



TOU Pilot Strategies and Lessons

Lon Huber, Senior Director

Topics Covered Today

- TOU Pilot Best Practices
- Findings from Pilots and TOU Programs Across North America
- Recommendations

Best Practices for TOU Pilots

1. Rate Design

- a) Adequate price signals
- b) Sensible time periods

2. Program Structure

- a) Control groups and sample sizes with high statistical power
- b) Some savings assurance
- c) Enabling/supplemental tools
- d) Allow customers to opt out

3. Customer Outreach and Interface

- a) Awareness/education campaign
- b) Ample customer support
- c) Support for information/control technologies

4. Analysis

- a) Peak demand reduction
- b) Customer satisfaction
- c) Customer segmentation impacts

5. Follow-up



Common Pitfalls

Rate Design:

- Too wide of a peak period
- Muted prices signals

Program Structure:

- Too many study groups in an opt-in structure
- Small sample sizes

Customer Outreach and Interface:

- Bad technology choices
- Lack of continued education and retention

Analysis:

Opt-in sample bias

Follow-up:

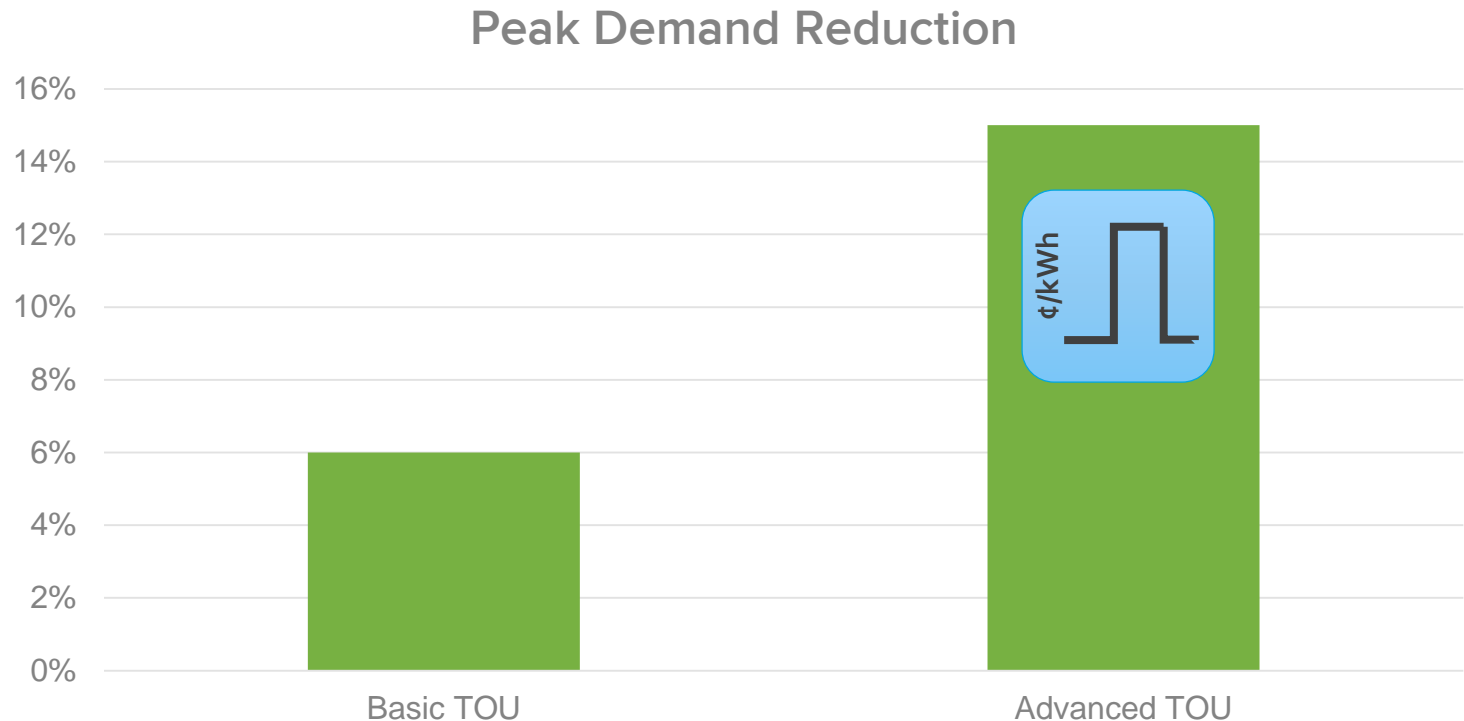
None

Learnings from Across the Country

- Best practices based on Strategen's first hand experience and review of over a dozen studies on TOU pricing
- Several recent studies conducted under DOE's Smart Grid Investment Grant Program:
 - 11 studies at 10 utilities across the country,
 - Many types sizes, and regions
 - Over 100,000 customers
 - Randomized controlled trials to measure customer response
- Additional DOE funded studies conducted for several northeast utilities (e.g. NSTAR, Unitil)



Strategy 1: Advanced TOU Rate Design

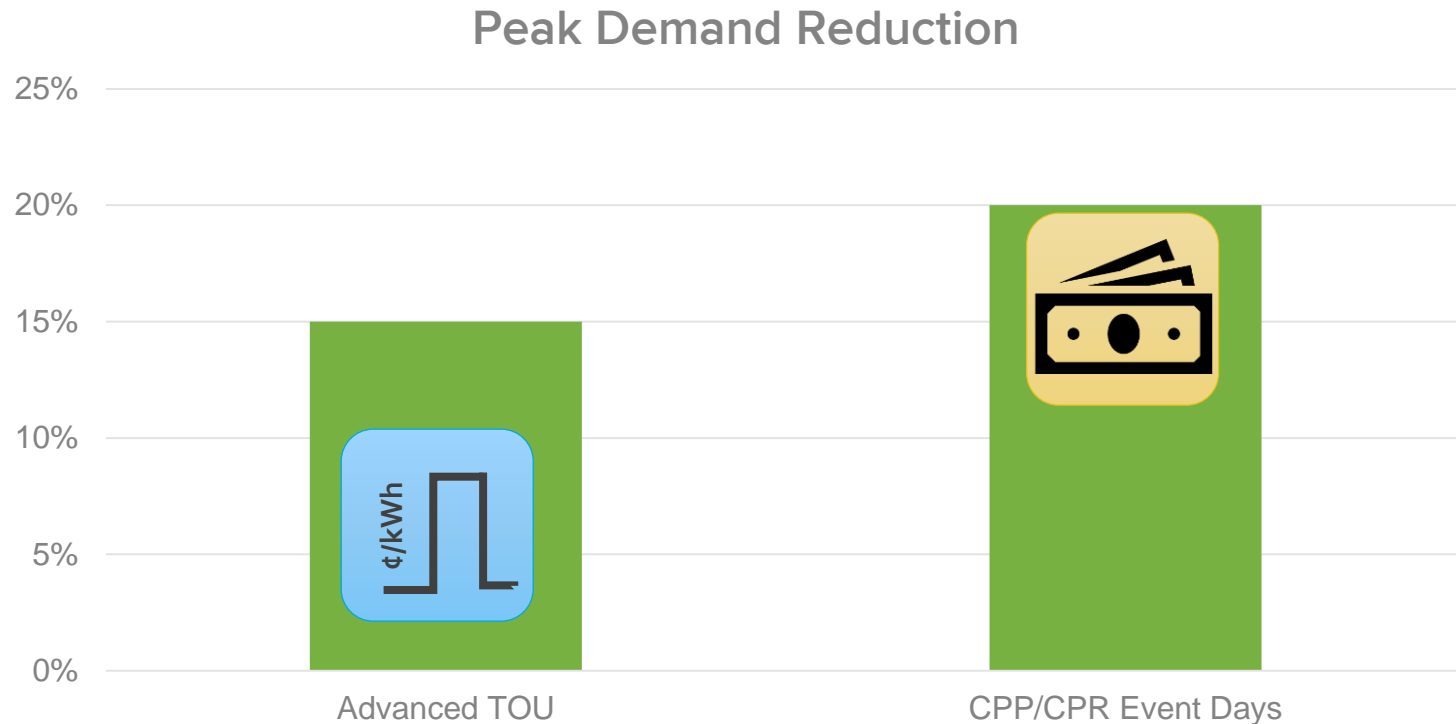


- Low on-peak to off-peak ratio (<2:1)
- Long peak time window

- High on-peak to off-peak ratio (e.g. >4:1)
- Narrow peak time window (e.g. <4 hrs)

Source: U.S. DOE, November 2016, Final Report on Customer Acceptance, Retention, and Response to Time-Based Rates from the Consumer Behavior Studies, https://www.smartgrid.gov/document/CBS_Results_Time_Based_Rate_Studies.html

Strategy 2: Critical Peak Pricing/Rebates

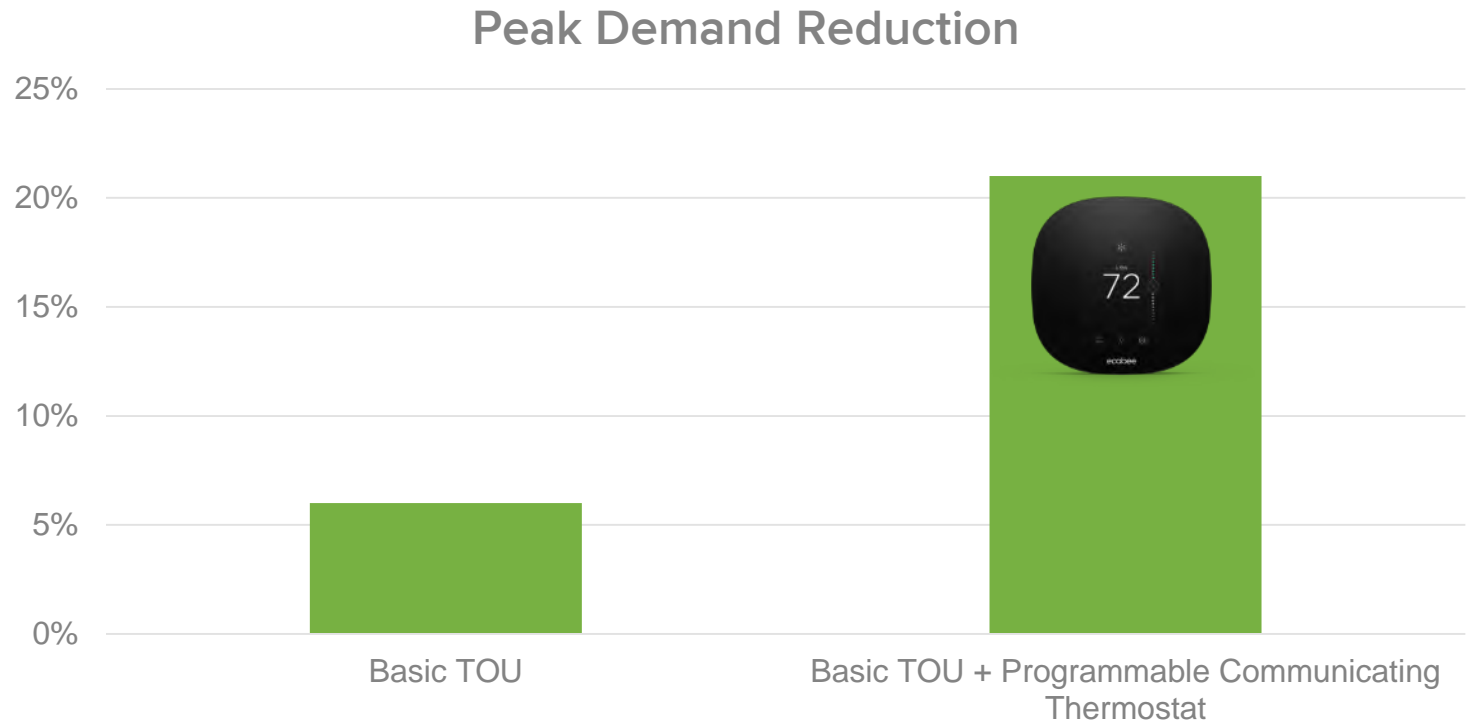


Pricing or Rebates?

