Distributed Resource Integration in the US: A Markets Perspective

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CITIES 4th General Consortium Meeting

May 29-30, 2017

Markets & Power System Operations
DR, PV, PEV aggregation and Wind/Solar integration

DSO/Aggregator

Demand Response

Dispatch Instructions & Prices

ISO

Control Center

Evolutionary Market Design

Wind/Solar Generators

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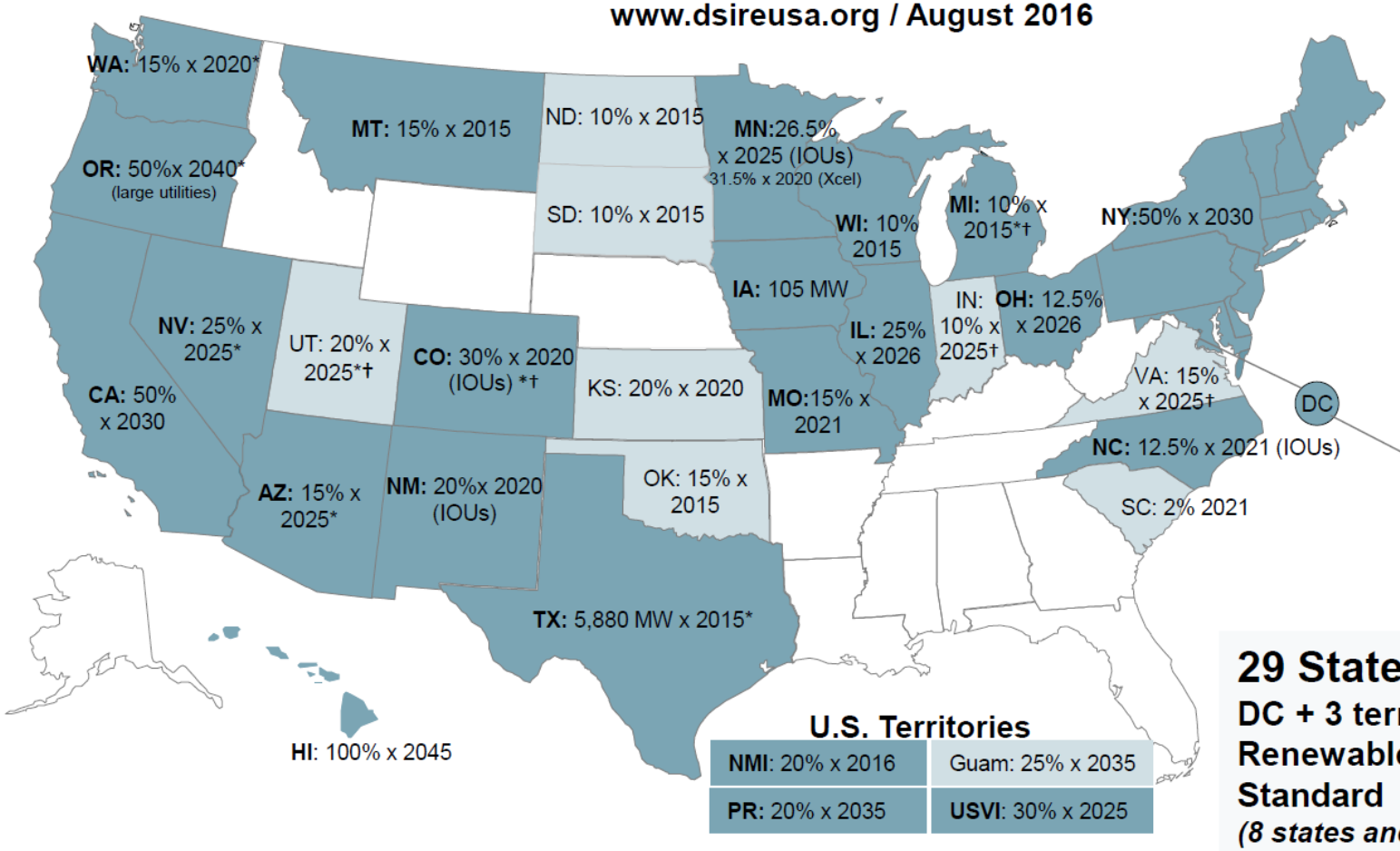
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Renewable Portfolio Standard Policies

www.dsireusa.org / August 2016



ME: 40% x 2017
NH: 24.8%x 2025
VT: 75% x 2032
MA: 15% x 2020(new resources) 6.03% x 2016 (existing resources)
RI: 38.5% x 2035
CT: 27% x 2020
NJ: 20.38% RE x 2020 + 4.1% solar by 2027
PA: 18% x 2021†
DE: 25% x 2026*
MD: 20% x 2022
DC: 20% x 2020

U.S. Territories

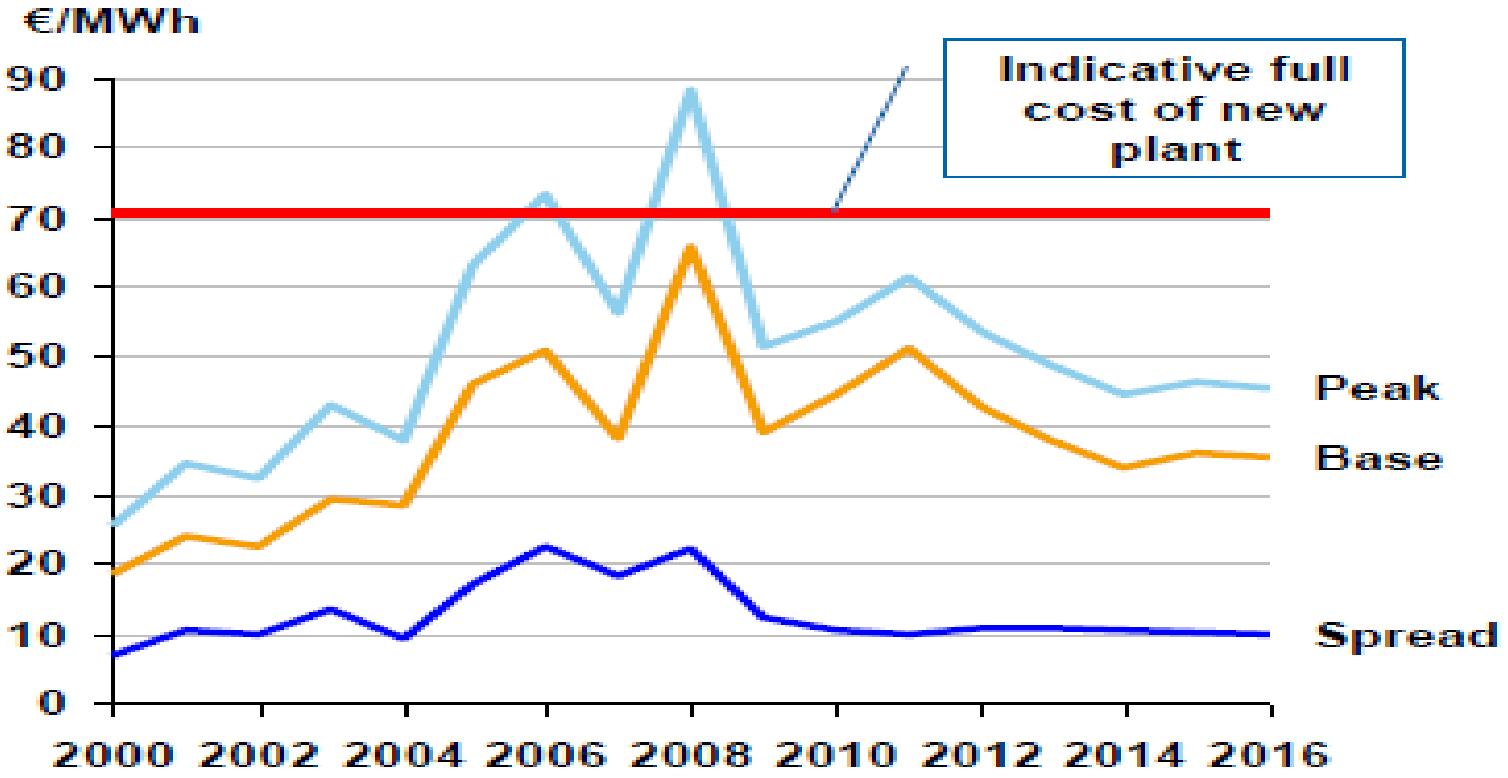
NMI: 20% x 2016	Guam: 25% x 2035
PR: 20% x 2035	**USVI:** 30% x 2025

29 States + Washington DC + 3 territories have a Renewable Portfolio Standard
(8 states and 1 territories have renewable portfolio goals)

Renewable portfolio standard
Renewable portfolio goal

* Extra credit for solar or customer-sited renewables
† Includes non-renewable alternative resources

German Wholesale prices Down 50%



Leading States Activities: California and New York

California
State Policy Goals/RPS Goals

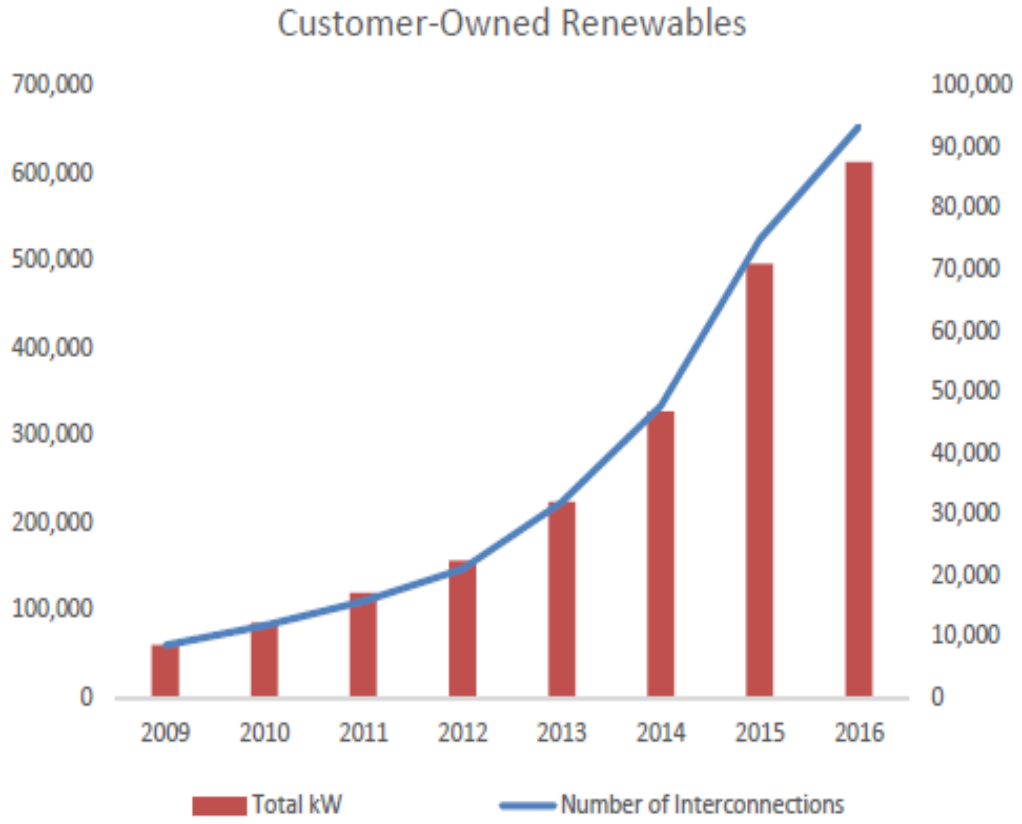
- AB 350 - reduce Greenhouse Gas Emissions to pre-1990 levels
  - State Goal: 33% RPS by 2020
  - State Goal: 50% RPS by 2030
  - SDG&E Progress: 33% RPS Currently
  - SDG&E Goal: 40% RPS by 2018
  - Mass deployment of electric vehicles and infrastructure
- AB 327 - facilitate the integration of DER at optimal locations when considering safety, reliability, costs and benefits.

- SDG&E supports the concept of "open access" for all types of DER and seeks to enable seamless integration of DERs while providing safe and reliable electric service across the distribution systems.
- The 4G Electric Grid

San Diego Gas & Electric

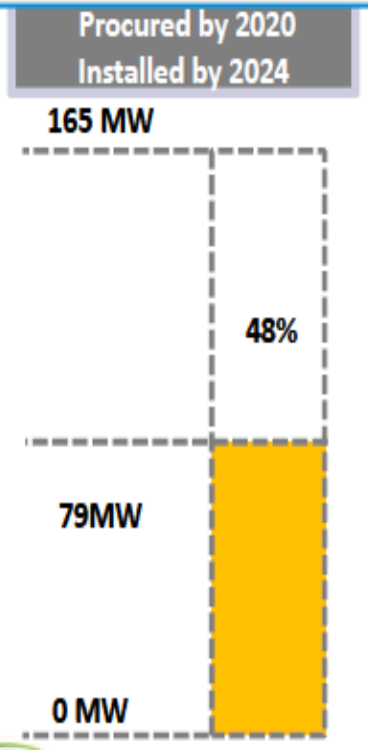
Rooftop PV Solar

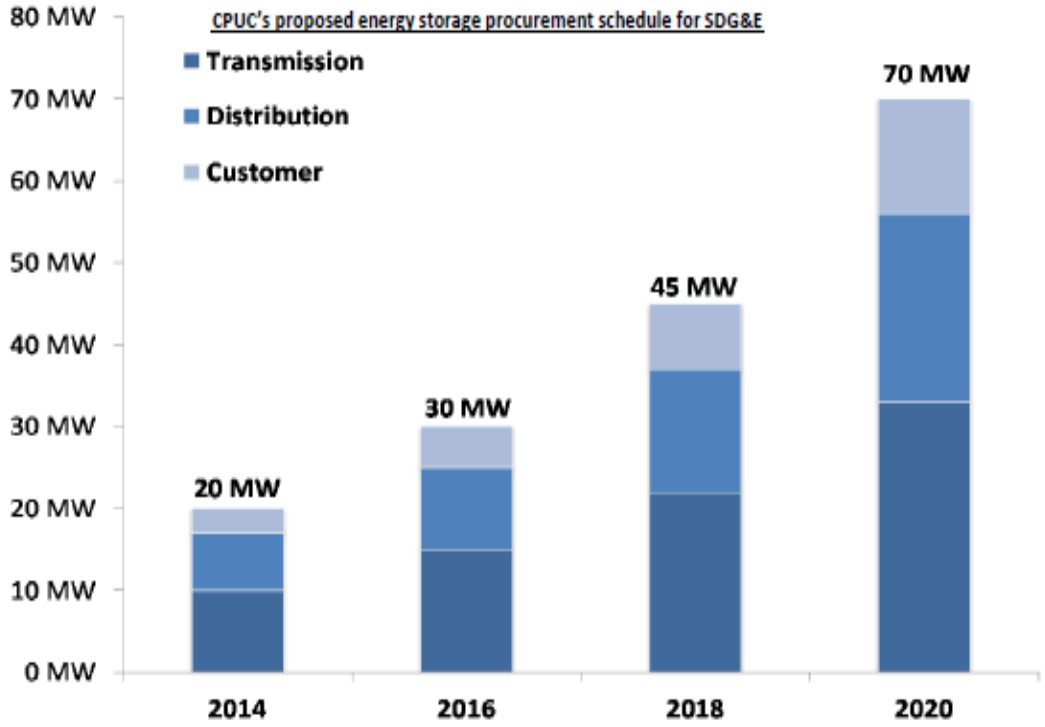
- 617.2 MW of roof top solar
- Over 93,000 interconnections
- Equivalent to a combined cycle power plant
- No foreseeable slow-down in solar interconnections



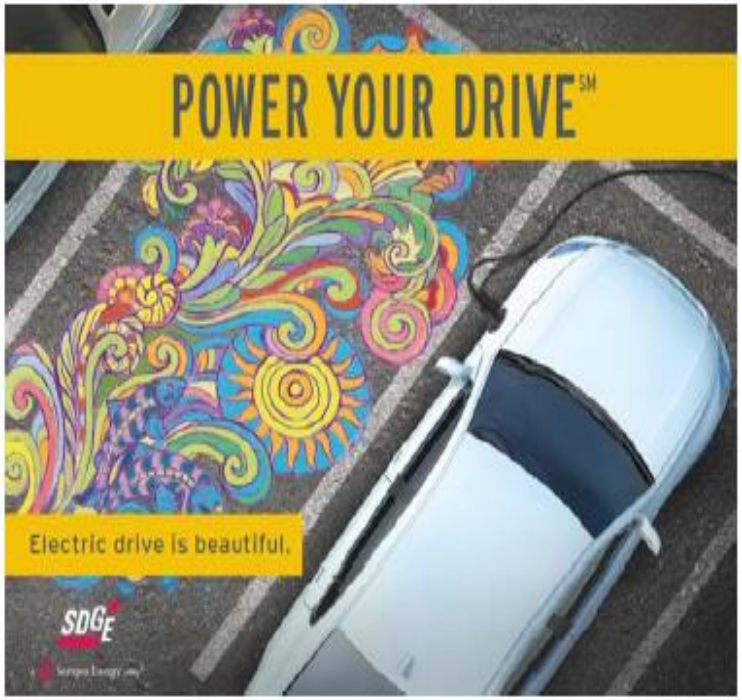
SDG&E's Storage Targets

The CPUC set statewide storage procurement target of 1325 MW by 2020. SDG&E's target is 165 MW. SDG&E has achieved 48% based on existing/in-progress projects (79 MW). Projects procured pursuant to the 2014 All Source RFO are expected to significantly increase progress towards the targets.



