NET ENERGY METERING EVALUATION

Draft Research Plan

Submitted to:
California Public Utilities Commission
Energy Division

Prepared by:

1111 Broadway
Suite 1800
Oakland, CA 94607
www.itron.com/consulting

DRAFT RESEARCH PLAN

Itron, Inc. (Itron) has been contracted by the California Public Utilities Commission (CPUC) Energy Division (ED) to perform an evaluation that examines the cost-effectiveness of distributed energy resource (DER) technologies taking service on net-energy metering (NEM) tariffs. This document summarizes ED's research questions and Itron's proposed technical approach to answering these questions.

I. BACKGROUND

California's NEM policies, beginning in 1995 with the original NEM tariff or "NEM 1.0," have encouraged the adoption of behind-the-meter (BTM) renewable DERs like solar photovoltaic (PV) systems, fuel cells, and distributed wind. Pursuant to Assembly Bill (AB) 327 (Perea, 2013), the CPUC adopted the current NEM structure, often referred to as "NEM 2.0" or "the NEM successor tariff," through the NEM 2.0 Decision (D.16-01-044) in January 2016.[1] NEM 2.0 went into effect in San Diego Gas and Electric Company's (SDG&E) service territory on June 29, 2016, in Pacific Gas and Electric Company's (PG&E) service territory on December 15, 2016, and in Southern California Edison Company's (SCE) service territory on July 1, 2017. Under NEM 1.0 and NEM 2.0, the three large California investor-owned utilities, or PG&E, SCE, and SDG&E (collectively, the "utilities"), have interconnected over 900,000 BTM PV systems representing approximately 8,000 MW_{AC} of capacity.

The NEM 2.0 Decision largely preserved the previously existing NEM structure with the rationale that ongoing efforts rolling out residential time-of-use (TOU) rates and determining the locational value of DERs could help inform the next iteration of the tariff, and therefore major changes would be premature at that time. The Decision also required the Energy Division to consider adjustments to the NEM 2.0 tariff in the future. Itron's NEM 2.0 evaluation will assist the CPUC in assessing PG&E's, SCE's, and SDG&E's NEM 2.0 tariffs by examining the effects of NEM 2.0.

II. STUDY OBJECTIVES AND KEY RESEARCH QUESTIONS

Itron will conduct an evaluation to review PG&E's, SCE's, and SDG&E's NEM 2.0 tariffs. The evaluation will include a cost-effectiveness analysis consistent with the Standard Practice Manual (SPM) and the CPUC Decision guiding cost-effectiveness evaluation of DERs (D.19-05-019).[2] The objectives of the evaluation are to examine the impacts of NEM 2.0 and to compare how different metrics have changed following the transition from NEM 1.0 to NEM 2.0. The evaluation will answer the following questions:

---

1 http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M158/K181/158181678.pdf

2 http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M293/K833/293833387.PDF

- What are the characteristics of systems installed under NEM 2.0?
- What are the characteristics of customers taking service under NEM 2.0?
- What have been the costs and benefits of the NEM 2.0 tariff to participating customers, to nonparticipating customers, Program Administrators, and to society as a whole?
- What is the utility's cost of service for different types of NEM 2.0 customers?
- Do different types of NEM 2.0 customers pay more or less than the cost of providing them electricity service before and after they install NEM systems?
- How have answers to the above questions changed from NEM 1.0 to NEM 2.0?

To complete this analysis, Itron will examine the following:

- Capacity of systems installed
- Solar PV and storage system design specifications (e.g., duration, tilt, and azimuth)
- Capacity factor of systems during 4pm – 9pm peak
- Number of systems paired with energy storage and capacity of paired storage
- Number of systems capable of safely islanding from the utility grid during an outage in order to provide backup power to the customer
- Typical generation profiles for systems paired and not paired with energy storage
- TOU rates chosen by customers
- Utility costs (e.g., billing, administrative, and interconnection upgrade costs)
- Adoption rates
- Bill savings
- Expected payback period and internal rate of return after installing DERs
- Demographics of customers, including income level and race/ethnicity
- Geographic distribution of systems, including an analysis of the number of installations in Disadvantaged Communities as identified by the California Communities Environmental Health Screening Tool (CalEnviroScreen)[3]

[3] https://calepa.ca.gov/envjustice/ghginvest/

- Number of DER manufacturers, project developers, and installers in California

III. SUMMARY OF APPROACH

The NEM 2.0 evaluation will be divided into three main areas:

