Emerging Technologies Lightning Round

Rebecca Foster
Director, Consulting
Vermont Energy Investment Corp.

Andrew Mitchell
ORISE Fellow
U.S. Department of Energy

Kim Erickson
Senior Program Manager
Consortium for Energy Efficiency

Edwin Hornquist
ET Program Manager
Southern California Edison

The Contenders

Manufactured Homes	Building Envelope	Natural Refrigerants
Multifunction Heat Pumps	Plug Loads, aka “MELs”	Grid Integration of ZNE Communities
Commercial Heat Pump Water Heaters	EIS: Energy Data	Energy Channel 2.0

MANUFACTURED HOMES

Manufactured Homes

Drivers

57% units occupied by households at < 200% of Federal Poverty Guideline

Relevance to members

Unique role

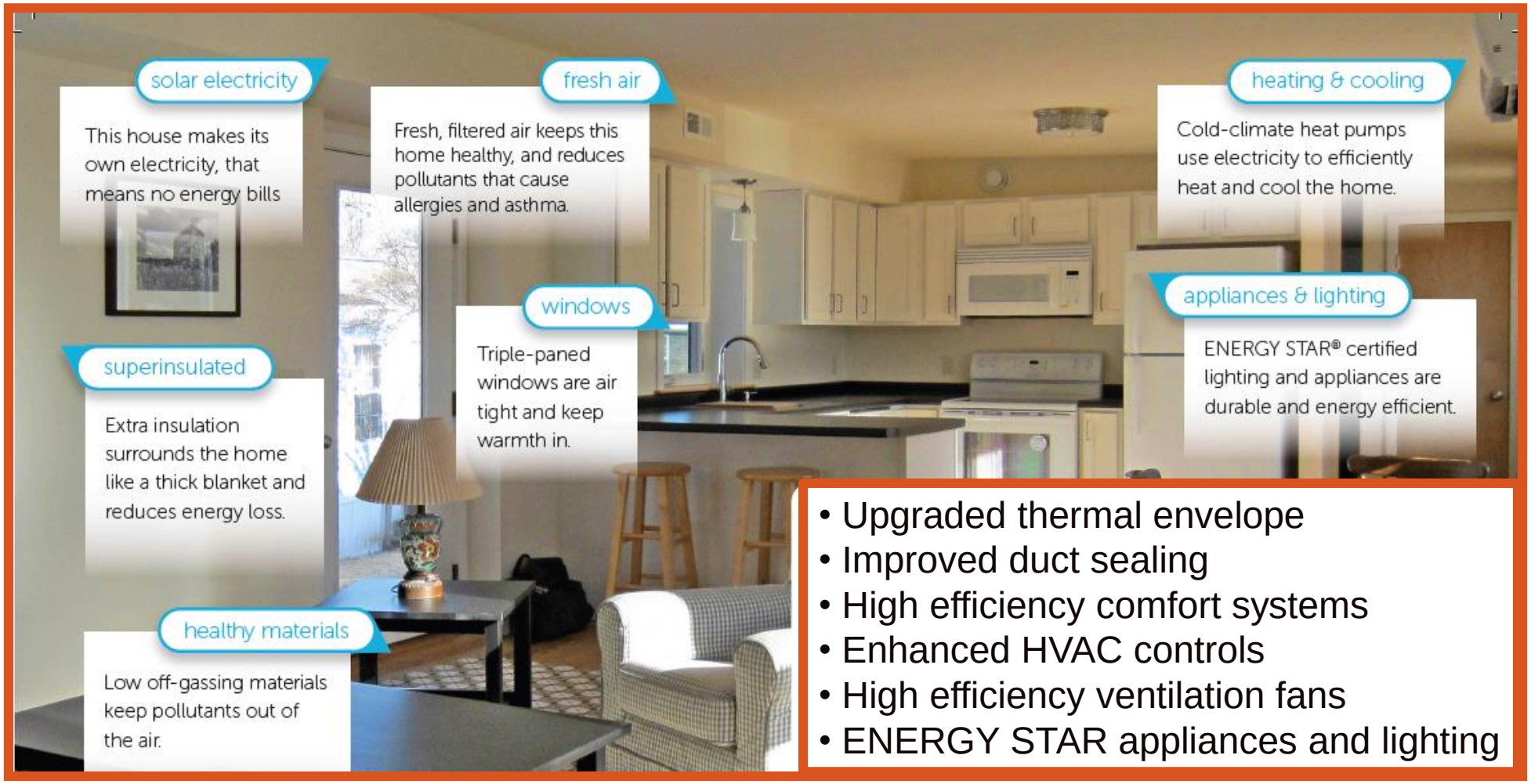
Potential assets

8

Member programs, pilots, assessments

Potential Assets

We Know How to Do This



- Upgraded thermal envelope
- Improved duct sealing
- High efficiency comfort systems
- Enhanced HVAC controls
- High efficiency ventilation fans
- ENERGY STAR appliances and lighting

Program Potential: Energy Savings

- 30% savings compared to HUD code very achievable
- Incremental price differential:
  - $2,423 more for single wide (7 year payback)
  - $3,745 more for multisection homes (7.6 year payback)

City	Source Energy Consumption (kBTU/home/year)		Source Energy Savings	
	HUD	Higher Efficiency	kBTU / home / year	%
Burlington	140,049	103,014	37,035	26%
Chicago	154,082	113,667	40,415	26%
Houston	113,678	78,884	34,794	31%
Jackson	127,237	88,298	38,939	31%
Memphis	122,930	88,204	34,726	28%
San Francisco	71,751	47,235	24,516	34%

Based on multisection home, 1568 sq. ft. Using DOE NOPR Analytical Tools: Manufactured Housing National Impact Analysis (NIA) Spreadsheet.

Program Potential: More Savings

Specification	Additional Energy Savings Features	Estimated Annual Site Energy Savings Beyond Prev. Slide in Pacific NW	Estimated Incremental Cost to Manufacturers
NEEM Version 2.0	2x6 Walls Better Insulation Upgraded Windows LED Lighting Improved Ventilation Flashing & House wrap	1,300 kWh	$1,100
NEEM Version 2.0 with Heat Pump	NEEM Version 2.0 features plus Upgraded Air Handler Heat Pump 9.0+ HSPF	4,300 kWh	$5,700
Zero Energy Ready	NEEM Version 2.0 with Heat Pump features plus Heat pump water heater Smart Controls Solar Ready Roof	5,600 kWh	$7,000

Filling a Gap

A Unique Opportunity for Coordination

- Members say manufacturer buy in is critical
- Market experience says program support is critical

