected cost-savings from
innovations in floating platforms, formal consideration of floating offshore wind as a candidate
resource during the 2019-2020 IRP would be premature. At this time, the NREL data should be
used with the RESOLVE model for preliminary study and to illustrate the unique benefits and

\textsuperscript{11} See generally NREL 2016.
\textsuperscript{12} Id. at 49.
attributes of offshore wind. This initial investigatory work is appropriate in anticipation of full consideration of offshore wind during a subsequent IRP cycle.

C. Resource Data

The NREL offshore wind data are presented in tabular form in Appendix A. The data consist of value ranges for sites identified by the 2016 NREL study that are most likely to reflect recent cost declines and interconnection feasibility.

II. ATTRIBUTES OF OFFSHORE WIND

Although offshore and onshore wind may seem interchangeable, offshore wind has a significantly different resource profile. Offshore wind has significantly higher wind speeds but a relatively flat 24-hour production profile with a modest peak in the late afternoon and evening for most months. These attributes increase generation potential.13

Offshore wind is also characterized by a high capacity factor. Existing projects have demonstrated capacity factors over 60%, which is approximately twice the capacity factor of onshore wind.14 Furthermore, NREL forecasts that California offshore wind turbines could have gross capacity factors as high as 73% by 2027.15 These values exceed the capacity factor for most forms of renewable energy and compare favorably with dispatchable and “baseload” resources such as natural gas, as shown in the following table:

13 Energy from Offshore Wind at 2 (“The wind blows faster and more uniformly at sea than on land. A faster, steadier wind means less wear on the turbine components and more electricity generated per turbine. The winds increase rapidly with distance from the coast, so excellent wind sites exist within reasonable distances from major urban load centers reducing the onshore concern of long distance power transmission.”).
15 NREL Study at 32.
### Comparison of Capacity Factors by Resource Type\(^{16}\)

<table>
<thead>
<tr>
<th>Resource Type</th>
<th>Net Capacity Factor (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear</td>
<td>92.2</td>
</tr>
<tr>
<td>Geothermal</td>
<td>76.4</td>
</tr>
<tr>
<td>Landfill Gas and Municipal Solid Waste</td>
<td>70.9</td>
</tr>
<tr>
<td>Offshore Wind</td>
<td>50.0 - 65.0*</td>
</tr>
<tr>
<td>Natural Gas - Combined Cycle</td>
<td>54.8</td>
</tr>
<tr>
<td>Coal</td>
<td>53.5</td>
</tr>
<tr>
<td>Other Biomass</td>
<td>50.7</td>
</tr>
<tr>
<td>Onshore Wind</td>
<td>36.7</td>
</tr>
<tr>
<td>Solar Photovoltaic</td>
<td>27.0</td>
</tr>
<tr>
<td>Solar Thermal</td>
<td>21.8</td>
</tr>
<tr>
<td>Natural Gas - Steam Turbine</td>
<td>11.3</td>
</tr>
<tr>
<td>Natural Gas - Combustion Turbine</td>
<td>9.4</td>
</tr>
</tbody>
</table>

### III. VALUE OF OFFSHORE WIND

#### A. Resource Diversity, Decarbonization, and Other Benefits

RESOLVE selected approximately 9,000 MW of utility-scale solar for procurement by 2030, which represents 73\% of the incremental capacity in the IRP Reference System Portfolio (RSP).\(^{17}\) Aside from 1,100 MW of in-state wind (9\% RSP), almost no new resources are added until 2030, at which point 200 MW of geothermal and 2,000 MW of battery storage is added (18\% RSP). This composition is consistent with the results of the RESOLVE sensitivity cases, which show that beyond a certain amount of solar, integration solutions will be necessary as curtailment costs increase and grid reliability is affected. Such solutions include resource diversity, long-duration storage, or increased regional trading. On its current trajectory, California will reach this threshold amount of solar between 2026 and 2030.

---


\(^{*}\) See NREL Study at 32–33; McKinsey & Co., *supra*, note 10.

Offshore wind can provide unique diversity, reliability, resilience, and decarbonization benefits for California. Its generation profile is largely flat and, as a result, “the market value of offshore wind is roughly similar to that of a similarly located flat block of power . . . over a 24-hour period.” At the same time, offshore wind displays a modest afternoon-evening peak that follows California’s demand profile and is complementary to solar. This profile allows offshore wind to provide dependable, zero-GHG power that can displace both thermal “baseload” and peaker generation that would otherwise be required during solar down-ramp and off-peak periods. Adding offshore wind to California’s resource portfolio could also reduce GHG-emissions associated with 100% renewable energy tariffs offered by utilities and community choice aggregators. Such tariffs primarily rely on solar and renewable energy credits to reach 100% renewable generation, which increases GHG emissions from thermal plants during solar off-peak periods and also drives curtailment and integration costs. In contrast, the steady generation offered by offshore wind could allow greater penetration of renewables while maintaining reliability and reducing GHG emissions.

Achieving California’s aggressive climate change goals, including an 80% reduction of GHG emissions by 2050, will require cross-sectoral solutions such as the extensive electrification of buildings and transportation. These policies, if successful, will increase load and the need for flexibility. RESOLVE sensitivity cases indicate that higher loads significantly increase the value of diversity, especially if energy efficiency deployment is low or flexibility is constrained. These conditions should increase the value of offshore wind, which can provide

---

19 See Energy Division, Proposed Reference System Plan, 75 (Sept. 18, 2017).
nighttime renewable generation to meet increased load from buildings and electric vehicle charging as well as reduce evening ramping needs.

Given its generation profile, the diversity value of offshore wind in the California market is likely to be high. Recent research from Lawrence Berkeley National Laboratory (LBNL) modeled the site-specific marginal value of offshore wind for states on the Atlantic Coast and found that its value ranged as high as $110/MWh for the period 2007-2016.\textsuperscript{20} The energy and capacity value of offshore wind exceeded the value of onshore wind by $6/MWh-$20/MWh due to offshore wind sites being located closer to major population centers and also having a time-varying profile of electricity production that is better correlated with electricity demand.\textsuperscript{21} Under more demanding conditions in California—including high solar penetration, transmission constraints, a 50% Renewable Portfolio Standard, and a GHG emissions reduction target of 40% below 1990 levels—the value of offshore wind should be even higher.

The Lawrence Berkeley National Laboratory study also suggests that offshore wind’s benefits may not be fully captured by the RESOLVE model. For example, avoided emissions are a measurable health and climate benefit of offshore wind. For Atlantic states, these health and climate benefits varied between $26/MWh and $120/MWh.\textsuperscript{22} Similar analyses could be performed for California to determine how offshore wind could facilitate decarbonization and reduce air pollution in disadvantaged communities identified by the IRP proceeding. The high capacity factor and flat generation profile of offshore wind could also permit the early retirement of thermal plants in disadvantaged communities without significantly increasing reliability costs or reducing resilience.

\textsuperscript{20} LBNL Study at 6, 11.
\textsuperscript{21} Id. at 9.
\textsuperscript{22} Id. at 11.
Offshore wind can also mitigate costs associated with curtailment and the duck curve. Currently, the RESOLVE model prefers solar for capacity expansion and favors curtailment for low-cost grid integration. Integrating solar and land-based wind is becoming more expensive, and day-ahead spot prices during the evening ramp can reach $609/MWh.\textsuperscript{23} Related daytime over-generation creates negative pricing that forces utilities (and ratepayers) to pay wholesale customers for demand response. Eventually, curtailment costs could limit the availability of project financing. By complementing the daytime peak and evening drop in solar generation, however, offshore wind “could potentially enable higher penetrations of renewable energy to be deployed.”\textsuperscript{24} In addition to reducing curtailment, offshore wind can limit the impact of California’s evening ramp. Energy Division has predicted that California will experience an extreme evening ramp by 2020 that will require the addition of 13 GW to the grid over a three-hour period.\textsuperscript{25} Offshore wind’s late-afternoon and evening peak largely overlaps with the evening ramp.

Finally, offshore wind helps solve California’s scalability problems. California must add several gigawatts of capacity each year to meet its 2050 GHG-reduction goal. NREL estimates that the amount of California offshore wind energy that is commercially viable with available technology and current permitting requirements is as much as 15 GW.\textsuperscript{26}

B. Avoided Transmission Costs and Locational Value

California has few options to easily increase out-of-state imports due to transmission constraints. Offshore wind can solve many transmission challenges by repurposing California’s existing transmission and distribution infrastructure, capacity on which is becoming available as

\textsuperscript{24} NREL 2016 at 3.
\textsuperscript{26} NREL 2016 at 5.
coastal conventional and nuclear generation is being retired. Favorable sites for offshore wind development are distributed along California’s northern and central coasts. This dispersion allows the deployment of zero-carbon, renewable generation near population centers without the need for overland transmission because multiple coastal generation sites have been or will be retired soon. These facilities are generally located near load centers such as Los Angeles and San Francisco, which eliminates the need to construct new long-distance transmission lines or to establish new rights-of-way. The reuse of existing infrastructure also improves grid resilience because power flows will more closely resemble flows for which transmission and distribution assets were originally designed. Furthermore, ratepayers will not be required to pay for new or stranded transmission assets.

Despite these advantages, transmission costs savings associated with offshore wind have not been quantified for California. Offshore wind values for the East Coast, however, indicate that the savings would be significant. As noted above, Lawrence Berkeley National Laboratory found that the energy and capacity value of offshore wind for Atlantic states exceeded the value of land-based wind by $6/MWh-$20/MWh. This value largely results from the ability to avoid long-distance transmission costs by siting offshore wind within miles of major population centers. European data also reveals the avoided cost of transmission. Recent auctions for offshore wind installations for the 2020-2025 timeframe have had strike prices less than $70/MWh, including transmission expenses.

27 LBNL Study at 1.
28 NREL 2017 at 58; LBNL Study at 14.
IV. NEXT STEPS

Trident thanks Energy Division and the Modeling Advisory Group for the opportunity to provide feedback on inputs for the RESOLVE model. Although the NREL data and other available evidence do not support inclusion of offshore wind as a candidate resource during the 2019-2020 IRP, such evidence does warrant initial investigation. Trident looks forward to working with Energy Division staff to develop reliable cost data on offshore wind that can be used for planning in the 2021-2022 IRP.

Respectfully submitted April 23, 2018, at San Francisco, California.

/s/ Christopher G. Parker

Laura G. Zagar
Christopher G. Parker
PERKINS COIE LLP
505 Howard Street, Suite 1000
San Francisco, CA 94105
Tel: (858) 720-5700
Email: LZagar@perkinscoie.com

Attorneys for TRIDENT WINDS, LLC
## LIFETIME COSTS

<table>
<thead>
<tr>
<th>Level</th>
<th>Category Name</th>
<th>Fixed Value or Factor (if applicable)</th>
<th>CAPEX</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>($2015)</td>
<td>Low</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Turbine Capital Cost (TCC)</td>
<td>971,630,632</td>
<td>971,630,632</td>
<td>1,619</td>
<td>1,619</td>
</tr>
<tr>
<td></td>
<td>Balance of System Capital Cost (BOS)</td>
<td>sum 1,376,335,532</td>
<td>1,566,227,022</td>
<td>2,294</td>
<td>2,610</td>
</tr>
<tr>
<td>2</td>
<td>Development</td>
<td>2%</td>
<td>43,563,340</td>
<td>47,163,178</td>
<td>73</td>
</tr>
<tr>
<td>2</td>
<td>Project Management</td>
<td>4%</td>
<td>76,235,844</td>
<td>82,535,562</td>
<td>127</td>
</tr>
<tr>
<td>2</td>
<td>Port &amp; Staging, Logistics, Transport</td>
<td>sum 50,000,000</td>
<td>50,000,000</td>
<td>50,000,000</td>
<td>83</td>
</tr>
<tr>
<td>3</td>
<td>Floating Substructure</td>
<td>sum 1,376,335,532</td>
<td>1,566,227,022</td>
<td>2,294</td>
<td>2,610</td>
</tr>
<tr>
<td>3</td>
<td>Mooring System (Lines &amp; Anchors)</td>
<td>sum 219,673,629</td>
<td>308,478,460</td>
<td>366</td>
<td>514</td>
</tr>
<tr>
<td>3</td>
<td>Assembly and Installation</td>
<td>sum 82,473,172</td>
<td>89,613,897</td>
<td>137</td>
<td>149</td>
</tr>
<tr>
<td>2</td>
<td>Electrical Infrastructure</td>
<td>sum 0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>Array Cable System</td>
<td>sum 118,505,434</td>
<td>150,919,507</td>
<td>198</td>
<td>252</td>
</tr>
<tr>
<td>3</td>
<td>Export Cable System</td>
<td>218,192,808</td>
<td>332,195,650</td>
<td>364</td>
<td>554</td>
</tr>
<tr>
<td>3</td>
<td>Grid Connection</td>
<td>80,000,000</td>
<td>83,200,000</td>
<td>133</td>
<td>139</td>
</tr>
<tr>
<td>1</td>
<td>Soft Costs</td>
<td>sum 112,292,355</td>
<td>131,807,595</td>
<td>520</td>
<td>640</td>
</tr>
<tr>
<td>2</td>
<td>Insurance During Construction</td>
<td>1%</td>
<td>23,479,662</td>
<td>25,378,577</td>
<td>39</td>
</tr>
<tr>
<td>2</td>
<td>Project Completions/Commissioning</td>
<td>1%</td>
<td>23,479,662</td>
<td>25,378,577</td>
<td>39</td>
</tr>
<tr>
<td>2</td>
<td>Surety Bond (Decommissioning)</td>
<td>15%</td>
<td>12,370,976</td>
<td>13,442,085</td>
<td>21</td>
</tr>
<tr>
<td>2</td>
<td>Sponsor Contingency</td>
<td>sum 91,220,251</td>
<td>146,395,059</td>
<td>152</td>
<td>244</td>
</tr>
<tr>
<td>3</td>
<td>Procurement Contingency</td>
<td>5%</td>
<td>64,336,082</td>
<td>121,310,523</td>
<td>107</td>
</tr>
<tr>
<td>3</td>
<td>Installation Contingency</td>
<td>30%</td>
<td>24,741,952</td>
<td>26,884,169</td>
<td>41</td>
</tr>
<tr>
<td>TOTAL CAPEX</td>
<td></td>
<td>2,660,168,518</td>
<td>2,893,633,167</td>
<td>4,434</td>
<td>4,823</td>
</tr>
</tbody>
</table>

## ENERGY PRODUCTION SUMMARY

<table>
<thead>
<tr>
<th>Level</th>
<th>Category Name</th>
<th>Low LCOE</th>
<th>High LCOE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Environmental Losses</td>
<td>1.59%</td>
<td>1.59%</td>
</tr>
<tr>
<td>2</td>
<td>Icing/Blade Soiling Loss</td>
<td>1.00%</td>
<td>1.00%</td>
</tr>
<tr>
<td>2</td>
<td>Low/High Temp Shutdown</td>
<td>0.05%</td>
<td>0.05%</td>
</tr>
<tr>
<td>2</td>
<td>Lightning Loss</td>
<td>0.10%</td>
<td>0.10%</td>
</tr>
<tr>
<td>2</td>
<td>Technical Losses</td>
<td>0.60%</td>
<td>0.60%</td>
</tr>
<tr>
<td>2</td>
<td>Hysteresis</td>
<td>0.50%</td>
<td>0.50%</td>
</tr>
<tr>
<td>2</td>
<td>Onboard Equipment (parasitic load)</td>
<td>0.05%</td>
<td>0.05%</td>
</tr>
<tr>
<td>2</td>
<td>Rotor Misalignment</td>
<td>0.05%</td>
<td>0.05%</td>
</tr>
<tr>
<td>2</td>
<td>Site Specific Losses</td>
<td>13.65%</td>
<td>12.99%</td>
</tr>
<tr>
<td>2</td>
<td>Wake Loss</td>
<td>4.91%</td>
<td>3.52%</td>
</tr>
<tr>
<td>2</td>
<td>Total Electrical Loss</td>
<td>3.41%</td>
<td>3.80%</td>
</tr>
<tr>
<td>2</td>
<td>Availability Loss</td>
<td>5.98%</td>
<td>6.26%</td>
</tr>
<tr>
<td>TOTAL LOSSES</td>
<td></td>
<td>15.53%</td>
<td>14.89%</td>
</tr>
</tbody>
</table>

## TOTAL CAPEX

<table>
<thead>
<tr>
<th></th>
<th>Low LCOE</th>
<th>High LCOE</th>
</tr>
</thead>
<tbody>
<tr>
<td>($/MWh)</td>
<td>($/MWh)</td>
<td>($/MWh)</td>
</tr>
<tr>
<td>108.09</td>
<td>111.00</td>
<td></td>
</tr>
</tbody>
</table>

## OPEX

<table>
<thead>
<tr>
<th>Level</th>
<th>Category Name</th>
<th>Low LCOE</th>
<th>High LCOE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Insurance During Construction</td>
<td>-40.3%</td>
<td>-38.9%</td>
</tr>
</tbody>
</table>

## APPENDIX A

### CAPEX

<table>
<thead>
<tr>
<th>Level</th>
<th>Category Name</th>
<th>Fixed Value or Factor (if applicable)</th>
<th>CAPEX</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>($2015/yr.)</td>
<td>Low</td>
<td>High</td>
<td></td>
</tr>
</tbody>
</table>

### OPEX

<table>
<thead>
<tr>
<th>Level</th>
<th>Category Name</th>
<th>Low LCOE</th>
<th>High LCOE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Insurance During Construction</td>
<td>-40.3%</td>
<td>-38.9%</td>
</tr>
</tbody>
</table>
BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking to Develop an
Electricity Integrated Resource Planning
Framework and to Coordinate and Refine
Long-Term Procurement Planning
Requirements.

INFORMAL COMMENTS OF THE UTILITY CONSUMERS’ ACTION NETWORK
(UCAN) ON THE DRAFT SOURCES FOR 2019-20 IRP SUPPLY-SIDE RESOURCES

Donald Kelly, Executive Director
Jane Krikorian, JD, Public Advocate
David Croyle, Energy Economist

Utility Consumers’ Action Network
3405 Kenyon St, Suite 401
San Diego, CA 92110
(619) 696-6966
don@ucan.org
jane@ucan.org

April 23, 2018
INFORMAL COMMENTS OF THE UTILITY CONSUMERS’ ACTION NETWORK (UCAN) ON THE DRAFT SOURCES FOR 2019-20 IRP SUPPLY-SIDE RESOURCES

The Utility Consumers’ Action Network submits these informal comments regarding the “Draft Sources for 2019-20 IRP Supply-side Resources” document emailed March 27, 2018, by the Energy Division. Throughout the Integrated Resource Plan (IRP) proceeding (R.16-02-007), UCAN made the case for flexibility for Load Serving Entities (LSEs), including the Investor-Owned Utilities (IOUs) when developing individual IRP’s and when adopting greenhouse gas (GHG) reducing generation. UCAN believes this to be the best path to achieve the state’s GHG reduction mandates while resulting in the lowest costs to utility ratepayers. UCAN continues this flexibility concept while answering questions 3, 3.2.3, 3.3, 7, 8, 12, 14 below, and adding a final comment.

**Question 3. Solar PV: How should high- and low-cost trajectories for future PV costs be developed?**

**UCAN:** No comment on expected solar PV technology development. However, the fact that these various renewable technologies are changing to improve efficiency and lower costs suggests that flexibility should be not only accepted but encouraged so that the LSEs adopt these technologies at the right time and avoid potential obsolescence because of ongoing technology developments. As these technologies improve in efficiency and/or lower costs, a reasonable strategy can be to wait rather than adopt. Combined with the ideal time to adopt in terms of when the resource is needed for the individual LSE, and consistent with meeting mandated GHG reduction and Renewables Portfolio Standard (RPS) objectives, the LSEs should have the flexibility to delay procurement when justified by need for power or expected costs.

**Section 3.2.3 Wind: NREL WIND Toolkit is the most current source for wind profiles, but its assumptions on power curves and hub height result in capacity factors that don’t accurately capture performance of older existing wind plants.**

**UCAN:** No comment on differences between older and newer wind technology development. However, the fact that these various renewable technologies are changing to improve efficiency and lower costs suggests that flexibility should be not only accepted but encouraged so that the
LSEs can adopt these technologies at the right time and avoid potential obsolescence because of technology developments and improvements. As these technologies improve in efficiency and/or lower in cost, a reasonable strategy can be to wait rather than adopt. Combined with the ideal time to adopt in terms of when the resource is needed for the individual LSE, and consistent with meeting mandated GHG reduction and RPS objectives, the LSEs should have the flexibility to delay procurement when justified by need for power or expected costs.

Section 3.3 Available Transmission Capacity

**UCAN:** This section is very brief but warrants careful consideration. Comparing the cost of alternative resources located at varying distances from the load center requires both the cost of the generation resource and the cost of delivering that resource to the load. This is especially true where the renewable resource such as solar PV or wind are remotely located and large acreage is needed to accommodate the number of solar panels or windmills comprising a utility generation resource. These transmission costs can include incremental transmission capacity necessary to access the resource, the corresponding operational and maintenance expenses per mile times the number of miles to the load center, and transmission losses per mile times the number of miles to the load center. Including these transmission costs is the only way to ensure that all resources are fairly compared. Ignoring transmission costs can ultimately and unfairly favor remote resources where the land may be less scarce and therefore less expensive but the cost to deliver the power to the load represents a critical compensating cost factor.

**Question 7. Battery:** How should high- and low-cost trajectories for future battery costs be developed?

**UCAN:** See response to Question 3. The same need for flexibility applies here.

**Question 8. Pumped Storage:** How should pumped storage costs be represented given that they are highly site-specific and difficult to estimate on a generic basis?
UCAN: The site-specific aspect of pumped storage offers another rationale for granting individual LSEs sufficient flexibility to procure resources at the best time for their unique need and other circumstances.

**Question 12. Resource Costs:** Are there any additional sources of capital cost, operating cost, and performance projections (not described in your responses to Questions 1 – 9) that should be considered for solar PV or wind? Please describe and provide a link for any suggested sources. Explain how the data source meets the data source criteria listed above.

