FILED
10-26-17
04:59 PM

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 (Filed Feb. 11, 2016)

OPENING COMMENTS OF THE UNION OF CONCERNED SCIENTISTS ON THE ADMINISTRATIVE LAW JUDGE'S RULING SEEKING COMMENT ON PROPOSED REFERENCE SYSTEM PLAN AND RELATED POLICY ACTIONS

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October 26, 2017

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Pursuant to the September 19, 2017 Administrative Law Judge ("ALJ") ruling requesting comments on the Proposed Reference System Plan and Related Commission Policy Actions ("Proposed Reference System Plan"), the Union of Concerned Scientists ("UCS") submits these opening comments.

I. INTRODUCTION

UCS appreciates the significant amount of time and effort that Commission staff and its consultants have invested in holding workshops and webinars to develop the inputs and assumptions for the IRP scenarios, generate and discuss preliminary results, and develop a Proposed Reference System Plan. UCS also thanks the Commission for making the RESOLVE model publicly available for stakeholders to run.

The RESOLVE model necessarily balances the need to provide granular enough resolution to credibly explore the economic and grid reliability implications of electricity system investments under different greenhouse gas ("GHG") emission scenarios with the need to simplify assumptions to reduce the model runtime to a manageable timeframe. However, through workshops and comments, stakeholders have surfaced some important limitations for RESOLVE that UCS urges the Commission to directly address before the next IRP cycle. These limitations include the inability of RESOLVE to optimize investments in demand-side resources and the uncertainty surrounding the most effective way to use IRP modeling to optimize grid

investments for GHG emission reductions and criteria air pollution reduction in disadvantaged communities. The Commission has started to address some of these issues in the "Path to Future All-Resource Planning" section of Attachment A of this ruling, and UCS looks forward to continuing that conversation.

UCS's opening comments on this Proposed Reference System Plan address almost all of the questions in the ruling and present the results of some additional modeling analysis that UCS conducted to address areas of weakness in the RESOLVE model with respect to its treatment of natural gas generation.

II. QUESTIONS FOR PARTIES

1.Please comment on the appropriateness of the baseline resources included in the RESOLVE model. What changes would you make and why?

Baseline demand-side resources

The implications of many demand-side resource investments, such as energy efficiency, building electrification, behind-the-meter PV, electric vehicles, and the impact of time-of-use ("TOU") electricity rates are represented in the annual load-forecast and therefore treated as inputs into RESOLVE. Because of this, the Commission and stakeholders are not able to quantify the ability of demand-side resources to help meet load and reduce greenhouse gas ("GHG") emissions. This is especially frustrating since we know that demand-side resources have the potential to meet energy and grid reliability needs in local areas and during "evening ramp" hours, which would help the state reduce its reliance on natural gas generation, thereby reducing both GHG emissions and air pollution. In the next IRP cycle, UCS urges the Commission to work with parties to determine whether it's possible to modify RESOLVE so that can optimize investments in demand-side resources and capture their ability to reduce evening

peak needs, improve renewable energy integration and grid reliability, and reduce GHG emissions.

Baseline supply-side resources: energy storage and renewables

UCS thanks the Commission for enforcing the full storage mandate—1325 MW by 2024—and assuming all load-serving entities ("LSEs") in California comply with the 50% Renewables Portfolio Standard ("RPS") by 2030.[1] In addition, UCS is pleased that one of the key updates to RESOLVE was to reduce capital cost assumptions for battery storage technologies. Existing analyses continue to underestimate the pace at which energy storage technology costs decline, and it will be especially important for the Commission to keep its cost assumptions for battery technologies as fresh as possible.[2]

Baseline supply-side resources: existing natural gas generation

UCS notes that RESOLVE quantified the number of stops/starts within each category of gas generation capacity, but did not calculate emissions associated with stops/starts. Since start-up emissions are a significant component of criteria air pollution associated with natural gas generation, UCS urges the Commission to ensure start-up emissions of gas units are included in future IRP cycles.

The biggest concern that UCS has with RESOLVE's assumptions for baseline resources is the assumption that all thermal resources will be online and available through 2030:

[1] *See* Comments from The Union of Concerned Scientists on the Staff Proposal for Implementing Integrated Resource Planning, June 28, 2017, pp.10-11.
[2] Kittner, N., Lill, F. & Kammen, D. M. Energy storage deployment and innovation for the clean energy transition. *Nature. Energy* 2, 17125 (2017). Paper and supplemental data are available online at: https://rael.berkeley.edu/project/innovation-in-energy-storage/

> By default, RESOLVE assumes that thermal generators will remain online in perpetuity unless they have formally announced intentions to retire, which results in the Baseline thermal fleet remaining relatively stable over time (with the expectation of the retirement of the once-through-cooling steam generators in 2020). However, RESOLVE also includes functionality to accelerate retirements of the thermal fleet according to assumptions of the economic useful lifetime. Users may select an assumed plant lifetime of 20, 25, or 30 years…[3]

UCS believes that assuming thermal generators will remain online in perpetuity is a significant blind spot in the IRP that may result in the Reference System Plan and the Preferred System Plan overestimating the role that natural gas generation should, and will likely be able, to play in California's future electricity mix. This shortcoming in RESOLVE pushes off the critically important discussion the Commission must initiate to identify the gas plant attributes that will have the most value to the grid in 2030, and the gas plant attributes that can be most cost-effectively replaced by cleaner resources.

