# Smart Grid and Energy Efficient Consumer Electronics

**Invited Speaker**





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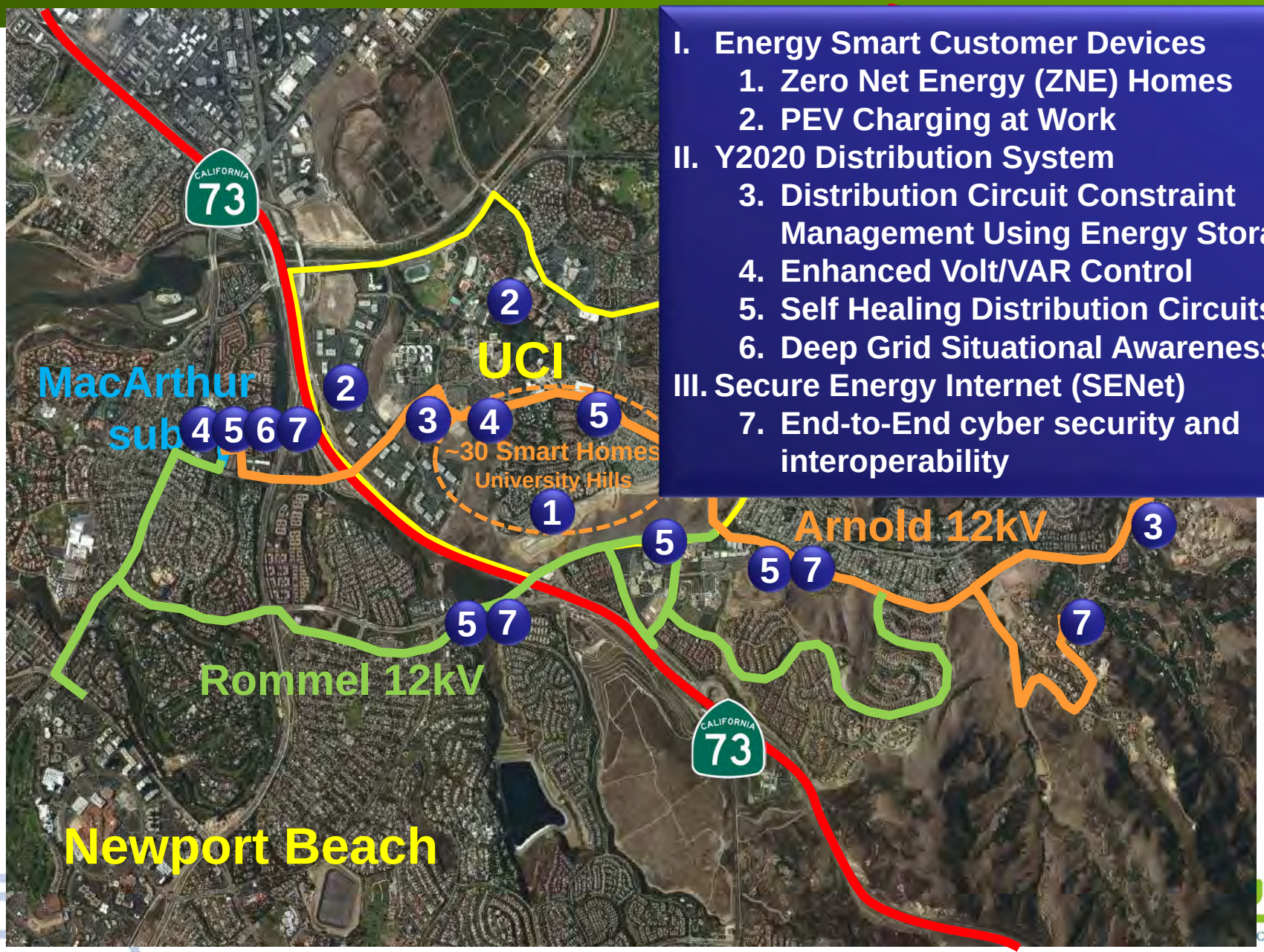
California Institute for Telecommunications and Information Technology, Irvine


April 11, 2013

# Outline

- California Dream of Smart Grid
- California Zero Net Energy(ZNE) Initiative
- California Plug Load Research Center
- Consumer Behavior and Consumer Integration(Personal Energy Footprint)
- How do we work together with CE community

# Irvine Smart Grid Demonstration (ISGD)



# Irvine Smart Grid Demonstration (ISGD)

- **Evolution of Energy Efficiency Technologies in ISGD**

| Test Case | Energy Efficiency Level* | Home Area Network† | PV | EVSE | PEV (non-commun-icating) | Home Storage | PEV (commun-icating) | # of Homes |
|---|---|---|---|---|---|---|---|---|
| Control | - | - | - | - | - | - | - | ~10 |
| 2012 | 35% | Yes | Yes | - | - | - | - | ~10 |
| 2015 | 55% | Yes | Yes | Yes | Yes | Yes | - | ~10 |
| 2020-ZNE | 65% | Yes | Yes | Yes | Yes | Yes | Yes | ~10 |

