Building a Low-Carbon Electric System

Andy Tang
Senior Director, Products
Integrated Demand-side Management

Bill Devereaux
Senior Director
SmartMeter™ Program

Pacific Gas and Electric Company

Pacific Gas and Electric Company

Energy services to 15 MM people:

- 5.1 MM Electric customer accounts
- 4.3 MM Natural Gas accounts

70,000 square miles with diverse topography and climate zones

20,000 employees

A regulated investor-owned utility

5% of US population, 1% of emissions

Newsweek GREEN RANKINGS 2009

Ranked the greenest utility in the United States

A Recognized Environmental Leader

Sample of over 30 environmental awards received in 2008-2010:

Corporate Knights Global 100 Most Sustainable Corporations – Ranked #2

Newsweek's Greenest Big Companies in America – Ranked #1 Utility

Solar Electric Power Association - 2008 Top Ten Utility Solar Integration Rankings

U.S. Environmental Protection Agency – ENERGY STAR® Sustained Excellence Award

Association of Energy Services Professionals (AESP) – Outstanding Achievement in Program Innovation

A Highly Diverse Customer Base

5.3 million residential customers, speaking 88 languages, living in two distinct environments:

Coastal communities / Bay Area:

- Urban and suburban, compact housing
- Temperate coastal summer climate
- Higher incomes and cost of living

Inland communities:

- Suburban and Rural, larger homes
- Hot inland summer climate
- Lower incomes and cost of living

Highly Diverse Energy Needs




- Agriculture & Food Processing
- Government
- Hospitality
- Health Care
- Biotech
- High Tech
- Industrial
- Wholesale Warehouses
- Office Buildings
- Retail
- Schools & Colleges
- Builders

300,000 Commercial and Industrial Customers

40,000 agricultural customers, producing 50% of all produce supplied in America

A Challenging Economy

- Seasonally adjusted California unemployment rate - **12.3%,** June 2010 (U.S. – 9.5%)[1]
  - unemployment projections for the Valley range from **17-22%[1] – Expected to increase**
  - **22 of the 25 California counties** with highest unemployment rates are in PG&E's service territory[1]
- **18 of the 25 California counties** hardest hit by foreclosures are in PG&E's service territory[2]
- Number of people unemployed 27 weeks or more increased by 106.8% since June 2009[1]
- The 2nd worst economy in the U.S. is in **Merced**[3]

1 California EDD- www.labormarketinfo.edd.ca.gov June 2010
2. www.realtytrac.com (June 2010)
3. 2/18/10 USA Today article "Recession sometimes takes uneven toll"

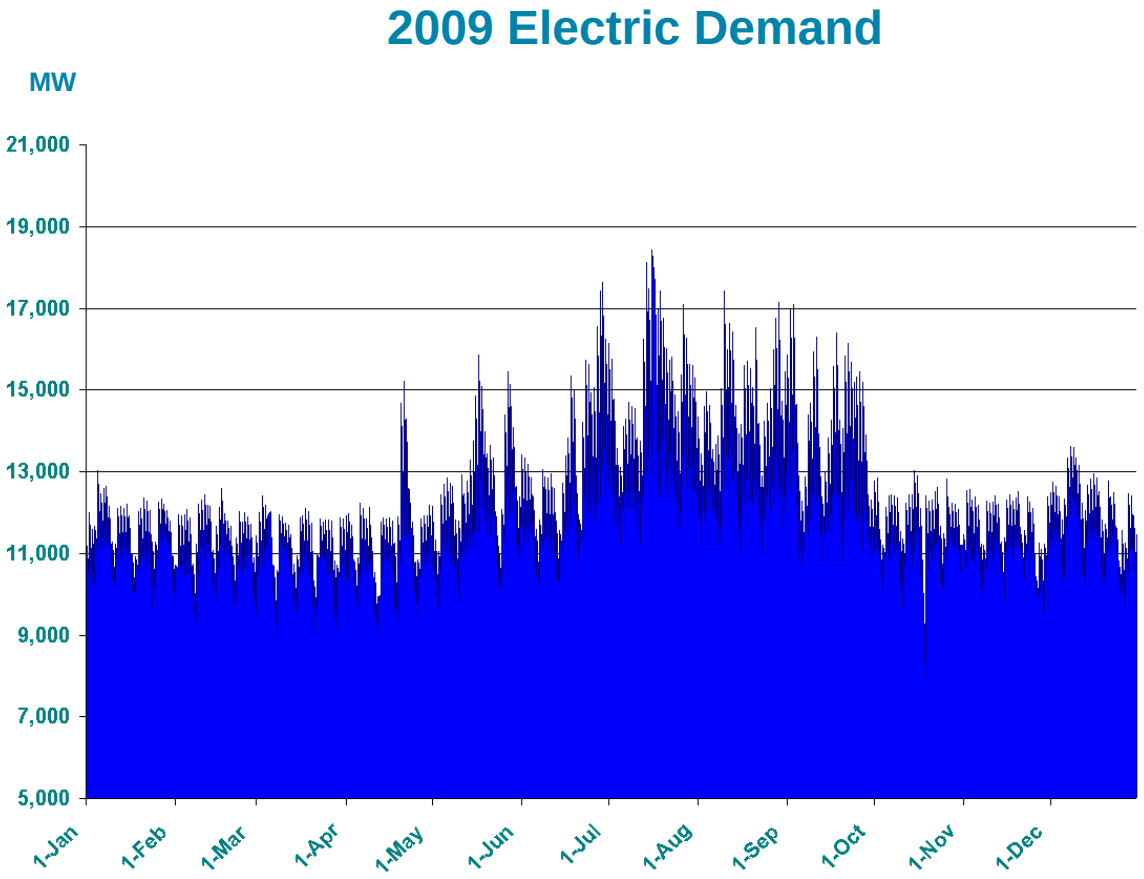
PG&E's Electric System:
Peaky Demand = Frequently Idle Capacity

Temperate climate with summer extremes

Summer demand can spike briefly to ~2X normal demand

Significant capacity sits idle most of of the time:

- 5% of CA capacity used only 50 hours per year
- 25% of CA capacity used only 10% of the time



Forward Thinking Energy Policies

30+ years of energy efficiency programs facilitated by "decoupling"

Renewable Portfolio Standard:

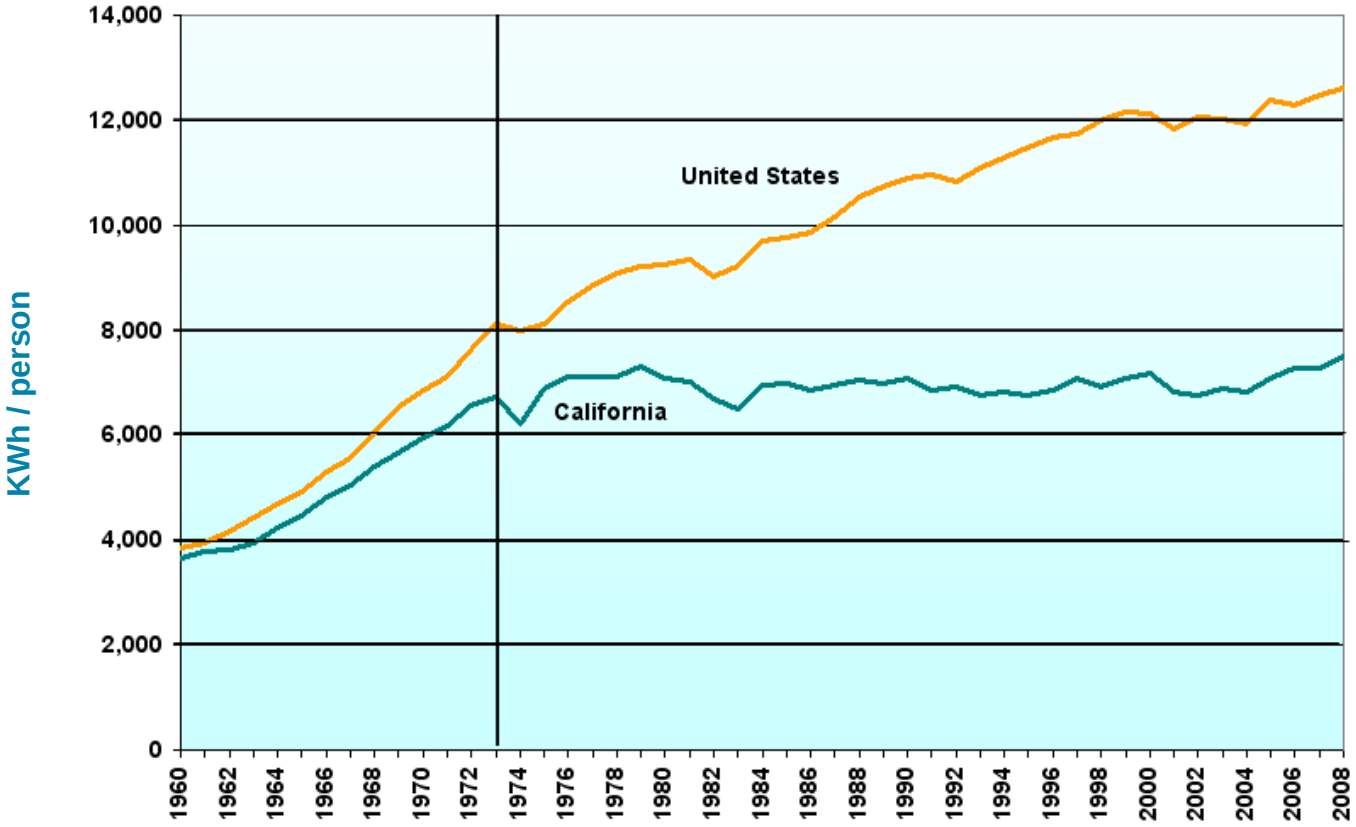
20% by 2010

33% by 2020

Preferred loading order:

1. Demand reductions: energy efficiency, demand response
2. New renewable and distributed generation
3. Clean gas-fired power plants

Legacy Of Energy Leadership



California Energy Commission

California per capita energy use has remained relatively flat, compared to the 50% increase in U.S. per capita energy use since 1974