Envelope Efficiency

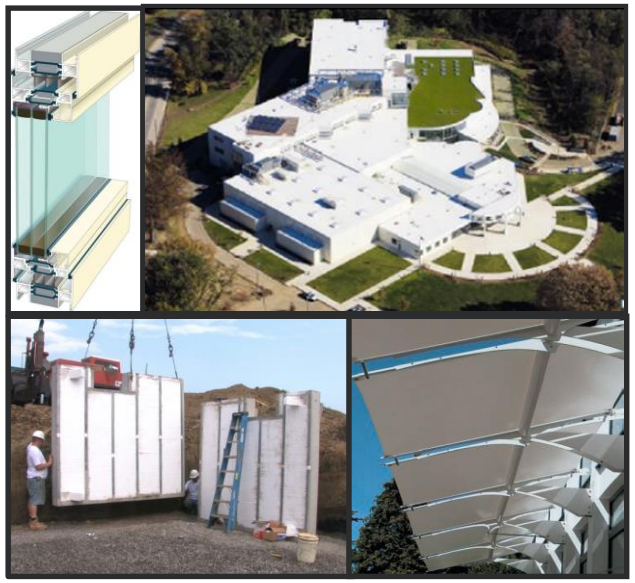
Envelope Efficiency

Demonstrations Completed

- Electrochromic and Thermochromic Windows and Dynamic Controls
- Solar Control Films / Low Emissivity Window Films / Daylighting Redirecting Window Films

Research and Demonstration Underway

- Sprayable sealant technologies / Primer-less membrane
- R-5 Windows
- Modified Atmospheric Insulated Panels for roofs and walls



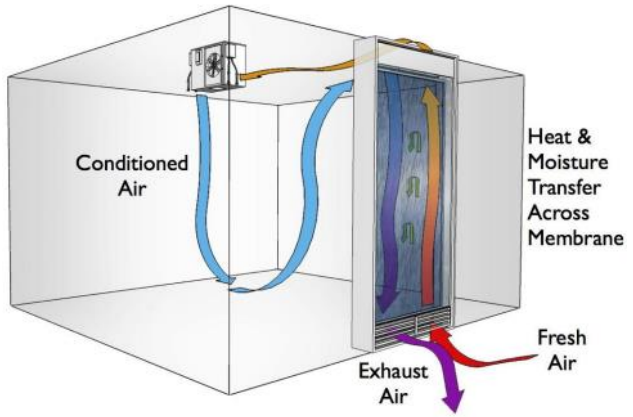
32% or 5.81 Quads of commercial building primary energy use

Envelope Efficiency: Emerging

Building Integrated Heat and Moisture Exchanger (e.g., Architectural Applications)

Description

- Modular wall panel (replaces standard envelope) that provides energy recovery ventilation.
- Panel contains a membrane-based air-air exchanger to transfer heat and moisture between supply and exhaust air streams



Market

- Key sectors: offices, schools, hospitals, and residences.
- Barrier to entry is cost of implementation, applicable only to new construction and major retrofits.

Energy Savings

- Technical savings potential of 150 TBtu/yr.
- Approximately 30% unit energy savings (DOE EERE) above current ERV applications by precooling, dehumidifying, and moving air from the exterior to the existing ventilation inlet.

Technology Status

- Originally granted $1,037,812 by DOE
- Key partners: LBNL, dPoint Technologies, Arup, MTR
- Commercialized and spinoff products available

Key Challenges

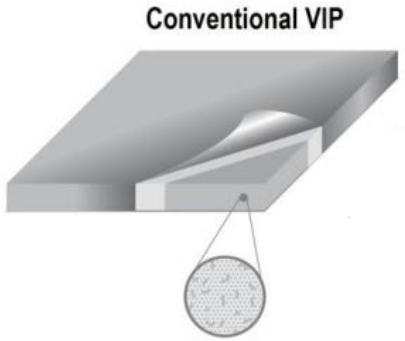
- Cost prohibitive for existing buildings
- Steep learning curve for installers

Envelope Efficiency: Emerging

Vacuum Insulated Panels (VIP)

Description

- Removing air reduces the heat transfer that can occur, thereby increasing insulation value.
- VIPs are comprised of membrane walls that prevent air from entering the vacuum, and a rigid, porous, panel for structure.



Market

- Key sectors: Insulation as part of building envelopes or as panels for refrigeration equipment.

Energy Savings

- Technical savings potential of 370 TBtu/yr.
- 35% unit energy savings potential with an effective R-value of 50 in building envelope applications.

Technology Status

- Commercially available from numerous vendors

Key Challenges

- High cost is the biggest challenge; currently more cost effective in small applications like commercial refrigeration
- Envelope applications face challenge of puncture resistance from with nails.

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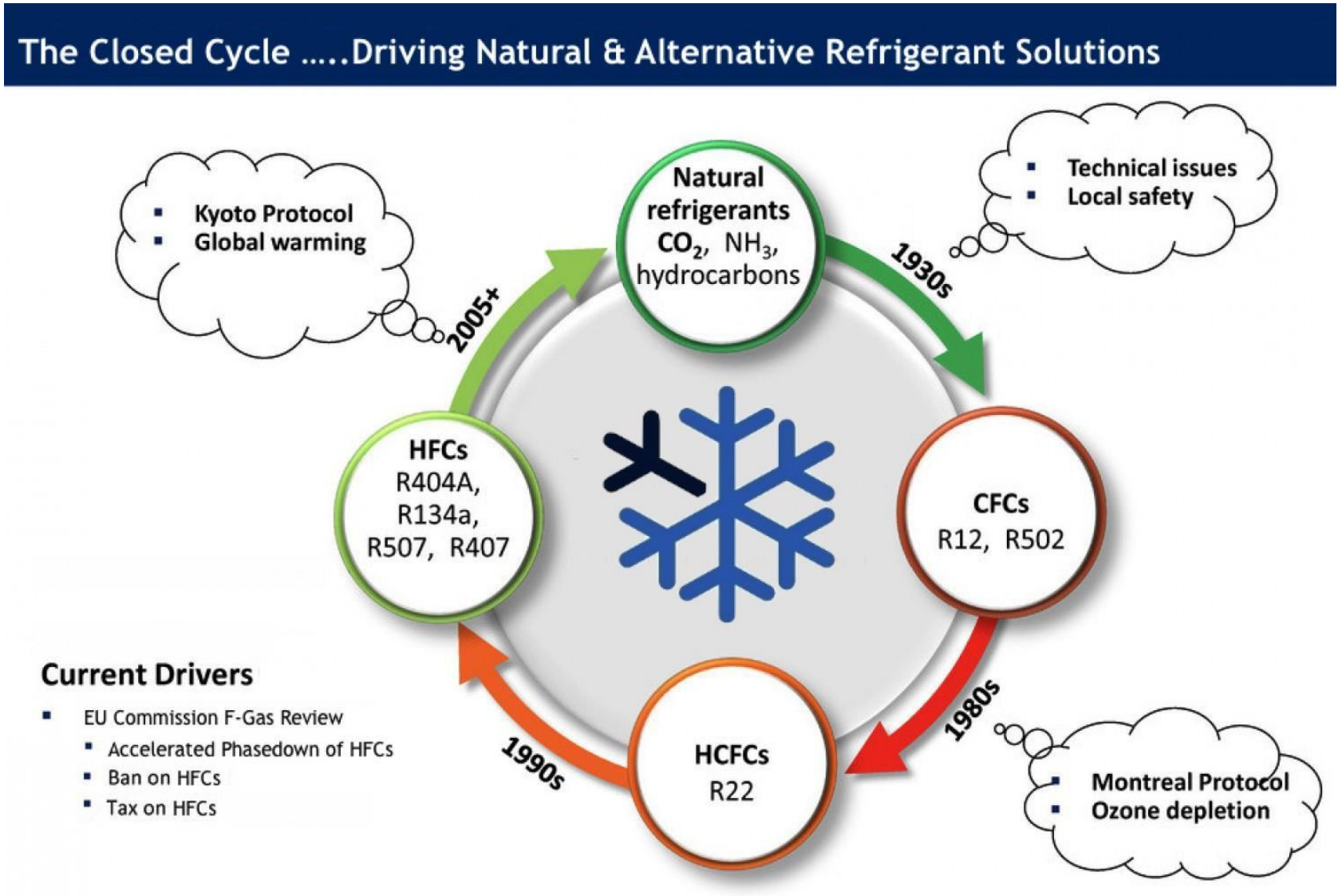
Natural Refrigerants