* above 2005 Title 24 level

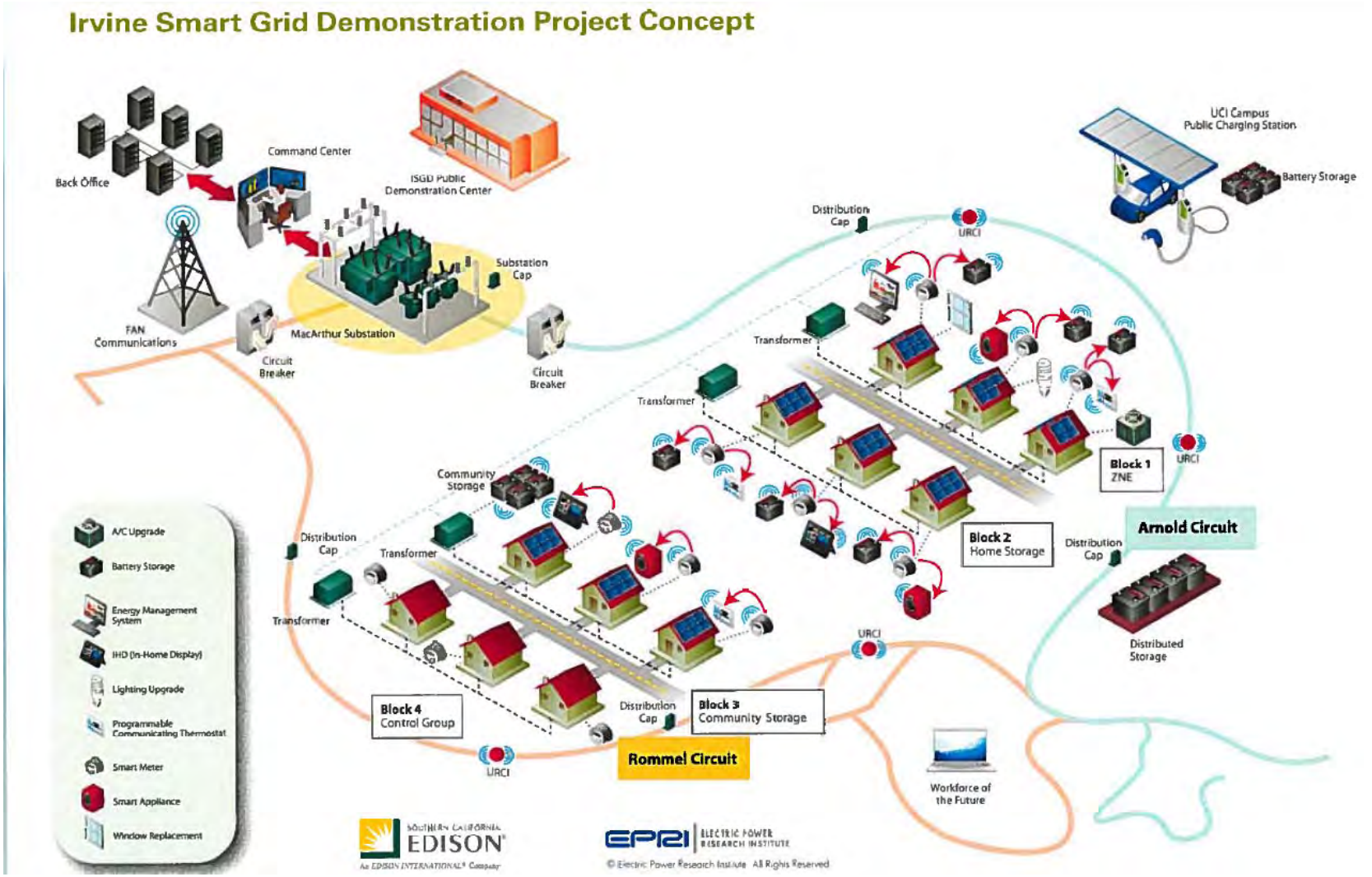
† includes in-home displays, programmable, controllable thermostats, energy manage systems, smart appliances, Edison SmartConnect™ meters

EVSE – electric vehicle supply equipment

PEV – plug-in electric vehicle

PV – photo-voltaic

# Irvine Smart Grid Demonstration

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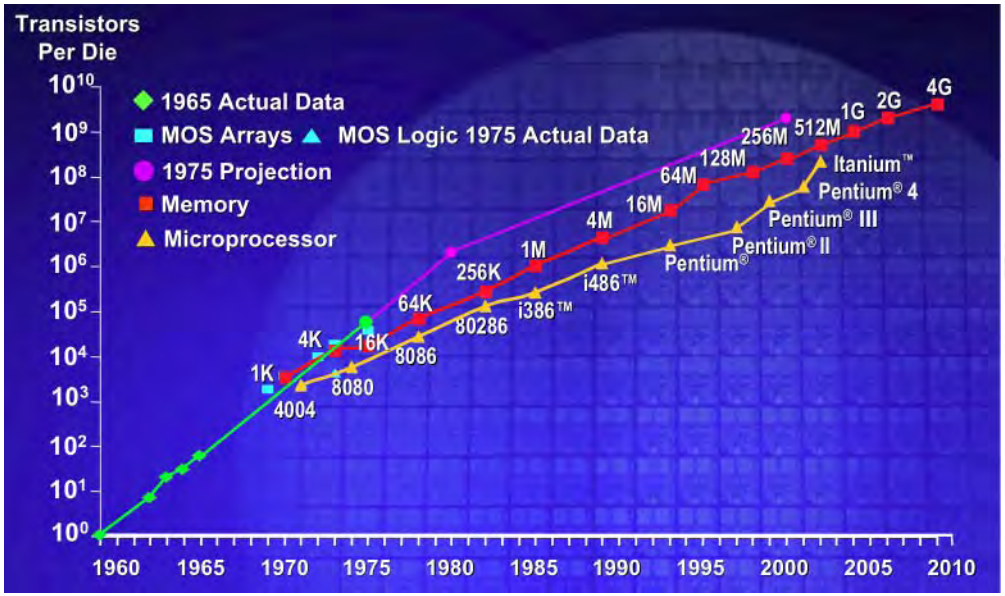
# From Micro to Nano

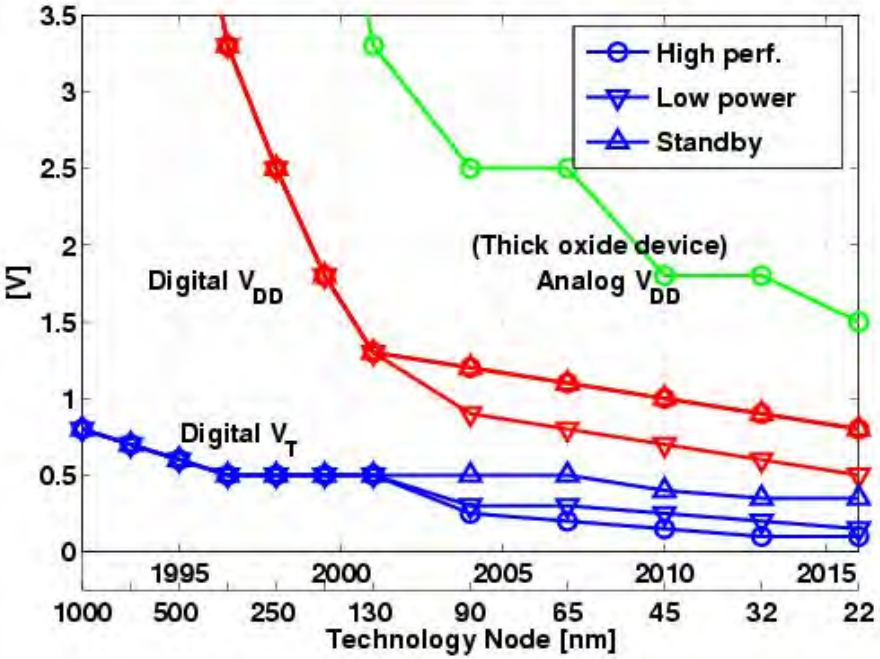
- **Smart Home Area network is needed to reach ZNE initiative!**