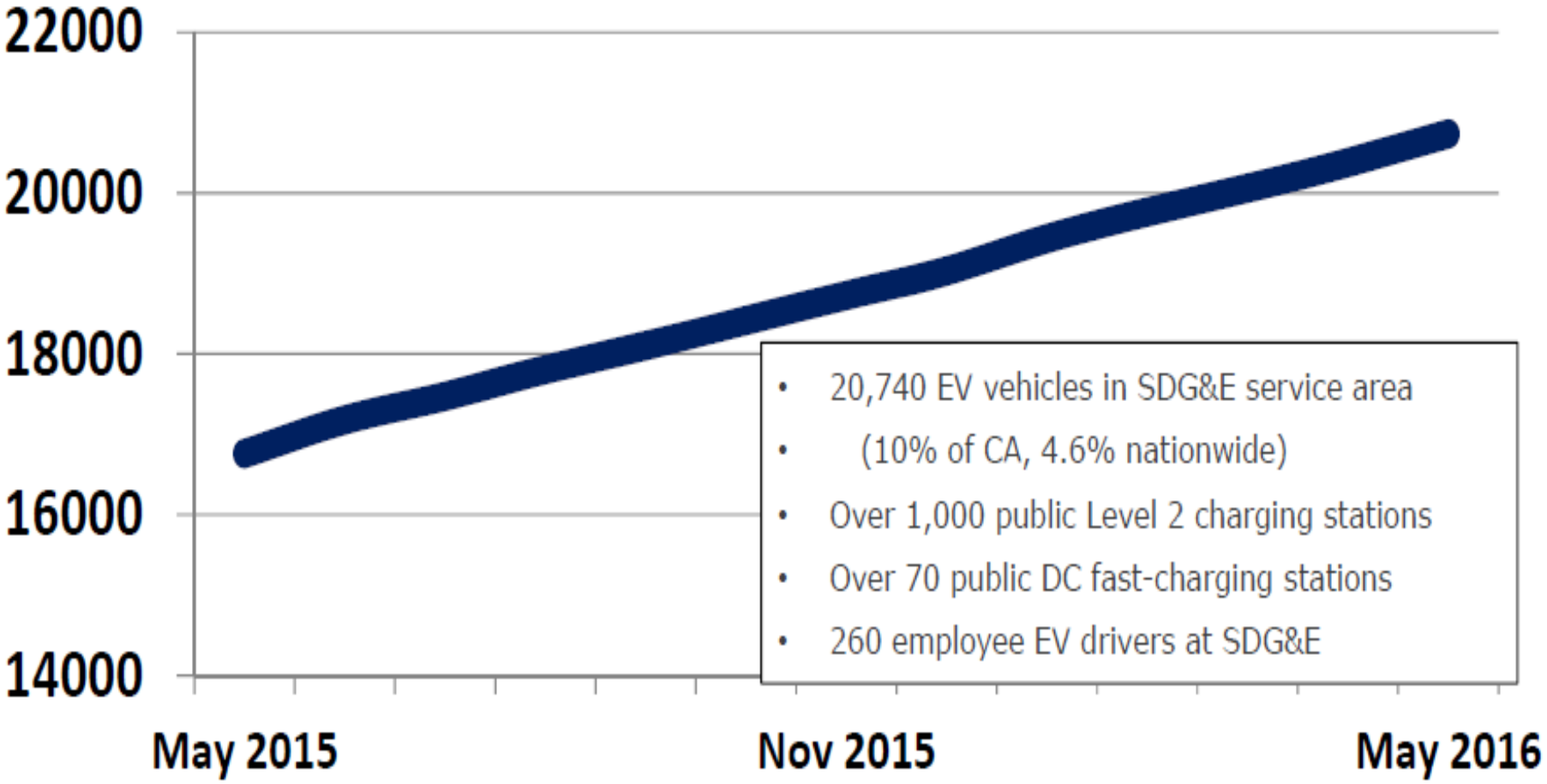


SDG&E Power Your Drive Details



- 3,500 charging stations in 350 locations
- New electric service from SDG&E grid
- Apartments, condos and work places
- Hourly rate encourages off-peak charging
  - Integrates renewable energy with the grid
  - Reduces need for more power plants
- Two billing options to SDG&E bill
  - Property pays
  - Driver pays

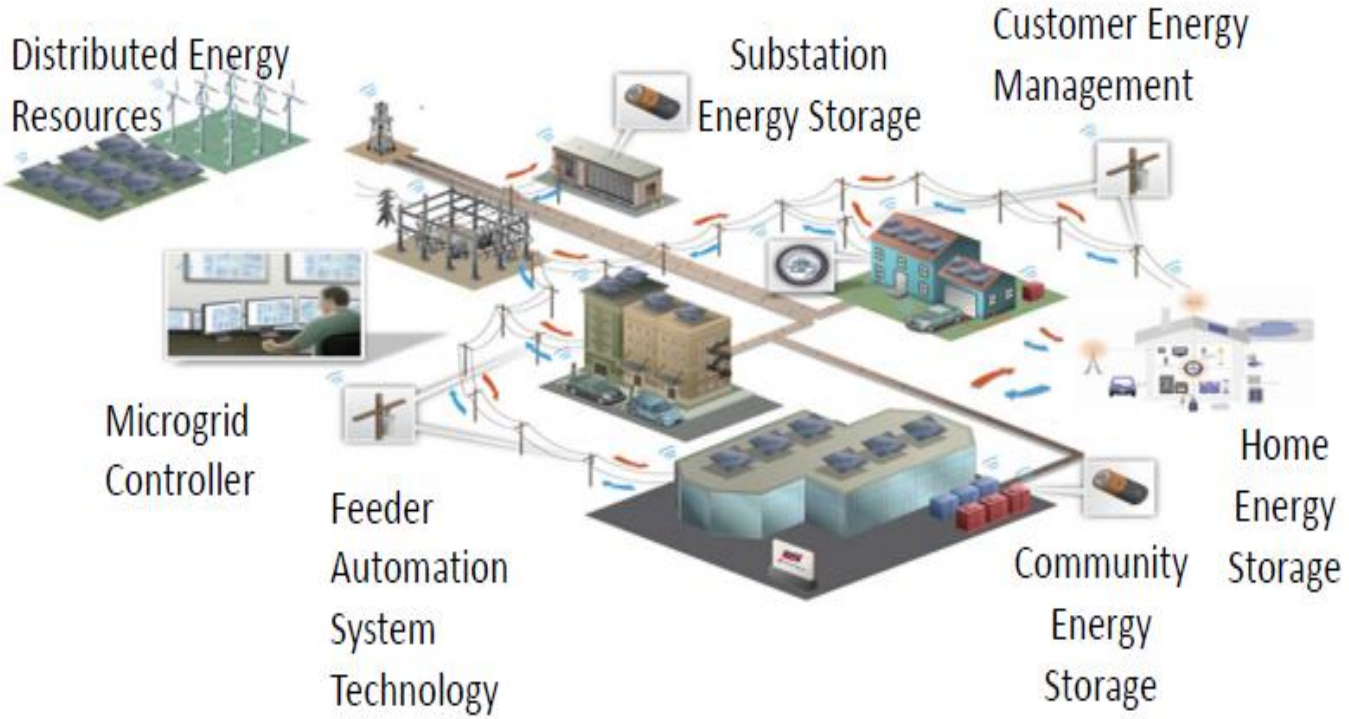
San Diego Regional EV Growth – June 2016



Borrego Springs Microgrid Demonstration Project (2010–2013)

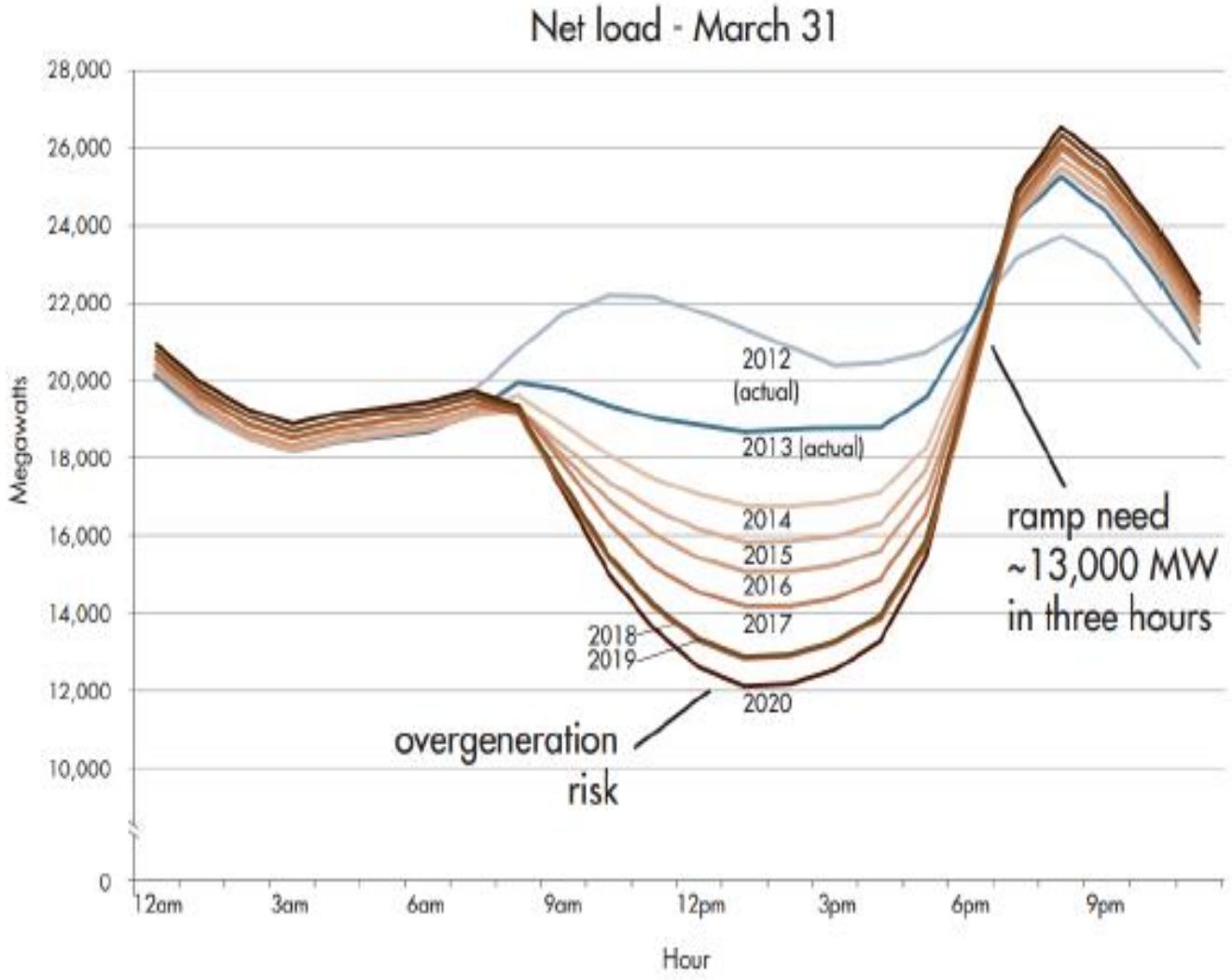
Utilize advanced technologies to integrate and manage distributed resources within the Smart Grid

Budget:	$8.0M DOE and $2.8M CEC plus matching funds from SDG&E and partners
Benefits:	▪ Integrate and leverage various generation and storage configurations ▪ Reduce the peak load of feeders and enhance system reliability ▪ Enable customers to become more active participants in managing their energy use



Integrating DER into the wholesale market

California Duck Curve



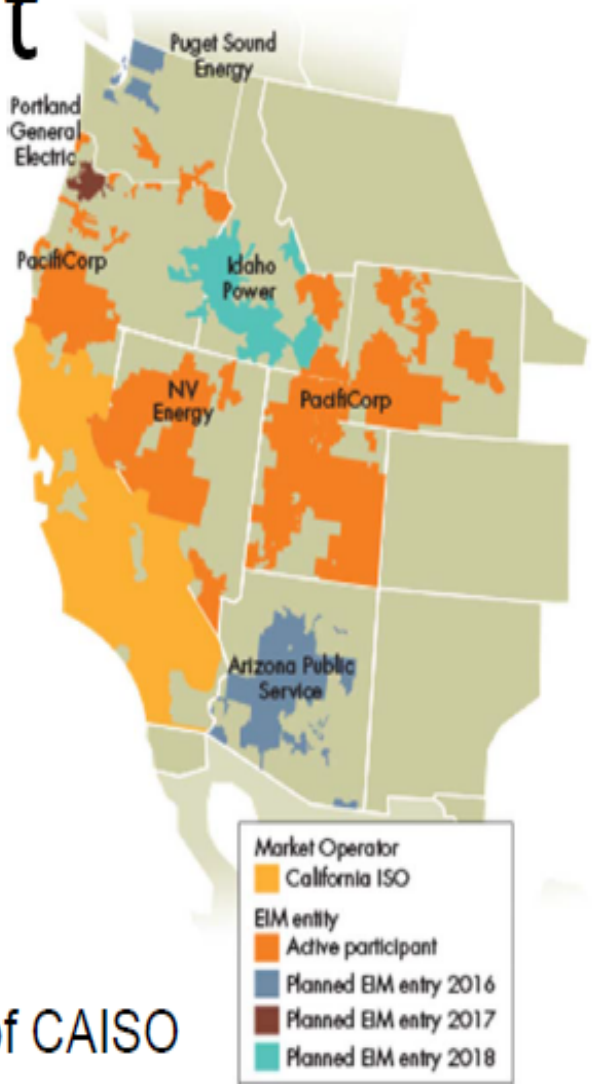
Courtesy of CAISO

Flexible Resource Adequacy

- On June 27, 2013 the California Public Utility Commission issued a ruling revising the Resource Adequacy Mechanism to include a fraction of Flexible Capacity:
  - Rule recognizes reliability needs due to 33% RPS target by 2020 and reduction in available flexible generation due to pending shut down of “once through cooling plants”.
  - Flexible capacity is defined as capacity able to sustain a 3 hour continuous ramp.
  - Procurement amount will be based on forecasted highest annual 3 hour continuous coincident ramp.
  - RA Mechanism requires each load serving entity to show three year forward contracting with sufficient capacity (with an appropriate fraction of flexible capacity) to serve it load (90% of need year ahead and 100% of need month ahead)

