



# NEM 2.0 Lookback Study

Draft Report Webinar

August 20, 2020

# CPUC INTRODUCTION

Energy Division



# BACKGROUND

The NEM 2.0 Lookback Study

Phase I



**Backward look at NEM 2.0:**

*Cost-Effectiveness Analysis*

*Cost of Service Analysis*

*Demographic Analysis*

**Solar Consumer Protection  
Guide Focus Groups**

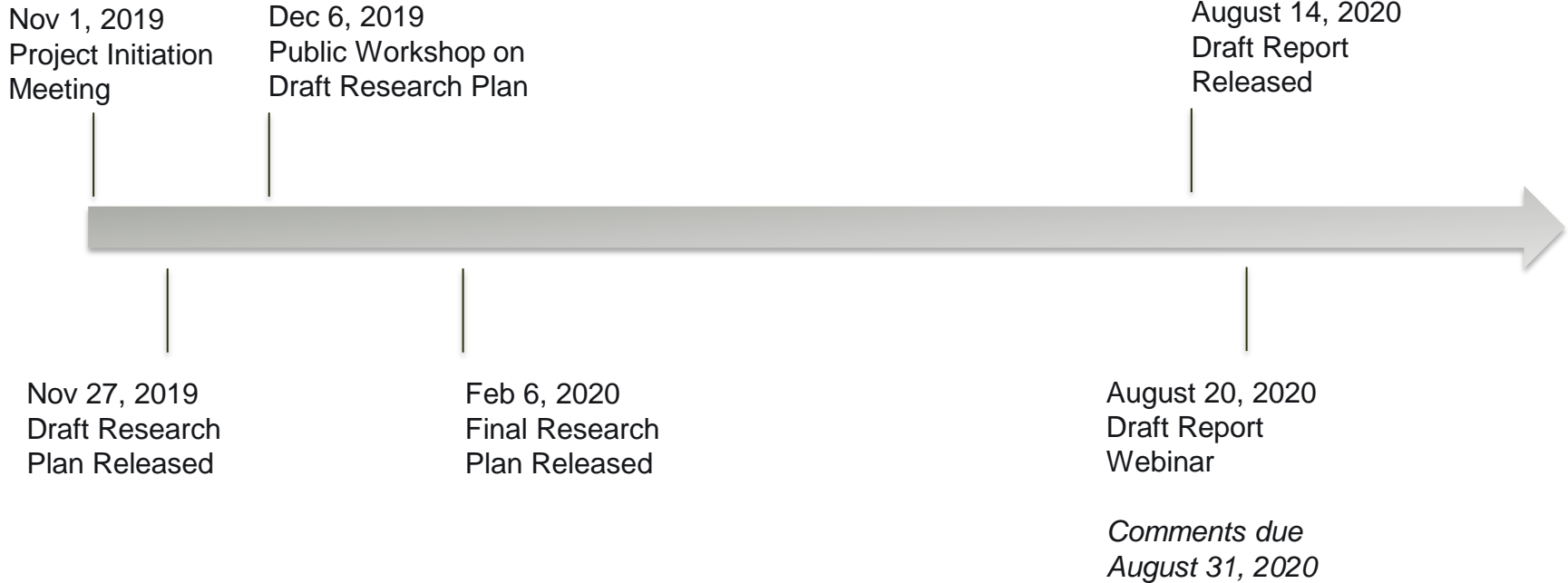
Phase II



**Forward look at NEM 2.0  
successor tariff**

# PHASE I DETAILED TIMELINE

The NEM 2.0 Lookback Study



# TODAY'S OBJECTIVES

## The NEM 2.0 Lookback Study

- » Walk through analysis approach, inputs, and assumptions
- » Present draft findings and results
- » Solicit feedback on inputs and approach
- » Discuss next steps

# DEFINITIONS

## What is NEM 2.0?

- » Customers who install small solar PV, solar PV + storage, and other renewable generation technologies to serve all or a portion of onsite electricity needs are eligible for NEM.
- » NEM allows customers who install eligible customer-sited renewable generation to receive a financial credit on their electric bills for any surplus energy fed back to their utility.
- » The current NEM program (NEM 2.0) was adopted by the CPUC in Decision (D.) 16-01-044 on January 28, 2016 and is available to customers of PG&E, SCE and SDG&E.

# DEFINITIONS

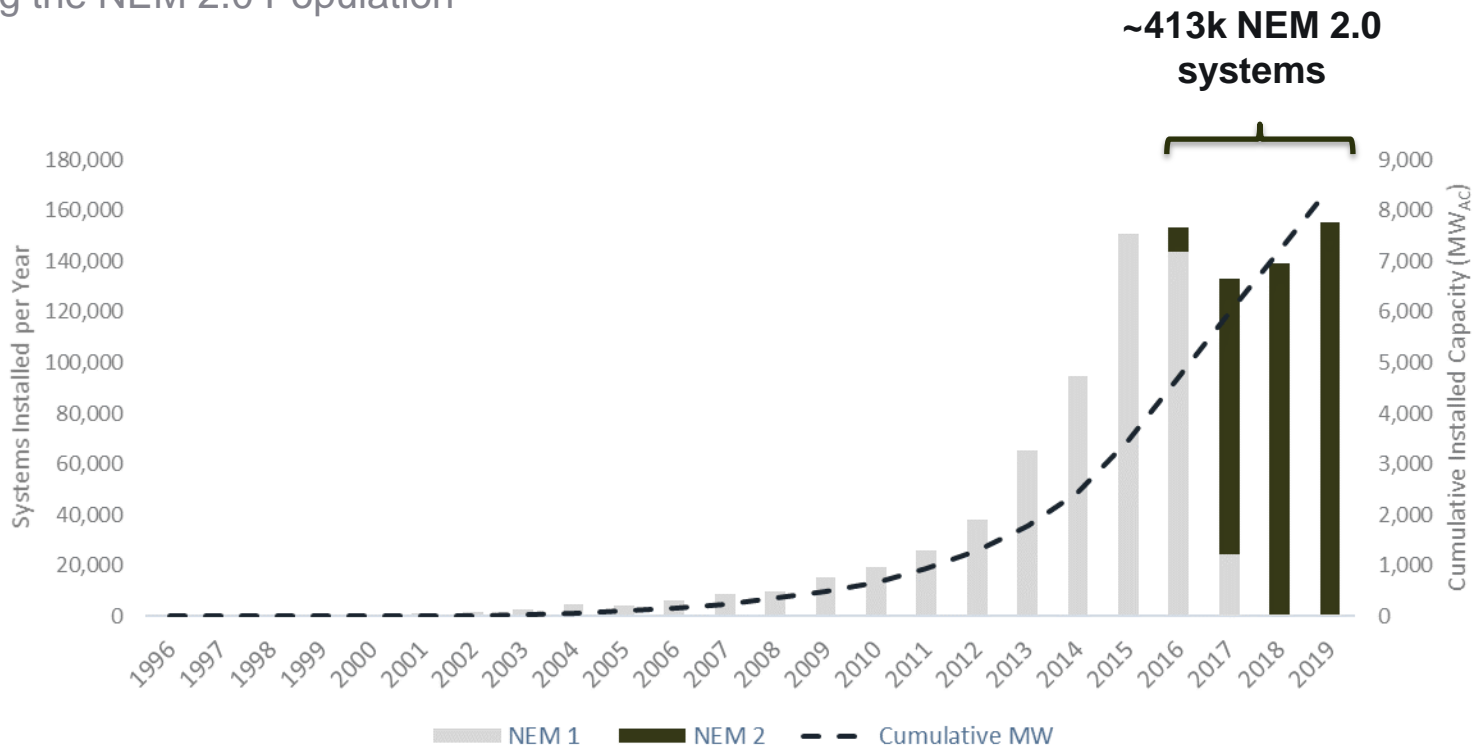
## What is NEM 2.0?