# DNA in Plug Loads: Microelectronics

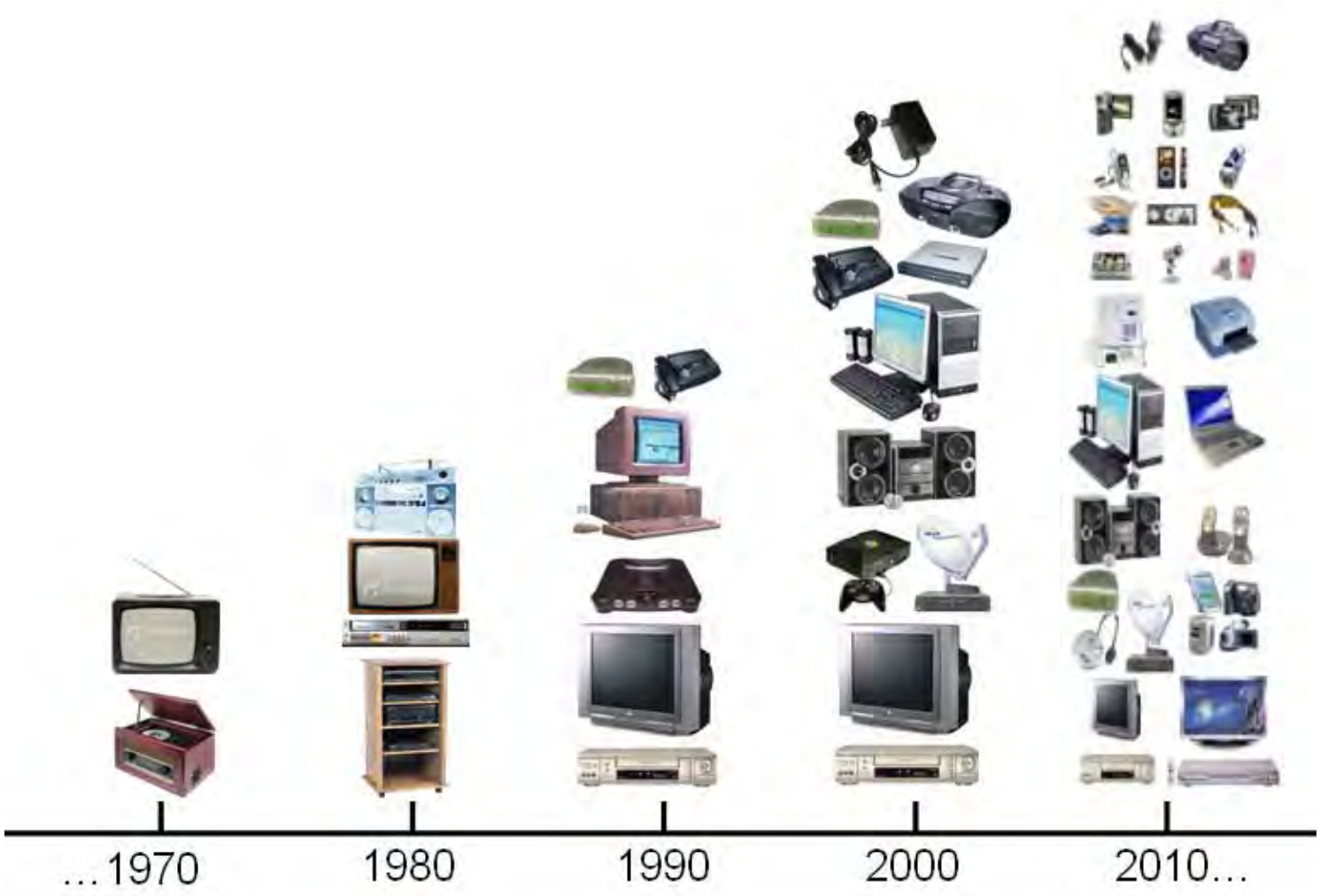
## Moore's Law: Doubling chip density every 18 months