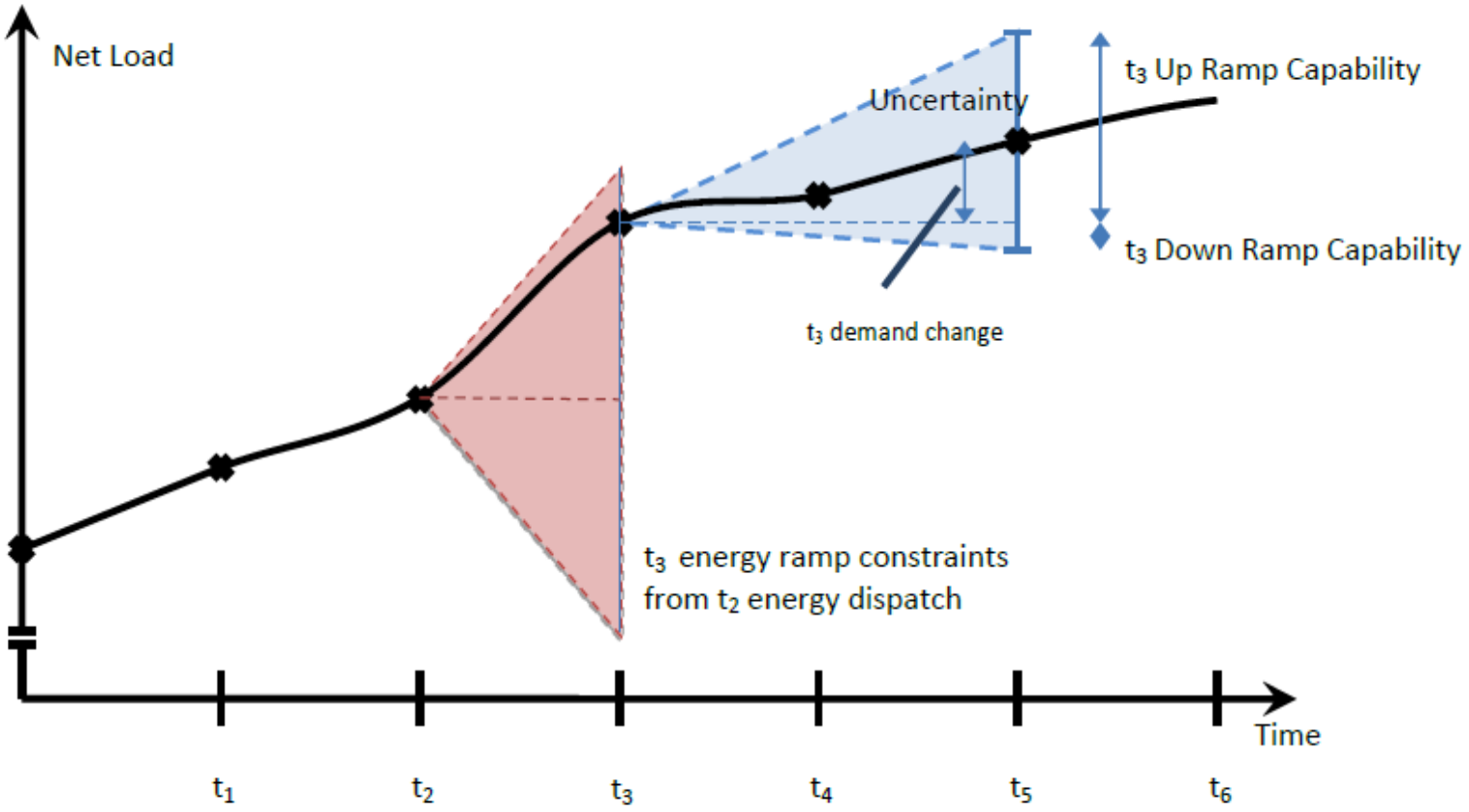
Energy Imbalance Market

- Benefits of EIM (Energy Imbalance Market)
  - Efficiency Automated dispatch to balance load and generation is more efficient than manual dispatch.
- Reduced costs
  - A wider portfolio of resources to maintain system balance could reduce the costs of energy and capacity.
- Operating flexibility
  - Improved situational awareness and real-time visibility of transmission constraints, and dispatches resources to reduce and avoid congestion issues. Captures the benefits of geographical diversity of load and resources.



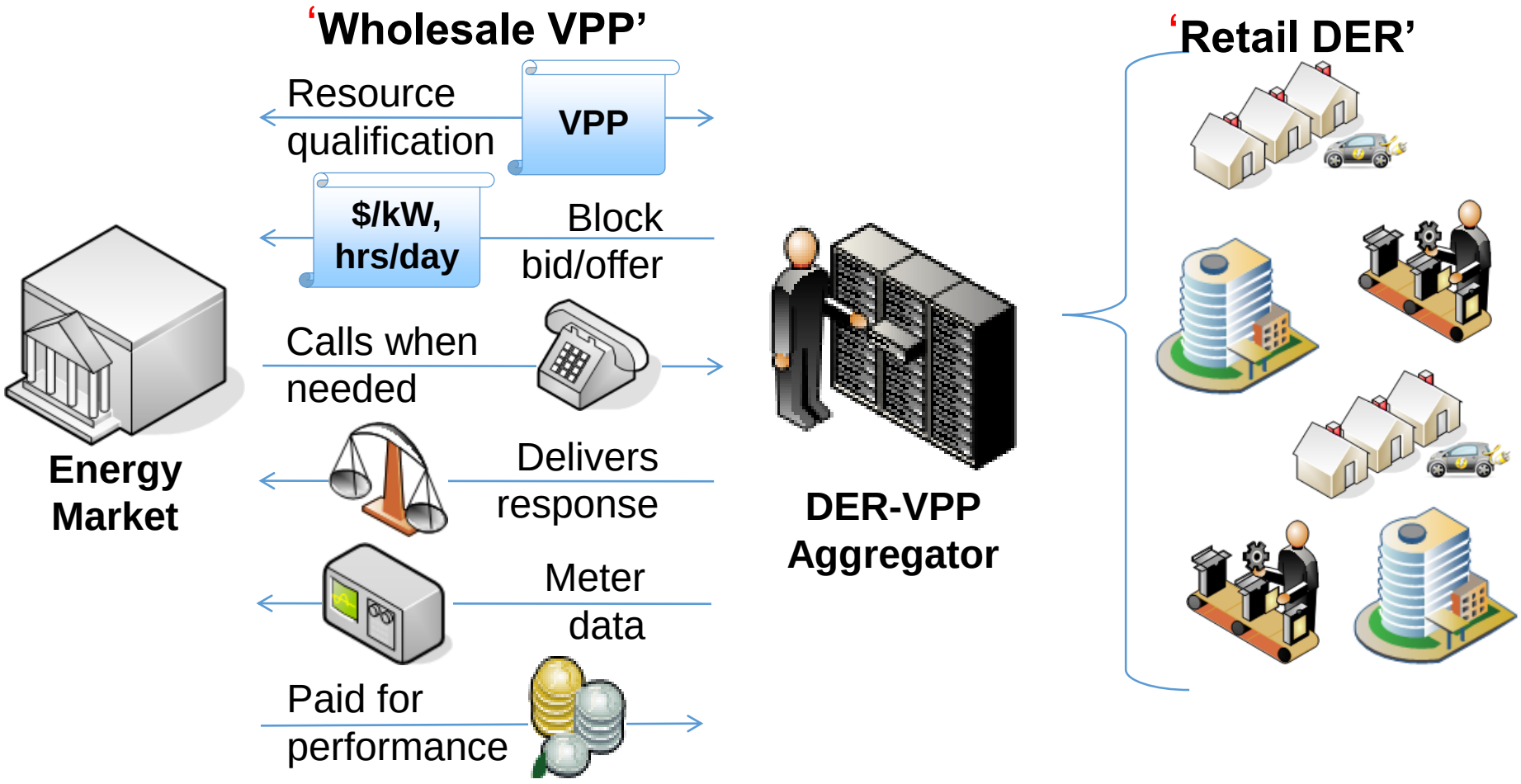
Courtesy of CAISO

Flexiramp Product Covers Potential Future Interval Variation in Current Dispatch Opportunity Cost Based Remunaration



DER Aggregators and Virtual Power Plants

Aggregators hide some of this complexity via VPP abstraction



155 FERC ¶ 61,229
UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

California Independent System Operator Corporation

Docket No. ER16-1085-000

ORDER ACCEPTING PROPOSED TARIFF REVISIONS SUBJECT TO CONDITION

1. On March 4, 2016, pursuant to section 205 of the Federal Power Act (FPA),[1] the California Independent System Operator Corporation (CAISO) filed proposed revisions to its Open Access Transmission Tariff (tariff) to facilitate participation of aggregations of distribution-connected or distributed energy resources in CAISO's energy and ancillary services markets. In this order, we accept the filing subject to condition, as discussed below, to become effective June 3, 2016, as requested.

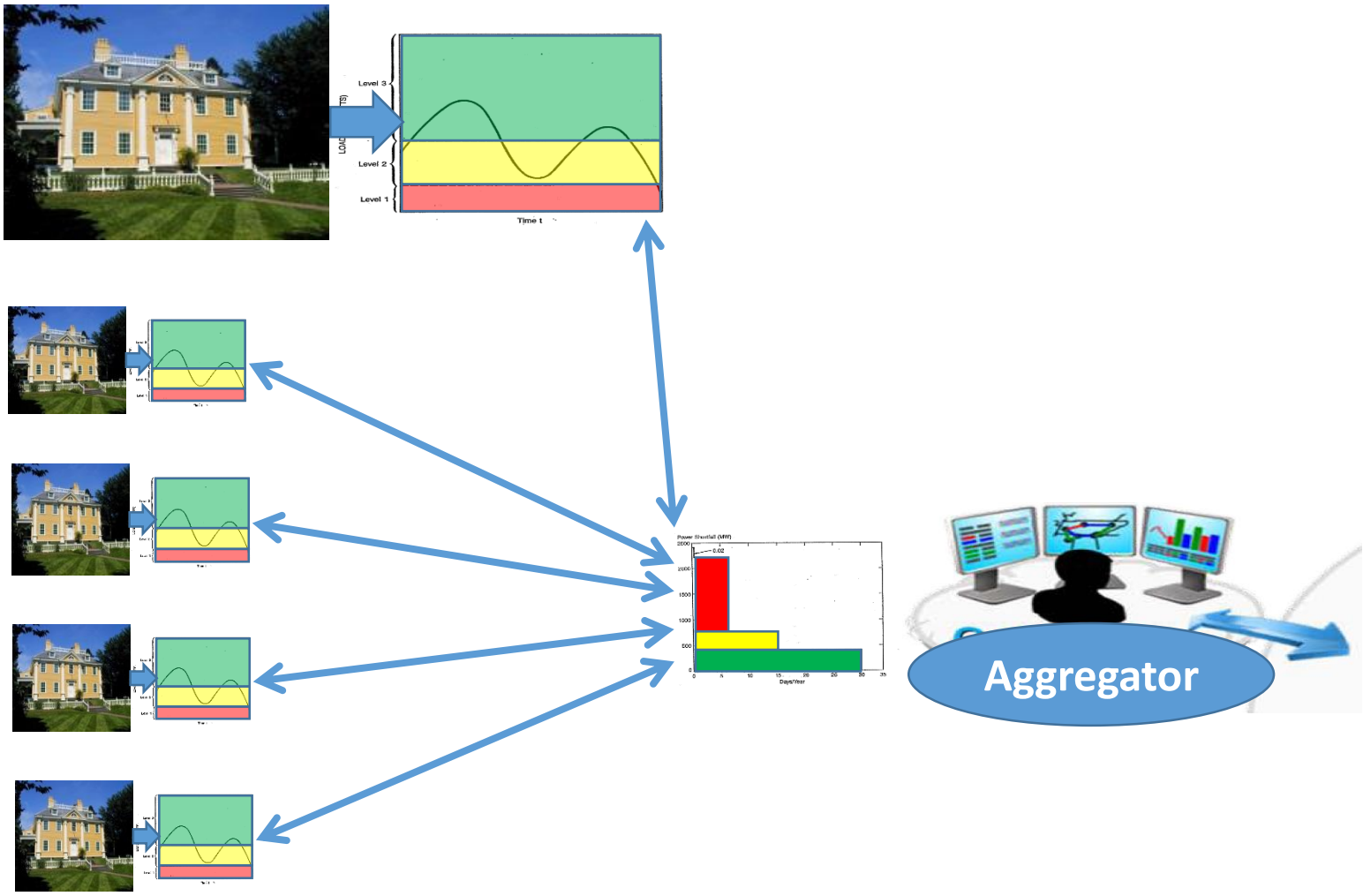
CAISO Proposed Tariff Revision

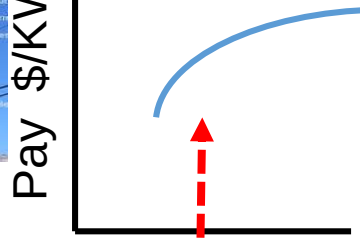
- CAISO tariff to support the participation of distributed energy resources in the CAISO markets. The proposed tariff revisions establish an initial framework to enable resources connected to distribution systems within CAISO's balancing authority area to form aggregations of 0.5 MW or more and participate in its energy and ancillary services markets.
- CAISO's proposed revisions address five topics:
  1. Provisions that recognize a distributed energy resource provider (DER Provider) as a market participant;
  2. Provisions that recognize a distributed energy resource aggregation as a market resource;
  3. Rules governing participation of these resources in the CAISO markets;
  4. Distinctions between the requirements for scheduling coordinators representing demand response and requirements for scheduling coordinators representing DER providers
  5. A new *pro forma* DER Provider Agreement

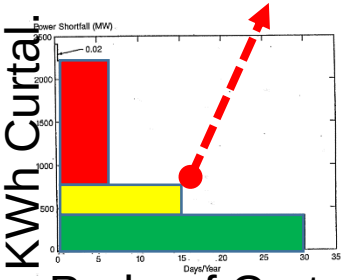
CAISO Filing Specifics

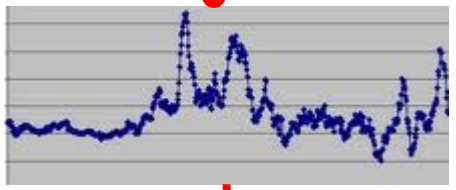
- DER Provider is the owner or operator of a distributed energy resource aggregation at a geographically contiguous metered subsystem located within a single CAISO zone for purposes of wholesale market participation.
- This broad definition encompasses multiple types of resources such as distributed generation, energy storage, and plug-in electric vehicle charging stations, in front of or behind a customer meter.
- Like all other market participants, a DER Provider may only participate in the CAISO markets through a scheduling coordinator or by becoming a scheduling coordinator itself.
- Individual generating units located in the CAISO balancing authority area that are 1 MW or greater will still be required to become participating generators and will not be eligible to aggregate their capacity through a DER Provider.
- Resources that are participating in retail programs, such as net metering with storage or virtual net metering, also cannot participate in a wholesale market aggregation (no double dipping). However, non-net energy metering distributed energy resources are allowed to participate.