Background…

- Montreal Protocol
  - Developing amendment for phase-out of HFC refrigerants by ~2050
- AB32 & Clean Power Plan
  - GHG reduction goals for CA
- CARB RMP
  - Imposes inspection and reporting requirements for all sites with >50 lbs of high GWP refrigerant in a single system
- CARB Proposal
  - Limit stationary refrigeration equipment to GWP<150 with 40% reduction in GWP by 2030
- EPA SNAP
  - De-lists several commonly-used refrigerants (R-22, R-134a, R-404A, R-507A)
  - Newly acceptable refrigerants (R-448A, R-449A, R-450, propane, isobutane)
- CA Drought / Water
  - Need to reduce water consumption, limit water/evaporative cooling

Phasing Out Ozone Depleting and High GWP Refrigerants



Discussion Topics (Lightning Round)

- Natural Refrigerants
  - Natural refrigerants are naturally occurring, non-synthetic substances that can be used as cooling agents in refrigerators and air conditioners.
  - These substances include hydrocarbons (propane, butane, and cyclopentane), CO2, ammonia, water and air.
- EPA's Significant New Alternatives Policy (SNAP) Program
  - Evaluates substitutes and lists as acceptable those that reduce overall risk to human health and environment; lists acceptable with use conditions if needed to ensure safe use; or lists as unacceptable

Customer Impacts and Opportunities

- End-users will need to choose new equipment/technologies to meet their refrigeration requirements
  - Mfrs have and are developing more solutions now…
- Typical end-users are commercial and industrial customers:
  - Refrigerated warehouses
  - Supermarkets
  - Food service
  - Hospitality
  - Food processing/manufacturing
  - Office buildings…

Chemical	GWP*
Refrigerant	
CFC-12	10,900
HFC-134a	1,430
R-513A	630
R-450A	601
R-441A	<5
HFO-1234yf	4
Propane (R-290)	3.3
Isobutane (R-600a)	3

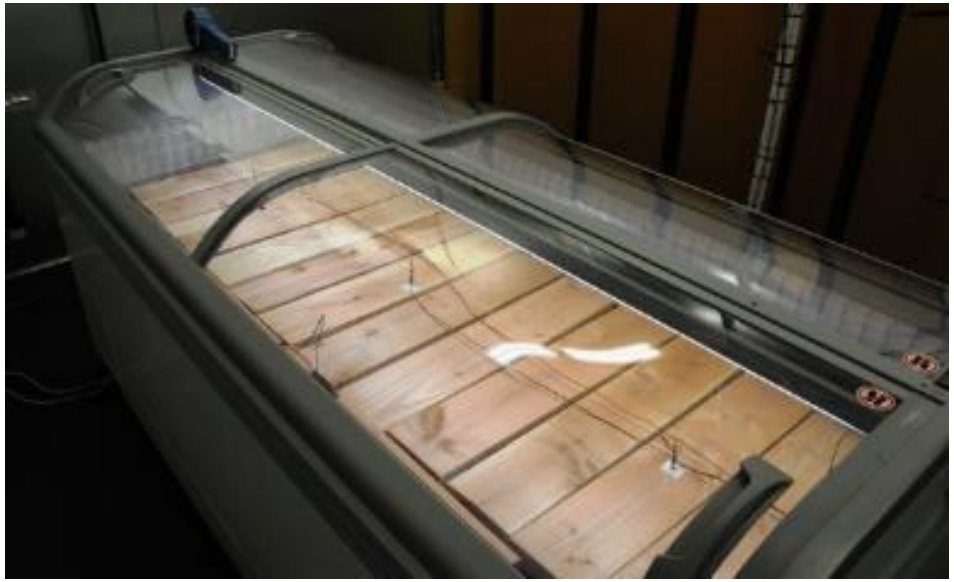
Source: EPA

Other equipment impacted…

- De-listing of commonly-used refrigerants for:
  - Walk In Refrigerators / Freezers
  - Reach in Coolers / Freezers
  - Display Cases
  - Prep Tables
  - Vending Machines
  - Remote Condensing Units
  - Rack Systems

Technology Evaluation

- Self-Contained Case
  - Tested in SCE Labs
  - Isobutene refrigerant (R600a), GWP = 3
  - 30% Energy Savings compared to standard refrigerant



