DOCKETED

Docket Number:	17-EPIC-01
Project Title:	Development of the California Energy Commission Electric Program Investment Charge 2018 â€“ 2020 Triennial Investment Plan
TN #:	215869
Document Title:	Marc J Perez Comments: High Penetration Renewables in CA at Minimal Cost
Description:	N/A
Filer:	System
Organization:	Marc J Perez
Submitter Role:	Public
Submission Date:	2/10/2017 3:47:16 PM
Docketed Date:	2/10/2017

Comment Received From: Marc J Perez
Submitted On: 2/10/2017
Docket Number: 17-EPIC-01

High Penetration Renewables in CA at Minimal Cost

Additional submitted attachment is included below.

CALIFORNIA ENERGY COMMISSION
1516 NINTH STREET
SACRAMENTO, CA 95814-5512
www.energy.ca.gov

The Energy Commission is currently soliciting ideas and stakeholder input for the 2018 – 2020 EPIC Triennial Investment Plan. For those that would like to submit an idea for consideration in the 2018-2020 EPIC Triennial Plan, we ask that you complete the form below. Submittals are due by **5:00 p.m. on February 10, 2017.**

Part 1. Initiative Description and Purpose:

1. Please provide a brief description of the proposed initiative:

With the extraordinary recent growth of the solar PV and wind industries in California, it is paramount to address the biggest barrier to their high-penetration across the Californian electrical grid: the inherent variability of the solar and wind resources. To achieve very high PV and wind penetration, the imbalance between the variable supply of sunlight and demand must be alleviated. There are a number of solutions on the supply and demand-side which in concert stand to minimize the cost of achieving this high penetration. Solutions on the supply-side seek to match supply to demand and include: the widespread geographically distributed deployment and electrical interconnection (geographic dispersion) of PV and wind generation resources and smart generation curtailment (where solar or wind capacity is oversized and excess generation is curtailed at key times to minimize the need for storage.) On the demand-side, load shifting and other demand-side management strategies exist to (conversely) match demand to supply. Finally, electricity storage (where excess solar or wind generation is stored when it exceeds demand and is released when it it does not meet demand) functions as a hybrid supply and demand-side strategy. Research at the International Energy Agency shows that when the optimal mix of these aforementioned solutions is identified, the cost of meeting load with high-penetrations of PV is 80% cheaper in contrast to meeting the same load using energy storage uniquely.

This initiative would yield a high-level strategic plan for minimizing the environmental and economic costs of integrating high penetrations of variable renewables into the Californian energy mix. It would also yield a set of proposed regulatory and market policies that would guide California in this development direction.

2. What technical and/or market barriers would the proposed initiative help overcome? For scientific analysis and tools, what knowledge gaps would the proposed initiative help fill?

Current regulatory and energy market structures are insufficient for stimulating least-cost implementation of high penetrations of renewables. This is in part because rate structures are developed a-priori for cost recovery based on historical supply and demand. This lack of transparency to actual supply and demand conditions yields inefficiencies and creates a functional market barrier for implementation of some of the aforementioned supply and demand-side strategies in a high penetration renewables context. Furthermore, there is no regulatory policy which drives adoption of renewables and corresponding solutions in the most cost effective way.

Lack of planning regarding the siting and operation of energy storage, PV, wind, and demand-side-management will increase costs for Californians by significantly more than they could or should. This initiative will address this by identifying the least-cost mix of supply and demand-side solutions for integrating variable renewables at high penetrations, and proposing corresponding regulatory policy and market structures to achieve this goal.

Regarding scientific knowledge gaps, this proposed initiative will take a holistic look at each of the supply and demand side strategies possible. Theoretical studies have been run to identify the optimal mix of solutions to to just this at the International Energy Agency,Columbia University and the DOE but never before has this type of analysis been run for a state as large as California with stakeholder engagement. Further, never has this optimal mix, once identified, been coupled with research on corresponding regulatory and market structure policy that will help achieve this goal.

Part 2. Benefits and Impacts

3. If this initiative is successful, either fully or partially, what would be the expected impact? Who are the primary users and/or beneficiaries?