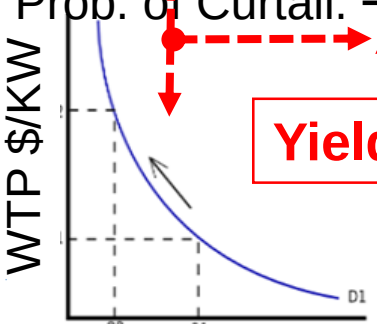
Fuse [capacity] Control Paradigm
(customer controls allocation of curtailed capacity)





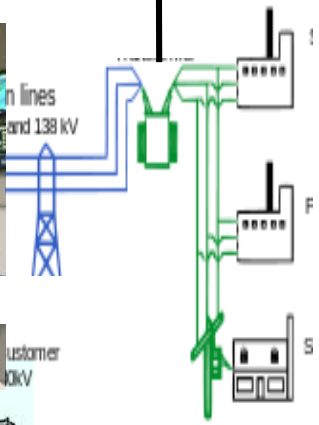


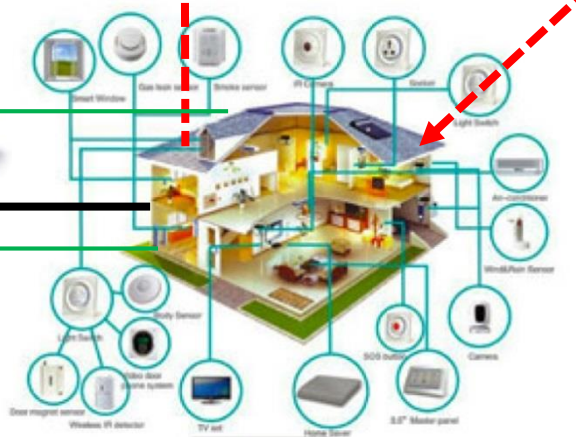


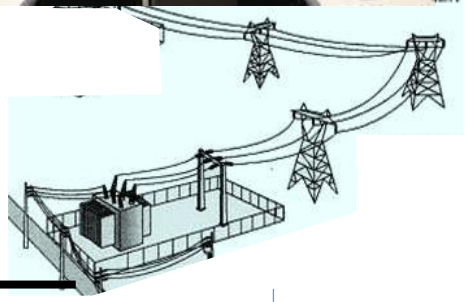


Yield Stats

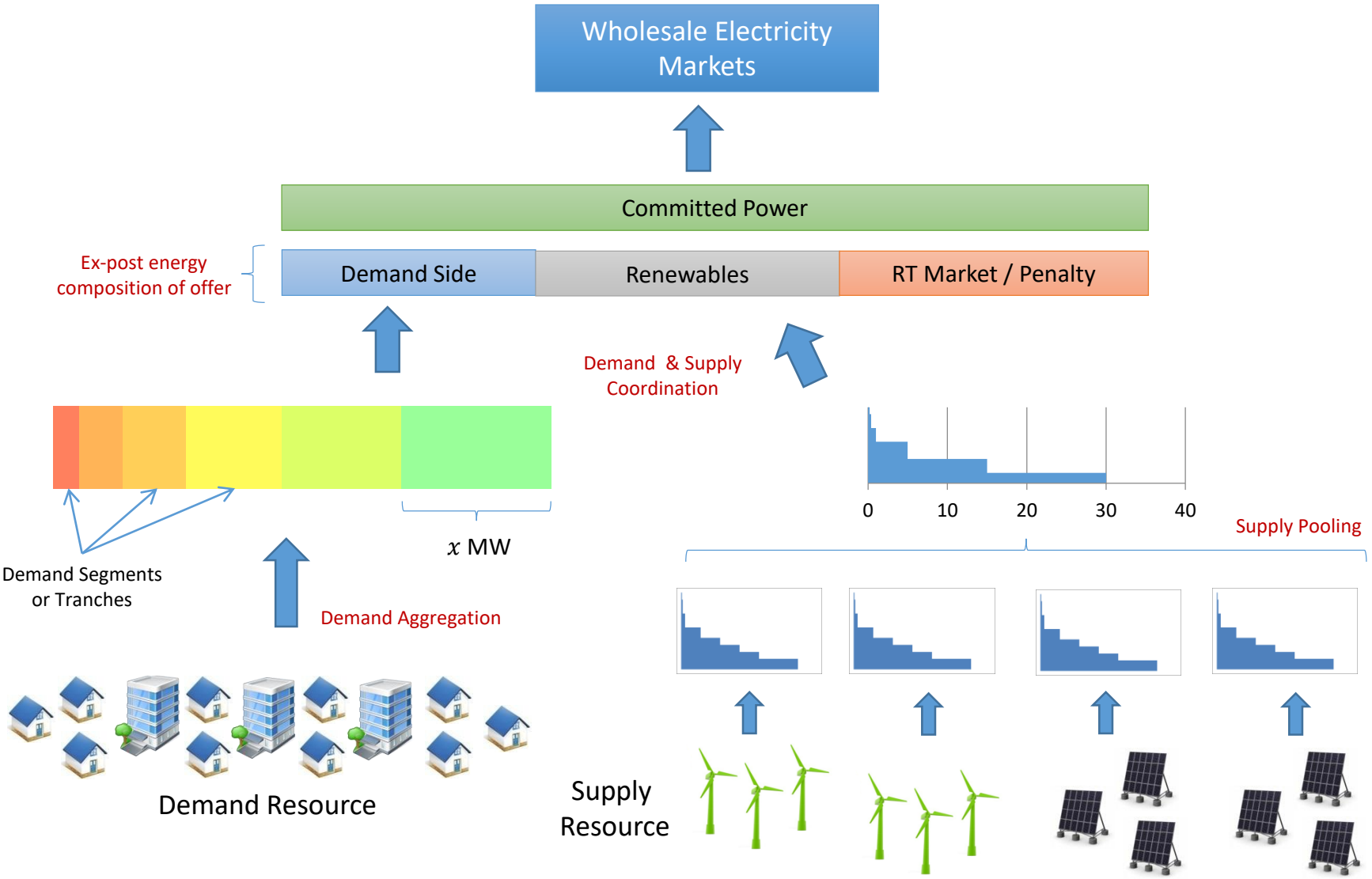
Curtailment Controller







Aggregated Firmed up Renewables Product



NEW YORK STATE OF OPPORTUNITY. | Reforming the Energy Vision

Reforming the Energy Vision (REV) is New York's comprehensive strategy to develop a cleaner and more reliable, resilient and affordable energy system for all New Yorkers

STATE OF NEW YORK
PUBLIC SERVICE COMMISSION

CASE 14-M-0101 - Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision.

First, our targets will be clear and ambitious. The 2015 New York State Energy Plan includes a target to meet 50% of the State's electric consumption with renewable resources in 2030, as well as targets of a 40% reduction in greenhouse gas emissions from 1990 levels and a 600 trillion Btu increase in statewide energy efficiency.

New York's Reforming the Energy Vision Articulated a Detailed End-State Vision

- Objective: A transactional, distributed electric grid that
  - Improves system efficiency, resilience, and air emissions,
  - Encompasses both sides of the utility meter
  - Relies increasingly on distributed resources and dynamic load management

- Defined "distribution system platform" (DSP) functions to include:
  - Planning, operations and enabling of markets
  - Improved temporal and spatial granularity of information
  - Improved information accessibility to consumers and participants
  - Greater transparency to grid needs to encourage innovation and investment

- Requires utilities to file Distributed System Implementation Plans (DSIP) –individual and joint –in 2016 Address distribution system planning and operations for high DER penetration

Proposed Market Structure

- Enable participation by companies and customers providing solar, storage, peak demand reduction, home energy management, etc.
- Integrate new electricity resources into the grid to ensure reliability and efficiency
- Plan and re-construct the distribution network
- Customers get paid as electricity producers do today

Consumers have increasing opportunities to

- Manage energy use in their home and business
- Use stored electricity to help manage electricity bills
- Use solar and other distributed energy to provide service to the grid, thereby enhancing reliability and resiliency and earning money
- Enhance safety and security (e.g., smart medical devices)

Customers may be able to use solar and other distributed energy to reduce electricity purchases, provide service to the grid, and enhance reliability and resiliency

New Marketplace is Envisioned

- Brings customers and providers of new products and services together
- Facilitates understanding and identification of products that meet consumers' needs

NEW YORK STATE OF OPPORTUNITY. | Reforming the Energy Vision

New York PSC Order
Developing a Distribution System Platform (DSP)

Source: Consolidated Edison

The DSP , a Common Theme

DSP Elements	NY	CA	MA	HI	MN
Reinventing the distribution grid role	●	●	●	●	◑
Integration of DER (Distributed Energy Resources)	●	●	●	●	◑
New rate design model	◑	●	◑	◑	◑
Customer-driven	●	◑	●	●	◑
Demand management	●	●	●	●	◑
Grid management	●	●	●	●	◑
Accommodate multiple players	●	●	◑	●	◑
Smart devices	◑	●	●	◑	◑

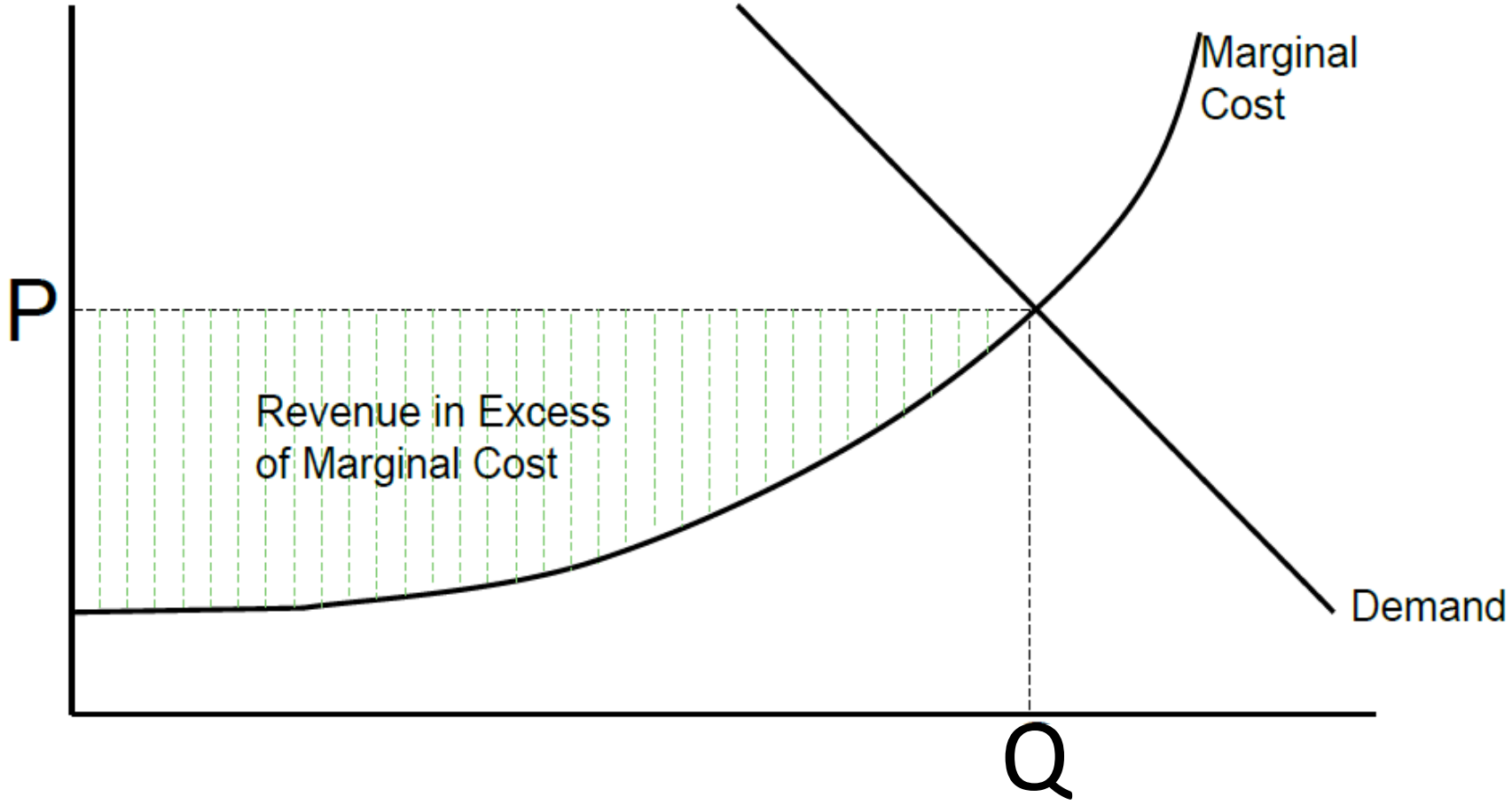
○ Not mentioned ◑ Less clear vision ● Very clear vision

Retail Pricing and Distribution Cost Recovery Mechanisms

Policy Objectives in Fixed Cost Recovery

- **Economic Efficiency** - volumetric energy prices should reflect social marginal cost (plus externalities) but that is not practical and may still result in revenue shortfall
- **Equity** – there is general belief that consumers that use more electricity should pay more toward recovering a revenue shortfall
- **Income Distribution** – desire to assure that low income household can afford basic necessities

Efficient Pricing Produces Inframarginal Revenue Toward Fixed Cost Recovery



But Efficient Pricing Yields Revenue Shortfall

- Because much of distribution costs are fixed relative to quantity of electricity consumed
- Because utility revenues covers many other costs that are not marginal
  - Low –Income programs
  - Energy efficiency programs
  - Sunk cost from the past and loan repayments
  - Subsidies for distributed generation
- Because volumetric charges typically exceed marginal cost so declining demand due to distributed generation, energy efficiency and customer defection amplifies shortfall

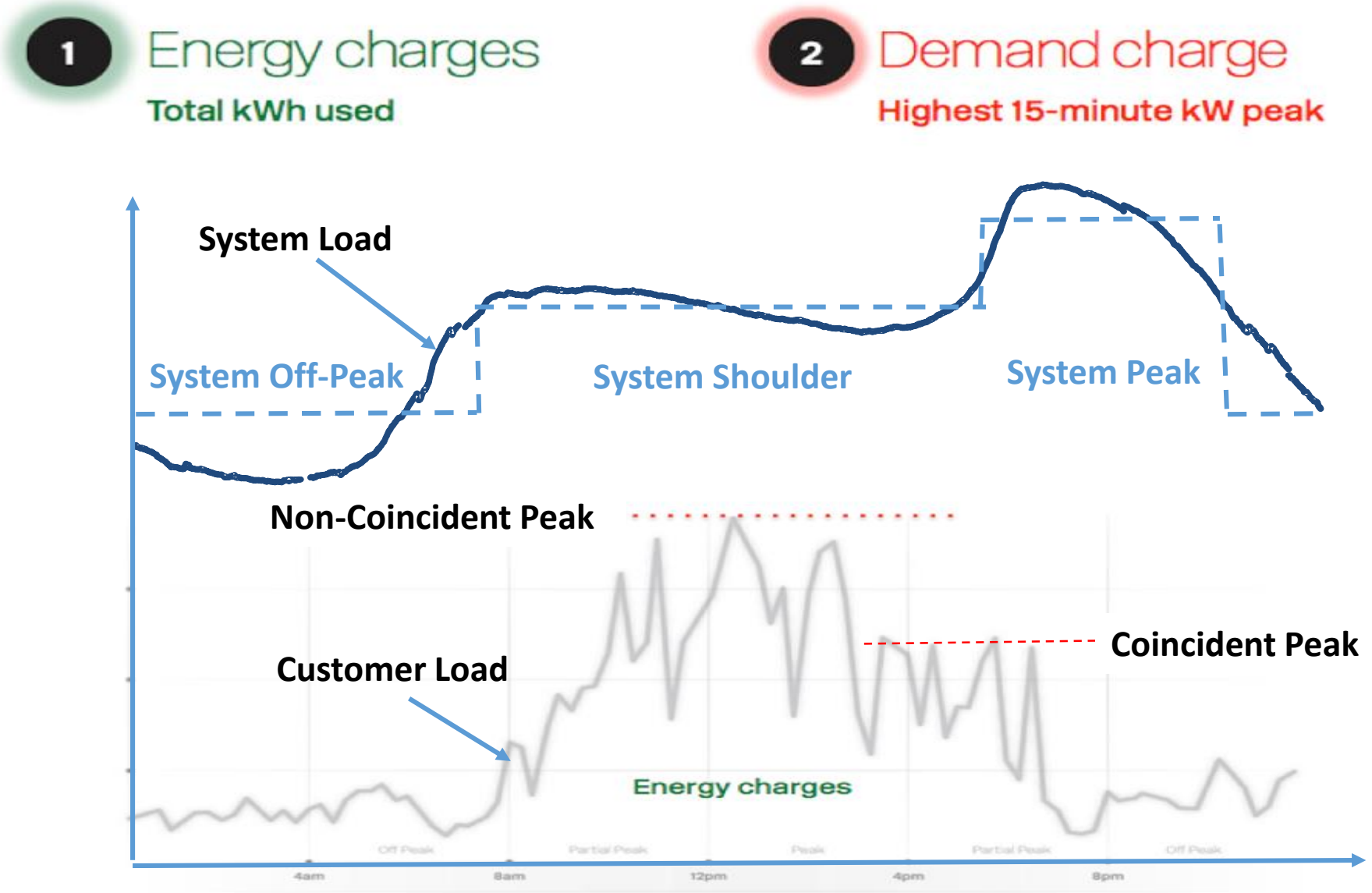
Options for Recovering Revenue Above Efficient Time –Varying Pricing