Balancing Competing Priorities

Environmental Sustainability

Reliable Service

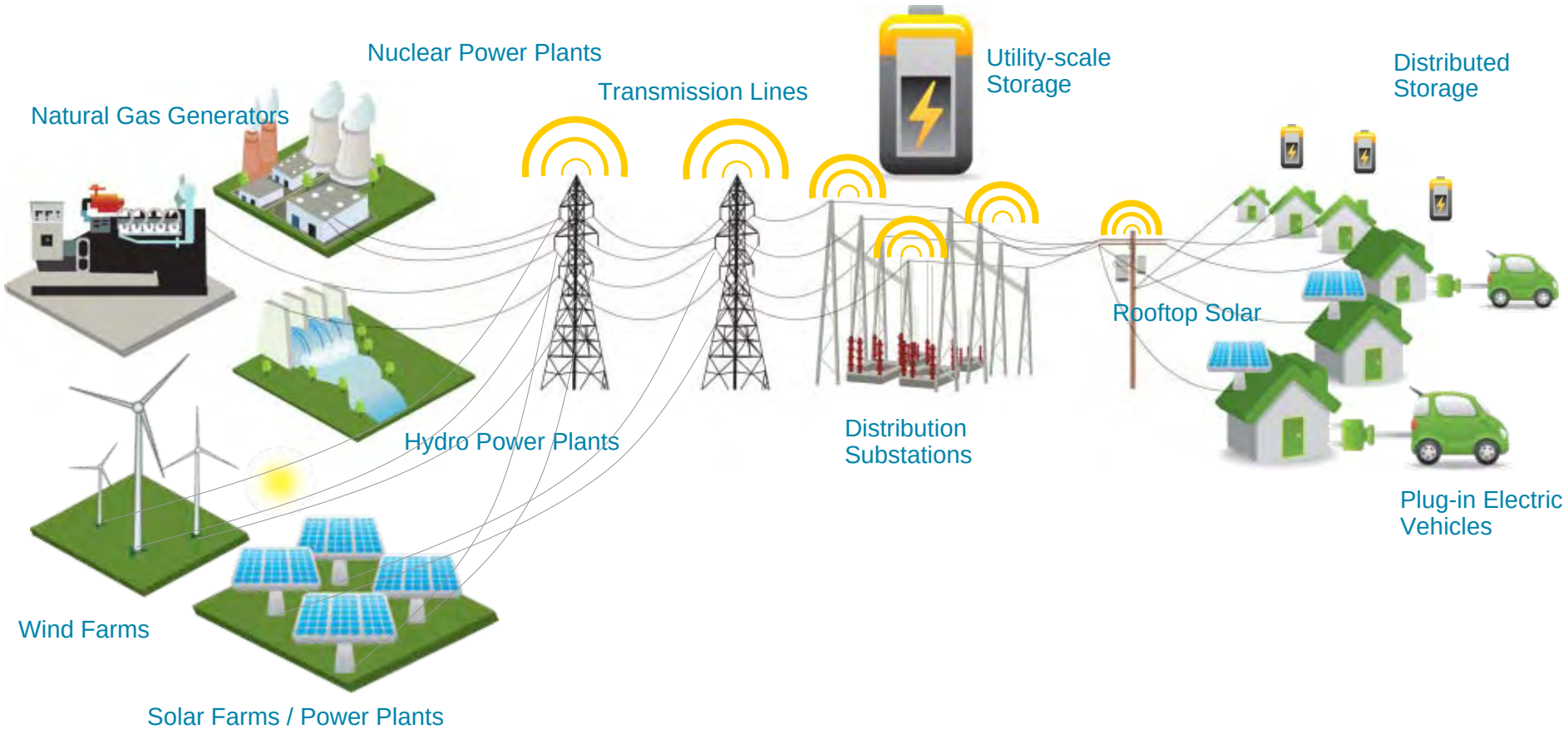
Reasonable Cost

Building A Sustainable Electric System

Power Plants

Electric Grid

Customers



A Smart Grid

Overlay with intelligence and automation

Sense	Communicate	Compute	Control

Power Plants

Transmission Networks

Substations

Distribution Networks

Consumers

Utility-scale Renewables

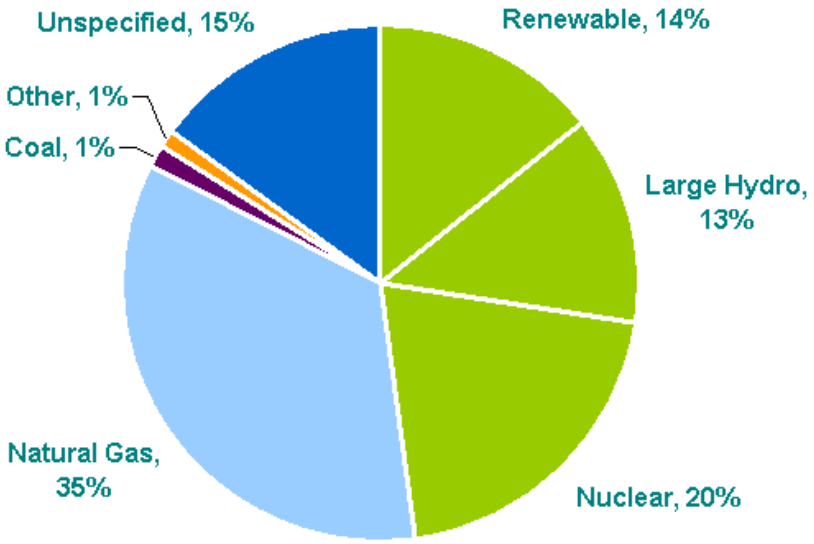
California's Renewable Portfolio Standard (RPS)

California has most aggressive RPS goal in the nation

2002	Legislative mandate for **20% by 2017 RPS** Only "eligible renewables" counted
2006	RPS accelerated to **20% by 2010, with flexible compliance**
2009	33% RPS by 2020 vetoed by the Governor
Sept. 2009	Governor's Executive Order directs the CA Air Resources Board to adopt regulation to support **33% by 2020** RPS
Sept. 2010	CA Air Resources Board adopts 33% by 2020 RPS

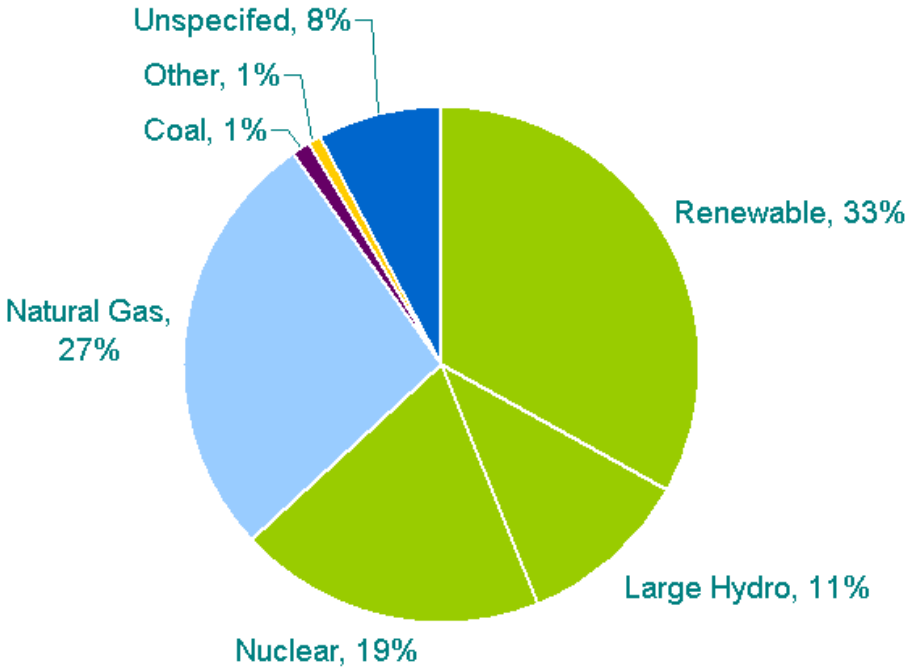
A Growing Reliance On Renewables

2009



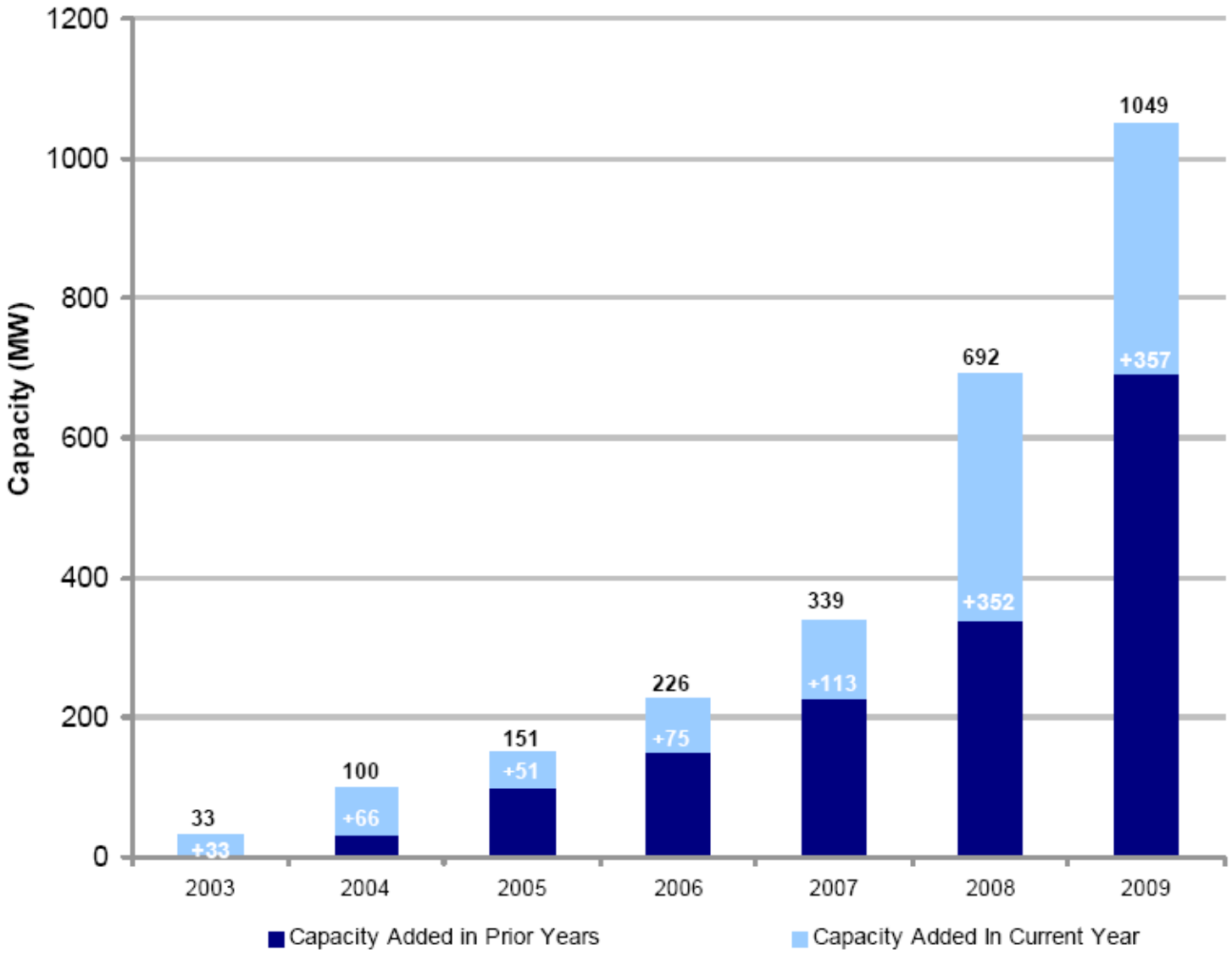
47% Non-emitting

2020



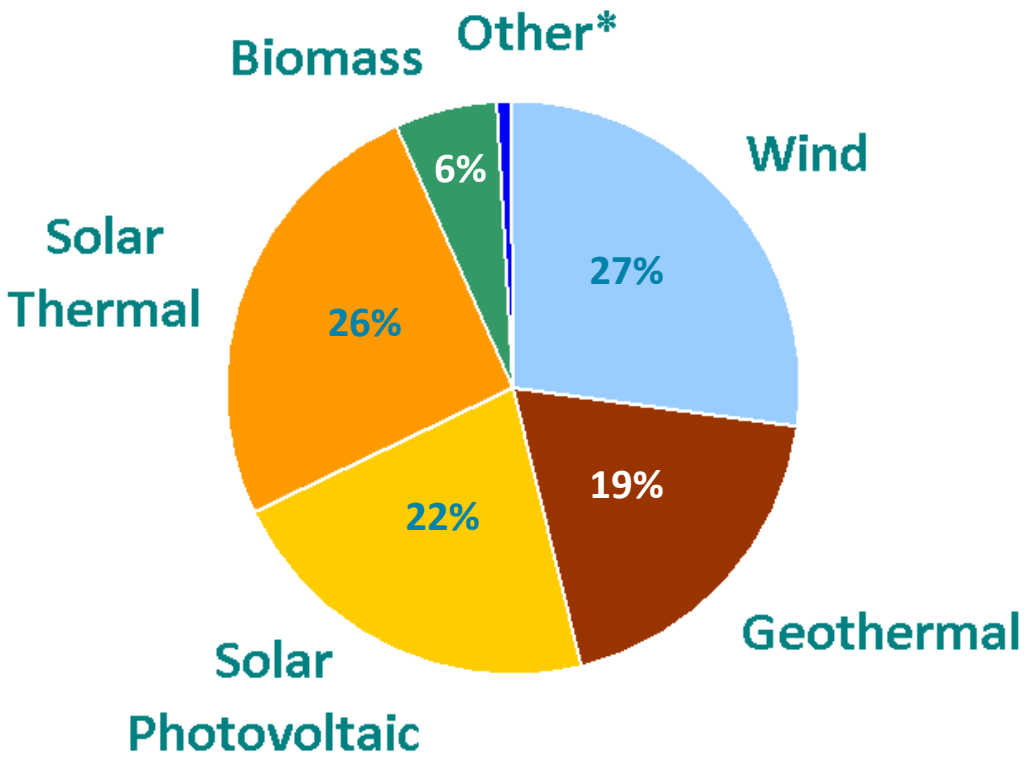
~63% Non-emitting

RPS Capacity Installed Since 2003



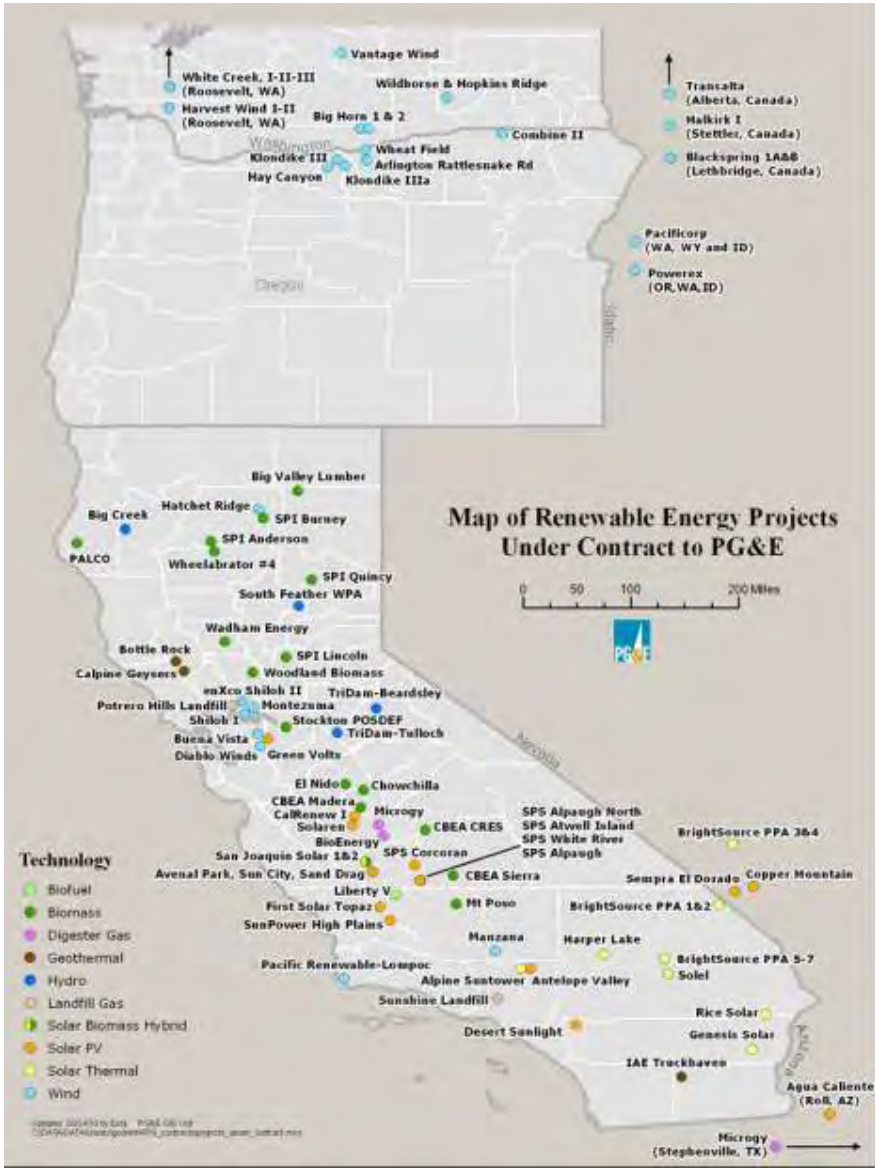
Source: California Public Utilities Commission, 1st Quarter 2010

