



From Technology to Data to Knowledge

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New Data Sources from Enhanced Automation
J. Lopes; AEG – AEIC Committee Meeting, Berkeley CA November 2004



Introduction

- **Enhanced Automation Technology**
 - **Monitoring and Control of Energy Systems, with Safety and Comfort**
 - **Advanced Metering Systems “Plus”**
 - **Submetering “Plus”**
 - **Time-of-Use and Real-Time Pricing (RTP)**
 - **Demand Response; Utility/ISO Incentives**
- **Advanced Monitoring = New Data Sources: How best to use?**

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Enhanced Automation Technology

- **New technology: wireless, PLC, Internet**
- **Common in large businesses**
 - Energy Management Systems
 - Support from On-site Energy Managers
- **Uncommon in residential, small business**
 - Expensive (until now?), Complex – training issues
- **Residential & small business starting to adopt advanced metering technology**
 - NYSERDA (NY) and Utility Programs, California interval metering requirement
 - New generation of software and hardware

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Enhanced Automation Technology

- **New Technology offers more benefits to residents and businesses:**
 - Internet access to comfort systems (thermostat)
 - Submetering of facility/apartment and end uses for energy management
- **Enables more pricing flexibility by utility, energy suppliers and building managers**
- **Load profile data is a by-product of two-way data communications systems**

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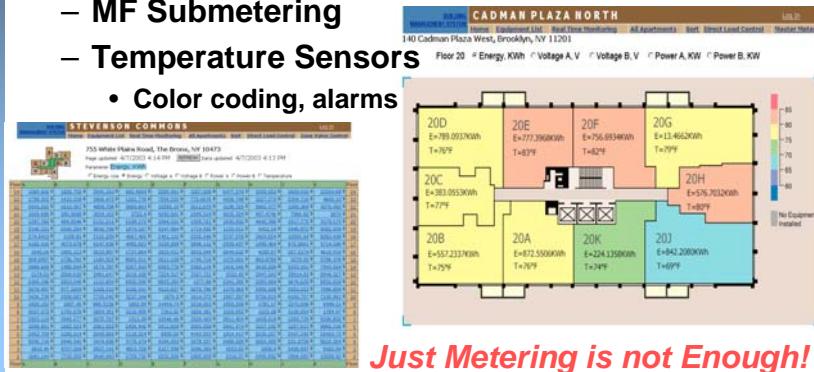
Case Studies

- Projects involving AEG and independent technology vendors
- NYSERDA Projects
 - Multifamily, Residential, Business
- Con Edison, LIPA, So Cal Edison
- Aquila
- ECONergy

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Case Study 1: Submetering “Plus”

- Advanced Metering System – Real-Time
 - MF Submetering
 - Temperature Sensors
 - Color coding, alarms

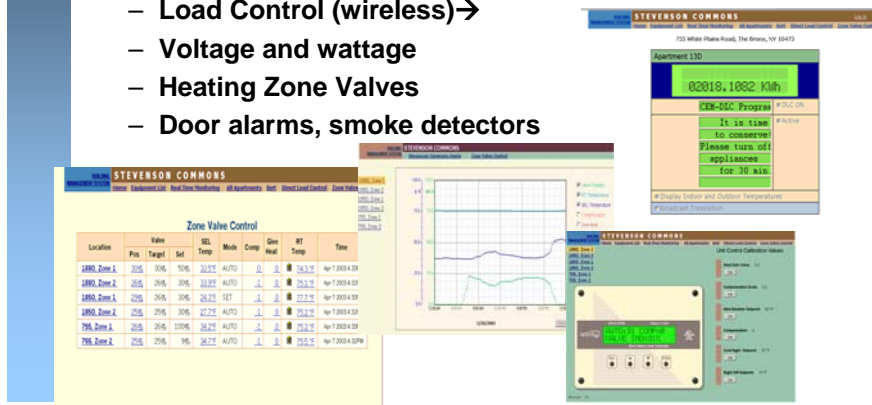


Just Metering is not Enough!