UCAN: No comment except to say that uncertainty about future costs suggests the need to grant LSEs sufficient flexibility compared to the Reference System Plan (RSP) to ensure that the right technologies will be adopted at the right time when they can be procured at least cost while contributing to mandated RPS and GHG objectives.

**Question 14. Resource Costs:** Should any of the cost and financing assumptions in RESOLVE’s LCOE calculations be modified, for example assumptions related to state and federal tax incentives, the cost of capital, and financing lifetime? Explain and support any recommended changes using publicly available information, to the greatest extent possible.

UCAN: Given the time horizon of the overall IRP, there is too much uncertainty beyond the current year and perhaps the very near future (1-3 years) to predict changes to state and federal tax incentives. We should expect rational tax incentives to take into account expected costs to the LSEs since tax incentives should decline as the cost of these resources decline and is more comparable to conventional resources.

**UCAN Final Comments:**

UCAN suggests that the characteristics of all the plant types should include a range of characteristics that indicate how the resource will operate. These include the construction lead times necessary to get a new plant online, features related to dispatchability, e.g., where the resource, if dispatchable, is placed in the generation stack (base load, cycling or peaking), heat rate (an indicator of plant efficiency), location of the resource (distance from the load centers or existing transmission grid), transmission costs (incremental transmission capacity necessary to access the new resource, operational and maintenance expenses per mile, and transmission losses.
per mile), operating costs at minimum and maximum plant capacity factor, fuel type, fuel costs and expected fuel costs.

Furthermore, each LSE will have different load curves that suggest different operating parameters at different load levels and times of the day and the resulting capacity utilization when placed in the stack which can affect the cost effectiveness of the resource depending on the unique load profile of the LSE. Specifically, plant operating characteristics as stand-alone plants are very different than the operating characteristics when placed in the generation stack. The economics that is most useful is in the context of the generation portfolio. Stand-alone operating characteristics are much less meaningful. This is another reason why the LSEs need flexibility in terms of what to add and when to minimize costs, consistent with meeting mandated GHG reduction and RPS objectives.

April 23, 2018

Respectfully submitted,

/s/ Jane Krikorian
Jane Krikorian, JD, Public Advocate

Utility Consumers’ Action Network
3405 Kenyon St, Suite 401
San Diego, CA 92110
(619) 696-6966
jane@ucan.org
BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking to Develop
an Electricity Integrated Resource Planning
Framework and to Coordinate and Refine
Long-Term Procurement Planning
Requirements

R.16-02-007
(February 11, 2016)

CERTIFICATE OF SERVICE

I, Jane Krikorian, certify under penalty of perjury under the laws of the State of California that the following is true and correct:

On April 23, 2018, I served a copy of:

INFORMAL COMMENTS OF THE UTILITY CONSUMERS’ ACTION NETWORK (UCAN) ON THE DRAFT SOURCES FOR 2019-20 IRP SUPPLY-SIDE RESOURCES

on all eligible parties on the attached list R.16-02-007 by sending said document by electronic mail to each of the parties via electronic mail, as reflected on the attached Service List.

Executed this Monday, April 23, 2018.

_____/S/_____
Jane Krikorian
Utility Consumers’ Action Network
CALIFORNIA PUBLIC UTILITIES COMMISSION
Service Lists

Proceeding: R1602007 - CPUC - OIR TO DEVELO
Filer: CPUC
List Name: LIST
Last changed: April 23, 2018

Download the Comma-delimited File
About Comma-delimited Files

Back to Service Lists Index

### Parties

<table>
<thead>
<tr>
<th>Name</th>
<th>Role</th>
<th>Firm/Company</th>
<th>Email Location</th>
<th>Company/Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAVID LYONS</td>
<td>ATTORNEY</td>
<td>PAUL HASTINGS LLP</td>
<td>EMAIL ONLY</td>
<td>FOR: LA PALOMA GENERATING COMPANY, LLC</td>
</tr>
<tr>
<td>JEFFREY KEHNE</td>
<td>CHIEF DEVELOPMENT OFFICE / GEN.COUNSEL</td>
<td>MEGELLAN WIND LLC</td>
<td>EMAIL ONLY, DC</td>
<td></td>
</tr>
<tr>
<td>JOHN W. LESLIE, ESQ.</td>
<td>ATTORNEY</td>
<td>DENTONS US LLP</td>
<td>EMAIL ONLY</td>
<td>FOR: SHELL ENERGY NORTH AMERICA (U.S.), (TURN) L.P.</td>
</tr>
<tr>
<td>MATTHEW FREEDMAN</td>
<td>STAFF ATTORNEY</td>
<td>THE UTILITY REFORM NETWORK</td>
<td>EMAIL ONLY</td>
<td>FOR: THE UTILITY REFORM NETWORK</td>
</tr>
<tr>
<td>MERRIAN BORGESON</td>
<td>SR. SCIENTIST</td>
<td>NATURAL RESOURCES DEFENSE COUNCIL</td>
<td>EMAIL ONLY</td>
<td>FOR: NATURAL RESOURCES DEFENSE COUNCIL (NRDC)</td>
</tr>
<tr>
<td>TIM MASON</td>
<td>POLICY DIRECTOR</td>
<td>LARGE-SCALE SOLAR ASSOCIATION</td>
<td>EMAIL ONLY</td>
<td>FOR: LAREG-SCALE SOLAR ASSOCIATION</td>
</tr>
<tr>
<td>KENNETH SAHM WHITE</td>
<td></td>
<td></td>
<td>EMAIL ONLY, CA</td>
<td></td>
</tr>
<tr>
<td>MIKE LEVIN</td>
<td></td>
<td></td>
<td>00000</td>
<td></td>
</tr>
</tbody>
</table>

Back to Service Lists Index
DIRECTOR, ECONOMIC & POLICY ANALYSIS
CLEAN COALITION
EMAIL ONLY
EMAIL ONLY, CA  00000-0000
FOR: CLEAN COALITION

AMY H. FISHER
MANAGING DIR. - REGULATORY AFFAIRS
GE ENERGY FINANCIAL SVCS, INC.
800 LONG RIDGE ROAD
STAMFORD, CT  06927
FOR: INLAND EMPIRE ENERGY CENTER, LLC

KATHRYN PERRY
AGERA ENERGY, LLC
555 PLEASANTVILLE ROAD, S-107
MANOR, NY  10510
FOR: AGERA ENERGY, LLC

LAURA SALVESEN
PALMCO POWER CA
1350 - 60TH STREET
BROOKLYN, NY  11219
FOR: PALMCO POWER CA

WILLIAM D. DEGRANDIS
ATTORNEY AT LAW
PAUL HASTING, LLP
875 15TH STREET, N.W.
WASHINGTON, DC  20005
FOR: GRIDLIANCE WEST TRANSCO, LLC
(GRIDLIANCE WEST)

JEFFREY S. SPURGEON
GENTRIX ENERGY POWER MGMT., LLC
9405 ARROWPOINT BOULEVARD
600
CHARLOTTE, NC  28273
FOR: COGENTRIX ENERGY POWER MANAGEMENT, LLC (COGENTRIX)

CURRY ALDRIDGE
TENASKA CALIFORNIA ENERGY MARKETING, LLC
14302 FNB PARKWAY, STE 100
OMAHA, NE  68154
FOR: TENASKA CALIFORNIA ENERGY MARKETING, LLC

DIR - GOVN'T AFFAIRS
FUELCELL ENERGY, INC.
3 GREAT PASTURE ROAD
DANBURY, CT  06810
FOR: FUELCELL ENERGY, INC.

DENISE GRAB
SR. ATTORNEY
INSTITUTE FOR POLICY INTEGRITY
139 MACDOUGAL STREET, 3RD FL.
NEW YORK, NY  10012
FOR: INSTITUTE FOR POLICY INTEGRITY

ERIKA DIAMOND
ENERGYHUB
232 3RD STREET, SUITE 201
BROOKLYN, NY  11215
FOR: ENERGYHUB

JEFFREY LEAHEY
DEPUTY EXECUTIVE DIR.
NATIONAL HYDROPOWER ASSOCIATION
25 MASSACHUSETTS AVE. NW, STE. 450
WASHINGTON, DC  20001
FOR: NATIONAL HYDROPOWER ASSOCIATION

PARDEEP GILL
CONSTELLATION NEWENERGY, INC.
100 CONSTELLATION WAY, STE 600
BALTIMORE, MD  21202
FOR: CONSTELLATION NEWENERGY, INC.

TABITHA CANTY
LIBERTY POWER DELAWARE, LLC
1901 W. CYPRESS CREEK ROAD, STE.
FT. LAUDERDALE, FL  33309
FOR: LIBERTY POWER DELAWARE, LLC / LIBERTY POWER HOLDINGS, LLC

BETHANY SOLER
REPRESENTATIVE
TIGER NATURAL GAS, INC.
EMAIL ONLY
TULSA, OK  74136
FOR: TIGER NATURAL GAS, INC.
GREG BASS  
DIR - WESTERN REGULATORY AFFAIRS  
CALPINE ENERGY SOLUTIONS, LLC  
LP  
401 WEST A STREET, SUITE 500  
SAN DIEGO, CA 92101  
FOR: NOBLE ENERGY AMERICAS ENERGY  
SEVEN SOLUTIONS, LLC (NOBLE SOLUTIONS)  
CALIPATRIA,  

TIM DUANE, ESQ.  
ATTORNEY AT LAW  
PROCOPIO CORY HARGREAVES & SAVITCH, LLP  
525 B STREET, SUITE 2200  
SAN DIEGO, CA 92101  
FOR: IMPERIAL COUNTY CONSISTS OF CITIES (BRAWLEY, CALEXICO, EL CENTRO, HOLTVILLE, IMPERIAL, AND WESTMORLAND), AND EIGHT UNINCORPORATED COMMUNITIES (BOMBAY BEACH, HEBER, NILAND, OCOTILLO, PALO VERDE, SALTON SEA, SEELEY, AND WINTERHAVEN)  

DRAKE WELCH  
NOBLE AMERICAS ENERGY SOLUTIONS (1364)  
401 WEST A STREET, SUITE 500  
SAN DIEGO, CA 92101-3017  
FOR: NOBLE AMERICAS ENERGY SOLUTIONS LLC  

MICHAEL J. AGUIRRE, ESQ.  
ATTORNEY  
AGUIRRE & SEVERSON LLP  
501 W. BROADWAY, STE. 1050  
SAN DIEGO, CA 92101-3591  
FOR: IMPERIAL IRRIGATION DISTRICT  

DONALD KELLY  
EXE. DIRECTOR  
UTILITY CONSUMERS' ACTION NETWORK  
3405 KENYON ST., STE. 401  
SAN DIEGO, CA 92110  
FOR: UCAN  

CLIFFORD D. EVANS, JR.  
VP  
CALPEAK POWER, LLC  
7365 MISSION GORGE ROAD, STE. C  
SAN DIEGO, CA 92120  
FOR: CALPEAK POWER, LLC  

JOHN W. LESLIE  
ATTORNEY  
DENTONS US LLP  
4655 EXECUTIVE DRIVE, STE. 700  
SAN DIEGO, CA 92121  
FOR: DENTONS US LLP (DENTONS)  

MARCIE MILNER  
SHELL ENERGY  
4445 EASTGATE MALL, STE 100  
SAN DIEGO, CA 92121  
FOR: SHELL ENERGY  

THOMAS R. DARTON  
ATTORNEY  
PILOT POWER GROUP, INC.  
8910 UNIVERSITY CENTER LANE, STE. 520  
SAN DIEGO, CA 92122  
FOR: PILOT POWER GROUP, INC. AUTHORITY  

KELLY RODGERS  
ENERGY PROGRAM MANAGER  
SAN DIEGO COUNTY WATER AUTHORITY  
4677 OVERLAND AVENUE  
SAN DIEGO, CA 92123  
FOR: SAN DIEGO COUNTY WATER  

GUSTAVO E. LUNA  
TERRA-GEN POWER, LLC  
11512 EL CAMINO REAL, SUITE 370  
SAN DIEGO, CA 92130  
FOR: TERRA-GEN POWER  

KEVIN SHORT  
ANZA ELECTRIC COOPERATIVE INC.  
58470 US HIGHWAY 371  
ANZA, CA 92539  
FOR: ANZA ELECTRIC COOPERATIVE INC.
GREG MICHAELS  
SOUTHERN CALIFORNIA TELEPHONE & ENERGY  
27515 ENTERPRISE CIRCLE WEST  
TEMECULA, CA 92590  
FOR: SOUTHERN CALIFORNIA TELEPHONE & ENERGY  
CENTER

SCOTT SAMUELSN  
DIRECTOR  
NATIONAL FUEL CELL RESEARCH CENTER  
UNIVERISTY OF CALIFORNIA  
IRVINE, CA 92697-3550  
FOR: NATIONAL FUEL CELL RESEARCH (NFCRC)

MONA TIERNEY-LLOYD  
SR. DIR., WESTERN REGULATORY AFFAIRS  
ENERNOC, INC.  
PO BOX 378  
CAYUCOS, CA 93430  
FOR: ENERNOC, INC. - TIERNEY-LLOYD IS (LANCASTER) REP

CATHY DEFALCO, EJD, C.P.M.  
ENERGY MGR. - REGULATORY  
CITY OF LANCASTER  
44933 FERN AVENUE  
LANCASTER, CA 93534  
FOR: LANCASTER CHOICE ENERGY

SUE MARA  
CONSULTANT  
RTO ADVISORS L.L.C.  
164 SPINGDALE WAY  
REDWOOD CITY, CA 94062  
FOR: ALLIANCE FOR RETAIL ENERGY MARKETS CALIFORNIA

MARC D. JOSEPH  
ATTORNEY  
ADAMS BROADWELL JOSEPH & CARDOZA  
601 GATEWAY BOULEVARD, SUITE 1000  
SO. SAN FRANCISCO, CA 94080  
FOR: THE COALITION OF CALIFORNIA UTILITY EMPLOYEES (CUE) AND UNIONS FOR RELIABLE ENERGY (CURE)

BARBARA HALE  
CLEAN POWER SF  
525 GOLDEN GATE AVE.  
SAN FRANCISCO, CA 94102  
FOR: CLEANPOWER SF COMPANY

DAWN ANAISCOURT  
ATTORNEY  
SOUTHERN CALIFORNIA EDISON COMPANY  
601 VAN NESS AVENUE  
SAN FRANCISCO, CA 94102  
FOR: SOUTHERN CALIFORNIA EDISON

SKY C. STANFIELD  
ATTORNEY  
SHUTE, MIHALY & WEINBERGER, LLP  
396 HAYES STREET  
SAN FRANCISCO, CA 94102  
FOR: INTERSTATE RENEWABLE ENERGY COUNCIL, INC. (ORA)

MATT MILEY  
CALIF PUBLIC UTILITIES COMMISSION  
LEGAL DIVISION  
ROOM 5135  
505 VAN NESS AVENUE  
SAN FRANCISCO, CA 94102-3214  
FOR: OFFICE OF RATEPAYER ADVOCATES

JEANNE M. SOLE  
DEPUTY CITY ATTORNEY  
CITY AND COUNTY OF SAN FRANCISCO  
1 DR. CARLTON B. GOODLETT PLACE, RM. 234  
SAN FRANCISCO, CA 94105

ANU VEGA  
PACIFIC GAS AND ELECTRIC COMPANY  
77 BEALE ST., ROOM 3120, B30A  
SAN FRANCISCO, CA 94105
SAN FRANCISCO, CA  94102-4682
COMPANY
FOR: PACIFIC GAS AND ELECTRIC
FOR: CITY AND COUNTY OF SAN FRANCISCO

ERICA BRAND
ACTING DIR. - CALIFORNIA ENERGY PROGRAM
 CORPORATION
THE NATURE CONSERVANCY
201 MISSION STREET, 4TH FL.
SAN FRANCISCO, CA  94105
FOR: THE NATURE CONSERVANCY

EVELYN KAHL
BUCHALTER, A PROFESSIONAL
55 SECOND STREET, SUITE 1700
SAN FRANCISCO, CA  94105
FOR: ENERGY PRODUCERS AND USERS
COALITION

LARISSA KOEHLER
ATTORNEY
ENVIRONMENTAL DEFENSE FUND
 CORPORATION
123 MISSION STREET, 28TH FLOOR
SAN FRANCISCO, CA  94105
FOR: ENVIRONMENTAL DEFENSE FUND

MICHAEL ALCANTAR
ATTORNEY AT LAW
BUCHALTER, A PROFESSIONAL
55 SECOND STREET, SUITE 1700
SAN FRANCISCO, CA  94105
FOR: COGENERATION ASSOCIATION OF
CALIFORNIA

NORA E. SHERIFF
ATTORNEY
BUCHALTER, A PROFESSIONAL CORPORATION
55 SECOND STREET, SUITE 1700
SAN FRANCISCO, CA  94105
FOR: CALIFORNIA LARGE ENERGY CONSUMERS
ASSOCIATION (CLECA)

STEVE CHADIMA
SVP - EXTERNAL AFFAIRS
ADVANCED ENERGY ECONOMY
135 MAIN ST., STE. 1320
SAN FRANCISCO, CA  94105
FOR: ADVANCED ENERGY ECONOMY

WILLIAM KISSINGER
MORGAN LEWIS BOCKIUS LLP
ONE MARKET, SPEAR STREET TOWER
SAN FRANCISCO, CA  94105
FOR: COMPETITIVE POWER VENTURES / POWER
DEVELOPMENT, INC.

SCOTT OLSON
DIR - GOV'T & REGULATORY AFFAIRS
DIRECT ENERGY LP
600 CALIFORNIA STREET, 11TH FL.
SAN FRANCISCO, CA  94108
FOR: DIRECT ENERGY BUSINESS

BRIAN CRAGG
ATTORNEY
GOODIN, MACBRIDE, SQUERI, DAY & LAMPREY
505 SANSOME STREET, SUITE 900
SAN FRANCISCO, CA  94111
FOR: INDEPENDENT ENERGY PRODUCERS
ASSOCIATION

DAVID L. HUARD
ATTORNEY
MANATT, PHELPS & PHILLIPS, LLP
ONE EMBARCADERO CENTER, 30TH FL.
SAN FRANCISCO, CA  94111
FOR: PIO PICO ENERGY CENTER

GEORGE HARDIE
PRESIDENT
PATTERN ENERGY GROUP 2
PIER 1, BAY 3
SAN FRANCISCO, CA  94111
FOR: PATTERN ENERGY GROUP 2
ASSOCIATION

JEANNE B. ARMSTRONG
ATTORNEY
GOODIN MACBRIDE SQUERI & DAY LLP
505 SANSOME STREET, SUITE 900
SAN FRANCISCO, CA  94111
FOR: SOLAR ENERGY INDUSTRIES
BETH VAUGHAN                              BRIAN THEAKER
EXE. DIR.                                 NRG ENERGY, INC.
CALIFORNIA COGENERATION COUNCIL           PO BOX 192
4391 NORTH MARSH ELDER CT.                PITTSBURG, CA  94565
CONCORD, CA  94521                       FOR: NRG ENERGY, INC.
FOR: CALIFORNIA COGENERATION COUNCIL

CHRISTIAN LENCI                           SANDEEP ARORA
PRAXAIR PLAINFIELD, INC.                  VICE PRESIDENT, TRANSMISSION
2430 CAMINO RAMON DR.                     LS POWER DEVELOPMENT, LLC
SAN RAMON, CA  94583                      5000 HOPYARD, ROAD, SUITE E480
FOR: PRAXAIR PLAINFIELD, INC.             PLEASANTON, CA  94588
FOR: LS POWER DEVELOPMENT (LS POWER)

APRIL ROSE SOMMER                         LAURA WISLAND
EXE DIR - LEAD COUNSEL                    SR. ENERGY ANALYST
PROTECT OUR COMMUNITIES FOUNDATION        UNION OF CONCERNED SCIENTISTS
1547 PALOS VERDES MALL NO. 196            500 12TH ST., STE. 340
WALNUT CREEK, CA  94598                   OAKLAND, CA  94607
FOR: PROTECT OUR COMMUNITIES FOUNDATION   FOR: UNION OF CONCERNED SCIENTISTS
(UCS)

MARK BYRON                                MELISSA BRANDT
WHOLESALE ELECTRICITY PROGRAM MGR.        DIR - REGULATORY AFFAIRS
UNIV. OF CALIF. OFFICE OF THE PRESIDENT    EAST BAY COMMUNITY ENERGY
1111 FRANKLIN ST., 6TH FL.                1111 BROADWAY, SUITE 3000
OAKLAND, CA  94607                        OAKLAND, CA  94607
FOR: THE REGENTS OF THE UNIVERSITY OF     FOR: EAST BAY COMMUNITY ENERGY
CALIFORNIA

ADAM BORISON                              CATHLEEN MONAHAN
MANAGING DIRECTOR                         SR. PROGRAMS DIR.
BERKELEY RESEARCH GROUP, LLC              GRID ALTERNATIVES
2200 POWELL STREET, SUITE 1200            1171 OCEAN AVENUE, SUITE 200
EMERYVILLE, CA  94608                     OAKLAND, CA  94608
FOR: BERKELEY RESEARCH GROUP, LLC (BRG)   FOR: GRID ALTERNATIVES

GRETCHEN DUMAS                            JASON B KEYES
PILOT TEAM                                 KEYES & FOX LLP
1749 PLEASANT VALLEY AVENUE               436 14TH STREET, SUITE 1305
OAKLAND, CA  94611                        OAKLAND, CA  94612
FOR: IHM COMMUNITY                         FOR: TESLA

JASON B. KEYES                             LAURENCE G. CHASET
PARTNER                                    COUNSEL
KEYES & FOX LLP                            KEYES & FOX LLP
436 14TH ST., STE.1305                    436 14TH STREET, STE. 1305
OAKLAND, CA  94612                        OAKLAND, CA  94612
GARSON KNAPP
LIBERTY POWER CORP.
131 - A STONY CIRCLE, STE. 500
SANTA ROSA, CA 95401
FOR: LIBERTY POWER HOLDINGS

DAVID KATES
DAVID MARK & COMPANY
3510 UNOCAL PLACE, SUITE 200
SANTA ROSA, CA 95403
FOR: THE NEVADA HYDRO COMPANY

STEVEN S. SHUPE
GENERAL COUNSEL
SONOMA CLEAN POWER AUTHORITY COUNCIL
50 SANTA ROSA AVE., 5TH FL.
SANTA ROSA, CA 95404
FOR: SONOMA CLEAN POWER AUTHORITY

MELANIE GILLETTE
SR. POLICY DIRECTOR
CA EFFICIENCY+DEMAND MANAGEMENT
1535 FARMERS LANE, SUITE 312
SANTA ROSA, CA 95405
FOR: CALIFORNIA ENERGY EFFICIENCY INDUSTRY COUNCIL (CEIC)

JORDAN PINJUV
COUNSEL
CALIFORNIA INDEPENDENT SYSTEM OPERATOR CAUCUS
250 OUTCROPPING WAY
FOLSOM, CA 95630
FOR: CALIFORNIA ISO ASSOCIATION
CAUCUS)

DANIELLE O. MILLS
DIR
AMERICAN WIND ENERGY ASSN CALIF
1970 MEADOW OAK LANE
MEADOW VISTA, CA 95722
FOR: AMERICAN WIND ENERGY
CALIFORNIA CAUCUS (AWEA CALIF.