- Rebates = Higher retention rates
- Pricing = Higher demand reduction effect

Source: U.S. DOE, November 2016, Final Report on Customer Acceptance, Retention, and Response to Time-Based Rates from the Consumer Behavior Studies, https://www.smartgrid.gov/document/CBS_Results_Time_Based_Rate_Studies.html

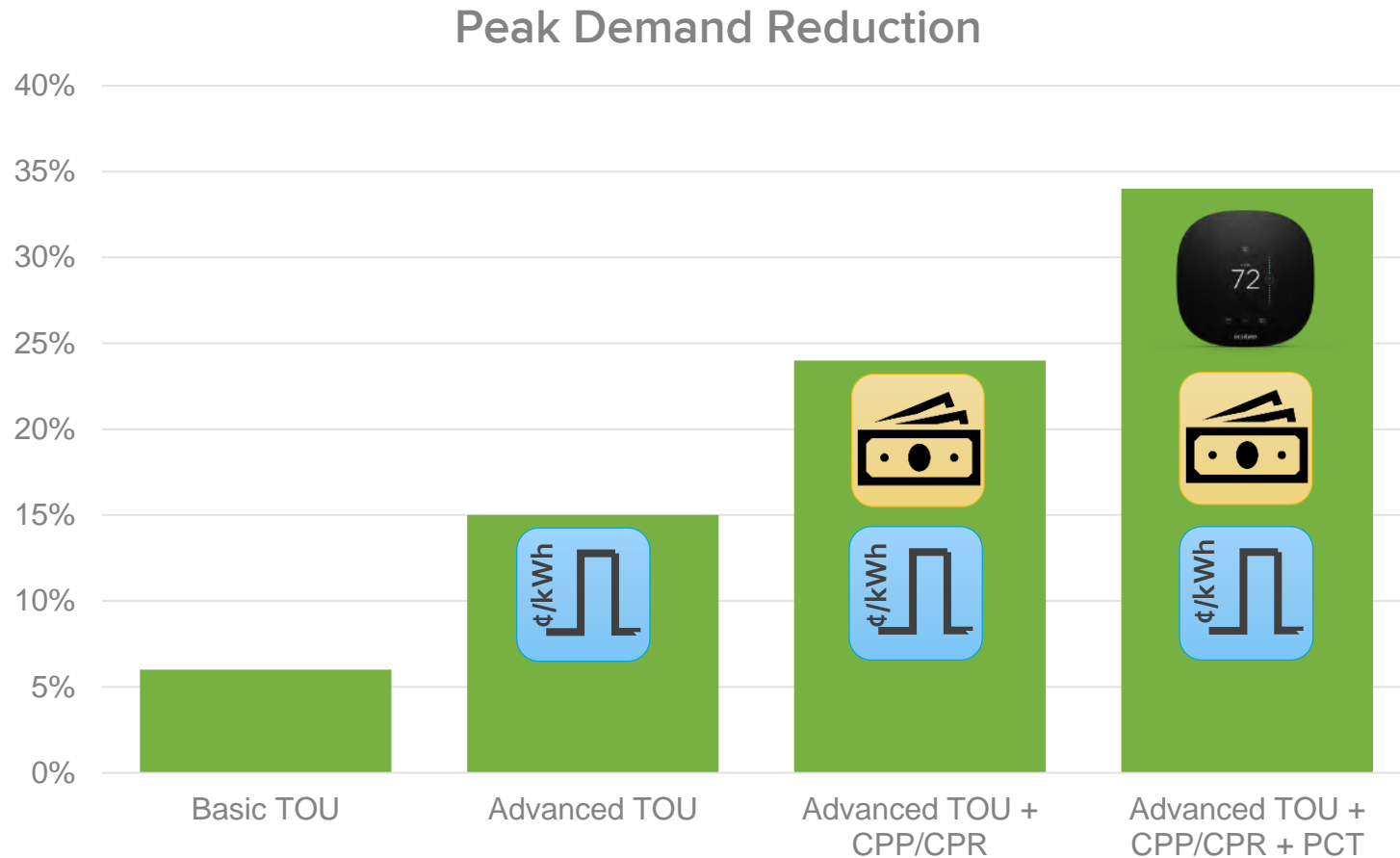
Strategy 3: Customer Control Technologies



- Utility controlled but customer can override
- Customers initially reluctant, but concerns alleviated with experience

Source: U.S. DOE, November 2016, Final Report on Customer Acceptance, Retention, and Response to Time-Based Rates from the Consumer Behavior Studies, https://www.smartgrid.gov/document/CBS_Results_Time_Based_Rate_Studies.html

Combined Approach

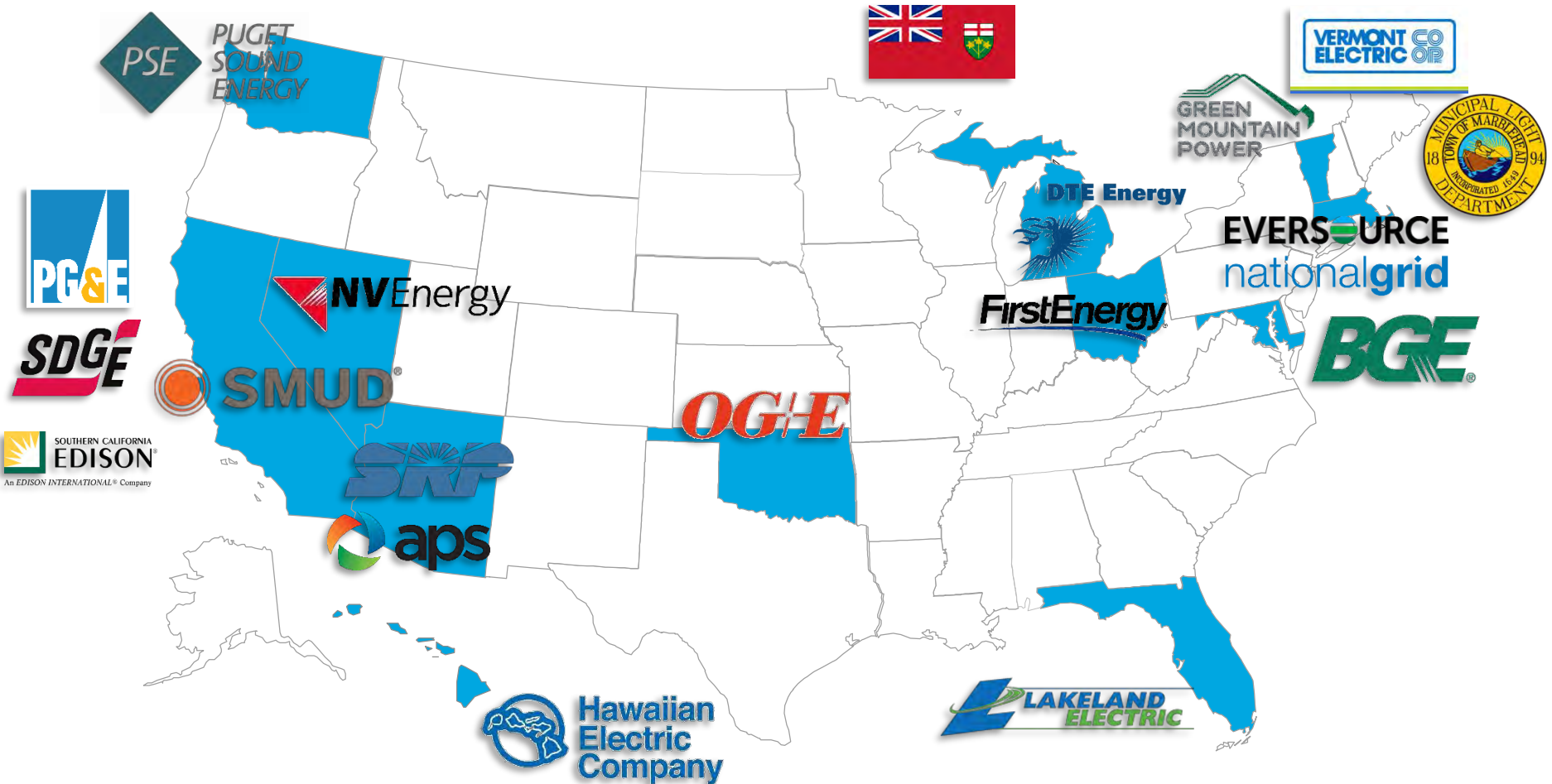


Source: U.S. DOE, November 2016, Final Report on Customer Acceptance, Retention, and Response to Time-Based Rates from the Consumer Behavior Studies, https://www.smartgrid.gov/document/CBS_Results_Time_Based_Rate_Studies.html

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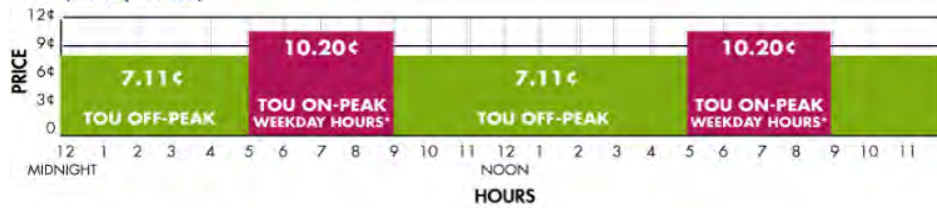
Pilots and Programs Across North America



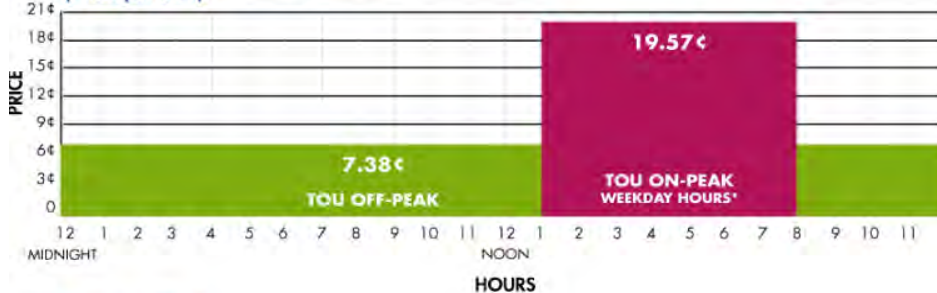
Salt River Project - Time of Use

Time of Use

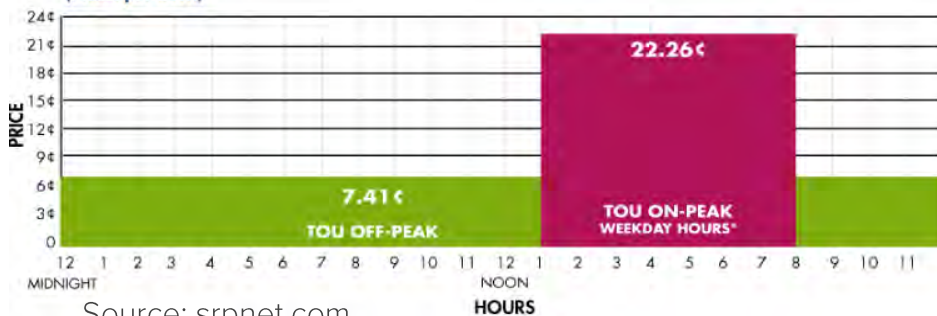
Winter
November through April
(Prices per kWh)



Summer
May, June, September, October
(Prices per kWh)

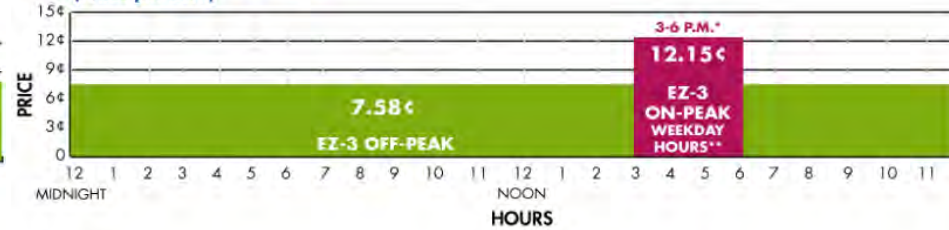


Summer Peak
July, August
(Prices per kWh)

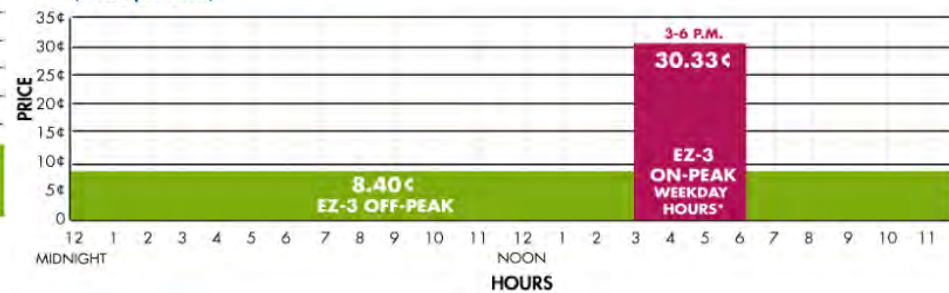


EZ-3 Rate Plan

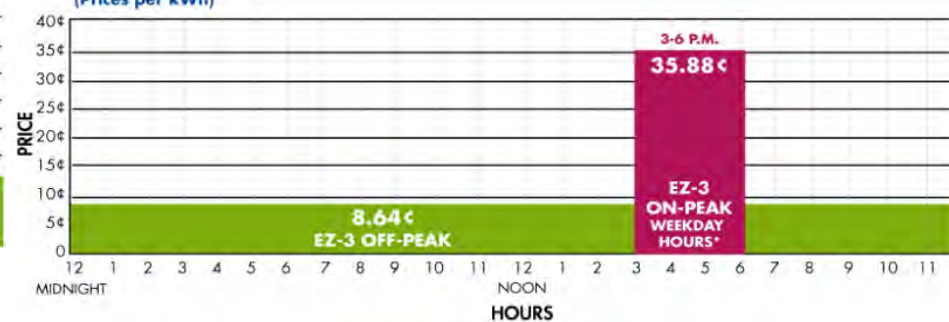
November through April
(Prices per kWh)



Summer
May, June, September, October
(Prices per kWh)