- Fixed charge – independent of quantity consumed
  - Can be charged per meter or may vary with connection size (Amps)
- Demand charges
  - non-coincident peak usage
  - coincident usage during system peak
- Volumetric average cost pricing (averaged over time and quantity)
- Tiered volumetric pricing – increasing block pricing
- Decoupling

Fixed Charges

- Very attractive on efficiency grounds because demand for connection is essentially inelastic
- Has equity problems (no consideration of usage)
- Concern about impact on low-income consumers

Demand Charge

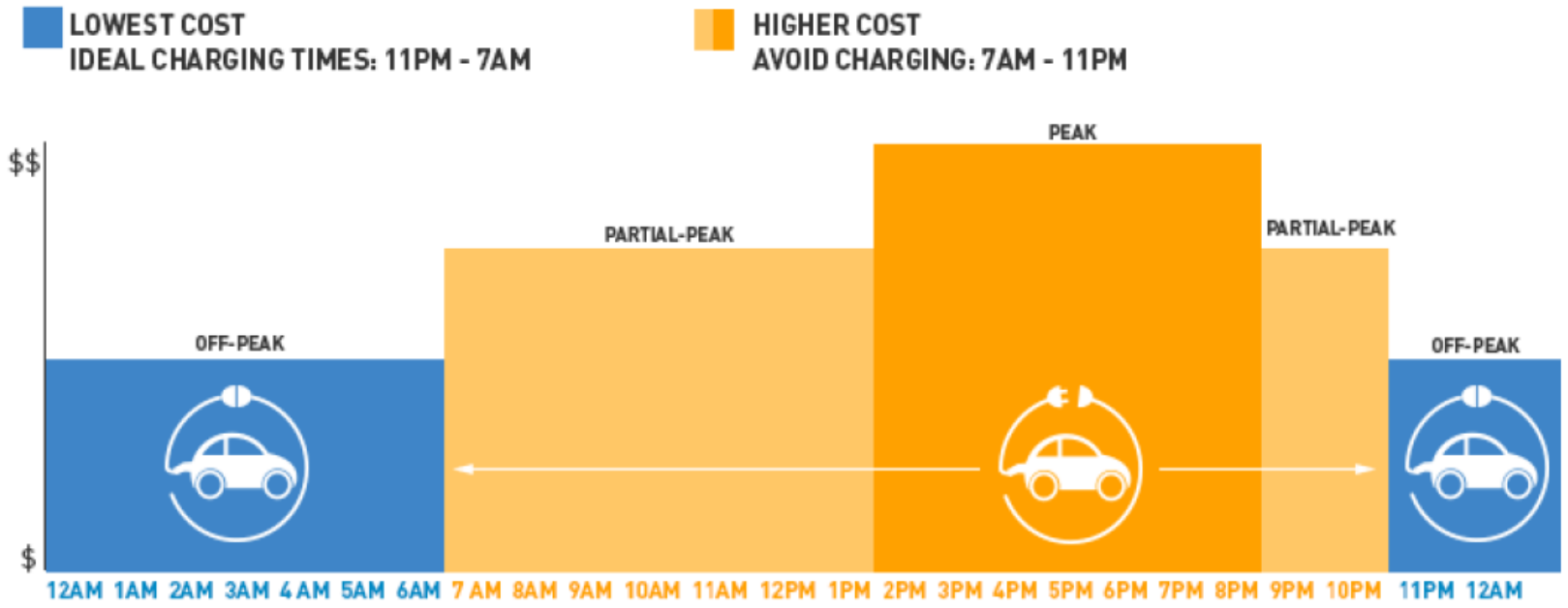


PG&E Volumetric Retail Tariffs

RATE	CUSTOMERS WHO MAY BENEFIT	DESCRIPTION	THINGS TO CONSIDER
EV-A (Non-tiered, Time-of-Use)	Higher energy consumers (tiers 2 and 3) or lower energy consumers (tier 1) who will drive often. If you can reduce your usage from 7 a.m. to 11 p.m. on weekdays, and 3 p.m. to 7 p.m. on weekends and holidays, this rate plan may be best for you.	Single meter for your home and EV charging. The price per kilowatt-hour varies depending on the time.	Avoid charging during peak hours. To maximize savings, consider shifting other household energy usage to less expensive, low demand hours (see chart, above).
EV-B (Non-tiered, Time-of-Use)	Customers who want to track their EV charging separate from their home energy consumption with a dedicated meter. If you can reduce your usage from 7 a.m. to 11 p.m. on weekdays, and 3 p.m. to 7 p.m. on weekends and holidays, this rate plan may be best for you.	Dual meters: one for your household and one for electric vehicle charging. The price for charging varies throughout the day. Your home energy use is measured separately.	Avoid charging during peak hours. Costs for second meter installation may be significant. One-time $100 fee per meter, plus cost to install charging station and second electric panel. Service upgrade may also be required.
E1 (Tiered)	Customers with low energy usage (tier 1) who can't shift their usage to off-peak hours and do not drive that often.	Single meter for your home and EV. Costs are based on three usage tiers. As you use more electricity during your billing period, you move into higher priced tiers.	You'll need to conserve energy throughout the month to stay in lower priced tiers as long as possible.
Time-of-Use Rate Plan 3-8 p.m. (ETOU-A)	Customers who don't use much energy (tier 1 on E1) and can be flexible about when you use it. If you can reduce your usage from 3 p.m. to 8 p.m. on weekdays this rate plan may be best for you.	Single meter for your home and EV. You receive a credit for all usage up to your baseline allowance. Prices are higher in the summer than in the winter.	Avoid charging EV during peak hours.
Time-of-Use Rate Plan 4-9 p.m. (ETOU-B)	Customers who use more energy (tier 2 or 3 on E1) and can be flexible about when you use it. If you can reduce your usage from 4-9 p.m. on weekdays, this rate plan would be beneficial.	Single meter for your home and EV. Prices are higher in the summer than in the winter.	Avoid charging EV during peak hours.
E6 (Tiered, Time-of-Use) *[**NOTE:** This rate plan was closed to new enrollment as of 5/30/2016]**	Low energy-use customers who can use major appliances before 10 a.m. in the summer and 5 p.m. in the winter, or after 9 p.m. in the summer and 8 p.m. in the winter—instead of on weekday afternoons.	Single household meter for your home and EV. The price per kilowatt-hour is based on the time you use electricity and the amount of electricity you use.	You'll need to conserve energy throughout the month, but the price you pay also varies by time of day and season.

PG&E EV Rates

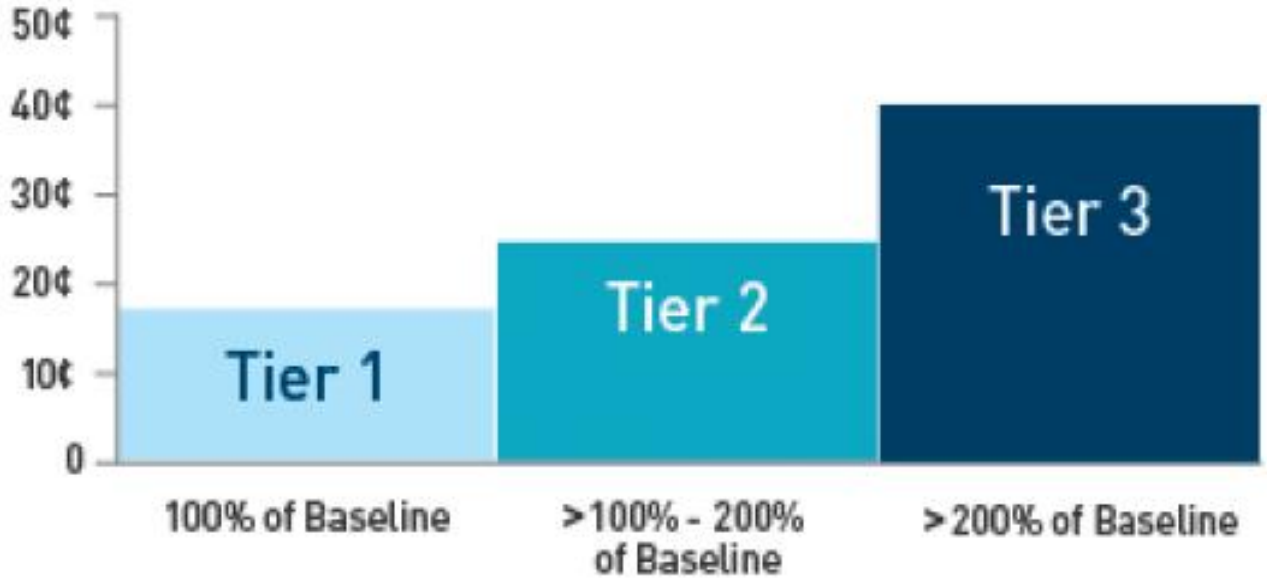
Both EV-A (one meter) and EV-B (dual meter) are non-tiered, time-of-use plans (prices vary by time but do not change with quantity)



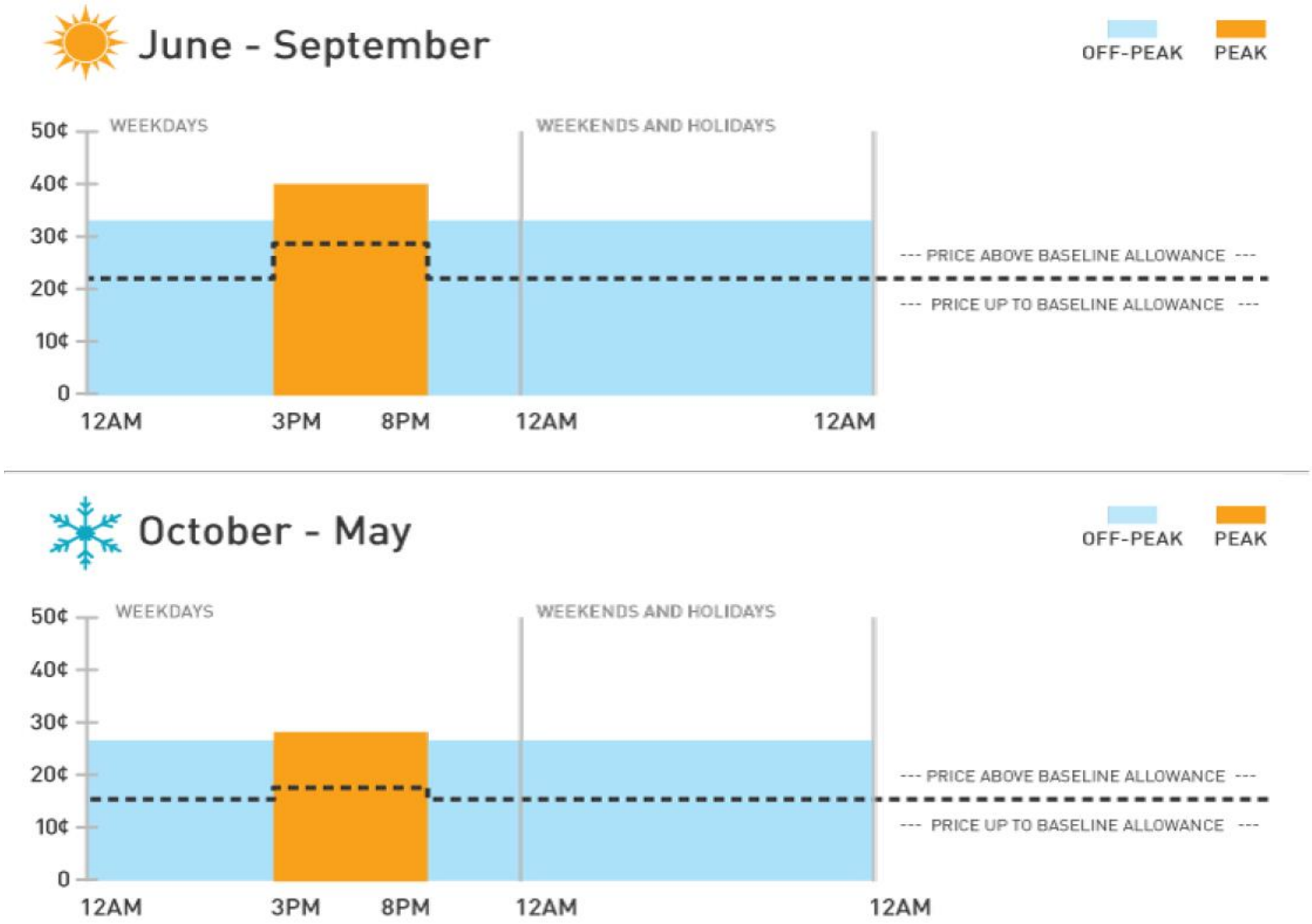
NOTE: Weekends and holidays only include Peak (3-7 p.m.) and Off-Peak (all other hours) periods.

PG&E Base Tiered Tariff (E1)

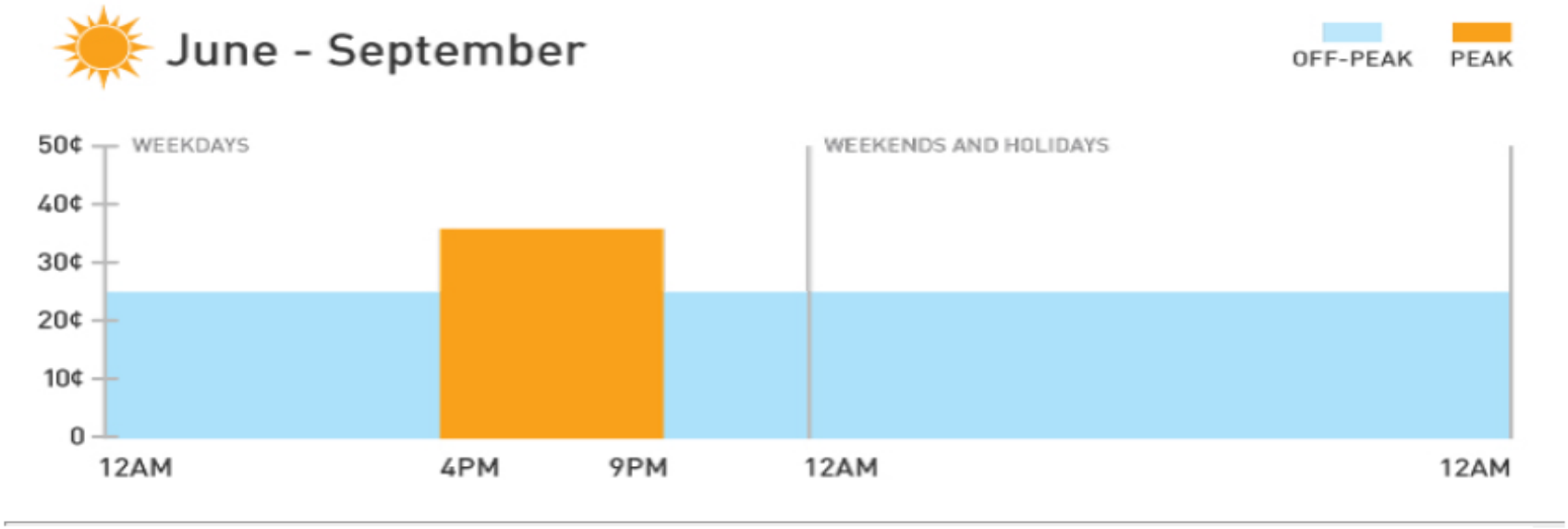
Each monthly billing period begins at the lowest price per kilowatt for your electric usage. Tiers are defined by usage amounts. Once you reach that allotted amount, you are moved into a higher priced tier.