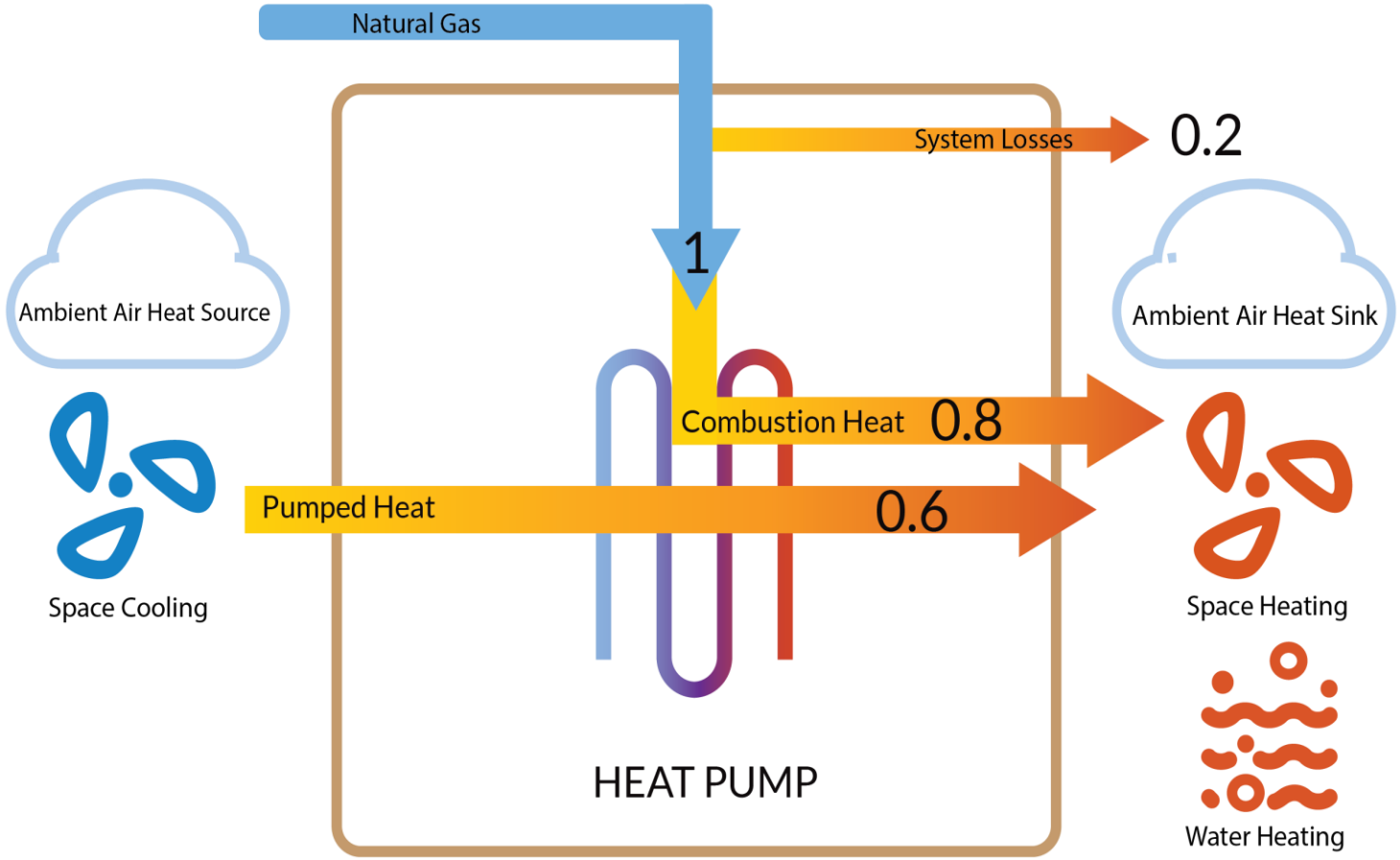
MULTIFUNCTION HEAT PUMPS

Scope and Definition

- MFHPs provide, at a minimum, space and water heating
- May also provide space cooling, dehumidification, power generation

- Gas absorption heat pumps (GAHPs)
- Gas engine driven heat pumps (GEHPs)
- Electric HPs using HFC or A2L refrigerants
- CO_2 heat pumps

Gas Absorption Heat Pump



Program Potential: Energy Savings

Technology	Energy Savings Potential (quads/year, US only)
Gas Absorption HP	0.66
Gas Engine Drive HP	0.15
Electric MFHP - HFC or A2L Refrigerants	0.55
Electric MFHP – CO_2	?

Program Potential: Two for One

- Improve cost-effectiveness
- Achieve greater savings through a bundled measure

Role and Timing?

Market and Program Barriers

- All the same barriers as for all high efficiency HVAC equipment
- All the same barriers as for all combination systems
- **Performance uncertainty**
- Test methods
- High first cost, uncertain cost reduction curve with scale
- Interaction with other space conditioning and water heating equipment
- Integration into existing systems
- Installation complexity, availability of qualified trade allies
- Installation limitations
- Perception of increased risk from failure with MF systems
- Refrigerants
- And more!

Highlight Needs to Partners

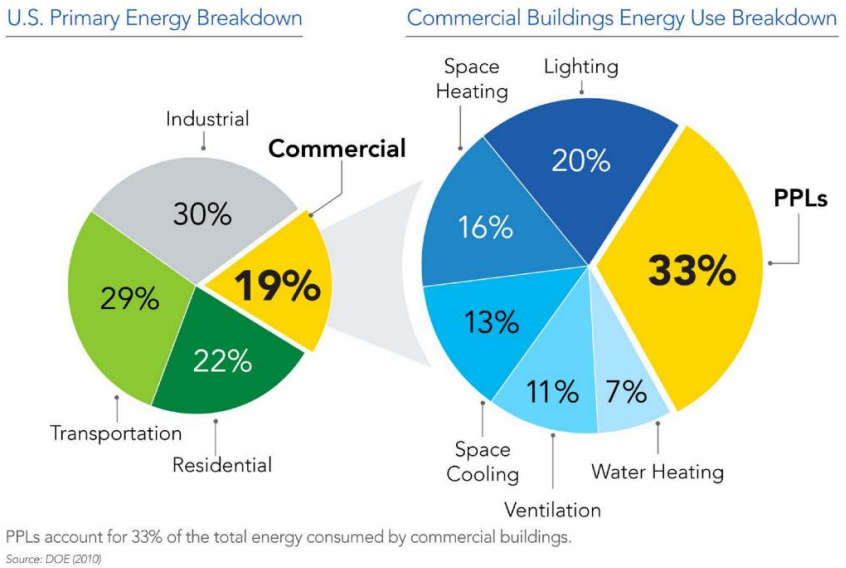
Understand value proposition	• Modeled information • Limited scenarios
Validate value proposition	• Field testing
Consistent test methods finalized	• Basis for apples to apples comparison
Full scale programs	• Validated performance • Accepted performance metrics

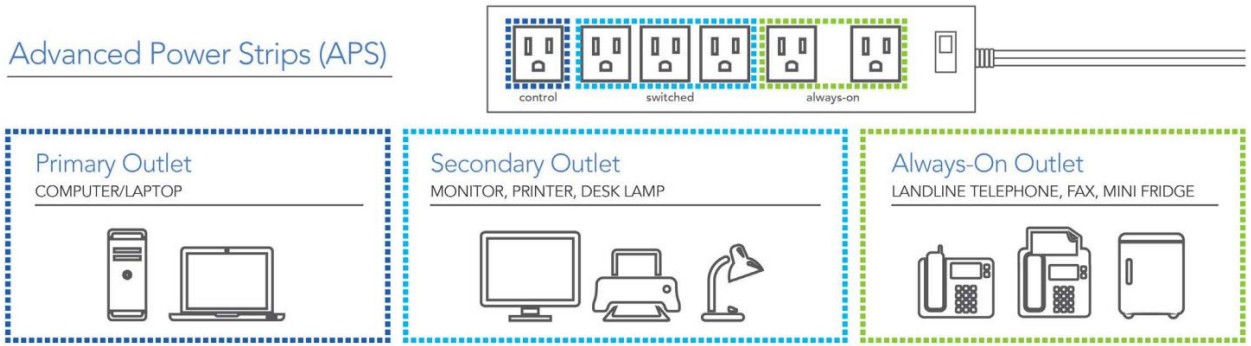
Plug and Process Loads

Plug and Process Loads

RESOURCES to STIMULATE ADOPTION

- **Decision Guides** for Plug and Process Load Controls
- **How To and Technical Specification** for Advanced Power Strips
- **Myth Busting: Market Barriers** to Advanced Power Strips