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Case Study: Submetering “Plus”

- “Plus” Monitoring and Control
 - Load Control (wireless)→
 - Voltage and wattage
 - Heating Zone Valves
 - Door alarms, smoke detectors

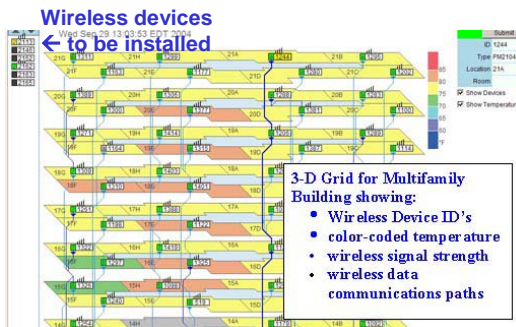


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Case Study: Submetering “Plus”

- “Plus” Monitoring and Control
 - Ease of Installation/troubleshooting

- Wireless connectivity established BEFORE site installation
- Wireless path and signal strength tested in real time
- Drag and Drop “installation”
- Clustering of sites very cost-effective



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Case Study: Submetering “Plus”

- **New Data Sources**
 - **Hourly interval data on apartment units**
 - Hundreds of apartments with data
 - **Design alerts and incentives within building:**
 - Participate in ISO incentives
 - Reduce building demand charges
 - **Hourly temperature data on all units**
 - Confirm heat complaints
 - Track variations in temperature by orientation (N, S, E, W), which influences heating and cooling

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Case Study 2: Time-of-Use Pricing

- **NYSERDA Program for Time-Sensitive Pricing**
 - **Multifamily Residential Building: Clinton Hill Houses (Brooklyn)**
 - **Building recently submetered after being only master-metered**
 - Unmetered tenants in master-metered buildings will waste electricity (save 18-26%: NYSERDA)
 - **Submetering System qualified for NYSERDA CEM incentive – advanced metering system capable of hourly readings**

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Case Study: Time-of-Use Pricing

- **Submetering: Pay for What you Use**
 - Submetering provides incentive for more efficient energy usage – a Price Signal!
 - Typical Submetering Bills based on allocation of Master-meter bill costs based on each resident's monthly kWh
- **Time-of-Use Price - Pay for When you Use**
 - Building master-metered bill has demand charges, time-of-use energy, etc.: When you use energy **MATTERS!**
 - Have submetered prices vary by time period matching utility/building peak

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NYSERDA Time-Sensitive Pricing

- **Information and workshops to help participants**
 - Brochures, refrigerator magnets with tips
- **Web Site (www.apartmentenergytips.com)**
- **First summer season incentives for savers based on “shadow” bills; no-one loses!**
- **Provide alerts during critical peak periods when building billing peak may occur**
- **Implementation of rate later in 2004 through 2005**

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NYSERDA Time-Sensitive Pricing

The image shows two overlapping screenshots of the ApartmentEnergyTips.com website. The top screenshot displays the 'Time-of-Use tips' section, which includes a 'General' heading and several bullet points about shifting usage to off-peak times. The bottom screenshot shows the 'Energy Saving tips' section, also with a 'General' heading and bullet points about energy-efficient appliances and habits.

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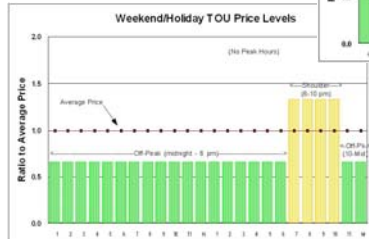
NYSERDA Time-Sensitive Pricing



TRAFFIC LIGHT GUIDE TO TOU

RED: Stop; YELLOW: Caution; GREEN: Go!