REGULATORY MANAGER
WELLHEAD ELECTRIC COMPANY, INC.
650 BERCUT DRIVE, STE. C
ASSOCIATION
SACRAMENTO, CA 95811
FOR: WELLHEAD ELECTRIC COMPANY, INC.
CALIFORNIA

BRAD HEAVNER
POLICY DIR.
CALIFORNIA SOLAR & STORAGE
EMAIL ONLY
EMAIL ONLY, CA 95814
FOR: CALIFORNIA SOLAR & STORAGE ASSOCIATION (CALSSA) F/K/A
SOLAR ENERGY INDUSTRIES ASSOCIATION

CHELSEA HAINES
REGULATORY ADVOCATE
ASSOCIATION OF CALIFORNIA WATER AGENCIES
910 K STREET, SUITE 100
SACRAMENTO, CA 95814
FOR: ASSOCIATION OF CALIFORNIA WATER NETWORK AGENCIES (ACWA)

DAN GRIFFITHS
ATTORNEY
BRAUN BLAISING SMITH & WYNNE, P.C.
915 L STREET, STE. 1480
SACRAMENTO, CA 95814
FOR: LOCAL ENERGY AGGREGATION (LEAN)

JULEE M. BALL
EXECUTIVE DIR.
CALIFORNIA BIOMASS ENERGY ALLIANCE P.C.

JUSTIN WYNNE
ATTORNEY
BRAUN BLAISING MCLAUGHLIN & SMITH,
1015 K STREET                             915 L STREET, SUITE 1480
SACRAMENTO, CA  95814                     SACRAMENTO, CA  95814
FOR: CALIFORNIA BIOMASS ENERGY ALLIANCE (CBEA) FOR: CALIFORNIA MUNICIPAL UTILITIES ASSOCIATION

KIM DELFINO                               MATT KLOPFENSTEIN
DIR - CALIF. PROGRAM                      GONZALEZ QUINTANA & HUNTER LLC
DEFENDERS OF WILDLIFE                     915 L STREET, SUITE 1270
980 9TH STREET, STE. 1730                 SACRAMENTO, CA  95814
SACRAMENTO, CA  95814 INC.
FOR: DEFENDERS OF WILDLIFE

SCOTT BLAISING                            SCOTT BLAISING
ATTORNEY                                  ATTORNEY
BRAUN BLAISING MCLAUGHLIN & SMITH, P.C.   BRAUN BLAISING SMITH WYNNE P.C.
915 L STREET, STE. 1480                   915 L STREET, STE. 1480
SACRAMENTO, CA  95814                     SACRAMENTO, CA  95814
FOR: THE KINGS RIVER CONSERVATION DISTRICT (KRCD) / MARIN CLEAN ENERGY (MCE)
FOR: PIONEER COMMUNITY ENERGY

SCOTT BLAISING                            SCOTT BLAISING
ATTORNEY AT LAW                           ATTORNEY AT LAW
BRAUN BLAISING SMITH & WYNNE. P.C.        BRAUN BLAISING SMITH WYNNE, P.C.
915 L STREET, STE. 1480                   915 L STREET, SUITE 1480
SACRAMENTO, CA  95814                     SACRAMENTO, CA  95814
FOR: SILICON VALLEY CLEAN ENERGY CHOICE AUTHORITY
FOR: THE CALIFORNIA COMMUNITY ASSOCIATION (CALCCA)

TY TOSDAL                                 HARRIET A. STEINER
OF COUNSEL                                ATTORNEY
BRAUN BALISING MCLAUGHLIN & SMITH, P.C.   BEST BEST & KRIEGER LLP
915 L STREET, SUITE 1270                  500 CAPITOL MALL, STE. 1700
SACRAMENTO, CA  95814                     SACRAMENTO, CA  95814-4704
FOR: CITY OF LANCASTER (VCEA)
FOR: VALLEY CLEAN ENERGY ALLIANCE

JEDEDIAH J. GIBSON                        JEFFERY D. HARRIS
ATTORNEY                                  ATTORNEY
ELLISON, SCHNEIDER & HARRIS, L.L.P. LLP    ELLISON SCHNEIDER HARRIS & DONLAN
2600 CAPITOL AVENUE, SUITE 400            2600 CAPITOL AVENUE, STE. 400
SACRAMENTO, CA  95816                     SACRAMENTO, CA  95816
FOR: BEAR VALLEY ELECTRIC SERVICE LLC
FOR: RANGE ENERGY STORAGE SYSTEMS
F/K/A PATHFINDER CAES 1, LLC

RONALD LIEBERT                            BRIAN S. BIERING
ATTORNEY AT LAW                           ATTORNEY
ELLISON SCHNEIDER HARRIS & DONLAN LLP
2600 CAPITOL AVENUE, STE. 400
SACRAMENTO, CA  95816
FOR: VOTE SOLAR

WILLIAM WESTERFIELD, III
SR. ATTORNEY, OFF OF GEN. COUNSEL CORP
SACRAMENTO MUNICIPAL UTILITY DISTRICT
6301 S STREET, MS A311
SACRAMENTO, CA  95817
FOR: SACRAMENTO MUNICIPAL UTILITY DISTRICT (SMUD)

ROBERT MARSHALL
GEN. MGR.
PLUMAS SIERRA RURAL ELECTRIC CO-OP.
PO BOX 2000
PORTOLA, CA  96122-2000
FOR: PLUMAS-SIERRA ELECTRICAL COOPERATIVE

S. BRADLEY VAN CLEVE
ATTORNEY AT LAW
DAVISON VAN CLEVE, PC
333 SW TAYLOR, SUITE 400
PORTLAND, OR  97204
FOR: VALLEY ELECTRIC ASSOCIATION, INC. (VEA)

DUSTIN TILL
ATTORNEY
PACIFICORP
825 NE MULTNOMAH ST., STE. 1800
PORTLAND, OR  97232
FOR: PACIFICORP

NATHAN SANDVIG
DIR - BUSINESS DEVELOPMENT
NATIONAL GRID USA
205 SE SPOKANE STREET, STE. 300
PORTLAND, OR  97202
FOR: NATIONAL GRID USA

VIRINDER SINGH
DIR - REGULATORY & LEGISLATIVE AFFAIRS
EDF RENEWABLE ENERGY
1000 SW BROADWAY, SUITE 1880
PORTLAND, OR  97205
FOR: EDF RENEWABLE ENERGY

ALLA WEINSTEIN
FOUNDER
TRIDENT WINDS, LLC
113 CHERRY STREET, SUITE 34912
SEATTLE, WA  98104-2205
FOR: TRIDENT WINDS, LLC (TRIDENT)

ALIA SCHOEN
PUBLIC POLICY MGR.
BLOOM ENERGY
EMAIL ONLY
EMAIL ONLY, CA  00000

ANA MILEVA
ICE ONE H
EMAIL ONLY
EMAIL ONLY, CA  00000
<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Company/Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANDREW LUSCZ</td>
<td></td>
<td>GLACIAL ENERGY OF CALIFORNIA</td>
</tr>
<tr>
<td>ANNE FALCON</td>
<td></td>
<td>EES CONSULTING, INC.</td>
</tr>
<tr>
<td>BARBARA BARKOVICH</td>
<td>Consultant</td>
<td>BARKOVICH &amp; YAP</td>
</tr>
<tr>
<td>BENYAMIN MORADZADEH</td>
<td></td>
<td>PACIFIC GAS AND ELECTRIC COMPANY</td>
</tr>
<tr>
<td>BILL POWERS</td>
<td></td>
<td>PROTECT OUR COMMUNITIES FOUNDATION</td>
</tr>
<tr>
<td>CEDRIC O. CHRISTENSEN</td>
<td>Dir - Oper &amp; Development</td>
<td>STRATEGEN CONSULTING LLC</td>
</tr>
<tr>
<td>COLEY GIROUARD</td>
<td>Associate, PUC Program</td>
<td>ADVANCED ENERGY ECONOMY</td>
</tr>
<tr>
<td>CURT BARRY</td>
<td>Senior Writer</td>
<td>INSIDE WASHINGTON PUBLISHERS</td>
</tr>
<tr>
<td>DAMON FRANZ</td>
<td>Director - Policy &amp; Electricity Markets</td>
<td>TESLA, INC.</td>
</tr>
<tr>
<td>DANIELLE O. MILLS</td>
<td>Sr. Policy Advisor</td>
<td>LARGE-SCALE SOLAR ASSOCIATION</td>
</tr>
<tr>
<td>DAVID MCCOARD</td>
<td></td>
<td>CALIFORNIA REGULATORY AFFAIRS</td>
</tr>
<tr>
<td>DESPINA NIEHAUS</td>
<td></td>
<td>SAN DIEGO GAS &amp; ELECTRIC COMPANY</td>
</tr>
<tr>
<td>DONALD LIDDELL</td>
<td></td>
<td>EBCE REGULATORY</td>
</tr>
<tr>
<td>ERIC WEINER</td>
<td>Analyst</td>
<td>PENINSULA CLEAN ENERGY</td>
</tr>
<tr>
<td>ERIN GRIZARD</td>
<td></td>
<td>BLOOM ENERGY</td>
</tr>
<tr>
<td>GEORGE WILTSEE</td>
<td></td>
<td>CLEAN POWER HOUSE, LLC</td>
</tr>
<tr>
<td>GREGORY S.G. KLATT</td>
<td>Attorney at Law</td>
<td></td>
</tr>
</tbody>
</table>
NELLIE TONG  
SENIOR CONSULTANT  
DNV KEMA ENERGY & SUSTAINABILITY  
EMAIL ONLY  
EMAIL ONLY, CA  00000  
CONSUMERS

PAUL NELSON  
BARKOVICH & YAP  
EMAIL ONLY  
EMAIL ONLY, CA  00000  
FOR: CALIFORNIA LARGE ENERGY ASSOCIATION

PETER T. PEARSON  
ENERGY SUPPLY SPECIALIST  
BEAR VALLEY ELECTRIC SERVICE  
EMAIL ONLY  
EMAIL ONLY, CA  00000

RACHEL A. GOLD  
CALIFORNIA AIR RESOURCES BOARD  
EMAIL ONLY  
EMAIL ONLY, CA  00000

RHONDA MILLS  
WESTERN ISSUES REP  
GEOTHERMAL ENERGY ASSOCIATION  
EMAIL ONLY  
EMAIL ONLY, CA  00000

RICK UMOff  
COUNSEL & DIR - STATE AFFAIRS  
SOLAR ENERGY INDUSTRIES ASSOCIATION  
EMAIL ONLY  
EMAIL ONLY, CA  00000

ROBERT GEX  
DAVIS WRIGHT TREMAINE LLP  
EMAIL ONLY  
EMAIL ONLY, CA  00000

SARAH M. KEANE  
ATTORNEY  
MORGAN LEWIS & BOCKIUS, LLP  
EMAIL ONLY  
EMAIL ONLY, CA  00000

SARITA SARVATE  
EMAIL ONLY  
EMAIL ONLY, CA  00000

SHARON YANG  
DIRECTOR OF LEGAL SERVICES  
LIBERTY UTILITIES (WEST REGION)  
EMAIL ONLY  
EMAIL ONLY, AA  00000

SIOBHAN DOHERTY  
ANALYST  
PENINSULA CLEAN ENERGY  
EMAIL ONLY  
EMAIL ONLY, CA  00000

STEPHEN COURY  
EUCI  
EMAIL ONLY  
EMAIL ONLY, CA  00000

STEPHEN ST. MARIE  
CPUC  
EMAIL ONLY  
EMAIL ONLY, CA  00000

STEVE CULBERTSON  
BKI CONSULTING  
EMAIL ONLY  
EMAIL ONLY, CA  00000

SUSANNAH CHURCHILL  
SOLAR POLICY ADVOCATE  
VOTE SOLAR  
EMAIL ONLY  
EMAIL ONLY, CA  00000

TOM JARMAN  
PACIFIC GAS & ELECTRIC COMPANY  
EMAIL ONLY  
EMAIL ONLY, CA  00000
UDI HELMAN
HELMAN ANALYTICS
EMAIL ONLY
EMAIL ONLY, CA  00000

WILL MITCHELL
MANAGER, REGULATORY AFFAIRS
RECURRENT ENERGY
EMAIL ONLY
EMAIL ONLY, CA  00000

WILLIAM DIETRICH
SENIOR CONSULTANT
STUDIES
DIETRICH CONSULTING
EMAIL ONLY
EMAIL ONLY, CA  00000

XIAOBO WANG, PH.D
SR. ADVISOR, MKT & INTEGRATION
CALIFORNIA ISO
EMAIL ONLY
EMAIL ONLY, CA  00000

REGULATORY CLERK
BRAUN BLAISING SMITH WYNNE, PC
EMAIL ONLY
EMAIL ONLY, CA  00000

MRW & ASSOCIATES, LLC
EMAIL ONLY
EMAIL ONLY, CA  00000

PILOT POWER GROUP, INC.
EMAIL ONLY
EMAIL ONLY, CA  00000

DAVIS WRIGHT TREMAINE LLP
EMAIL ONLY
EMAIL ONLY, CA  00000

DAVID MARCUS
EMAIL ONLY
EMAIL ONLY, CA  00000-0000

MICHAEL BERLINSKI
BEACON POWER LLC
65 MIDDLESEX ROAD
TYNSBORO, MA 01879

BOB FAGAN
CONSULTANT TO ORA
SYNAPSE ENERGY ECONOMICS
485 MASSACHUSETTS AVENUE
CAMBRIDGE, MA  02139

MARK MELLANA
GE ENERGY FINANCIAL SVCS, INC.
800 LONG RIDGE ROAD
STAMFORD, CT 06927

CONSTANTINE LEDNEV
ASSOCIATE-US UTILITIES & POWER RESEARCH
DEUTSCHE BANK SECURITIES INC.
60 WALL STREET
NEW YORK CITY, NY  10005

DINA ABDULHADI
INSTITUTE FOR POLICY INTEGRITY
NYU LAW SCHOOL
139 MACDOUGAL ST., 3RD FL.
NEW YORK, NY  10012

JAMES (JIM) VON RIESEMANN
MIZUHO SECURITIES USA, INC.
RESEARCH
320 PARK AVENUE, 12TH FLOOR
NEW YORK, NY  10022

JERIMIAH BOOREAM
POWER, UTILITIES, & ALT ENERGY
RESEARCH
BANK OF AMERICA MERRILL LYNCH
ONE BRYANT PARK
NEW YORK, NY  10036

JOSEPHINE MOORE

JULIEN DUMOULIN-SMITH
POWER AND UTILITIES RESEARCH
ENERGY
BANK OF AMERICA MERRILL LYNCH
ONE BRYANT PARK
NEW YORK, NY 10036

NICHOLAS CAMPANELLA
POWER AND UTILITIES RESEARCH
BANK OF AMERICA MERRILL LYNCH
ONE BRYANT PARK
NEW YORK, NY 10036

TONY WETZEL
DIR - ASSET OPTIMIZATION
EPP SERVICE CO.
1605 N. CEDAR CRESCENT BLVD., NO. 509
ALLENTOWN, PA 18104

DAMON MOGLEN
SR. ADVISOR - CLIMATE & ENERGY PROJECT
FRIENDS OF THE EARTH
1100 15TH STREET NW, 11TH FLOOR
WASHINGTON, DC 20005

S. DAVID FREEMAN
C/O FRIENDS OF THE EARTH
1100 15TH STREET, NW, 11TH FLOOR
WASHINGTON, DC 20005

SEAN YOVAN
SOUTHERN POWER
30 IVAN ALLEN JR. BLVD. NW
ATLANTA, GA 30308

CONOR B. WARD
GRIDLIANCE WEST TRANSCO, LLC
2 N. LASALLE STREET, SUITE 420
CHICAGO, IL 60602

SARAH N. GALIOTO
GRIDLIANCE WEST TRANSCO, LLC
2 N. LASALLE STREET, SUITE 420
CHICAGO, IL 60602

HEAD OF US PWR, UTILITIES & ALT
ENERGY
BANK OF AMERICA MERRILL LYNCH
ONE BRYANT PARK
NEW YORK, NY 10036

LAURA KIER
ENERGYHUB
232 3RD STREET
BROOKLYN, NY 11215

BRANDON SMITHWOOD
MGR - CALIF STATE AFFAIRS
SOLAR ENERGY INDUSTRIES ASSOCIATION
600 14TH STREET, NW, SUITE 400
WASHINGTON, DC 20005

JENNA L. MCGRATH
ATTORNEY AT LAW
PAUL HASTINGS, LLP
875 15TH STREET, N.W.
WASHINGTON, DC 20005
FOR: GRIDLIANCE WEST TRANSCO LLC

JOHN COLLINS
VP - DEVELOPMENT
CO Gentrix ENERGY POWER MANAGEMENT
9405 ARROWPOINT BLVD.
CHARLOTTE, NC 28273
FOR: CO Gentrix ENERGY POWER

STEVE ROWLEY
DIR - BUSINESS DEVELOPMENT
BHE U.S. TRANSMISSION, LLC
666 GRAND AV., STE. 500
DES MOINES, IA 50309-2692

N. BETH EMERY
GRIDLIANCE WEST TRANSCO, LLC
2 N. LASALLE STREET, SUITE 420
CHICAGO, IL 60602

SHEERIE GREEN
CHARTER COMMUNICATIONS
12405 POWERS COURT DTIVE
ST. LOUIS, MO 63131
<table>
<thead>
<tr>
<th>Name</th>
<th>Company</th>
<th>Address</th>
<th>City, State, ZIP</th>
</tr>
</thead>
<tbody>
<tr>
<td>GREG JONES</td>
<td>ATTORNEY</td>
<td>GRIDLIANCE WEST TRANSCO, LLC</td>
<td>IRVING, TX  75039</td>
</tr>
<tr>
<td>RYAN HARWELL</td>
<td>DIRECT ENERGY SERVICES, LLC</td>
<td>12 GREENWAY PLAZA, STE 250</td>
<td>HOUSTON, TX  77046</td>
</tr>
<tr>
<td>CHRIS JONES</td>
<td>DUKE ENERGY</td>
<td>5555 SAN FELIPE STREET</td>
<td>HOUSTON, TX  77056</td>
</tr>
<tr>
<td>DAVID F. SMITH</td>
<td>DIR - ENGINEERING AND OPERATIONS</td>
<td>555 SEVENTEENTH STREET, STE. 2400</td>
<td>DENVER, CO  80202</td>
</tr>
<tr>
<td>KARA MORGAN</td>
<td>TRANSWEST EXPRESS LLC</td>
<td>555- 17TH STREET, STE. 2400</td>
<td>DENVER, CO  80202</td>
</tr>
<tr>
<td>KELLY CRANDALL</td>
<td>EQ RESEARCH, LLC</td>
<td>1580 LINCOLN STREET, SUITE 880</td>
<td>DENVER, CO  80203</td>
</tr>
<tr>
<td>CAITLIN COLLINS LIOTIRIS</td>
<td>ENERGY STRATEGIES, LLC</td>
<td>215 SOUTH STATE STREET, STE 200</td>
<td>SALT LAKE CITY, UT  84111</td>
</tr>
<tr>
<td>DANIEL RAMIREZ</td>
<td>ANALYST</td>
<td>215 SOUTH STATE STREET, STE 200</td>
<td>SALT LAKE CITY, UT  84111</td>
</tr>
<tr>
<td>ROBERT D. SMITH</td>
<td>VP, TRANSMISSION PLANNING &amp; DEVELOP</td>
<td>400 EAST VAN BUREN ST., STE 350</td>
<td>PHOENIX, AZ  85004</td>
</tr>
<tr>
<td>EMILY SCHNEIDER</td>
<td>VALLEY ELECTRIC ASSOCIATION, INC.</td>
<td>800 E. HWY 372</td>
<td>PAHRUMP, NV  89048</td>
</tr>
<tr>
<td>PAUL THOMSEN</td>
<td>GOVERNMENT AND REGULATORY AFFAIRS</td>
<td>6225 NEIL ROAD</td>
<td>RENO, NV  89511</td>
</tr>
<tr>
<td>JOE GRECO</td>
<td>SR. V.P.</td>
<td>TERRA-GEN POWER LLC</td>
<td>RENO, NV  89521-5916</td>
</tr>
<tr>
<td>LAUREN HOLDWAY</td>
<td>TERRA-GEN POWER LLC</td>
<td>9590 PROTOTYPE COURT, SUITE 200</td>
<td>RENO, NV  89521-5916</td>
</tr>
<tr>
<td>CHRISTOPHER BISSONNETTE</td>
<td>ACTING - ASSISTANT GEN. COUNSEL</td>
<td>SOUTHERN CALIFORNIA GAS COMPANY</td>
<td>LOS ANGELES, CA  90013</td>
</tr>
<tr>
<td>ERIN PALERMO BROOKS</td>
<td>REGULATORY POLICY / REPORTING MGR.</td>
<td>SOUTHERN CALIFORNIA GAS</td>
<td>LOS ANGELES, CA  90013</td>
</tr>
<tr>
<td>KENDRA TALLEY</td>
<td>CASE MGR.</td>
<td>SOUTHERN CALIFORNIA GAS COMPANY</td>
<td>LOS ANGELES, CA  90013</td>
</tr>
<tr>
<td>PAMELA WU</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROSALINDA MAGANA</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2244 WALNUT GROVE AVE. G.O.1, RM 345E  
ROSEMEAD, CA  91770  
CASE ADMINISTRATION  
SOUTHERN CALIFORNIA EDISON COMPANY  
2244 WALNUT GROVE AVE. / PO BOX 800  
 ROSEMEAD, CA  91770  
FOR: SOUTHERN CALIFORNIA EDISON COMPANY