1. **Analysis of NEM 2.0 systems.** Itron will collect utility interconnection data to define the population of NEM systems interconnected through the end of 2019. This will allow us to answer questions like: Are systems installed under NEM 2.0 materially different from NEM 1.0 systems in size, orientation, or otherwise?
2. **Cost-effectiveness analysis of NEM 2.0.** Itron will build a model that quantifies the cost-effectiveness of NEM 2.0 for participants, non-participants, Program Administrators, and society based on the Standard Practice Manual tests and consistent with CPUC D.19-05-019. Two additional sub-tasks will feed into this analysis:
    a. **Analysis of generation and storage charge/discharge data.** Itron will leverage existing data sources and simulation tools to quantify the capacity factor of systems during the 4pm – 9 pm peak TOU period and develop typical DER generation profiles with and without energy storage for use in the analysis.
    b. **Clustering analysis of utility billing and interval load data.** Itron will apply clustering algorithms and other machine learning techniques to develop a set of residential and nonresidential load profiles that are representative of the statewide NEM 2.0 population to be used in the analysis.
3. **Cost of service analysis of NEM 2.0.** Itron will perform an analysis to compare the actual bill payments that NEM 2.0 customers make to the utility costs needed to serve the customers.

a. Analysis of NEM Interconnection Data

The first step will be to characterize the population of NEM 1.0 and 2.0 systems interconnected by PG&E, SCE, and SDG&E. We will first leverage the information publicly available through the California DG Statistics website.[4] Should additional information be needed, we will request it from PG&E, SCE and SDG&E, and develop a comprehensive statewide dataset for all systems interconnected on or before December 31, 2019. This dataset will form the basis of the NEM 2.0 evaluation.

4 https://www.californiadgstats.ca.gov/

System Characteristics

Part of this study will require developing an understanding of NEM system characteristics such as system size, tilt, azimuth, and mounting configuration. Some fields like system size are likely well populated in the interconnection datasets whereas others like tilt or azimuth may not be. We will attempt fill these gaps using additional data sources like program application databases in order to generate as robust a dataset as possible. This will allow us to quantify size and configuration differences between NEM 1.0 and NEM 2.0 systems.

Demographic Distribution

The demographic trends for NEM PV adoption will be based on the American Community Survey (ACS)[5] datasets available through the Census Bureau. Itron will cross map the location of each system in the interconnection dataset to the census tract that shares demographic indicators over a relatively homogenized population. The data contain several key indicators relevant to solar adoption such as:

- Median household income
- Median home value
- Home ownership (as percent of owner-occupied units)
- Education (as percent of population over 25 years) with high school or higher and bachelors and professional degrees
- Median age
- Race (percent of non-white population including single race and more than two or more races)

Itron will also map the location of each system to the top 25 percent scoring census tracts identified by the CalEnviroScreen tool.[6] CalEnviroScreen identifies disadvantaged communities (DACs) that are disproportionately burdened by, and vulnerable to, multiple sources of pollution.

b. Cost-Effectiveness Analysis of NEM 2.0

i. Analysis of Generation and Storage Charge/Discharge Data

A key input in the cost-effectiveness analysis will be DER generation and storage charge/discharge shapes that are representative of real-world operations. For this analysis, we will leverage all available metered data sources (e.g., California Solar Initiative Impact Evaluation, Self-Generation Incentive Program Impact evaluation) to develop representative generation profiles of NEM 2.0 systems, as well

5 https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml

6 https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30

as charge/discharge profiles for systems paired with storage. This will help us develop a realistic depiction of how DER generation and storage charge/discharge is taking place relative to customer load and TOU retail rates.

ii. Clustering Analysis for Utility Billing and Interval Load Data

Hundreds of thousands of DER systems have been interconnected since PG&E, SCE, and SDG&E transitioned to NEM 2.0. Rather than model the cost-effectiveness of DERs for each customer, we will select a set of prototypical load shapes that represent the overall NEM 2.0 population. The NEM interconnection list will be combined with utility data to identify characteristics shared between customers to develop representative load shapes. Various combinations of these characteristics will be used to form groupings, or bins, of customers. The key characteristics that might define the bins include:

- Utility service territory
- Utility rate schedule or TOU period definitions
- Customer rate class or sector
- Location, such as California Building Climate Zone
- Gross annual consumption
- Fraction of gross consumption covered by PV system

We will combine the available data for customers within each bin to create sub-hourly generation and usage profiles. To create the representative profiles, we will first analyze NEM customer data to develop DG system performance profiles. Using the system installation characteristics, the PV_LIB modeling toolbox, and NSRDB[7] weather data, we will simulate performance for all solar PV systems (or groupings of systems with similar characteristics) for which metered data are not available for all years being evaluated.[8] For non-PV systems we will rely on historical SGIP data to develop representative generation profiles. We will use utility billing and AMI data to "true up" any differences between simulated generation shapes and actual performance. Once the system generation and charge/discharge profiles are created, we will develop gross consumption profiles for each representative bin by adding the DER profiles back to the net usage profiles. The difference between the gross consumption profiles and the net usage profiles represents the impact of the DER and the basis of the customer bill impacts calculations.

