INVESTIGATING A HIGHER RENEWABLES PORTFOLIO STANDARD IN CALIFORNIA: *SUMMARY*

This study is the first comprehensive effort to assess the operational challenges and potential solutions, costs, and greenhouse gas (GHG) reductions associated with a renewables portfolio standard (RPS) greater than 33% in California. The report examines scenarios that combine a 40% or 50% RPS with 7000 MW of behind the meter distributed generation in 2030. The renewable resource portfolios assessed represent a significantly higher penetration of wind and solar than has been achieved anywhere in the world.

The study, conducted by Energy and Environmental Economics, Inc. (E3) with support from DNV KEMA and ECCO International, was funded by the Los Angeles Department of Water and Power, Pacific Gas and Electric Company, the Sacramento Municipal Utility District, San Diego Gas & Electric Company, and Southern California Edison Company. An independent advisory panel of experts from industry, government and academia reviewed the reasonableness of the assumptions, provided input throughout the project, and published an independent review of the study. The California Independent System Operator (CAISO) also provided input on key study assumptions.

This study is part of an ongoing effort to evaluate strategies to achieve long-term GHG reductions in California. It builds upon analysis conducted by E3 for the CAISO in support of the California Public Utility Commission's examination of renewable integration needs in its 2012 Long Term Procurement Planning proceeding (R.12-03-014). This work also complements ongoing work by E3 and others to explore pathways to GHG abatement in 2030 and beyond.

The study finds that significant renewable integration challenges are likely to emerge at an RPS above 33%. The most important challenge is overgeneration during daylight hours. Overgeneration occurs when "must-run" generation—

non-dispatchable renewables, combined-heat-and-power (CHP), nuclear generation, run-of-river hydro and minimum levels of thermal generation needed for grid stability—is greater than load plus exports. The study shows that overgeneration is most likely during spring and fall, but can occur in any month. Scheduled curtailment of renewable energy production is shown to be a critical strategy to ensure reliable operations, by avoiding overgeneration and reducing the frequency of extreme generation ramping events.

The study also examined a number of other potential renewable integration solutions. The most valuable are those that can reduce overgeneration over a multi-hour period when the system experiences low load conditions and high renewable generation. These include enhanced regional coordination, a diverse portfolio of renewable resources, energy storage, and advanced demand response that can adjust loads both upward and downward. Achievement of a higher RPS at least cost to electric customers would likely require implementation of a portfolio of integration solutions, with individual and collective actions required on an unprecedented scale. Timely implementation of these integration solutions is critical but would likely involve substantial challenges related to cost, feasibility, and siting. For example, to substantially mitigate the overgeneration observed in the 40% RPS Scenario would require an increase of 5,000 to 14,000 MW of integration solutions, and 15,000 to 25,000 MW in the 50% RPS Scenarios. As a point of comparison, the installed capacity of pumped hydro storage in California is roughly 3,000 MW.[1] The California Public Utilities Commission has set a target for an additional 1,325 MW of energy storage be online by 2024 (D.13-10-040). Furthermore, all scenarios assume that significant investments and upgrades to both the California electrical grid and the state's thermal fleet occur between 2013 and 2030. If

[1] See FERC licensed pumped storage projects, FERC staff, August 1, 2013, available: http://www.ferc.gov/industries/hydropower/gen-info/licensing/pump-storage/licensed-projects.pdf

these investments are not realized, the operational challenges and costs of meeting a higher RPS in 2030 might look very different than what is shown in this report.

The study also estimates the impact of a higher RPS on average utility rates and GHG emissions. Absent the implementation of integration solutions, the 50% RPS Scenarios are estimated to increase average electric rates within the five-utility study area by 9 to 23% in real terms relative to a 33% RPS in 2030 (under base case assumptions for natural gas, CO_2 and renewable energy prices). The solutions mentioned above are shown to help reduce these cost impacts by enabling a larger proportion of renewable energy output to be delivered to the grid. GHG emissions are estimated to be reduced by 14 to 15 million metric tons relative to a 33% RPS in 2030.

In addition to more extensive market and physical changes that would be needed to accommodate higher levels of RPS, the study suggests four near-term actions that California should pursue:

1) Increase operational and planning coordination with neighboring systems;
2) Procure a diverse portfolio of renewable resources;
3) Develop and implement long-term, sustainable solutions to address overgeneration; and
4) Implement solutions to reduce distribution system impacts from renewable distributed generation.

The need for additional research in a number of areas is also highlighted, including operational challenges at the sub-five-minute time step, the technical and market potential to achieve the identified renewable integration solutions, and the relative cost of GHG reductions through higher renewable penetration compared to other GHG mitigation measures.