## DC Power Supply Voltage In Integrated Circuits



# Increasing Penetration of Residential Consumer Electronics Plug Loads



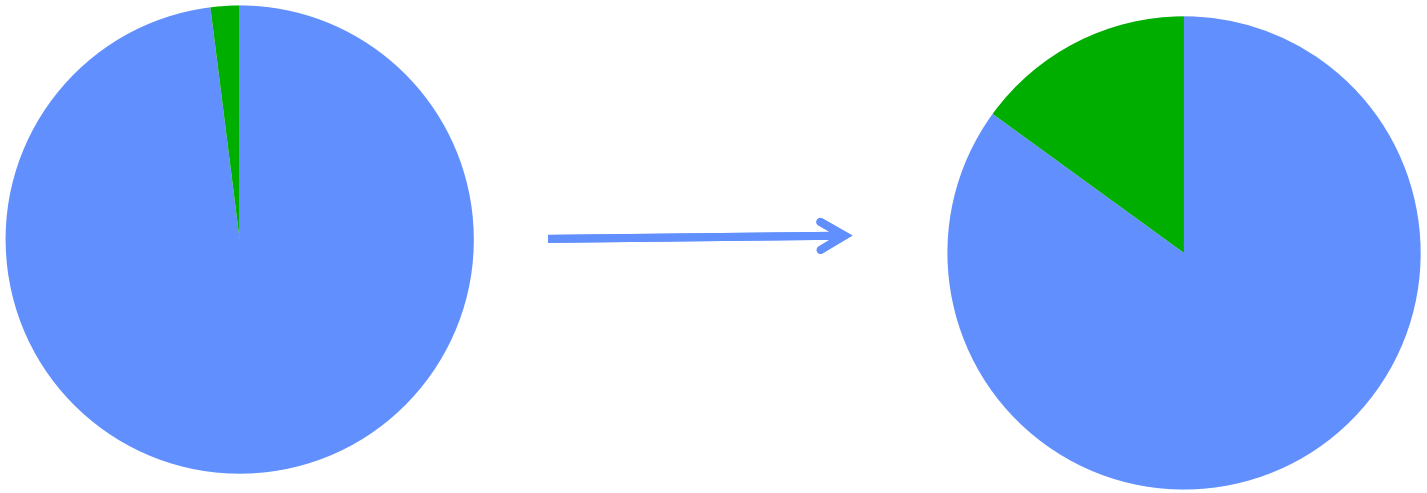

Source: Natural Resources Canada

# The Plug Load is Not a Typical Buildings-Standards Problem

**Wide range of devices**
**Wide range of users**

**Wide range of retailers**
**Fast development cycles**

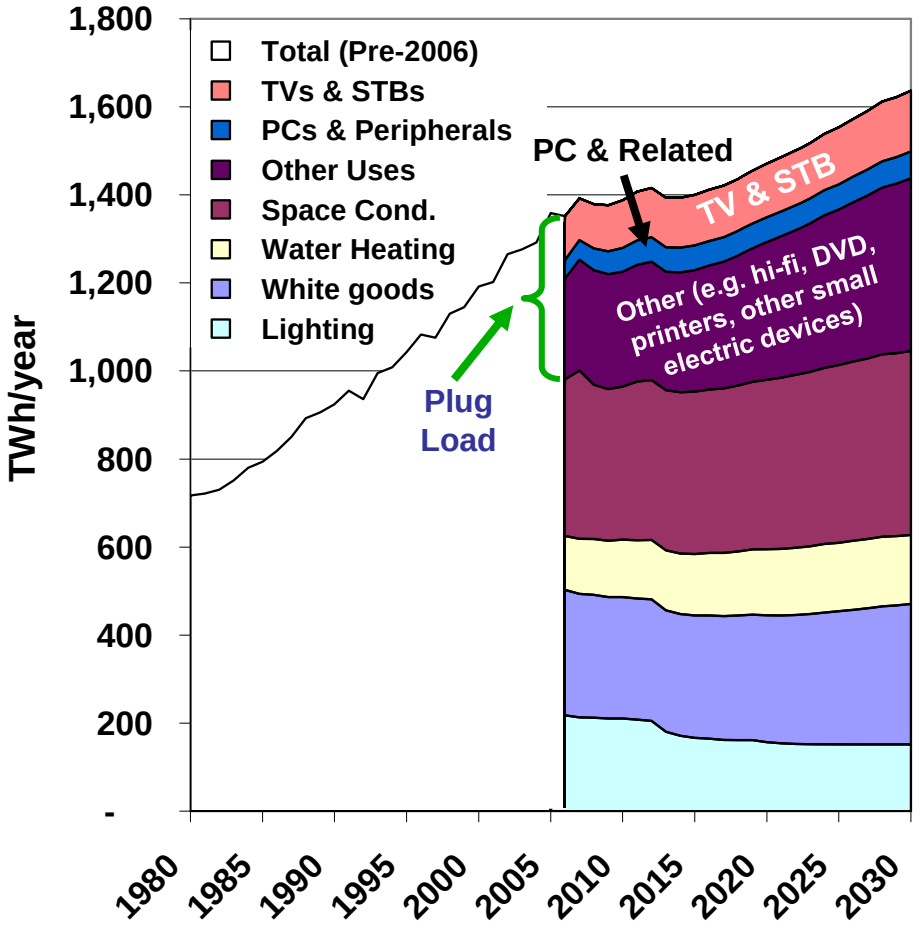
…and it's no longer just a small remainder