Demonstration: Data-Driven Receptacle Control

What we will demonstrate:

- Cloud-based data and user-interface for Plug Load Control
- Intelligent sockets capture and control device energy
- Gateway communicates energy data to cloud network
- User Interface enables trending for management of devices

What we will verify:

- Assess occupant satisfaction
- Understand connectivity and security

Why put this in buildings?

- Data + control for plug and miscellaneous loads
- Ease of installation
- Energy reduction from appliances

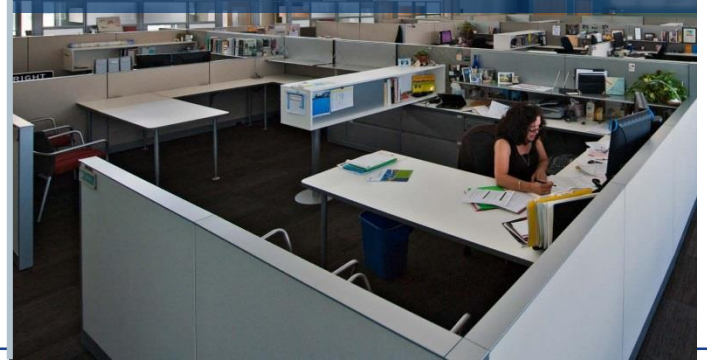
AT A GLANCE…

Better data on miscellaneous loads; energy reduction of plug loads

Technology claim:

40% savings for controlled plugs

2-4 year payback



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Grid Integration of ZNE Communities

Grid Integration of ZNE Communities

Project Partners

PUBLIC UTILITIES COMMISSION EUREKA STATE OF CALIFORNIA

GO solar CALIFORNIA

Itron CSI RD&D Program Manager

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL Company

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

MeritageHomes

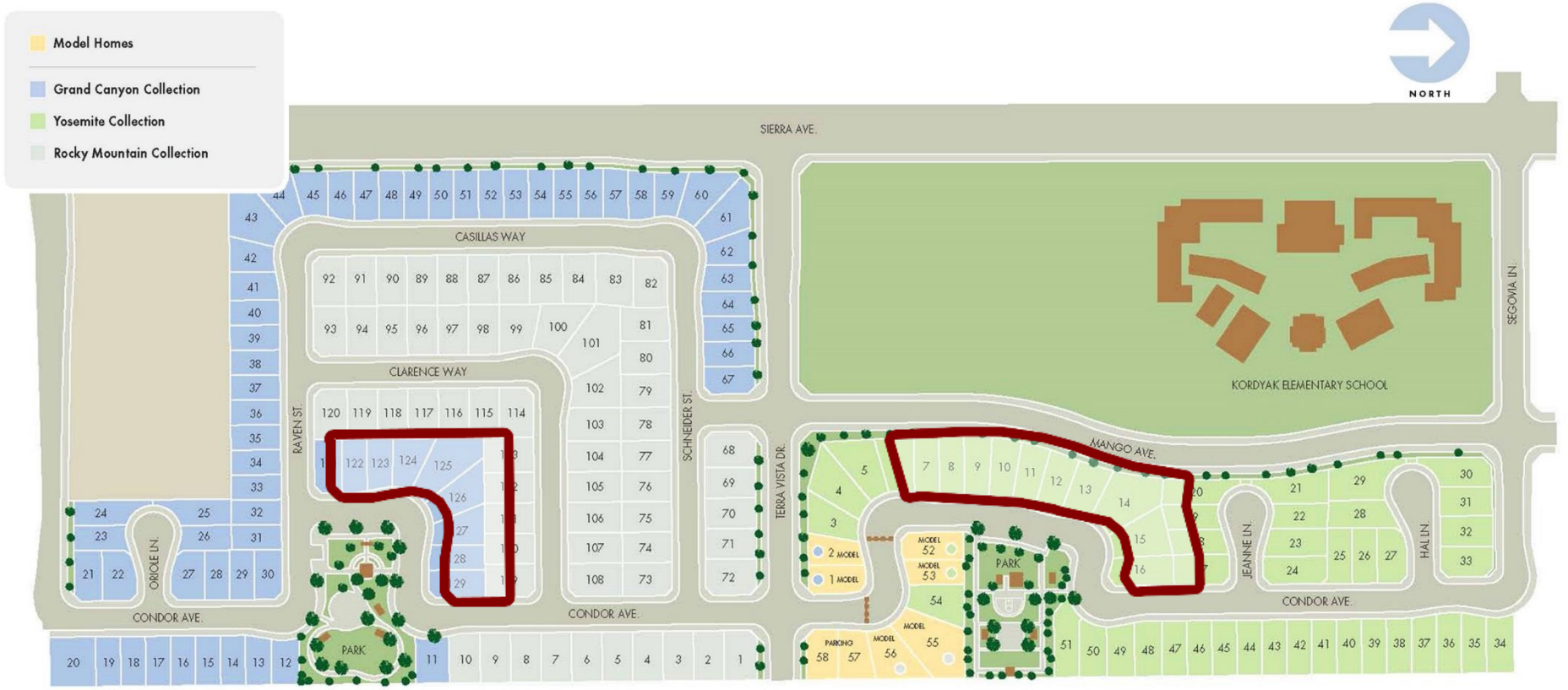
biraenergy

Project Goals

Evaluate impact of ZNE communities on electrical grid and technology strategies to enhance grid benefit

- Demonstrate new technologies and strategies that enable cost effective Zero Net Energy homes and resulting high PV adoption
- Measure the impact of concentrations of ZNE homes on electrical distribution
- Demonstrate how residential Energy Management systems can balance PV with loads and support power system needs
- Evaluate and demonstrate optimal location of Energy Storage in ZNE communities (residential vs. neighborhood)
- Develop integrated modeling approach to integrate building and distribution models

The Community



Sierra Crest

MeritageHomes

Net Zero Energy Homes

Designed to generate as much energy as it uses over the course of a year.