Weekdays ----->
 Peak Hours: 2-6 pm (red)
 Shoulder 10am-2pm, 6-10pm (yellow)
 Off-Peak 10pm-10am (green)



←----- Weekends/Holidays
 No Peak hours
 Shoulder 6-10pm (yellow)
 Off-Peak 10pm-6pm (green)

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NYSERDA Time-Sensitive Pricing

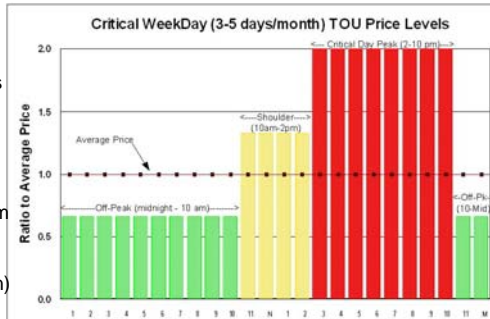
Critical Days: Coincide with utility system stress and/or building peak billing demand (30%+ of bill\$)

Critical Day (3-5 peak days per month) ----->

Peak Hours: 2-10 pm (red) (extended from 2-6 pm)

Shoulder 10am-2pm, 6-10pm (yellow)

Off-Peak 10pm-10am (green)

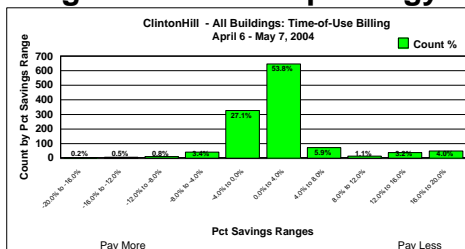


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NYSERDA Time-Sensitive Pricing



BENEFITS:

- Energy Costs are allocated more fairly and in line with building's true costs
- Residents have the opportunity to \$ave by reducing energy, shifting and can recoup energy investments
- Under TOU rate, nearly all residents' bills would be within 4% of non-TOU bill without changing their usage patterns →



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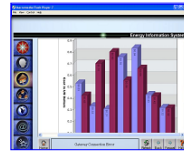
Case Study 3: Real-Time Pricing (RTP)

- **NYSERDA Project**
 - **ECONergy Service Area**
 - e.g. Westchester & Rockland County
 - **Target 125 Commercial, 25 Residential**
 - **Install Communicating Meter** -----> 
 - **Broadband Gateway** -----> 
 - **Central A/C Thermostat (Stage 1)**
 - **Other control devices (Stage 2)**
 - (e.g. lighting, water heater, cameras, etc.)
 - **Real-Time Pricing via ECONergy (Day-ahead)**

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Case Study: Real-Time Pricing

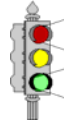
- **Utility/Energy Supplier Remote Meter Reading (real-time)**
- **Customer-programmed control of thermostat and (Stage 2) other control devices**
 - Customer sets threshold for thermostat control and other devices based on real-time prices – automatically
 - Commercial customers (Stage 2) can configure control for demand-limiting



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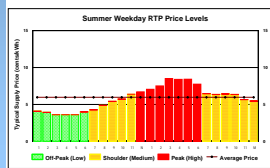
Case Study: Real-Time Pricing (RTP)

- RTP based on ISO Day-Ahead Prices
 - Prices directly related to system costs/needs

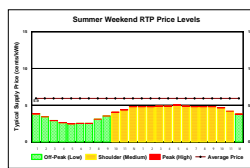


The charts below reflect the “traffic light” concept of RTP rates:

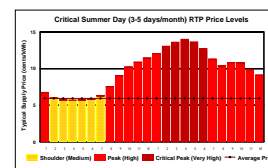
RED: Peak hours - **STOP!** Reduce and shift energy use; high prices
 YELLOW: Shoulder hours - **CAUTION!** Defer if possible; average prices
 GREEN: Off-Peak hours - **GO!** Shift energy use to this period; low prices



Typical Summer Weekday



Typical Summer Weekend



Typical Summer Peak Day

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Case Study: Real-Time Pricing (RTP)