The RESOLVE "early retirement scenarios" attempt to address the early retirement issue by demonstrating what non-gas resources are *capable* of replacing the services provided by gas (e.g. geothermal, DR, imports, storage, etc.), but are insufficient to determine the value of gas generation to the system. In addition, RESOLVE includes the ability to retire fossil plants after 25 years instead of 40, but simply allowing gas plants to retire in 25, rather than 40 years is a suboptimal approach to fully understanding the impacts of early gas fleet retirements on GHG emissions and grid reliability. Whatever model the Commission uses in future IRP cycles should ideally be able to proactively retire gas capacity if it is not valuable to the system, rather than arbitrarily after a predetermined number of years.

[3] RESOLVE Documentation: CPUC 2017 IRP; Energy+Environmental Economics; September 2017, p.17.

Even without conducting modeling runs to investigate how much gas may be at risk of retirement, parties can get a sense of the issue by simply looking at RESOLVE's capacity factors for each gas generation fleet type in 2030 (as shown in Table 1 below). UCS has highlighted in gray the extremely low capacity factors for the CCGT_2, and peaker generation fleet types. It's difficult for UCS to believe that many gas plants will continue to operate in 2030 at such extremely low capacity factors.

Table 1: Capacity factors of CCGT and peaker fleet types in RESOLVE

		50% RPS				**42 MMT**				**30 MMT**			
Technology	Unit	2018	2022	2026	2030	2018	2022	2026	2030	2018	2022	2026	2030
CAISO_CCGT1	GWh	62.8%	45.5%	59.7%	60.0%	61.1%	34.7%	47.3%	53.6%	61.1%	31.0%	46.2%	41.2%
CAISO_CCGT2	GWh	5.3%	2.2%	3.9%	2.7%	5.1%	0.7%	2.0%	3.0%	5.1%	0.7%	1.8%	0.0%
CAISO_Peaker 1	GWh	0.0%	0.0%	0.0%	0.3%	0.0%	0.0%	0.0%	0.1%	0.0%	0.1%	0.1%	0.0%
CAISO_Peaker 2	GWh	0.3%	0.3%	0.3%	0.1%	0.3%	0.4%	0.4%	0.0%	0.3%	0.5%	0.2%	0.0%

UCS believes that it is important to improve the modeling capability in the IRP so that stakeholders can better understand the value of gas on the electricity system, and whether the services provided by gas can be *economically* replaced by other resources. Without doing this research, UCS is concerned that state regulators and grid operators may rush to the conclusion that California needs to find additional revenue streams for gas, to ensure all of this gas capacity continues to stay online. An overreliance on natural gas, especially where it is more cost effective to allow the gas to retire, will not benefit ratepayers and will make it more difficult and

expensive to reduce GHG emissions in the electricity sector. A targeted and orderly transition away from fossil generation for grid services is also critical for achieving public health benefits by lowering criteria air pollutant levels, especially for communities disproportionately burdened by local fossil fuel infrastructure.

To understand how much natural gas capacity might retire if doing so was the most cost-effective approach for the grid, UCS ran the same scenarios used for RESOLVE in GridPath[4], a capacity-expansion model with similar functionality to RESOLVE. The GridPath model is able to "retire" gas capacity if it is more cost-effective to the system to avoid paying annual fixed operations and maintenance (O&M) costs– and provide grid services with other resources – rather than keep the generation capacity available and pay the fixed O&M.

Using the same baseline assumptions as RESOLVE [5], UCS ran two sets of natural gas retirement cases: "allow peaker and CCGT retirements," and "allow all gas retirements" (peaker, CCGT, steam turbines, CHP, and reciprocating engines) for each of the three GHG scenarios in the Proposed Reference System Plan: 50% Default RPS, 42 MMT, 30 MMT. In these comments, UCS only includes the results of the "allow peaker and CCGT retirement" runs because we

[4] GridPath, a comprehensive grid analytics platform that integrates several types of power system modeling approaches, including multi-stage production-cost simulation, long-term capacity expansion, and price-based asset valuation. GridPath can simulate the operations of the power system, capturing the capabilities of and constraints on generation, storage, and transmission resources to understand grid integration and flexibility needs. Here, we use GridPath in capacity-expansion mode with a linear optimization problem formulation similar to RESOLVE's. Like RESOLVE, GridPath considers both capital expenditures and variable costs to identify cost-effective deployment of grid assets. We also include functionality not available in RESOLVE, namely the ability to retire generation capacity, therefore avoiding the need to pay its annual fixed O&M cost, if cost-effective for the system. GridPath was created by Dr. Ana Mileva, who was also the primary developer of RESOLVE while a consultant at E3.

[5] UCS ported to GridPath the publicly-available IRP RESOLVE data released in July 2017 and aligned assumptions as much as possible: we modeled the 37 RESOLVE days and four investment periods with the same zones and transmission links, load assumptions, reserve requirements, transmission flow constraints, carbon and RPS policies, PRM targets and ELCC contributions, existing generator stacks (aggregated to "fleets") and generator operational characteristics, candidate resources with their costs and potentials, fuel and carbon prices, hurdle rates, etc. as the IRP.

believe the focus of the discussion about the future value of gas on the system will be about peaker and CCGT plants.

Table 2 contains UCS's assumptions for natural gas annual fixed O&M costs, which are based on the technology characteristics from the RESOLVE user interface. Like RESOLVE, GridPath modeled generators with similar operational characteristics as aggregated into "fleets." The retirement decisions are therefore continuous, so they do not correspond to specific generators.

Table 2: Generator fleet types that can be retired in GridPath and their fixed O&M costs

Fleet Type	Fixed O&M Cost ($/kW-yr)
CAISO_CCGT1	10
CAISO_CCGT2	10
CAISO_Peaker1	6
CAISO_Peaker2	6

The GridPath gas retirement results are summarized in Chart 1 and Table 3. By allowing natural gas generation capacity to economically retire in GridPath, UCS found that gas capacity in both categories—CCGTs and peakers—retires in each of the three GHG emission reduction scenarios contained in the Proposed Reference System Plan.