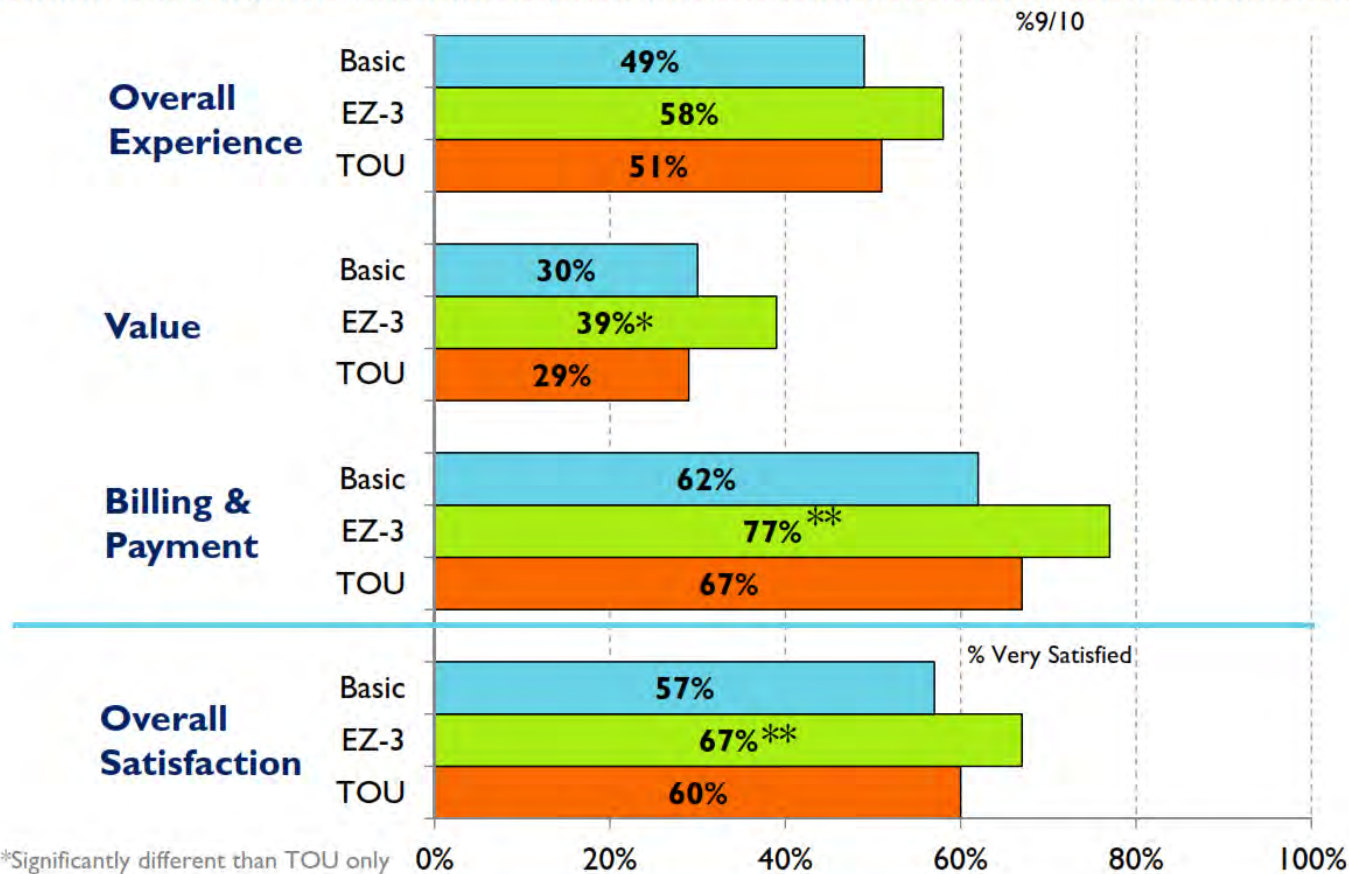
Summer Peak
July, August
(Prices per kWh)



Source: srpnet.com

Salt River Project - Time of Use

Customer Satisfaction (Large Residential)



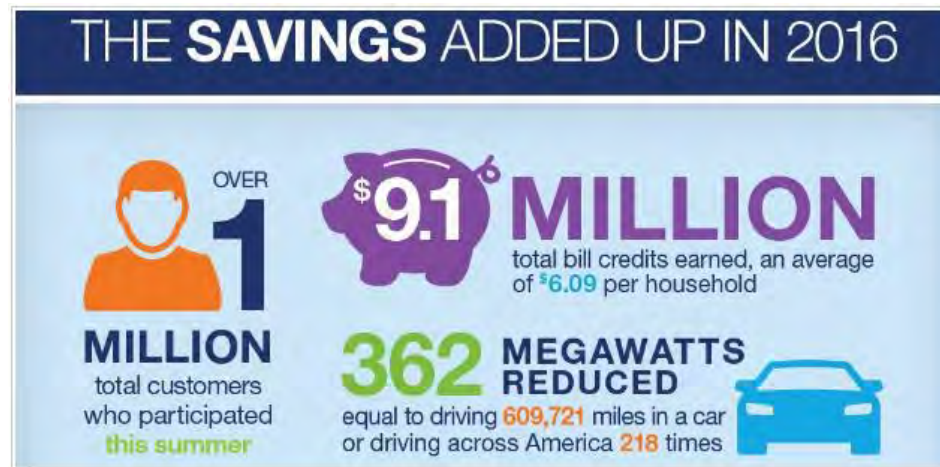
*Significantly different than TOU only
 **Significantly different than Basic only
 Samples range from 100-700

Courtesy of SRP

Baltimore Gas and Electric CP Rebate



- Optional, opt-in program
- Customers earn bill credits for reducing demand during peak days
 - \$1.25 credit per kW reduction in average usage during Energy Savings Days



Source: BGE.com

NV Energy – PowerShift Program

- Controlled thermostat and energy optimization service for residential customers
- 1.8 kW average per customer demand reduction per event
- ~35,000 customers enrolled



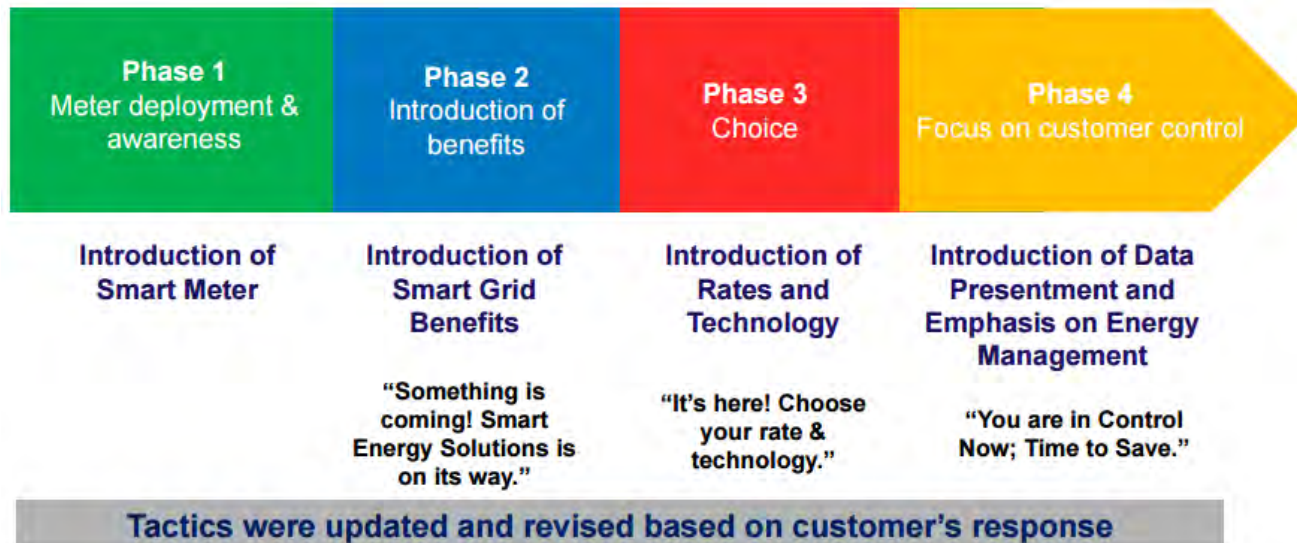
- 85% of NV Energy's customers enrolled in the program have positive attitudes towards the program

Source: NVenergy.com

National Grid Worcester Pilot



- Opt-out
- Early deployment of 15,000 AMI meters in Worcester, MA
- 10% received in home technologies
- 95% on TOU with CPP, 5% on PTR
- Goal to reduce active participants' peak and average loads by at least 5% - Energy and demand targets with wide peak



Source: National Grid Smart Energy Solutions Pilot Interim Evaluation Report, 2016

National Grid Worcester Pilot Interim Results

Table E-1. Total and Percentage Savings for Residential Customers

Impact Category	Total Savings	Percentage Savings – Active Customers (n=2,524)	Percentage Savings – All Customers (n=10,882)
Peak Event Savings – Average*	0.55 MW	16.8%	3.9%
Peak Event Savings – Maximum**	1.59 MW	29.0%	12.3%
Energy Savings in 2015***	2,300 MWh	4.1%	0.2%
Bill Savings in 2015****	\$1,250,000	-	-

Source: Navigant analysis

- **Active Customers reduced their average peak demand during peak events 4x more than other customers**
 - Active Customers are participants who opted into enabling technologies and customers that logged into the pilot portal at least once

Active participants + active technologies = high demand reductions

Source: National Grid Smart Energy Solutions Pilot Interim Evaluation Report, 2016

National Grid Worcester Pilot Interim Results

- Active customers load reductions ranged from 10% to 31% on Peak Conservation Days
- Customers with PCTs saw greatest load reductions, up to 31% on CPP
- Average customer annual savings of \$109
- 98% customer retention in year 1 (2015)
- 72% customer satisfaction rate



Source: National Grid

The goal is to turn passive customers into active customers

Source: National Grid Smart Energy Solutions Pilot Interim Evaluation Report, 2016

California TOU Pilots and Study Timeline

Three main initiatives:

- 1) Statewide Pricing Pilot 2003 – 2004
- 2) Sacramento Municipal Utility District (SMUD) SmartPricing Pilot 2010 – 2014
- 3) Interim TOU Pilots (D. 15-07-001) 2016 – 2018
 - Intend to inform default residential TOU rates in 2019

California Statewide Pricing Pilot

- Response to 2000 – 2001 energy crisis
- All three CA IOUs conducted TOU pilot
- Goals
 - Estimate average impact of TOU rates to predict impacts of alternative pricing plans
 - Determine customer preferences for Time Varying Rates (TVR)
 - Evaluate effectiveness and customer perceptions about TVR
- 2,500 customers from July 2003 to December 2004
- Found savings from TOU and CPP

Small sample size made many findings statistically insignificant

SMUD – SmartPricing Pilot

SmartPricing Options pilot

- Project ran Aug 2010 – Jun 2014
- ~7,000 customers at project start
- Rates effective June 2012
- Pilot end Jan 2014
- Final evaluation Jun 2014
- \$9.9 million total budget
- Five different rate offerings
- Positive results were cited in CPUC decision to default all CA IOU residential customers to TOU rates in 2019
- SMUD is outside of CPUC jurisdiction. This allowed SMUD to design an opt-out program

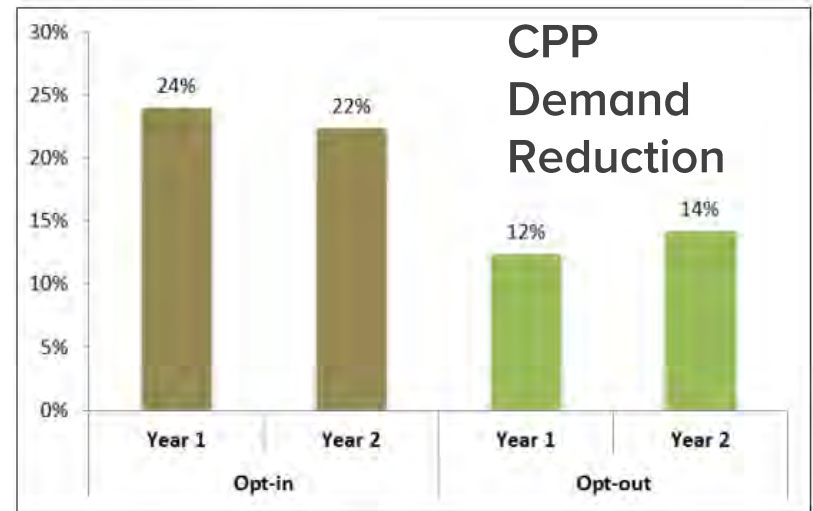
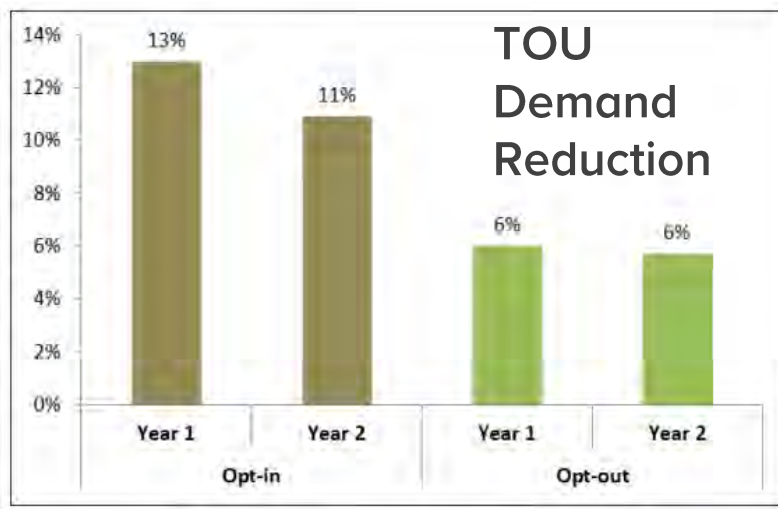


Source: SmartPricing Options Final Evaluation, 2014

SMUD – SmartPricing Pilot

Table 5. SMUD Cost Effectiveness Analysis Results³⁷

Recruitment Approach	Scenario Offer	Benefit-Cost Ratio
Opt-in	TOU, no IHD	1.19
	TOU, with IHD	0.74
	CPP, no IHD	2.05
	CPP, with IHD	1.30
Opt-Out	TOU, with IHD	2.04
	CPP, with IHD	2.22
	TOU-CPP, with IHD	2.49

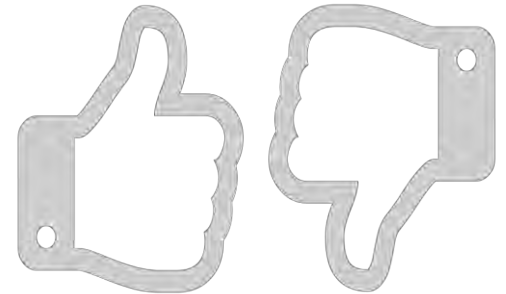


Opt-out TOU rates with CPP (no IHD) would be very cost effective and yield high demand savings