Diverse Mix of RPS Contracts



% of MWh contracted

As of September 2010

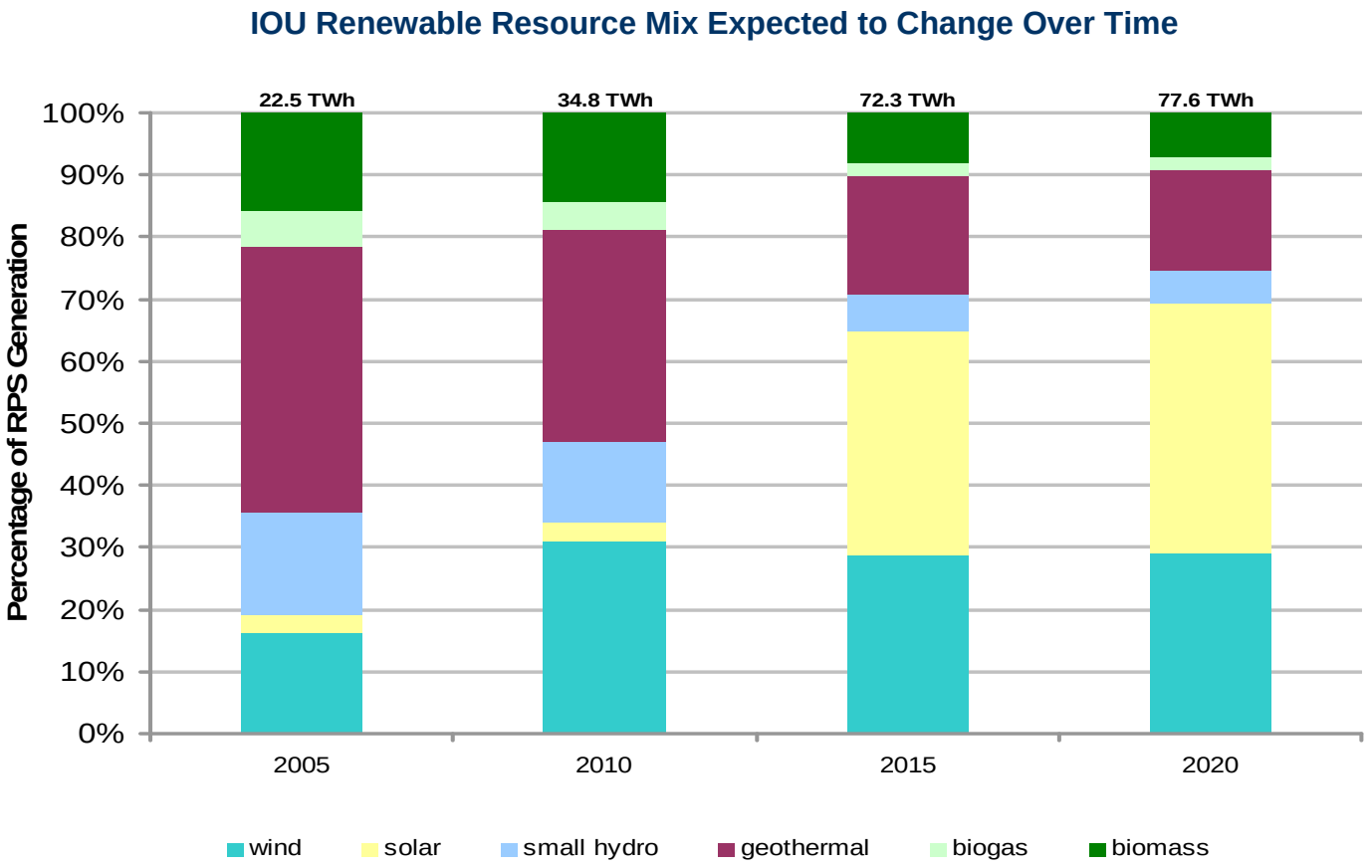


* Other (1%): Small Hydro, Biogas, Landfill Gas, Ocean\Tidal\Wave

RPS Generation by Fuel Type

Wind and geothermal largest contributors to 2010 RPS generation

Solar increases significantly in the next ten years



Source: California Public Utilities Commission, 3rd Quarter 2009

A Diverse Portfolio Utility-scale Solar Technologies

250-MW Parabolic Trough

1,310 MW Power Tower

550-MW Cd Te PV

Illustrative

250 MW Dispersed PV
(1-20 MW ea) (PPA)

Illustrative

250 MW Dispersed PV
(1-20 MW ea) (owned)

Illustrative

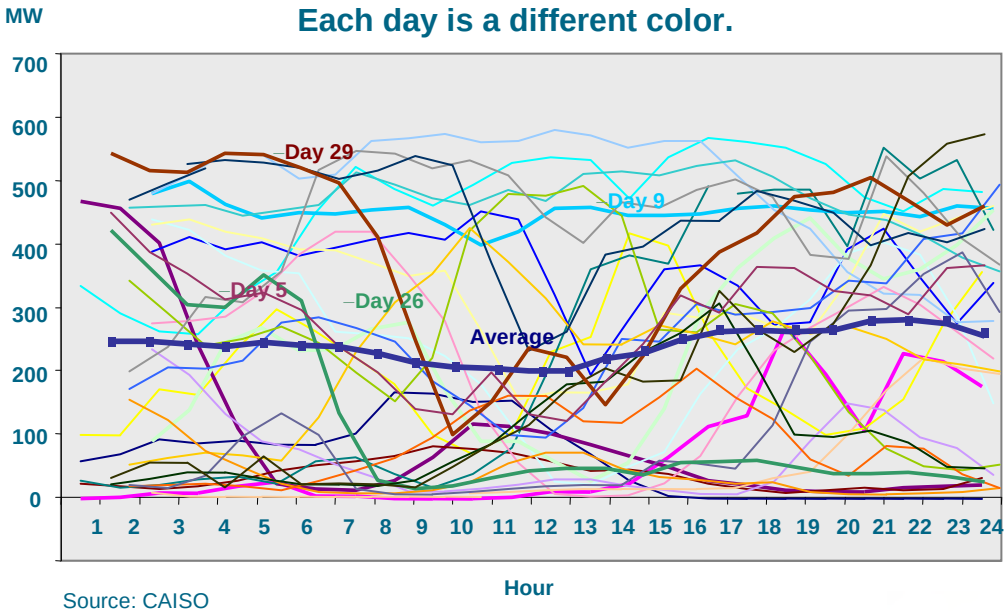
210 MW c-Si Tracking PV

Expanding PG&E Ownership Of Renewables

“Hybrid” Photovoltaic (PV) Program

- 5-Year Program
- 1.3% of PG&E’s RPS requirement by 2014
- **500 MW of 1 to 20 MW** photovoltaic installations
  - Up to 250 MW utility-owned generation
  - Up to 250 MW of PPAs
- PG&E to build its installations on land owned by utility, or near existing substations
- CPUC pre-approves terms of PPAs; pricing through competitive solicitation

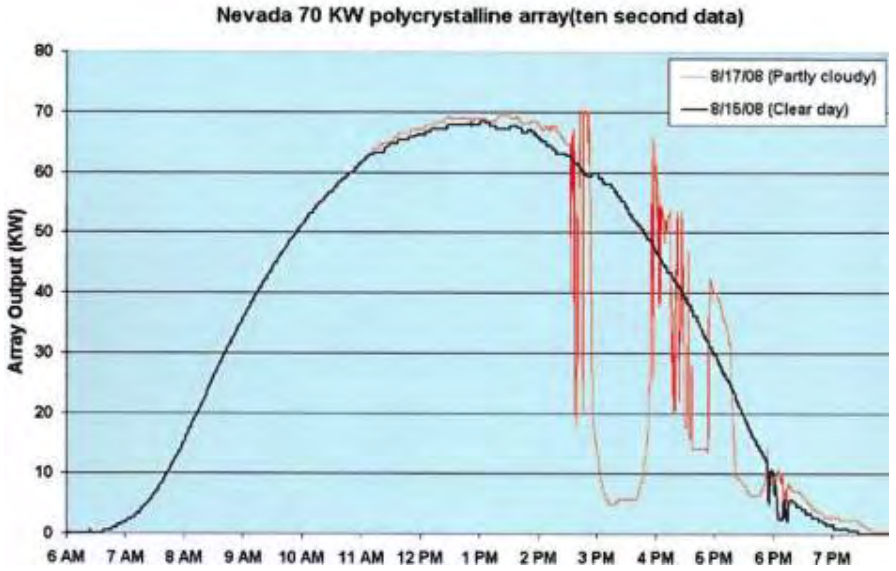
Renewable Intermittency Challenge



Source: CAISO

Smooth average, but significant day-to-day variability

Rapid variation in output due to cloud cover



Engaged Customers

Electric Demand is a Balancing Resource

Renewable Resources

Smart Grid

Balancing Resources

Demand-side Resources

Storage

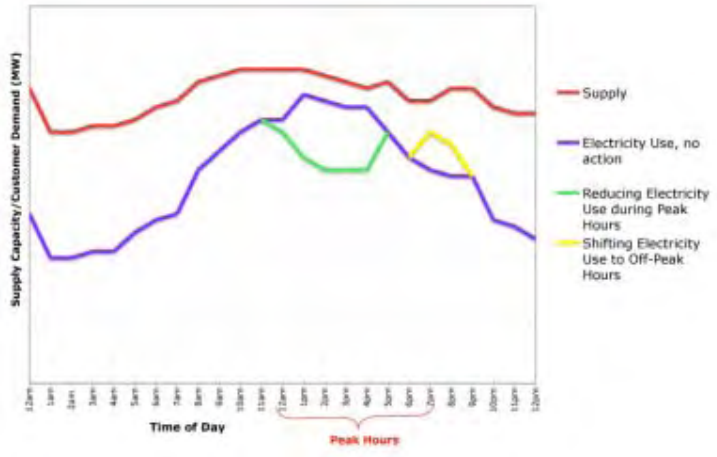
Back-up Generation

Demand-Side Resources

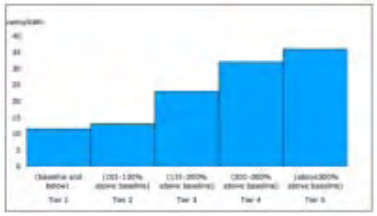
Conservation

Energy Efficiency

Demand Response



Energy Conservation



California policy to promote less electricity use through a tiered rate structure

Customer education and outreach to promote energy awareness and a conservation ethic

- Awareness campaigns (e.g. “We can do this”)
- Tips for using less energy (brochure, bill inserts)
- Carbon footprint calculator
- Energy awareness month, Earth Day
- *Energenius* energy curriculum for schools

PG&E Energy Efficiency Portfolio

Since 1976, PG&E's energy efficiency programs have:

- **Saved 155 million MWH and 12.5 billion therms**
- **Helped California avoid building 24 large power plants**
- **Saved customers over $24 billion**
- **Avoided 155 million tons of $C0_2$ emissions**

Our services include:

- Financial incentives and rebates
- Training and education
- Energy audits and technical assistance
- Energy codes and standards support
- Low income energy efficiency programs

Channels:

- Utility programs
- Local government partnerships
- Third-party implementers

PG&E Demand Response Portfolio

Programs

- Price-responsive
- Reliability

Sample Program Components

- kW load reduction
- Contract period
- Eligibility (e.g. size, meter)
- Curtailment window
- Event trigger
- Notification time
- Incentive payment
- Non-compliance penalties
- Enabling technology