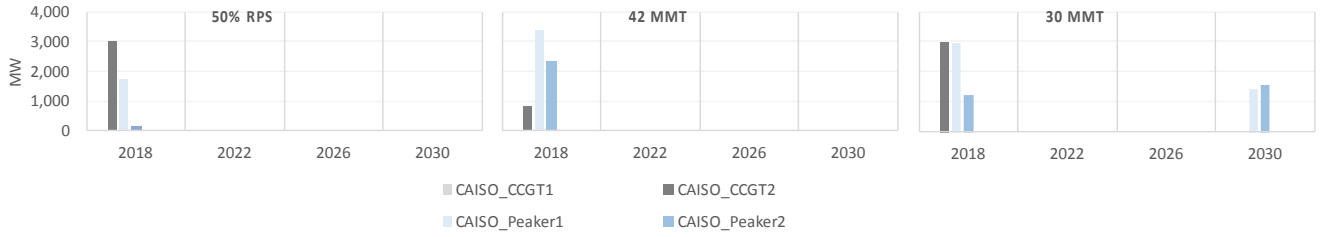
It appears that the most efficient CCGTs ("CCGT_1") are the most valuable to a future grid that optimizes resources to reduce GHG emissions at lowest cost. In UCS's GridPath runs, no CCGT_1 capacity is retired in any carbon reduction scenario in any of the years modeled.

Compared to the 50% Default RPS case, CCGT_2s are cycled more frequently in the 42 MMT case to accommodate the added solar generation. This may have negative consequences for criteria air pollution emissions that warrant additional research and discussion about how alternative clean-energy technologies could be utilized to reduce the need to cycle CCGT_2

plants. However, utilization of CCGT_2s decline in the 30 MMT case as it becomes necessary to reduce GHG emissions outside of daytime hours, and instead of gas, the model begins to rely more upon energy storage to shift GHG-free electricity to the evening hours. This suggests to UCS that there is some value to fairly-flexible CCGTs to integrate higher levels of renewables on the system, but if the state is to ultimately reduce GHG emissions below 42 MMT, the value of that gas generation may be temporary because stronger carbon reduction targets will require moving to cleaner sources of flexibility.

Natural gas peaker plants appear to have the least amount of value to the electricity system in the GridPath runs. The last row of Table 3 displays the range of peaker capacity retirement – from 25% in the 50% Default RPS case to 96% in the 30 MMT case. This suggests that the Commission should be especially wary of assuming all existing peaker capacity is valuable and cost-effective in a future electricity system that plans for GHG emission reductions.

Chart 1 & Table 3: Economic retirements of CCGT and peaker fleets by investment period in the GridPath analysis.



	Default 50% RPS (MW retired)	42 MMT (MW retired)	30 MMT (MW retired)
CCGT_1 retirements in 2018	0	0	0
CCGT_1 retirements in 2022	0	0	0
CCGT_1 retirements in 2026	0	0	0
CCGT_1 retirements in 2030	0	0	0
Total CCGT_1 retirements by 2030	0	0	0

CCGT_2 retirements in 2018	2974	790	2974
CCGT_2 retirements in 2022	0	0	0
CCGT_2 retirements in 2026	0	0	0
CCGT_2 retirements in 2030	0	0	0
Total CCGT_2 retirements by 2030	2974	790	2974
TOTAL CCGT retirements by 2030	*2974*	*790*	*2974*
% of 2018 CCGT capacity retired by 2030	*19%*	*5%*	*19%*
Peaker_1 retirements in 2018	1730	3393	2969
Peaker_1 retirements in 2022	0	0	0
Peaker_1 retirements in 2026	0	0	0
Peaker_1 retirements in 2030	0	0	1444
Total Peaker_1 retirements by 2030	1730	3393	4413
Peaker_2 retirements in 2018	130	2290	1248
Peaker_2 retirements in 2022	0	0	0
Peaker_2 retirements in 2026	0	0	0
Peaker_2 retirements in 2030	0	0	1546
Total Peaker_2 retirements by 2030	130	2290	2794
TOTAL Peaker retirements by 2030	*1860*	*5683*	*7207*
% of 2018 peaker capacity retired by 2030	*25%*	*76%*	*96%*

UCS realizes that without being able to ensure all RESOLVE assumptions are fully aligned with GridPath, and without providing other parties the ability to run GridPath alongside RESOLVE, it is difficult for the Commission and other stakeholders to take these results at face value. The purpose of this exercise is not to predict a specific amount of cost-effective gas retirement, but instead point out a potentially significant blind spot in the current IRP process that, unless mitigated, could lead stakeholders to assume that natural gas will play a certain role in our electricity system for the next 15 years and leave the state very unprepared when that gas fails to stay online.

Table 4 summarizes what additional investments are made in GridPath to compensate for the gas retirement. In general, the effect of allowing gas retirements on new resource investments is small, with slight increases in geothermal and storage deployment compensating for the lower gas capacity.

Table 4: Additional resource deployment in GridPath cases that allow economic gas retirement

	Change in Deployment (MW)	Change in Deployment (%)
Default 50% RPS		
Solar PV	-12 MW	-0.3%
Wind	+ 0 MW	+0.0%
Geothermal	-	-
Storage	+228 MW	- [6]
42 MMT		
Solar	-539 MW	-6.9%
Wind	+ 0 MW	+0.0%
Geothermal	+ 117 MW	+23.3%
Storage	+414 MW	+38.5%
30 MMT		
Solar	-232 MW	-1.9%
Wind	+ 0 MW	+ 0%
Geothermal	+360 MW	+44.4%
Storage	+543 MW	+15.7%

[6] Storage deployment in the 50% RPS case is zero.

