



**SMART METERS:  
TARIFF DESIGN OPTIONS AND CASE STUDIES**

Chris King, President  
eMeter Strategic Consulting  
November 16, 2010



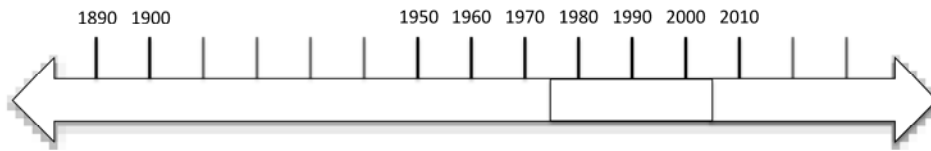
## Who is eMeter Strategic Consulting?

- **Anaheim Public Utilities** - Turn-key Spare the Power Days critical peak rebate program
- **PG&E** - Smart meters for PG&E's customers above 200 kW representing \$3B annual revenue
- **California Large IOUs** - Data management for the California Statewide Pricing Pilot
- **PowerCentsDC™** – Project design, implementation and operation for Washington D.C. smart meter/thermostat pilot
- **Ontario Smart Price Pilot** – Project design, implementation, and operation for time-of-use and critical peak pricing pilot
- **Southern Company** – Integrated AMI-distribution automation pilot



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# History of Pricing Options



## Pre-electronic metering era

- 1880's: appliance/device-based pricing
- 1888: introduction of metering, usage based pricing
- 1950's: addition of demand rates, mainly for large commercial/industrial customers
- 1960's: widespread time-based pricing for electric water heating in Europe (using two electromechanical meters)

## Electronic metering era

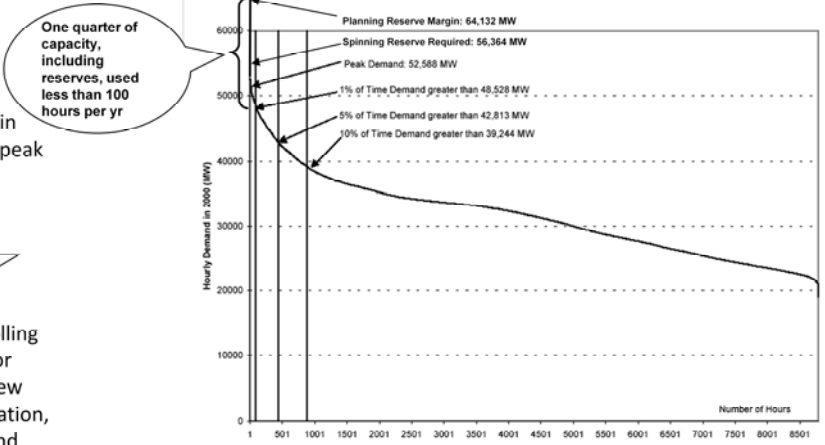
- 1970's: PURPA mandate to study and offer time-of-use rates
- 1980's: Real Time Pricing (RTP)/hourly pricing pilots & programs; inverted tiers
- 1990's: Critical Peak Pricing (CPP, aka Peak Day Pricing, PDP) pilots

## Electronic metering with comms (AMI or "smart" meters)

- 2000's: Peak Time Rebate (PTR, aka Critical Peak Rebate) pilots
- 2010's: RTP, PDP, and PTR programs; appliance based pricing (EVs, FITs)

# Goals of Dynamic Pricing

California Load Duration Curve



One quarter of capacity, including reserves, used less than 100 hours per yr

Small changes in load at critical peak times



Avoidance of rolling blackouts and/or need to build new capacity (generation, transmission, and distribution)



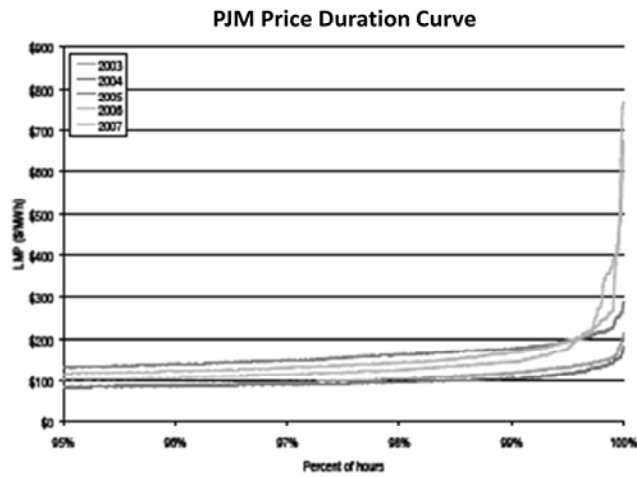
- Greater reliability
- Lower total electric system costs
- Lower individual electric bills