Source: SmartPricing Options Final Evaluation, 2014

Opt-in vs Opt-out

- Four types of customers:
 - Always adopters (would always opt-in)
 - Complacents (do not opt-out of default rates)
 - Opt-out
 - Unaware
- Default rates with an opt-out option have much higher overall enrollment; approximately 5x
- Default rates yield much higher aggregate load impacts due to some complacents response to the tariff
- SMUD SmartPricing: 20% always adopters, 50% complacents, and 30% likely unaware



Opt-in rates may more effectively reduce demand per customer, however, results from opt-in pilots are not likely to predict system-wide demand savings

Source: SmartPricing Options Final Evaluation, 2014

California Interim TOU pilots

- High renewable generation has increased the need for peak demand reductions late in the day – ‘Head of Duck’
- ‘Interim’ because these studies are being performed in the period before Time of Use rate will be default for all CA residential customers
- In 2019, all residential customers in CA IOUs territory will be defaulted onto a Time of Use tariff with the option to opt out.
- Each IOU is currently performing studies
- \$23 million budget over 2015 – 2018 study period

Results from this pilot study will inform the default TOU rates for all California IOU customers in 2019

Source: California Statewide Opt-in Time-of-Use Pricing Pilot Interim Evaluation, 2017

California Interim TOU Design

- Randomized Control Trial (RCT) strategy - Participants are randomly assigned to a rate (or control), unlike opt-in strategies.
- Pay-to-Play (PTP) recruitment strategy – customers are paid to enroll in the program, rather than a specific rate option
- Substantial portion incentives is tied to the completion of customers surveys
- Target various climate zones, income levels and usage patterns
- Approximately 52,000 customers across all three IOUs

Financial incentives can reduce the effect of selection bias

Source: California Statewide Opt-in Time-of-Use Pricing Pilot Interim Evaluation, 2017

SCE Interim TOU Pilot Tariffs

Figure 5.1-1: SCE Pilot Rate 1⁸¹

Rate 1	Season	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00
Weekday	Summer	Super Off-Peak (23.0¢)							Off-Peak (27.61¢)						On-Peak (34.51¢)										
	Winter	Super Off-Peak (22.91¢)							Off-Peak (22.91¢)						On-Peak (27.49¢)										
Weekend	Summer	Super Off-Peak (23.0¢)							Off-Peak (27.61¢)																
	Winter	Super Off-Peak (22.91¢)							Off-Peak (22.91¢)																

Figure 5.1-2: SCE Pilot Rate 2

Rate 2	Season	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00
Weekday	Summer	Super Off-Peak (17.33¢)							Off-Peak (29.32¢)						On-Peak (53.26¢)										
	Winter	Super Off-Peak (17.41¢)							Off-Peak (26.03¢)						On-Peak (27.91¢)										
Weekend	Summer	Super Off-Peak (17.33¢)							Off-Peak (29.32¢)																
	Winter	Super Off-Peak (17.41¢)							Off-Peak (26.03¢)																

Figure 5.1-3: SCE Pilot Rate 3

Rate 3	Season	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00
Weekday	Summer	Off-Peak (16.39¢)							On-Peak (22.64¢)						Super On-Peak (37.03¢)										
	Winter	Off-Peak (18.24¢)															Mid-Peak (20.96¢)								
	Spring	Off-Peak (18.24¢)							Super Off-Peak (9.94¢)						On-Peak (24.86¢)										
Weekend	Summer	Off-Peak (16.39¢)															Mid-Peak (18.77¢)								
	Winter	Off-Peak (18.24¢)							Super Off-Peak (10.39¢)						Mid-Peak (20.96¢)										
	Spring	Off-Peak (18.24¢)							Super Off-Peak (9.94¢)						Mid-Peak (20.96¢)										

Source: California Statewide Opt-in Time-of-Use Pricing Pilot Interim Evaluation, 2017

Interim TOU Report Takeaways

Preliminary results from a few summer months

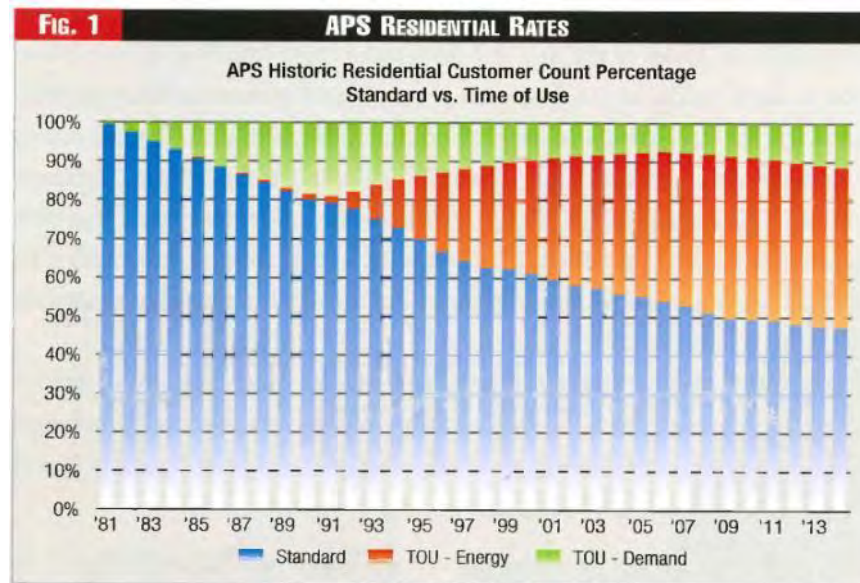
- 4%-6% average savings over all the rate plans
- Summer bills slightly increased for almost all participants
- Largest demand reductions occurred in hot climates and the lowest reductions occurred in cool climates
- CARE/FERA customers had lower average peak reductions
- Smart phone app had very few downloads

Source: California Statewide Opt-in Time-of-Use Pricing Pilot Interim Evaluation, 2017

Arizona Public Service



- Began offering Time of Use rates in 1982
- Well marketed and advertised
- 568,500 residential customers on time differentiated rates
- ~50% opt-in Time of Use rates



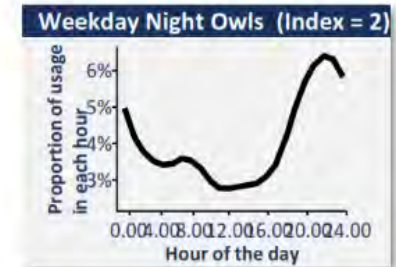
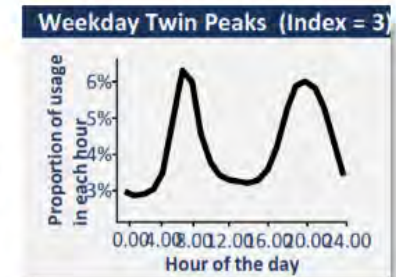
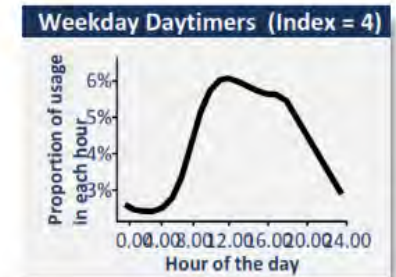
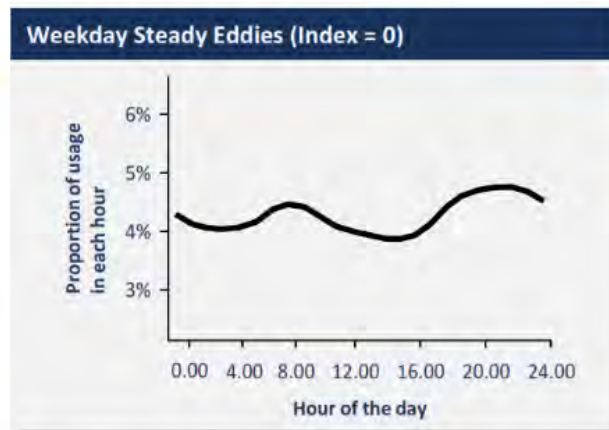
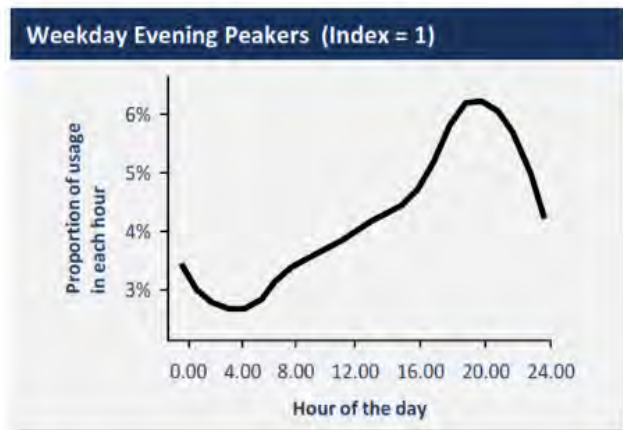
Customers are happy with Time Varying Rates over the long run

Source: APS 2015 Demand Side Management Annual Progress Report
There and Back Again, Fortnightly November 2015

The APS Approach

RECOGNIZE it is important to know our customer profiles in order to create tailored messaging

UNDERSTAND who they are, how they use our product and how best to communicate with them

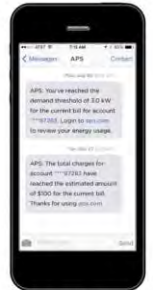
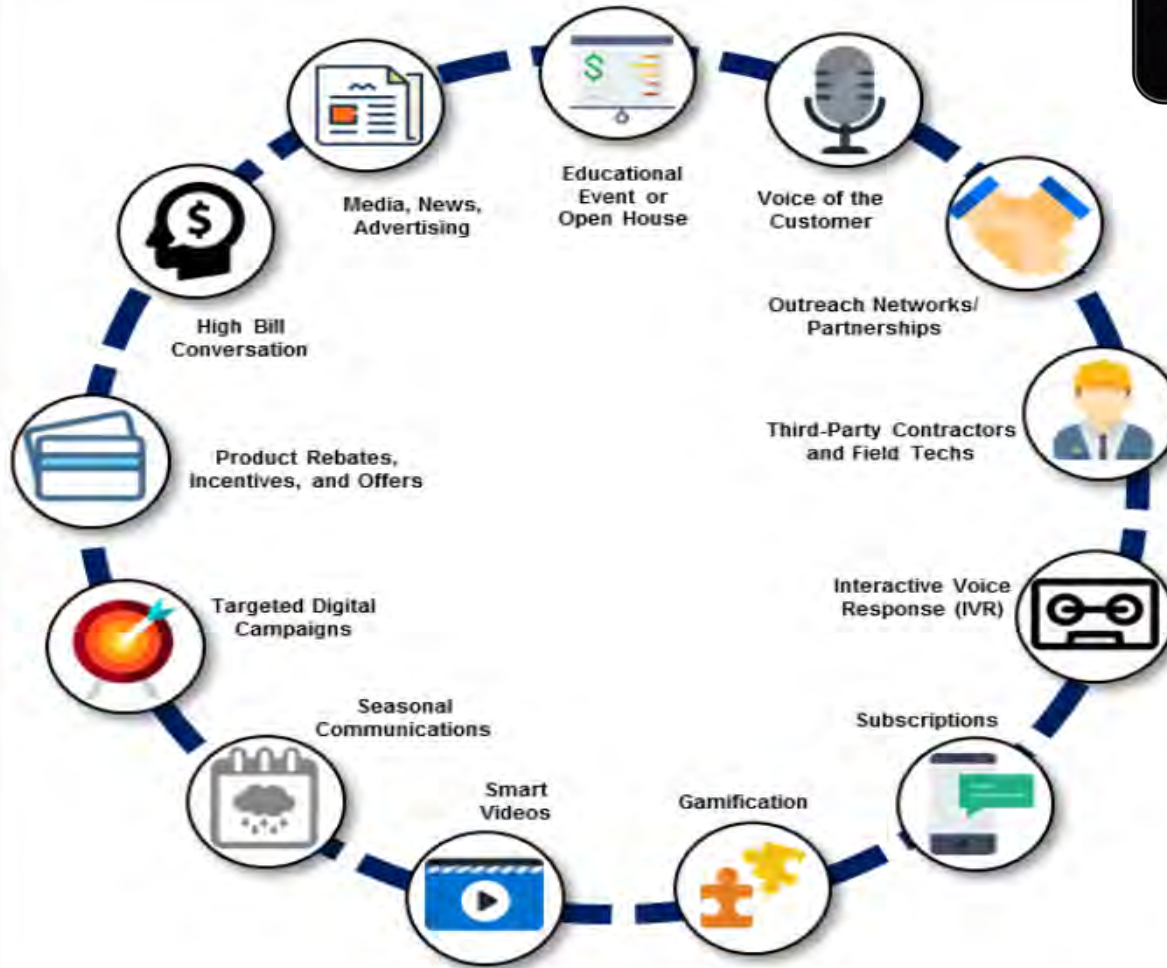


Courtesy of APS

The APS Approach

MOBILE PHONE APP AND NOTIFICATIONS

Ongoing Proactive Management and Adoption



Mobile app interface

Courtesy of APS

Oklahoma Gas and Electric Pilots



TVP Structure	Technology	Average Impacts on Peak Load (Daily)	Average Impacts on Peak Load (Critical Event Day)
TOU-CPP (opt-in)	None	-6%	-17%
	Smart Thermostat	-6%	-34%
VPP (opt-in)	None	-10%	-16%
	Smart Thermostat	-18%	-28%

- OG&E projected that a widely used VPP rate would be able to avoid a generation investment.
 - Successful pilot continues into 2017
 - 1.3kW average peak demand reduction per customer
 - High customer satisfaction rates
- Well designed price signals can defer or avoid generation investments
 - Successful pilots can be extended into full programs

Source: A Primer on Time-Variant Electricity Pricing, 2015 Environmental Defense Fund