» Any customer-generator applying for NEM 2.0 will:

- Pay a one-time interconnection fee.
- Pay non-bypassable charges on each kilowatt-hour (kWh) of electricity they consume from the grid.
- Transfer to a time-of-use (TOU) rate.

# NEM POPULATION OVER TIME

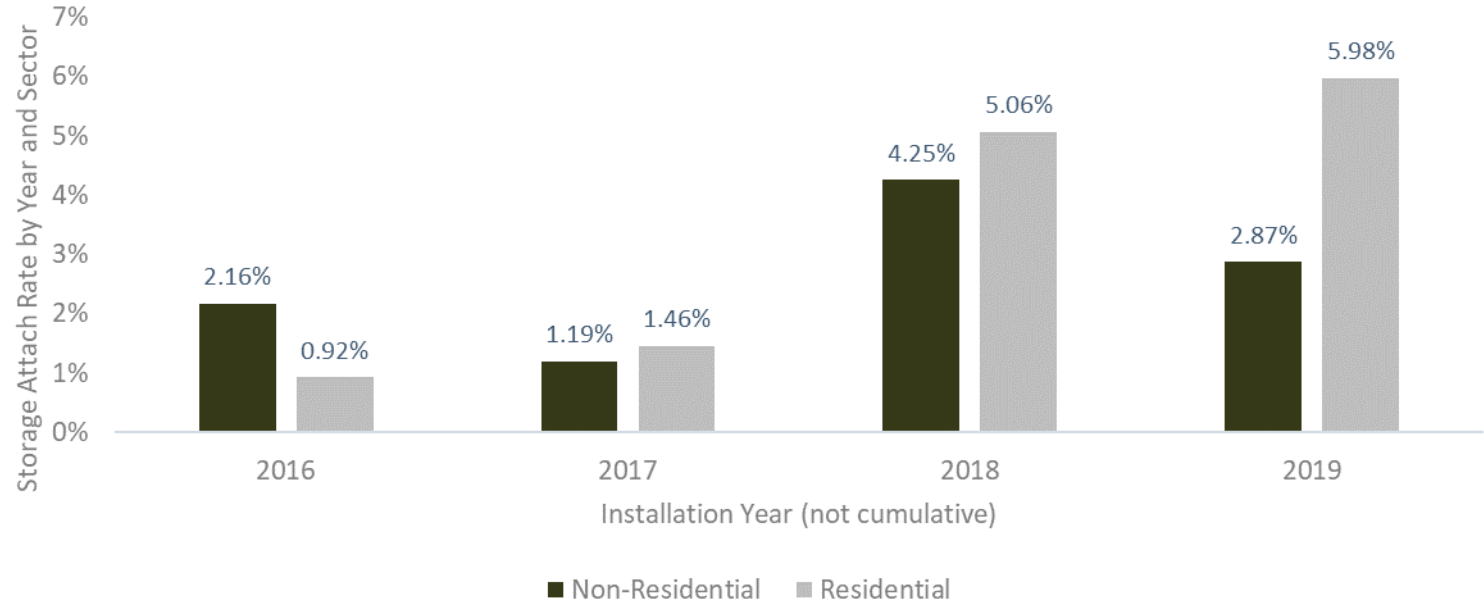
Defining the NEM 2.0 Population





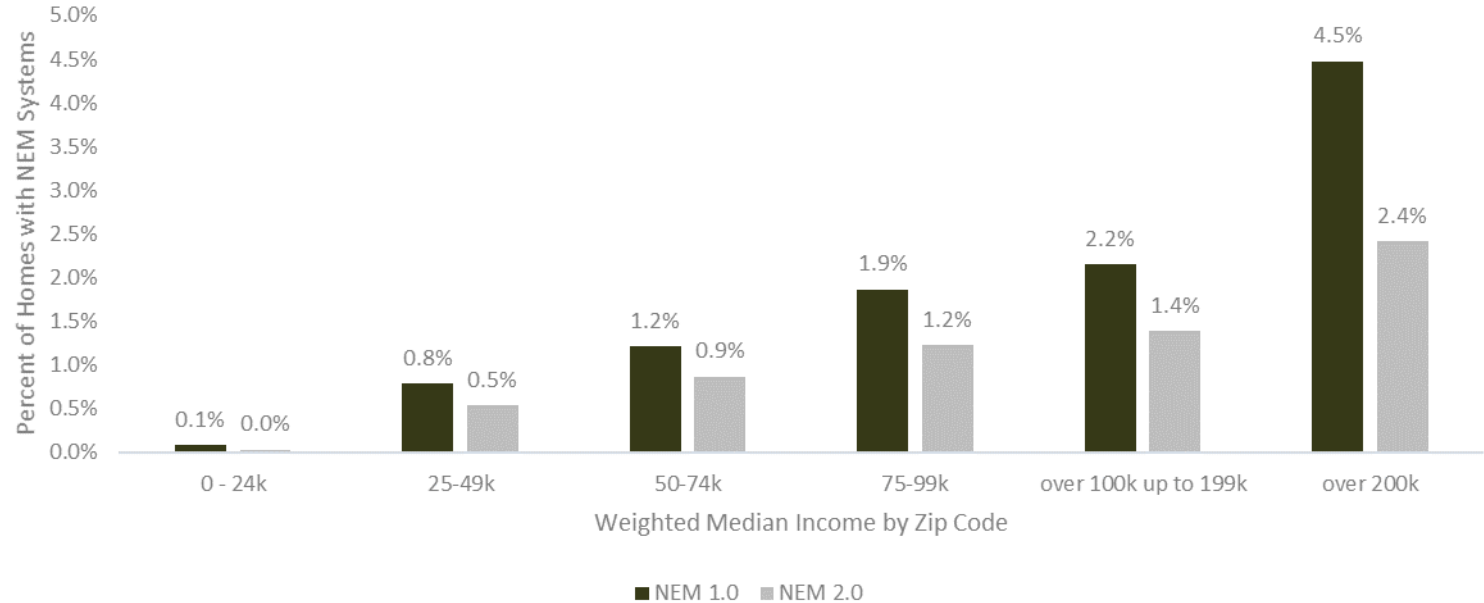
# NEM POPULATION OVER TIME

## Storage Attach Rate



# NEM POPULATION DEMOGRAPHICS

NEM 1.0 vs NEM 2.0



# NEM SYSTEM SIZES

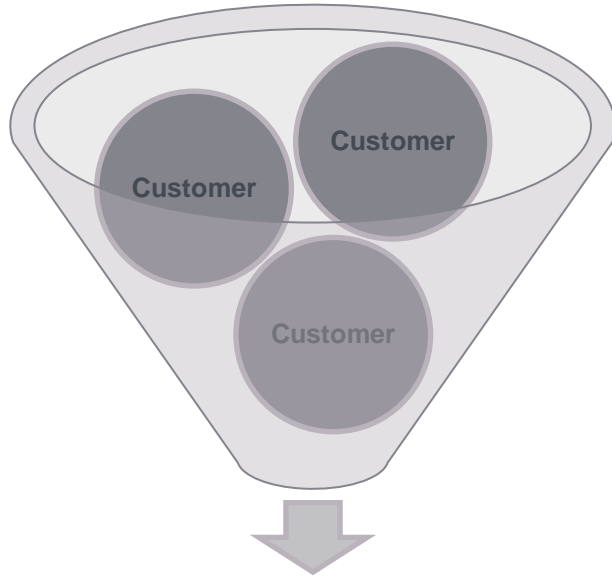
NEM 1.0 vs NEM 2.0 – Residential

| <b>NEM Program</b> | <b>Metric</b>   | <b>PG&amp;E Residential</b> | <b>SCE Residential</b> | <b>SDG&amp;E Residential</b> |
|--------------------|---|-----------------------------|------------------------|------------------------------|
| NEM 2.0            | Average Electricity Consumption                             | 9,735                       | 10,513                 | 8,764                        |
|                    | % Consumption Supplied by PV                                | 112%                        | 101%                   | 112%                         |
| NEM 1.0            | Average Electricity Consumption                             | 14,830                      | 16,118                 | 15,036                       |
|                    | % Consumption Supplied by PV                                | 63%                         | 63%                    | 69%                          |
| CA Statewide       | Average Consumption for Single Family Residential Customers | 7,545                       | 7,545                  | 7,194                        |

