Smart Grid and Energy Efficient Consumer Electronics

Invited Speaker

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California Plug Load Research Center
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)

I. Energy Smart Customer Devices
   1. Zero Net Energy (ZNE) Homes
   2. PEV Charging at Work
II. Y2020 Distribution System
   3. Distribution Circuit Constraint Management Using Energy Storage
   4. Enhanced Volt/VAR Control
   5. Self Healing Distribution Circuits
   6. Deep Grid Situational Awareness
III. Secure Energy Internet (SENet)
   7. End-to-End cyber security and interoperability
**Irvine Smart Grid Demonstration (ISGD)**

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

<table>
<thead>
<tr>
<th>Test Case</th>
<th>Energy Efficiency Level*</th>
<th>Home Area Network†</th>
<th>PV</th>
<th>EVSE</th>
<th>PEV (non-communicating)</th>
<th>Home Storage</th>
<th>PEV (communicating)</th>
<th># of Homes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>-</td>
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<tr>
<td>2012</td>
<td>35%</td>
<td>Yes</td>
<td>Yes</td>
<td>-</td>
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<tr>
<td>2015</td>
<td>55%</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>~10</td>
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<tr>
<td>2020-ZNE</td>
<td>65%</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>~10</td>
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</table>

* above 2005 Title 24 level
† includes in-home displays, programmable, controllable thermostats, energy management systems, smart appliances, Edison SmartConnect™ meters

- EVSE – electric vehicle supply equipment
- PEV – plug-in electric vehicle
- PV – photo-voltaic
Irvine Smart Grid Demonstration Project Concept
From Micro to Nano

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

Commercial Electricity Consumption

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

Creating Connections: Powering Innovation: Boosting Efficiency
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.
CalPlugs 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

![Graph showing growth relative to 2006 (%) for different uses of plug loads.](image)
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 - Emerging Technology Summit 2012
CalPlug Applied Research

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

Technology

Feb 1st: 1st Workshop
Call for Champions

Oct 30th: 2nd Workshop
STB Task Forces

Mar 1st: 3rd Workshop
Initial Reports

Sep 1st: 4th Workshop
Midterm Reports

Mar 1st: 5th Workshop
Final Reports

2012
May: Satellite STB Workshop/Alliance
August: STB research champions

2013
Cablelabs: Sleep Mode Specifications
DoE Test Procedure Final Rule
DoE Energy Standard Final Rule

2014
Versions 4.0 ENERGY STAR STB specifications
CalPlug/Champions Incentive Program Proposal (draft)
Distribution of light-sleep function among stakeholders

2015
CalPlug/Champions Incentive Program Proposal (final)
Cablelabs: Field Trials of Deep Sleep

Industry

Remove ‘click to add text’
stuross, 10/30/2012

Should we add the imminent Voluntary Agreement?
stuross, 10/30/2012

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
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
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”?
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 stakeholders 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 chart: Utility 21%, Government Agency 19%, Manufacturers 17%, Industry Alliance 12%, Institution 10%, Consulting 7%, Service provider 7%, Others 7%.]
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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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!