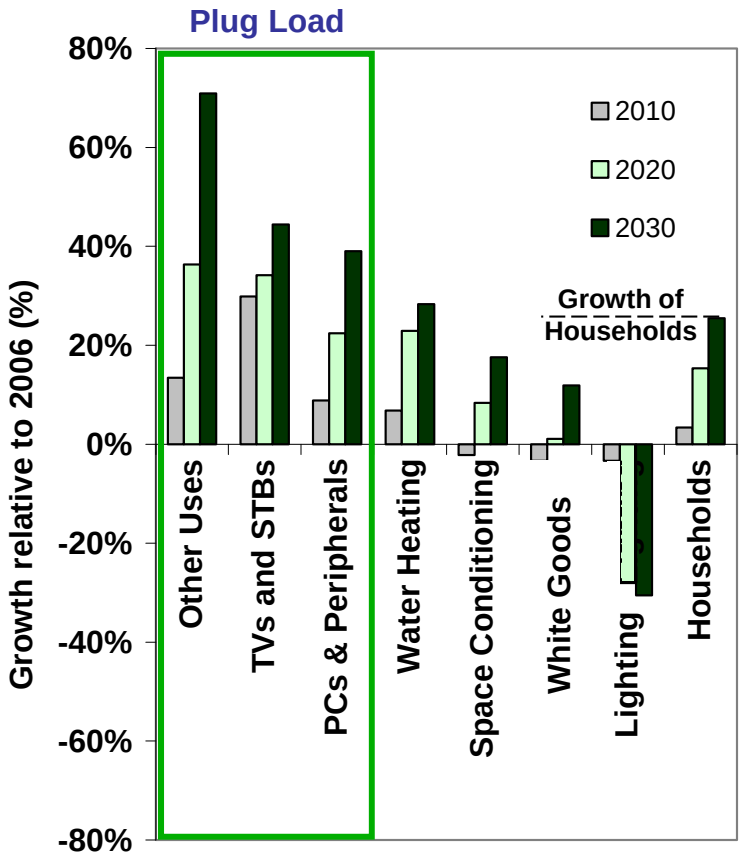


**Now**

**Future**

# Residential Electricity Consumption

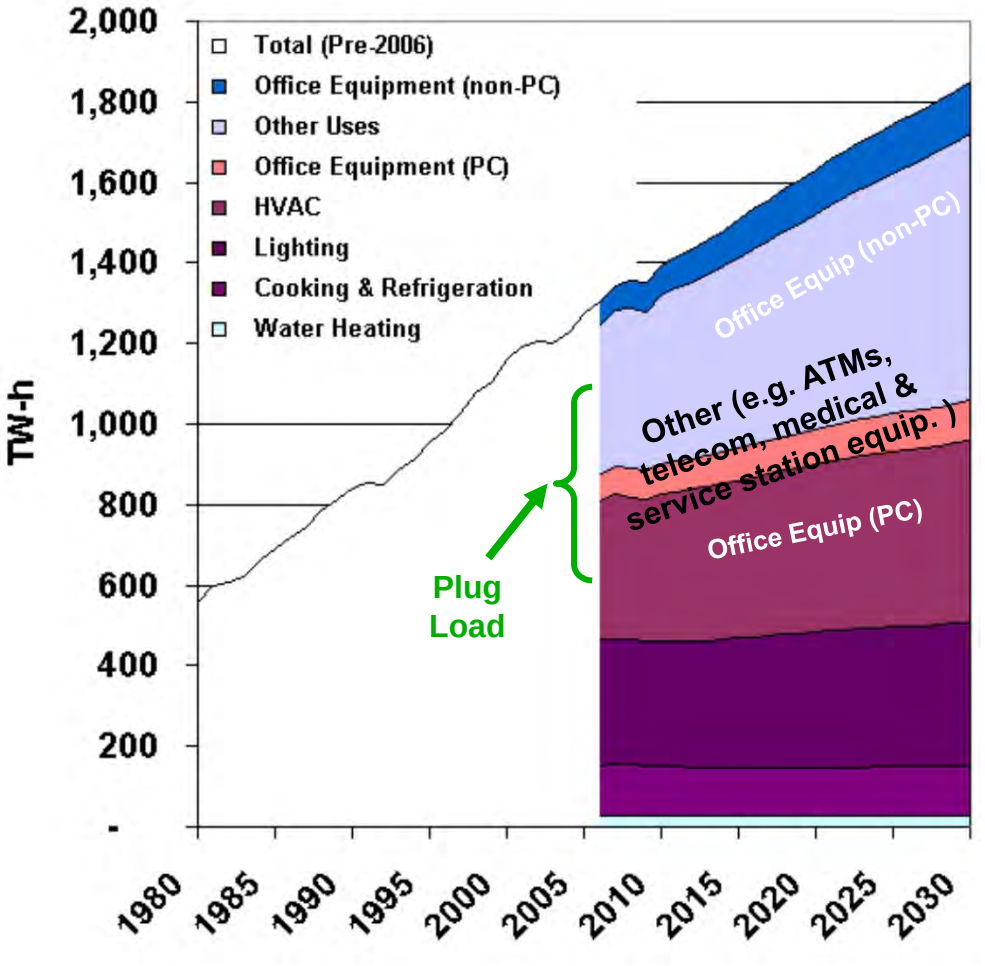


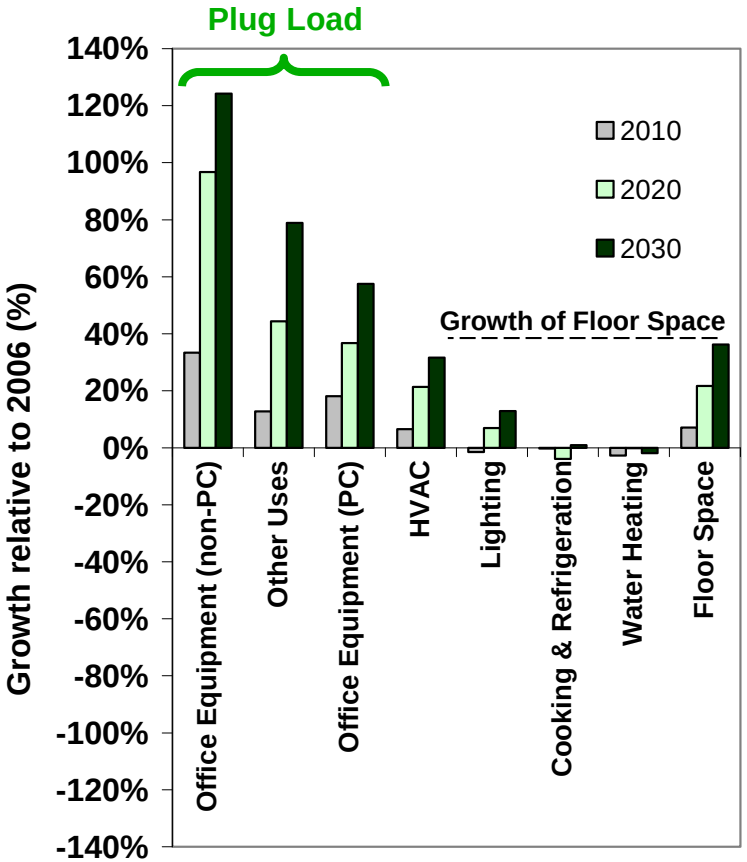






Source: U.S. Department of Energy: Energy Information Administration, Annual Energy Outlook 2009 Early Release

# Commercial Electricity Consumption




Source: U.S. Department of Energy: Energy Information Administration, Annual Energy Outlook 2009 Early Release

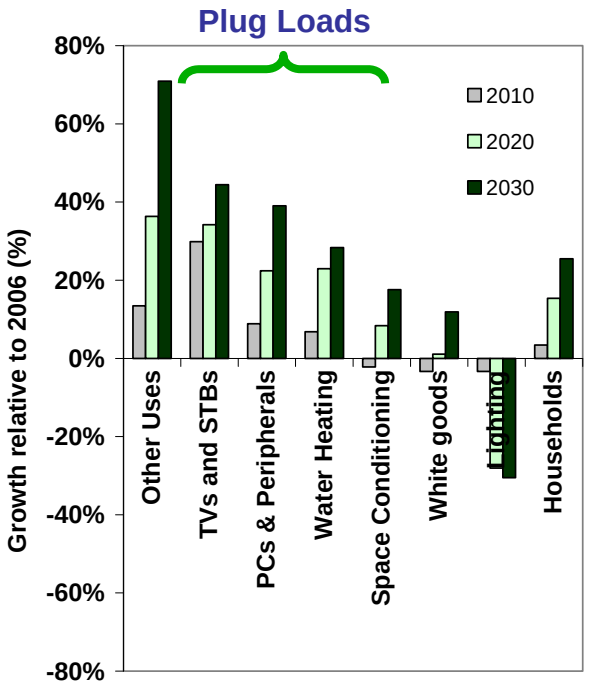
# The Interactions Among Plug Load Devices Need Attention

**Not enough plug load devices have been studied, let alone managed and made compliant.**

**The operation and interactions of many plug load devices in one place (office, home, store) have been studied even less.**

# CalPlug Purpose

- **Help California and U.S. improve energy efficiency in appliances and electronic devices**
- **In the residential and commercial sectors**
- **Through research, demonstration, education**
- **About engineering, incentives, codes and standards, and user behavior**



# CalPlug Latest Progress

- **March 2012 – DirecTV joins as first industry member; DirecTV demo setup**
- May 2012 – CalPlug Satellite TV system workshop
- June 2012 – CalPlug RD&D team (Faculty, Staff, Postdoc, Electronics Technician, Ph.D. candidates)
- July 1st 2012 – CalPlug's first conference papers accepted to International Conference of Consumer Electronics (IEEE)
- July 20th 2012 – CEC Commissioner Andrew McAllister visited CalPlug
- **July 24th 2012 – Official date to begin set-top box research for CEC work authorization**
- **August 1st 2012 – CalPlug STB 5W5s roadmap announced**
- **Oct 16th 2012 - Emergency Technology Summit 2012**