Oklahoma Gas and Electric Pilots



- Two rates for residential and small commercial:
 - Time of Use
 - Variable Peak Pricing with Critical Pricing component
- Customers with central air are offered a free PCT preprogrammed to respond to OG&E's dynamic pricing signal – Non-PCT customers bring 1/3 the load reduction.
- 2015 program cost was \$15 million
- Over ~170 MW of demand response
 - OG&E has received very high customer satisfaction
- Currently over 120,000 customers are enrolled in VPP rate

Source: <http://www.utilitydive.com/news/is-the-promise-of-oges-dynamic-pricing-program-starting-to-fade/303455/>

EverSource (NSTAR) TOU Pilot Study

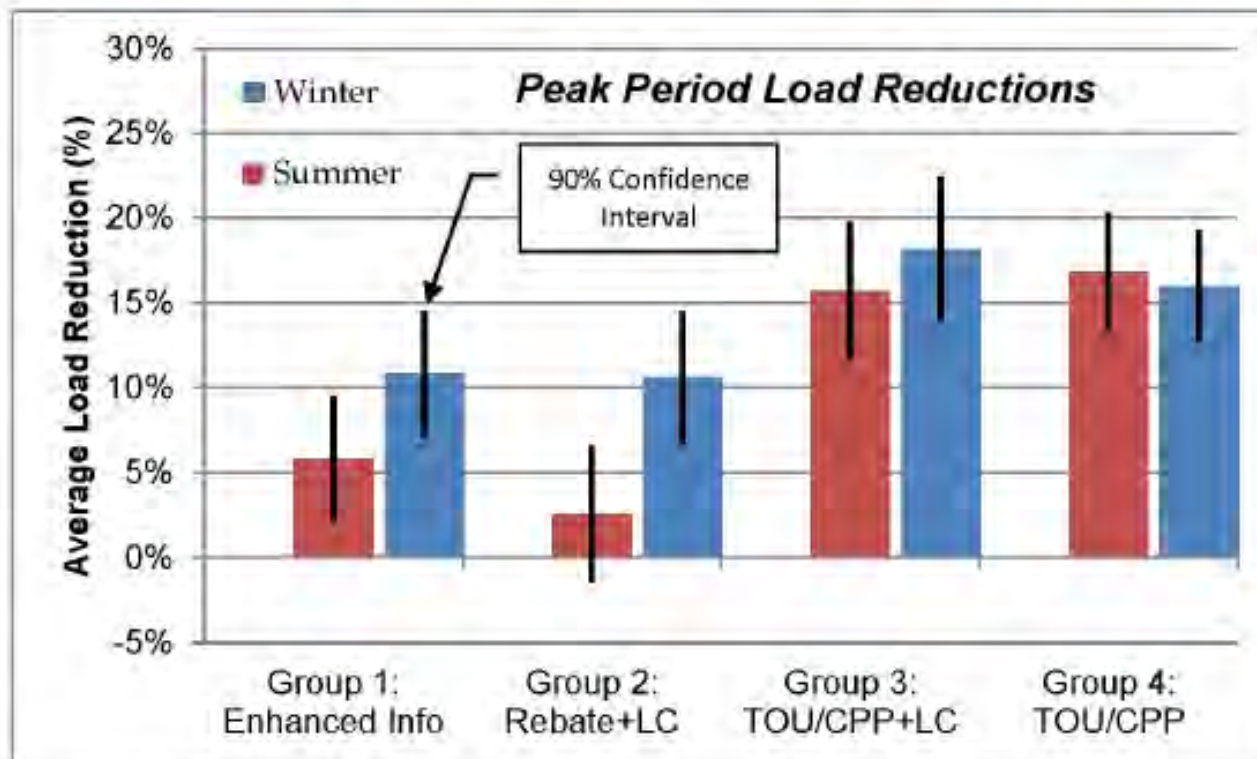


- 2 year study (2012-2013), covering 5 distinct areas within service territory
- ~2,700 initial participants, divided into four groups:
 1. Enhanced consumption information, no change in rates
 2. Peak time rebate (\$5 per event) + direct load control (NSTAR control of smart thermostat), no change in rates
 3. TOU rate with critical peak pricing (CPP) + direct load control (NSTAR control of smart thermostat)
 4. TOU rate with CPP, no direct load control
- 57% of participants remained enrolled at end of study

Study participants enrolled in TOU with CPP and Load Control had the largest demand reductions during peak events

Average Peak Load Reductions

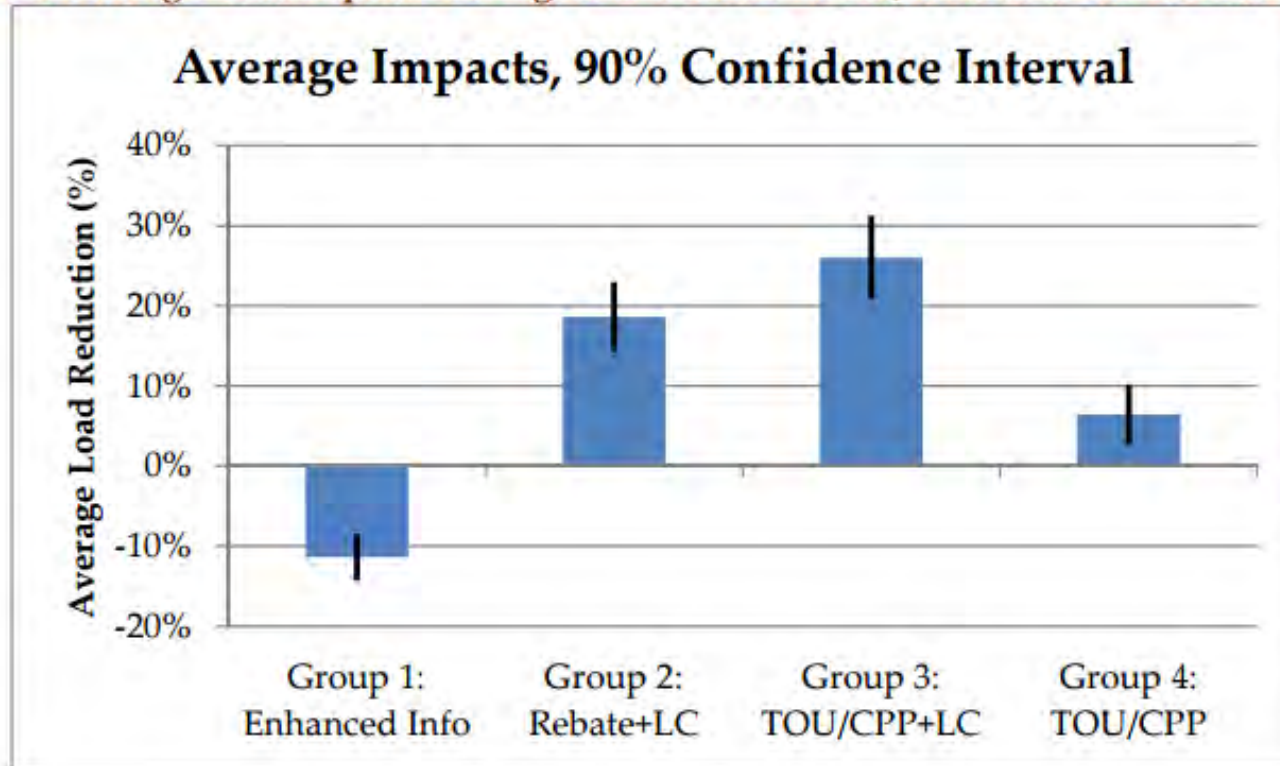
Figure 3-1. Average Peak Period Load Reductions, by Group and Season



Source: Navigant analysis

Event Day Load Reductions

Figure 3-1. Average Load Impacts During Summer 2012 Events, with 90% Confidence Intervals



Source: Navigant analysis

Cautionary Tale: Ontario TOU

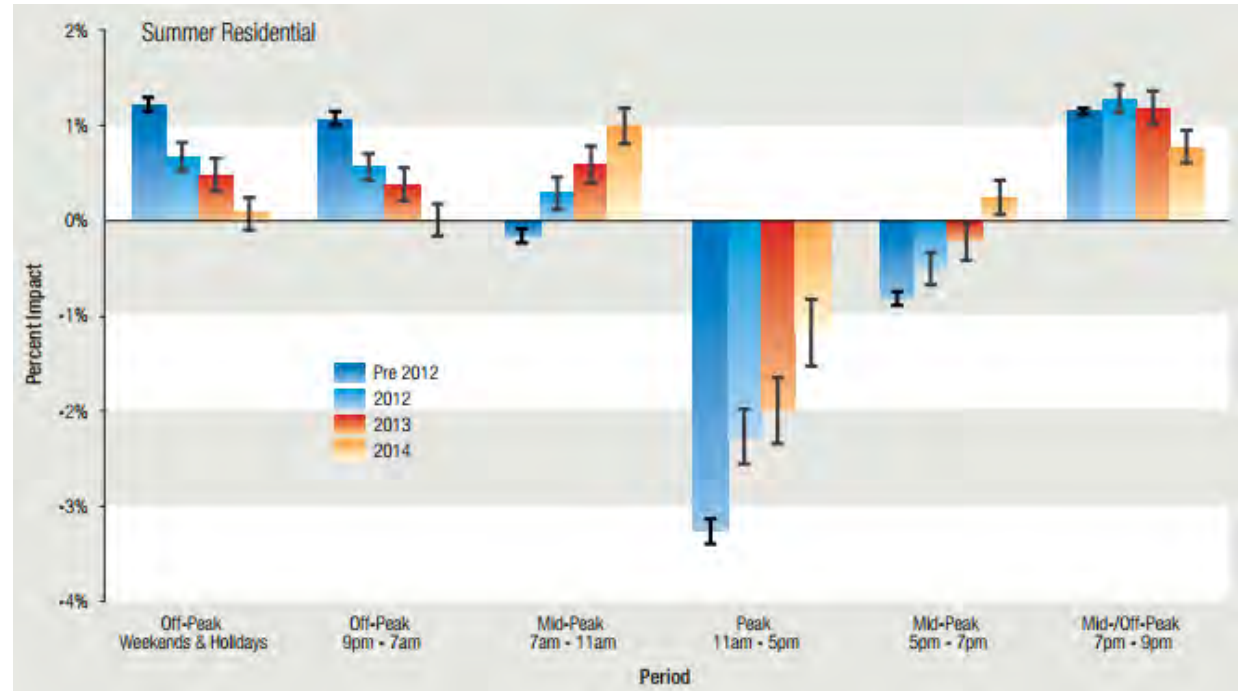
- 100% AMI and default TOU for all customers with opt-out option
- ~90% enrollment
- 103,000 qualified customers involved in study
- Very long summer peak period; 11am to 5pm
- Extremely modest results
- Declining results year over year

Year	Peak	Mid Peak	Off Peak	Peak to Off-Peak Ratio
2012	11.7	10.0	6.5	1.8
2013	12.4	10.4	7.8	1.6
2014	13.5	11.2	7.5	1.8

Source: The Impact of Time-of-Use Rates in Ontario, 2017
<http://www.ontario-hydro.com/historical-rpp-rates>

Cautionary Tale: Ontario TOU

- Province-wide summer peak residential demand reductions
 - 3.26% pre-2012
 - 2.27% in 2012
 - 2.00% in 2013
 - 1.18% in 2014

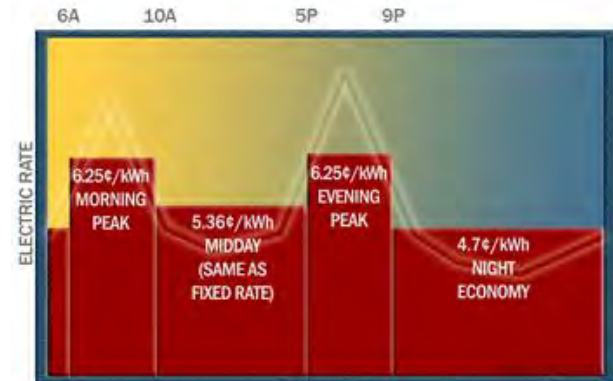


- Customers may struggle to respond to Time of Use rates with very long peak periods
- Customer response may fatigue year to year if bill savings are not sufficient