Business Programs

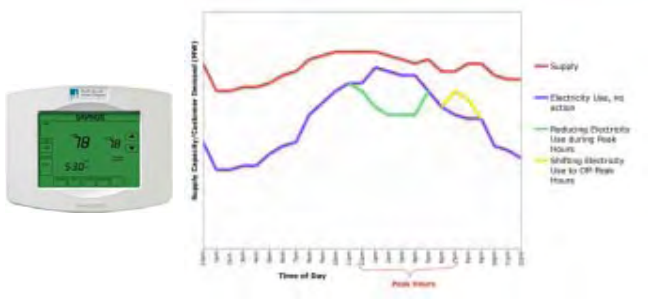
- Peak Choice
- Aggregator (retail, bilateral)
- Optional Bidding Mandatory Curtailment
- Scheduled Load Reduction
- Base Interruptible
- Critical Peak Pricing

Residential Programs

- Smart AC

Enabling Technology Programs

- Technology Incentive
- Automated Demand Response
- Permanent Load Shift



SmartMeter™ Program Technology Foundation

Automated meter reading for all gas and electric customers

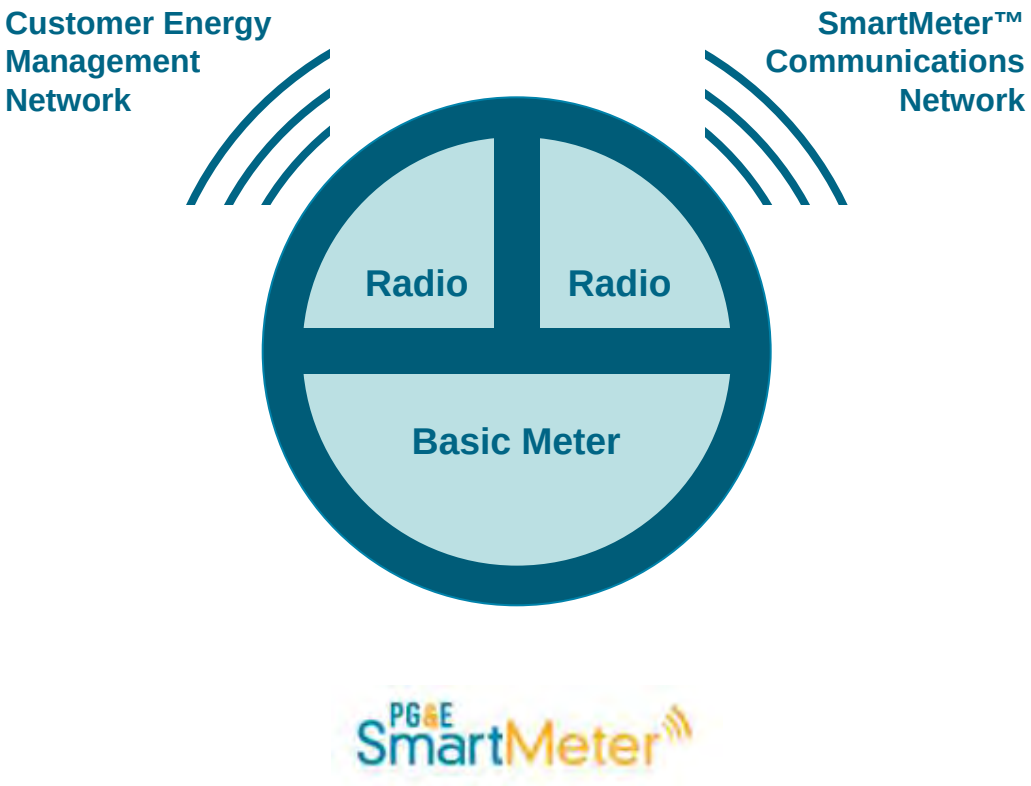
- 5 million advanced meters installed
- 10 million by mid-2012

Frequent meter reads

- Hourly intervals for electricity
- Daily intervals for gas

Customer benefits today and a platform for future innovation

Advanced Electric Meter



Solid-state technology

Integrated remote connect / disconnect, load-limiting switch

In-premise network gateway

How the SmartMeter™ System Works

Communication between the meter, PG&E and customers

Secure wireless network technology

Electric meters transmit data once per hour, for usually less than one second

Neighborhood network access point, usually on a street lamp or utility pole – data is then relayed periodically to PG&E

SmartMeter Timeline

2005: 5000 Meter Pilot

2006: Full Deployment Launch

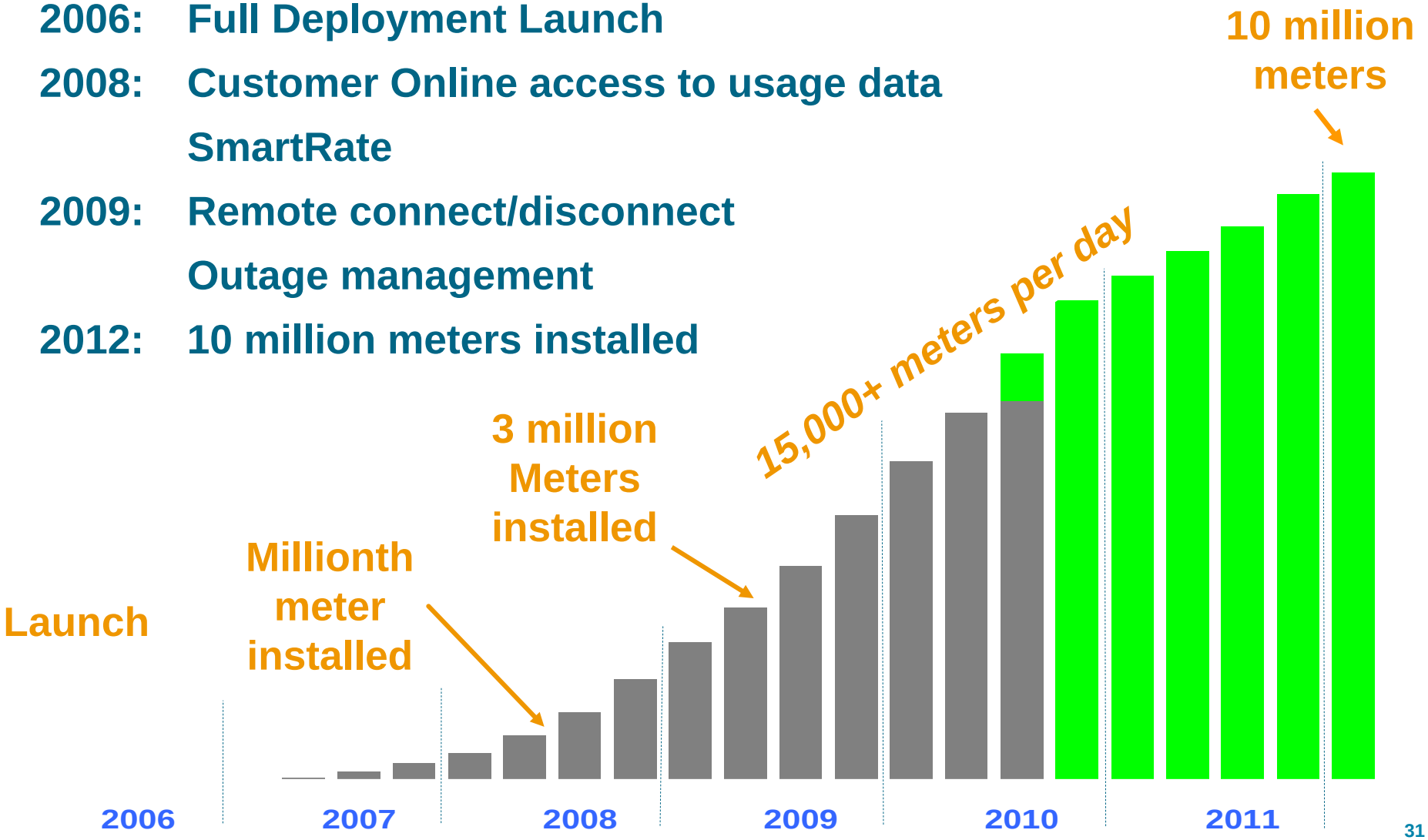
2008: Customer Online access to usage data