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# Wholesale Prices

- Wholesales price trends follow demand curve
- Regulators cannot set wholesale prices directly but can provide retail price signals to the demand side, which then influences wholesale prices



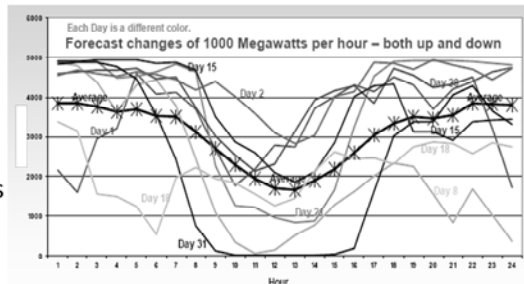
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## Another Reason for Price Options

- Problem: NERC requirement that natural gas (or other) plant needed as backup for intermittent solar and wind
- Solution: automated load following
  - Storage
    - EV charging (and discharging)
    - Building thermal storage
    - Refrigeration
  - Scheduling
    - Appliance & equipment timers
    - Process control
- Prerequisites
  - Pricing incentives (consumer motivation)
  - Automated control capability (HAN and other options)

Hourly Wind Generation by Day for a Month in CA



# Time-of-Use Pricing

- Definition

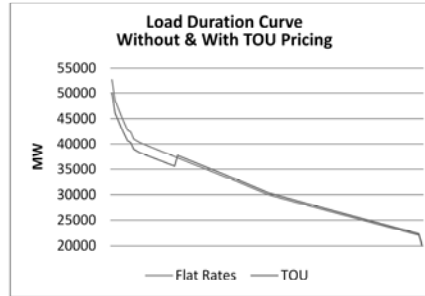
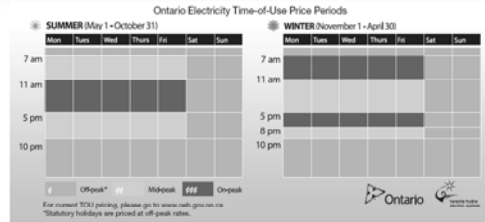
- Peak, off-peak, and sometimes mid-peak periods
- Times fixed within summer and winter seasons

- Attributes

- Moderate savings opportunity for consumers because it operates every day
- Flattens load curve but has only small effect on annual peak

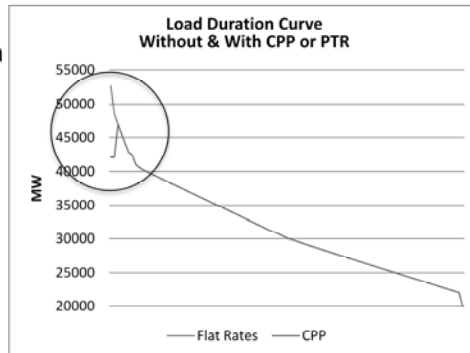
- Case Studies

- Mandatory TOU for above 500 kW commercial/industrial customers in California since early 1980's with 3-5% peak reduction
- Mandatory TOU for 1 million residential customers in Ontario, going to 4.5 million by 2012



## Critical Peak Options

- Top 1% of hours
  - System conditions-based dispatch
  - 10 to 15 days
  - 4 to 6 hours per day
- Flavors
  - Critical Peak Pricing (Peak Day Pricing)
  - Peak Time Rebate (Critical Peak Rebate)
- Attributes
  - Smaller savings opportunity
  - Captures 75% or so of annual capacity savings
  - Significantly lowers annual peak