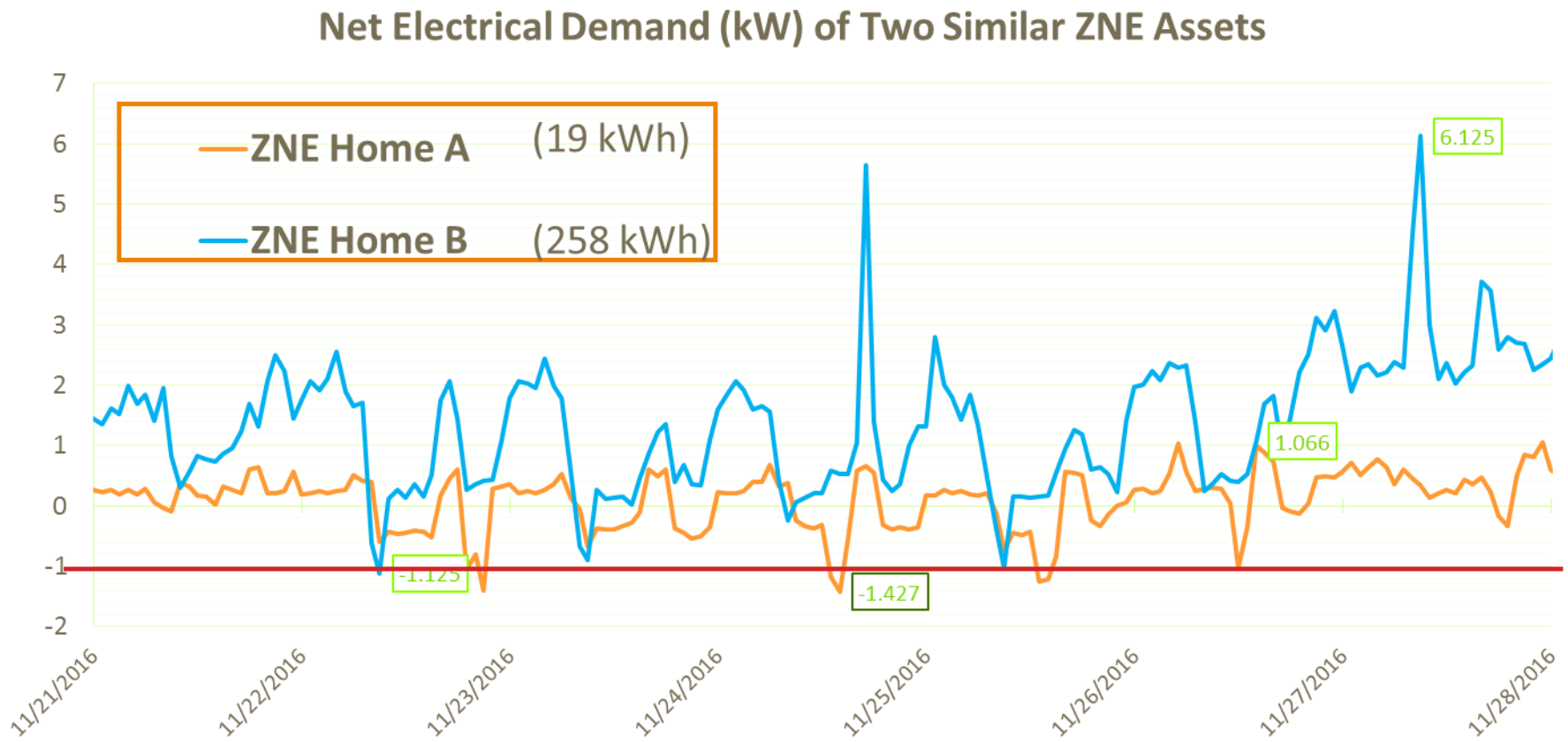
Annual Energy Use and PV sizing

	Annual Energy Usage			PV Sizing	
Home	Modeled Annual Energy Used (kWh)	kWh Needed for ZNE (kWh)	kWh/sq. ft	Base Case PV	Integrated EE PV
6	6,923	6,099	2.59	6.1kW	4.5kW
7	7,485	6,518	2.57	6.4kW	4.5kW
8	6,882	6,199	2.57	5.5kW	4.0kW
9	7,485	6,518	2.63	6.4kW	4.5kW
10	6,882	6,445	2.36	5.7kW	4.0kW
11	6,923	6,208	2.44	5.3kW	4.0kW
12	7,518	7,213	2.58	5.5kW	4.0kW
13	6,926	5,956	2.44	5.5kW	4.0kW
14	7,512	7,213	3.24	5.5kW	4.0kW
15	6,902	5,961	3.16	5.5kW	4.0kW
16	6,773	5,768	3.5	5.5kW	4.0kW
121	6,331	5,801	2.73	5.5kW	4.0kW
122	6,550	5,800	3	4.6kW	3.5kW
123	6,143	5,021	3.17	5.0kW	3.8kW
124	6,521	5,759	2.99	5.3kW	4.0kW
125	6,559	5,560	3.01	4.7kW	3.5kW
126	6,521	5,568	2.99	5.0kW	3.8kW
127	6,035	5,798	3.12	5.5kW	4.0kW
128	6,451	5,800	2.96	5.0kW	3.8kW
129	6,451	5,800	2.96	5.0kW	3.8kW
AVG.	**6,789 kWh**	**6,050kWh**	**2.85**	**5.4kW**	**4.0kW**

Comparing PV Sizing – With and Without EE Measures

- Energy Efficiency measures result in reduced PV size of 1.4kW/home (~$5000)
- Evening peak load reduction of 1.6 kW
- Approx. $17,000 incremental cost to attain Zero Net Energy
- With CA NEM rules:
  - annual energy cost to customer is around $350 (electric + gas)
  - Electrification of water heating helps offset net annual generation

SCE's Initial Findings and Potential Challenges



SCE's Initial Findings and Potential Challenges

Findings, opportunities and challenges may change as more ZNE projects are completed, and data is analyzed.

Initial Finding

- The number of ZNE builders are increasing
- Incremental costs per home for ZNE capability is shrinking
- Trend towards increased electrification
- Prominent technologies in ZNE Homes include LED lighting, electric heat pumps for cooling, space and water heating applications, PV, foam insulation, controls
- ZNE success highly depends on sales/marketing strategies

Potential Challenges

- ZNE does not mean zero bills
- Understanding impacts (asset/liability) to the electrical grid
- Finance industry plays a key role in ZNE – comps do not exist for appraisers
- Energy simulation tools
- Standardized Permitting process for DERs
- Regulatory alignment between ZNE definition and ZNE implementation

COMMERCIAL HEAT PUMP WATER HEATERS

Program Potential, Relevance, Timing

- Achieve greater energy savings
- Reduce peak load
- Increase grid reliability
- Meet local directives to reduce GHG emissions or electrify end uses
- Meet local directives to construct or renovate to ZNE
- New mass market products being explored

Many Unknowns At This Stage

- Greater understanding of technical potential
- Greater understanding of market dynamics
- Level of effort required

Energy Management and Information Systems

The Importance of Energy Information?