*Based on assumed 20% AC Capacity Factor and 12-month pre-interconnection consumption*

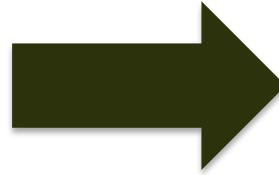
# NEM 2.0 LOOKBACK STUDY

Overview of Approach



Representative Customers

*NEM 2.0 Lookback  
Model*

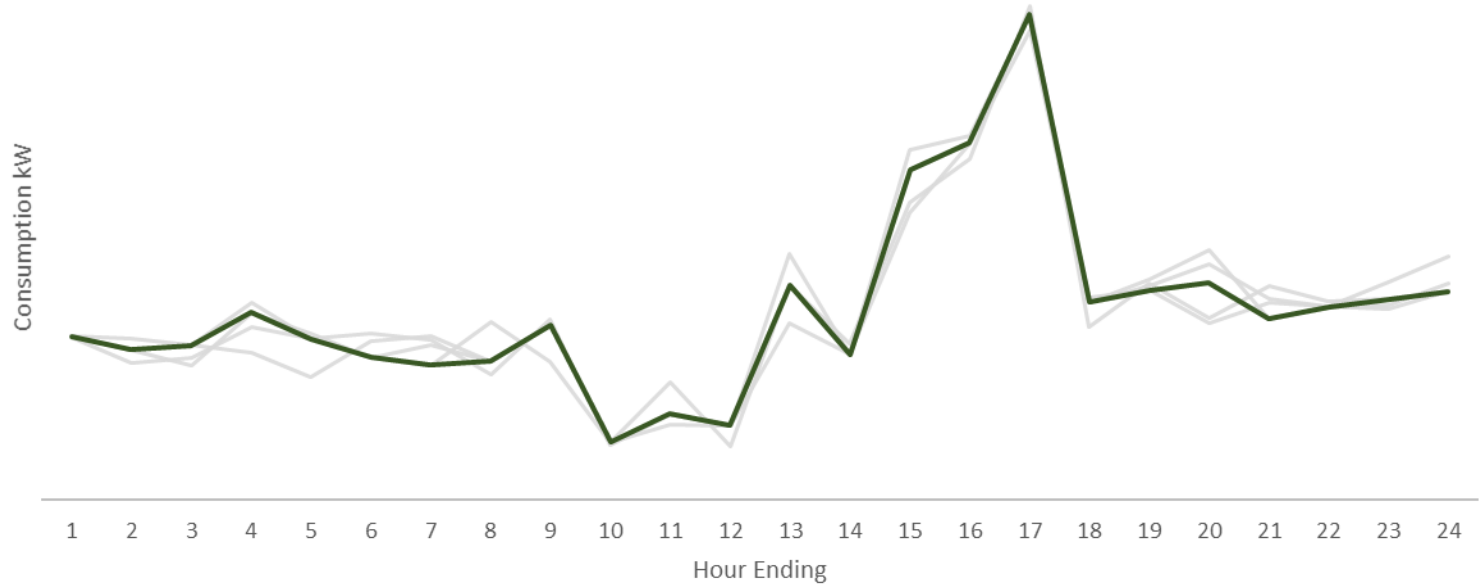


Cost-Effectiveness Estimate

Cost of Service Estimate

# NEM 2.0 LOOKBACK STUDY

Customer Binning / Clustering



# NEM 2.0 LOOKBACK STUDY

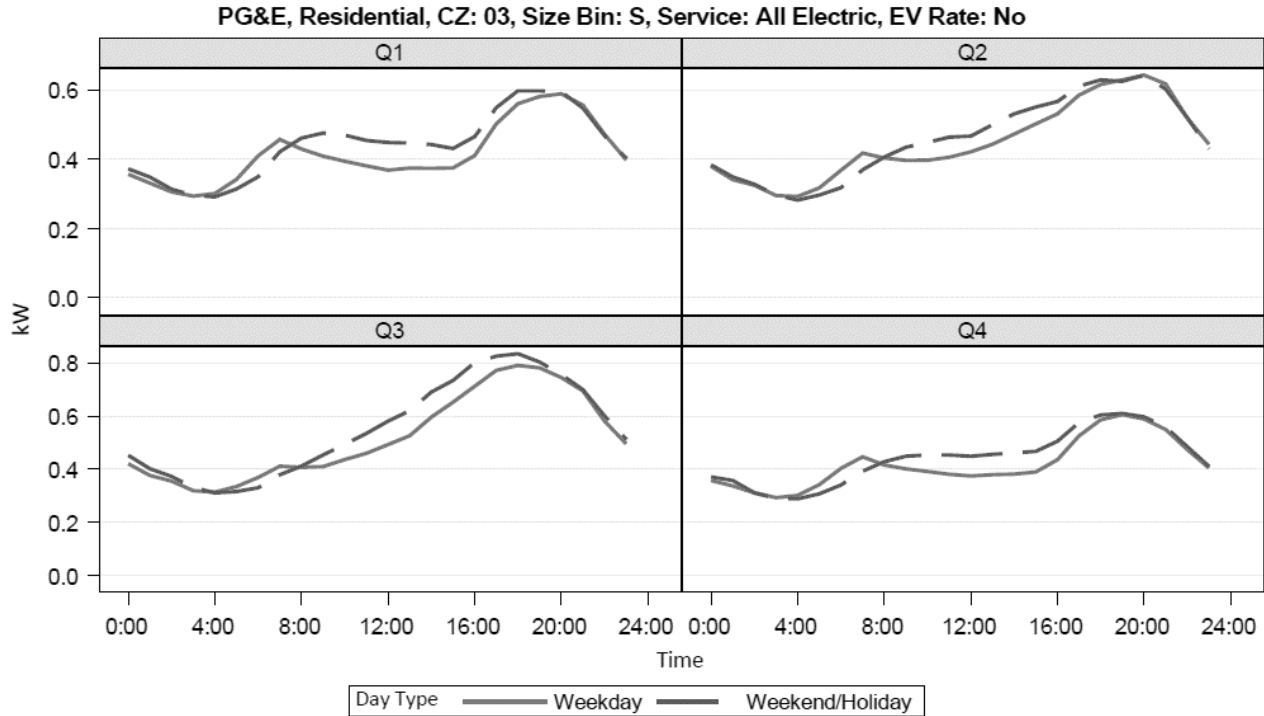
Customer Binning / Clustering

- » **Electric Utility:** PG&E, SCE, SDG&E
- » **Sector:** Residential, Commercial, Industrial, Agricultural
- » **Customer Size (Consumption)**
- » **Service Type** – Electric Only, Electric and Gas – Residential only
- » **Electric Vehicle (EV) Rate:** Residential only, not SCE