UCS also ran sensitivities in GridPath to test the effects of battery storage costs, the net export limit, and the availability of out-of-state wind resources. Reducing the cost of batteries has some of the largest effect on retirement of CCGT_2s in particular, as evening use of CCGT_2s is displaced by batteries and solar. Similarly, deployment of out-of-state wind resources reduces reliance on solar and the need for balancing with CCGT_2s in the 42 MMT case, increasing economic retirements of CCGT_2s.

Baseline assumptions: reserve requirements

UCS is pleased that RESOLVE allows supply-side storage devices to provide frequency response, regulation, load following, and spinning reserves. In addition, UCS is pleased to see that RESOLVE can curtail renewables on a subhourly level to provide load-following down services. Given the CAISO's recent pilot study validating the ability of large-scale PV plants to provide a range of grid services, including both load-following up and down, UCS believes that future IRP cycles should explore the ability of utility-scale renewables to provide services beyond load-following down:

> This data showed how the development of advanced power controls can leverage PV's value from being simply an intermittent energy resource to providing services that range from spinning reserves, load following, voltage support, ramping, frequency response, variability smoothing and frequency regulation to power quality. Specifically, the tests conducted included various forms of active power controls such as automatic generation control (AGC) and frequency regulation, droop response, and reactive power/voltage/power factor controls. [7]

[7] Using Renewables to Operate a Low-Carbon Grid: Demonstration of Advanced Reliability Services from a Utility-Scale Solar PV Plant; CAISO; January 2017; p.5; available at: http://www.caiso.com/Documents/UsingRenewablesToOperateLow-CarbonGrid.pdf

Also, RESOLVE uses an hourly requirement for load following based subhourly analyses done for one 33% RPS scenario and two 50% RPS scenarios. UCS believes that this approach is sufficient for now given the quantity of renewables contained in three major carbon scenarios chosen for this IRP cycle, but in the future as the Commission explores the impact of higher amounts of renewables on the system, UCS believes that load following requirements will need to be updated.

2. Comment on the appropriateness of the three major scenarios modeled by staff (Default Scenario, 42 MMT Scenario, 30 MMT Scenario).

UCS supports the Commission's assumption that the 50% RPS by 2030 is achieved in every scenario since the RPS is a legal requirement for all California LSEs. UCS does not think it makes sense to spend time and resources running scenarios that fail to meet state requirements. Therefore, given that implementing a 50% RPS corresponds to roughly 51 MMT of GHG emissions in the electric sector in 2030, UCS agrees with the Commission that it should drop further analysis of the 62 MMT scenario. In addition, UCS believes its appropriate to assume the "default" or "business as usual" scenario also complies with the 50% RPS, and so supports the Commission using the 50% RPS Scenario in RESOLVE as the default scenario against which other scenarios will be compared.

UCS understands why, given limited time and resources, the Commission only chose to evaluate three GHG emissions scenarios for the Proposed Reference System Plan. Yet limiting the analysis to three GHG scenarios makes it difficult for stakeholders and the Commission to understand where the inflection points are for the cost-effectiveness of various investments. For example, there are a couple of significant differences between the resource portfolios in the 42 MMT case and the 30 MMT case. The level of geothermal in the 30 MMT case is tenfold that of

the 42 MMT case; the amount of pumped storage is zero for the 42 MMT case and increases to over 1 GW in the 30 MMT. UCS was interested in understanding at what level of GHG reduction between 42 and 30 MMT would these resources become part of an optimal portfolio, and so ran 5 additional GHG scenarios in RESOLVE, in addition to the 42 and 30 MMT cases, to explore the change in investment levels between 42 MMT and 30 MMT. All other baseline assumptions were unchanged.

Table 5 summarizes the results of these additional RESOLVE runs. Resources for which there was no change in output between the GHG scenarios are represented with one row only. For resources that experience a change in investment level depending on the GHG scenario, the output for each GHG case is listed in a separate row. For example, the level of CHP did not change in any of the 7 GHG cases UCS ran, so there is just one row for CHP in the table. Geothermal investment changed depending on the GHG case. Therefore, the output for geothermal is represented in 7 rows: the output in the 42 MMT case is represented as "Geo_42", the 40 MMT case is represented as "Geo_40", and so on…

Table 5: RESOLVE Output: Resources selected in seven GHG cases ranging from 42-30 MMT (MW)

	2018	***2022***	***2026***	***2030***
Nuclear	0	0	0	0
CHP	0	0	0	0
Gas	0	0	0	0
Hydro (Large)	0	0	0	0
Biomass	0	0	0	0
Geo_42	0	0	0	202
Geo_40	0	0	0	708
Geo_38	0	0	0	1,533
Geo_36	0	0	0	1,700
Geo_34	0	0	0	2,020
Geo_32	0	0	0	2,020
Geo_30	0	0	0	2,020

Hydro (Small)	0	0	0	0
Wind_42	1,145	1,145	1,145	1,145
Wind_40	1,145	1,145	1,145	1,645
Wind_38	1,145	1,145	1,145	1,645
Wind_36	1,145	1,145	1,145	2,290
Wind_34	1,145	1,145	1,145	3,741
Wind_32	1,145	1,145	1,145	4,171
Wind_30	1,145	1,145	1,145	4,775
Solar_42	0	8,828	8,828	8,828
Solar_40	0	8,749	8,749	8,749
Solar_38	0	8,176	8,176	8,176
Solar_36	0	8,388	8,388	8,388
Solar_34	0	8,867	8,867	8,867
Solar_32	0	10,155	10,155	10,155
Solar_30	0	11,011	11,011	11,121
Battery_42	0	0	162	1,992
Battery_40	0	0	156	2,147
Battery_38	0	0	132	2,191
Battery_36	0	0	142	2,416
Battery_34	0	0	239	2,887
Battery_32	0	0	301	3,455
Battery_30	0	0	414	3,792
Pumped Storage_42	0	0	0	0
Pumped Storage_40	0	0	0	0
Pumped Storage_38	0	0	0	0
Pumped Storage_36	0	0	0	0
Pumped Storage_34	0	0	0	0
Pumped Storage_32	0	0	0	572
Pumped Storage_30	0	0	0	1,209
Shed DR	0	0	0	0
Shift DR	0	0	0	0
Hydrogen Load	0	0	0	0