CATHY A. KARLSTAD  
SR. ATTORNEY  
SOUTHERN CALIFORNIA EDISON COMPANY  
2244 WALNUT GROVE AVE., PO BOX 800  
ROSEMEAD, CA  91770  
FOR: KARLSTAD - CASE ADMINISTRATOR

FARAH MANDICH  
SOUTHERN CALIFORNIA EDISON COMPANY  
8631 RUSH ST  
ROSEMEAD, CA  91770  
FOR: KARLSTAD - CASE ADMINISTRATOR

ROBERT FRANCIS LEMOINE  
SENIOR ATTORNEY, LAW DEPARTMENT  
SOUTHERN CALIFORNIA EDISON COMPANY  
2244 WALNUT GROVE AVE. SUITE 346L  
ROSEMEAD, CA  91770  
FOR: KARLSTAD - CASE ADMINISTRATOR

TRISTIAN REYES  
SOUTHERN CALIFORNIA EDISON COMPANY  
2244 WALNUT GROVE AVE.  
ROSEMEAD, CA  91770  
FOR: KARLSTAD - CASE ADMINISTRATOR

NGUYEN QUAN  
BEAR VALLEY ELECTRIC SERVICE  
630 EAST FOOTHILL BLVD.  
SAN DIMAS, CA  91773  
FOR: BEAR VALLEY ELECTRIC SERVICE

CHAD COLTON  
LAW CLERK  
TOSDAL LAW FIRM  
777 S. HIGHWAY 101, STE. 215  
SOLANA BEACH, CA  92075  
FOR: KARLSTAD - CASE ADMINISTRATOR

ALVIN PAK  
ATTORNEY AT LAW  
CALIFORNIA POWER LAW GROUP  
501 WEST BROADWAY, SUITE 800  
SAN DIEGO, CA  92101  
FOR: ATTORNEY FOR NOBLE SOLUTIONS (RESPONDENT)

KATY WILSON  
SEMPRA GENERATION, LLC  
488 8TH AVENUE, HQ11N1  
SAN DIEGO, CA  92101  
FOR: KARLSTAD - CASE ADMINISTRATOR

MARIA E. BYRNES  
LEGAL ASSISTANT  
AGUIRRE & SEVERSON, LLP  
501 WEST BROADWAY, SUITE 1050  
SAN DIEGO, CA  92101  
FOR: KARLSTAD - CASE ADMINISTRATOR

MARIA C. SEVERSON, ESQ.  
ATTORNEY  
ADMINISTRATION  
AGUIRRE & SEVERSON LLP  
501 WEST BROADWAY, STE. 1050  
SAN DIEGO, CA  92101-3591  
FOR: KARLSTAD - CASE ADMINISTRATOR

JANE KRIKORIAN, J. D.  
SUPERVISOR, ADVOCACY &  
UTILITY CONSUMERS' ACTION NETWORK  
3405 KENYON STREET, SUITE 401  
SAN DIEGO, CA  92110  
FOR: UTILITY CONSUMERS' ACTION NETWORK

DAVID CROYLE  
UCAN’S EXPERT  
3405 KENYON STREET STE 401  
520  
FOR: KARLSTAD - CASE ADMINISTRATOR

KELLY FOLEY  
PILOT POWER GROUP  
8910 UNIVERSITY CENTER LANE, SUITE
PERKINS COIE LLP
505 HOWARD STREET, STE. 1000
SAN FRANCISCO, CA  94105

F. JACKSON STODDARD
ATTORNEY
MORGAN LEWIS & BOCKIUS, LLP
ONE MARKET, SPEAR STREET TOWER
SAN FRANCISCO, CA  94105-1126

MONICA A. SCHWEBS
ATTORNEY AT LAW
MORGAN LEWIS BOCKIUS LLP
ONE MARKET, SPEAR STREET TOWER
SAN FRANCISCO, CA  94105-1126

MATT GONZALES
PACIFIC GAS AND ELECTRIC COMPANY
77 BEALE STREET, B9A
SAN FRANCISCO, CA  94105-1814

BRIAN KOOIMAN
OHMCONNECT, INC.
350 TOWNSEND ST., STE. 210
SAN FRANCISCO, CA  94107

FRANCESCA WAHL
SR. ASSOCIATE, BUS. DEVELOPMENT
TESLA, INC.
444 DE HARO STREET, STE. 101
SAN FRANCISCO, CA  94107

JOHN W. ANDERSON
DIR - ENERGY MARKETS
OHMCONNECT, INC.
350 TOWNSEND S., SUITE 210
SAN FRANCISCO, CA  94107

SAMUEL GOLDFING
PRESIDENT
COMMUNITY CHOICE PARTNERS, INC.
58 MIRABEL AVENUE
SAN FRANCISCO, CA  94110

BUCK ENDEMANN
ATTORNEY
K&L GATES, LLP
FOUR EMBARCADERO, STE 1200
SAN FRANCISCO, CA  94111

JOHN MCINTYRE
ATTORNEY
GOODIN, MACBRIDE, SQUERI & DAY, LLP
505 SANSOME ST., STE. 900
SAN FRANCISCO, CA  94111

KATIE JORRIE
ATTORNEY
DAVIS WRIGHT TREMAINE, LLP
505 MONTGOMERY STREET, SUITE 800
SAN FRANCISCO, CA  94111

LOUISE DYBLE
ATTORNEY
WINSTON & STRAWN
101 CALIFORNIA STREET, STE. 3500
SAN FRANCISCO, CA  94111

MOLLY DERINGER CROLL
CALIFORNIA ENVIRONMENTAL ASSOCIATES
423 WASHINGTON ST.
SAN FRANCISCO, CA  94111

NINA ROBERTSON
STAFF ATTORNEY
EARTHJUSTICE
50 CALIFORNIA STREET, STE. 500
SAN FRANCISCO, CA  94111

RIKKI WEBER
LITIGATION ASSISTANT
EARTHJUSTICE
50 CALIFORNIA STREET, SUITE 500
SAN FRANCISCO, CA  94111

SEAN P. BEATTY
WEST REGION GEN. COUNSEL
NRG ENERGY, INC,
100 CALIFORNIA STREET, SUITE 400
SAN FRANCISCO, CA  94111
STEVE MCCARTY
STEVEN MCCARTY AND ASSOCIATES
2460 LAVENDER DRIVER, SUITE 101
WALNUT CREEK, CA  94596

ALICE L. HARRON
CEO
HARRON, LLC
4016 EVERETT AVE.
OAKLAND, CA  94602

ERIC C. WOYCHIK
EXEC. CONSULTANT & PRINCIPAL
STRATEGY INTEGRATION, LLC
9901 CALODEN LANE
OAKLAND, CA  94605
FOR: VOTE SOLAR

ALLIE DETRIO
POLICY MANAGER
ENGIE SERVICES
500 12TH STREET, SUITE 300
OAKLAND, CA  94607

CYNTHIA CLARK
MANAGER, WHOLESALE ELECTRICITY PROGRAM
UNIV. OF CALIF. - OFFICE OF THE PRES.
1111 BROADWAY . SUITE 1450
OAKLAND, CA  94607

ELISE HUNTER
DIR - POLICY & REGULATORY AFFAIRS
GRID ALTERNATIVES
1171 OCEAN AVE., STE. 200
OAKLAND, CA  94608

ED SMELOFF
MANAGING DIRECTOR, REGULATOR TEAM
VOTE SOLAR
360 22ND STREET, SUITE 730
OAKLAND, CA  94612

JAMES HANSELL
DNV GL GROUP
1505 JACKSON STREET
OAKLAND, CA  94612

JIM BAAK
PROGRAM DIR - GRID INTEGRATION
VOTE SOLAR
360 22ND FLOOR, SUITE 730
OAKLAND, CA  94612

KATHERINE RAMSEY
STAFF ATTORNEY
SIERRA CLUB ENVIRONMENTAL LAW
2101 WEBSTER STREET, SUITE 1300
OAKLAND, CA  94612

RACHEL BIRD
DIR - POLICY & BUS. DEVELOPMENT, WEST
BORREGO SOLAR SYSTEMS, INC.
360 22ND STREET, SUITE 600
OAKLAND, CA  94612

TIM LINDL
COUNSEL
KEYES & FOX LLP
436 14TH STREET, STE. 1305
OAKLAND, CA  94612

CLAIRE V. BROOME
26 NORTHGATE AVE
BERKELEY, CA  94708

R. THOMAS BEACH
PRINCIPAL CONSULTANT
CROSSBORDER ENERGY
2560 NINTH STREET, SUITE 213A
BERKELEY, CA  94710

MCE REGULATORY
MARIN CLEAN ENERGY
1125 TAMALPAIS AVENUE
SAN RAFAEL, CA  94901

SHALINI SWAROOP
REGULATORY & LEGISLATIVE COUNSEL
MARIN CLEAN ENERGY
1125 TAMALPAIS AVENUE
SAN RAFAEL, CA  94901
FOR: MARIN CLEAN ENERGY
FOR: CALIFORNIA ISO

KARL MEEUSEN, PH.D
CALIFORNIA INDEPENDENT SYSTEM OPERATOR
250 OUTCROPPING WAY
FOLSOM, CA  95630

KIM PEREZ
CALIFORNIA ISO
250 OUTCROPPING WAY
FOLSOM, CA  95630

LEGAL & REGULATORY DEPT.
CALIFORNIA INDEPENDENT SYSTEM OPERATOR
250 OUTCROPPING WAY
FOLSOM, CA  95630

MARGARET MILLER
DIR OF MARKET INTELLIGENCE - WEST
CUSTOMIZED ENERGY SOLUTIONS
101 PARKSHORE DRIVE, SUITE 100
FOLSOM, CA  95630

PAUL D. MAXWELL
NAVIGANT CONSULTING, INC.
35 IRON POINT CIRCLE, STE. 225
FOLSOM, CA  95630

SHUCHENG LIU
PRINCIPAL, MARKET DEVELOPMENT
CALIF. INDEPENDENT SYSTEM OPERATOR
250 OUTCROPPING WAY
FOLSOM, CA  95630

TIM MASON
GRID SUBJECT MATTER EXPERTS, LLC
1847 IRON POINT RD., STE. 140
FOLSOM, CA  95630

JOHN GOODIN
CALIFORNIA ISO
250 OUTCROPPING WAY
FOLSOM, CA  95630-8773

LORENZO KRISTOV
CALIFORNIA ISO
250 OUTCROPPING WAY
FOLSOM, CA  95630-8773

TAO DR. GUO
ABB CORPORATION
8609 CASTLE CREEK DR.
ROSEVILLE, CA  95661

CARRIE BENTLEY
RESEER CONSULTING
9289 SHADOW BROOK PLACE
GRANITE BAY, CA  95746
FOR: ALLIANCE FOR RETAIL ENERGY MARKETS

WENXIONG HUANG
WH ENERGY SOLUTIONS LLC
5014 CHELSHIRE DOWNS ROAD
GRANITE BAY, CA  95746

ROBIN SMUTNY-JONES
DIR., CALIFORNIA POLICY & REGULATION
IBERDROLA RENEWABLES, LLC
3009 E. PINTAIL WAY
ELK GROVE, CA  95757

MATTHEW SWINDLE
CEO & FOUNDER
NLINE ENERGY, INC. (NLINE)
5170 GOLDEN FOOTHILL PARKWAY
EL DORADO HILLS, CA  95762
FOR: NLINE ENERGY, INC. (NLINE)

GWENN O’HARA
ATTORNEY
CALIFORNIA POWER LAW GROUP
1325 19TH STREET
SACRAMENTO, CA  95811

KLOPFFENSTEIN IS REP

CAROLYN KEHREIN
ENERGY MANAGEMENT SERVICES
2602 CELEBRATION WAY
WOODLAND, CA  95776

MATT
<table>
<thead>
<tr>
<th>Name</th>
<th>Title and Affiliation</th>
</tr>
</thead>
<tbody>
<tr>
<td>OLOF BYSTROM</td>
<td>MGR - RESOURCE STRATEGY, SACRAMENTO MUNICIPAL UTILITY DISTRICT, SMUD</td>
</tr>
<tr>
<td>AUDRA HARTMANN</td>
<td>PRINCIPAL, SMITH, WATTS &amp; HARTMANN, 925 L STREET, SUITE 220, SACRAMENTO, CA 95814</td>
</tr>
<tr>
<td>DAN GRIFFITHS</td>
<td>ATTORNEY, BRAUN BLAISING MCLAUGHLIN &amp; SMITH, P.C., 915 L STREET, SUITE 1480, SACRAMENTO, CA 95814, FOR: CALIFORNIA COMMUNITY CHOICE ASSOCIATION</td>
</tr>
<tr>
<td>KEVIN WOODRUFF</td>
<td>CONSULTANT, WOODRUFF EXPERT SERVICES, 1127 - 11TH STREET, SUITE 514, SACRAMENTO, CA 95814</td>
</tr>
<tr>
<td>LINDA JOHNSON</td>
<td>DIRECTOR, CENTER FOR ENERGY EFFICIENCY, 1100 11TH STREET, STE. 311, SACRAMENTO, CA 95814</td>
</tr>
<tr>
<td>MICHAEL KENNEY</td>
<td>ENERGY ANALYST, EFFICIENCY DIVISION, CALIFORNIA ENERGY COMMISSION, 1415 L STREET, STE. 800, SACRAMENTO, CA 95814</td>
</tr>
<tr>
<td>ROSANNA CARVACAO</td>
<td>ASSOCIATE, BROWNSTEIN HYATT FARBER SCHRECK, 1215 K STREET, STE. 900, SACRAMENTO, CA 95814</td>
</tr>
<tr>
<td>SARAH KOZAL</td>
<td>ASSOCIATE, STOEL RIVES LLP, 500 CAPITOL MALL, STE. 1600, SACRAMENTO, CA 95814</td>
</tr>
<tr>
<td>SARAH TAHERI</td>
<td>SO. CALIF. PUBLIC POWER AUTHORITY, INDEPENDENT ENERGY PRODUCERS ASSOCIATION, 1215 K STREET, STE. 900</td>
</tr>
<tr>
<td>STEVEN KELLY</td>
<td>POLICY DIR, INDEPENDENT ENERGY PRODUCERS ASSOCIATION, 1215 K STREET, STE. 900</td>
</tr>
</tbody>
</table>
Plumas Sierra Rural Electric Cooperative
73233 State Route 70 / PO Box 2000
Portola, CA  96122-2000

Regulatory Affairs Mgr.
Pacificorp
825 NE Multnomah St., Ste 300
Portland, OR  97232
For: Pacificorp

Pooja Kishore
Pacificipant
825 NE Multnomah, Ste. 600
Portland, OR  97232

Amber Nyquist
Sr. Project Manager
Ees Consulting
570 Kirkland Way, Ste 100
Kirkland, WA  98033

Anne Falcon
Sr. Associate
Ees Consulting, Inc.
570 Kirkland Way, No. 100
Kirkland, CA  98033

Gary Saleda
Ees Consulting
570 Kirkland Way, No. 100
Kirkland, WA  98033

State Service

Carlos Velasquez
CPUC - Energy Planning
Email Only
Commission
Email Only, CA  00000

David Miller
Energy Div. - Infrastructure
California Public Utilities
Email Only
Email Only, CA  00000

Eli Harland
California Energy Commission
Energy Research & Development Div.
Email Only
Email Only, CA  00000

Eric Dupre
CPUC - Energy
Email Only
Email Only, CA  00000

Frederick Taylor-Hochberg
CPUC - Energy Div.
Email Only
Email Only, CA  00000

Jason Houch
Sr. Analyst
CPUC - Energy Div.
Email Only
Email Only, CA  00000

Julie Pitch
ALJ Division
California Public Utilities Commission
Email Only
Email Only, CA  00000

Legal Division
CPUC
Email Only
Email Only, CA  00000

Linda Kelly
Patrick Young
<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Division</th>
<th>Room</th>
<th>Address</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>President Picker</td>
<td>Market Structure, Costs and Natural Gas</td>
<td>Area</td>
<td>4108</td>
<td>505 Van Ness Ave</td>
<td>4102-3214</td>
</tr>
<tr>
<td>Diana L. Lee</td>
<td>Legal Division</td>
<td>Permitting B</td>
<td>4107</td>
<td>505 Van Ness Ave</td>
<td>4102-3214</td>
</tr>
<tr>
<td>Elizabeth Dorman</td>
<td>Legal Division</td>
<td>Program</td>
<td>4300</td>
<td>505 Van Ness Ave</td>
<td>4102-3214</td>
</tr>
<tr>
<td>Iryna Kwasny</td>
<td>Legal Division</td>
<td>Permitting B</td>
<td>4107</td>
<td>505 Van Ness Ave</td>
<td>4102-3214</td>
</tr>
<tr>
<td>Julie A. Fitch</td>
<td>Division of Administrative Law Judges Branch</td>
<td>Area</td>
<td>5115</td>
<td>505 Van Ness Ave</td>
<td>4102-3214</td>
</tr>
<tr>
<td>Karolina Maslanka</td>
<td>Infrastructure Planning and Permitting B Area</td>
<td>Area</td>
<td></td>
<td>505 Van Ness Ave</td>
<td>4102-3214</td>
</tr>
<tr>
<td>Liam Weaver</td>
<td>Energy Safety &amp; Infrastructure Branch Branch</td>
<td></td>
<td></td>
<td>505 Van Ness Ave</td>
<td>4102-3214</td>
</tr>
</tbody>
</table>
MARC PRYOR
ELECTRIC GENERATION SPECIALIST III
CALIFORNIA ENERGY COMMISSION
1516 NINTH ST., MS - 20
SACRAMENTO, CA  95814

MICHAEL JASKE
CALIFORNIA ENERGY COMMISSION
1516 9TH STREET, MS-21
SACRAMENTO, CA  95814

PAUL DEAVER
CALIFORNIA ENERGY COMMISSION
1516 9TH STREET
SACRAMENTO, CA  95814

ROBERT KENNEDY
CALIFORNIA ENERGY COMMISSION
1516 9TH STREET, MS-20
SACRAMENTO, CA  95814

ANGELA TANGHETTI
CALIFORNIA ENERGY COMMISSION
1516 NINTH STREET, MS-20
SACRAMENTO, CA  95819

RICHARD JENSEN
CA ENERGY COMMISSION
1516 9TH ST MS-20
SACRAMENTO, CA  95826
BEFORE THE PUBLIC UTILITIES
COMMISSION OF THE STATE OF
CALIFORNIA

Order Instituting Rulemaking to
Develop an Electricity Integrated
Resource Planning Framework and to
Coordinate and Refine Long-Term
Procurement Planning Requirements.

Rulemaking 16-02-007
(Filed February 11, 2016)

INFORMAL COMMENTS OF WELLHEAD POWER SOLUTIONS, LLC ON
QUESTIONS RAISED IN CONNECTION WITH MODELING 2019-20 IRP
SUPPLY-SIDE RESOURCES.

Harold E. Dittmer, President
Wellhead Power Solutions, LLC
650 Bercut Dr., Suite C
Sacramento, CA 95811
Tel: (916) 447-5171
E-mail: hdittmer@wellhead.com

April 23, 2018
BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking to Develop an Electricity Integrated Resource Planning Framework and to Coordinate and Refine Long-Term Procurement Planning Requirements.

Rulemaking 16-02-007
(Filed February 11, 2016)

INFORMAL COMMENTS OF WELLHEAD POWER SOLUTIONS, LLC ON QUESTIONS RAISED IN CONNECTION WITH MODELING 2019-20 IRP SUPPLY-SIDE RESOURCES.

Wellhead Power Solutions, LLC is pleased to submit the following in response to the Energy Division’s Modeling Advisory Group’s request for comments on questions raised in connection with modeling 2019-20 IRP Supply-Side Resources.

More specifically, our comments respond to question 10 by proposing that the IRP model Energy Storage Hybrid Gas Turbine (aka “Hybrid EGT”) technology as a separate resource category. Then we will cover question one by responding to the requests for costs and performance information for the retrofit of existing LM6000 gas turbines with this new technology.
A. **Response to Question 10**

Question 10: Are there any new resource types (not described in your responses to Questions 1 – 9) that Energy Division should prioritize including as a candidate resource in the 2019 IRP? Describe how the new resource type satisfies the new candidate resource criteria listed above. List the data sources available for quantifying the cost and potential of the proposed resource type and describe how the data sources satisfy the data source criteria listed above.

1. **Response:** Wellhead proposes that the retrofit of gas resources in California with Energy Storage Hybrid EGT technology be included as a candidate resource category in the 2019 IRP.

2. **Background and justification:** In 2017, for the first time, a battery (10MW/4.3MWh) was electronically integrated with a simple cycle combustion turbine to give it 100% flexibility, reduce GHG emissions, and spinning reserves qualification in the CAISO market. The Hybrid EGT technology from General Electric\(^1\) was commissioned by Southern California Edison Company as a retrofit of its LM6000 Peaker plants at Center and Grapeland.

SCE recently reported\(^2\) to the CPUC that, pre-construction, the Hybrid EGT was expected to significantly reduce overall plant emissions by providing grid services such as Spinning Reserve without burning fuel -

- Fewer Gas Turbine Starts and Run Hours
- Higher capacity utilization

\(^1\) GE refers to the technology as the “Electric Gas Turbine” or “EGT.”