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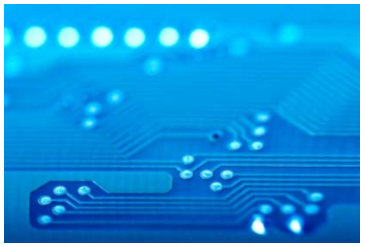
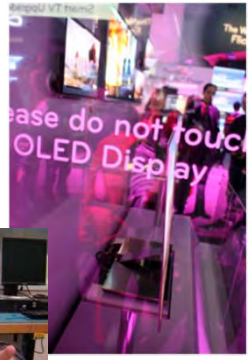
# CalPlug Applied Research

- **Efficient STB solution**
- **PC power savings modes**
- **Consumer outreach**






# Efficient Set-Top Box Solution

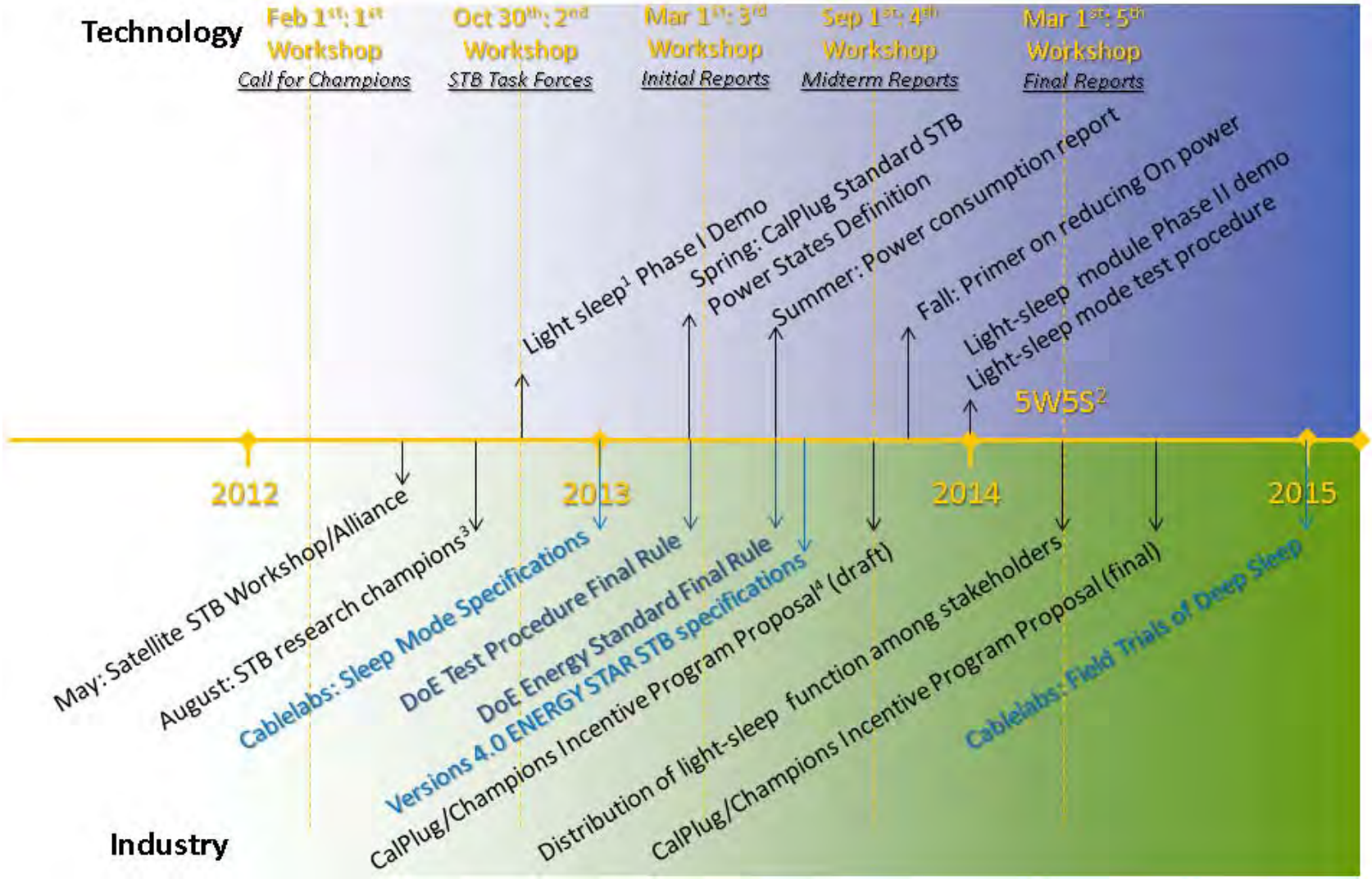
- **Goal:**

  **To accelerate energy efficiency in STBs (box and network) by innovations in STB hardware and software, codes and standards, and incentives and rebates**

- **Anticipated outcomes:**

- **Demonstrate STB energy-saving technology that is feasible to existing and future fleet**
- **An effective working group for strong collaborations among research centers, manufacturers, service/content providers, utilities and government agencies**

# CalPlug's 5W5s Roadmap for Efficient STBs



## Slide 17

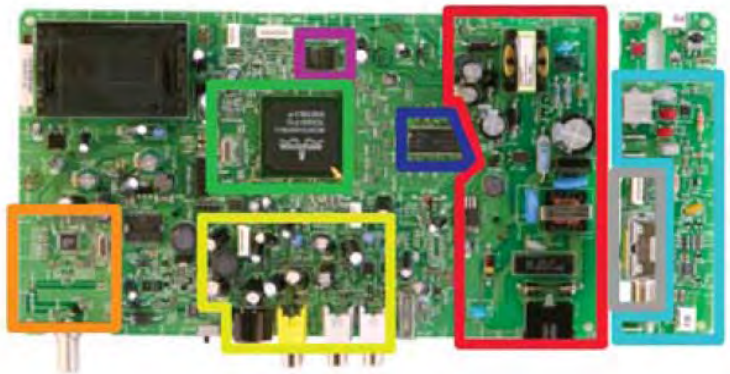
**sr7** Remove 'click to add text'
stuross, 10/30/2012

**sr8** Should we add the imminent Volujntary Agreement?
stuross, 10/30/2012

**sr9** What is or will be the Champions Incentive Proposal?  I have heard nothing about it and it hasn't been explained in other slides.
For example:
Why are only our Champions involved?
Why aren't our Champions doing other reports too?
stuross, 10/30/2012