One of the most interesting takeaways from looking at the results of a larger range of GHG scenarios is that RESOLVE selects more than 3x the geothermal compared to the 42 MMT case when it optimizes for the 40 MMT case. This suggests to UCS that the value of geothermal increases when the system plans to reduce GHG emissions just slightly down from 42 MMT. On the other hand, pumped storage investments do not appear in the optimal mix of investments

until the GHG cap is much closer to the 30 MMT bookend. Batteries are chosen at a consistent investment rate throughout all 7 scenarios, suggesting that incremental investments in battery storage between now and 2030 will continue to be cost-effective.

3. Provide any comments or reactions to the cost metrics analyzed and the estimated cost results.

UCS has no comments on this question at this time.

4. Comment on the viability of renewable curtailment as a grid integration strategy.

UCS strongly supports the use of renewable energy curtailment as a grid integration strategy. In 2014, UCS began advocating that the Commission and the CAISO start considering using renewable generation, through the use of compensated or "economic" curtailment, as a source of frequency response services. This position was first explained in our testimony submitted in R.13-12-010 for the 2014 LTPP, and further supported by UCS's own analysis using PLEXOS to look at the impacts of a 50% RPS in California.[8&9] The CAISO's own pilot study evaluating the ability of large-scale solar PV plants to provide grid services is further evidence that holding back some renewable energy generation to provide upward flexibility, and curtailing renewables to provide downward flexibility can provide valuable grid services.[10]

The RESOLVE modeling for the Proposed Reference System Plan supports the idea that renewable energy curtailment is a cost-effective renewable integration tool: "This [renewable]

[8] *See* Prepared Opening Testimony of Dr. Jimmy Nelson on Behalf of the Union of Concerned Scientists and Sierra Club California, September 24, 2014; R.13-12-010; pp.22-23.

[9] Nelson, J., & Wisland, L.; Achieving 50 Percent Renewable Electricity in California; Union of Concerned Scientists; August 2015; available at: www.ucsusa.org/California50RPSanalysis.

[10] Using Renewables to Operate a Low-Carbon Grid: Demonstration of Advanced Reliability Services from a Utility-Scale Solar PV Plant; CAISO; January 2017; p.5; available at: http://www.caiso.com/Documents/UsingRenewablesToOperateLow-CarbonGrid.pdf

curtailment alternative is lower cost than many of the more expensive renewable integration options for much of the time period analyzed."[11] Furthermore, the RESOLVE modeling runs using baseline assumptions estimate that in 2030, curtailment will range from 3.2% to 7.3%, which UCS believes is an acceptable amount of systemwide curtailment. For these reasons, UCS believes that the Commission should not only explore renewable energy curtailment as a grid management strategy, but facilitate a discussion with stakeholders that are involved in executing PPAs for renewables to identify how standard contract terms might be adjusted to support dispatching renewables more flexibly. In addition, UCS does not believe the Commission should spend limited modeling resources to run "no curtailment" scenarios in future IRP cycles.

5. Comment on the advisability of early procurement of renewables to take advantage of federal ITC and PTC availability.

Results from both the 42 MMT and the 30 MMT clearly indicate that California will need renewable generation in excess of what's legally required by the current RPS program to meet long-term GHG emission reductions goals. In addition, PG&E has publicly stated that it plans to replace the carbon-free electricity generation lost once Diablo Canyon has retired with a combination of energy efficiency and GHG-free generation resources. For these reasons, and because the RESOLVE modeling results clearly show that there is economic value to early procurement of wind and solar before the federal ITC and PTC expire or ramp down, UCS believes it is advisable for the Commission to strongly encourage LSEs to consider early renewable energy procurement in their individual IRP plans. This is especially true for LSEs that will be in charge of meeting customer load that would have otherwise been met with electricity

[11] ALJ's Ruling Seeking Comment on Proposed Reference System Plan and Related Commission Policy Actions; September 19, 2017; R.16-02-007; p.12.

from Diablo Canyon, and LSEs that do not have banks of excess renewable energy credits ("RECs").

6. Comment on the impact of banked RPS procurement on this analysis.

In both the 42 MMT and 30 MMT cases, the amount of renewables on the system exceeds the 50% RPS requirement without taking banked RECs into account. Since the RPS program rules allow LSEs to bank RECs in compliance with Section 399.13(a)(4)(B) of the Public Utilities Code, UCS believes its appropriate for a systemwide analysis to account for banked RECs before additional renewables are picked for the plan. The impact of banked RECs will obviously range from LSE to LSE in individual IRPs and the Commission should ensure that any LSE that is planning on using banked RECs to meet its RPS requirements or the GHG emissions targets for the IRP uses banked RECs in a way that complies with California law.

7. Comment on the impact of import/export constraints on this analysis.

Not surprisingly, renewable energy curtailment is lower in the "high exports" sensitivity compared to curtailment in the scenarios using the reference case export assumption. RESOLVE selects additional solar PV in almost all the cases it ran for the IRP, and the ability to export solar generation during hours of the day when California load cannot use all that is available is a cost-effective integration tool that helps reduce solar curtailment. UCS hopes that these results will further bolster the Commission's efforts to do what it can to support increased coordination between the CAISO and neighboring balancing area authorities, to improve the state's ability to reduce unnecessary solar curtailment.