2013 Study of Energy Management and Information Systems

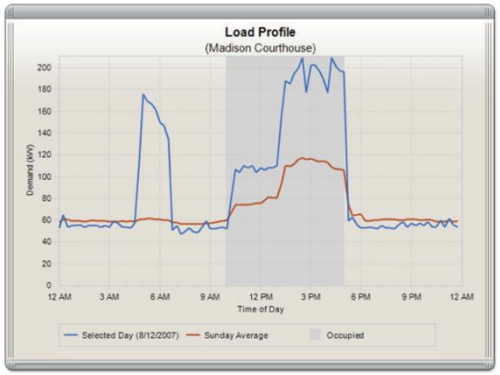
- 28 sites, 9 building portfolios
- Median savings/building = 17% or $56,000/yr
- Median savings/portfolio = 8% or $1.3 million/yr
- 5-year software procurement = $150,000 or .06/sq. ft.
- 2 year payback

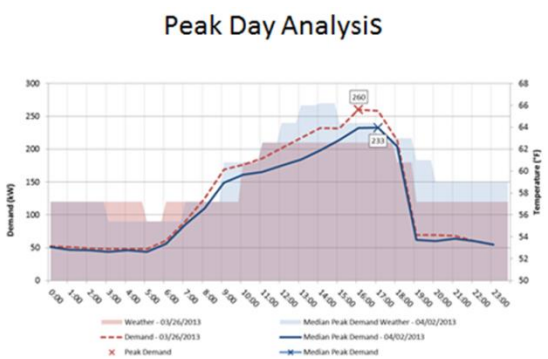
Energy information systems (EIS): Technology costs, benefit, and best practice uses @ http://eis.lbl.gov/pubs/lbnl-6476e.pdf

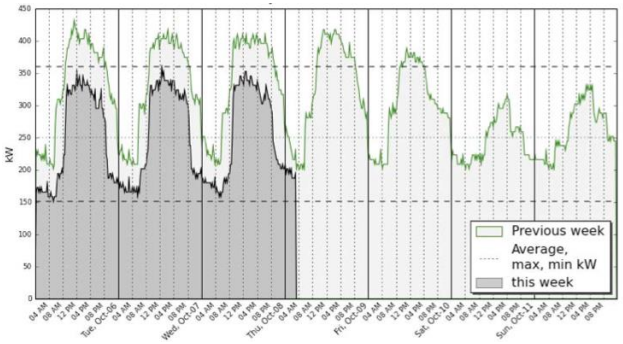
The Importance of Energy Information?

- ✓ Identify **operational efficiency opportunities**
  - Scheduling, faults and anomalies, changes in load profile
- ✓ **Track performance and compare** to self and others
- ✓ Monitor peak load and **manage demand charges**
- ✓ Convert **energy into $$,** verify energy savings
- ✓ **Set and justify energy goals**

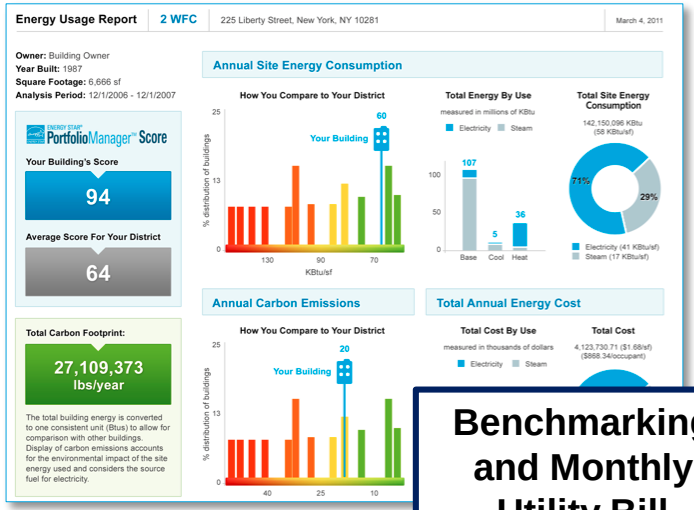
Energy Information can help us save 1 quadrillion BTU in commercial buildings.



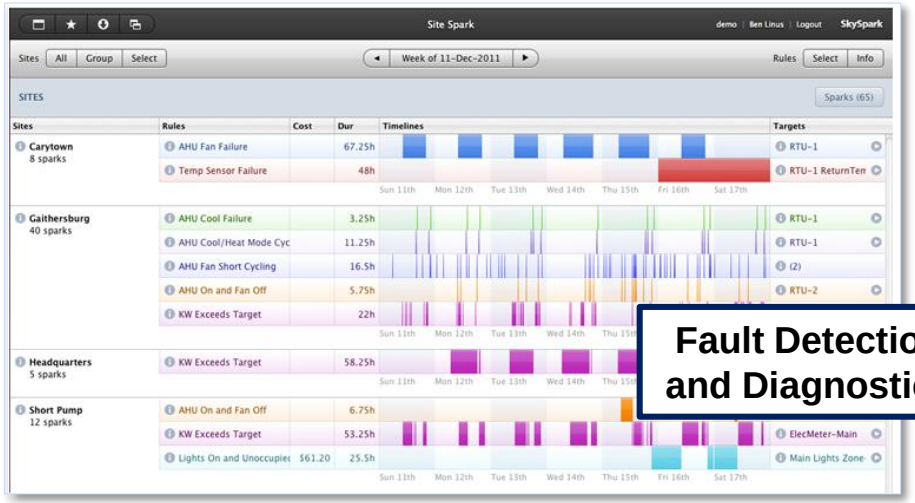




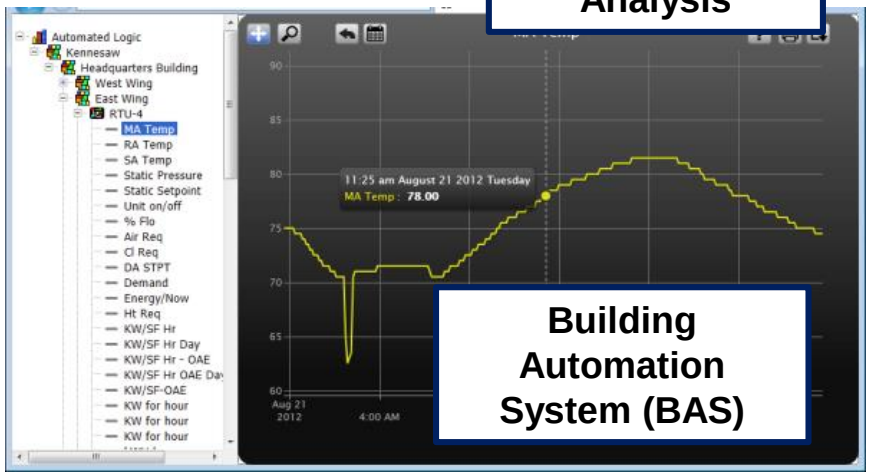
Demonstration: Systems for Energy Analytics