Source: The Impact of Time-of-Use Rates in Ontario, 2017

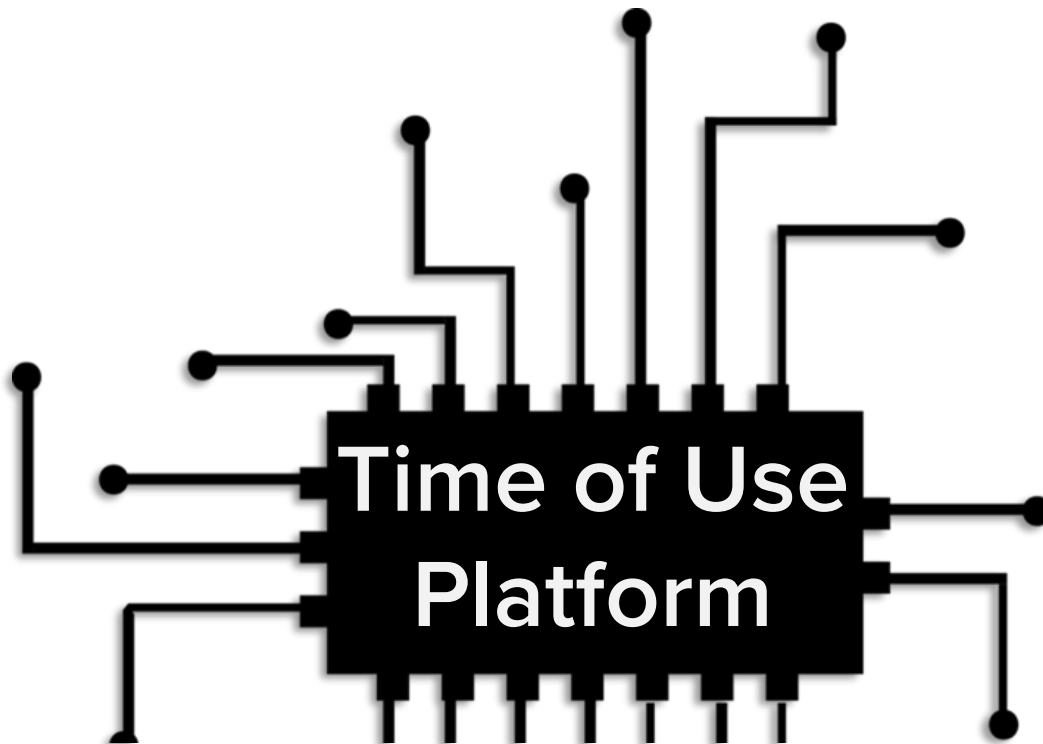
Cautionary Tale: Puget Sound Energy

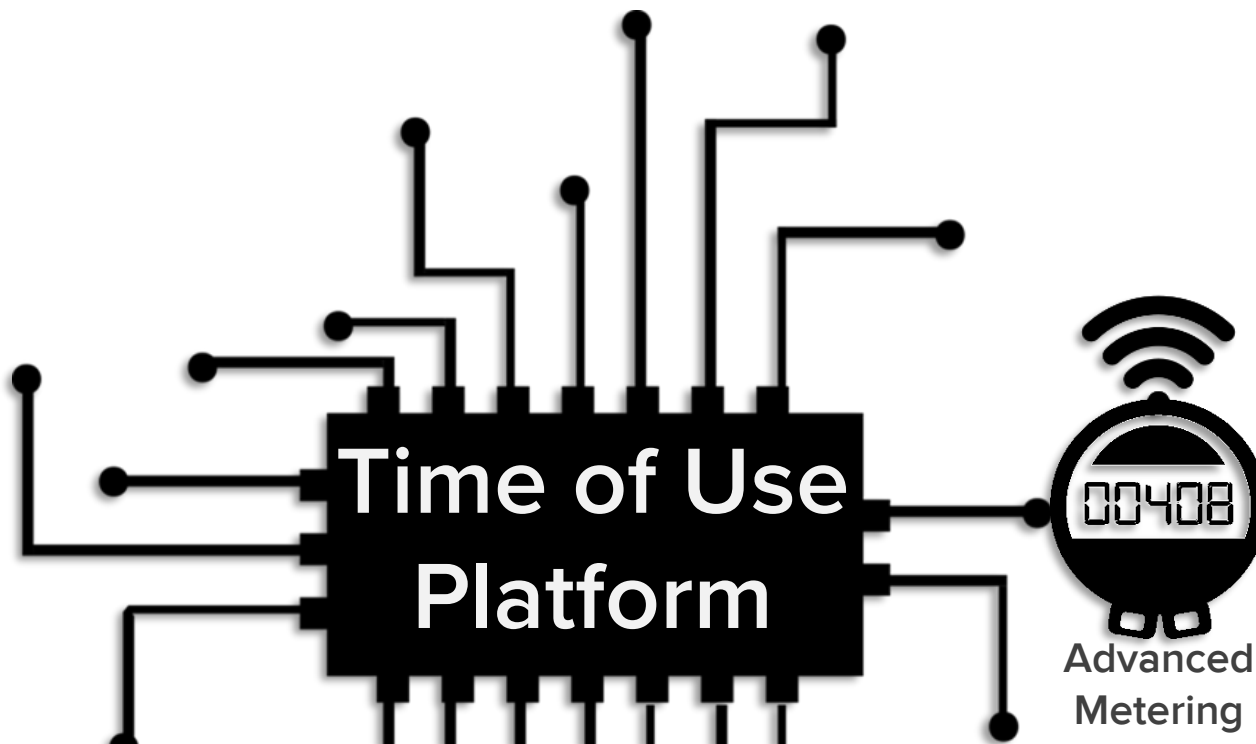
- TOU Pricing Pilot launched in 2001 with 300,000 customers.
 - 4 daily meter reads using AMR technology.
 - Customer charge of \$1.25/month to cover the automated meter reading costs
- Rate differential too small?
 - Customers did respond and conserve, but...
 - Shifting 200 kWh per month saved <\$2.00. Often not enough to cover meter fee!
- Customer backlash:
 - 94% of participants ended up paying higher bills.
 - Cancellations soared after customers began receiving quarterly reports on bill savings.
- Program cancelled one year ahead of schedule:
 - Commission analysis: “Not only have TOU (time of use) customers been paying higher bills than they would have paid under non-TOU rates, but, in addition, PSE apparently has experienced net lost revenue.”

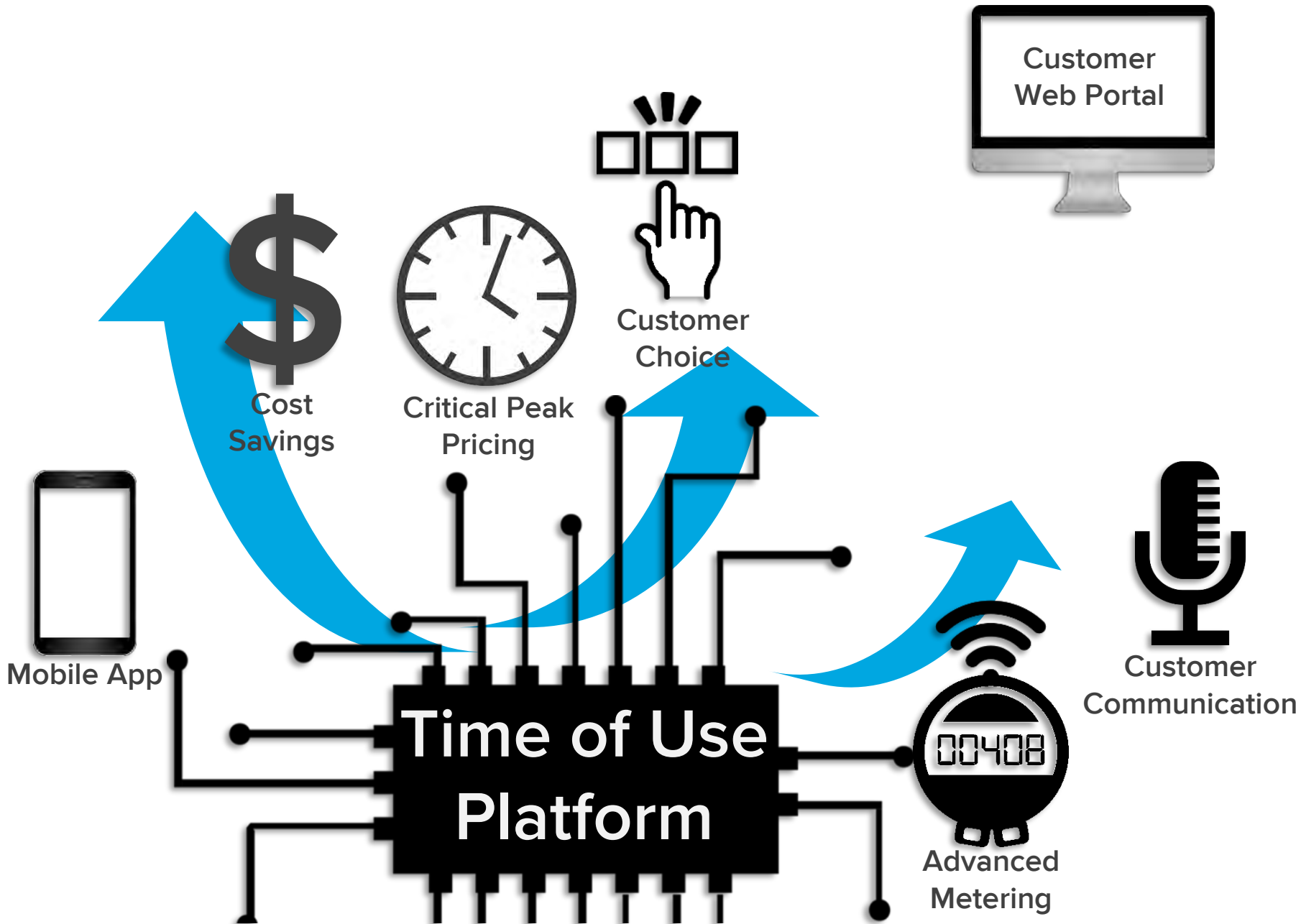


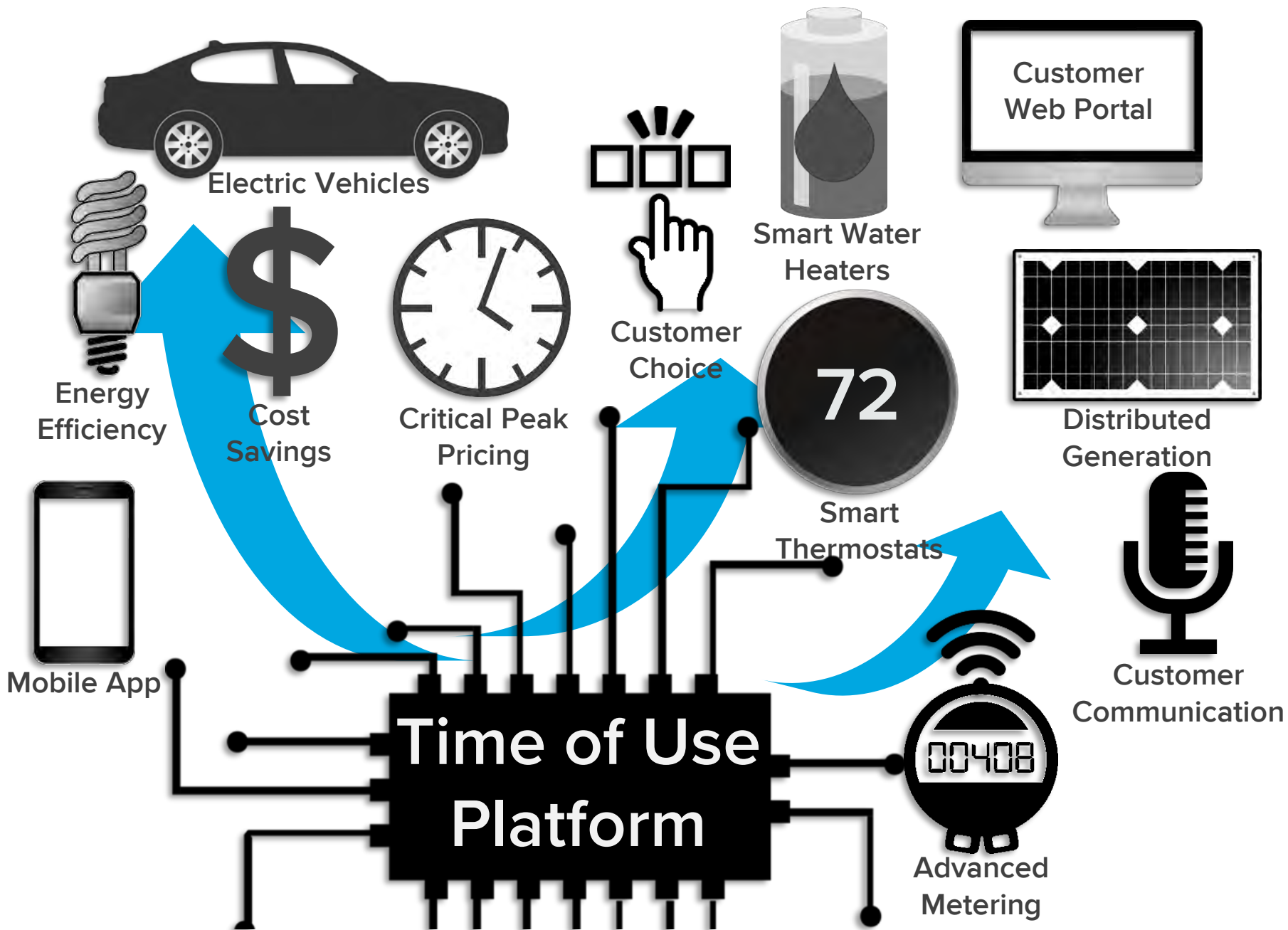
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Program Design Choices

Enrollment

- Opt-in
- Opt-out
- Rate Designs
- Number of customers
- Duration (Number of years)

Education

- Community outreach
- Marketing
- Staff training
- IT support

Incentives

- Pay-to-Play
- Bill protection
- Peak Time Rebate
- Free technology (e.g. thermostat)

Participant Types

- Residential and/or Commercial
- Income level
- Usage level
- Income/Medical discount

Technology

- Programmable Communicable Thermostats
- Load control devices
- Behavioral software

Recommendations for TOU Design

- Set objectives and metrics first
 - What are you trying to get customers to do?
- Engagement is important
 - Without education and outreach, TOU price signals alone will not achieve program goals.
 - Outreach must extend beyond ‘welcome package’
- Understand customers are not utility-focused
 - Most customers do not want to know complex energy information, even if it can save them money
 - Instead, use data for better marketing

Key Findings

- TOU rates can be customer friendly and reduce peak period loads.
 - Peak day programs and technology enhance impact, particularly during event days.
- Without ongoing efforts, customers lose interest over time.
 - Aggressive marketing and education is important for sustaining impact over time.
- Technology does not always function as designed and customers must play a role in maintaining operability

Recommendations for TOU Design

- Set realistic expectations
 - There are always tradeoffs
- Rate design and implementation strategy are equally important to a successful pilot
- Opt-out pilots are more cost effective and more representative of the customer base
 - Segmenting to understand group impacts can be helpful
- Make the pilot useful and do something based on the findings after its conclusion

More Information

Thank you!