*Load shapes were adjusted to represent usage of underlying customers in bin*

# NEM 2.0 LOOKBACK STUDY

Customer Binning / Clustering Example



# NEM 2.0 LOOKBACK STUDY

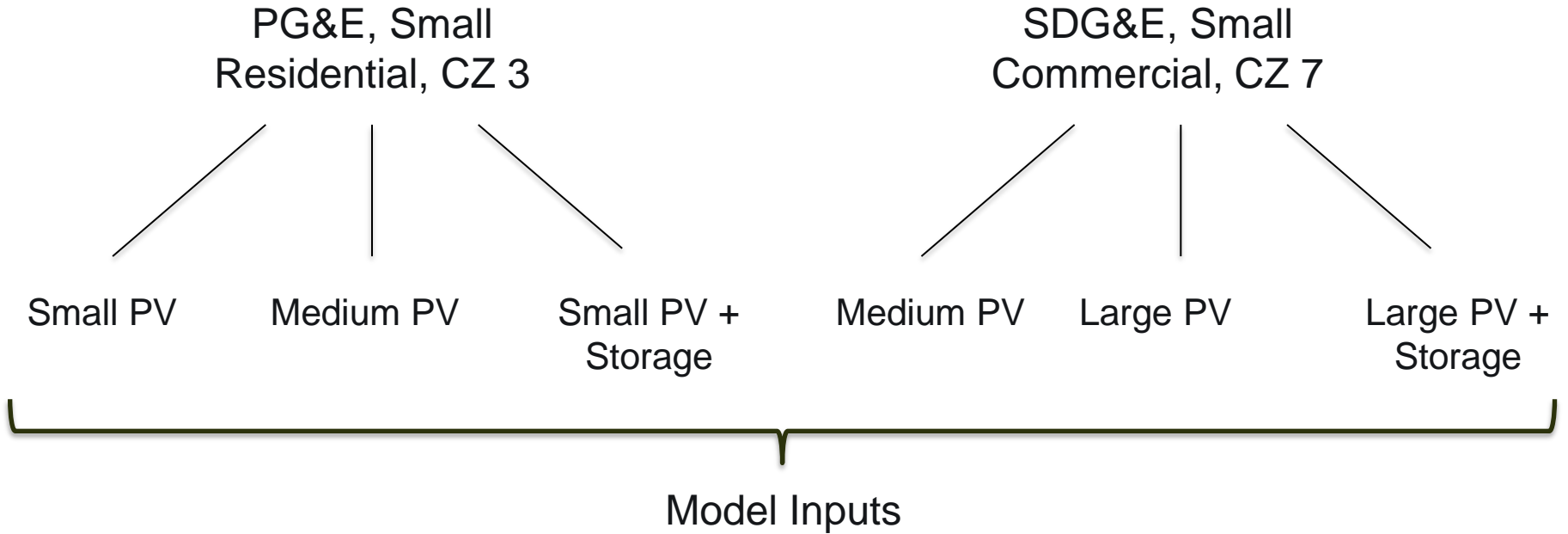
## Customer Binning / Clustering Summary

| Utility      | Number of Distinct Load Shapes |            |            |             |            |
|--------------|--------------------------------|------------|------------|-------------|------------|
|              | Agriculture                    | Commercial | Industrial | Residential | All        |
| PG&E         | 1                              | 23         | 2          | 57          | 83         |
| SCE          | 1                              | 18         | 7          | 24          | 50         |
| SDG&E        | 2                              | 12         | 2          | 53          | 69         |
| <b>Total</b> | <b>4</b>                       | <b>53</b>  | <b>11</b>  | <b>134</b>  | <b>202</b> |



# NEM 2.0 LOOKBACK STUDY

## Simulation Inputs



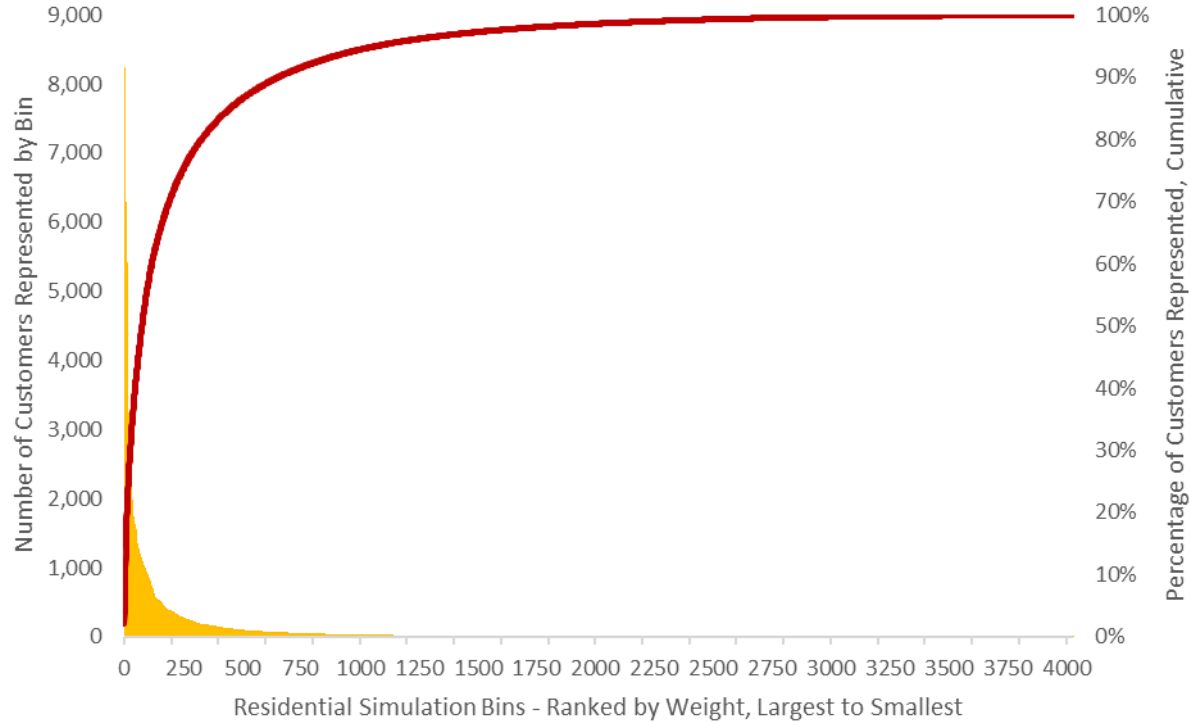
# NEM 2.0 LOOKBACK STUDY

## Simulation Inputs Summary

| Utility      | Number of Simulations |                    |          |           |              |
|--------------|-----------------------|--------------------|----------|-----------|--------------|
|              | Solar PV              | Solar PV + Storage | Wind     | Fuel Cell | All          |
| PG&E         | 1,546                 | 416                | 1        | 0         | 1,963        |
| SCE          | 1,086                 | 440                | 0        | 6         | 1,532        |
| SDG&E        | 1,059                 | 403                | 0        | 1         | 1,463        |
| <b>Total</b> | <b>3,691</b>          | <b>1,259</b>       | <b>1</b> | <b>7</b>  | <b>4,958</b> |

# NEM 2.0 LOOKBACK STUDY

## Simulation Inputs Summary



# NEM 2.0 LOOKBACK STUDY

## Analysis Overview

- » Cost-Effectiveness Analysis: What are the estimated costs and benefits attributed to NEM 2.0 on the margin?
  - Based on California Standard Practice Manual (SPM) tests
  - Utilizes CPUC Avoided Cost Calculator (ACC 2020 v1c)
  - Emphasis on bill savings
  
- » Cost of Service Analysis: What is the estimated marginal cost borne by the utility to serve a NEM 2.0 customer?
  - Based on estimates of utility marginal costs and total customer bills

# NEM 2.0 LOOKBACK STUDY

## Standard Practice Manual Tests

- » **Participant Cost Test (PCT):** Measure of the quantifiable benefits and costs to the consumer due to participation in the program.

### Benefits

Electricity Bill Savings

State Rebate (e.g., SGIP)

Federal Investment Tax  
Credit (ITC, 30%)

State/Federal Taxes

### Costs

Equipment Acquisition Costs  
(i.e., equity, financing,  
insurance)

# NEM 2.0 LOOKBACK STUDY

## Standard Practice Manual Tests

- » **Program Administrator (PA) Test:** Measures the net costs of a program as a resource option based on the costs incurred by the PA and excluding any net costs incurred by participants.

### Benefits

Electricity Avoided Costs

Interconnection Fee

### Costs

NEM Program Costs

# NEM 2.0 LOOKBACK STUDY

## Standard Practice Manual Tests

- » **Ratepayer Impact (RIM) Test:** Measures what happens to customer bills or rates due to changes in utility revenues and operating costs caused by the program.