• Higher value grid services such as Spinning Reserve

The Hybrid EGT’s actual performance results compared with SCE’s non-hybrid peakers demonstrated over the same period -

• Higher capacity utilization
• Lower fuel gas usage
• Lower emissions
• Higher market revenues

Further, SCE reported that the performance of the initial two Hybrid EGTs have exceeded expectations thus far -

• Spinning reserve utilization higher than expected
• Primary frequency response performance much higher than expected
• The Hybrid EGT has at times responded to over 500 frequency droops in a day, helping to maintain a stable electric system frequency

Finally, SCE reportedly is actively analyzing the customer value of additional Hybrid EGT upgrades at its three remaining GE LM6000 peakers -

• Mira Loma Peaker (Ontario, CA)
• Barre Peaker (Stanton, CA)
• McGrath Peaker (Oxnard, CA)

3. Data Sources:

a) SCE report to CPUC³

³ Id.
SCE’s Hybrid EGT plants have been in operation for over one year and SCE recently reported to the CPUC the following attributes and benefits of the technology:

**Greenhouse Gas Free Attributes**

- Instant Response/Always Ready Technology
- 50 MWs of Operating Reserve
- Primary Frequency Response
- -8 to +5 MVAR Voltage Support
- 134 MW-Secs Inertia
- Black Start Technology

**With Fuel Consumption Attributes**

- 50 MWs Peaking Energy for Local Contingency
- 25 MWs of High Speed Frequency Regulation
- Demand Charge Management
- Self-Managed Battery System State Of Charge ("SOC")

In other public documents,⁴ SCE has forecasted that the Hybrid EGT retrofit will reduce GHG and criteria pollutants by over 60% and water usage by over 45% (about one million gallons per year) compared to pre-Hybrid EGT peaker performance. This would significantly benefit disadvantaged communities.

**b) Wellhead Modeling Results**

---

⁴ Brochure: *Southern California Edison’s Hybrid Enhanced Gas Turbine, Unlocking the Value*, Published April 2017.
1. **Hybrid LM6000s.** Wellhead Power Solutions has commissioned independent system modeling of retrofitting LM6000 peakers with the following results:

- Installing two Hybrid EGTs providing spinning reserves in a certain IOU’s service territory in CAISO would:
  - reduce GHG by approximately 14,000 MT/year per EGT and
  - create over $4 million of annual load payment savings per EGT from reducing the marginal heat rate of the dispatch stack by allowing CCGTs, previously backed down to provide spinning reserves, to run at their most efficient load point.

- Retrofitting a single LM6000 as a Hybrid EGT in a certain WECC balancing area would result in system production cost savings over the 13-year study period of between $31 million and $44 million ($20-$30MM of present value at the BA’s WACC), as well as a reduction in renewable energy curtailment.

2. **Hybrid CCGT’s.** Wellhead Power Solutions has commenced modeling efforts for evaluating the integration of a battery with a CCGT to eliminate the steam-turbine lag in startup thereby dramatically increasing the ramp rate of the facility. This technology is expected to have important benefits in reducing system curtailment and GHG emissions. Performance metrics should be available later this year so that this technology may be modeled as a separate candidate resource in the 2019-20 IRP.

3. **Expected Future Modeling Results.** Wellhead’s recent Hybrid EGT modeling in the CAISO assumed the current RPS with only 12 months of operation. Future modeling is expected to show that the additional flexibility gained by
hybridizing existing gas-fired resources will result in the California not only reaching its GHG goals faster but also with significantly lower renewable overbuild. As renewables increase, the level of needed reserves increases. We expect the modeling to show the EGT as one of the lowest GHG options to meet increasing flexibility and reserve requirements.

B. Responses to Other Questions

**Question 1:** Do parties have recommendations on public data sources that capture the costs and operational characteristics of retrofitted power plants?

1. **Response:**

The Hybrid EGT technology is newly installed in the fleet. As a consequence, there is limited public cost data available. The following data is provided by Wellhead Power Solutions based on the performance characteristics provided by General Electric. SCE is expected to be filing additional performance reports to the CPUC.

Because the Hybrid EGT is both a gas turbine and a battery, our responses will deal with both technologies separately in two sections – first as a gas retrofit and secondly as a battery.

2. **Gas Retrofits**

**Description:** Cost and performance assumptions for retrofits of existing gas generators.

**Data needs:**

- **Cost inputs:** - Not publicly available at this time.
• Capital cost, $/kW - Not publicly available at this time.
• Fixed O&M, $/kW-yr - Not publicly available at this time.
• Variable O&M, $/MWh - Not publicly available at this time.
• Financing assumptions (cost of capital, capital structure, contract duration etc.) - Not publicly available at this time.
• Tax assumptions - Not publicly available at this time.

o Performance assumptions in Hybrid Mode:

• Pmax, MW – 47 to 49.9 MW
• Pmin, MW – zero
• Ramp rates, MW/min – 10
• Start cost, $/start – zero commitment cost
• Heat rate (Btu/kWh)
  @ Pmin – zero
  @ Pmax – 9,900
• Minimum up time – zero
• Minimum down time – zero

3. Battery

Description: Options for new battery technologies.

Data needs:

o Assumed operational parameters for each technology option:

• Storage duration (hrs) – 0.43 hrs
• Round-trip losses (%) – 85%
• Ability to contribute to reserve requirements (spin/frequency response/regulation/load following) - Yes
• Point of interconnection – Inverter AC output connects to gas turbine output breaker
• Ramping limitations, if applicable (MW/min) -20MW/sec
• Online date -
• Capacity (MW) – 10MW AC
• Other operational limits such as minimum time to switch from charge to discharge – 1sec Dmax to Cmax or Cmax to Dmax

○ Current cost, performance, and financing assumptions (used to develop forward-looking projections of levelized capacity cost, $/kW-yr):

  • Capital cost, $/kW (power block) and $/kWh (reservoir) – Not publicly available at this time.
  • Fixed O&M, $/kW-yr – Not publicly available at this time.
  • Financing inputs (cost of capital, capital structure, contract duration etc.) – Not publicly available at this time.
  • Tax credits (PTC, ITC) – Does not currently qualify for PTC or ITC

○ Assumed future cost reductions for battery technology (multiple levels of cost reduction will be examined) – Substantial cost reductions are forecasted.

**Conclusion**

The Hybrid EGT technology is a commercially proven technology that has demonstrated material benefits to the system by reducing GHG, production costs, and load payment costs. Wellhead Power Solutions, as patent holder and
co-developer with General Electric of the Hybrid EGT technology is committed to working with the Energy Division to develop public cost and performance data so that this new technology, for both peaker and CCGT retrofits, can be accurately modeled in the 2019-20 IRP as candidate resources.

Respectfully submitted,

__________/s/___________________
Harold E. Dittmer, President
Wellhead Power Solutions, LLC
650 Bercut Dr., Suite C
Sacramento, CA 95811
Tel: (916) 447-5171
E-mail: hdittmer@wellhead.com
BEFORE THE PUBLIC UTILITIES
COMMISSION OF THE STATE OF
CALIFORNIA

Order Instituting Rulemaking to
Develop an Electricity Integrated
Resource Planning Framework and to
Coordinate and Refine Long-Term
Procurement Planning Requirements.

Rulemaking 16-02-007
(Filed February 11, 2016)

CERTIFICATE OF SERVICE

I hereby certify that I have this day served a copy of “INFORMAL COMMENTS
OF WELLHEAD POWER SOLUTIONS, LLC ON QUESTIONS RAISED IN
CONNECTION WITH MODELING 2019-20 IRP SUPPLY-SIDE RESOURCES”
on all known parties listed on the Service List for this Proceeding R.16-02-007. All
parties have been served by email, in accordance with Commission Rules.

Executed April 23, 2018 in Sacramento, California

/s/___________________
Harold E. Dittmer, President
Wellhead Power Solutions, LLC
650 Bercut Dr., Suite C
Sacramento, CA 95811
Tel: (916) 447-5171
E-mail: hdittmer@wellhead.com
CALIFORNIA PUBLIC UTILITIES COMMISSION
Service Lists

PROCEEDING: R1602007 - CPUC - OIR TO DEVELO
FILER: CPUC
LIST NAME: LIST
LAST CHANGED: APRIL 23, 2018

Download the Comma-delimited File
About Comma-delimited Files

Back to Service Lists Index

Parties

DAVID LYONS                              JEFFREY KEHNE
ATTORNEY                                  CHIEF DEVELOPMENT OFFICE / GEN.COUNSEL
PAUL HASTINGS LLP                         MEGELLAN WIND LLC
EMAIL ONLY                                EMAIL ONLY
EMAIL ONLY, CA  00000                     EMAIL ONLY, DC  00000
FOR: LA PALOMA GENERATING COMPANY, LLC    FOR: MAGELLAN WIND LLC

JOHN W. LESLIE, ESQ.                     MATTHEW FREEDMAN
ATTORNEY                                  STAFF ATTORNEY
DENTONS US LLP                            THE UTILITY REFORM NETWORK
EMAIL ONLY                                EMAIL ONLY
EMAIL ONLY, CA  00000                     EMAIL ONLY, CA  00000
FOR: SHELL ENERGY NORTH AMERICA (U.S.),   FOR: THE UTILITY REFORM NETWORK (TURN)
   L.P.

MERRIAN BORGESON                         TIM MASON
SR. SCIENTIST                             POLICY DIRECTOR
NATURAL RESOURCES DEFENSE COUNCIL         LARGE-SCALE SOLAR ASSOCIATION
EMAIL ONLY                                EMAIL ONLY
EMAIL ONLY, CA  00000                     EMAIL ONLY, CA  00000
FOR: NATURAL RESOURCES DEFENSE COUNCIL   FOR: LAREG-SCALE SOLAR ASSOCIATION
   (NRDC)

KENNETH SAHM WHITE                       MIKE LEVIN
DIRECTOR, ECONOMIC & POLICY ANALYSIS      DIR - GOVN'T AFFAIRS
CLEAN COALITION                           FUELCELL ENERGY, INC.
EMAIL ONLY                                3 GREAT PASTURE ROAD
EMAIL ONLY, CA  00000-0000                DANBURY, CT  06810
FOR: EDF INDUSTRIAL POWER SERVICES (CA), LLC
FOR: ENERCAL USA, LLC YEP ENERGY

JOHN H. RITCH
GEXA ENERGY CALIFORNIA, LLC
20455 STATE HIGHWAY 249, STE. 200
HOUSTON, TX 77070
FOR: GEXA ENERGY CALIFORNIA, LLC

DAVID P. LOWREY
DIRECTOR, REGULATORY STRATEGY
COMVERGE, INC.
999 18TH STREET, SUITE 2300
DENVER, CO 80202
FOR: COMVERGE, INC.

ROXANE J. PERRUSO
VP / GENERAL COUNSEL
TRANSWEST EXPRESS LLC
555 SEVENTEENTH STREET, STE 2400
DENVER, CO 80202
FOR: TRANSWEST EXPRESS, LLC

JASON R. SMITH
PRESIDENT
TRANSCANYON, LLC
ONE ARIZONA CENTER
400 EAST VAN BUREN ST., STE. 350
PHOENIX, AZ 85004
FOR: TRANSCANYON, LLC

DAVID GETTS
GEN. MGR.
SOUTHWESTERN POWER GROUP II, LLC
3610 N. 44TH ST., STE. 250
PHOENIX, AZ 85018
FOR: SOUTHWESTERN POWER GROUP (SWPG)

JOSHUA A. NORDQUIST
DIR. - BUSINESS DEVELOPMENT
ORMAT TECHNOLOGIES, INC.
6225 NEIL ROAD
RENO, NV 89511
FOR: ORMAT TECHNOLOGIES, INC.

EDWARD L. HSU
SR COUNSEL
SOUTHERN CALIFORNIA GAS COMPANY
555 WEST 5TH STREET, GT14E7
LOS ANGELES, CA 90013
FOR: SOUTHERN CALIFORNIA GAS COMPANY (SOCAL)

STEVE ZURETTI
DIRECTOR, REGULATORY AFFAIRS
BROOKFIELD RENEWABLE ENERGY PARTNERS WEST COAST
601 S. FIGUEROA STREET, SUITE 2200
LOS ANGELES, CA 90017
FOR: (BROOKFIELD RENEWABLE ENERGY PARTNERS)

HOWARD CHoy
GENERAL MGR.
COUNTY OF LOS ANGELES
OFFICE OF SUSTAINABILITY
1100 NORTH EASTERN AVENUE
LOS ANGELES, CA 90063
FOR: COUNTY OF LOS ANGELES

JERRY R. BLOOM
ATTORNEY AT LAW
WINSTON & STRAWN LLP
333 SOUTH GRAND AVENUE, 38TH FL.
LOS ANGELES, CA 90071
FOR: CALIFORNIA COGENERATION COUNCIL

LISA BOND
RICHARDS WATSON GERSHON
355 SOUTH GRAND AVE., 40TH FLOOR
LOS ANGELES, CA 90071
FOR: CITY OF REDONDO BEACH

DAN MARSH
MGR, RATES AND REGULATORY AFFAIRS
LIBERTY UTILITIES (CALIFORNIA)
9750 WASHBURN ROAD
DOWNEY, CA 90241-7002
FOR: LIBERTY UTILITIES (CALPECO ELECTRIC) LLC

MICHAEL MAZUR
3 PHASES RENEWABLES, LLC
1228 E. GRAND AVENUE
EL SEGUNDO, CA 90245
FOR: 3 PHASES RENEWABLES, LLC

J. DOUGLAS DIVINE
CHIEF EXECUTIVE OFFICER
EAGLE CREST ENERGY COMPANY
3000 OCEAN PARK BLVD., STE. 1020
SANTA MONICA, CA 90405
FOR: EAGLE CREST ENERGY COMPANY

INGER GOODMAN
JUST ENERGY SOLUTIONS INC.
6 CENTERPOINTE DRIVE, SUITE 750
LA PALMA, CA 90623-2520
FOR: JUST ENERGY SOLUTIONS, INC. F/K/A COMMERCE ENERGY, INC.

DANIEL W. DOUGLASS
ATTORNEY
DOUGLASS & LIDDELL
4766 PARK GRANADA, SUITE 209
CALABASAS, CA 91302
FOR: WESTERN POWER TRADING FORUM (WPTF)/ ALLIANCE FOR RETAIL ENERGY MARKETS (AREM) / DIRECT ACCESS CUSTOMER COALITION (DACC) / NEST LABS, INC.

JONATHAN WORD
DIR OF STRATEGIC OPERATIONS
BISON PEAK PUMPED STORAGE, LLC
9795 CABRINI DR., STE. 206
BURBANK, CA 91504
FOR: BISON PEAK PUMPED STORAGE, LLC

C.C. SONG
SR. POLICY ANALYST
MARIN CLEAN ENERGY
1125 TAMALPAIS AVE
SAN RAFAEL, CA 91901
FOR: MARIN CLEAN ENERGY (MCE)

RAYN HARWELL
DIRECT ENERGY BUSINESS
7220 AVENIDA ENCINAS, STE 120
CARLSBAD, CA 92009
FOR: DIRECT ENERGY BUSINESS

JEFF MALONE
VP
HIGH DESERT POWER PROJECT, LLC
888 PROSPECT STREET, STE. 200
LA JOLLA, CA 92037-4261
FOR: HIGH DESERT POWER PROJECT, LLC

AIMEE SMITH
SAN DIEGO GAS & ELECTRIC COMPANY
101 ASH ST., HQ-12
SAN DIEGO, CA 92101
FOR: SAN DIEGO GAS & ELECTRIC COMPANY

DANIEL A. KING
SEMFPRA U.S. GAS & POWER, LLC
101 ASH STREET, HQ-15B
SAN DIEGO, CA 92101
FOR: SEMFPRA U.S. GAS & POWER

GREG BASS
DIR - WESTERN REGULATORY AFFAIRS
CALFIRE ENERGY SOLUTIONS, LLC
401 WEST A STREET, SUITE 500
SAN DIEGO, CA 92101
FOR: NOBLE ENERGY AMERICAS ENERGY SOLUTIONS, LLC (NOBLE SOLUTIONS)

TIM DUANE, ESQ.
ATTORNEY AT LAW
PROCPIO CORY HARGREAVES & SAVITCH, LLP
525 B STREET, SUITE 2200
SAN DIEGO, CA 92101
FOR: IMPERIAL COUNTY CONSISTS OF SEVEN CITIES (BRAWLEY, CALEXICO, CALIPATRIA, EL CENTRO, HOLTVILLE, IMPERIAL, AND WESTMORLAND), AND EIGHT UNINCORPORATED COMMUNITIES (BOMBAY BEACH, HEBER, NILAND, OCOTILLO, PALO VERDE, SALTON SEA, SEELEY, AND WINTERHAVEN)

DRAKE WELCH
NOBLE AMERICAS ENERGY SOLUTIONS (1364)
401 WEST A STREET, SUITE 500
SAN DIEGO, CA 92101-3017
FOR: NOBLE AMERICAS ENERGY SOLUTIONS LLC

MICHAEL J. AGUIRRE, ESQ.
ATTORNEY
AGUIRRE & SEVERSON LLP
501 W. BROADWAY, STE. 1050
SAN DIEGO, CA 92101-3591
FOR: IMPERIAL IRRIGATION DISTRICT

DONALD KELLY
EXE. DIRECTOR
UTILITY CONSUMERS' ACTION NETWORK

CLIFFORD D. EVANS, JR.
VP
CALPEAK POWER, LLC
3405 KENYON ST., STE. 401
SAN DIEGO, CA  92110
FOR: UCAN

JOHN W. LESLIE
ATTORNEY
DENTONS US LLP
4655 EXECUTIVE DRIVE, STE. 700
SAN DIEGO, CA  92121
FOR: DENTONS US LLP (DENTONS)

THOMAS R. DARTON
ATTORNEY
PILOT POWER GROUP, INC.
8910 UNIVERSITY CENTER LANE, STE. 520
SAN DIEGO, CA  92122
FOR: PILOT POWER GROUP, INC.

GUSTAVO E. LUNA
TERRA-GEN POWER, LLC
11512 EL CAMINO REAL, SUITE 370
SAN DIEGO, CA  92130
FOR: TERRA-GEN POWER

GREG MICHAELS
SOUTHERN CALIFORNIA TELEPHONE & ENERGY
27515 ENTERPRISE CIRCLE WEST
TEMECULA, CA  92590
FOR: SOUTHERN CALIFORNIA TELEPHONE & ENERGY

MONA TIERNEY-LLOYD
SR. DIR., WESTERN REGULATORY AFFAIRS
ENERNOC, INC.
PO BOX 378
CAYUCOS, CA  93430
FOR: ENERNOC, INC. - TIERNEY-LLOYD IS REP

SUE MARA
CONSULTANT
RTO ADVISORS L.L.C.
164 SPRINGDALE WAY
REDWOOD CITY, CA  94062
FOR: ALLIANCE FOR RETAIL ENERGY MARKETS

BARBARA HALE
CLEAN POWER SF
525 GOLDEN GATE AVE.
SAN FRANCISCO, CA  94102
FOR: CLEANPOWER SF

7365 MISSION GORGE ROAD, STE. C
SAN DIEGO, CA  92120
FOR: CALPEAK POWER, LLC

MARCIE MILNER
SHELL ENERGY
4445 EASTGATE MALL, STE 100
SAN DIEGO, CA  92121
FOR: SHELL ENERGY

KELLY RODGERS
ENERGY PROGRAM MANAGER
SAN DIEGO COUNTY WATER AUTHORITY
4677 OVERLAND AVENUE
SAN DIEGO, CA  92123
FOR: SAN DIEGO COUNTY WATER AUTHORITY

KEVIN SHORT
ANZA ELECTRIC COOPERATIVE INC.
58470 US HIGHWAY 371
ANZA, CA  92539
FOR: ANZA ELECTRIC COOPERATIVE INC.