SmartRate

2009: Remote connect/disconnect

Outage management

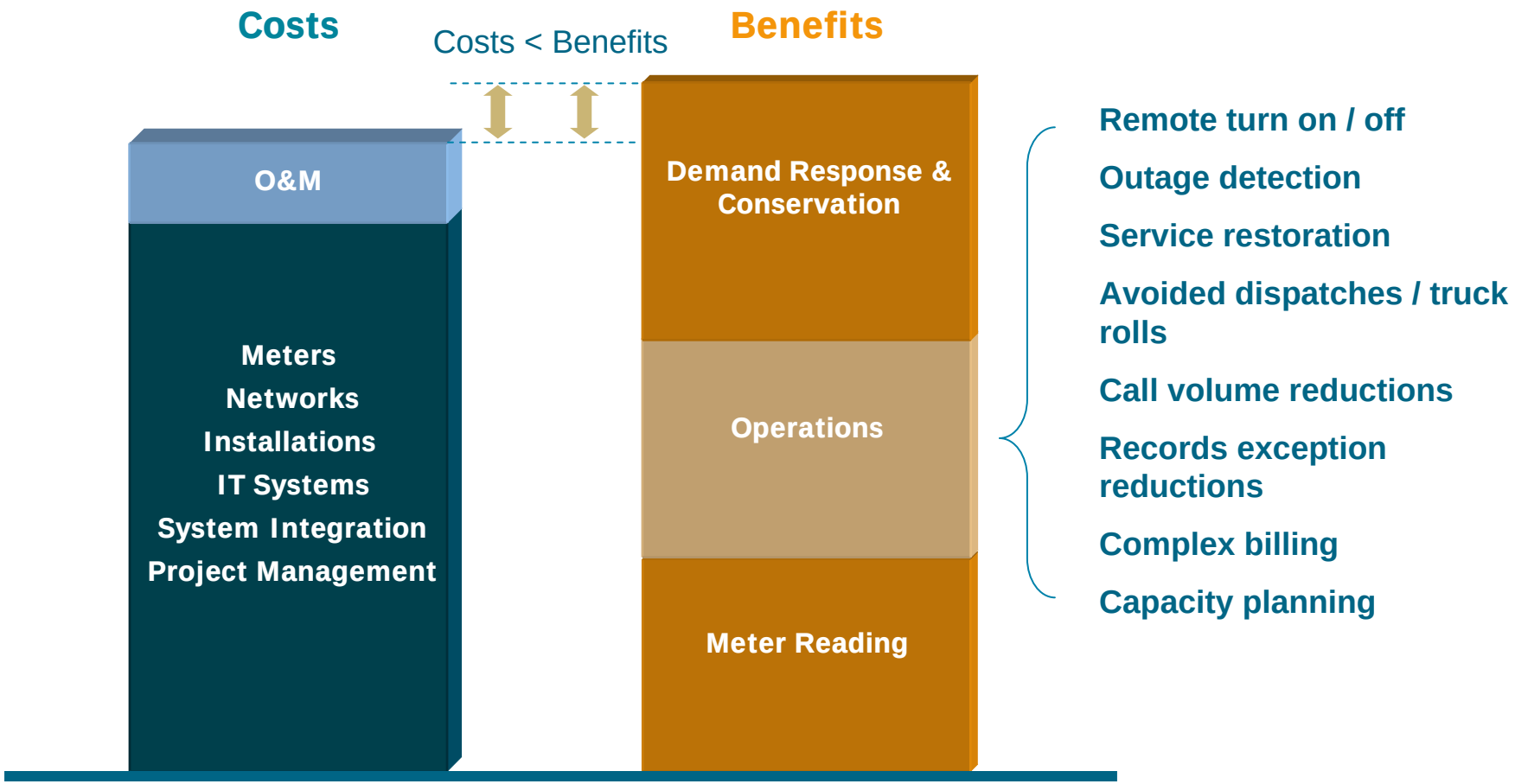
2012: 10 million meters installed



Where We are Now

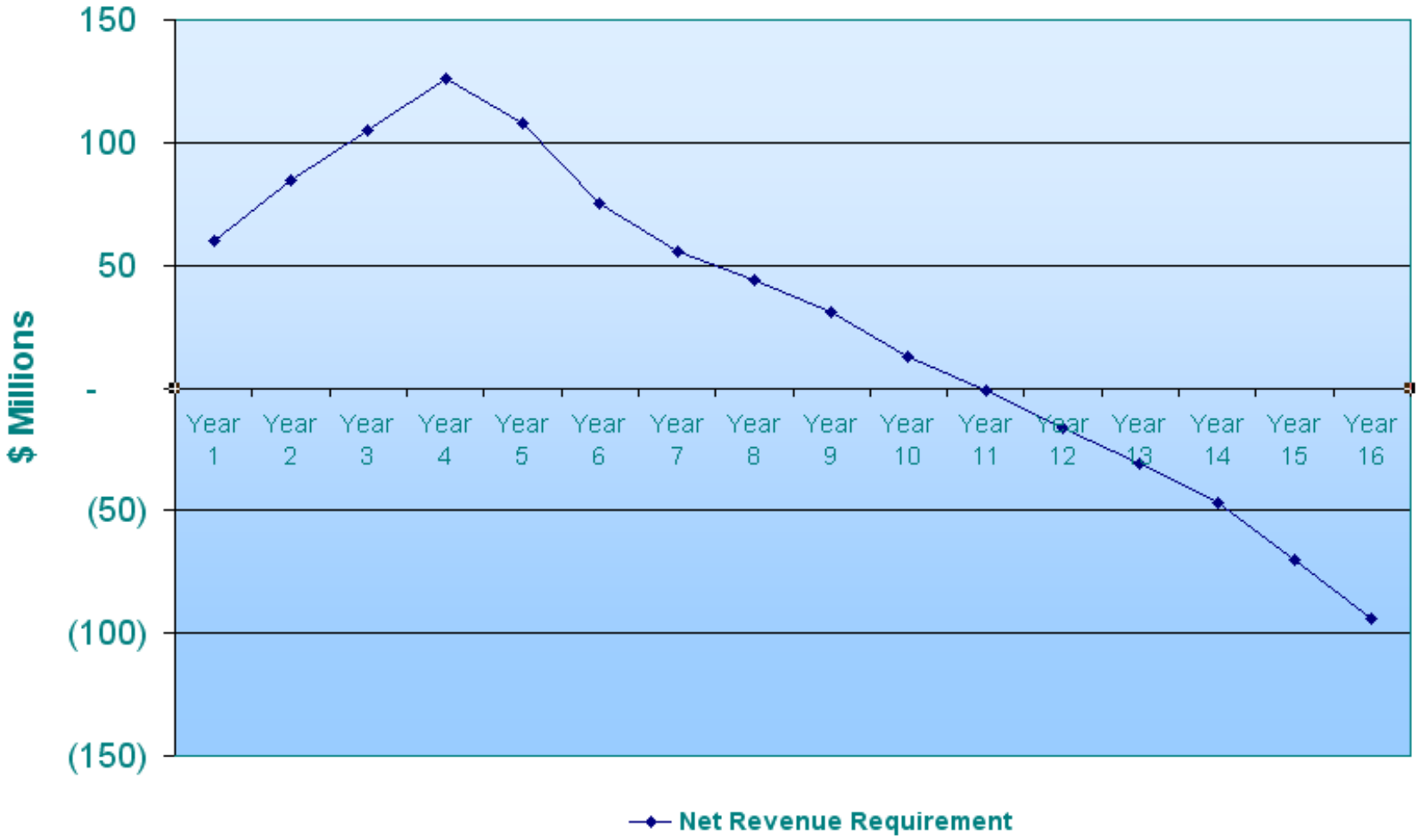
- The largest AMI deployment of in North America
  - Installing ~15,000 per day
  - 5 Million meter milestone achieved 3/2/ 2010
- Deployment facts as of 10/8/2010
  - 3.5 Million electric meters installed
  - 3.4 Million gas modules installed
  - 5.7 Million meters billed using SmartMeter™

SmartMeter Program Pays For Itself



The **SmartMeter** program has a **positive business case**: Projected benefits exceed projected costs over a 20 year program life

Net Reduction In Rates Beginning In Year 11



Source: PG&E Application A. 05-06-028, Work papers Supporting Exhibit 5, Chapter 5, pages 5-1 and 5-20

Customer Segmentation

A system that becomes more robust over time

Leverages comprehensive energy use and customer data

Performs detailed statistical analysis

Generates specific insights on customer values and behaviors

Enables targeted, value-added energy management solutions

Integrated Demand-Side Programs

Advanced Energy Information, Analysis

Smart Energy Efficiency

Time-variable Pricing

Demand Response

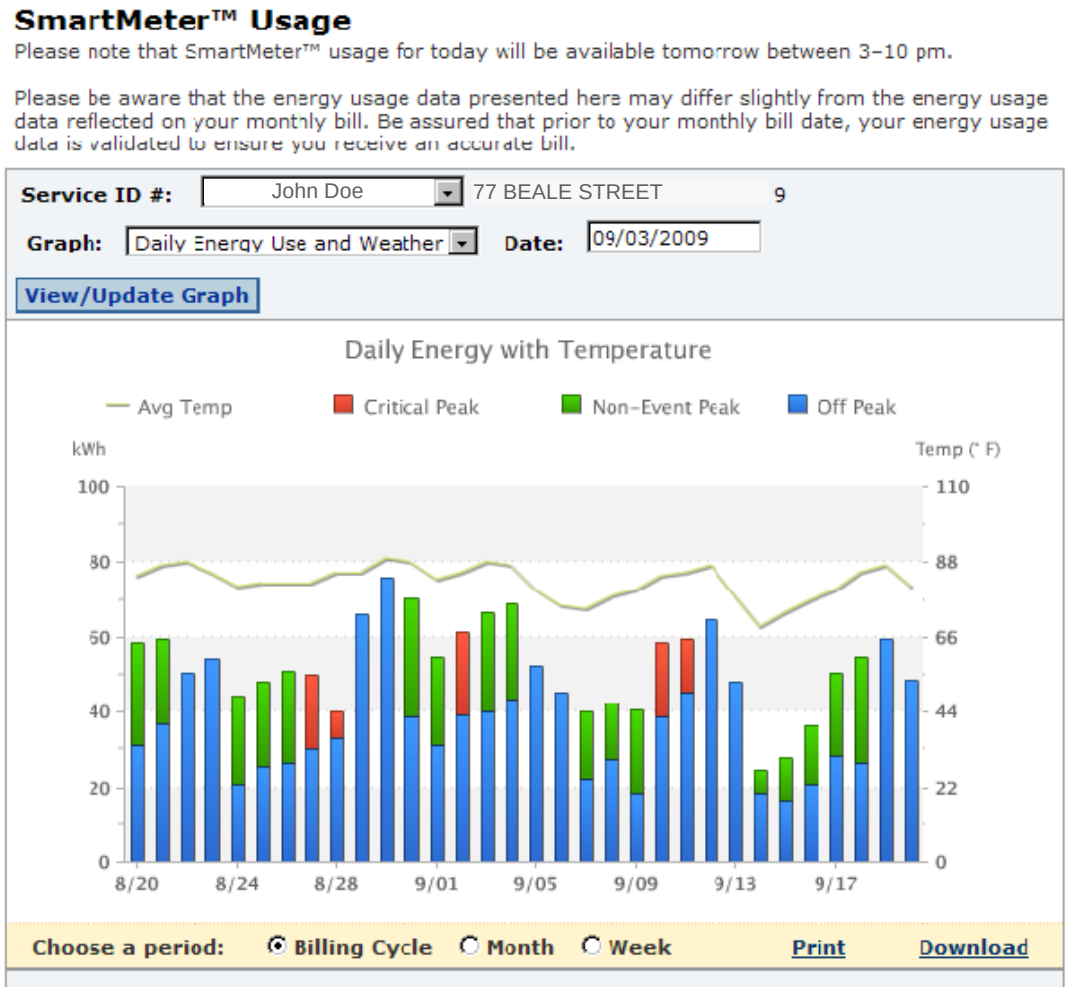
Voluntary Load Control

Automated Energy Management

On-site Generation and Storage

Electric Vehicle Charging

Customers Can View Their Energy Use



Secure customer access through PGE.com

Energy use by hour or day

View by billing cycle, month, or week

For SmartRate customers, colors designate critical peak, peak, and off-peak

Temperature overlay

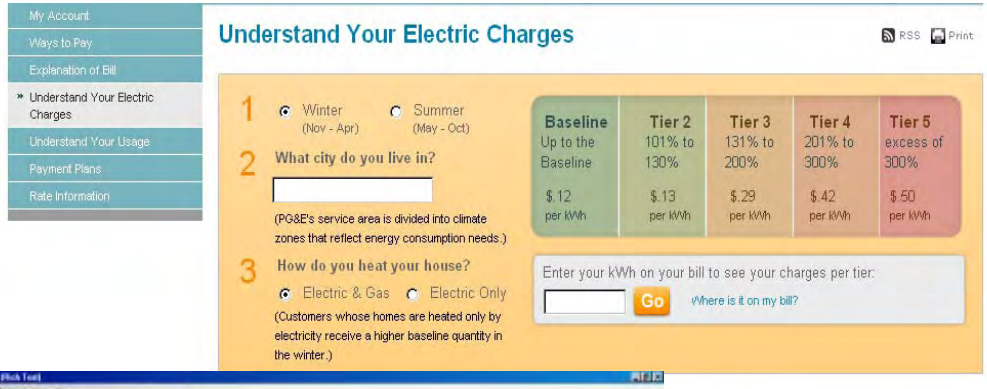
Energy Alerts

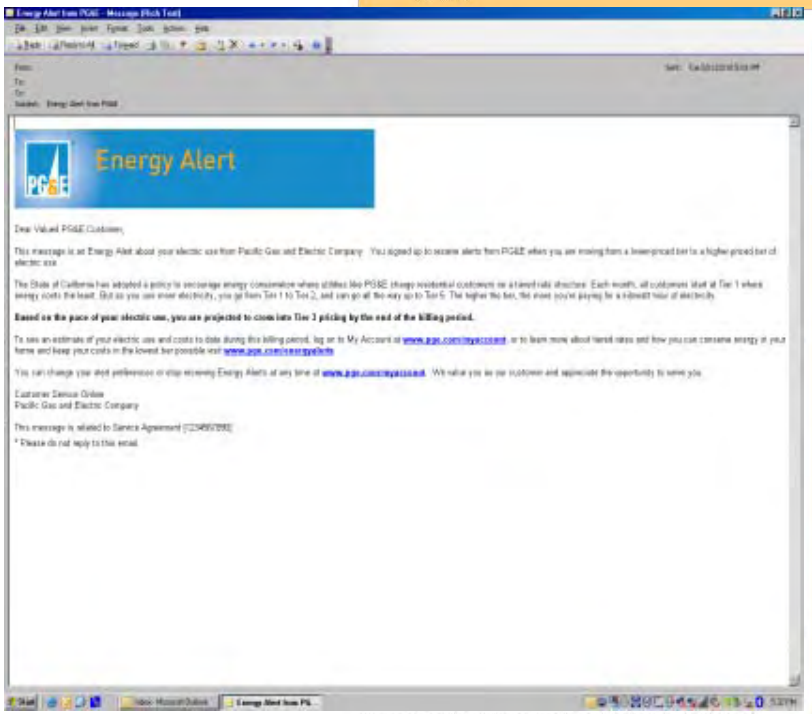
Provide customers early warning of high usage

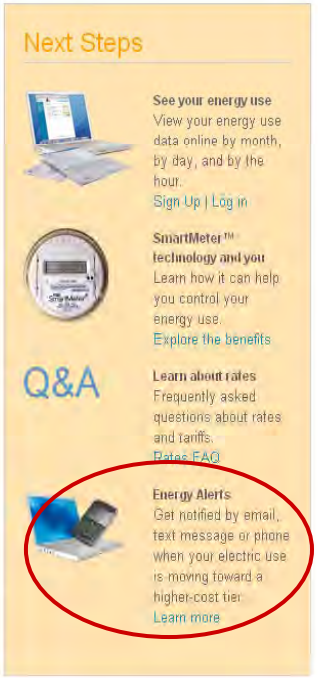
- When actual usage-to-date crosses Tier 3, 4, 5
- When usage is forecast to cross Tier 3, 4, 5 by end of billing period

Delivered via:

- Email
- Text message
- Outbound phone call

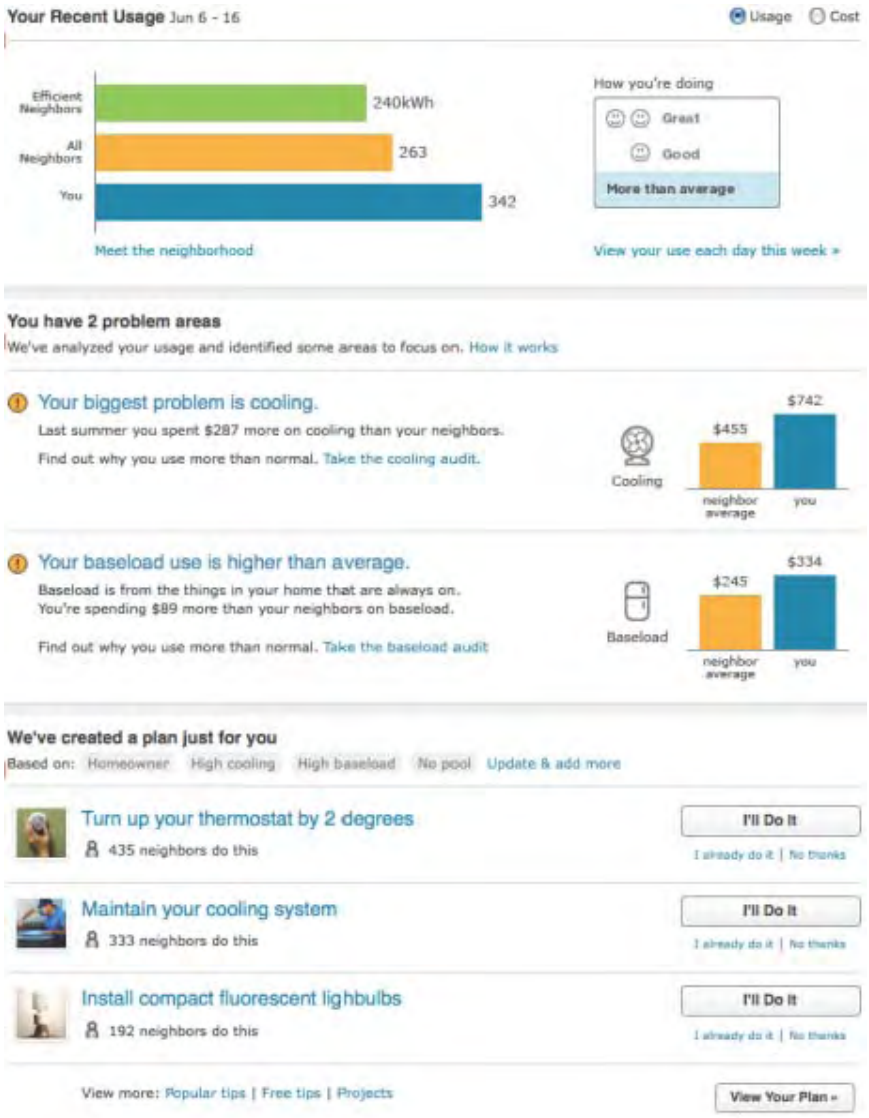






average residential customer uses in each territory. In the winter, all-

Future: Personalized Energy Advice



Comparative Norms

- Help customers understand their usage in the context of a bigger picture
- "What does one kWh mean?"