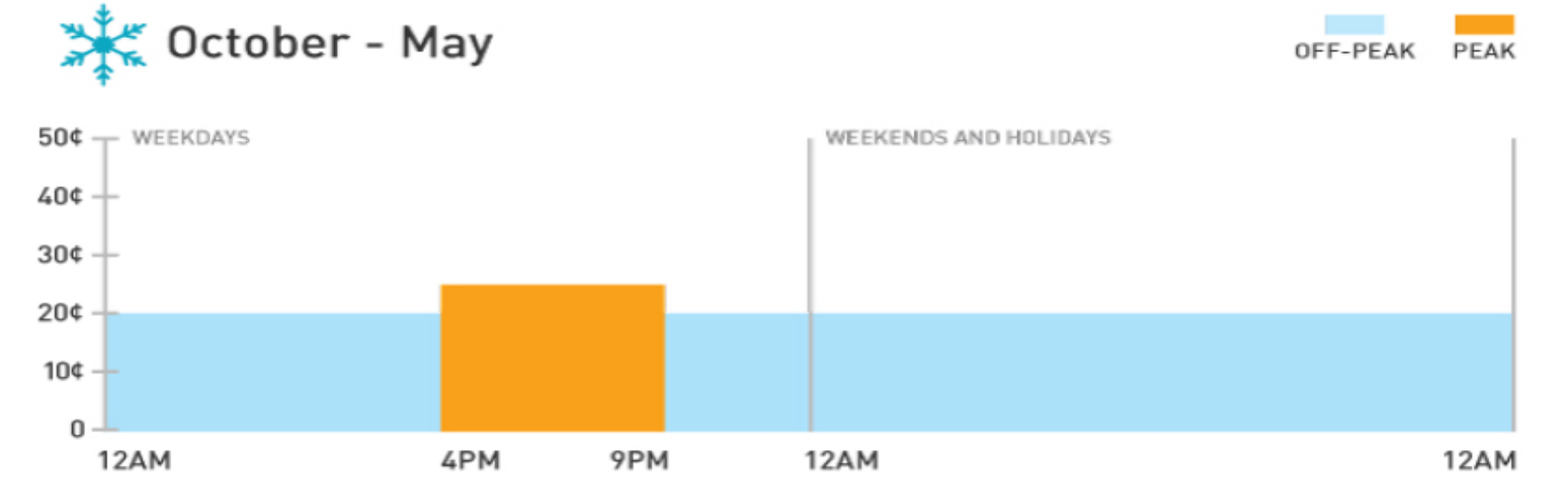


PG&E Time-of Use Rate 3-8 (ETOU-A)



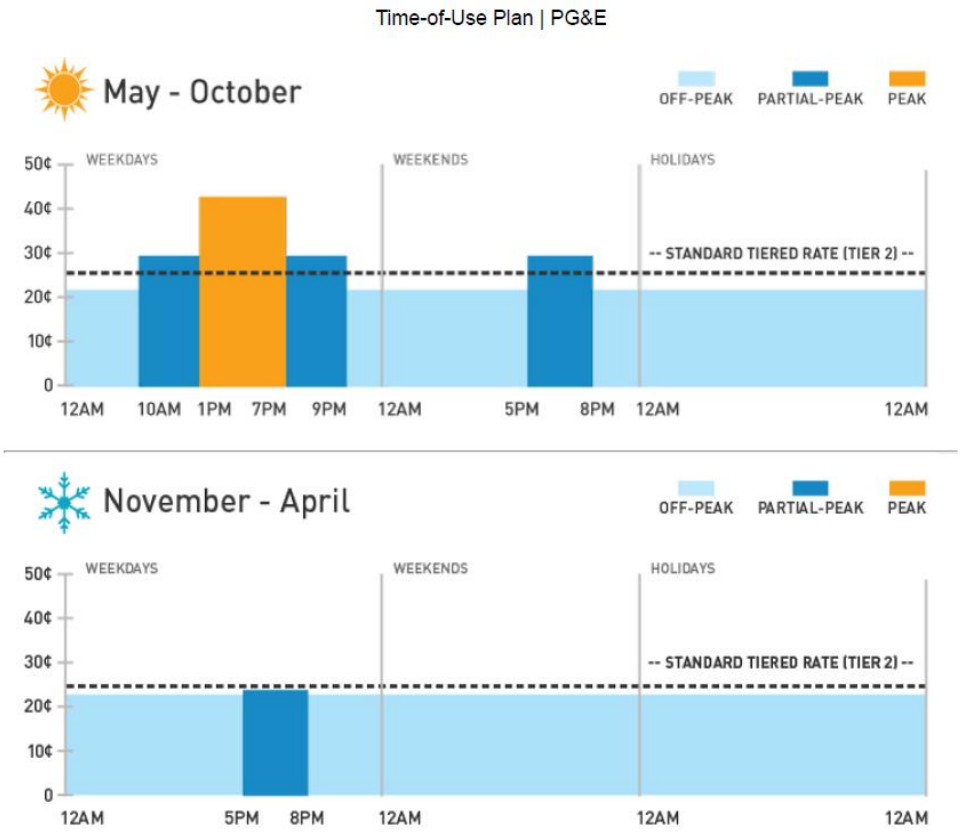
PG&E Time-of Use Rate 4-9 (ETOU-B)





PG&E Time-of-Use Rate (E6)

(Closed to new customers effective May 31, 2016)



Price Cent/Kwh

Time-of-Use	Tier 1	Tier 2	Tier 3
MAY - OCTOBER			
Peak	34.2	40.0	55.9
Partial-Peak	22.6	28.5	44.3
Off-Peak	15.0	20.8	36.7
NOVEMBER - APRIL			
Partial-Peak	17.1	23.0	38.8
Off-Peak	15.4	21.3	37.1
Tiered Rate Plan			
YEAR ROUND	18.2	24.1	40.0

Time-of-Use and Tiers

Like the Tiered rate plan, as you use the electricity allotments in each tier, you move to the next tier and higher prices.

SmartRate™ Add-on

Available with the Tiered and Time-of-Use Base Plan, the SmartRate™ Add-on discounts your summer rate in exchange for a higher rate, 2-7 p.m., on up to 15 SmartDays, May through October.

ELECTRIC SCHEDULE E-6
RESIDENTIAL TIME-OF-USE SERVICE

RATES: (Cont'd.)

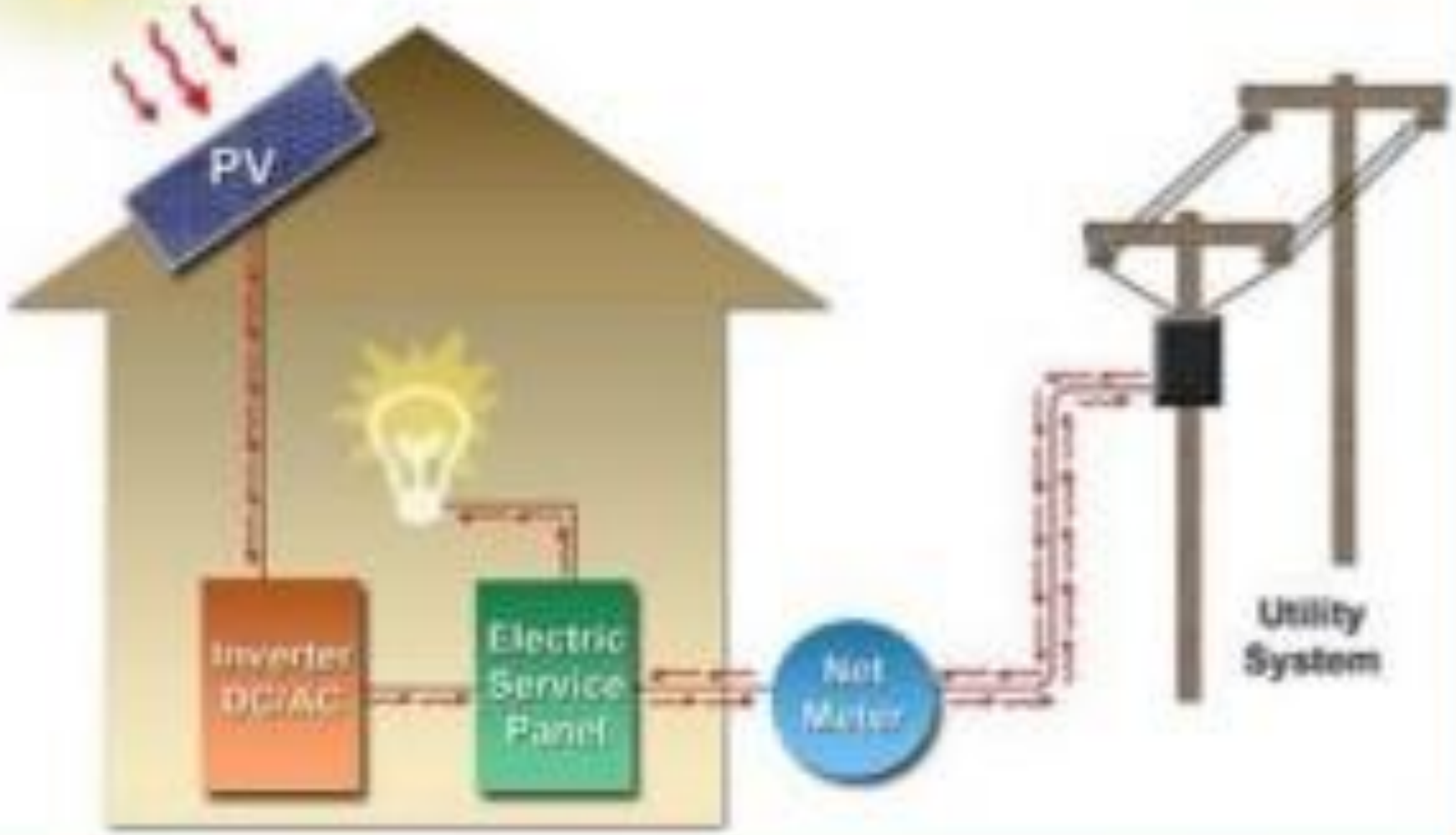
UNBUNDLING OF TOTAL RATES

Meter Charge Rates: Meter charge rates provided in the Total Rate section above are assigned entirely to the unbundled distribution component.

Energy Rates by Component ($ per kWh)	PEAK	PART-PEAK	OFF-PEAK
Generation:			
Summer	$0.21338	$0.11209	$0.07075
Winter	–	$0.09370	$0.08233
Distribution:**			
Summer	$0.24996 (I)	$0.09998 (I)	$0.04999 (I)
Winter	–	$0.09606 (I)	$0.06404 (I)
Conservation Incentive Adjustment:			
Summer			
Baseline Usage	($0.16902) (R)	($0.03302) (R)	($0.01847) (R)
101% - 130% of Baseline	($0.11024) (I)	$0.02576 (I)	$0.04032 (I)
131% - 200% of Baseline	($0.11024) (R)	$0.02576 (R)	$0.04032 (R)
201% - 300% of Baseline	$0.04795 (I)	$0.18395 (I)	$0.19850 (I)
Over 300% of Baseline	$0.04795 (I)	$0.18395 (I)	$0.19850 (I)
Winter			
Baseline Usage	–	($0.06632) (R)	($0.03976) (R)
101% - 130% of Baseline	–	($0.00754) (I)	$0.01902 (I)
131% - 200% of Baseline	–	($0.00754) (R)	$0.01902 (R)
201% - 300% of Baseline	–	$0.15065 (I)	$0.17721 (I)
Over 300% of Baseline	–	$0.15065 (I)	$0.17721 (I)
Transmission* (all usage)	$0.02144	$0.02144	$0.02144
Transmission Rate Adjustments* (all usage)	$0.00010	$0.00010	$0.00010
Reliability Services* (all usage)	$0.00023	$0.00023	$0.00023
Public Purpose Programs (all usage)	$0.01405	$0.01405	$0.01405
Nuclear Decommissioning (all usage)	$0.00022	$0.00022	$0.00022
Competition Transition Charges (all usage)	$0.00338	$0.00338	$0.00338
Energy Cost Recovery Amount (all usage)	($0.00002)	($0.00002)	($0.00002)
DWR Bond (all usage)	$0.00539	$0.00539	$0.00539
New System Generation Charge (all usage)**	$0.00255	$0.00255	$0.00255

Integration of DER at the Distribution Level Through Net Metering and Incentive Plans

Net Energy Metering 101



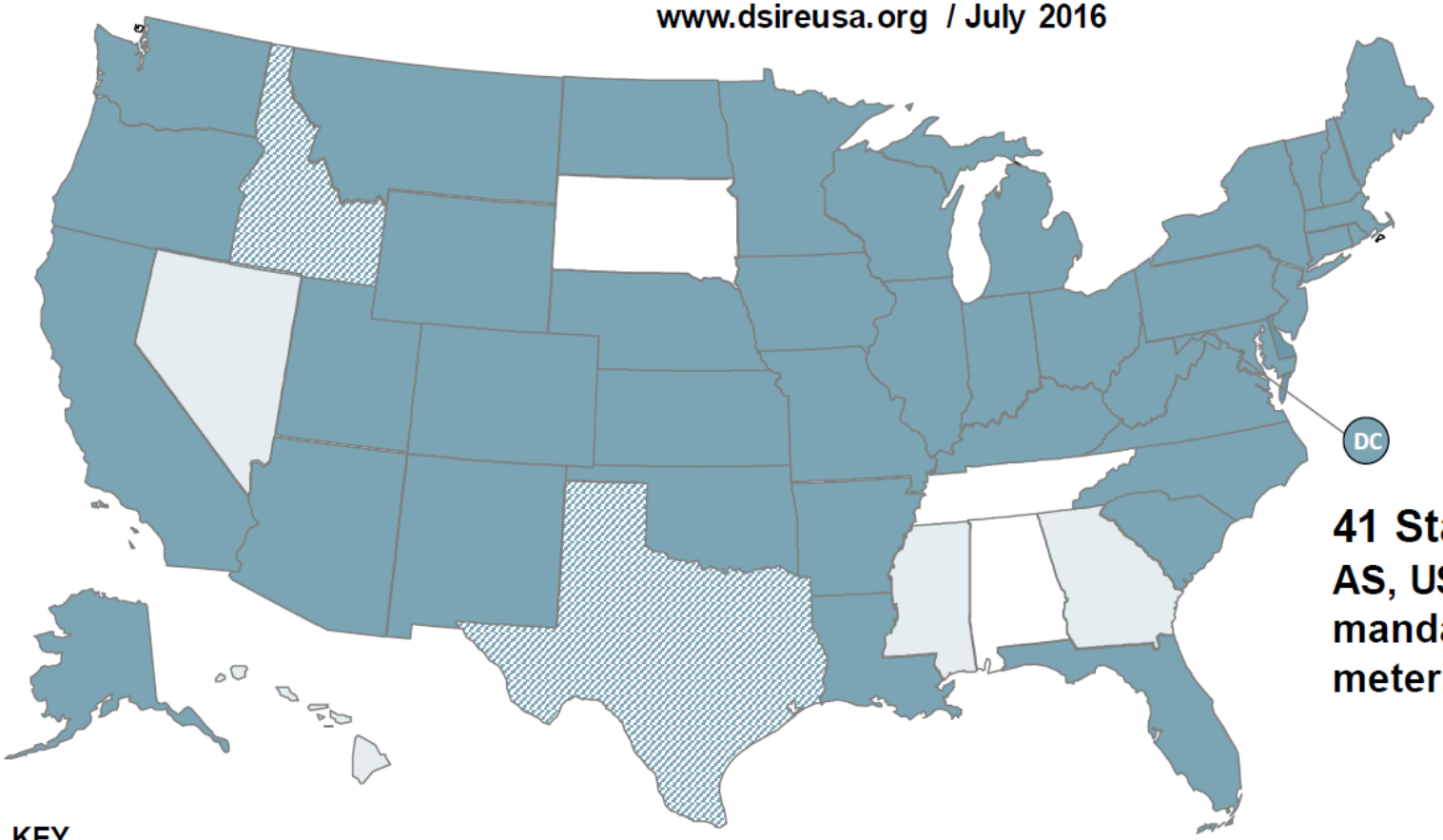
DSIRE®

NC CLEAN ENERGY TECHNOLOGY CENTER

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Net Metering

www.dsireusa.org / July 2016



41 States + DC, AS, USVI, & PR have mandatory net metering rules

KEY

- State-developed mandatory rules for certain utilities (41 states + DC+ 3 territories)
- No statewide mandatory rules, but some utilities allow net metering (2 states)
- Statewide distributed generation compensation rules other than net metering (4 states + 1 territory)