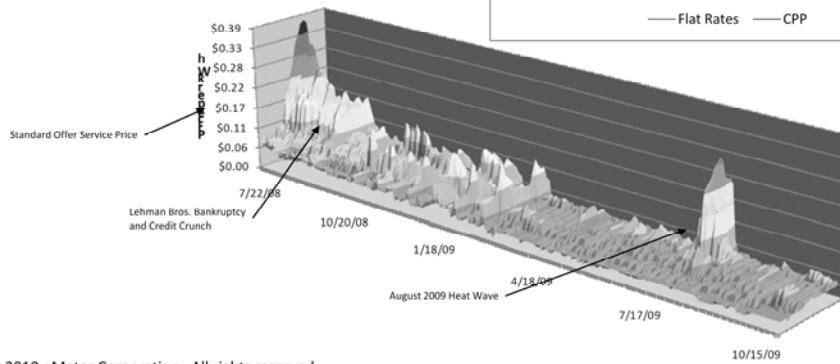
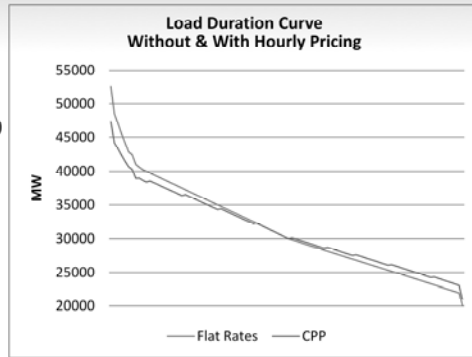


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# Hourly Pricing

- Price varies hourly
  - Day ahead or post hoc
  - PJM in 2008-9 from \$0.37 per kWh to \$0.00
- Attributes
  - Greatest savings opportunity
  - Potentially highest risk
  - Incentive to shift from high- to low-cost periods throughout year
  - Good for intermittent renewables & EVs



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# PowerCentsDC Case Study

## Smart Grid pilot

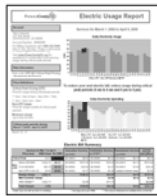
- About 1,000 residential customers across District of Columbia
- Designed and evaluated by Dr. Frank Wolak, Stanford U.
- Random sample, including low-income



Covered summers of 2008 and 2009, winter of 2008-9

## Integrated “smart products and services” approach

- “Smart,” dynamic prices: CPP and CPR
- “Smart” energy information feedback: Energy Reports with bills, Web portal, seasonal bill inserts, quasi-in home display
- “Smart” appliances: automated control via smart thermostats



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# PowerCentsDC Enrollment

- Random District-wide selection
- “Secured choice” model
  - Opt-in was not available
  - Default/opt-out not possible
  - Customer must provide contact info to receive notifications and, thus, participate (not true of universal PTR, though)
- CPR highest participation levels in spite of no \$100 thank you payment
- Limited income customers participated at higher rate than other customers



Price Group	Confirmation Rate
CPP	6.5%
CPR	7.4%
Hourly Pricing	5.5%

Customers	Confirmation Rate
Regular	6.4%
Limited Income	7.6%

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## Peak Demand Reduction By Group

- Higher price differentials led to greater peak demand reductions

Price Plan	Summer Peak Reduction	Winter Peak Reduction
CPP	34%	13%
CPR	13%	5%
HP	4%	2%

- Participants at all income levels responded to the price signals

CPR Participants by Income Level	Summer Peak Reduction
Residential	13%
Residential with Limited Income	11%

# Automation and Weather

- Smart thermostats caused larger reductions

Rate Group	No Smart Thermostat	With Smart Thermostat
R-CPP	29%	49%
R-CPR	11%	17%
AE-CPP	22%	51%
AE-CPR	6%	24%

- Higher temperatures caused larger reductions

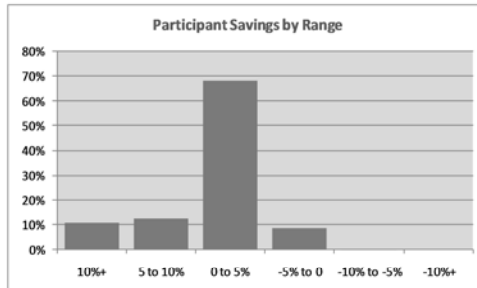
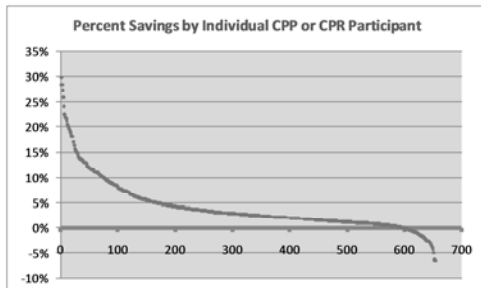
Rate Group	Peak Reduction	
	At 85°F	At 97°F
CPP	26%	43%
CPR	8%	20%
HP	3%	3%