This initiative would address the central issue of integrating high penetrations of renewable electricity: the fact that a variable supply derived from the sun and wind does not match a variable demand. There are many different ways to address this issue without relying on increased out-of-state imports or fossil-fuel generation, the most conceptually easy to understand of which is energy storage. However, if only energy storage is used to bridge this supply/demand imbalance, the costs would be extraordinarily burdensome. This initiative seeks to identify the optimized basked of solutions which in concert will yield the lowest cost for all Californians. The expected impacts would be (1) identification of the technical path to cost minimization of high penetration renewables integration and (2) identification of suggested regulatory and market structures that would help California achieve this goal.

The main beneficiary of this research would be the Californian ratepayers as this initiative would yield a pathway to minimized costs on the aggregate while still achieving environmental goals.

4. Describe what quantitative or qualitative metrics or indicators would be used to evaluate the impacts of the proposed initiative:

The initiative would yield a high-level strategic plan for minimizing the environmental and economic costs of integrating high penetrations of variable renewables into the Californian energy mix. It would also yield a set of proposed regulatory and market policies that would guide California in this development direction.

The impacts of such an initiative could be measured by examining the difference in aggregate cost and ratepayer impact between a status quo scenario and a scenario in which regulatory and market structure policy are changed to mold the market into integrating the optimized basket of solutions identified to minimize cost. Costs could be contrasted both on an economic and environmental basis in both nominal ($, CO2-e) and relative ($/kWh, CO2-e/kWh) terms on a levelized and unlevelized basis.

5. Please provide a list of peer-reviewed references that support the responses for questions 3 and 4. Proposed initiatives that include peer-reviewed references will be given stronger consideration.

1) Perez, R., K. Rabago, M. Trahan, M. Perez (2016) Achieving Very High PV Penetration – The Need for an Effective Electricity Remuneration Framework and a Central Role for Grid Operators. Energy Policy 96:27-35.
2) Perez, R., M. David, T. Hoff, S. Kivalov.,J. Kleissl, P. Lauret & M. Perez. (2015) Spatial and Temporal Variability of Solar Energy. Foundations and Trends in Renewable Energy.
3) Perez, M.J.R. (2015) Geographic Dispersion and Curtailment of VLS-PV Electricity. IEA PVPS Task 8, Ch.4 Future Technical Options for the Entire Energy System.
4) Perez, M. J. R. (2014). A model for optimizing the combination of solar electricity generation, supply curtailment, transmission and storage. (Columbia University). ProQuest Dissertations and Theses, 246 pages.
5) Perez, M.J.R. & Fthenakis, V.M. (2013) Long-distance interconnection as solar resource intermittency solution: Optimizing the use of energy storage and the geographic dispersion + interconnection of solar generating facilities. Proc. IEEE PVSC 39th Photovoltaic Specialists Conference.
6) Perez, M.J.R. & Fthenakis, V.M. (2013): Optimizing the Mix of Energy Storage and Long-Distance Interconnection as Solutions to Solar Resource Intermittency at High Penetrations of PV on the Grid. Proc. ASES National Solar Conference.
7) Perez, R., Hoff, T., Perez, M.J.R. (2010): Quantifying the Cost of High Photovoltaic Penetration. Proc. ASES National Solar Conference, Phoenix, AZ.

6. (For technologies only) What competitive advantages does the proposed technology solution have over current benchmark technologies? If the technology is beyond the prototype stage, what strategies do you suggest to bring to scale?

N/A

Part 3. Connection to Energy Commission's EPIC Framework

Energy Commission staff have developed a draft strategic framework to guide the CEC's planning and implementation of EPIC across triennial investment cycles. One of the objectives of the draft strategic framework is to communicate a consistent set of priorities for organizing current and future EPIC investments.

7. Please indicate which of the following strategic framework themes you feel the proposed initiative best fits within:
    - Advance Technology Solutions for Deep Energy Savings in Building and Facilities
    - Accelerate Widespread Customer Adoption of Distributed Energy Resources
    - Increase System Flexibility from Low-Carbon Resources
    - Increase the Cost-Competiveness of Renewable Generation
    - Create a Statewide Ecosystem for Incubating New Energy Innovations
    - Maximize Synergies in the Water-Energy-Food Nexus
    - Develop Tools and Analysis to Inform Energy Policy and Planning Decisions
    - Catalyze Clean Energy Investments in California's Underrepresented and Disadvantaged Communities

If Other, Please Specify

This initiative largely seeks to develop tools and analysis to inform energy policy and planning decisions but it also seeks to increase the cost-competitiveness of renewable generation (at high-penetrations) and thereby accelerate the widespread customer adoption of DERs in a thoughtful and cost-effective manner.