U.S. Territories:

AS | PR | VI | GU

California

Net Energy Metering (NEM)

- Customers who install small solar, wind, biogas, and fuel cell generation facilities (1 MW or less) to serve all or a portion of onsite electricity needs are eligible for the state's net metering program.
- NEM allows a customer-generator to receive a financial credit for power generated by their onsite system and fed back to the utility. The credit is used to offset the customer's electricity bill.
- Participation in NEM does not limit a customer-generator's eligibility for any other rebate, incentive, or credit provided by an electric utility, or as part of a governmental program
- NEM allows the customer to size their generation to meet their annual load instead of the peak demand (system provides effective storage to customer and enables more efficient use of customer capacity)
- NEM also reduces concerns about short term fluctuations in generation
- NEM provides a long term, predictable benefit tied to market value (bundled retail rates) for the customer, improving the financial viability of distributed generation (DG) investments.

Net Metering (cont'd)

- NEM allows customers to receive the fully bundled retail rate for generation that offsets load (coincident or non-coincident), and may be expanded to cover net excess generation.
- NEM program rules and regulations allow regulators and utilities to provide transparent, simplified and expedited interconnection procedures for small customers.
- NEM systems are primarily intended to offset onsite load, mitigating to some extent the impact on the Transmission and Distribution system, allowing for simplified interconnection procedures.
- Useful for encouraging interconnection of small to medium sized PV systems.
- NEM projects pay little to no charges to interconnect to the utility grid.
- NEM customers do pay "non bypassable" charges, but based on net rather than gross consumption.
  - Department of Water Resources surcharge
  - Public Goods Charge (to fund public goods research, development and demonstration,)
  - Energy efficiency activities
  - Low income assistance programs

NEM Billing (California)

- Electricity tariff billing mechanism designed to facilitate the installation of onsite renewable generation
- Under NEM tariffs, participating customers receive a bill credit for excess generation that is exported to the electric grid during times when it is not serving onsite load.
- On a month to month basis, bill credits for the excess generation are applied to a customer's bill at the same retail rate (including generation, distribution, and transmission components) that the customer would have paid for energy consumption, according to their otherwise applicable rate structure.
- At the end of a customer's 12 month billing period, any balance of surplus electricity is truedup at a separate fair market value, known as net surplus compensation (NSC).
- The NSC rate is based on a 12 month rolling average of the market rate for energy, or approximately $0.04 to $0.05 per kWh, (per Commission Decision (D.) 1106016 following AB 920)

Renewable Energy Credits (California)

- NEM customers who generate a balance of energy at the end of their 12month billing period are eligible to receive compensation for the renewable energy credits (RECs) associated with excess generation.
- This payment is equal to the net surplus kWhs multiplied by the Renewable Attribute Adder rate, which reflects an average premium utilities pay for renewable energy in order to comply with California's Renewable Portfolio Standard (RPS).
- To receive compensation for RECs, a customer-generator must register their generation facility with the Western Renewable Energy Generation Information System (WREGIS) and follow California Energy Commission eligibility guidelines for RPS

NEM Caps (California)

- Pursuant to AB 327, each large investor owned utility is required to offer NEM until the earlier of July 1, 2017, or the date on which the utility reaches its NEM program cap.
- The NEM program cap is reached when the total installed NEM capacity in a utility territory exceeds 5% of its aggregate customer peak demand
- Utility 5% NEM Cap (MW)
  - PG&E 2,409 MW (remaining as of, 3/2016, 435.4 MW)
  - SCE 2,240 MW (remaining as of, 3/2016, 643.7 MW)
  - SDG&E 607 MW (remaining as of, 3/2016, 34.1 MW)

NEM Aggregation and Virtual NEM

- California Senate Bill (SB) 594 authorizes NEM aggregation, in which an eligible customer-generator elects to aggregate the electrical load from multiple meters, and NEM credits are shared among all property that is attached, adjacent, or contiguous to the generation facility.
- A customer-generator must be the sole owner, lessee, or renter of the properties in order to utilize NEM aggregation. (e.g., an agricultural customer could use a single solar system to provide NEM bill credits to offset the electrical load from their home as well as from an irrigation pump located on an adjacent parcel.)
- SB 594 conditioned implementation of NEM aggregation for the three investor owned utilities on a Commission determination that the policy would not result in an increase in the expected revenue obligations of customers who are not eligible customer-generators.
- The Commission authorized investor owned utilities to implement NEM aggregation in Resolution E4610.
- NEM aggregation applications are counted towards the 5% NEM cap, and all other NEM restrictions apply.
- Virtual Net Metering (VNM) is a tariff available to multitenant properties that enables an owner of such property to allocate a solar system's benefits to tenants across multiple units.
- Current tariff rules allow the system owner to allocate bill credits of a percentage of the solar generation between common load areas and tenants along a single service delivery point.

Hawaii

HOUSE OF REPRESENTATIVES
TWENTY-SEVENTH LEGISLATURE, 2014
STATE OF HAWAII

HB1943 CD1 HMS 2014-3486-1

- Enable a diverse portfolio of renewable energy resources;
- Expand options for customers to manage their energy use;
- Maximize interconnection of distributed generation to the State's electric grids on a cost-effective basis at non-discriminatory terms and at just and reasonable rates
- Determine fair compensation for electric grid services and other benefits provided to customers by distributed generation customers and other non- utility service providers; and
- Maintaining or enhancing grid reliability and safety through modernization of the State's electric grids.

Too Much of a Good Thing

- Net Metering systems have increased by over 60 times the cap established by the initial 1996 legislation that set up the metering program. Program capacity now runs from 30% to 53% of system peak load, depending on the utility. Nearly 20% of all customers of the Oahu (HECO) and Maui (MECO) utilities have net metered DG.
- The Hawaii Public Utility Commission concluded that simple retail rate net metering credit is driving uncontrolled, undirected growth, and raising questions about cost shifting to non-solar customers.

Trending Hi-Pen Circuits (12kV) – Loch Ness Profile

Time-Series | Histogram | Scatter Plot

Legend

- Commercial Load profile
- Residential Load profile
- Residential Load profile
- Residential Load profile

Greatest PV production period
10am-2pm

1:00 3:00 5:00 7:00 9:00 11:00 13:00 15:00 17:00 19:00 21:00 23:00 1:00

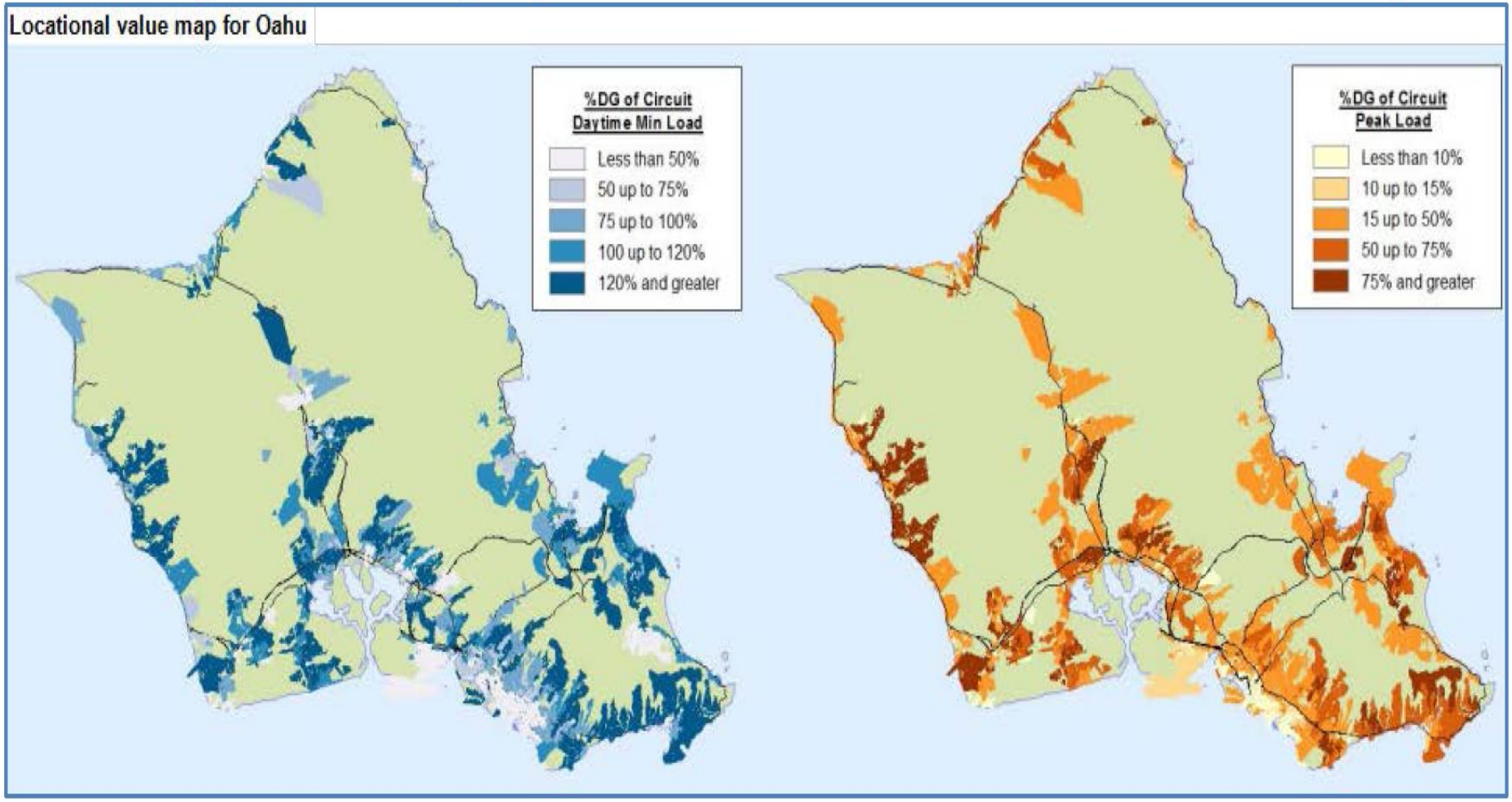
Sun Apr 29 2013 08:46:34.432 GMT-1000

Tue Apr 30 2013 01:00:02.000 GMT-1000

min hour day week 4w 52w | crop expand left right

Source: HECO

Density of Solar PV Systems on Electric Distribution Circuits
Percentage of DER During Daytime Minimum Loads (Left) and Maximum Loads (Right)



Source: EIA, "Hawaii's electric system is changing with rooftop solar growth and new utility ownership," *Today in Energy*, January 27, 2015.

Hawaii Regulators Discontinue NEM for Fooftop Solar

(October 12, 2015) .

- The Hawaii Public Utility Commission closed retail rate net energy metering (NEM) reimbursement programs from the Hawaiian Electric utilities to owners of solar and other distributed generation (DG).
- Electric programs capped at existing levels as of the release of the Oct. 12 decision
  - **lower remuneration rates put into place for new rooftop solar systems**
  - **Systems with existing retail rate net metering deals will be able to keep them for the life of their contracts.**
- The commission will consider further modifications (Phase 2) of DER policies to ensure Hawaii continues to benefit from the safe and reliable integration of these resources.
- In its order, the PUC stated that the state's high net metering credit has led to unprecedented DER penetration in a short period of time. “Extraordinarily high retail prices, combined with dramatic cost declines in renewable energy and storage technologies, have combined to transform the competitive landscape facing the State's electric utilities.”
- The commission concluded that simple retail rate net metering credit is driving uncontrolled, undirected growth, and raising questions about cost shifting to non-solar customers.
- Alliance for Solar Choice (TASC), a solar advocacy group, has filed suit against the PUC, requesting an injunction on the rooftop solar ruling.

New Solar Tariffs and TOU Rates Grid Supply Option

- Replaces NEM's retail rate credit for electricity sent to the grid by customers' solar systems.
- New tariff for each utility, based on the avoided costs of fossil generation during peak generation hours measured from July 2014 to June 2015.
  - $0.151/kWh for Oahu, $0.154/kWh for Hawaii, and $0.172/kWh for Maui.)
  - Compares to PPAs for new utility scale PV projects that range from $0.111/kWh to $0.145/kWh.
  - Reduces return on investment to 7.5 to 9% (depending on utility)
- Grid-supply tariff to be guaranteed for two years.
- To force right-sizing of rooftop installations, annual rollover of credits to be reduced to a monthly close-out.
- New residential solar owners will also face a minimum monthly bill of $25.

New Solar Tariffs and TOU Rates Self-Supply Option

- A synthesis of proposals from many proceeding stakeholders. Primarily aimed at creating solar owners who do not export their generation to the grid, but can provide grid support when needed.
- Allows system owners to earn retail rate credit in the form of reduced bills for generation that aligns with their energy demand patterns.
- Provides incentive for load shifting and behind the meter storage.
- Utilities are required to manage the self-supply option along with the streamlining of interconnection standards ordered by regulators.
- Utilities to file a new time-of-use (TOU) rate proposal according to its guidance.

New Time-of-Use Rates

- Time-of-use rate be an “opt-in” choice for customers and the design need to include three time periods, corresponding to the overall system peak period, a mid-day period, and an off-peak period.
- The mid-day period rate is to be set at a projected 2017 marginal cost of generation, while the peak period rate will be calculated by combining fixed generation, transmission, and distribution costs during peak hours.
- The off-peak rate will be a marginal generation cost adjusted so that the overall price change is neutral for average residential customers that do not change their consumption behavior in response to the new tariff.

Nevada

Nevada Ends Net Metering

- The Nevada PUC order of December 22, 2015, tripled the fixed charges solar customers will pay over the next four years, and reduced the credit solar customers receive for net excess generation by three-quarters.
- Under the new rates, Southern Nevada solar customers, who make up the vast majority of solar customers in the state, will see their monthly fixed charge increase incrementally from $12.75 to $38.51 by 2020. Over the same period, the net-metering credit will drop from 11 cents per kilowatt-hour to 2.6 cents per kilowatt-hour.
- Regulators said the order was designed to make solar customers pay their fair share for use of NV Energy's grid and it implements Nevada Senate Bill 374.