- **Benefits:**
 - RTP gives price signal – worthwhile for customers to save on-peak and shift; make other investments
 - Customers have an automated tool (via web site) to custom configure control of end uses
 - Set it and forget it!
 - Utility/Energy Company can monitor energy use in real-time
 - Infrastructure (Gateway, data communications, web site) has potential for many more devices
 - Safety, security, comfort

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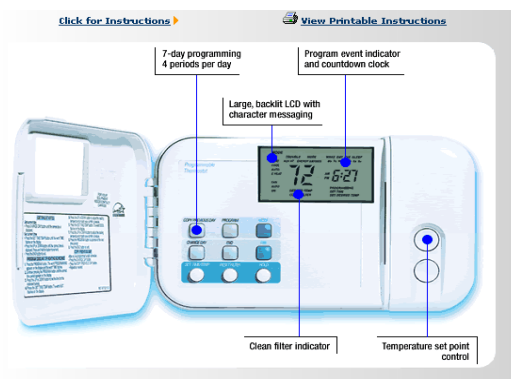
Case Study 4: Demand Response

- In Summer Peaking areas, target air conditioning
- Historically, implemented with one-way switches on Central A/C systems (only a sample monitored)
- New generation of electronic thermostats now available and used by many utilities:
 - Customer has remote access via web site to all thermostat features
 - Two-way communications, which ensures verification
 - Monitoring and control capability
 - Interval data (runtime and temperature) available for virtually ALL sites
 - Customer overrides can be tracked

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Controllable Thermostat

Programmable thermostat with 2-way pager access



- Customer can access thermostat features over the Internet
- Customer can override utility control
- Customer gets fully programmable thermostat to save on energy

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Thermostat Program Case Studies

- **Long Island Power Authority (LIPA)**
 - Since 2001, Central A/C units in over 20,000 residential, over 3,000 small commercial
 - Control up to 7 days per season from 2-6 pm
- **Con Edison (New York)**
 - Since 2002, now over 10,000 residential sites, with Commercial Pilot Program underway
 - Typically control when NY ISO requests (typically peak summer days 1-6 pm)
- **Both Con Edison and LIPA**
 - Free thermostat and \$25 (one-time)
 - Customer override without penalty

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Thermostat Program Case Studies

- **Southern California Edison**
 - Pilot Study of 5,000 Commercial sites (2002/2003)
 - Free thermostat plus \$300 annual incentive, with \$5 penalty for each override
 - Control varies from 1-6 pm; in 2003 up to 20 control days allowed
- **Aquila - Minnesota (Gas)**
 - Pilot study for thermostat control of gas heating (75 sites)
 - Thermostat also controls Central A/C
 - Aquila could “rent” A/C load control to electric utility

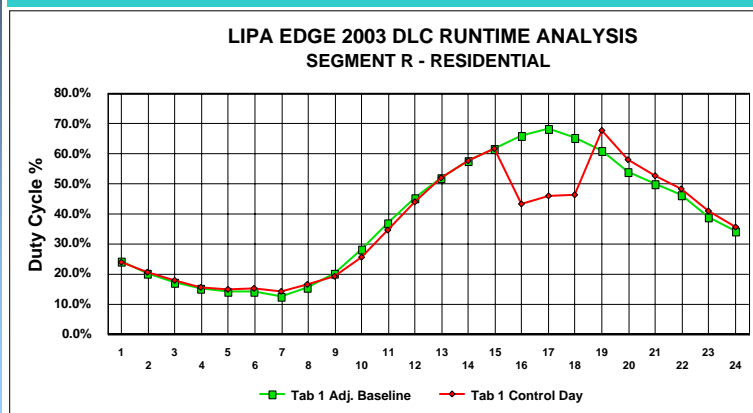
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Thermostat Control Options