# STB Device-Level Power Saving Potentials

- Power scaling system-on-a-chip CPUs
- Improved switching power supplies
- More efficient recording memory (Hard-drive-less, Hybrid, spin-down on-demand)
- Software, middleware updates
- Light-sleep/Deep-sleep bus system design to selectively de/activate components



MPEG Decoder + Transport + Modem + Control CPU + NTSC Encoder
AC-DC Power Supply
Volatile RAM
EMPROM (Flash) Non-Volatile Memory
Modem Analog Front End
Satellite Tuner
Analog Video and Audio Output
RF Modulator

STEPHEN DULAC, PROCEEDINGS OF THE IEEE, VOL. 94, NO. 1, JANUARY 2006

## Slide 18

**sr12** use left justification

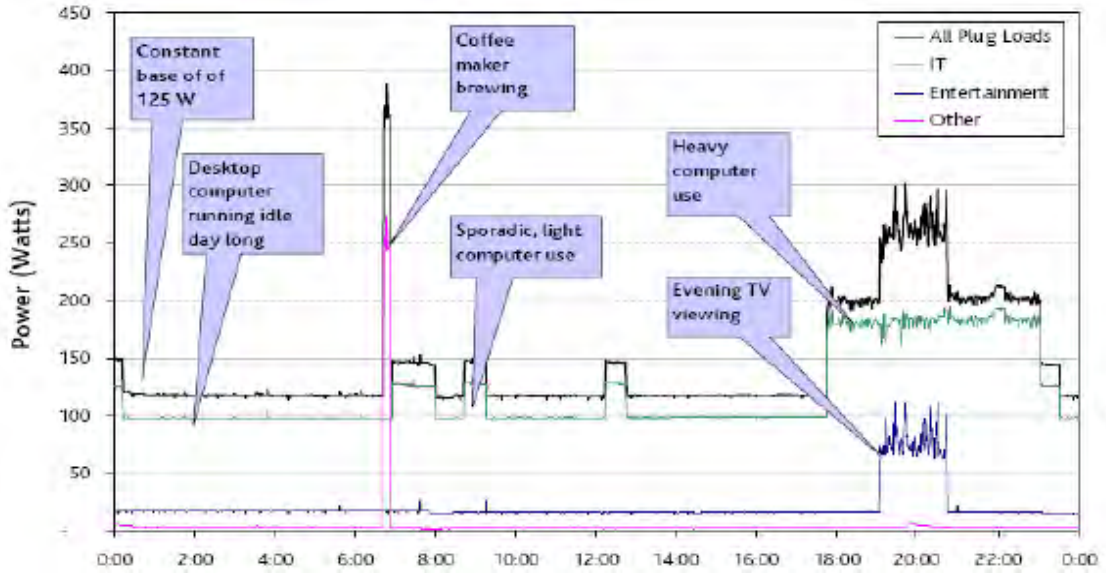
stuross, 10/30/2012

# PC Power Saving Modes

- **Are PCs really going to sleep at night?**
- **Major PC industry players in participation**

# Research Methodology: Energy efficient plug load devices

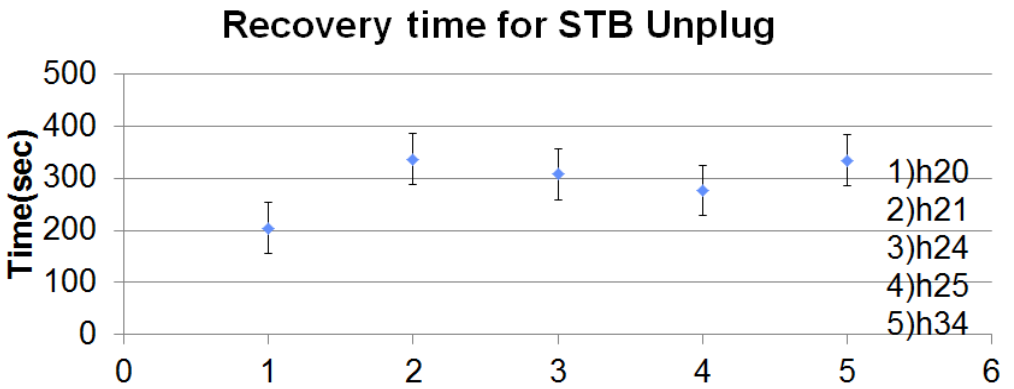
- **Define efficiency**
- **Duty-cycle, sleep modes, and deemed savings**
- **Personal energy footprint (PEF) management**

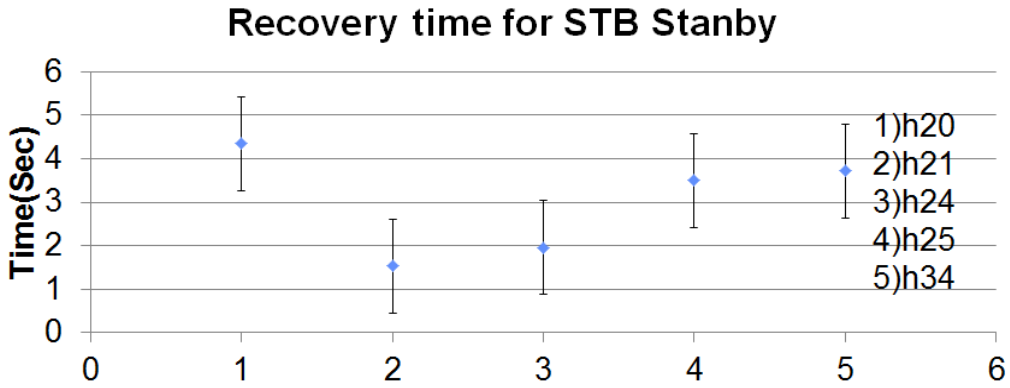



Source: Porter et al. 2006

# Consumer Tradeoffs in Efficiency Designs

- **Efficient, on-demand designs always have tradeoffs in system response time**
- **“Frustration threshold” study**
- **How to reduce consumer perceived “Delay”?**