SCOTT SAMUELEN
DIRECTOR
NATIONAL FUEL CELL RESEARCH CENTER
UNIVERISTY OF CALIFORNIA
IRVINE, CA  92697-3550
FOR: NATIONAL FUEL CELL RESEARCH CENTER (NFCRC)

CATHY DEFALCO, EJD, C.P.M.
ENERGY MGR. - REGULATORY
CITY OF LANCASTER
44933 FERN AVENUE
LANCASTER, CA  93534
FOR: LANCASTER CHOISE ENERGY (LANCASTER)

MARC D. JOSEPH
ATTORNEY
ADAMS BROADWELL JOSEPH & CARDOZA
601 GATEWAY BOULEVARD, SUITE 1000
SO. SAN FRANCISCO, CA  94080
FOR: THE COALITION OF CALIFORNIA UTILITY EMPLOYEES (CUE) AND CALIFORNIA UNIONS FOR RELIABLE ENERGY (CURE)

DAWN ANAISCOURT
ATTORNEY
SOUTHERN CALIFORNIA EDISON COMPANY
601 VAN NESS AVENUE
SAN FRANCISCO, CA  94102
FOR: SOUTHERN CALIFORNIA EDISON COMPANY
<table>
<thead>
<tr>
<th>Name</th>
<th>Title/Company</th>
<th>Address</th>
<th>City, State, Zip</th>
<th>Organization/Issue</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATT MILEY</td>
<td>Calif Public Utilities Commission Legal Division</td>
<td>505 Van Ness Avenue</td>
<td>San Francisco, CA, 94102-3214</td>
<td>For: Office of Ratepayer Advocates (ORA)</td>
</tr>
<tr>
<td>JEANNE M. SOLE</td>
<td>Deputy City Attorney</td>
<td>1 Dr. Carlton B. Goodlett Place</td>
<td>San Francisco, CA, 94102-4682</td>
<td>For: City and County of San Francisco</td>
</tr>
<tr>
<td>ANU VEGA</td>
<td>Pacific Gas and Electric Company</td>
<td>77 Beale St., Room 3120, B30A</td>
<td>San Francisco, CA, 94105</td>
<td>For: Pacific Gas and Electric Company</td>
</tr>
<tr>
<td>ERICA BRAND</td>
<td>Acting Dir. - California Energy Program</td>
<td>The Nature Conservancy</td>
<td>San Francisco, CA, 94105</td>
<td>For: The Nature Conservancy</td>
</tr>
<tr>
<td>EVELYN KAHL</td>
<td></td>
<td>Buchalter, A Professional Corporation</td>
<td>San Francisco, CA, 94105</td>
<td>For: Energy Producers and Users Coalition</td>
</tr>
<tr>
<td>LARissa KOEHLER</td>
<td>Attorney</td>
<td>Environmental Defense Fund</td>
<td>San Francisco, CA, 94105</td>
<td>For: Environmental Defense Fund</td>
</tr>
<tr>
<td>MICHAEL ALCANTAR</td>
<td>Attorney at Law</td>
<td>Buchalter, A Professional Corporation</td>
<td>San Francisco, CA, 94105</td>
<td>For: Cogeneration Association of California</td>
</tr>
<tr>
<td>NORA E. SHERIFF</td>
<td>Attorney</td>
<td>Buchalter, A Professional Corporation</td>
<td>San Francisco, CA, 94105</td>
<td>For: California Large Energy Consumers Association (CLECA)</td>
</tr>
<tr>
<td>SCOTT OLSON</td>
<td>Dir - Gov't &amp; Regulatory Affairs</td>
<td>Direct Energy LP</td>
<td>San Francisco, CA, 94108</td>
<td>For: Direct Energy Business</td>
</tr>
<tr>
<td>BRIAN CRAGG</td>
<td>Attorney</td>
<td>Goodin, Macbride, Squeri, Day &amp; Lamprey</td>
<td>San Francisco, CA, 94111</td>
<td>For: Independent Energy Producers Association</td>
</tr>
<tr>
<td>DAVID L. HUARD</td>
<td></td>
<td>Manatt, Phelps &amp; Phillips, LLP</td>
<td>San Francisco, CA, 94111</td>
<td>For: PIO Pico Energy Center</td>
</tr>
</tbody>
</table>

https://ia.cpuc.ca.gov/servicelists/R1602007_83513.htm
GEORGE HARDIE
PRESIDENT
PATTERN ENERGY GROUP 2
PIER 1, BAY 3
SAN FRANCISCO, CA  94111
FOR: PATTERN ENERGY GROUP 2

JOHNNY CASANA
EXTERNAL AFFAIRS & GOV'T RELATIONS
PATTERN DEVELOPMENT
PIER 1, BAY 3
SAN FRANCISCO, CA  94111
FOR: PATTERN ENERGY GROUP 2 LP

MEGAN SOMOGYI
ATTORNEY
GOODIN, MACBRIDE, SQUERI, & DAY, LLP
505 SANSOME ST., STE. 900
SAN FRANCISCO, CA  94111
FOR: CALIFORNIA BUILDING INDUSTRY ASSOCIATION (CBIA)

VIDHYA PRABHAKARAN
ATTORNEY
DAVIS WRIGHT TREMAINE LLP
505 MONTGOMERY STREET, SUITE 800
SAN FRANCISCO, CA  94111
FOR: LIBERTY UTILITIES

PATRICK FERGUSION
ATTORNEY AT LAW
DAVIS WRIGHT TREMAINE
505 MONTGOMERY STREET, SUITE 800
SAN FRANCISCO, CA  94111-6533
FOR: CALPINE CORPORATION

MEGAN M. MYERS
ATTORNEY
LAW OFFICES OF SARA STECK MYERS
122 - 28TH AVENUE
SAN FRANCISCO, CA  94121
FOR: GEOTHERMAL ENERGY ASSOCIATION

CHRIS KING
GLOBAL CHIEF REGULATORY OFFICER
SIEMENS SMART GRID SOLUTIONS
4000 E 3RD AVE., STE. 400
FOSTER CITY, CA  94404
FOR: EMETER, A SIEMENS BUSINESS (SIEMENS)

BETH VAUGHAN
EXE. DIR.

JEANNE B. ARMSTRONG
ATTORNEY
GOODIN MACBRIDE SQUERI & DAY LLP
505 SANSOME STREET, SUITE 900
SAN FRANCISCO, CA  94111
FOR: SOLAR ENERGY INDUSTRIES ASSOCIATION

MATTHEW VESPA
ATTORNEY
EARTHJUSTICE, CALIF. OFFICE
50 CALIFORNIA STREET, STE. 500
SAN FRANCISCO, CA  94111
FOR: SIERRA CLUB

SETH D. HILTON
ATTORNEY AT LAW
STOEL RIVES LLP
THREE EMBARCADERO CENTER, STE. 1120
SAN FRANCISCO, CA  94111
FOR: DUKE AMERICAN TRANSMISSION COMPANY (DATC) / AES SOUTHLAND

VIDHYA PRABHAKARAN
ATTORNEY
DAVIS WRIGHT & TREMAINE LLP
505 MONTGOMERY STREET, SUITE 800
SAN FRANCISCO, CA  94111
FOR: PENINSULA CLEAN ENERGY AUTHORITY (PCE)

MATTHEW A. FOGELSON
SR. COUNSEL
PACIFIC GAS AND ELECTRIC COMPANY
77 BEALE STREET, B30A / PO BOX 7442
SAN FRANCISCO, CA  94120-7442
FOR: PACIFIC GAS AND ELECTRIC COMPANY

SARA STECK MYERS
ATTORNEY AT LAW
LAW OFFICES OF SARA STECK MYERS
122 - 28TH AVENUE
SAN FRANCISCO, CA  94121
FOR: CENTER FOR ENERGY EFFICIENCY AND RENEWABLE TECHNOLOGIES (CEERT)

JENNIFER CHAMBERLIN
EXECUTIVE DIRECTOR, MARKET DEVELOPMENT
CPOWER
2633 WELLINGTON CT
CLYDE, CA  94520
FOR: CPOWER

BRIAN THEAKER
NRG ENERGY, INC.
<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Company/Institution</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHRISTIAN LENCI</td>
<td>PRAXAIR PLAINFIELD, INC.</td>
<td>2430 CAMINO RAMON DR.</td>
<td>SAN RAMON, CA 94583</td>
</tr>
<tr>
<td>SANDEEP ARORA</td>
<td>VICE PRESIDENT, TRANSMISSION</td>
<td>LS POWER DEVELOPMENT, LLC</td>
<td>5000 HOPYARD ROAD, SUIT E480</td>
</tr>
<tr>
<td>APRIL ROSE SOMMER</td>
<td>EXE DIR - LEAD COUNSEL</td>
<td>PROTECT OUR COMMUNITIES FOUNDATION</td>
<td>1547 PALOS VERDES MALL NO. 196</td>
</tr>
<tr>
<td>LAURA WISLAND</td>
<td>SR. ENERGY ANALYST</td>
<td>UNION OF CONCERNED SCIENTISTS</td>
<td>500 12TH ST., STE. 340</td>
</tr>
<tr>
<td>MARK BYRON</td>
<td>WHOLESALE ELECTRICITY PROGRAM MGR.</td>
<td>UNIV. OF CALIF. OFFICE OF THE PRESIDENT</td>
<td>1111 FRANKLIN ST., 6TH FL.</td>
</tr>
<tr>
<td>MELISSA BRANDT</td>
<td>DIR - REGULATORY AFFAIRS</td>
<td>EAST BAY COMMUNITY ENERGY</td>
<td>1111 BROADWAY, SUITE 3000</td>
</tr>
<tr>
<td>ADAM BORISON</td>
<td>MANAGING DIRECTOR</td>
<td>BERKELEY RESEARCH GROUP, LLC</td>
<td>2200 FOWELL STREET, SUITE 1200</td>
</tr>
<tr>
<td>CATHLEEN MONAHAH</td>
<td>SR. PROGRAMS DIR.</td>
<td>GRID ALTERNATIVES</td>
<td>1171 OCEAN AVENUE, SUITE 200</td>
</tr>
<tr>
<td>GRETCHEN DUMAS</td>
<td>PILOT TEAM</td>
<td>IHM COMMUNITY</td>
<td>1749 PLEASANT VALLEY AVENUE</td>
</tr>
<tr>
<td>JASON B. KEYES</td>
<td>KEYES &amp; FOX LLP</td>
<td>TESLA</td>
<td>436 14TH STREET, SUITE 1305</td>
</tr>
<tr>
<td>JASON B. KEYES</td>
<td>PARTNER</td>
<td>SOLARCIETY CORPORATION</td>
<td>436 14TH ST., STE. 1305</td>
</tr>
<tr>
<td>LAURENCE G. CHASET</td>
<td>COUNSEL</td>
<td>WORLD BUSINESS ACADEMY</td>
<td>1212 BROADWAY, STE. 800</td>
</tr>
<tr>
<td>LISA BELENKY</td>
<td>SR. ATTY</td>
<td>CENTER FOR BIOLOGICAL DIVERSITY</td>
<td>7677 OAKPORT STREET, STE. 525</td>
</tr>
<tr>
<td>PATRICK VANBEEK</td>
<td>DIR - CUSTOMER SUPPORT</td>
<td>COMMERCIAL ENERGY OF CALIFORNIA</td>
<td>1212 BROADWAY, STE. 800</td>
</tr>
</tbody>
</table>

https://ia.cpuc.ca.gov/servicelists/R1602007_83513.htm

4/23/2018
ALEX MORRIS  
SR. DIR., POLICY & REGULATORY AFFAIRS  
CALIFORNIA ENERGY STORAGE ALLIANCE  
2150 ALLSTON WAY, SUITE 210  
BERKELEY, CA  94704  
FOR: CALIFORNIA ENERGY STORAGE ALLIANCE (CESA)  

GREGG MORRIS  
DIRECTOR  
THE GREEN POWER INSTITUTE  
2039 SHATTUCK AVE., SUITE 420  
BERKELEY, CA  94704  
FOR: GREEN POWER INSTITUTE  

NANCY RADER  
EXECUTIVE DIRECTOR  
CALIFORNIA WIND ENERGY ASSOCIATION  
1700 SHATTUCK AVENUE, SUITE 17  
BERKELEY, CA  94709  
FOR: CALIFORNIA WIND ENERGY ASSOCIATION (CALWEA)  

SHANA LAZEROW  
ATTORNEY  
COMMUNITIES FOR A BETTER ENVIRONMENT  
120 BROADWAY, SUITE 2  
RICHMOND, CA  94804  
FOR: CALIFORNIA ENVIRONMENTAL JUSTICE ALLIANCE (CEJA)  

FRANK R. LINDH  
ATTORNEY AT LAW  
340 SANTA MARGARITA  
SAN RAFAEL, CA  94901  
FOR: FRIENDS OF THE EARTH (FOE)  

SHAWN MARSHALL  
DIRECTOR  
LEAN ENERGY US  
PO BOX 961  
MILL VALLEY, CA  94941  
FOR: LEAN ENERGY US  

JENNIFER A. CHAMBERLIN  
DIR. REG AFFAIRS - INT. DEMAND RESOURCES  
JOHNSON CONTROLS, INC.  
901 CAMPISI WAY, SUITE 260  
CAMPBELL, CA  95008-2348  
FOR: JOHNSON CONTROLS, INC.  

PUSHKAR WAGLE, PHD  
FLYNN RESOURCE CONSULTANTS, INC.  
2900 GORDON AVENUE, STE. 100-3  
SANTA CLARA, CA  95051  
FOR: BAY AREA MUNICIPAL TRANSMISSION GROUP  

L. JAN REID  
COAST ECONOMIC CONSULTING  
3185 GROSS ROAD  
SANTA CRUZ, CA  95062  
FOR: COAST ECONOMIC CONSULTING - SELF  

HEIDI SICKLER  
SR. ASSOCIATE, ENERGY & ENVIRONMENT  
SILICON VALLEY LEADERSHIP GROUP  
2001 GATEWAY PLACE SUITE 101E  
SAN JOSE, CA  95110  
FOR: SILICON VALLEY LEADERSHIP GROUP (LEADERSHIP GROUP)  

GARSON KNAPP  
LIBERTY POWER CORP.  
131 - A STONY CIRCLE, STE. 500  
SANTA ROSA, CA  95401  
FOR: LIBERTY POWER HOLDINGS  

DAVID KATES  
DAVID MARK & COMPANY  
3510 UNOCAL PLACE, SUITE 200  
SANTA ROSA, CA  95403  
FOR: THE NEVADA HYDRO COMPANY  

STEVEN S. SHUPE  
GENERAL COUNSEL  
SONOMA CLEAN POWER AUTHORITY  
50 SANTA ROSA AVE., 5TH FL.  
SANTA ROSA, CA  95404  
FOR: SONOMA CLEAN POWER AUTHORITY  

MELANIE GILLETTE  
SR. POLICY DIRECTOR  
CA EFFICIENCY+DEMAND MANAGEMENT COUNCIL  
1535 FARMERS LANE, SUITE 312  
SANTA ROSA, CA  95405  
FOR: CALIFORNIA ENERGY EFFICIENCY INDUSTRY COUNCIL (CEEC)  

JORDAN PINJUV  
COUNSEL  
CALIFORNIA INDEPENDENT SYSTEM OPERATOR  

DANIELLE O. MILLS  
DIR  
AMERICAN WIND ENERGY ASSN CALIF CAUCUS  

---

https://ia.cpuc.ca.gov/servicelists/R1602007_83513.htm  4/23/2018
250 OUTCROPPING WAY
FOLSOM, CA  95630
FOR: CALIFORNIA ISO

REGULATORY MANAGER
WELLHEAD ELECTRIC COMPANY, INC.
650 BERCUT DRIVE, STE. C
SACRAMENTO, CA  95811
FOR: WELLHEAD ELECTRIC COMPANY, INC.

CHELSEA HAINES
REGULATORY ADVOCATE
ASSOCIATION OF CALIFORNIA WATER AGENCIES
910 K STREET, SUITE 100
SACRAMENTO, CA  95814
FOR: ASSOCIATION OF CALIFORNIA WATER AGENCIES (ACWA)

JULIE M. BALL
EXECUTIVE DIR.
CALIFORNIA BIOMASS ENERGY ALLIANCE
1015 K STREET
SACRAMENTO, CA  95814
FOR: CALIFORNIA BIOMASS ENERGY ALLIANCE (CBEA)

KIM DELFINO
DIR - CALIF. PROGRAM
DEFENDERS OF WILDLIFE
980 9TH STREET, STE. 1730
SACRAMENTO, CA  95814
FOR: DEFENDERS OF WILDLIFE

SCOTT BLAISING
ATTORNEY
BRAUN BLAISING MCLAUGHLIN & SMITH, P.C.
915 L STREET, STE. 1480
SACRAMENTO, CA  95814
FOR: THE KINGS RIVER CONSERVATION DISTRICT (KRCD) / MARIN CLEAN ENERGY (MCE)

SCOTT BLAISING
ATTORNEY
BRAUN BLAISING SMITH WYNNE P.C.
915 L STREET, STE. 1480
SACRAMENTO, CA  95814
FOR: THE CALIFORNIA COMMUNITY CHOICE ASSOCIATION (CALCCA)

TY TOSDAL
HARRIET A. STEINER
OF COUNSEL                                ATTORNEY
BRAUN BALISING MCLAUGHLIN & SMITH, P.C.   BEST BEST & KRIEGER LLP
915 L. STREET, SUITE 1270                 500 CAPITOL MALL, STE. 1700
SACRAMENTO, CA  95814                     SACRAMENTO, CA  95814-4704
FOR: CITY OF LANCASTER                    FOR: VALLEY CLEAN ENERGY ALLIANCE (VCEA)

JEDEDIAH J. GIBSON                        JEFFERY D. HARRIS
ATTORNEY                                  ATTORNEY
ELLISON, SCHNEIDER & HARRIS, L.L.P.       ELLISON SCHNEIDER HARRIS & DONLAN LLP
2600 CAPITOL AVENUE, SUITE 400            2600 CAPITOL AVENUE, STE. 400
SACRAMENTO, CA  95816                     SACRAMENTO, CA  95816
FOR: BEAR VALLEY ELECTRIC SERVICE         FOR: RANGE ENERGY STORAGE SYSTEMS LLC
F/K/A PATHFINDER CAES 1, LLC

RONALD LIEBERT                            BRIAN S. BIERING
ATTORNEY AT LAW                           ATTORNEY
ELLISON SCHNEIDER HARRIS & DONLAN LLP     ELLISON SCHNEIDER HARRIS & DONLAN LLP
2600 CAPITOL AVENUE, STE. 400             2600 CAPITOL AVENUE, SUITE 400
SACRAMENTO, CA  95816                     SACRAMENTO, CA  95816-5905
FOR: VOTE SOLAR                           FOR: DIAMOND GENERATING CORPORATION

WILLIAM WESTERFIELD, III                  JANE EATON
SR. ATTORNEY, OFF OF GEN. COUNSEL         SURPRISE VALLEY ELECTRIFICATION CORP
SACRAMENTO MUNICIPAL UTILITY DISTRICT     516 US HWY 395 E
6301 S STREET, MS A311                    ALTURAS, CA  96101
SACRAMENTO, CA  95817                     FOR: SURPRISE VALLEY ELECTRIFICATION
FOR: SACRAMENTO MUNICIPAL UTILITY         CORP.
DISTRICT (SMUD)

ROBERT MARSHALL                           NATHAN SANDVIG
GEN. MGR.                                 DIR - BUSINESS DEVELOPMENT
PLUMAS SIERRA RURAL ELECTRIC CO-OP.       NATIONAL GRID USA
PO BOX 2000                               205 SE SPOKANE STREET, STE. 300
FORTOLA, CA  96122-2000                   PORTLAND, OR  97202
FOR: PLUMAS-SIERRA ELECTRICAL            FOR: NATIONAL GRID USA
COORDERATIVE

S. BRADLEY VAN CLEVE                      VIRINDER SINGH
ATTORNEY AT LAW                           DIR - REGULATORY & LEGISLATIVE AFFAIRS
DAVISON VAN CLEVE, PC                     EDF RENEWABLE ENERGY
333 SW TAYLOR, SUITE 400                  1000 SW BROADWAY, SUITE 1880
PORTLAND, OR  97204                       PORTLAND, OR  97205
FOR: VALLEY ELECTRIC ASSOCIATION, INC.    FOR: EDF RENEWABLE ENERGY
(VEA)

DUSTIN TILL                               ALLA WEINSTEIN
ATTORNEY                                  FOUNDER
PACIFICORP                                TRIDENT WINDS, LLC
825 NE MULTNOMAH ST., STE. 1800           113 CHERRY STREET, SUITE 34912
PORTLAND, OR  97232                       SEATTLE, WA  98104-2205
FOR: PACIFICORP                           FOR: TRIDENT WINDS, LLC (TRIDENT)

Information Only

https://ia.cpuc.ca.gov/servicelists/R1602007_83513.htm  4/23/2018
<table>
<thead>
<tr>
<th>Name</th>
<th>Title/Position</th>
<th>Company/Mailing Address</th>
<th>Email Only Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALIA SCHOEN</td>
<td>PUBLIC POLICY MGR.</td>
<td>BLOOM ENERGY</td>
<td>EMAIL ONLY</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EMAIL ONLY, CA 00000</td>
<td></td>
</tr>
<tr>
<td>ANA MILEVA</td>
<td>ICE ONE H</td>
<td>EMAIL ONLY</td>
<td>EMAIL ONLY, CA 00000</td>
</tr>
<tr>
<td>ANDREW LUSCZ</td>
<td>GLACIAL ENERGY OF CALIFORNIA</td>
<td>EMAIL ONLY</td>
<td>EMAIL ONLY, AA 00000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EMAIL ONLY, AA 00000</td>
<td></td>
</tr>
<tr>
<td>BARRBARA BARKOVICH</td>
<td>CONSULTANT</td>
<td>BARKOVICH &amp; YAP</td>
<td>EMAIL ONLY</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EMAIL ONLY, CA 00000</td>
<td></td>
</tr>
<tr>
<td>BILL POWERS</td>
<td>PROTECT OUR COMMUNITIES FOUNDATION</td>
<td>EMAIL ONLY</td>
<td>EMAIL ONLY, CA 00000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FOR: PROTECT OUR COMMUNITIES FOUNDATION</td>
<td>EMAIL ONLY</td>
</tr>
<tr>
<td>COLEY GIROUARD</td>
<td>ASSOCIATE, PUC PROGRAM</td>
<td>ADVANCED ENERGY ECONOMY</td>
<td>EMAIL ONLY</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EMAIL ONLY, CA 00000</td>
<td></td>
</tr>
<tr>
<td>DAMON FRANZ</td>
<td>DIRECTOR - POLICY &amp; ELECTRICITY MARKETS</td>
<td>TESLA, INC.</td>
<td>EMAIL ONLY</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EMAIL ONLY, CA 00000</td>
<td></td>
</tr>
<tr>
<td>DAVID MCCOARD</td>
<td></td>
<td>EMAIL ONLY</td>
<td>EMAIL ONLY, CA 00000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EMAIL ONLY, CA 00000</td>
<td></td>
</tr>
<tr>
<td>DONALD LIDDELL</td>
<td></td>
<td>DOUGLAS &amp; LIDDELL</td>
<td>EMAIL ONLY</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EMAIL ONLY, CA 00000</td>
<td></td>
</tr>
<tr>
<td>ERIC WEINER</td>
<td>ANALYST</td>
<td>PENINSULA CLEAN ENERGY</td>
<td>EMAIL ONLY</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EMAIL ONLY, CA 00000</td>
<td></td>
</tr>
<tr>
<td>GEORGE WILTSEE</td>
<td></td>
<td>GREGORY S.G. KLATT</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

https://ia.cpuc.ca.gov/servicelists/R1602007_83513.htm  4/23/2018
CLEAN POWER HOUSE, LLC
EMAIL ONLY
EMAIL ONLY, AA  00000