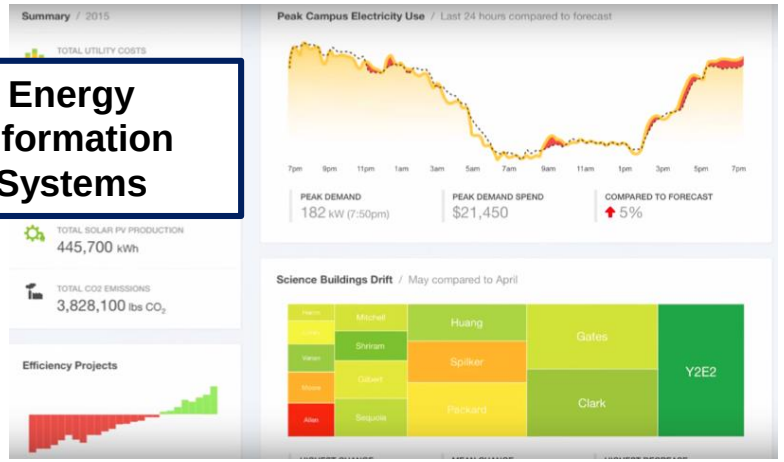
Benchmarking and Monthly Utility Bill Analysis



Fault Detection and Diagnostics



Building Automation System (BAS)



Energy Information Systems

Demonstration: Turnkey Controls + Analytics

Energy management for Portfolios of Small Buildings

- Turnkey installation and service
- Cloud-based portfolio trending and analytics
- User Interface for visualization and evaluation of data

Value of Study

- Validate energy savings, commissioning and cost
- Assess ease of use
- Understand connectivity and security

Value to Owners/Operators

- Better data on building operations and control for building performance
- Hands-off, service-based approach

AT A GLANCE…

Better data on cost, energy savings, ease of use, applications and security

Technology claim:

8-35% savings

ROI = 24 months

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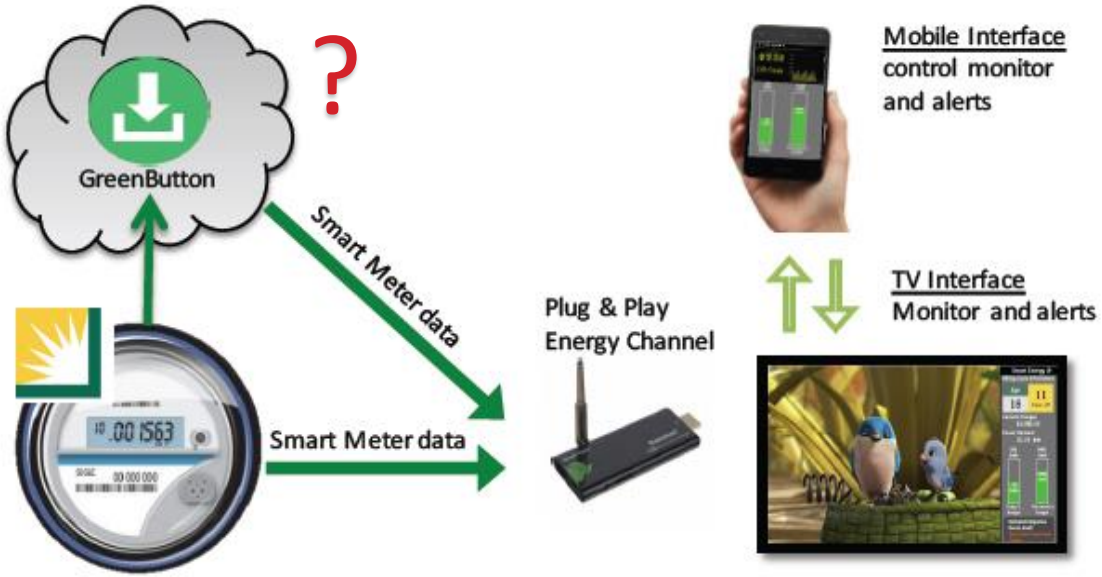
Energy Channel 2.0

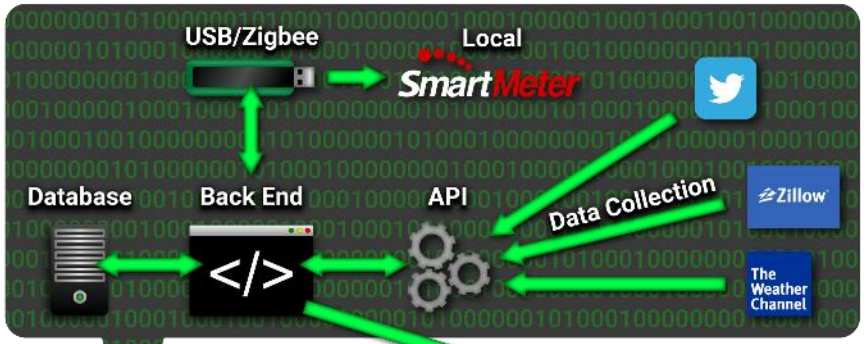
Energy Channel 2.0

- "Display of Smart Meter Information Via Set-Top Box Systems" - AKA "Energy Channel 1.0"
  - CalPlug lab partnered with set-top box provider to display the consumption data from the Smart Meter
- Further explore the additional opportunities of displaying real-time consumption data to the customer
- Project Goals:
  - To expand the capability and availability of Smart Meter consumption data to the customer
  - Expand the reach beyond the TV to mobile devices via an app
  - Integrate additional energy information
  - Improve user interface
  - Reduce the reliance on specific media providers



Methods

Requirements: Easy access (1) + real-time data (2) + Comparison (4)



Devices in use - (left) Intel stick with windows 10 and (right) MK809 stick with Android 5.1.

Home Area Network

Did Anyone Change Their Vote?

Manufactured Homes	Building Envelope	Natural Refrigerants
Multifunction Heat Pumps	Plug Loads, aka “MELs”	Grid Integration of ZNE Communities
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Contacts

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Director, Consulting
Vermont Energy Investment Corp.
802-540-7882
rfoster@veic.org

Andrew Mitchell
ORISE Fellow
U.S. Department of Energy
202-287-1578
andrew.mitchell@ee.doe.gov

Kim Erickson
Senior Program Manager
Consortium for Energy Efficiency
617-532-0026
kerickson@cee1.org

Edwin Hornquist
ET Program Manager
Southern California Edison
626-302-0299
Edwin.Hornquist@sce.com