Lon Huber
Strategen Consulting, LLC

- Email: lhuber@strategen.com
- Phone: 928-380-5540

Appendix

Minnesota Principles and Objectives

- Low Income Access
- Marginal Cost-based
- Cost Causation-based
- Utility Revenue Stability
- Encourage Conservation
- Reduce System Peak
- Stable and Understandable
- Economically Efficient
- Aligned with Wholesale Prices



The Importance of a Good Implementation Plan



7.0
TREPPENHAUS
9,55m²

INST.-SCHACHT

8.3
BAD

Facts on the Ground

- Customers tend to:
 - Like flat kWh rates
 - Be risk adverse
 - Be reluctant to change
- Research lacking around peak demand charges vs. TOU
- Knowledge Gap
 - Studies currently show that customers have very little idea about how their current rates work, let alone how alternative rate structures would impact them.
 - 75% of customers reported they have attempted to save money on their bill by shifting their usage to different times of the day, despite less than 5% of customers actually enrolled in TOU rate plans.

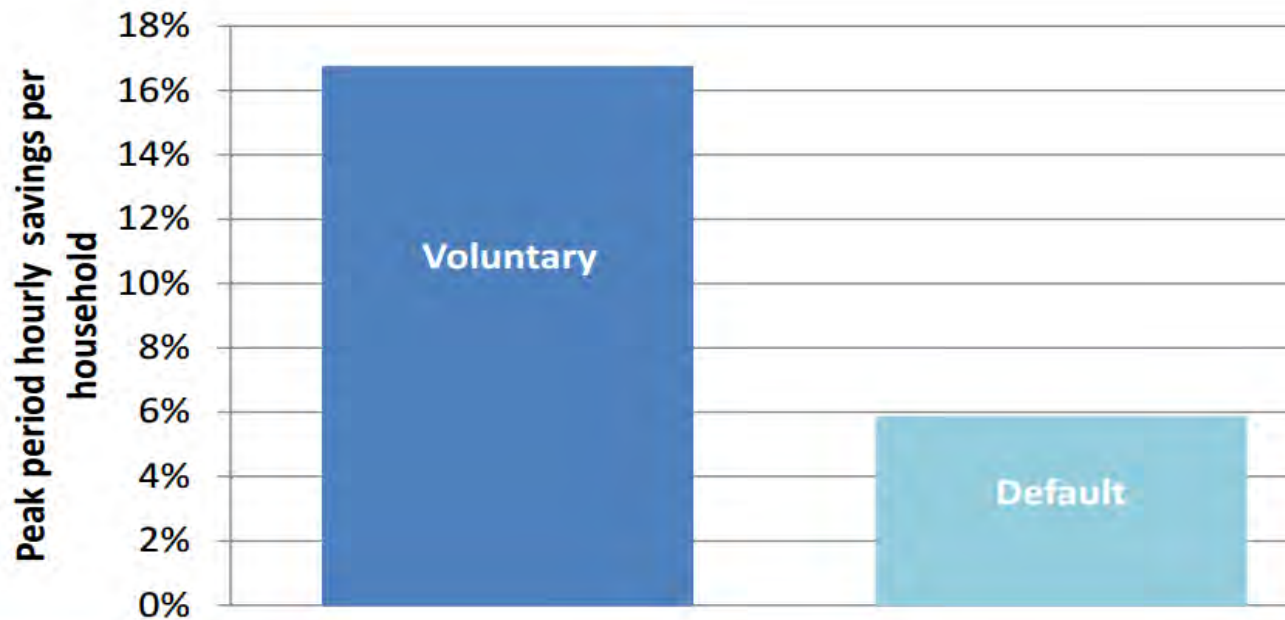
–Sources: CSIRO and a large survey conducted by Hiner & Partners in 2013

Considerations: Transitioning to New Rate Designs

- Opt-in, default, or transition
 - Should all customers be required to be on the new rate?
 - How should utilities transition customers to a new default rate?
 - How long must they stay on the rate?
- Education
 - Rate impacts will not be the same for all customer segments
 - Targeted and personalized communications
 - Customers are interested to know how *their* bills will be affected.
 - “Try-Before-You-Buy” - Bill protection
- Utility Preparation
 - Identification of most impacted customers (e.g. load profile analysis, etc.)
 - Investment in analytics and software solutions (bill calculators)
 - Metrics for new rate rollouts
- Technology Availability

Implementation Strategies

- Enrollment rates were 5 times higher under the default enrollment approach vis-à-vis a voluntary TOU rate offering, with drop-out rates that were nearly identical (less than 5%)



LBNL – Smart Grid Investment Grant Consumer Behavior Study Analysis

Enabling Technologies with Rate Design Roll Out

- Smart and connected thermostats
 - Allow customers wireless control of HVAC use



- Smart appliances

- Appliances that are able to operate at optimal times to reduce demand or when rates are lower due to time of use rates

- Demand limiter

- Hardware that prevents high demand devices from operating simultaneously



- Behavioral and Data Services
 - Currently available only to C&I customers. Providers could offer programs to residential customers

Implementation Strategies

- Bill inserts, brochures, telephone marketing
 - Low-tech but effective means of customer education



- Shadow billing

- Customers receive two bills, one under their current rate, the other under the new rate - Customer only pays new rate bill

- Usage portal

- A web-based portal where customers can usually access monthly, daily, and hourly historical usage data



- In home display

- Allows customers to monitor current consumption without requiring a log in

Interim TOU Pilot Tariffs

Weekday Rate Periods

Tariff	Season	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
PG&E Rate 1	Spring	Off-peak (25.1¢)										Peak (27.0¢)						Off Peak (25.1¢)							
	Summer	Off-peak (30.3¢)										Peak (40.6¢)						Off Peak (30.3¢)							
	Winter	Off-peak (25.1¢)										Peak (27.0¢)						Off Peak (25.1¢)							
PG&E Rate 2	Spring	Off Peak (24.1¢)															Peak (26.3¢)			Off Peak (24.1¢)					
	Summer	Off Peak (29.5¢)															Partial Peak (40.2¢)		Peak (45.9¢)			PP (40.2¢)	Off Peak (29.5¢)		
	Winter	Off Peak (24.1¢)															Peak (26.3¢)			Off Peak (24.1¢)					
PG&E Rate 3	Spring	Off Peak (24.8¢)								Super Off Peak (15.3¢)						Peak (26.3¢)			Off Peak (24.8¢)						
	Summer	Off Peak (SOP) (31.4¢)															Peak (44.3¢)			Off Peak (31.4¢)					
	Winter	Off Peak (25.0¢)															Peak (27.2¢)			Off Peak (25.0¢)					
SCE Rate 1	Spring	Off Peak (23.9¢)										Peak (28.7¢)						Off Peak (23.9¢)							
	Summer	Off Peak (24.9¢)								Partial Peak (29.8¢)						Peak (37.3¢)			PP (29.8¢)	Off Peak (24.9¢)					
	Winter	Off Peak (23.9¢)										Peak (28.7¢)						Super Off Peak (23.9¢)							
SCE Rate 2	Spring	Super Off Peak (17.2¢)								Off Peak (26.6¢)						Peak (29.1¢)			OP (26.6¢)	Super Off Peak (17.2¢)					
	Summer	Super Off Peak (17.1¢)								Off Peak (31.7¢)						Peak (58.9¢)			OP (31.7¢)	Super Off Peak (17.1¢)					
	Winter	Super Off Peak (17.2¢)								Off Peak (26.6¢)						Peak (29.1¢)			OP (26.6¢)	Super Off Peak (17.2¢)					
SCE Rate 3	Spring	Off Peak (23.2¢)								Super Off Peak (15.7¢)						Peak (28.7¢)			Off Peak (23.2¢)						
	Summer	Off Peak (23.2¢)								Partial Peak (28.7¢)						Peak (59.1¢)			PP (28.7¢)	OP (23.2¢)					
	Winter	Off Peak (23.2¢)															Peak (26.7¢)			Off Peak (23.2¢)					
SDG&E Rate 1	Summer	Off Peak (30.2¢)							Partial Peak (35.5¢)								Peak (57.5¢)			Partial Peak (35.5¢)					
	Winter	Off Peak (32.4¢)							Partial Peak (33.4¢)								Peak (34.4¢)			Partial Peak (33.4¢)					
SDG&E Rate 2	Summer	Off Peak (33.5¢)															Peak (57.5¢)			Off Peak (33.5¢)					
	Winter	Off Peak (33.0¢)															Peak (34.4¢)			Off Peak (33.0¢)					

SDG&E Interim TOU Pilot Tariffs

Figure 6.1-1: SDG&E Pilot Rate 1¹¹⁶

Tariff	Season	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00
Weekday	Summer	Super Off Peak (29.71¢)						Off Peak (34.91¢)									Peak (56.57¢)			Off Peak (34.91¢)					
	Winter	Super Off Peak (35.12¢)						Off Peak (36.2¢)									Peak (37.31¢)			Off Peak (36.2¢)					
Weekend	Summer	Super Off Peak (29.71¢)													Off Peak (34.91¢)		Peak (56.57¢)			Off Peak (34.91¢)					
	Winter	Super Off Peak (35.12¢)													Off Peak (36.2¢)		Peak (37.31¢)			Off Peak (36.2¢)					

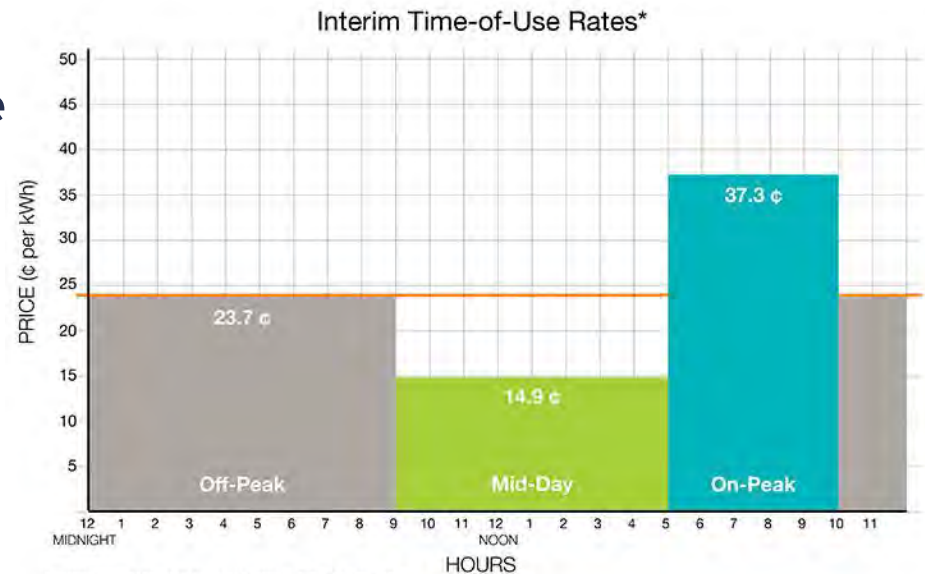
Figure 6.1-2: SDG&E Pilot Rate 2

Tariff	Season	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00
Weekday	Summer	Off Peak (32.94¢)													Peak (56.57¢)			Off Peak (32.94¢)							
	Winter	Off Peak (35.77¢)													Peak (37.31¢)			Off Peak (35.77¢)							
Weekend	Summer	Off Peak (32.94¢)													Peak (56.57¢)			Off Peak (32.94¢)							
	Winter	Off Peak (35.77¢)													Peak (37.31¢)			Off Peak (35.77¢)							

HECO Time of Use Pilot



- Limited to 5,000 residential customers across five islands
 - Began enrollment in September 2016
- Optional opt-in
- No-penalty opt-out at any time
- Three periods
 - Mid-day
 - Peak
 - Off-peak
- No AMI technology



*Illustration reflects October 2016 Interim Time-of-Use rates.

Time-of-Use Enrollment				
	Hawaiian Electric	Hawaii Electric Light	Maui Electric	Total
As of 10/28/2016	426	21	61	508