JAMES A. ROSS
REGULATORY & COGENERATION SERVICES INC
EMAIL ONLY
EMAIL ONLY, CA  00000

JENNIFER W. SUMMERS
CALIFORNIA REGULATORY AFFAIRS
SAN DIEGO GAS & ELECTRIC COMPANY
EMAIL ONLY
EMAIL ONLY, CA  00000

JESSICA NELSON
GENERAL MANAGER
GOLDEN STATE POWER COOPERATIVE
EMAIL ONLY
EMAIL ONLY, CA  00000

JORDAN DECKER
UTILITY SPECIALIST, CLEAN POWER SF
SF PUC
EMAIL ONLY
EMAIL ONLY, CA  00000

KEITH WHITE
KD WHITE CONSULTING
EMAIL ONLY
EMAIL ONLY, CA  00000

MAGGIE CHAN
PACIFIC GAS AND ELECTRIC COMPANY
EMAIL ONLY
EMAIL ONLY, CA  00000

MEGHAN COX
CALIFORNIA POWER LAW GROUP
EMAIL ONLY
EMAIL ONLY, CA  00000
FOR: NOBLE SOLUTIONS

MOHIT CHHABRA
SCIENTIST
NATURAL RESOURCES DEFENSE COUNCIL
EMAIL ONLY
EMAIL ONLY, CA  00000

NELLIE TONG
SENIOR CONSULTANT
EMAIL ONLY
EMAIL ONLY, CA  00000

ATTORNEY AT LAW
DOUGLASS & LIDDELL
EMAIL ONLY
EMAIL ONLY, CA  00000

JEANETTE MELGAR
RESIDENTIAL TARIFFS & ADVICE LTRS
SCE STATE REGULATORY OPERATIONS
EMAIL ONLY
EMAIL ONLY, CA  00000

JESSICA HILGART
PACIFIC GAS & ELECTRIC COMPANY
EMAIL ONLY
EMAIL ONLY, CA  00000

JIMMY NELSON, PH.D
KENDALL SCIENCE FELLOW IN ELECTRICITY
UNION OF CONCERNED SCIENTISTS
EMAIL ONLY
EMAIL ONLY, CA  00000

KAVYA BALARAMAN
REPORTER
CALIFORNIA ENERGY MARKETS
EMAIL ONLY
EMAIL ONLY, CA  00000

KEVIN FALLON
SIR CAPITAL MANAGEMENT
EMAIL ONLY
EMAIL ONLY, NY  00000

MATTHEW TISDALE
EMAIL ONLY
EMAIL ONLY, CA  00000

MELANIE GILLETTE
SENIOR POLICY DIRECTOR
EFFICIENCY COUNCIL
1885 GRAZZIANI WAY
ROSEVILLE, CA  00000

NATHAN MURTHY
ANALYTICS ENGINEER
WIRELESS GLUE NETWORKS, INC.
EMAIL ONLY
EMAIL ONLY, CA  00000

PAUL NELSON
BARKOVICH & YAP
<table>
<thead>
<tr>
<th>Name</th>
<th>Position/Title</th>
<th>Email 1</th>
<th>Email 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNV KEMA ENERGY &amp; SUSTAINABILITY</td>
<td>Email Only</td>
<td>Email Only, CA 00000</td>
<td>For: California Large Energy Consumers Association</td>
</tr>
<tr>
<td>PETER T. PEARSON</td>
<td>ENERGY SUPPLY SPECIALIST BEAR VALLEY ELECTRIC SERVICE</td>
<td>Email Only</td>
<td>Email Only, CA 00000</td>
</tr>
<tr>
<td>RHONDA MILLS</td>
<td>WESTERN ISSUES REP GEOTHERMAL ENERGY ASSOCIATION</td>
<td>Email Only</td>
<td>Email Only, CA 00000</td>
</tr>
<tr>
<td>ROBERT GEX</td>
<td>DAVIS WRIGHT TREMAINE LLP</td>
<td>Email Only</td>
<td>Email Only, CA 00000</td>
</tr>
<tr>
<td>SARITA SARVATE</td>
<td>Email Only</td>
<td>Email Only, CA 00000</td>
<td></td>
</tr>
<tr>
<td>SIOBHAN DOHERTY</td>
<td>ANALYST PENINSULA CLEAN ENERGY</td>
<td>Email Only</td>
<td>Email Only, CA 00000</td>
</tr>
<tr>
<td>STEPHEN ST. MARIE</td>
<td>CPUC</td>
<td>Email Only</td>
<td>Email Only, CA 00000</td>
</tr>
<tr>
<td>SUSANNAH CHURCHILL</td>
<td>SOLAR POLICY ADVOCATE VOTE SOLAR</td>
<td>Email Only</td>
<td>Email Only, CA 00000</td>
</tr>
<tr>
<td>UDI HELMAN</td>
<td>HELMAN ANALYTICS</td>
<td>Email Only</td>
<td>Email Only, CA 00000</td>
</tr>
<tr>
<td>WILLIAM DIETRICH</td>
<td>Email Only</td>
<td>XIAOBO WANG, PH.D</td>
<td></td>
</tr>
</tbody>
</table>
SENIOR CONSULTANT
DIETRICH CONSULTING
EMAIL ONLY
EMAIL ONLY, CA 00000

REGULATORY CLERK
BRAUN BLAISING SMITH WYNNE, PC
EMAIL ONLY
EMAIL ONLY, CA 00000

PILOT POWER GROUP, INC.
EMAIL ONLY
EMAIL ONLY, CA 00000

DAVID MARCUS
EMAIL ONLY
EMAIL ONLY, CA 00000-0000

BOB FAGAN
CONSULTANT TO ORA
SYNAPSE ENERGY ECONOMICS
485 MASSACHUSETTS AVENUE
CAMBRIDGE, MA 02139

CONSTANTINE LEDNEV
ASSOCIATE-US UTILITIES & POWER RESEARCH
DEUTSCHE BANK SECURITIES INC.
60 WALL STREET
NEW YORK CITY, NY 10005

JAMES (JIM) VON RIESEMANN
MIZUHO SECURITIES USA, INC.
320 PARK AVENUE, 12TH FLOOR
NEW YORK, NY 10022

JOSEPHINE MOORE
POWER AND UTILITIES RESEARCH
BANK OF AMERICA MERRILL LYNCH
ONE BRYANT PARK
NEW YORK, NY 10036

NICHOLAS CAMPANELLA
POWER AND UTILITIES RESEARCH
BANK OF AMERICA MERRILL LYNCH
ONE BRYANT PARK
NEW YORK, NY 10036

TONY WETZEL
DIR - ASSET OPTIMIZATION
EPP SERVICE CO.
1605 N. CEDAR CREST BLVD., NO. 509

SR. ADVISOR, MKT & INTEGRATION STUDIES
CALIFORNIA ISO
EMAIL ONLY
EMAIL ONLY, CA 00000

MRW & ASSOCIATES, LLC
EMAIL ONLY
EMAIL ONLY, CA 00000

DAVIS WRIGHT TREMAINE LLP
EMAIL ONLY
EMAIL ONLY, CA 00000

MICHAEL BERLINSKI
BEACON POWER LLC
65 MIDDLESEX ROAD
TYNDBORO, MA 01879

MARK MELLANA
GE ENERGY FINANCIAL SVCS, INC.
800 LONG RIDGE ROAD
STAMFORD, CT 06927

DINA ABDULHADI
INSTITUTE FOR POLICY INTEGRITY
NYU LAW SCHOOL
139 MACDOUGAL ST., 3RD FL.
NEW YORK, NY 10012

JERIMIAH BOOREAM
POWER, UTILITIES, & ALT ENERGY RESEARCH
BANK OF AMERICA MERRILL LYNCH
ONE BRYANT PARK
NEW YORK, NY 10036

JULIEN DUMOULIN-SMITH
HEAD OF US PWR, UTILITIES & ALT ENERGY
BANK OF AMERICA MERRILL LYNCH
ONE BRYANT PARK
NEW YORK, NY 10036

LAURA KIER
ENERGYHUB
232 3RD STREET
BROOKLYN, NY 11215

BRANDON SMITHWOOD
MGR - CALIF STATE AFFAIRS
SOLAR ENERGY INDUSTRIES ASSOCIATION
600 14TH STREET, NW, SUITE 400

https://ia.cpuc.ca.gov/servicelists/R1602007_83513.htm
4/23/2018
ALLENTOWN, PA  18104  WASHINGTON, DC  20005

DAMON MOGLEN  JENNA L. MCGRATH
SR. ADVISOR - CLIMATE & ENERGY PROJECT  ATTORNEY AT LAW
FRIENDS OF THE EARTH  PAUL HASTINGS, LLP
1100 15TH STREET NW, 11TH FL.  875 15TH STREET, N.W.
WASHINGTON, DC  20005  WASHINGTON, DC  20005
FOR: GRIDLIANCE WEST TRANSCO LLC

S. DAVID FREEMAN  JOHN COLLINS
C/O FRIENDS OF THE EARTH  VP - DEVELOPMENT
1100 15TH STREET, NW, 11TH FLOOR  COGENTRIX ENERGY POWER MANAGEMENT
WASHINGTON, DC  20005  9405 ARROWPOINT BLVD.
CHARLOTTE, NC  28273  FOR: COGENTRIX ENERGY POWER MANAGEMENT

SEAN YOVAN  STEVE ROWLEY
SOUTHERN POWER  DIR - BUSINESS DEVELOPMENT
30 IVAN ALLEN JR. BLVD. NW  BHE U.S. TRANSMISSION, LLC
ATLANTA, GA  30308  666 GRAND AV., STE. 500
DES MOINES, IA  50309-2692

CONOR B. WARD  N. BETH EMERY
GRIDLIANCE WEST TRANSCO, LLC  GRIDLANCE WEST TRANSCO, LLC
2 N. LASALLE STREET, SUITE 420  2 N. LASALLE STREET, SUITE 420
CHICAGO, IL  60602  CHICAGO, IL  60602

SARAH N. GALIOTO  SHEERIE GREEN
GRIDLANCE WEST TRANSCO, LLC  CHARTER COMMUNICATIONS
2 N. LASALLE STREET, SUITE 420  12405 POWERSOURCE DRIVE
CHICAGO, IL  60602  ST. LOUIS, MO  63131

GREG JONES  RYAN HARWELL
ATTORNEY  DIRECT ENERGY SERVICES, LLC
GRIDLANCE WEST TRANSCO, LLC  12 GREENWAY PLAZA, STE 250
201 E. JOHN CARPENTER FREEWAY, STE. 900  HOUSTON, TX  77046
IRVING, TX  75039  FOR: DIRECT ENERGY SERVICES, LLC

CHRIS JONES  DAVID F. SMITH
DUKE ENERGY  DIR - ENGINEERING AND OPERATIONS
5555 SAN FELIPE STREET  TRANSWEST EXPRESS LLC
HOUSTON, TX  77056  555 SEVENTEENTH STREET, STE. 2400
DENVER, CO  80202

KARA MORGAN  KELLY CRANDALL
TRANSWEST EXPRESS LLC  EQ RESEARCH, LLC
555- 17TH STREET, STE. 2400  1580 LINCOLN STREE, SUITE 880
DENVER, CO  80202  DENVER, CO  80203

CAITLIN COLLINS LIOTIRIS  DANIEL RAMIREZ
ENERGY STRATEGIES, LLC  ANALYST
215 SOUTH STATE STREET, STE 200  ENERGY STRATEGIES, LLC
SALT LAKE CITY, UT  84111  215 SOUTH STATE STREET, STE 200

https://ia.cpuc.ca.gov/service_lists/R1602007_83513.htm  4/23/2018
ROBERT D. SMITH
VP, TRANSMISSION PLANNING & DEVELOP
TRANSCANYON, LLC
400 EAST VAN BUREN ST., STE 350
PHOENIX, AZ  85004

EMILY SCHNEIDER
VP, TRANSMISSION PLANNING & DEVELOP
TRANSCANYON, LLC
400 EAST VAN BUREN ST., STE 350
PHOENIX, AZ  85004

PAUL THOMSEN
GOVERNMENT AND REGULATORY AFFAIRS
6225 NEIL ROAD
RENO, NV  89511

JOE GRECO
SR. V.P.
TERRA-GEN POWER LLC
9590 PROTOTYPE COURT, SUITE 200
RENO, NV  89521-5916

LAUREN HOLDWAY
TERRA-GEN POWER LLC
9590 PROTOTYPE COURT, SUITE 200
RENO, NV  89521-5916

CHRISTOPHER BISSONNETTE
TERRA-GEN POWER LLC
9590 PROTOTYPE COURT, SUITE 200
RENO, NV  89521-5916

ERIN PALERMO BROOKS
REGULATORY POLICY / REPORTING MGR.
SOUTHERN CALIFORNIA GAS
555 W 5TH STREET
LOS ANGELES, CA  90013

KENDRA TALLEY
CASE MGR.
SOUTHERN CALIFORNIA GAS COMPANY
555 W. FIFTH STREET, GT14D6
LOS ANGELES, CA  90013

PAMELA WU
SOUTHERN CALIFORNIA GAS COMPANY
555 W. FIFTH STREET, GT14D6
LOS ANGELES, CA  90013

ROSALINDA MAGANA
SOUTHERN CALIFORNIA GAS COMPANY
555 W. FIFTH STREET, GT20B8
LOS ANGELES, CA  90013

STEVEN HRUBY
SOUTHERN CALIFORNIA GAS COMPANY
555 W. FIFTH ST., GT14D6
LOS ANGELES, CA  90013

SARAH FRIEDMAN
SIERRA CLUB
714 W. OLYMPIC BLVD., STE. 1000
LOS ANGELES, CA  90015

LUJUANA MEDINA
REGULATORY MANAGER
ENERGYRSC
EMAIL ONLY
LOS ANGELES, CA  90032

ANDREW H. MEYER
LATHAM & WATKINS LLP
355 S. GRAND AVENUE
LOS ANGELES, CA  90071

BO BUCHIYNSKY
SENIOR VICE PRESIDENT
DIAMOND GENERATING CORPORATION
633 WEST FIFTH STREET, SUITE 1000
LOS ANGELES, CA  90071

DAVID HICKS
DIAMOND GENERATING CORPORATION
633 WEST FIFTH STREET, SUITE 1000
LOS ANGELES, CA  90071

MABEL GARCIA PAINE
PRINCIPAL
ICF INTERNATIONAL
601 W 5TH STREET, STE. 900
LOS ANGELES, CA  90071

PAUL SHEPARD
VP - PORTFOLIO & ASSET MGMT
DIAMOND GENERATING CORPORATION
333 S. GRAND AVE., STE. 1570
LOS ANGELES, CA  90071

https://ia.cpuc.ca.gov/servicelists/R1602007_83513.htm 4/23/2018
JASON M. ACKERMAN  
ATTORNEY  
BEST BEST & KRIEGER, LLP  
3390 UNIVERSITY AVENUE, 5TH FLOOR  
RIVERSIDE, CA 92501

MONICA CASTANON  
BEST BEST & KRIEGER LLP  
3390 UNIVERSITY AVENUE, 5TH FLOOR  
RIVERSIDE, CA 92501

ED DUGGAN  
ALTON ENERGY, INC.  
6201 SHELLEY DRIVE  
HUNTINGTON BEACH, CA 92647

RICH BATEY  
SIEMENS ENERGY INC.  
2441 RIDGE ROUTE DRIVE, STE. 230  
LAGUNA HILLS, CA 92653

RICHARD ROBERTS  
KINETIC ENERGY RESOURCES  
25282 DERBYHILL DR.  
LAGUNA HILLS, CA 92653

EMANUEL WAGNER  
ASSISTANT DIRECTOR  
CALIFORNIA HYDROGEN BUSINESS COUNCIL  
18847 VIA SERENO  
YORBA LINDA, CA 92886  
FOR: CALIFORNIA HYDROGEN BUSINESS COUNCIL (CHBC)

DONALD DAME  
ENERGY CONSULTANT  
2022 PEIRPONT BLVD  
VENTURA, CA 93001

JEFF HIRSCH  
JAMES J. HIRSCH & ASSOCIATES  
12185 PRESILLA ROAD  
SANTA ROSA VALLEY, CA 93012-9243

JERRY B. BROWN, PH.D  
DIRECTOR - SAFE ENERGY PROJECT  
WORLD BUSINESS ACADEMY  
2020 ALAMEDA PADRE SERRA, STE. 135  
SANTA BARBARA, CA 93103

RINALDO BRUTUCO  
WORLD BUSINESS ACADEMY  
2020 ALAMEDA PADRE SERRA, STE. 135  
SANTA BARBARA, CA 93103

HEATHER SWAN  
LANCASTER POWER AUTHORITY  
CITY OF LANCASTER  
44933 FERN AVE.  
LANCASTER, CA 93534

DEEANN TOZLIAN  
STRATEGIC PLANNING RESEARCH MGR  
RICHARD HEATH & ASSOCIATES, INC.  
590 W LOCUST AVENUE, SUITE 103  
FRESNO, CA 93650

JIM BAAK  
SR. MGR. - REGULATORY AFFAIRS WEST  
STEM, INC.  
100 ROLLINS ROAD  
MILLBRAE, CA 94030

TED KO  
DIRECTOR OF POLICY  
STEM, INC.  
100 ROLLINS ROAD  
MILLBRAE, CA 94030

EMILY LESLIE  
ENERGY REFLECTIONS  
1028 MONTE VERDE DR  
PACIFICA, CA 94044

JEREMY WAEN  
SR. REGULATORY ANALYST  
PENINSULA CLEAN ENERGY  
2075 WOODSIDE RD.  
REDWOOD CITY, CA 94061

JOSEPH F. WIEDMAN  
SR. REGULATORY & LEGISLATIVE ANALYST  
PENINSULA CLEAN ENERGY AUTHORITY  
400 COUNTY CENTER, SIXTH FL.  
REDWOOD CITY, CA 94063

MARC D. JOSEPH  
ATTORNEY AT LAW  
ADAMS, BROADWELL, JOSEPH & CARDOZO  
601 GATEWAY BLVD., STE. 1000  
SOUTH SAN FRANCISCO, CA 94080
KPMG LLP
55 SECOND ST., STE. 1400
SAN FRANCISCO, CA  94105

CASE ADMINISTRATION
PACIFIC GAS AND ELECTRIC COMPANY
77 BEALE STREET
SAN FRANCISCO, CA  94105

DON BROOKHYSER
BUCHALTER, A PROFESSIONAL CORPORATION
55 SECOND STREET, SUITE 1700
SAN FRANCISCO, CA  94105

EMILIE OLSON
POLICY & PROGRAM ASSOCIATE
ADVANCED ENERGY ECONOMY
135 MAIN STREET, STE. 1320
SAN FRANCISCO, CA  94105

MARK R. HUFFMAN
ATTORNEY AT LAW
PACIFIC GAS AND ELECTRIC COMPANY
77 BEALE STREET, B30A
SAN FRANCISCO, CA  94105

PATTY COOK
SENIOR VICE PRESIDENT
ICF INTERNATIONAL
620 FOLSOM STREET, STE. 200
SAN FRANCISCO, CA  94105

SHOSHAN LUCICH
ATTORNEY AT LAW
MORGAN, LEWIS & BOCKIUS, LLP
ONE MARKET, SPEAR STREET TOWER
SAN FRANCISCO, CA  94105

TOVAH TRIMMING
ENVIRONMENTAL LAW & JUSTICE CLINIC
GOLDEN GATE UNIVERSITY SCHOOL OF LAW
536 MISSION STREET
SAN FRANCISCO, CA  94105

PERKINS COIE LLP
505 HOWARD STREET, STE. 1000
SAN FRANCISCO, CA  94105

F. JACKSON STODDARD
ATTORNEY
MORGAN LEWIS & BOCKIUS, LLP
ONE MARKET, SPEAR STREET TOWER
SAN FRANCISCO, CA  94105-1126
MONICA A. SCHWEBS  
ATTORNEY AT LAW  
MORGAN LEWIS BOCKIUS LLP  
ONE MARKET, SPEAR STREET TOWER  
SAN FRANCISCO, CA  94105-1126

MATT GONZALES  
PACIFIC GAS AND ELECTRIC COMPANY  
77 BEALE STREET, B9A  
SAN FRANCISCO, CA  94105-1814

BRIAN KOOIMAN  
OHMCONNECT, INC.  
350 TOWNSEND ST., STE. 210  
SAN FRANCISCO, CA  94107

FRANCESCA WAHL  
SR. ASSOCIATE, BUS. DEVELOPMENT  
TESLA, INC.  
444 DE HARO STREET, STE. 101  
SAN FRANCISCO, CA  94107

JOHN W. ANDERSON  
DIR - ENERGY MARKETS  
OHMCONNECT, INC.  
350 TOWNSEND S., SUITE 210  
SAN FRANCISCO, CA  94107

SAMUEL GOLDING  
PRESIDENT  
COMMUNITY CHOICE PARTNERS, INC.  
58 MIRABEL AVENUE  
SAN FRANCISCO, CA  94110

BUCK ENDEMANN  
ATTORNEY  
K&L GATES, LLP  
FOUR EMBARCADERO, STE 1200  
SAN FRANCISCO, CA  94111

JOHN MCINTYRE  
ATTORNEY  
GOODIN, MACBRIE, SQUERI & DAY, LLP  
505 SANSOME ST., STE. 900  
SAN FRANCISCO, CA  94111

KATIE JORRIE  
ATTORNEY  
DAVIS WRIGHT TREMAINE, LLP  
505 MONTGOMERY STREET, SUITE 800  
SAN FRANCISCO, CA  94111

L Louise Dyble  
ATTORNEY  
WINSTON & STRAWN  
101 CALIFORNIA STREET, STE. 3500  
SAN FRANCISCO, CA  94111

MOLLY DERINGER CROLL  
CALIFORNIA ENVIRONMENTAL ASSOCIATES  
423 WASHINGTON ST.  
SAN FRANCISCO, CA  94111

NINA ROBERTSON  
STAFF ATTORNEY  
EARTHJUSTICE  
50 CALIFORNIA STREET, STE. 500  
SAN FRANCISCO, CA  94111

RIKKI WEBER  
LITIGATION ASSISTANT  
EARTHJUSTICE  
50 CALIFORNIA STREET, SUITE 500  
SAN FRANCISCO, CA  94111

SEAN P. BEATTY  
WEST REGION GEN. COUNSEL  
NRG ENERGY, INC.  
100 CALIFORNIA STREET, SUITE 400  
SAN FRANCISCO, CA  94111

THOMAS W. SOLOMON  
ATTORNEY AT LAW  
WINSTON & STRAWN LLP  
101 CALIFORNIA STREET  
SAN FRANCISCO, CA  94111

MICHAEL S. HINDUS  
PILLSBURY WINTHROP SHAW PITTMAN LLP  
4 EMBARCADERO CENTER, 22ND FL.  
SAN FRANCISCO, CA  94111-5998

EMILY P. SANGI  
ATTORNEY  
DAVIS WRIGHT TREMAINE LLP  
505 MONTGOMERY ST., STE. 800  
SAN FRANCISCO, CA  94111-6533

STEVEN MOSS  
ENVIRONMENT DEFENSE FUND  
296 LIBERTY STREET  
SAN FRANCISCO, CA  94114
CALIFORNIA ENERGY MARKETS
425 DIVISADERO ST STE 303
SAN FRANCISCO, CA  94117-2242