8. Comment on the results of the three long-lead-time resource studies summarized in this analysis:
a. Pumped storage
b. Geothermal
c. Out-of-state wind

None of the GHG scenarios between 42 MMT and 30 MMT that UCS ran in RESOLVE build pumped storage before 2030, and only the 30 MMT case results in more than 1 GW of additional pumped storage (see Table 5). Therefore, it is not a surprise that adding 1 GW of pumped storage to the baseline portfolio in 2022 increases costs across all scenarios. The takeaway from these results for UCS is that pumped storage is most valuable if the state begins planning for levels of renewables on the grid that are necessary deeper levels of GHG reduction, in line with the 30 MMT case, and that (luckily) California has several years to figure out how to build and pay for that resource before we really need it. It's worth mentioning here that the California Legislature had a very robust debate about Senate Bill ("SB") 100, which would have set a goal for the electricity sector to be 100% carbon-free by 2045. SB 100 is still alive in the Legislature, and if legislation like SB 100 were to pass, seasonal storage like pumped hydropower will very likely need to play a role in California's energy future.

None of the GHG scenarios between 42 MMT and 30 MMT that UCS ran in RESOLVE build geothermal before 2030, so it is also not surprising that building an additional 1 GW of geothermal in 2022 increases costs across portfolios. However, it's notable that all the GHG cases between 42 and 30 MMT see a value to building some geothermal by 2030 (see Table 5). This is because geothermal is able to provide the system with GHG-free electricity during evening hours. The results of the long-lead time geothermal case indicate that 1 GW of additional geothermal may be overkill for the system in 2022, but some additional geothermal has value, and the Commission should be thinking about how to make sure additional geothermal

procurement (but probably less than 1 GW) occurs between now and 2030 (in addition to making sure California does not lose any of its existing geothermal resources once current contracts expire).

The results of the long-lead time out-of-state wind case indicate that there is value to making additional investments in out-of-state wind if the state is to reduce its electricity sector emissions below 42 MMT. Since UCS strongly supports continuing to analyze electricity sector investments that reduce GHGs below 42 MMT, we believe the Commission should working with the CAISO to explore the value of additional out-of-state wind investments. For more on this, please see our answers to Question 23.

9. Do you agree with the recommendation to utilize the 42 MMT Scenario for IRP planning purposes? Why or why not?

For this IRP cycle, UCS supports the Commission's recommendation to use the 42 MMT scenario for the Reference System Plan. However, this target needs to be revisited in each IRP cycle, and analyzed in the broader context of California's legal requirement to reduce GHG emissions throughout the economy.[12] GHG emission reductions are likely to be achieved at lower cost in the electricity sector than in other sectors, and a substantial fraction of the "unallocated" GHG reductions envisioned to be driven by the cap and trade program will very likely come from the electric sector as well. Therefore, an IRP that plans only to reduce GHG emissions commensurate with the state's existing 50% RPS requirement will undervalue the role of the electricity sector in reducing economy-wide GHG emissions, potentially leading to a need for costly and controversial course corrections in the future.

[12] Senate Bill 32, enacted September 8, 2016.

In addition, ultimately planning for a 2030 electricity system with GHG emissions below 42 MMT may be the most important way for the Commission to fulfill its obligation to "minimize localized air pollutants and other greenhouse gas emissions, with early priority on disadvantaged communities identified pursuant to Section 39711 of the Health and Safety Code."[13] The results from the sensitivities performed in each of the three GHG scenarios in RESOLVE show very little variation in NOx emitted from CCGTs and only slightly more variation in NOx emitted from peaker plants. The same trends occur for PM2.5 across all the sensitivities.[14] This suggests that the most important factor in reducing criteria air pollution associated with natural gas generation in the state (which disproportionately occurs in disadvantaged communities) is reducing the statewide GHG emissions cap.

10. Do you support the use of the Reference System Portfolio associated with the 42 MMT Scenario as the model for LSE portfolio planning for their individual IRPs? Why or why not?

UCS supports using the Reference System Portfolio associated with the 42 MMT scenario as a general blueprint for LSE portfolio planning for individual IRPs, but doing so should not be overly prescriptive. This is because LSEs have unique circumstances that may point them in the direction of procuring more or less renewable generation than what is expected systemwide, or a different portfolio mix. In addition, as mentioned earlier in these comments, UCS expects individual IRPs to do a better job representing local capacity requirements and the ability of distributed and demand-side resources to meet those needs, which may also result in a slightly different portfolio than what's represented in the Reference System Plan. UCS believes that the

[13] Public Utilities Code § 454.52(a)(1)(H)

[14] ALJ's Ruling Seeking Comment on Proposed Reference System Plan and Related Commission Policy Actions; Attachment A: Proposed Reference System Plan; September 19, 2017; slides 88-91.

most important role of the Reference System Plan is to set the overall GHG planning target and GHG Planning Price, and indicate general trends to guide Commission directions and LSE procurement.

11. Do you support transmitting the Default Scenario and associated portfolio to the CAISO for use as the reliability base case in the TPP for 2018? Why or why not?

UCS has no comments at this time.

12. Do you support transmitting the 42 MMT Scenario and associated portfolio to the CAISO for use as the policy-driven case in the TPP for 2018? Why or why not?

UCS has no comments at this time.

13. Should the RETI 2.0 work or other available information be incorporated into the TPP recommendations for 2017? If so, how?

UCS has no comments at this time.

14. Do you support the staff recommendation for how LSEs should utilize the GHG Planning Price in preparing their individual LSE IRPs. Why or why not?