Source: Hawaiiianelectric.com

Marblehead Municipal Lighting District

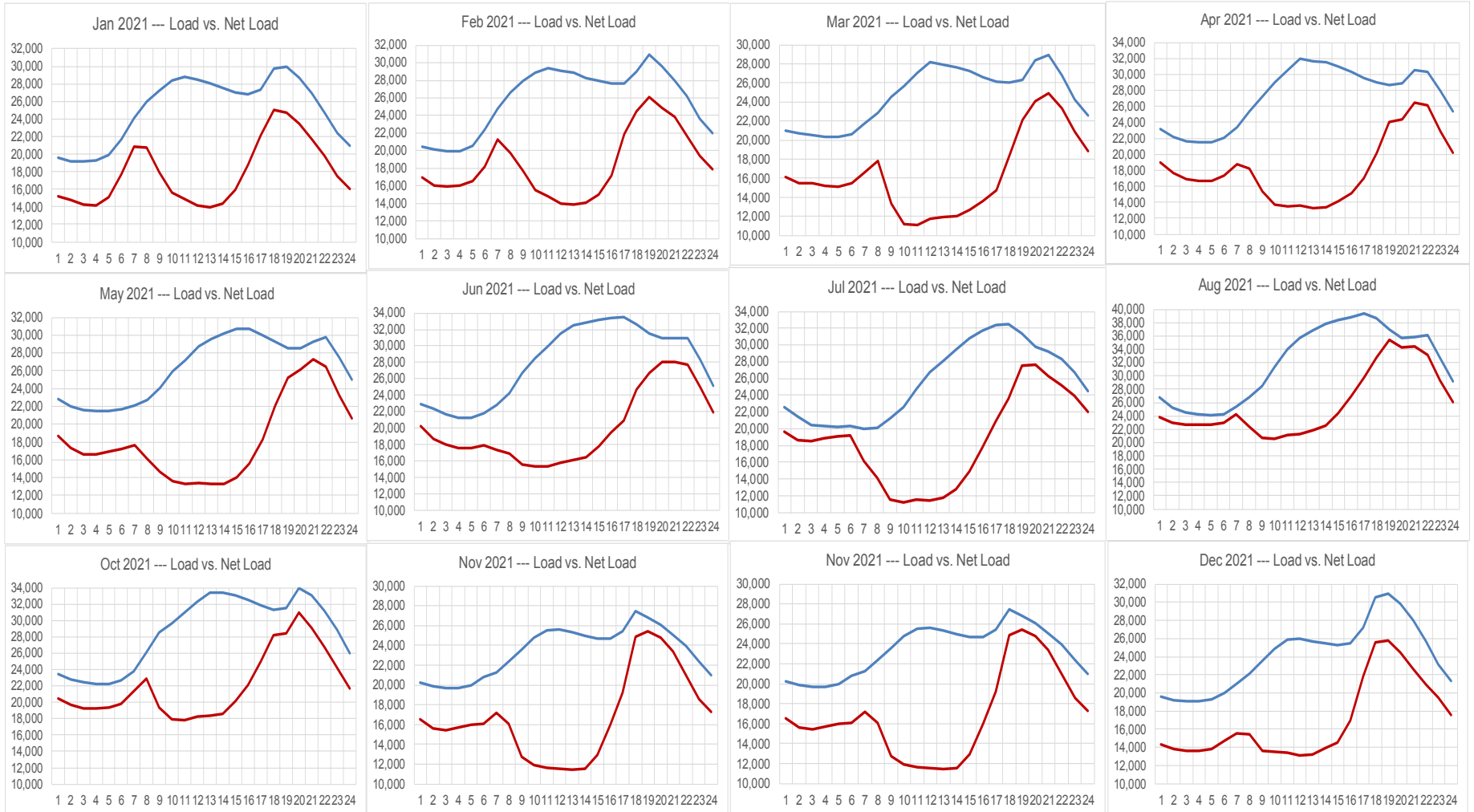
- Marblehead Municipal Lighting District in Massachusetts
 - Summer of 2011
 - 500 residential customers
 - 37% peak reduction on event days
 - 85% customer satisfaction
 - 0.74 kW average peak demand reduction per customer during events
 - First year offered 100% bill protection, second year protection was removed
 - Standard rate for the control group was 14.25¢ per kWh



Price Level	Residential CPP Price	Number of days in summer 2011 at each price level
Flat	9.0¢ per kWh	89
Critical peak event	105.0¢ per kWh	3

CPP rates can deliver very high system peak demand reductions without severe negative customer impacts

2021 Monthly Load vs. Net Load profiles --- weekdays



Source: CPUC presentation to TOU OIR Workshop, May 2015

CAISO Proposed TOU Periods for Supplemental Analysis

WEEKDAYS

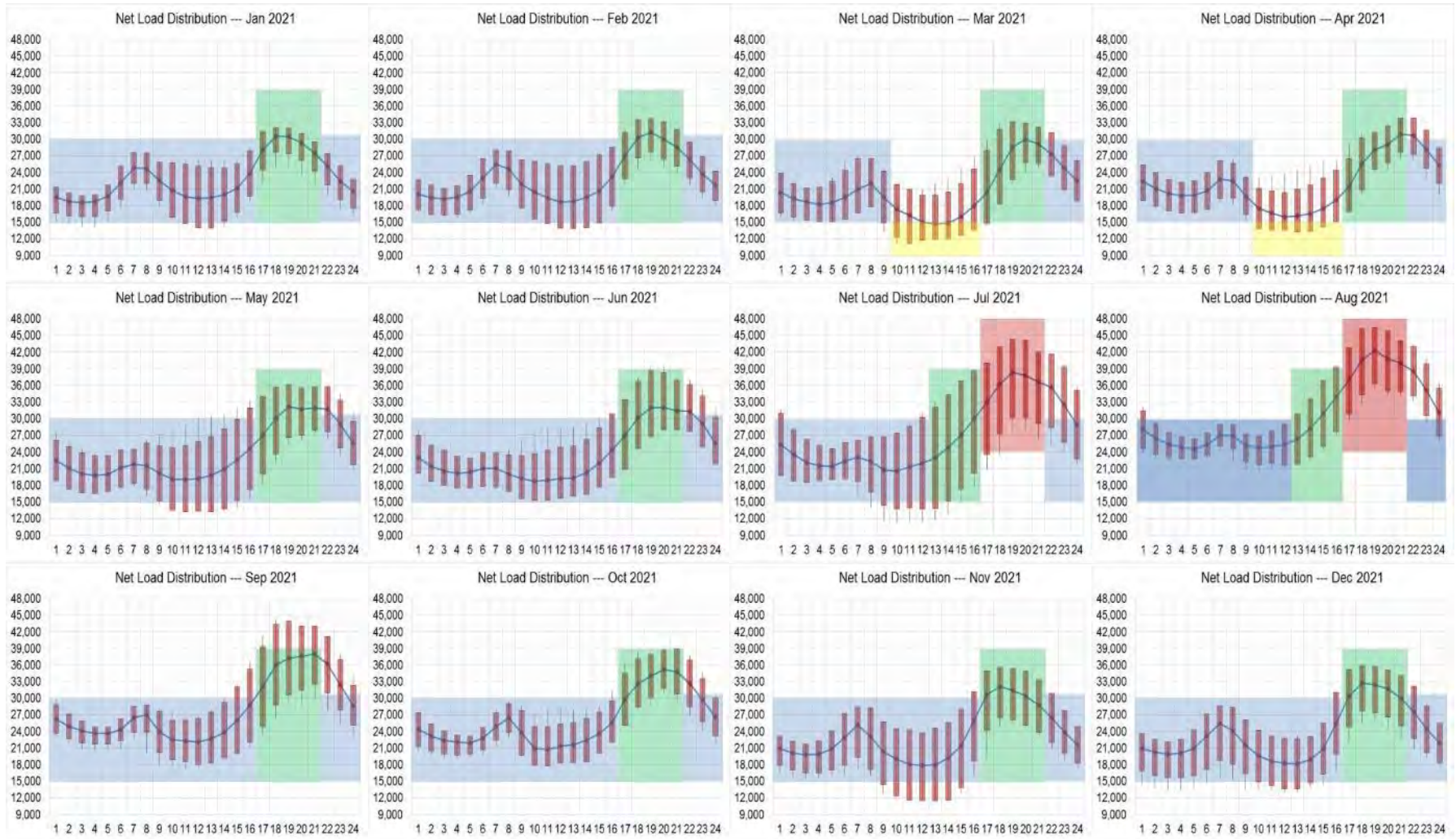


WEEKENDS



Source: CPUC presentation to TOU OIR Workshop, May 2015

2021 Monthly Net Load Distribution - Weekdays



Off-Peak
 Super Off-Peak
 Peak
 Super Peak

Source: CPUC presentation to TOU OIR Workshop, May 2015

Interim TOU pilot – PG&E

- \$8.4 million total budget from 2015 – 2018
- Intended to enroll 18,500 but 20,713 accepted the ‘pay to play’ offer
- Three rates
 - 1) Simple TOU with 5 hour peak from 4pm to 9pm year-round using hourly generation data
 - 2) Addition of partial peak for summer season and higher Peak-to-Off Peak ratio
 - 3) Addition of Super-Off-Peak period in spring season
- Pay-to-Play strategy
 - \$75 after enrollment, \$50 for first survey, \$75 for final survey

PG&E Interim TOU Pilot Tariffs

Figure 4.1-1: TOU Pilot Rate 1 (Hour Ending)⁴⁷

Tariff	Season	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00
Weekday	Summer	Off-Peak (31.67¢)																Peak (41.97¢)							
	Winter	Off-Peak (27.1¢)																Peak (28.98¢)							
	Spring	Off-Peak (27.1¢)																Peak (28.98¢)							
Weekend	Summer	Off-Peak (31.67¢)																							
	Winter	Off-Peak (27.1¢)																							
	Spring	Off-Peak (27.1¢)																							

Figure 4.1-2: TOU Pilot Rate 2 (Hour Ending)

Tariff	Season	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00
Weekday	Summer	Off Peak (29.59¢)																Partial Peak (39.27¢)	Peak (44.48¢)						
	Winter	Off Peak (26.99¢)																Peak (29.6¢)							
	Spring	Off Peak (26.99¢)																Peak (29.6¢)							
Weekend	Summer	Off Peak (29.59¢)																Partial Peak (39.27¢)	Peak (44.48¢)						
	Winter	Off Peak (26.99¢)																Peak (29.6¢)							
	Spring	Off Peak (26.99¢)																Peak (29.6¢)							

Figure 4.1-3: TOU Pilot Rate 3 (Hour Ending)

Tariff	Season	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00
Weekday	Summer	Off-Peak (28.59¢)																Peak (57.19¢)							
	Winter	Off-Peak (27.08¢)																Peak (28.97¢)							
	Spring	Off Peak (26.74¢)								Super Off-Peak (18.02¢)				Peak (36.05¢)											
Weekend	Summer	Off-Peak (28.59¢)																							
	Winter	Off-Peak (27.08¢)																							
	Spring	Off Peak (26.74¢)								Super Off-Peak (18.02¢)															

Interim TOU pilot – SCE

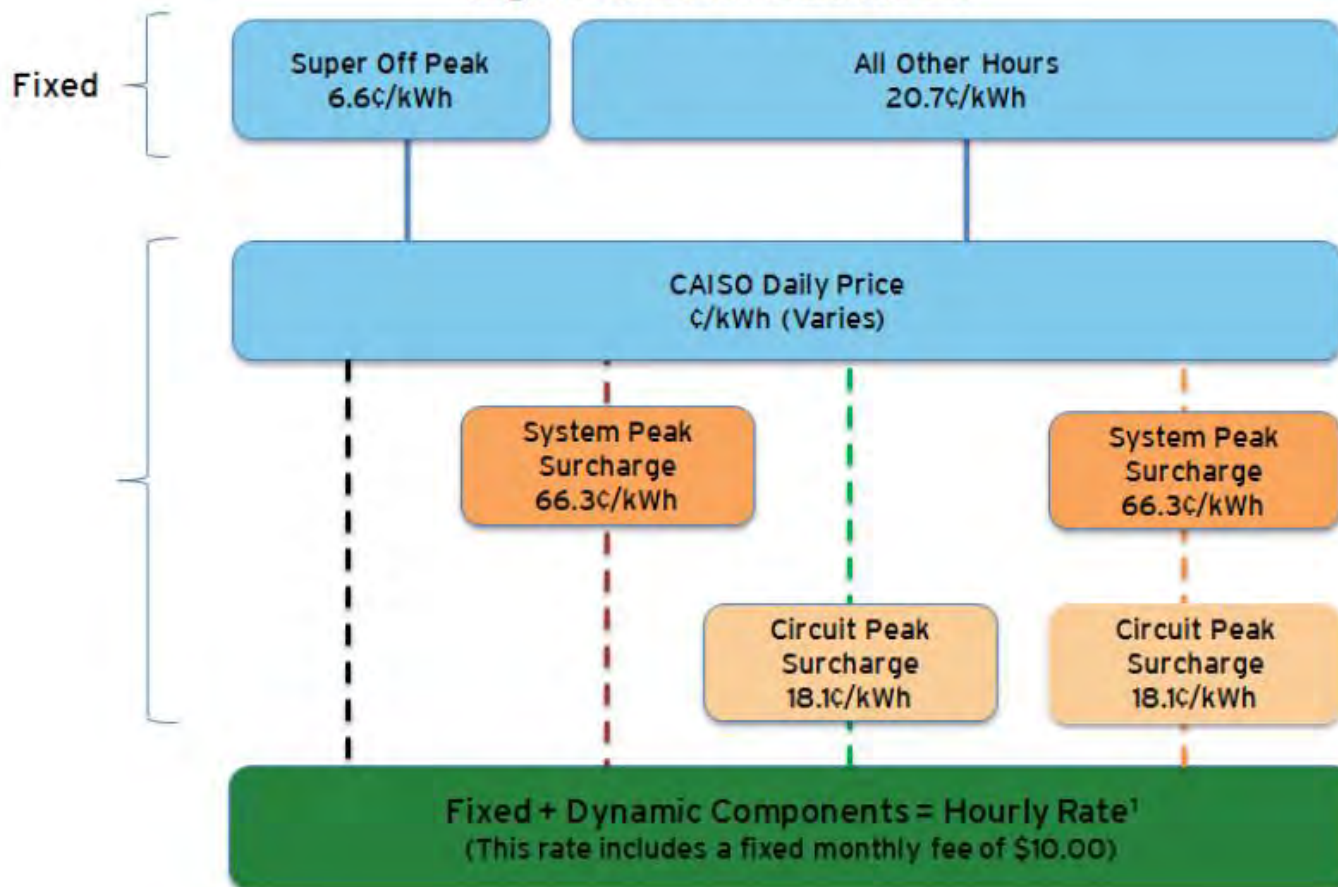
- \$10.0 million total budget from 2015 – 2018
- 21,000 customers
- Three Rates
 - 1) Six hour peak period with super off peak periods
 - 2) Shorter year round peak periods and same Super Off-Peak periods
 - 3) No baseline credit and addition of a summer Super On-Peak and Mid Peak periods
- Pay-to-Play strategy
 - \$100 at enrollment \$50 for each two surveys

Interim TOU pilot – SDG&E

- \$5.1 million total budget from 2015 – 2018
- 15,000 customers
- Three rates
 - 1) Relatively simple TOU with super off-peak period
 - 2) Similar structure to Rate 1 with no super-off peak period
 - 3) Unique complex dynamic rate available to only 200 customers that have adopted innovative technology and have an understanding of their usage.
 - Hourly prices tied to CAISO wholesale market, system peak and local system peak

SDG&E Interim TOU Pilot Tariffs

Figure 6.1-3: SDG&E Rate 3



TOU Examples Across the US