# Bill Savings

- Prices designed to be revenue neutral
  - Average customer pays same bill if no peak load reduction

## Analysis for CPP and CPR customers

- **91% of participants saved money**
- Average 12-month savings was \$43.83 (4%)
- Average 12-month bill increase for the other 9% was \$17.43 (2%)



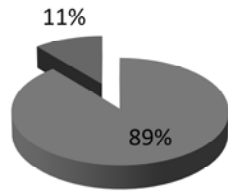
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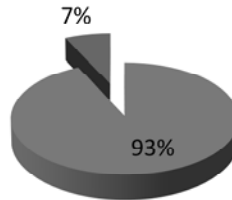
# Participants Liked the Program

Would you recommend PowerCentsDC electricity pricing to your friends and family?



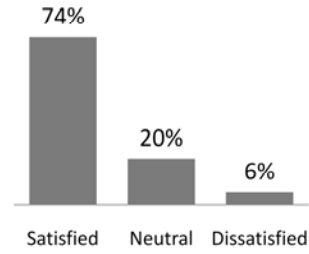
■ Yes ■ No

Which price plan did you prefer?



■ PowerCentsDC Plan  
■ Former Pricing Plan

Overall, were you satisfied, neutral, or dissatisfied with the PowerCentsDC program?



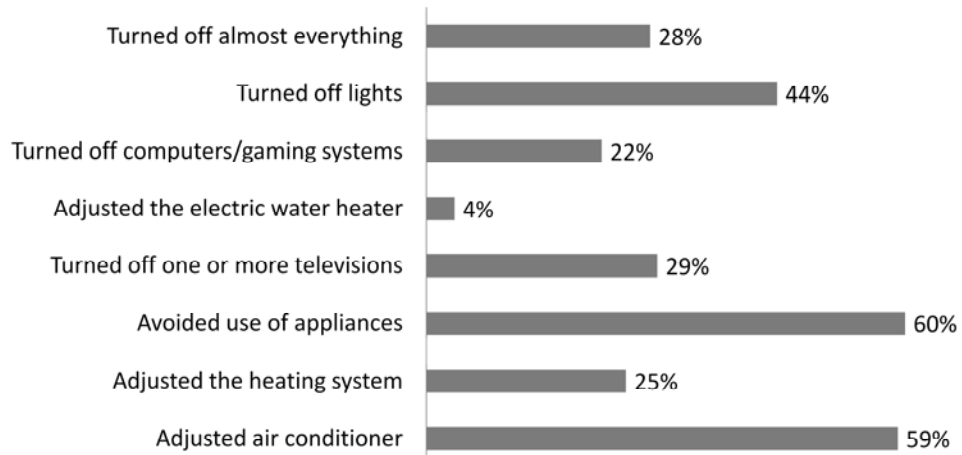
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**What actions, if any, did you take to reduce your electricity use during critical peak periods or during times of high energy prices?**



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## Other Critical Peak Case Examples

- CPP/PDP
  - Numerous pilots showing peak reductions of 10-54%
  - California commercial customers being “defaulted” to Peak Day Pricing (secure choice model)
    - Above 200 kW in May 2010
    - Remainder in fall 2011
  - To date, 25 to 40% opting out to TOU or an alternate demand response program
    - In spite of bill protection program
- PTR/CPR
  - Programs in MD, CT, CA, and Ontario found same peak reduction as CPP
  - Pepco pilot (PowerCentsDC™) found lower response to PTR than CPP
  - PG&E, SDG&E, and SCE to roll out PTR to 10 million residential customers beginning in 2011
  - BGE to roll out in 2013