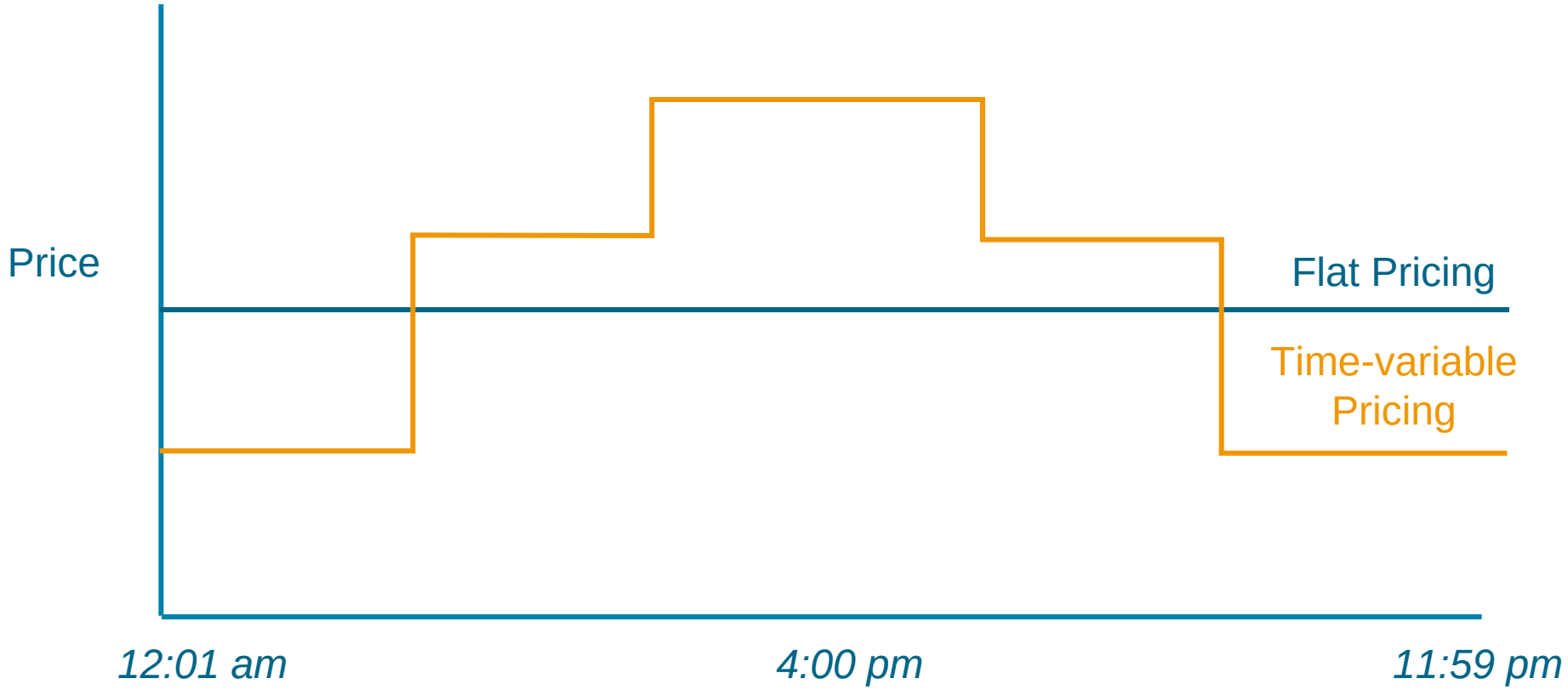
Deep Dive into Usage

- Interval usage patterns lead to insights on customer behavior
- Educate customers on how they use energy daily
- Incent customers to change their behavior and proactively manage their energy usage

Relevant, actionable tips

- Insights generated from interval usage can lead to personalized and actionable tips for the customer

Time-Varying Electric Pricing Plans



Customers Save When They Shift their Electricity Use To Nights and Weekends

Time-Variable Electric Prices

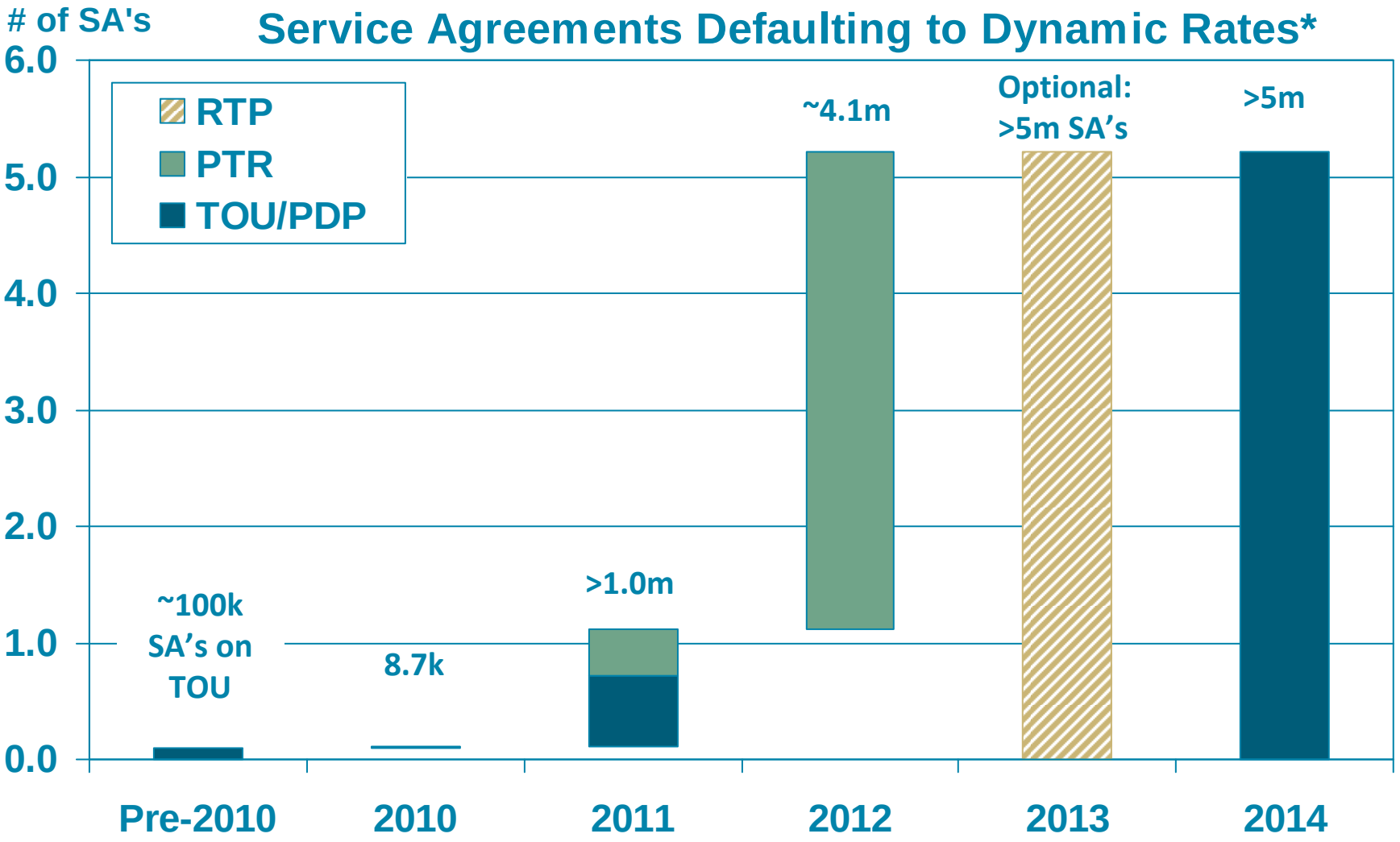
Time of Use (TOU): Prices vary across peak and off-peak hours and sometimes also across seasons. The rates and pricing periods are fixed ahead of time.

Critical Peak Pricing (CPP) and Peak Day Pricing (PDP): Very high prices during event hours. Discounted TOU rates during other times.

Peak-time Rebate (PTR): Customers who reduce their energy use during peak times receive a rebate.

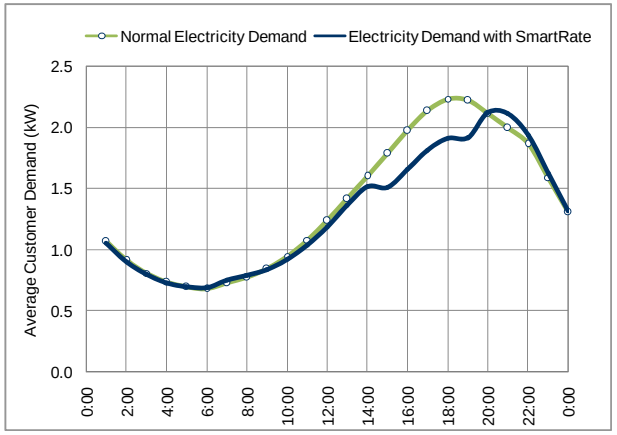
Real-time Prices (RTP): Prices vary around the clock and are not known ahead of time. They are communicated to customers on a day-ahead or hour-ahead basis.

Shifting Electric Pricing Landscape



* *Reflects total size of customer class who are mandated to default, not just eligible SAs*

SmartRate Residential Pricing Plan



Recruitment

Voluntary participants: 10,000 in 2008; 20,000 in 2009

Experience

2008: Across 9 called events, the average residential customer achieved a **reduction of 16.6%**

2009: Across 15 called events, the average residential customer achieved a **reduction of 15%**

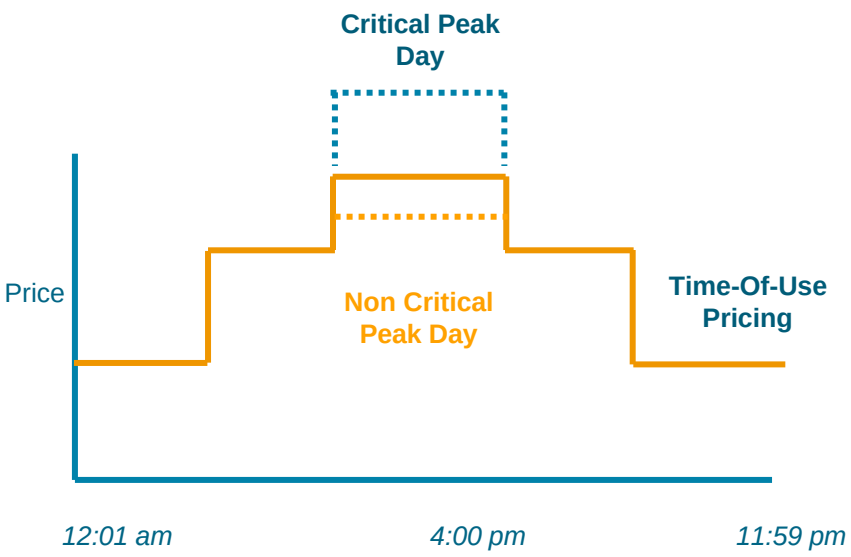
2010: 13 events called

Retention

90% of 2008 customers remained on the plan in 2009

83% of 2009 customers remained on the plan in 2010

Peak Day Pricing (PDP)



Overview

New time-variable pricing plan for all customers

Mandatory for most business customers

- May 2010 rollout to largest business customers
- Option to opt out if sign up for DR program or Time-of-Use rate