---

7 https://nsrdb.nrel.gov/

8 Itron will use PV_LIB toolbox to model solar PV generation. The PV_LIB Toolbox provides a set of well-documented functions for simulating the performance of photovoltaic energy systems. The toolbox was developed at Sandia National Laboratories. https://pvpmc.sandia.gov/applications/pv_lib-toolbox/

iii. Cost-Effectiveness Analysis

Following analysis of NEM interconnection, DER generation, storage charge/discharge, and utility AMI/load data, Itron will have developed a set of representative cases that will form the basis of Itron's cost-effectiveness analysis of the customer-sited DERs taking service under the NEM 2.0 tariff. Itron will customize a version of Itron's cost-effectiveness model used for SGIP battery storage cost-effectiveness to conduct the analysis.[9]

Itron's DER cost-effectiveness model was first developed in 2011 to evaluate the cost-effectiveness of all SGIP eligible technologies. It was updated in 2015 to reflect changes in technology costs and eligible technologies. In 2019 Itron updated the model again with an exclusive focus on energy storage costs and benefits.

Itron's DER cost-effectiveness tool is a highly flexible economic model that quantifies the various cash flows associated with the acquisition and operation of DERs including solar PV, solar thermal, combined heat and power (CHP), fuel cells, and energy storage. The model calculates the bill impacts of technologies throughout their lifetime and the associated acquisition costs including financing, insurance, and tax costs (or credits). Looking from different perspectives, the model will quantify the changes in the utility's marginal operating costs and will consider incentive payments and program administration costs. The model will quantify the present value of all cost and benefit streams for the entire life of the technology accounting for changes in retail rates, technology capital and operating costs, and changes in utility marginal costs.

For this analysis we propose making the following updates to the DER cost-effectiveness model:

- **Load shapes.** Residential and nonresidential customer load shapes will be selected to be representative of the NEM 2.0 population.
- **Retail rates.** We will select the most appropriate retail rates that represent the NEM 2.0 population.
- **Technology characteristics.** We will define the characteristics of NEM 2.0 systems installed at each customer location, including storage technology (e.g., lithium ion, flow battery), system size (kWh/kW), round trip efficiency (RTE), degradation rate, and capital cost assumptions.

9 Itron's cost-effectiveness model was most recently updated for the 2019 SGIP Energy Storage Market Assessment and Cost-Effectiveness Report. This report is pending release and the model is not yet publicly available. A complete description of the model and its functionality are included in the 2015 SGIP Cost-Effectiveness study: https://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=7889

- **Utility avoided costs.** We will update the model with the most recently approved and publicly available version of the CPUC avoided cost calculator to develop representative marginal costs for PG&E, SCE, and SDG&E.
- **Incentive program assumptions.** We will define the incentive levels offered by programs like SGIP and the implied program administration costs to closely match recent program actuals.
- **Global assumptions.** We will update marginal tax rates/credits, discount rates, and other financing assumptions.

The DER cost-effectiveness model's primary purpose will be to evaluate the cost-effectiveness of customer-sited resources under NEM 2.0 using the SPM tests including the total resource cost test (TRC), the participant cost test (PCT), the program administrator cost test (PA), and the rate payer impact test (RIM). Each test evaluates the tariff's cost-effectiveness from alternative perspectives, assessing the impact of the tariff on society, participants, Program Administrators, and non-participants. We will evaluate cost-effectiveness using 2019 as a base year and for the duration of the life of the systems.

Other Financial Metrics

Itron will ensure that the NEM 2.0 evaluation's cost-effectiveness analysis provides stakeholders with information on total and levelized savings and costs. The cost-effectiveness tool will develop estimates of the cost-effectiveness of systems installed under NEM 2.0 under a wide range of customer demographics, geographic strata associated with grid related cost constraints and solar system designs, system sizes, customer sizes, and utility rates. The stratification will be developed to highlight the range of cost effectiveness under the NEM 2.0 tariff.

The customized model will use information on system costs and the value of energy savings to develop estimates of payback periods and internal rates of return for NEM 2.0 systems. These data will provide additional information on the financial impacts of NEM 2.0 and help to describe the customers for whom the NEM 2.0 tariff is more cost-effective from the participant's perspective.

Energy, Bill, and Avoided Cost Savings

The customer's bill savings and avoided costs will be calculated based on the difference between the gross consumption shape without the DER and the net load shape with the impact of the DER. Itron will use the cost-effectiveness model's bill and avoided cost savings module to calculate energy and bill savings applying strata specific attributes of the NEM 2.0 tariff and utility rates.