## Hourly Pricing – Illinois Ameren

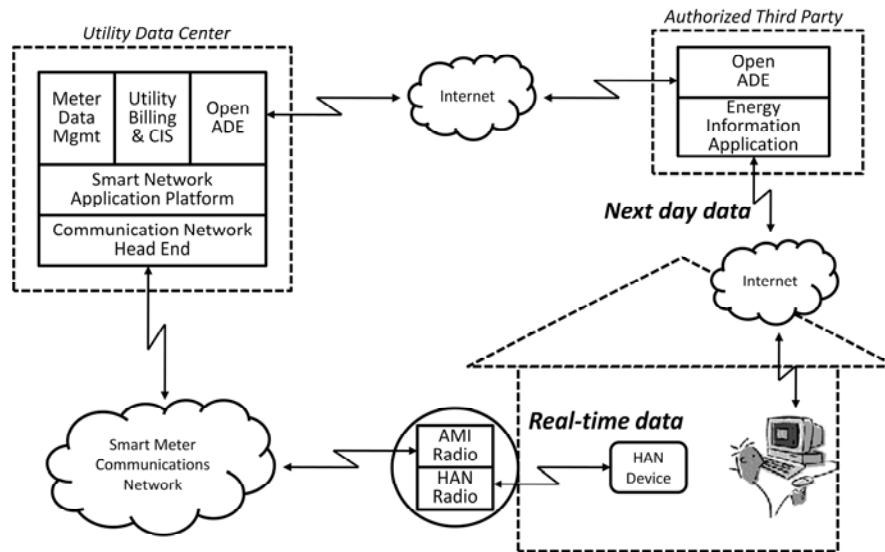
- Successful pilot led to ongoing program
- Participation
  - Over 7,000
  - Adding 3-4,000 per year
- Results
  - Bill savings averaging 10.1%
  - Peak demand reduction of up to 24% based on elasticity of demand of about 0.04
  - Energy conservation of 1.5 to 3% annually
  - Survey
    - 88% reported changes in energy use
    - 71% say participation is “quick and easy”
    - Another 20% say “not difficult”
    - Over 99% retention rate
  - Lower income customers had higher price elasticity of demand (more peak reduction)



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# Information to Consumers: Key Interfaces

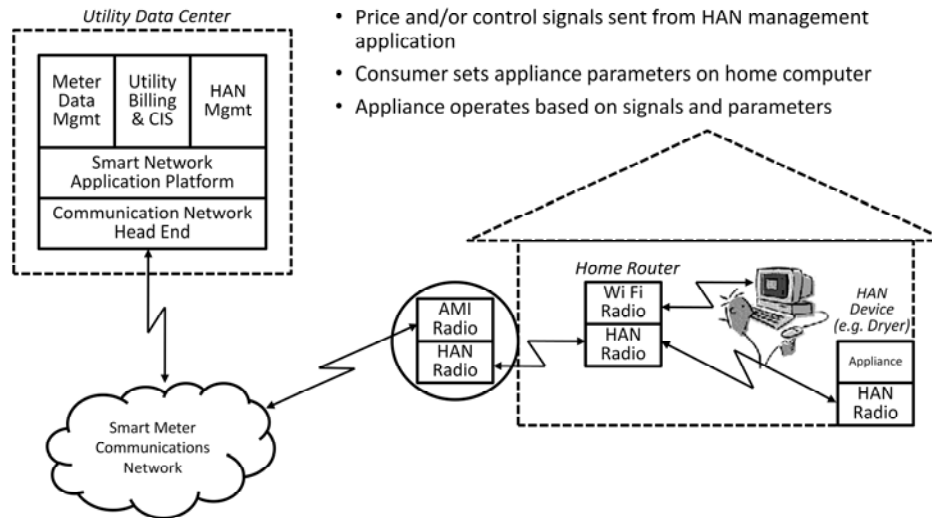


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# HAN Simplified – Appliance Control

- Appliance comes equipped with HAN radio
- Price and/or control signals sent from HAN management application
- Consumer sets appliance parameters on home computer
- Appliance operates based on signals and parameters



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## Consumer's Perspective

- Smart grid empowers consumers with...
  - Price options that allow saving through shifting and peak reduction
  - Energy information in real-time or next day that gives understanding and the ability to make informed choices about using energy and purchasing new appliances
  - Smart thermostats and appliances that allow “informed choice, set and forget” operation as instructed by the energy user according to his...
    - Preferences
    - Price incentives
    - Knowledge of usage and cost relationships