Optional for residential customers beginning one year later, May 2011

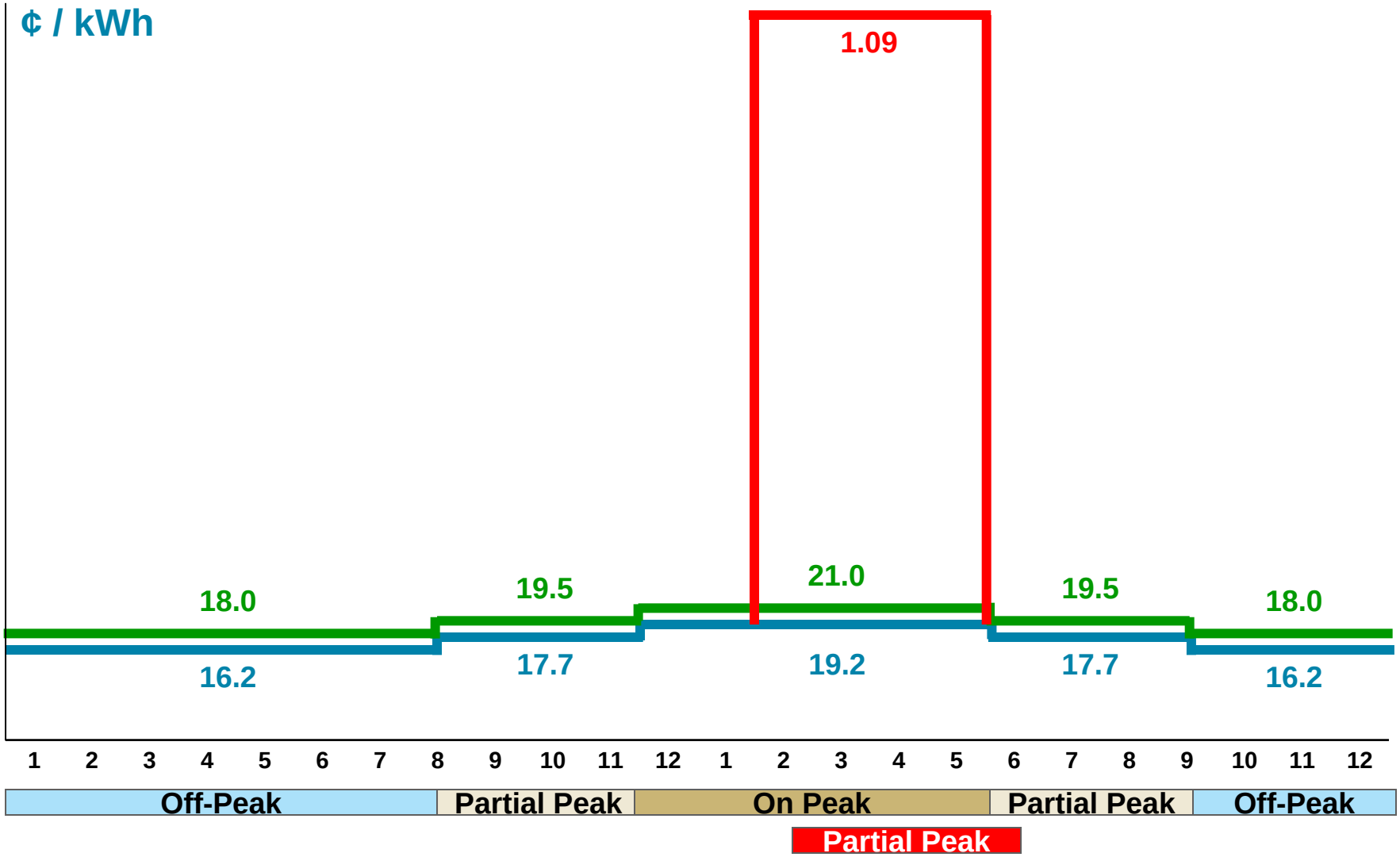
How it Works

Time-of-Use pricing all year

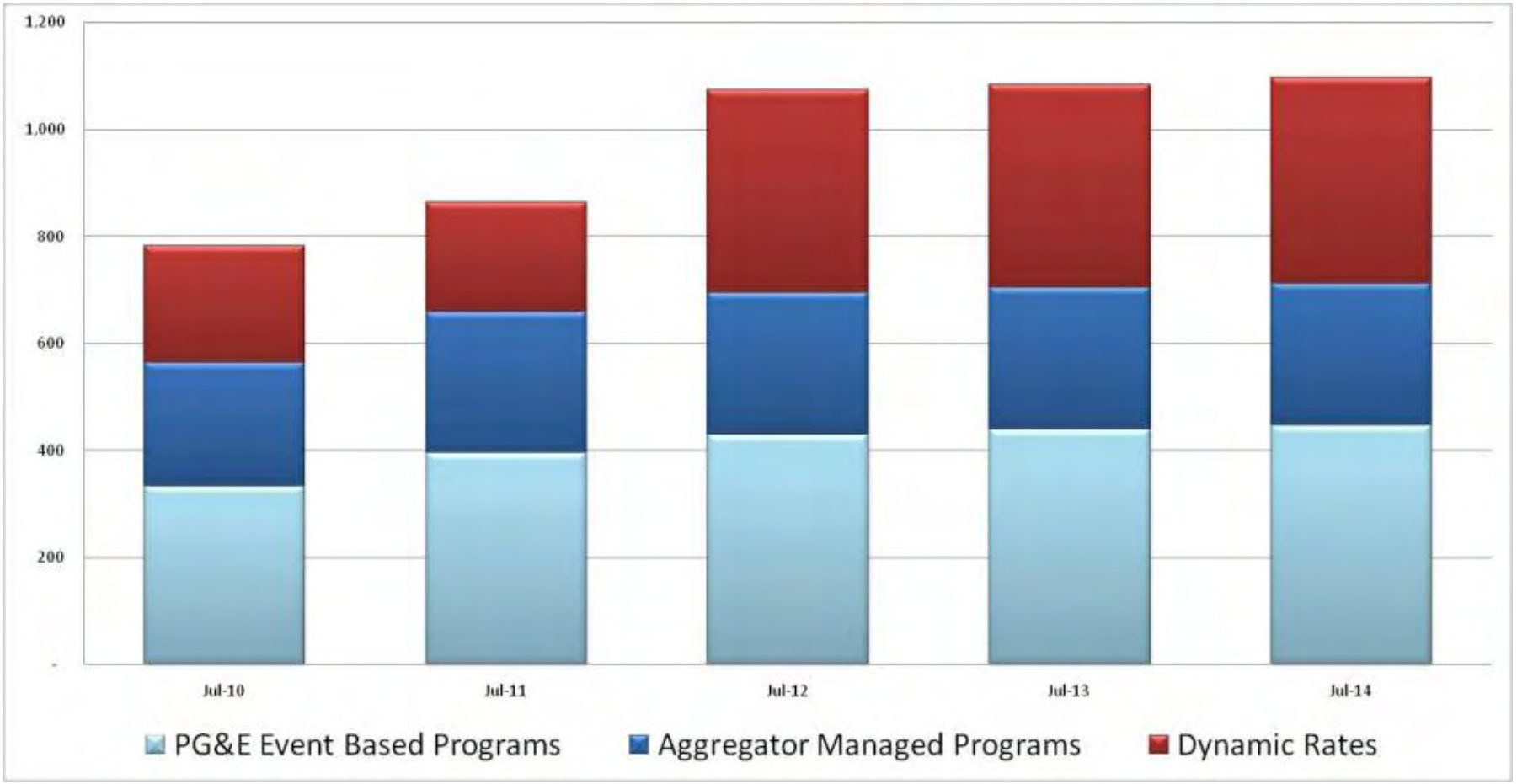
In addition, during May through October summer months

- An additional surcharge during peak hours on between 9 and 15 days
- Lower mid-day electric rates

Sample Medium Business PDP Rate



Forecast MW Demand Reduction By Program Type



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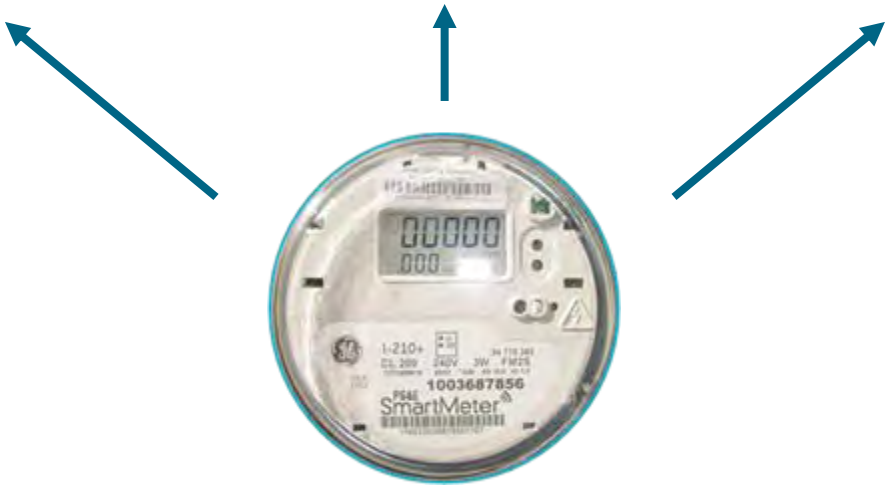
Expanding Customer Technologies

Automated in-premise energy management

On-site generation and storage

Smart charging for electric vehicles



SmartAC: Automated AC Cycling

Customers:

Volunteer for the program

Receive a free load management device

Have the option of opting out for the day

Results in 2009:

Clear reductions in customer loads

Customers highly satisfied and stay with the program

Automated Demand Response (DR)

Conducted two pilots in 2009

- Successfully demonstrated that DR **load reductions at large industrial customers** can be bid into the CAISO wholesale market using open protocol communications
- Demonstrated that **customer AC load control** can provide very rapid reductions in load

In 2010, ongoing work to integrate automated DR into wholesale energy markets as a resource

- Regulator frameworks, technical systems, processes, rules, and customer acceptance research