CHARLES R. MIDDLEKAUFF
ATTORNEY
PACIFIC GAS AND ELECTRIC COMPANY
PO BOX 7442, MC-B30A-2475
SAN FRANCISCO, CA  94120
FOR: PACIFIC GAS AND ELECTRIC COMPANY (PG&E)

DONNA BARRY
ANALYSIS AND RATES
PACIFIC GAS AND ELECTRIC COMPANY
PO BOX 770000, MC B10B
SAN FRANCISCO, CA  94120-7442

DEBORAH BEHLES
OF COUNSEL
CALIFORNIA ENVIRONMENTAL JUSTICE ALLIANCE
EMAIL ONLY
EMAIL ONLY, CA  94131

WILL DONG
PACIFIC GAS AND ELECTRIC COMPANY
PO BOX 770000
SAN FRANCISCO, CA  94177

DEBRA LLOYD
UTILITIES COMPLIANCE MGR
CITY OF PALO ALTO UTILITIES
1007 ELWELL CT.
PALO ALTO, CA  94303
FOR: BAY AREA MUNICIPAL TRANSMISSION GROUP

LUISA F. ELKINS
SR. ASSOCIATE
PROCOPIO, CORY, HARGREAVES & SAVITCH LLP
1117 S CALIFORNIA AVE., STE. 200
PALO ALTO, CA  94304
FOR: COUNTY OF IMPERIAL

BONNIE DATTA
SIEMENS USA
4000 E. THIRD AVENUE
FOSTER CITY, CA  94404
FOR: (SIEMENS) CHRIS KING IS REP

MATTHEW BARMACK
DIR. - MARKET & REGULATORY ANALYSIS
CALPINE CORPORATION
4160 DUBLIN BLVD., SUITE 100
DUBLIN, CA  94568

KATHY TRELEVEN
KATHY TRELEVEN CONSULTING
103 BANDOL CT.
SAN RAMON, CA  94582

STEVE MCCARTY
STEVEN MCCARTY AND ASSOCIATES
2460 LAVENDER DRIVER, SUITE 101
WALNUT CREEK, CA  94596

ALICE L. HARRON
CEO
HARRON, LLC
4016 EVERETT AVE.
OAKLAND, CA  94602

ERIC C. WOYCHIK
EXEC. CONSULTANT & PRINCIPAL
STRATEGY INTEGRATION, LLC
9901 CALODEN LANE
OAKLAND, CA  94605
FOR: VOTE SOLAR

ALLIE DETRIO
POLICY MANAGER
ENGIE SERVICES
500 12TH STREET, SUITE 300
OAKLAND, CA  94607

CYNTHIA CLARK
MANAGER, WHOLESALE ELECTRICITY PROGRAM
UNIV. OF CALIF. - OFFICE OF THE PRES.
1111 BROADWAY . SUITE 1450
OAKLAND, CA  94607

ELISE HUNTER
DIR - POLICY & REGULATORY AFFAIRS
GRID ALTERNATIVES
1171 OCEAN AVE., STE. 200
OAKLAND, CA  94608
SANTA ROSA, CA  95404
PETER RUMBLE
CALIFORNIA CLEAN POWER
50 SANTA ROSA AVENUE, SUITE 420
SANTA ROSA, CA  95404
MARGIE GARDNER
EXECUTIVE DIRECTOR
CAL. ENERGY EFFICIENCY INDUSTRY COUNCIL
1535 FARMERS LANE, SUITE 312
SANTA ROSA, CA  95405

JAMES H. CALDWELL, JR.
1650 E NAPA STREET
SONOMA, CA  95476
FOR: (CEERT)
JAN MCFARLAND
SONIC
1650 EAST NAPA STREET
SONOMA, CA  95476

ALLISON CAMPBELL
MGR - POWER RESOURCES
REDWOOD COAST ENERGY AUTHORITY
633 3RD STREET
EUREKA, CA  95501
CHRISTOPHER DEVON
CALIFORNIA INDEPENDENT SYSTEM OPERATOR
250 OUTCROPPING WAY
FOLSOM, CA  95630
FOR: CALIFORNIA ISO

DELPHINE HOU
CALIF. INDEPENDENT SYSTEMS OPERATOR
250 OUTCROPPING WAY
FOLSOM, CA  95630
JILL POWERS
CALIFORNIA INDEPENDENT SYSTEM OPERATOR
250 OUTCROPPING WAY
FOLSOM, CA  95630
FOR: CALIFORNIA ISO

KARL MEEUSEN, PH.D
CALIFORNIA INDEPENDENT SYSTEM OPERATOR
250 OUTCROPPING WAY
FOLSOM, CA  95630
KIM PEREZ
CALIFORNIA ISO
250 OUTCROPPING WAY
FOLSOM, CA  95630

LEGAL & REGULATORY DEPT.
CALIFORNIA INDEPENDENT SYSTEM OPERATOR
250 OUTCROPPING WAY
FOLSOM, CA  95630
MARGARET MILLER
DIR OF MARKET INTELLIGENCE - WEST
CUSTOMIZED ENERGY SOLUTIONS
101 PARKSHORE DRIVE, SUITE 100
FOLSOM, CA  95630

PAUL D. MAXWELL
NAVIGANT CONSULTING, INC.
35 IRON POINT CIRCLE, STE. 225
FOLSOM, CA  95630
SHUCHENG LIU
PRINCIPAL, MARKET DEVELOPMENT
CALIF. INDEPENDENT SYSTEM OPERATOR
250 OUTCROPPING WAY
FOLSOM, CA  95630

TIM MASON
GRID SUBJECT MATTER EXPERTS, LLC
1847 IRON POINT RD., STE. 140
FOLSOM, CA  95630
JOHN GOODIN
CALIFORNIA ISO
250 OUTCROPPING WAY
FOLSOM, CA  95630-8773

LORENZO KRISTOV
CALIFORNIA ISO
250 OUTCROPPING WAY
FOLSOM, CA  95630-8773
TAO DR. GUO
ABB CORPORATION
8609 CASTLE CREEK DR.
ROSEVILLE, CA  95661
CARRIE BENTLEY                              WENXIONG HUANG
RESERO CONSULTING                           WH ENERGY SOLUTIONS LLC
9289 SHADOW BROOK PLACE                     5014 CHELSHIRE DOWNS ROAD
GRANITE BAY, CA  95746                      GRANITE BAY, CA  95746
FOR: ALLIANCE FOR RETAIL ENERGY MARKETS

ROBIN SMUTNY-JONES                          MATTHEW SWINDLE
DIR., CALIFORNIA POLICY & REGULATION        CEO & FOUNDER
IBERDROLA RENEWABLES, LLC                   NLINE ENERGY, INC.
3009 E. PINTAIL WAY                         5170 GOLDEN FOOTHILL PARKWAY
ELK GROVE, CA  95757                        EL DORADO HILLS, CA  95762
FOR: NLINE ENERGY, INC. (NLINE) MATT
KLOPFENSTEIN IS REF

CAROLYN KEHREIN                             GWENN O'HARA
ENERGY MANAGEMENT SERVICES                   ATTORNEY
2602 CELEBRATION WAY                        CALIFORNIA POWER LAW GROUP
WOODLAND, CA  95776                          1325 19TH STREET
SACRAMENTO, CA  95811                        SACRAMENTO, CA  95811

OLOF BYSTROM                                 AUDRA HARTMANN
MGR - RESOURCE STRATEGY                     PRINCIPAL
SACRAMENTO MUNICIPAL UTILITY DISTRICT       SMITH, WATTS & HARTMANN
6201 S STREET                               925 L STREET, SUITE 220
SACRAMENTO, CA  95812                        SACRAMENTO, CA  95814
FOR: SMUD

DAN GRIFFITHS                                DAVID PEFFER
ATTORNEY                                     BRAUN BLAISING MCLAUGHLIN & SMITH, P.C.
BRAUN BLAISING MCLAUGHLIN & SMITH, P.C.      915 L STREET, SUITE 1480
915 L STREET, SUITE 1480                     SACRAMENTO, CA  95814
SACRAMENTO, CA  95814                        FOR: THE CALIFORNIA COMMUNITY CHOICE
FOR: CALIFORNIA MUNICIPAL UTILITIES ASSOC.

KELLY KATE                                  KEVIN WOODRUFF
DEFENDERS OF WILDLIFE                        CONSULTANT
980 9TH STREET, 16TH FLOOR                   WOODRUFF EXPERT SERVICES
SACRAMENTO, CA  95814                        1127 - 11TH STREET, SUITE 514
SACRAMENTO, CA  95814

LINDA JOHNSON                                ROSANNA CARVACHO
BRAUN BLAISING MCLAUGHLIN & SMITH P.C.       BROWNSTEIN HYATT FARBER SCHRECK, LLP
915 L STREET, SUITE 1270                     1415 L STREET, STE. 800
SACRAMENTO, CA  95814                        SACRAMENTO, CA  95814
FOR: CEERT

MICHAEL KENNEY                               LIZ ANTHONY PH.D
ENERGY ANALYST - EFFICIENCY DIVISION         DIRECTOR
CALIFORNIA ENERGY COMMISSION                 CENTER FOR ENERGY EFFICIENCY
1516 9TH STREET, MS-26                      1100 11TH STREET, STE. 311
SACRAMENTO, CA  95814                        SACRAMENTO, CA  95814

https://ia.cpuc.ca.gov/servicelists/R1602007_83513.htm  4/23/2018
RUTHANN G. ZIEGLER  
ATTORNEY  
MEYERS NAVE  
555 CAPITOL MALL, SUITE 1200  
SACRAMENTO, CA  95814  
FOR: PIONEER COMMUNITY ENERGY (PIONEER)

SARAH KOZAL  
ASSOCIATE  
STOEL RIVES LLP  
500 CAPITOL MALL, STE. 1600  
SACRAMENTO, CA  95814

SARAH TAHERI  
SO. CALIF. PUBLIC POWER AUTHORITY  
915 L STREET, STE. 1410  
SACRAMENTO, CA  95814

STEVEN KELLY  
POLICY DIR  
INDEPENDENT ENERGY PRODUCERS ASSOCIATION  
1215 K STREET, STE. 900  
SACRAMENTO, CA  95814

TERESA COOKE  
BROWNSTEIN HYATT FARBER SCHRECK, LLP  
1415 L STREET, STE. 800  
SACRAMENTO, CA  95814

CHASE KAPPEL  
ELLISON SCHNEIDER HARRIS & DONLAN LLP  
2600 CAPITOL AVE., SUITE 400  
SACRAMENTO, CA  95816

LYNN HAUG  
ATTORNEY  
ELLISON SCHNEIDER HARRIS & DONLAN LLP  
2600 CAPITOL AVENUE, SUITE 400  
SACRAMENTO, CA  95816

SAMANTHA G. POTTENGER  
ELLISON, SCHNEIDER AND HARRIS L.L.P.  
2600 CAPITOL AVENUE, SUITE 400  
SACRAMENTO, CA  95816

ANDREW BROWN  
ATTORNEY AT LAW  
ELLISON & SCHNEIDER  
2600 CAPITOL AVENUE, SUITE 400  
SACRAMENTO, CA  95816-5905  
FOR: ALLIANCE FOR RETAIL ENERGY MARKETS (AREM)

CHRISTOPHER T. ELLISON  
ATTORNEY  
ELLISON, SCHNEIDER & HARRIS, L.L.P  
2600 CAPITOL AVENUE, SUITE 400  
SACRAMENTO, CA  95816-5905

DERIC WITTENBORN  
ELLISON SCHNEIDER HARRIS & DONLAN LLP  
2600 CAPITOL AVENUE, SUITE 400  
SACRAMENTO, CA  95816-5905

DOUGLAS K. KERNER  
ATTORNEY AT LAW  
ELLISON, SCHNEIDER & HARRIS, LLP  
2600 CAPITOL AVENUE, SUITE 400  
SACRAMENTO, CA  95816-5905

GREGGORY L. WHEATLAND  
ATTORNEY  
ELLISON SCHNEIDER HARRIS & DONLAN LLP  
2600 CAPITOL AVENUE, SUITE 400  
SACRAMENTO, CA  95816-5905

0/ MASTACHE  
SR. ATTY - OFF. OF GEN. COUNSEL  
SACRAMENTO MUNICIPAL UTILITY DISTRICT  
6301 S STREET, MS A311  
SACRAMENTO, CA  95817

DANIELLE ROBERTS  
GOVN’T AFFAIRS REP  
SACRAMENTO MUNICIPAL UTILITY DISTRICT  
6301 S STREET, MS A311  
SACRAMENTO, CA  95817

BILL DI CAPO  
DI CAPO LEGAL ADVISORS  
77 CAMPUS COMMONS ROAD, SUITE 200  
SACRAMENTO, CA  95825

ANN L. TROWBRIDGE  
ATTORNEY  
DAY CARTER & MURPHY LLP  
3620 AMERICAN RIVER DR., STE. 205  
SACRAMENTO, CA  95817

NANCY SARACINO  
MANAGING ATTORNEY  
WESTERN ENERGY & WATER, PC  
1020 CORONADO BLVD

https://ia.cpuc.ca.gov/service lists/R1602007_83513.htm  4/23/2018
State Service

CARLOS VELASQUEZ
CPUC - ENERGY
EMAIL ONLY
EMAIL ONLY, CA  00000

ELI HARLAND
CALIFORNIA ENERGY COMMISSION
ENERGY RESEARCH & DEVELOPMENT DIV.
EMAIL ONLY
EMAIL ONLY, CA  00000

FREDERICK TAYLOR-HOCHBERG
CPUC - ENERGY DIV.
EMAIL ONLY
EMAIL ONLY, CA  00000

JULIE FITCH
ALJ DIVISION
CALIFORNIA PUBLIC UTILITIES COMMISSION
EMAIL ONLY
EMAIL ONLY, CA  00000

LINDA KELLY
CALIFORNIA ENERGY COMMISSION
EMAIL ONLY
EMAIL ONLY, CA  00000

DAVID MILLER
ENERGY DIV. - INFRASTRUCTURE PLANNING
CALIFORNIA PUBLIC UTILITIES COMMISSION
EMAIL ONLY
EMAIL ONLY, CA  00000

ERIC DUPRE
CPUC - ENERGY
EMAIL ONLY
EMAIL ONLY, CA  00000

JASON HOUCH
SR. ANALYST
CPUC - ENERGY DIV
EMAIL ONLY
EMAIL ONLY, CA  00000

LEGAL DIVISION
CFUC
EMAIL ONLY
EMAIL ONLY, CA  00000

PATRICK YOUNG
CPUC - ENERGY
EMAIL ONLY
EMAIL ONLY, CA  00000
<table>
<thead>
<tr>
<th>Name</th>
<th>Office</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iryna Kwasny</td>
<td>Legal Division</td>
<td>505 Van Ness Avenue</td>
</tr>
<tr>
<td>Jason Ortego</td>
<td>Electricity Pricing and Customer Program</td>
<td>505 Van Ness Avenue</td>
</tr>
<tr>
<td>Julie A. Pitch</td>
<td>Division of Administrative Law Judges</td>
<td>505 Van Ness Avenue</td>
</tr>
<tr>
<td>Kaj Peterson</td>
<td>Infrastructure Planning and Permitting B Area</td>
<td>505 Van Ness Avenue</td>
</tr>
<tr>
<td>Karolina Maslanka</td>
<td>Infrastructure Planning and Permitting B Area</td>
<td>505 Van Ness Avenue</td>
</tr>
<tr>
<td>Lee-Whei Tan</td>
<td>Electricity Planning &amp; Policy Branch Area</td>
<td>505 Van Ness Avenue</td>
</tr>
<tr>
<td>Liam Weaver</td>
<td>Energy Safety &amp; Infrastructure Branch Area</td>
<td>505 Van Ness Avenue</td>
</tr>
<tr>
<td>Merideth Sterkel</td>
<td>Energy Division</td>
<td>505 Van Ness Avenue</td>
</tr>
<tr>
<td>Michele Kito</td>
<td>Procurement Strategy and Oversight Branch Area</td>
<td>505 Van Ness Avenue</td>
</tr>
<tr>
<td>Mitchell Shapson</td>
<td>Legal Division</td>
<td>505 Van Ness Avenue</td>
</tr>
<tr>
<td>Nathan Barcic</td>
<td>Infrastructure Planning and Permitting B Area</td>
<td>505 Van Ness Avenue</td>
</tr>
<tr>
<td>Neha Bazaj</td>
<td>Demand Response, Customer Generation, An Area</td>
<td>505 Van Ness Avenue</td>
</tr>
<tr>
<td>Nick Dahlberg</td>
<td>Procurement Strategy and Oversight Branch Area</td>
<td>505 Van Ness Avenue</td>
</tr>
</tbody>
</table>
PATRICK CUNNINGHAM
CALIF PUBLIC UTILITIES COMMISSION
ELECTRICITY PLANNING & POLICY BRANCH
AREA
505 VAN NESS AVENUE
SAN FRANCISCO, CA  94102-3214

PAUL DOUGLAS
CALIF PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE PLANNING AND PERMITTING B AREA
505 VAN NESS AVENUE
SAN FRANCISCO, CA  94102-3214

PAULA GRUENDLING
CALIF PUBLIC UTILITIES COMMISSION
ENERGY EFFICIENCY BRANCH
AREA 4-A
505 VAN NESS AVENUE
SAN FRANCISCO, CA  94102-3214

PETER SPENCER
CALIF PUBLIC UTILITIES COMMISSION
ELECTRICITY PLANNING & POLICY BRANCH
ROOM 4104
505 VAN NESS AVENUE
SAN FRANCISCO, CA  94102-3214
FOR: ORA

RACHEL MCMAHON
CALIF PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE PLANNING AND PERMITTING B AREA
505 VAN NESS AVENUE
SAN FRANCISCO, CA  94102-3214

RADU CIUPAGEA
CALIF PUBLIC UTILITIES COMMISSION
ELECTRICITY PLANNING & POLICY BRANCH
ROOM 4104
505 VAN NESS AVENUE
SAN FRANCISCO, CA  94102-3214

ROBERT LEVIN
CALIF PUBLIC UTILITIES COMMISSION
ENERGY DIVISION
AREA
505 VAN NESS AVENUE
SAN FRANCISCO, CA  94102-3214

SANDY GOLDBERG
CALIF PUBLIC UTILITIES COMMISSION
COMMISSIONER RECHTSCHAFFEN
ROOM 5202
505 VAN NESS AVENUE
SAN FRANCISCO, CA  94102-3214

SCARLETT LIANG-UEJIO
CALIF PUBLIC UTILITIES COMMISSION
MARKET STRUCTURE, COSTS AND NATURAL GAS AREA
505 VAN NESS AVENUE
SAN FRANCISCO, CA  94102-3214

SEAN A. SIMON
CALIF PUBLIC UTILITIES COMMISSION
COMMISSIONER RECHTSCHAFFEN
AREA 4-A
505 VAN NESS AVENUE
SAN FRANCISCO, CA  94102-3214

SHELLY LYSER
CALIF PUBLIC UTILITIES COMMISSION
ELECTRICITY PRICING AND CUSTOMER PROGRAM AREA
505 VAN NESS AVENUE
SAN FRANCISCO, CA  94102-3214

SIMONE BRANT
CALIF PUBLIC UTILITIES COMMISSION
PROCUREMENT STRATEGY AND OVERSIGHT BRANC AREA
505 VAN NESS AVENUE
SAN FRANCISCO, CA  94102-3214

STANLEY KUAN
CALIF PUBLIC UTILITIES COMMISSION
ELECTRICITY PRICING AND CUSTOMER PROGRAM AREA
505 VAN NESS AVENUE
SAN FRANCISCO, CA  94102-3214

XIAN "CINDY" LI
CALIF PUBLIC UTILITIES COMMISSION
ELECTRICITY PLANNING & POLICY BRANCH
ROOM 4104
505 VAN NESS AVENUE
SAN FRANCISCO, CA  94102-3214

YULIYA SHMIDT
CALIF PUBLIC UTILITIES COMMISSION
COMMISSIONER RECHTSCHAFFEN
ROOM 4209
SAN FRANCISCO, CA  94102-3214

JAKUB ZIELKIEWICZ
CALIFORNIA AIR RESOURCES BOARD
EMAIL ONLY
SACRAMENTO, CA  95812

https://ia.cpuc.ca.gov/servicelists/R1602007_83513.htm
505 VAN NESS AVENUE
SAN FRANCISCO, CA  94102-3214

ASISH GAUTAM                              DAVE VIDAVER
CALIFORNIA ENERGY COMMISSION              CALIFORNIA ENERGY COMMISSION
1516 9TH STREET MS-20                     1516 NINTH STREET, MS-20
SACRAMENTO, CA  95814                     SACRAMENTO, CA  95814

HEATHER BIRD                              LYNN MARSHALL
CALIFORNIA ENERGY COMMISSION              CONSULTANT
1516 NINTH STREET, MS 52                  CALIFORNIA ENERGY COMMISSION
SACRAMENTO, CA  95814                     1516 9TH STREET, MS-20
SACRAMENTO, CA  95814

MARC PRYOR                                MICHAEL JASKE
ELECTRIC GENERATION SPECIALIST III        CALIFORNIA ENERGY COMMISSION
CALIFORNIA ENERGY COMMISSION              1516 9TH STREET, MS-21
1516 NINTH ST., MS - 20                   SACRAMENTO, CA  95814
SACRAMENTO, CA  95814

PAUL DEAVER                               ROBERT KENNEDY
CALIFORNIA ENERGY COMMISSION              CALIFORNIA ENERGY COMMISSION
1516 9TH STREET                           1516 9TH STREET, MS-20
SACRAMENTO, CA  95814                     SACRAMENTO, CA  95814

ANGELA TANGHETTI                          RICHARD JENSEN
CALIFORNIA ENERGY COMMISSION              CA ENERGY COMMISSION
1516 NINTH STREET, MS-20                  1516 9TH ST MS-20
SACRAMENTO, CA  95819                     SACRAMENTO, CA  95826

TOP OF PAGE
BACK TO INDEX OF SERVICE LISTS