- Solar companies warned that the changes make rooftop solar economics unworkable. Shortly after the new rate took effect on January 1, SolarCity, Sunrun and Vivint all announced they would have to cease operations in the state. Local installers have also been forced to cut staff.
- The most controversial decision was to apply the changes retroactively to Nevada's nearly 18,000 existing solar customers, in addition to new ones. But grandfathering options are being reconsidered.
- On July 12, 2016 the Nevada Secretary of State certified a **Nevada Solar Rate Restoration Veto Referendum Question** on the November 8, 2016 general election ballot, for or against **repealing** the section of Senate Bill 374 that established a higher fixed fee for solar customers but on August 4, 2016 the Nevada Supreme Court ordered to remove the question from the ballot, citing biased language.

Back to California

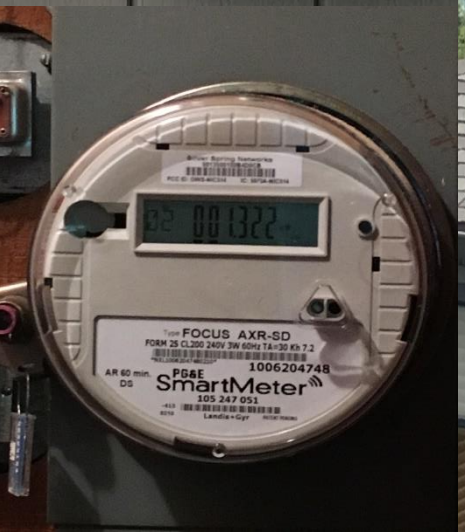
Final Decision Released On California's NEM 2.0 Program

- On January 28, 2016, the California Public Utilities Commission (CPUC) narrowly voted 3-to-2 to enact its net energy metering (NEM)
- For the past decade, the original California NEM program provided investor owned utility (IOU) customers that went solar with a full retail-rate credit for the surplus solar power they send back to the grid.
- As of September 30, 2015, over 410,000 customers had connected over 3,200 Megawatts of net-metered generation systems, making California the leading state for U.S. solar adoption.

New Elements to the NEM Successor Tariff

- New one-time interconnection fee: Requires NEM successor customers with systems under 1 MW to pay a reasonable, pre-approved interconnection fee.
  - **Utilities will propose the fee via Advice Letter based on actual historical interconnection costs. Likely to be approximately $75-$150.**
  - **Customers larger than 1 MW will pay all interconnection fees and upgrade costs.**
- Non-bypassable charges: NEM successor customers will pay non-bypassable charges on each kilowatt-hour (kWh) of electricity they consume from the grid.
  - **Non-bypassable charges fund important programs such as low income and efficiency programs.**
  - **All utility customers, except current NEM customers, pay non-bypassable charges on all energy they consume from the gird. Current NEM customers only pay on usage from the grid after NEM exports are subtracted.**
  - **Non-bypassable charges are equivalent to approximately 2-3 cents per kWh.**
- Time-of-use (TOU) rate: Residential NEM successor customers to take service on a TOU rate.


WARNING
ELECTRIC SHOCK HAZARD
THE DC CONDUCTORS OF
THE PV SYSTEM ARE
UNGROUNDED AND MAY
BE ENERGIZED.
SYSTEM CHARACTERISTICS
SOLAR DC
DISCONNECT


FOCUS AXR-SD
FORM 2S CL200 240V 3W 60Hz TA=30 Kh 7.2
1006204748
PG&E
SmartMeter
105 247 051


55
DAN

ENERGY STATEMENT

www.pge.com/MyEnergy

Account No: 5025909376-8
Statement Date: 05/07/2017
Due Date: 05/30/2017

Summary of Your NEM True-Up Period Charges

Service For: 57 HILL RD
Service Agreement ID: 5025909097
Rate Schedule: E6 TB Residential Time-of-Use Service

Summary of NEM Charges

Bill Period End Date	Net Peak Usage (kWh)	Net Part Peak Usage (kWh)	Net Off Peak Usage (kWh)	Net Usage (kWh)	Estimated NEM Charges Before Taxes	Estimated Taxes	Estimated Total NEM Charges
06/05/2016	-344	-108	352	-99	-$89.14	-$6.72	-$95.86
07/05/2016	-394	-140	239	-296	-135.76	-10.27	-146.03
08/04/2016	-419	-120	300	-238	-127.78	-9.66	-137.44
09/05/2016	-325	-34	348	-12	-66.87	-5.02	-71.89
10/04/2016	-269	8	339	77	-38.79	-2.88	-41.67
11/02/2016	-50	106	467	524	113.91	8.70	122.61
12/04/2016	0	123	497	620	131.04	10.01	141.05
01/04/2017	0	169	1028	1196	350.47	26.63	377.10
02/02/2017	0	173	905	1079	311.71	23.69	335.40
03/06/2017	0	131	757	889	228.99	17.43	246.42
04/04/2017	0	110	343	453	95.47	7.29	102.76
05/04/2017	3	50	527	580	126.97	9.70	136.67
TOTAL	-1798	468	6102	4773	$900.22	$68.90	$969.12

Differences in net usage may occur due to rounding

Electric Charges

Bill Period End Date	Minimum Delivery Charges	Energy Charges *
06/05/2016	$10.84	-$60.50
07/05/2016	9.86	-82.95
08/04/2016	9.85	-81.52
09/05/2016	10.51	-48.65
10/04/2016	9.52	-32.63
11/02/2016	9.53	34.56
12/04/2016	10.51	52.43
01/04/2017	10.18	100.65
02/02/2017	9.53	92.19
03/06/2017	10.51	75.82
04/04/2017	9.53	39.19
05/04/2017	9.85	48.88
TOTAL	$120.22	$137.47

* Please go to **pge.com/electricrates** to find the generation component of your Energy Charges.

Explanation of Calculations

This is your True-Up statement. You are being billed for your total NEM Charges Before Taxes minus your total electric Minimum Delivery Charges in addition to any applicable charges and taxes.

Since this is your **True-Up statement**, all electric usage charges and credits are reset to zero starting with your next billing cycle.

The Minimum Delivery Charge is billed monthly and credited at True-Up if the total NEM Charges Before Taxes are greater than your cumulative Minimum Delivery Charges.

Energy Charges are basic commodity costs related to energy usage. These charges will only be billed at True-Up if they are a positive amount and when the total NEM Charges Before Taxes are less than the sum of your total Minimum Delivery Charges and Energy Charges.

Based on your **Net Usage (kWh)**, the True-Up calculations are:

Total NEM Charges Before Taxes	$900.22
Total Electric Minimum Delivery Charges	-120.22
Taxes	59.88
Total NEM Charges Due	**$839.88**

ENERGY STATEMENT

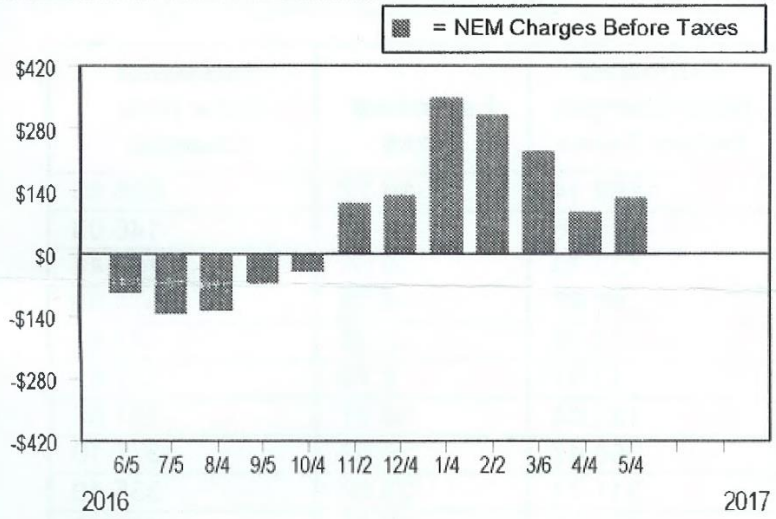
www.pge.com/MyEnergy

Account No: 5025909376-8
Statement Date: 05/07/2017
Due Date: 05/30/2017

Summary of Your NEM True-Up Period Charges (continued)

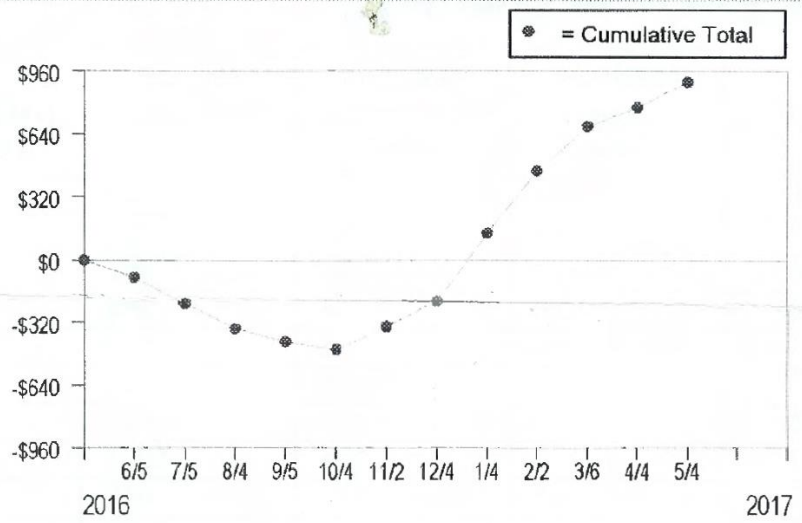
Service For: 57 HILL RD
Service Agreement ID: 5025909097
Rate Schedule: E6 TB Residential Time-of-Use Service

NEM Charges Before Taxes



Monthly NEM Charges
Monthly NEM Charges represent the cost of the electricity you use each month. You don't pay your monthly NEM balance each month. Instead, your Monthly NEM Charges are added up to calculate your Cumulative NEM balance, which you pay at True-Up.

Cumulative NEM Balance by Month



Cumulative NEM Balance
Cumulative NEM balance is a running total of your electricity costs and can increase or decrease depending on each month's use and generation. You only pay your Cumulative NEM balance at True-Up.

ENERGY STATEMENT

www.pge.com/MyEnergy

Statement Date: 05/07/2017

Due Date: 05/30/2017

Details of NEM Charges

04/05/2017 - 05/04/2017 (30 billing days)

Service For: 57 HILL RD
Service Agreement ID: 5025909097
Rate Schedule: E6 TB Residential Time-of-Use Service
Enrolled Programs: Net Energy Metering (NEM)

04/05/2017 – 04/30/2017

Tier 1 Allowance	221.00	kWh	(26 days x 8.5 kWh/day)	
Tier 1 Net Usage				
Part Peak	15.020000	kWh	@ $0.18845	$2.83
Off Peak	205.980000	kWh	@ $0.17162	35.35
Tier 2 Net Usage				
Part Peak	17.450800	kWh	@ $0.26478	4.62
Off Peak	239.175200	kWh	@ $0.24795	59.30
Energy Commission Tax				0.14
Berkeley Utility Users' Tax (7.500%)				7.66

05/01/2017 – 05/04/2017

Tier 1 Allowance	28.00	kWh	(4 days x 7.0 kWh/day)	
Tier 1 Net Usage				
Peak	0.840000	kWh	@ $0.35933	$0.30
Part Peak	4.760000	kWh	@ $0.24406	1.16
Off Peak	22.400000	kWh	@ $0.16728	3.75
Tier 2 Net Usage				
Peak	2.263200	kWh	@ $0.43566	0.99
Part Peak	12.727000	kWh	@ $0.32039	4.08
Off Peak	59.882800	kWh	@ $0.24362	14.59
Energy Commission Tax				0.03
Berkeley Utility Users' Tax (7.500%)				1.87

Monthly NEM Charges **$136.67**

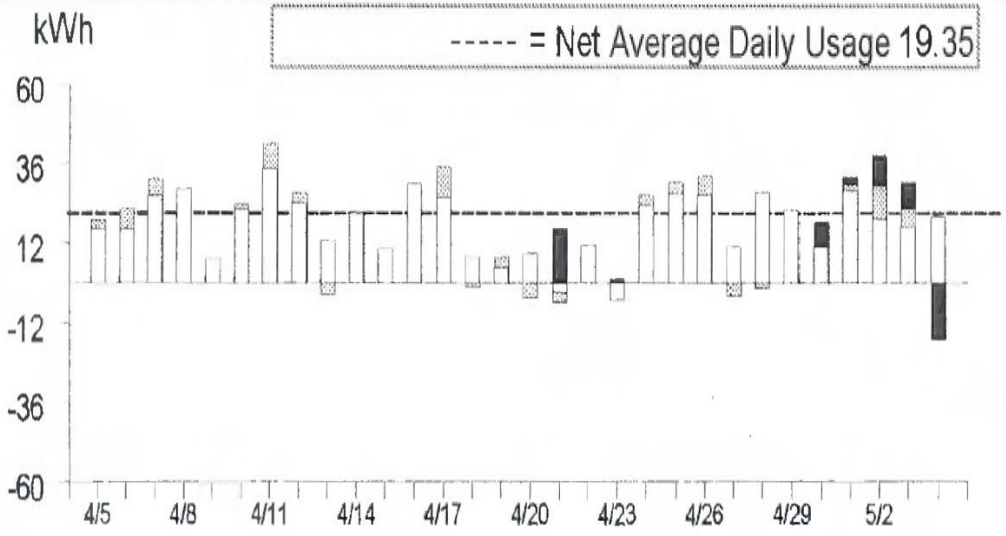
Service Information

Meter #	1006204748
Consumption	940.988600 kWh
Net Generation	-360.489600 kWh
Total Usage	580.499000 kWh
Baseline Territory	T
Heat Source	Not Electric
Serial	L
Rotating Outage Block	50

Additional Messages

PLEASE NOTE: You are enrolled in a Tiered rate plan where the price of energy increases based on the amount of energy used. Effective **March 1**, your rate plan will be simplified and the number of tiers will be reduced from 3 to 2. For more information please visit: **pge.com/tierchange**

Net Electric Usage This Period: 580.499000 kWh, 30 billing days



Energy Charges	
Peak[1]	$1.29
Part Peak[2]	$12.69
Off Peak[3]	$112.99

[1]**Peak:** 5/1-10/31 1:00pm-7:00pm, M-F;
[2]**Part Peak:** 5/1-10/31 10:00am-1:00pm, 7:00pm-9:00pm, M-F; 5:00pm-8:00pm, Sat-Sun; 11/1-4/30 5:00pm-8:00pm, M-F;
[3]**Off Peak:** All Other Hours (including Holidays)

ENERGY STATEMENT

www.pge.com/MyEnergy

Account No: 5025909376-8
Statement Date: 05/07/2017
Due Date: 05/30/2017

Details of Electric Monthly Charges

04/05/2017 - 05/04/2017 (30 billing days)

Service For: 57 HILL RD
Service Agreement ID: 5025909097
Rate Schedule: E6 TB Residential Time-of-Use Service
Enrolled Programs: Net Energy Metering (NEM)

04/05/2017 – 04/30/2017

Minimum Delivery Charge[1]	26 days	@ $0.32854	$8.54
Berkeley Utility Users' Tax (7.500%)			0.64

05/01/2017 – 05/04/2017

Minimum Delivery Charge[1]	4 days	@ $0.32854	$1.31
Berkeley Utility Users' Tax (7.500%)			0.10

Electric Monthly Charges **$10.59**

NEM True-Up Charges

05/04/2016 – 05/04/2017

Total NEM Charges Before Taxes	$900.22
Total Electric Minimum Delivery Charges	-120.22
Energy Commission Tax	1.38
Berkeley Utility Users' Tax (7.500%)	58.50

Total NEM Charges **$839.88**

Service Information

Meter #	1006204748
Consumption	940.988600 kWh
Net Generation	-360.489600 kWh
Total Usage	580.499000 kWh
Baseline Territory	T
Heat Source	Not Electric
Serial	L
Rotating Outage Block	50

Questions?