### Benefits

Electric Avoided Costs

Interconnection Fee

### Costs

NEM Program Costs

Electricity Bill Savings

# NEM 2.0 LOOKBACK STUDY

## Standard Practice Manual Tests

- » **Total Resource Cost (TRC) Test:** Measures the net costs of a program as a resource option based on the total costs of the program, including both the participant's and the utility's costs.

### Benefits

Electric Avoided Costs

Federal ITC (30%)\*

### Costs

NEM Program Costs  
Equipment Acquisition Costs  
(i.e., equity, financing,  
insurance)

Federal Taxes



# NEM 2.0 LOOKBACK STUDY

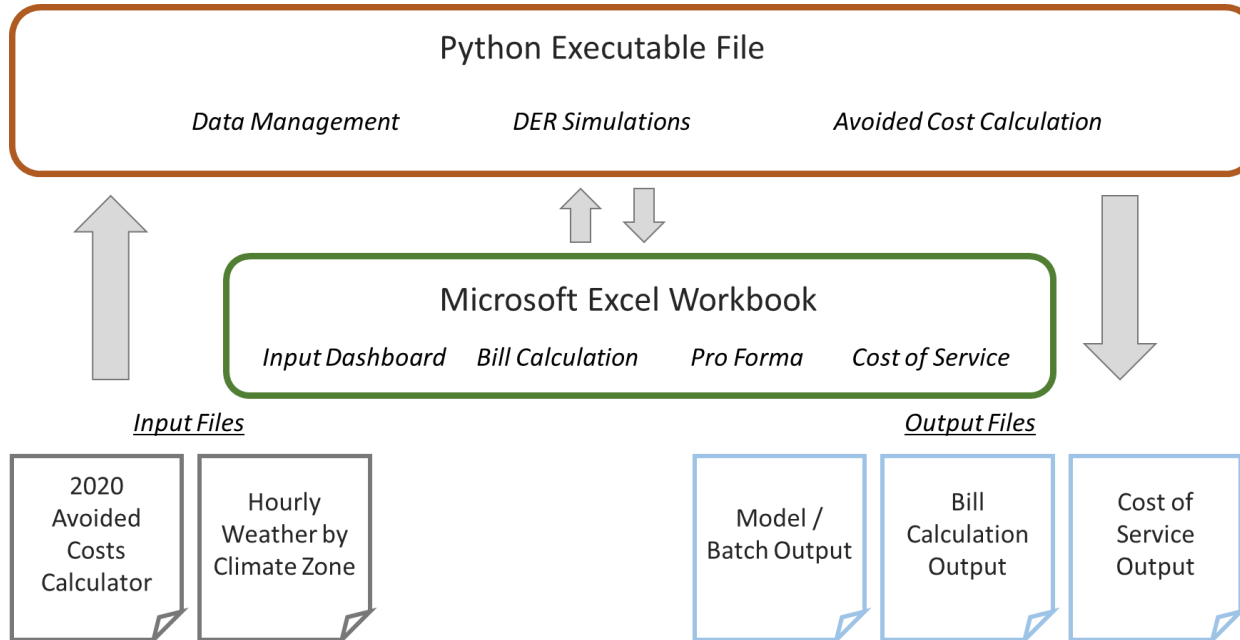
## Cost of Service Analysis

- » Calculated for first-year only
- » Comparison of estimate of total bill to estimate of cost to serve customer

$$\begin{aligned} \text{Full COS} = & MEC \cdot Load * EPMC(G) + MGCC \cdot GenerationAllocationFactor \cdot Load \cdot EPMC(G) \\ & + MDCC \cdot DistributionAllocationFactor \cdot Demand \cdot EPMC(D) + (T + Reg) \cdot Load \\ & + MCC \cdot EPMC(D) + NEMC \end{aligned}$$

# NEM 2.0 LOOKBACK STUDY MODEL

## Model Overview



# NEM 2.0 LOOKBACK STUDY MODEL

## Model Dashboard/Inputs

**Load Shape Input**  
 Select Load Shape ID: PGE\_A\_CZ\_ALL\_ALL

**Utility Rate Inputs**

|  |             |
|--|-------------|
| Utility                                  | PG&E        |
| IOU Baseline Territory / Climate Zone    | R - CZ 12   |
| Sector                                   | Residential |
| Customer Fuel Mix                        | B           |
| Retail Rate Escalator (Nominal)          | 4.0%        |
| CCA? (% reduction energy commodity rate) | No          |

**Utility NEM Costs**

|   |           |
|---|-----------|
| One-Time NEM Costs (\$/kW <sub>ac</sub> ) | 50.00     |
| One-Time NEM Costs (\$ / Customer)        | 51,056.00 |
| Ongoing NEM Costs (\$/yr)                 | 50.00     |
| Ongoing NEM Cost Escalator                | 2.00%     |

**Model Output**  
 Enter Case Description: Case1

**Weather Inputs (Lookup)**  
 Weather File Name CA\_SACRAMENTO-EXECUTIVE-AP\_724830S\_CT222.csv

**Run Case**      **Run Batch Mode**

**Current Directory**  
 P:\SDGENEM\_Eval\RateCalc

**Retail Rate Inputs**

| Year ->               | 1       | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       | 10      | 11      | 12      | 13      | 14      | 15      | 16      |
|-----------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Non-DER Baseline Rate | E-1     | E-1     | E-1     | E-1     | E-1     | E-1     | E-1     | E-1     | E-1     | E-1     | E-1     | E-1     | E-1     | E-1     | E-1     | E-1     |
| NEM DER Rate          | E-TOU-A | E-TOU-A | E-TOU-A | E-TOU-A | E-TOU-A | E-TOU-A | E-TOU-A | E-TOU-A | E-TOU-A | E-TOU-A | E-TOU-A | E-TOU-A | E-TOU-A | E-TOU-A | E-TOU-A | E-TOU-A |

**Global Technology Inputs**

|   |                    |
|---|--------------------|
| Technology Type                                   | Solar PV + Storage |
| NEM Generator Size (kW <sub>ac</sub> )            | 7.62               |
| NEM Generator Upfront Cost (\$/kW <sub>ac</sub> ) | \$3,700.00         |
| NEM Generator Useful Life (Yrs)                   | 25                 |
| Partial Equip. Replacement Cost                   | \$ 2,284.80        |
| Partial Equip. Replacement Time (Yr)              | 13                 |
| NEM Gen. Degradation Rate (Pct. kWh / yr)         | 1.36%              |
| O&M Cost (\$/kW <sub>hac</sub> )                  | 50.00              |
| O&M Cost Escalator (Nominal)                      | 2%                 |

**Solar PV Technology Inputs**

|                      |      |
|----------------------|------|
| Tilt (0° = Flat)     | 18.0 |
| Azimuth (0° = North) | 240  |

**Tax Inputs**

|                          |       |
|--------------------------|-------|
| Federal Tax Rate         | 24.0% |
| State Tax Rate           | 9.30% |
| Federal MACRS Term (yrs) | -     |
| State MACRS Term (yrs)   | -     |
| Apply Tax Credit?        | Y     |
| Tax Credit Rate          | 30%   |

**State DER Incentive (SGIP) Inputs**

|  |         |
|--|---------|
| Apply SGIP Incentive (Y/N)?                        | Y       |
| Storage Incentive Amount (\$/Wh <sub>ac</sub> )    | \$0.35  |
| Generation Incentive Amount (\$/Wh <sub>ac</sub> ) | \$0.60  |
| Incentive Payment Mechanism                        | Upfront |

**Financing and Insurance Inputs**

|                               |        |
|-------------------------------|--------|
| Percent Financed with Equity  | 20%    |
| Financing Period (Years)      | 25     |
| Years of Debt Service in DSRF | 1      |
| Cost of Debt                  | 4.50%  |
| Cost of Equity                | 25.09% |
| Insurance Expense Mult.       | 0.50%  |
| Insurance Escalator           | 2.00%  |

**Renewable Energy Credit (REC) Inputs**

|                  |   |
|------------------|---|
| Sell RECs (Y/N)? | N |
|------------------|---|