- **Duty Cycle Control**
 - Limits runtime to a fixed percentage (e.g. 50% control limits to 15 minutes off per half-hour)
 - LIPA and Con Ed typically used 50% duty cycle control
- **Setpoint Temperature Control**
 - Increase current A/C thermostat setpoint by a specific value (e.g. 4 degrees)
 - SoCal Ed usually uses 4 degree temperature control
 - Aquila controls temperature (winter gas heat)

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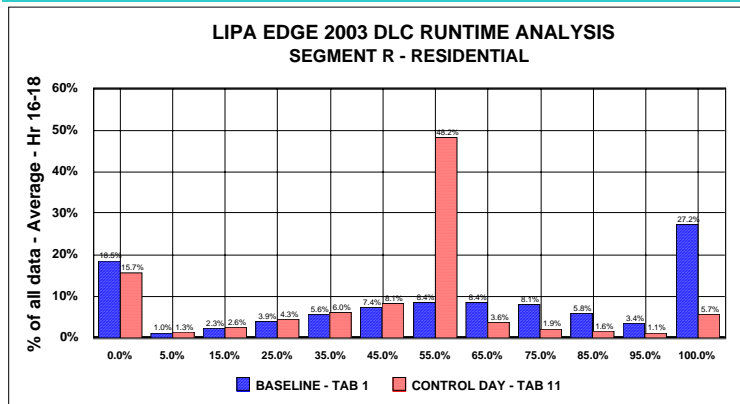
Duty Cycle Control Case



Some “payback” after control ends

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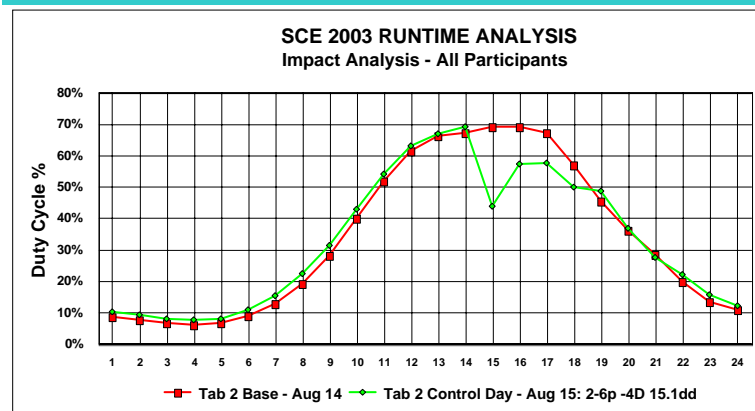
Duty Cycle Control Case



15-18% off; 25% of baseline run @ 100%; overrides over 55%

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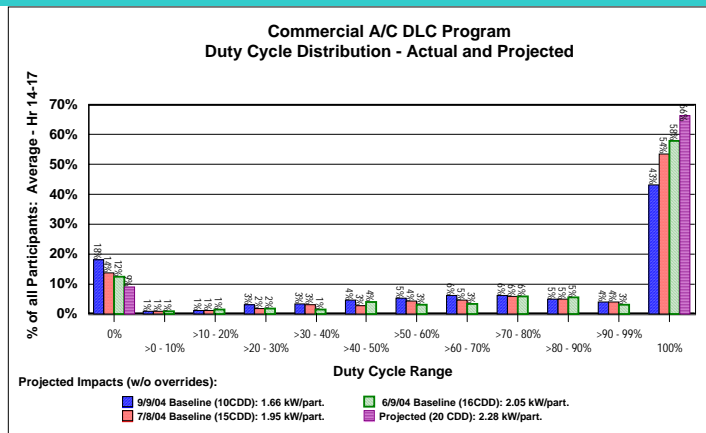
Duty Cycle Control Case