Yes, UCS supports the use of a GHG Planning Price in individual IRPs. UCS's primary concern with using a planning price is that this strategy by itself does not guarantee that the sum of GHG emissions associated with all the individual LSE IRPs is less than or equal to the GHG cap in the Reference System Plan. But, using a planning price alongside a GHG emissions benchmark to serve as a reference point ameliorates UCS's concerns enough so that we support the Commission's recommendation to use a GHG Planning Price in this first IRP cycle, as long as the method is evaluated once the Preferred System Plan is developed.

15. Do you support the staff recommendation for how LSEs should utilities the Reference System Portfolio in preparing their individual LSE IRPs? Why or why not?

16. Do you agree with the above-described relationship between the Reference System Portfolio and the GHG Planning Price? Why or why not?

Yes, UCS believes that applying a straight line to the planning price over time will protect against the need to procure a large quantity of clean resources in the last few years to meet the carbon target.

17. Do you support the staff recommendation for calculating and assigning a GHG Emissions Benchmark for LSEs to use in preparing their individual LSE IRPs? Why or why not? Would you recommend an alternative means of developing a similar benchmark? Explain.

Yes. UCS believes that using a GHG Emissions Benchmark for each LSE will provide a simple way to identify whether the sum of emissions associated with all LSE plans are on track to be equal to or less than the total GHG emissions associated with the Preferred System Plan.

18. Do you support the staff recommendations for requiring IOUs filing Standard IRPs to submit revenue requirement and system average rate forecasts to evaluate the impact of IRP costs on ratepayer costs of the IRP process? Why or why not?

UCS has no comments at this time.

19. Are there additional components that would need to be explored in order to develop a more comprehensive approach to conducting ratepayer impact analysis in later IRP cycles, for both IOUs and other LSEs? Explain.

UCS has no comments at this time.

20. Do you agree with the proposed requirements for LSEs to address the impact of their IRPs and any planned procurement on disadvantaged communities?

Yes, UCS agrees with the proposed requirements on LSEs to describe how GHGs and criteria air pollutants will be reduced in disadvantaged communities and how opportunities for local economic development will be advanced. LSEs should be required to calculate the amount of

GHGs and air pollutants associated with gas generation in their service territories, and these emissions calculations should include emissions associated with cycling as well as starting up and shutting down. In addition, UCS would like to see individual IRP plans analyze how to reduce natural gas plant cycling as a way to reduce local air pollution.

21. Should the Commission raise the RPS compliance requirement for 2030 and/or intervening years for all LSEs?
a. If so, to what percentage? b. If so, in this proceeding or as a recommendation to be considered in the RPS rulemaking (or another venue: please specify)?

Please see UCS's response to Question 22.

22. Should the Commission require additional renewable procurement outside of the RPS program? Why or why not? If so, how? If so, at what level? If so, from whom?

At this time, UCS does not believe it is necessary to raise the RPS compliance requirement for all LSEs. However, given that RESOLVE results indicate it will be necessary for LSEs to collectively procure more renewables than what's required under the 50% RPS to meet the 42 MMT cap, the Commission should make it very clear that if LSEs *do not* plan to exceed their RPS requirement, they should be expected to present extremely compelling evidence in their IRPs proving that they can procure no more than 50% renewables and still contribute their appropriate share of GHG emissions reductions to the statewide cap.

UCS believes the Commission should consider requiring certain LSEs to procure additional renewables before the expiration of the PTC and ITC. The RESOLVE results clearly indicate there is economic value to procuring wind and solar before the federal tax credits expire. In addition, the state will need more electricity from carbon-free resources than what is currently expected under the 50% RPS. Pacific Gas and Electric Company ("PG&E") expects to retire Diablo Canyon at the end of 2025. That plant is currently providing the state with approximately

18,000 GWh of GHG-free electricity each year. UCS hopes that a sizable portion of the electricity demand created by the loss of Diablo can be mitigated with stronger energy efficiency measures. Nevertheless, some additional procurement will be needed to backfill the loss of Diablo, and PG&E has made a public commitment to backfill that need with carbon-free resources. Given the significant cost savings associated with procuring wind and solar in the next year while the ITC and PTC are still at current levels, UCS believes the Commission should seriously consider the ratepayer benefits of requiring LSEs responsible for serving load that would have otherwise been served by Diablo to procure additional renewables before the PTC and ITC expire.

23. Should the Commission initiate activities with the CAISO or other to investigate further development of out-of-state wind? Why or why not? If so, what specific steps should be taken? Should out-of-state wind be included in a special study or as apart as a policy-driven scenario for TPP? Why or why not?

UCS supports the Commission initiating activities with the CAISO to further investigate out-of-state wind development because the RESOLVE results indicate that these resources are cost-effective and have a resource diversity benefit that helps with renewable energy integration. Out-of-state wind could also be an important hedge if solar PV prices increase as a result of federal tariffs.[15] UCS does not have an opinion regarding whether this discussion should occur as part of a special study or a scenario for the TPP, but believes it's worthwhile for the Commission to identify how current RPS portfolio content category requirements might be modified to facilitate the development of out-of-state wind for RPS compliance.

24. Should the Commission utilize the GHG Planning Price as an input to the IDER avoided cost calculator, as described in this ruling?

[15] *See* http://fortune.com/2017/09/22/solar-costs-tariffs/

Yes. UCS supports using the same GHG Planning Price for the IRP and the IDER avoided cost calculator.

25. If the Commission were to engage in development of a CRVM:
a. What resource areas should be prioritized for incorporation into the CRVM?