**Storage Technology Inputs**

|  |               |
|--|---------------|
| Storage Energy Capacity (kWh <sub>ac</sub> ) | 10.00         |
| Storage Inverter Size (kW <sub>ac</sub> )    | 5.00          |
| Storage RTE (AC-AC)                          | 80%           |
| Storage Upfront Cost (\$/kWh <sub>ac</sub> ) |               |
| Storage Export Allowed?                      | No            |
| Storage Operating Mode                       | TOU Arbitrage |

**Other Discount Rate Inputs**

|                                  |       |
|----------------------------------|-------|
| Weighted Average Cost of Capital | 7.50% |
| Utility Discount Rate            | 7.50% |
| Societal Discount Rate           | 5.00% |

# SOLAR PV MODELING

» Using **PV\_Lib** functions in Python

» **Inputs:** DC System Size, Tilt, Azimuth, Location, Annual Degradation Rate (1.36%)

1. Get solar position using `pvlib.solarposition` (time, Lat, Long, Elevation)
2. Get airmass parameters using `pvlib.atmosphere`
3. Calculate angle of incidence using `pvlib.irradiance.aoi`
4. Calculate total irradiance using `pvlib.irradiance.get_total_irradiance` (Haydavies model)
5. Calculate effective irradiance using `pvlib.pvsystem.sapm_effective_irradiance`
6. Calculate DC output using `pvlib.pvsystem.pvwatts_dc` (~14% DC losses)
7. Calculate AC output using `pvlib.pvsystem.pvwatts_ac`

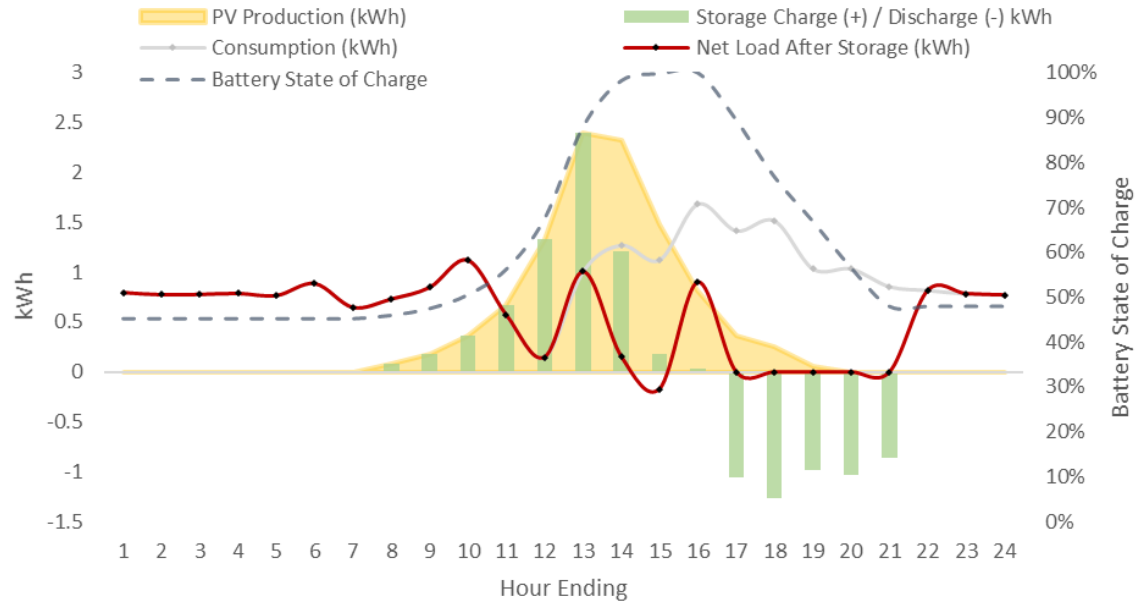
# SOLAR PV + STORAGE MODELING

» Modeled after the solar PV output

» Residential

» TOU Arbitrage

» No Export

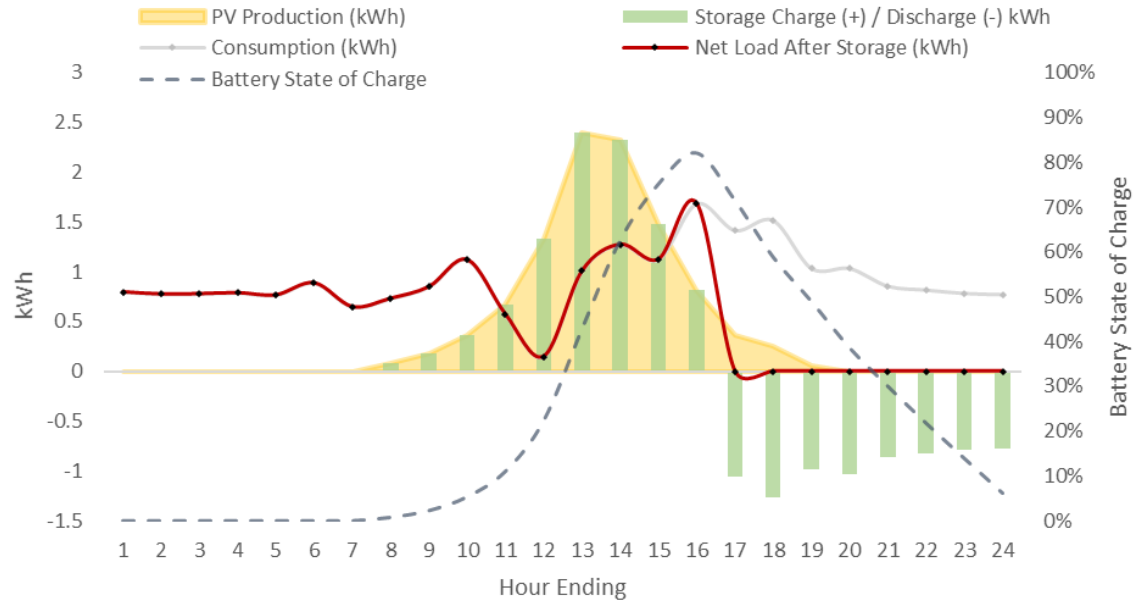


# SOLAR PV + STORAGE MODELING

» Modeled after the solar PV output

» Residential

» Self-Consumption



# OTHER DER GENERATION

- » Baseload generation technologies assigned 80% capacity factor
- » Distributed wind modeled using wind data in weather files

$$v_2 = v_1 \cdot \left(\frac{z_2}{z_1}\right)^\alpha$$
$$PowerkW(x) = \begin{cases} 0, & x \leq 3 \\ P_{MAX} - (12 - x) \left(\frac{P_{MAX}}{9}\right), & 3 < x \leq 12 \\ P_{MAX}, & x > 12 \end{cases}$$

# SOLAR PV COSTS

| <b>Sector</b>           | <b>Installed Cost 2018 \$/W</b> |                  |                 |
|-------------------------|---------------------------------|------------------|-----------------|
|                         | <b>Base Case</b>                | <b>High Cost</b> | <b>Low Cost</b> |
| Residential             | \$3.7                           | \$4.5            | \$3.1           |
| Small<br>Nonresidential | \$3.0                           | \$4.0            | \$2.4           |
| Large<br>Nonresidential | \$2.4                           | \$3.3            | \$1.8           |



# DER ACQUISITION AND FINANCING

- » Equity (20%)/Debt (80%) Financing
  - Financed for length of system life (25 years)
  - Cost of Debt 4.5% Residential / 6% Non-Residential
  
- » Federal MACRS Term: 1 Year
- » State MACRS Term: 5+ Bonus
  
- » Federal Tax Rate: 24% Residential, 21% Nonresidential
- » State Tax Rate: 9.30% Residential, 8.84% Nonresidential
  
- » 30% Federal Investment Tax Credit

# BILL CALCULATION

Inputs, assumptions

- » Two bills calculated for each analysis year:
  - Pre-NEM Baseline Bill (no customer-sited renewable generation)
  - NEM Bill (customer-sited renewable generator installed)
  