Itron will collect information from the utilities on rates, interconnection fees, other interconnection costs borne by the customer (e.g., interconnection facility costs and interconnection upgrade costs for projects larger than 1 MW), and non-bypassable charges applicable to NEM 2.0 customers during the development of bill savings. Customers on NEM 2.0 are on TOU rates that vary by time of day and season. The bill savings analysis carefully accounts for the time of energy generation, valuing the energy at the time-varying rate. As part of the bill savings analysis, Itron will delineate the bill impact of TOU rates, demand charges, interconnection fees and costs, and non-bypassable charges.

Program Costs

Itron will reach out to the utilities to acquire program costs associated with implementing the NEM 2.0 tariff. Itron will request information on the incremental costs of setting up a NEM 2.0 billing account, any one-time incremental metering costs, and any interconnection costs borne by the utility. Itron will also request data on other integration costs associated with NEM 2.0.

PV and Storage Measure Costs

Itron will develop estimates of DER costs using information on the capacity and year of installation for customer-sited systems. Itron will undertake a limited literature search to refine our measure cost estimates. If NEM 2.0 has led to an increase in PV system sizing, an increase in the total cost of the system may be observed relative to previous NEM analyses. We will leverage publicly available sources like Lawrence Berkeley National Lab's "Tracking the Sun" report and SGIP application data, which includes limited cost information.[10]

For the modeling of the customer-sited resource cost-effectiveness, Itron will assume that customers are taking advantage of the federal investment tax credit. The investment tax credit will be modeled as a benefit to the customer.

c. Cost of Service Analysis

The cost of service analysis compares the utility cost of servicing NEM 2.0 customer with their bills. The cost of service is the total cost associated with the NEM 2.0 customer's net load based on the costs NEM 2.0 customers impose on the utility. Itron will use information from the utility's General Rate Case (GRC), regulatory costs, and NEM customer incremental costs to help develop estimates of the cost of service for NEM 2.0 customers. The total cost of service has inputs or components that are similar to the cost-effectiveness analysis, but it also differs primarily in the avoided costs used in the cost-effectiveness analysis. The total cost of service estimates the cost of servicing the remaining or net load. The avoided costs used in the cost-effectiveness analysis are an estimate of the cost savings from the reduction in usage after becoming a NEM 2.0 customer.

[10] https://emp.lbl.gov/tracking-the-sun

The cost of service analysis will consider utility costs associated with NEM 2.0 customers' net load. The GRC costs of service are the largest component of these costs. GRC costs include generation, sub-transmission and distribution costs. Itron will work with the utilities to develop costs associated with each utility's GRC costs to ensure appropriate cost development. Additional costs of service include regulatory costs that are included in customer bills and incremental costs that are unique to NEM accounts. Incremental costs include interconnection and billing setup costs. Itron will work with the CPUC to develop appropriate scenarios associated with the cost of service analysis. These scenarios may be based on the use of net or gross load as was undertaken for the previous NEM cost of service analysis. The scenarios will be conducted to resolve uncertainty associated with whether cost components should reflect gross or net load. For costs that are based on quantity, such as generation costs, costs should be based on net. For costs that are based on potential usage, it may be better to use gross load. Itron will review scenarios using net as a low-cost case for transmission and distribution costs and gross energy as a high-cost case for these costs.

The cost of service will be compared to the customer bill costs. The billing costs will use similar components developed for the cost-effectiveness analysis. As with the cost of service, the customer bill cost will be based on the net load whereas the cost-effectiveness bill savings are based on the reduction in load associated with the DER generation possibly coupled with energy storage charge/discharge.

IV. PROJECT TIMELINE

The NEM 2.0 evaluation study will be completed and delivered to the CPUC ED no later than June 30, 2019. Below we provide various interim milestones leading up to the conclusion of the study:

- November 27, 2019 – draft research plan released
- December 6, 2019 – public workshop on draft research plan
- December 20, 2019 – informal comments due on draft research plan
- January 2020 – CPUC ED and Itron respond to comments on draft research plan
- January to February 2020 – Director of CPUC ED approves final research plan through letter to NEM service list
- TBD before June 30, 2019: Draft NEM 2.0 evaluation report
- TBD before June 30, 2019: Workshop on draft report
- On or after June 30, 2019: Final report and webinar on final report

V. INITIAL QUESTIONS FOR STAKEHOLDER COMMENT

1. What key characteristics should be used to form groupings, or bins, of customers?
2. What customer segments or demographics are important to examine in the cost-effectiveness analysis?
3. What are reliable sources of data for installed PV and energy storage costs?
4. Should PV_LIB (which implements NREL's PVWatts DC power model) be used to develop solar profiles?
5. Besides grid upgrade costs, are there other integration costs that should be considered in the cost-effectiveness analysis?
6. Regarding Itron's cost-effectiveness model used for SGIP battery storage cost-effectiveness, are there any inputs or assumptions that should be modified for this analysis?
7. What scenarios should be included in the cost of service analysis?