UCS is not yet sure whether the Commission should develop a common resource valuation methodology (CRVM) for future IRP cycles. On one hand, UCS believes it is a good idea to strengthen the link between insight gained in the IRP process and actual procurement activities. It would be a missed opportunity and significant waste of resources if actual procurement decisions did not reflect the Commission's Preferred System Plan. On the other hand, developing a CRVM that adequately reflects the value transmission-level and distribution-level resources, can account for local capacity needs on the system, and reflects current market conditions on cost and performance sounds extremely complicated. UCS suggests the Commission expand on its ideas for how to develop a CRVM in a workshop setting before stakeholders are asked to engage on the details of setting up a CRVM.

b. Do you have specific recommendations for the appropriate structure of a CRVM?
c. What would be the appropriate application of such a method?

UCS does not have comments on these follow-up questions at this time, but hopes to have thoughts to offer once the Commission has expanded on its ideas in a workshop.

26. Should the Commission initiate activities with the CAISO or others to analyze the type and viability of the natural gas fleet? What activities should be undertaken and why?

UCS believes the Commission should work with the CAISO to determine which gas plants and gas plant attributes are *most and least* valuable to an increasingly decarbonized electricity system. Understanding where gas is least valuable is equally as important because it will help

the Commission and LSEs focus on procurement activities to cost-effectively provide cleaner grid services instead of continuing to rely on natural gas generation.

UCS used GridPath to examine the extent to which gas capacity would retire if fleet types could do so because it's most cost effective for the system, because this functionality does not exist in RESOLVE. Our results indicate that gas capacity retirement is cost effective in all GHG cases, especially with respect to peaker capacity (See Table 3). Therefore, the Commission should use GridPath, or improve the functionality of RESOLVE so that it can quantify the potential of cost-effective gas retirement and understand the impacts of this retirement on the need to make additional resource investments.

For reasons already stated in these comments, any analysis of gas fleet attributes and value should not be solely in the context of an electricity grid with a 42 MMT GHG cap, but also investigated in the context of lower GHG emission scenarios, including one that plans for zero GHG emissions in the electricity sector by 2045.

This type of analysis can start by looking at fleet attributes, but ultimately needs to drill down to individual plants, since the most challenging services to provide without gas could be local capacity services. And, since demand-side and distribution-level resources may be very well-suited to provide local grid services, the Commission must ensure that any analysis on this topic adequately captures the value that demand-side and distribution-level resources could provide.

27. Please comment on the slides in Attachment A titled "Path to Future All-Resource Planning" with respect to the following: Are any of the conclusions, implications, or action items inappropriate?

UCS is pleased that the Commission, in the "Path to Future All-Resource Planning" section of Attachment A, is acknowledging and addressing the current limitations of the IRP modeling to

optimize demand-side resources. UCS believes it's especially helpful that the Commission has pointed out that demand-side resources might not appear to be the most cost-effective ways to provide system-level grid services, but more work needs to be done to determine the value of certain resources in local areas. One of the questions coming out of the IRP for UCS is the role of future IRPs in reducing GHG emissions associated with local grid reliability services. How can the IRP better address these questions?

UCS does not see anything in the Commission's conclusions, implications, and action items that it would consider inappropriate. However, UCS believes the Commission's conclusion that the best way to reduce localized air pollution in disadvantaged communities is to simply focus on reducing CCGT use maybe premature. It's true that there is more CCGT installed capacity in disadvantaged communities than peaker plants. However, UCS does not believe the IRP modeling so far has adequately analyzed the air quality implications of natural gas on the system for several reasons. First, as UCS points out in its response to Question 1, RESOLVE's assumption that all of the CCGTs and peakers in the 2018 will be available in 2030 is overly optimistic (see Question 1). Second, RESOLVE did not account for NOx emissions associated with stopping/starting gas plants. Therefore, UCS believes its premature for the Commission to conclude anything about what will be most effective method for reducing air pollution from gas plants in disadvantaged communities. Since UCS's GridPath analysis suggests significant retirement in the peaker fleet by 2030, UCS suggests that the Commission more thoroughly analyze the impact of peaker retirements on the system and how this dynamic may change the way remaining gas plants on the system are operated (with a focus on emissions associated with cycling and stating/stopping).

Are any conclusions, implications, or actions missing that the Commission should consider? Explain.

If the Commission were not operating under such a tight timeline for the first IRP cycle, UCS would suggest that RESOLVE be modified to accommodate economic retirement of natural gas for the reasons we provide in these comments. Assuming all natural gas capacity in 2018 will remain online through 2030 is a blind spot that hinders the ability of the Commission and stakeholders to identify how to most cost-effectively phase out gas and replace it with other resources. But since UCS does not believe there is adequate time to address this issue in RESOLVE in the current IRP timeline, UCS urges the Commission to address this issue as soon as possible for the next IRP.

28. Please comment on any aspect of the staff proposal included as Attachment E to this ruling. Explain the reasoning behind any recommended revisions. Please organize your comments according to the major topics of the proposal.

UCS is confused about why the Commission is proposing to use the SERVM production cost model to evaluate whether scenarios meet the Planning Reserve Margin ("PRM") requirement. It is UCS's understanding that the PRM was not a binding constraint in any of the 42 MMT cases. If that is the case, then using the PRM to determine whether any system reliability-driven additional procurement is necessary may cause the Commission to ignore other very important aspects of operational performance and grid reliability that should be addressed in the IRP.

29. Please comment on the results and recommendations from the CES-21 grid integration project final report filed on September 12, 2017 in this proceeding. The Commission seeks comment on: a. The technical merits of the analytical framework used in the CES-21 project, b. What aspects of the CES-21 project (e.g., directional findings or recommendations, or the modeling techniques) can be used to improve the staff proposal in Attachment E, in the current or future IRP proceedings, and how.

UCS has no comments at this time.

Respectfully submitted,

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October 26, 2017