- » Non-Bypassable Charges assessed on all energy imported
  
- » 4% Retail Rate Escalation
  
- » Community Choice Aggregators: treated as a sensitivity. Model allows for a flat percentage discount on the energy commodity rate and the addition of PCIA

# BILL CALCULATION CONT.

Inputs, assumptions

- » Minimum delivery charge / monthly flat charge
- » California Climate Credit
- » Net Surplus Compensation (NSC) fixed at \$0.031/kWh
- » Six percent tax rate on total monthly charges

# RETAIL RATE TRANSITION ASSUMPTIONS

## » Residential customers:

- If not on a TOU rate prior to PTO then transitioned to TOU rate in 1-3 years depending on utility (baseline case)
- If on legacy rate, allowed 2-3 years to transition to non-legacy rate (NEM case)
- If on an EV rate, kept on an EV rate (baseline and NEM)

## » Nonresidential customers:

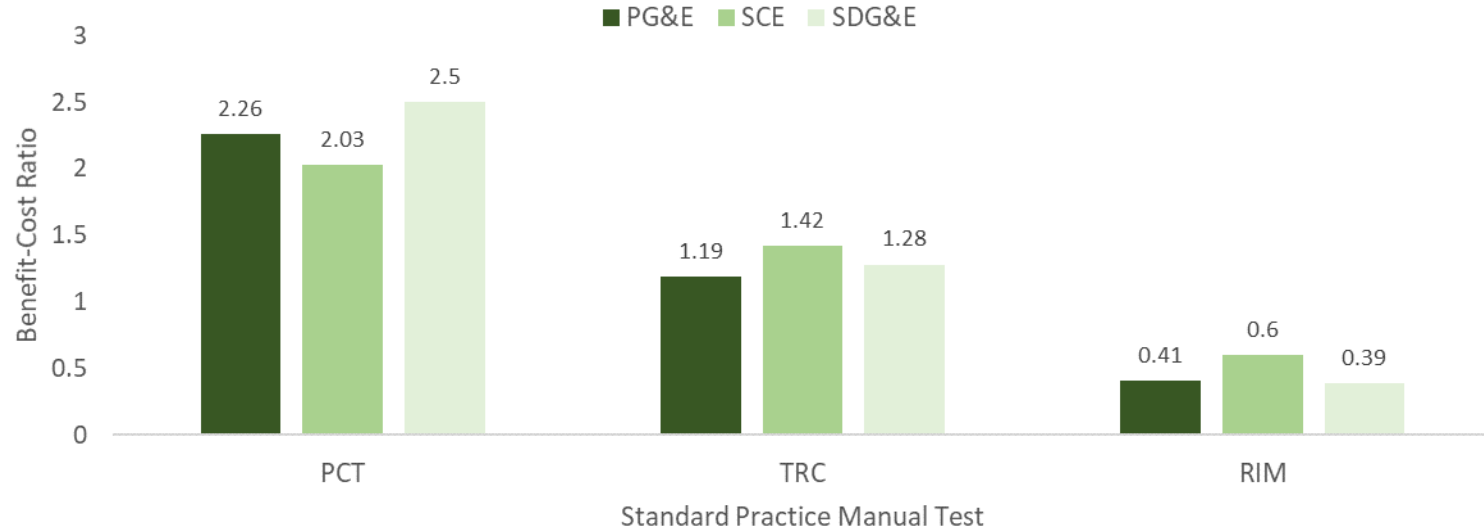
- If on a TOU rate, remains on same TOU rate
- If on a legacy/discontinued rate then switched to current rate after 8 years

## » NEM 2.0 program assumed to persist for the duration of the analysis

# MODEL OVERVIEW / DEMO

# NEM 2.0 LOOKBACK STUDY RESULTS

## Cost-Effectiveness Results by Utility



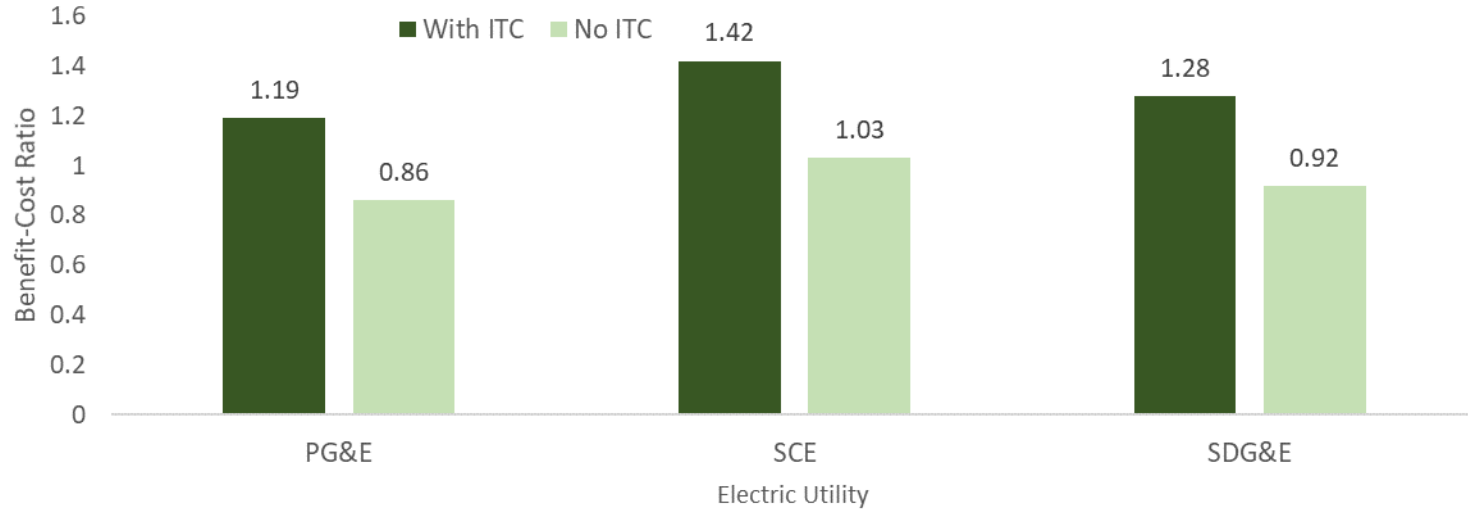
# NEM 2.0 LOOKBACK STUDY RESULTS

## Cost-Effectiveness Results by Utility

| Utility      | 25% to 75% Range of Benefit Cost Ratio |                     |                     |                       |
|--------------|--|---------------------|---------------------|-----------------------|
|              | PCT                                    | TRC                 | RIM                 | PA                    |
| PG&E         | 2.01 to 2.95                           | 1.21 to 1.25        | 0.31 to 0.48        | 24.22 to 46.11        |
| SCE          | 1.94 to 2.47                           | 1.29 to 1.40        | 0.46 to 0.61        | 7.70 to 13.68         |
| SDG&E        | 2.39 to 3.10                           | 1.28 to 1.41        | 0.32 to 0.41        | 85.74 to 152.07       |
| <b>Total</b> | <b>2.04 to 2.86</b>                    | <b>1.23 to 1.36</b> | <b>0.33 to 0.51</b> | <b>13.92 to 55.13</b> |