## Slide 21

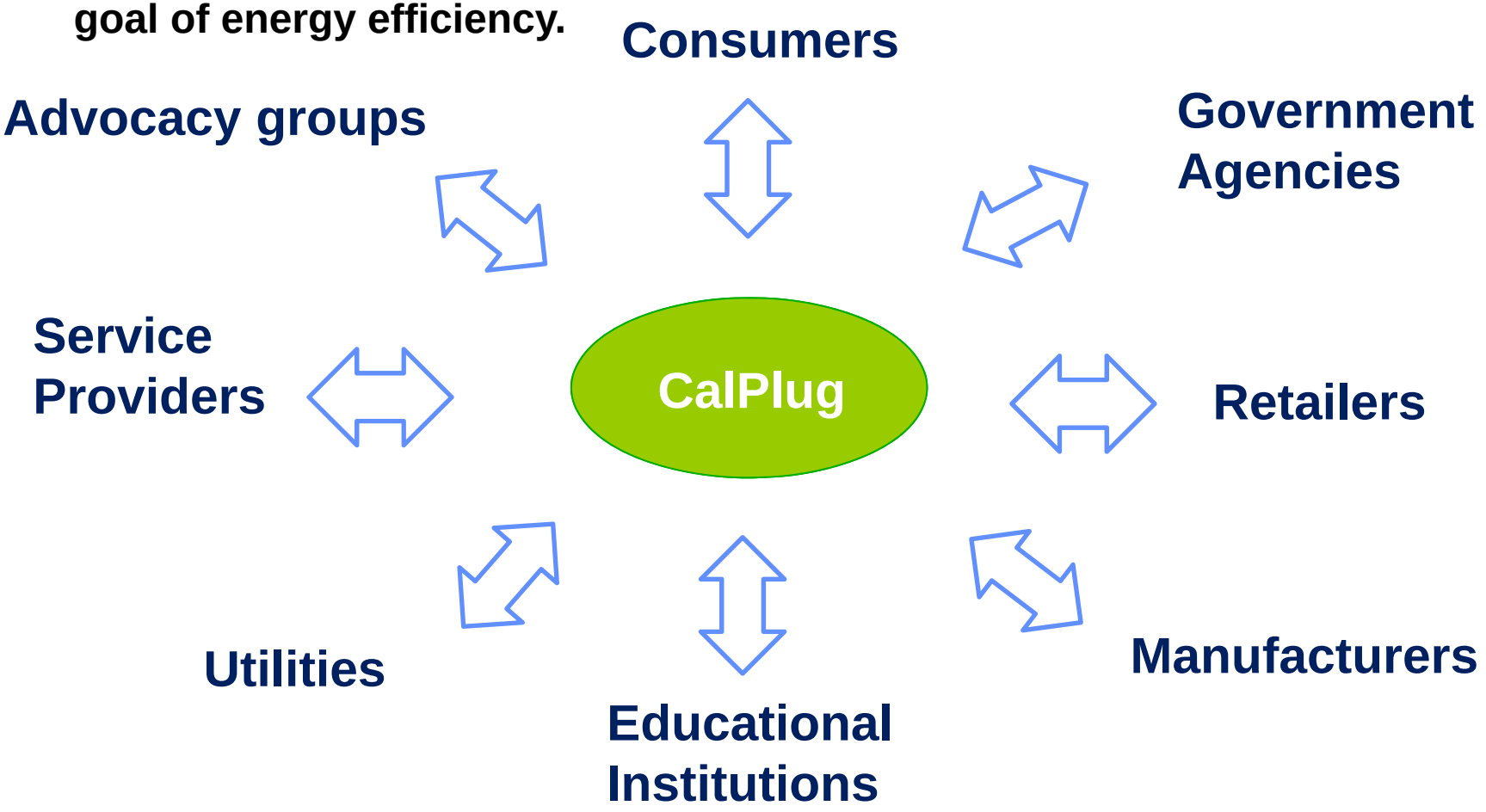
**sr13** Skip the photo to expand the charts for readability.

Use left justification
stuross, 10/30/2012

**sr14** What are the 'tradeoffs'?
Customer satisfaction vs. energy saved?
stuross, 10/30/2012

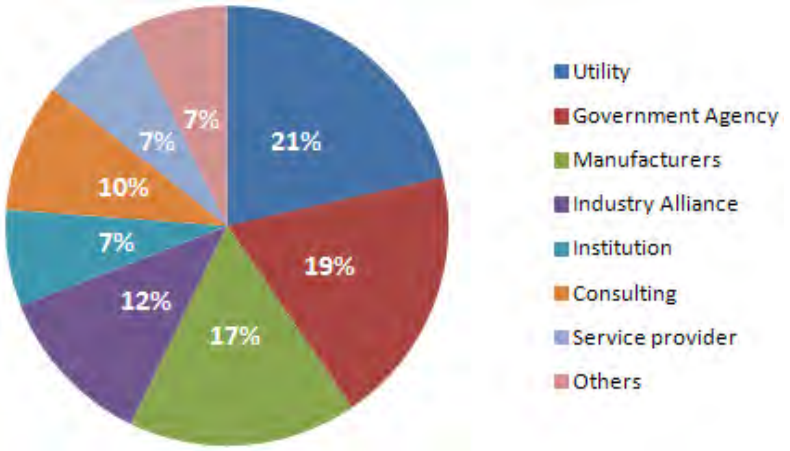
# How do we work with CE community

**Neutral playing ground for diverse groups with various challenges and approaches to explore common objectives and goals with the ultimate goal of energy efficiency.**



# STB Workshop Series

- **Established a collaborative forum for all STB stake-holders to make concerted efforts.**
- **Identified top-priority research areas for STB energy efficiency.**
- **Received wide support from participants and recruited STB research project champions.**
- **Demonstrated research progress and prototypes**




**Workshop participants**

# CalPlug Membership

# CalPlug Current Academic/Industry Collaboration

- Manufacturer: Motorola, Cisco, VIZIO
- Service providers: Comcast, Cox, Verizon, DirectTV
- Utilities: SMUD, SCE, PG&E, LADWP, SEMPRA
- Microelectronics: Broadcom, Intel
- Institutions: UC Irvine, UC Davis, UCLA, UCSD, LBNL
- Energy policy agencies: CEC, CPUC, EPA, DOE, CEE
- Public interest groups: CEA, NRDC, Emerge Alliance, eSource, NCA

# Our Team

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The Paul Merage School of Business
University of California • Irvine

School of Physical Sciences
University of California • Irvine

UC Irvine | School of Social Sciences
where I make a difference

Integrated Nanosystems Research Facility

Creating Connections. Powering Innovation. Boosting Efficiency.

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# Introducing the city of Irvine, Orange County

- 6th most populous county in US
- Irvine Business Center, South Coast Metro and Newport Center
- Fortune500: Ingram Micro, Western Digital, Broadcom, Blizzard Entertainment
- Coastlines and Disneyland


# We welcome opportunities for collaboration.

# Thank you!