Comm: 98° max day; 4° setpoint change 2-6pm, no payback

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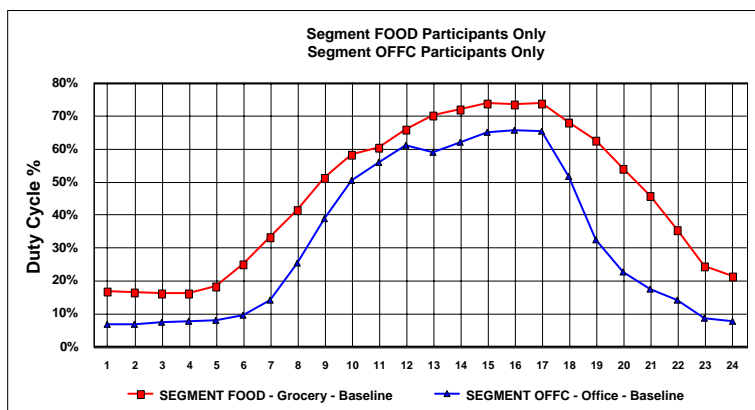
Duty Cycle Control Case



Using baseline duty cycle distribution to model/project impacts

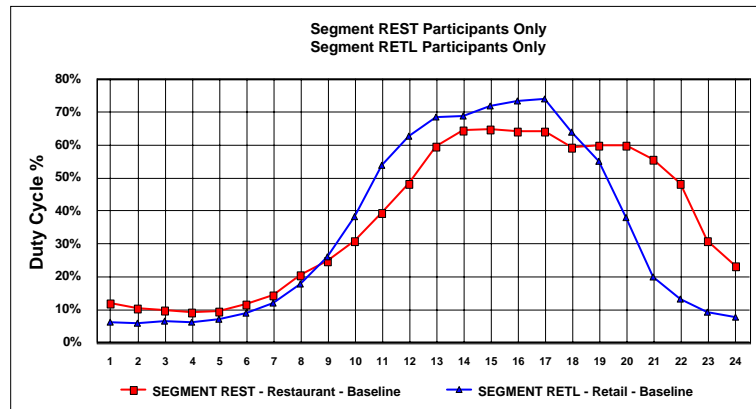
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Thermostat Data by Business Type



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Thermostat Data by Business Type



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Duty Cycle Control

- Only effective on customers whose base duty cycle (runtime) exceeds limit (e.g. 50%)
- Impacts are larger on more severe days as more customers exceed the duty cycle limit – more suited to emergency operation
- Impacts are more consistent and maintained for a longer period
- Potentially more severe on some customers than others, such as those with undersized systems
- Easy to identify overrides from runtime data

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Setpoint Temperature Control

- **Affects all customers equally in terms of relative comfort**
- **Impacts are consistent across a range of weather conditions – more suited to frequent use as a load reduction option**
- **Impacts are more pronounced in first hour and decline in subsequent hours**
- **Potential for customers to pre-cool and reduce impact achieved**
- **Could penalize customers already conserving**
- **Difficult to identify overrides from runtime data, but should see fewer overrides**

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Thermostat Program Case

- **New Data Sources**
 - **Runtime data (percent on-cycle) available with two-way systems for virtually all sites**
 - **Robust segmentation possibilities: business type segments, weather zones**
 - **Indoor hourly temperatures**
 - **Model heat gain and customer tolerance**

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SUMMARY

- **New Technology can enhance customer energy efficiency, safety and comfort**
- **Advanced Metering – *by itself* – is not enough to gain acceptance**
 - Rate programs provide flexibility, fairness and modest savings
 - Customers will embrace knowledge and control
- **Data available from advanced metering systems can be abundant and valuable**

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SUMMARY

- **New Technology Systems are a Tool for customers and utility to understand and manage loads**
- **Examples of additional data uses**
 - Commercial A/C load profiles by business type (large “sample” means plenty of points and precision)
 - Large “samples” of interval load data for clusters of customers (extrapolate to population by weighting schemes)
- **Load Researchers need to be involved to ensure best use of data for multiple purposes – don’t waste opportunities!**

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