# NEM 2.0 LOOKBACK STUDY RESULTS

Cost-Effectiveness Results by Utility and Sector, Impact of ITC





# NEM 2.0 LOOKBACK STUDY RESULTS

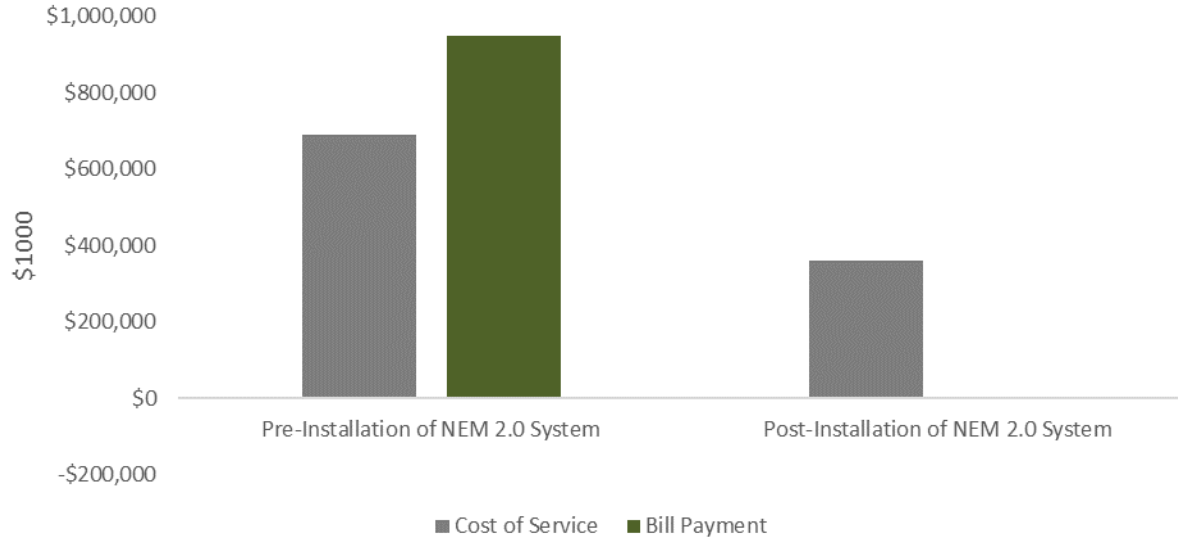
Cost-Effectiveness Results by Utility and Technology

| Utility | Technology         | Weighted Average Benefit Cost Ratio |      |      |        |
|---------|--------------------|-------------------------------------|------|------|--------|
|         |                    | PCT                                 | TRC  | RIM  | PA     |
| PG&E    | Solar PV           | 2.28                                | 1.20 | 0.41 | 51.63  |
|         | Solar PV + Storage | 1.82                                | 1.10 | 0.51 | 35.50  |
| SCE     | Solar PV           | 2.07                                | 1.43 | 0.59 | 13.46  |
|         | Solar PV + Storage | 1.70                                | 1.36 | 0.71 | 22.56  |
| SDG&E   | Solar PV           | 2.61                                | 1.32 | 0.38 | 143.35 |
|         | Solar PV + Storage | 1.76                                | 1.07 | 0.52 | 532.02 |



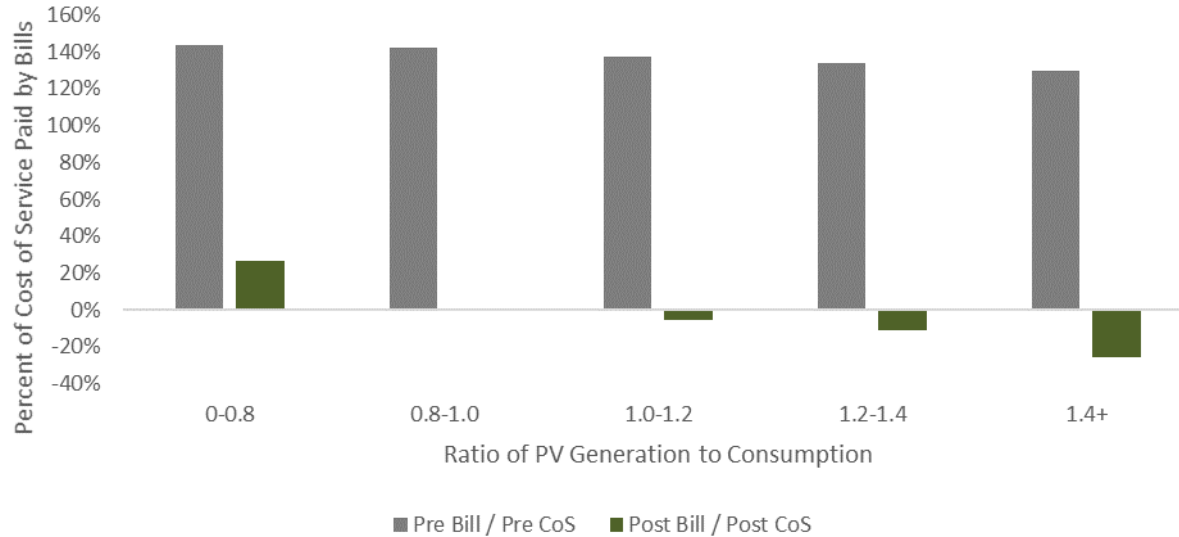
# NEM 2.0 LOOKBACK STUDY RESULTS

## Cost of Service Results – Residential



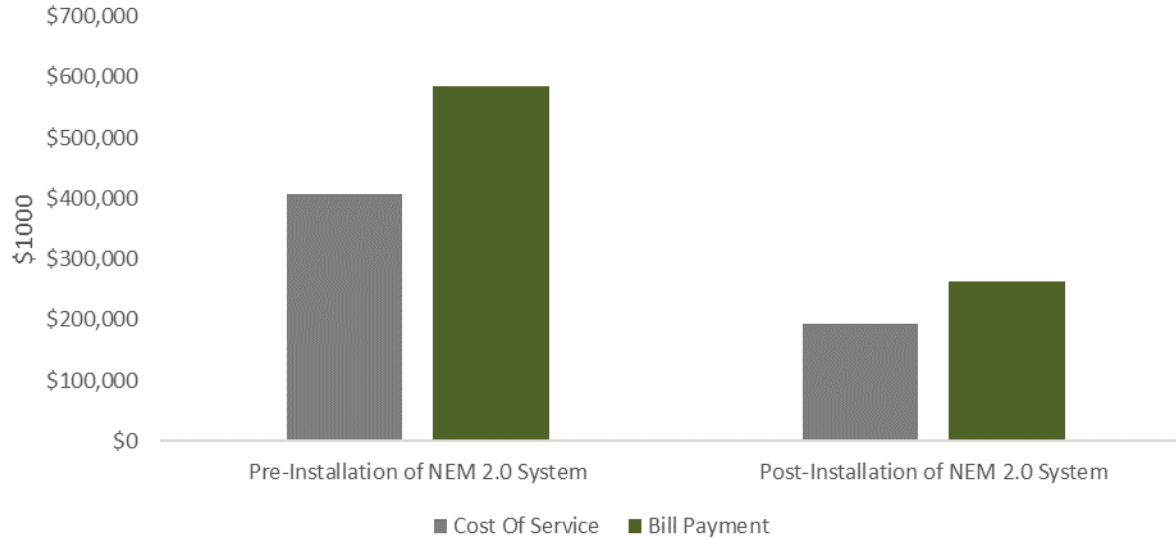
# NEM 2.0 LOOKBACK STUDY RESULTS

## Cost of Service Results – Residential



# NEM 2.0 LOOKBACK STUDY RESULTS

## Cost of Service Results – Non-Residential



# ISSUES WE ADDRESSED SINCE DRAFT RELEASE

- » Angle of incidence on PV panels was being set incorrectly, causing PV yield to increase beyond reasonable levels
  - Impact: Moderate
- » Bills in volumetric rates were being calculated incorrectly for customers with usage in Tier III
  - Impact: Minor
- » SGIP upfront incentive was not being removed from TRC calculation
  - Impact: Minor
- » Interconnection cost paid by participant not being counted as benefit in PA/RIM tests
  - Impact: Minor

# NEXT STEPS

- » Written comments due back on 8/31
  - Please use the comment template and email responses to [William@verdantassoc.com](mailto:William@verdantassoc.com)
- » Verdant team will review comments, make necessary changes to model/report, and release final report

# QUESTIONS AND ANSWERS



VERDANT

THANK YOU

[www.verdantassoc.com](http://www.verdantassoc.com)