Smart Appliances

Smart Refrigerator

Barcode Scanning Microwave

Internet Controlled Refrigerator- oven

Smart Laundry Room Appliances

Customer Energy Management Ecosystem: Innovation, Opportunity

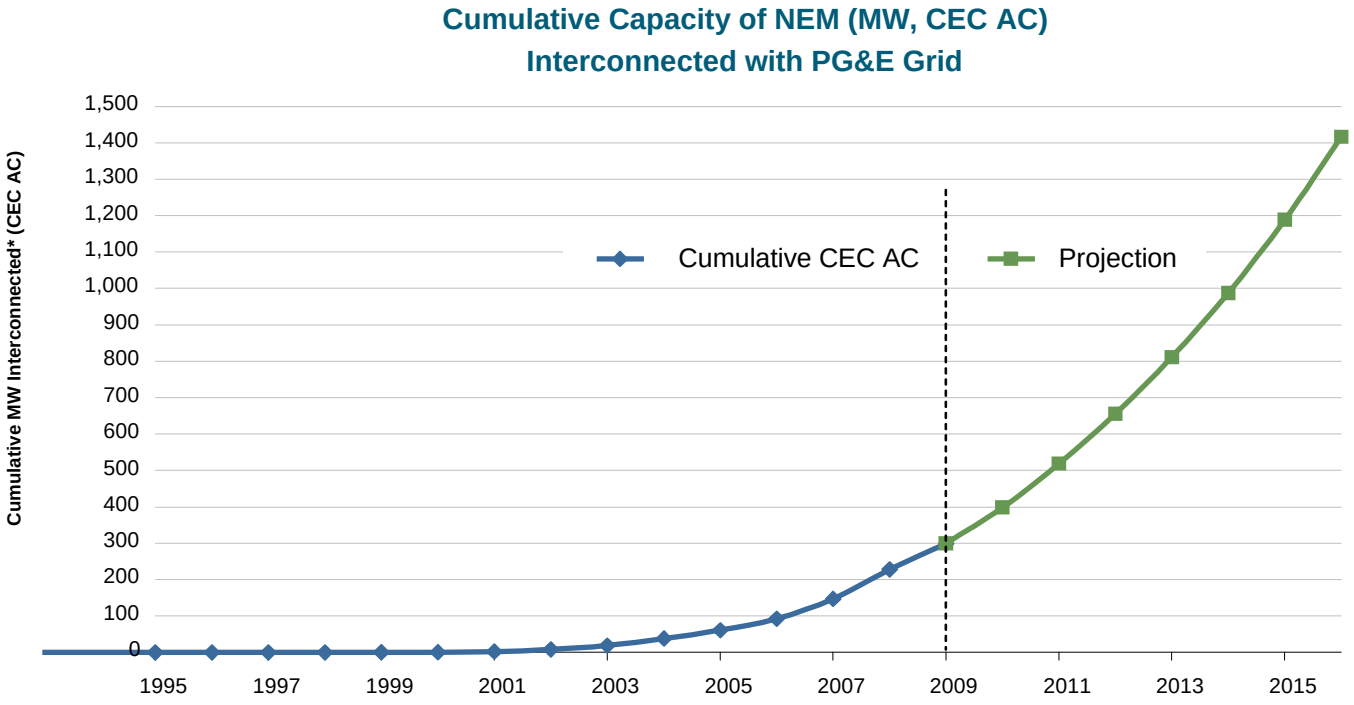
Device/ Equipment Vendors

Application Software Vendors

Software Platform Vendors

Systems Integrators/ Service Providers

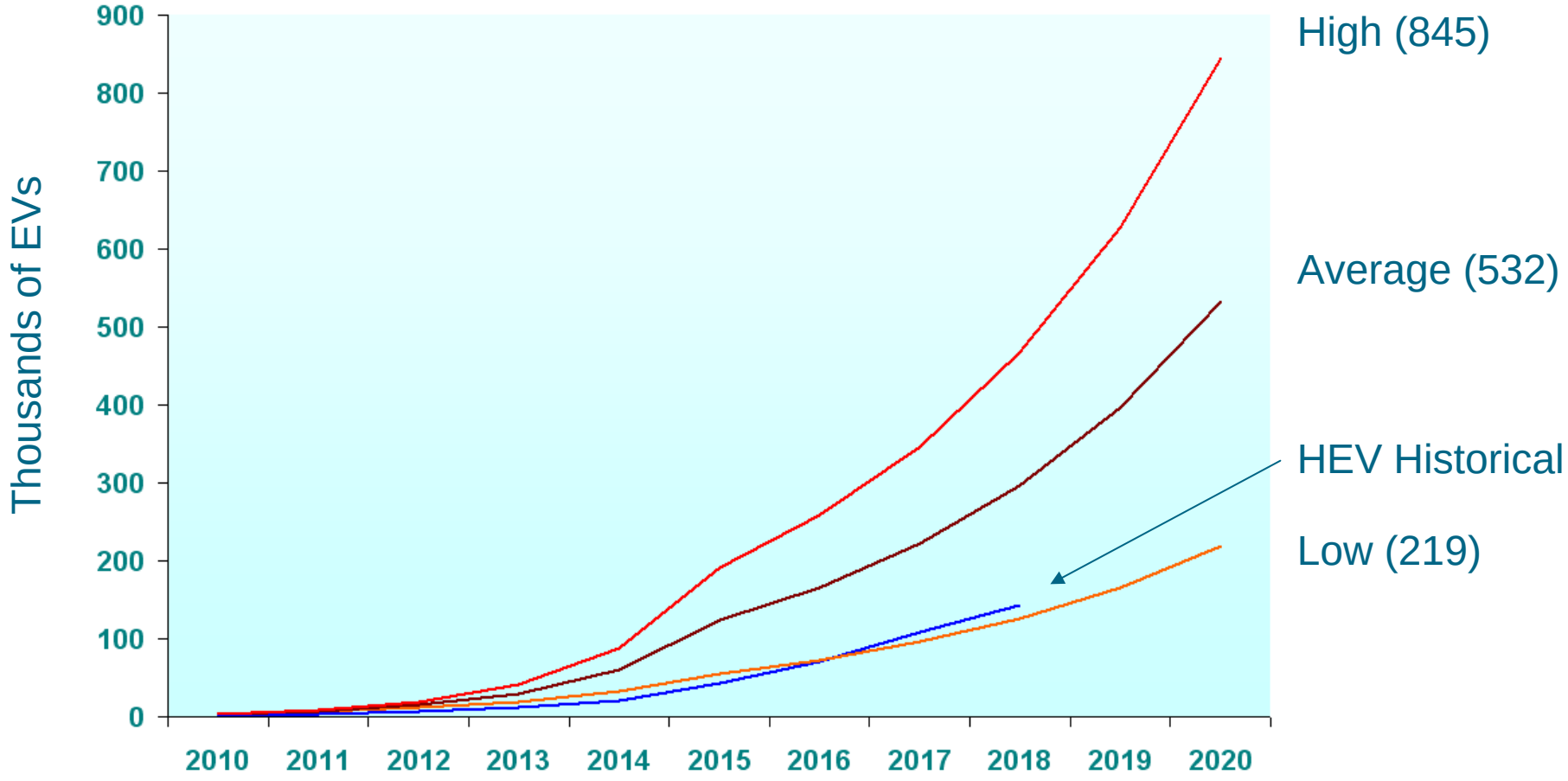
Customer Generation



Integrating Customer Generation

- Distribution-level grid impacts
- Variability and two-way electric flows
- Exceed distribution circuit thresholds
- Protection systems can trip off PV systems at their maximum production
- Smart Inverters will help the utility manage additional complexity
- Emerging energy storage technologies hold promise

Projected Adoption Of Plug-in Electric Vehicles



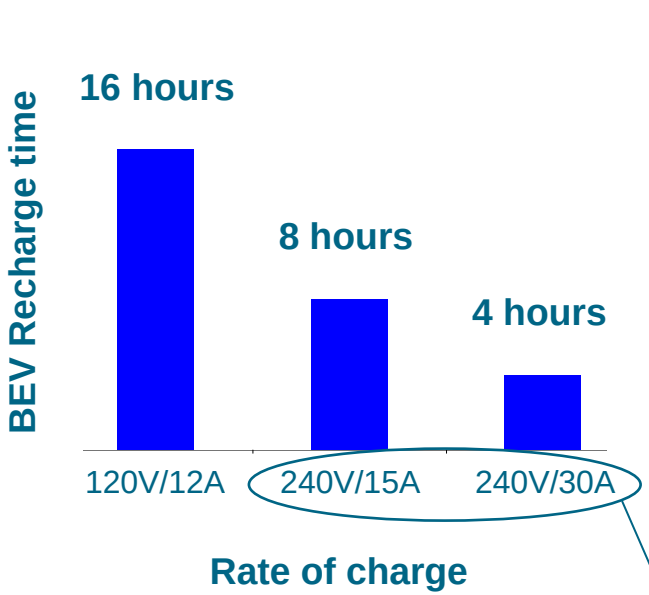
Cumulative PG&E Service Territory PEV Market Adoption Scenarios

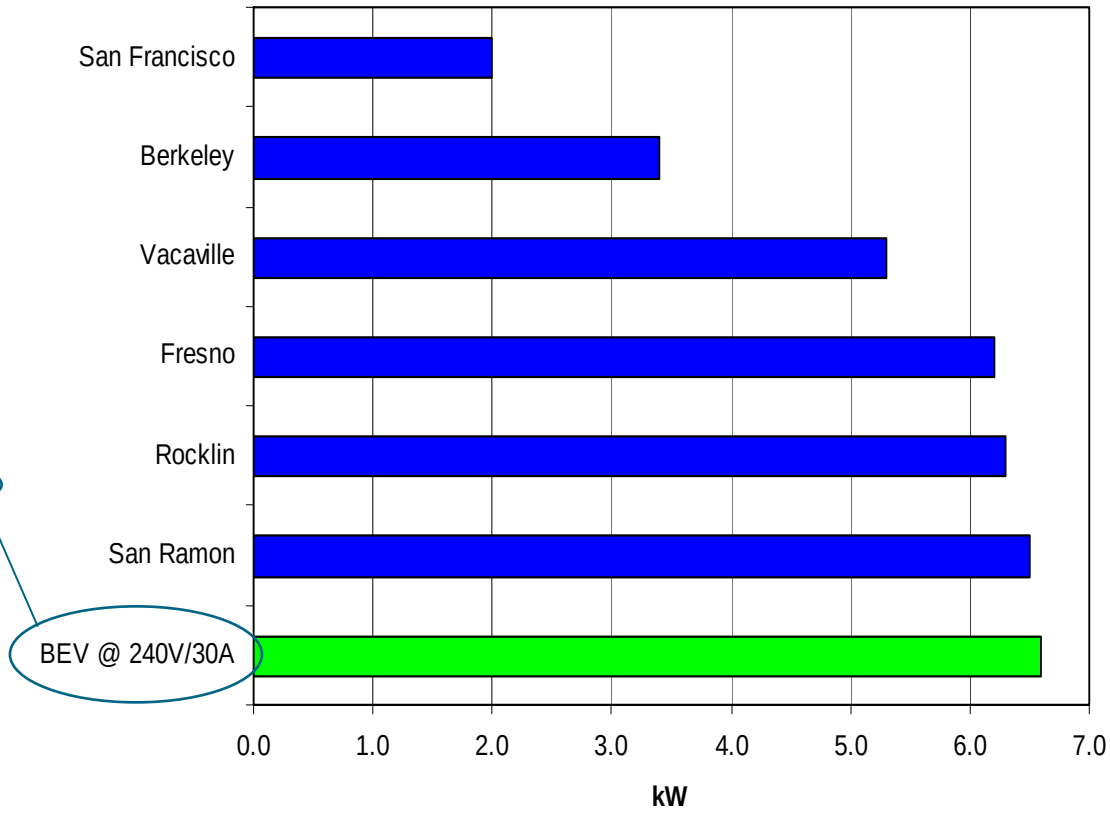
* Shifted 10 years forward

Plug-in Electric Vehicle Energy Demand

Customers will prefer a 240V charge to shorten recharge times

PEV charging is a large load for PG&E customers, comparable to average peak summer load of a single home





Source: http://www.nissanusa.com/leaf-electric-car/#/charging, August 14, 2009

Toward the Smart Grid

Smart Grid Is A Journey

Today
Integrate existing services to new platform

- Automated meter reading
- Electric field vehicles

Near Term
Transform existing services

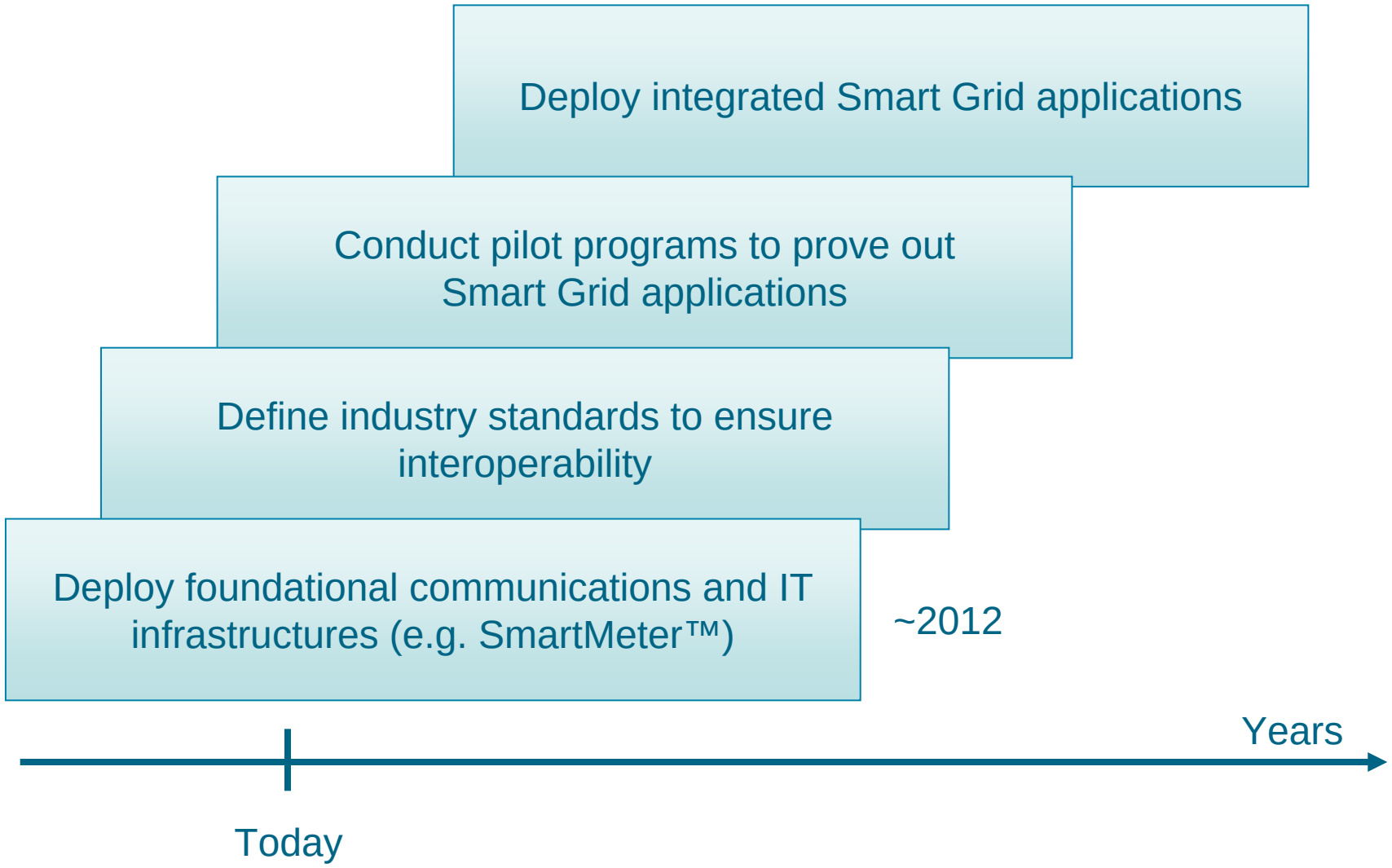
- Automated home energy management
- Plug-in hybrid electric vehicle SmartCharge™

Future
Enable future services and foster innovation

- Integrated local generation and storage
- Deep penetration of Demand Side Management

Years

Smart Grid Efforts Are Incremental



Leading Industry Work on Smart Grid Standards

Required by Energy Independence and Security Act (EISA) of 2007

A standard architecture to enable “plug and play” capability

Create markets

Industry-led effort coordinated by NIST and supported by EEI

EDISON ELECTRIC INSTITUTE

The Association of Shareholder-Owned Electric Companies

Significant Smart Grid Benefits

Customers

- Energy awareness
- Choice and Control
- Savings opportunities

Society

- Address global warming challenge
- Cleaner air, environment
- New economic opportunities

Utility

- Grid efficiency
- Grid reliability
- Long term fuel price stability
- Enhanced value / service opportunities

At PG&E,
We Are Committed To Sustainability