SOUTHERN CALIFORNIA EDISON®
Energy for What's Ahead℠

SCE Emerging Technologies Overview

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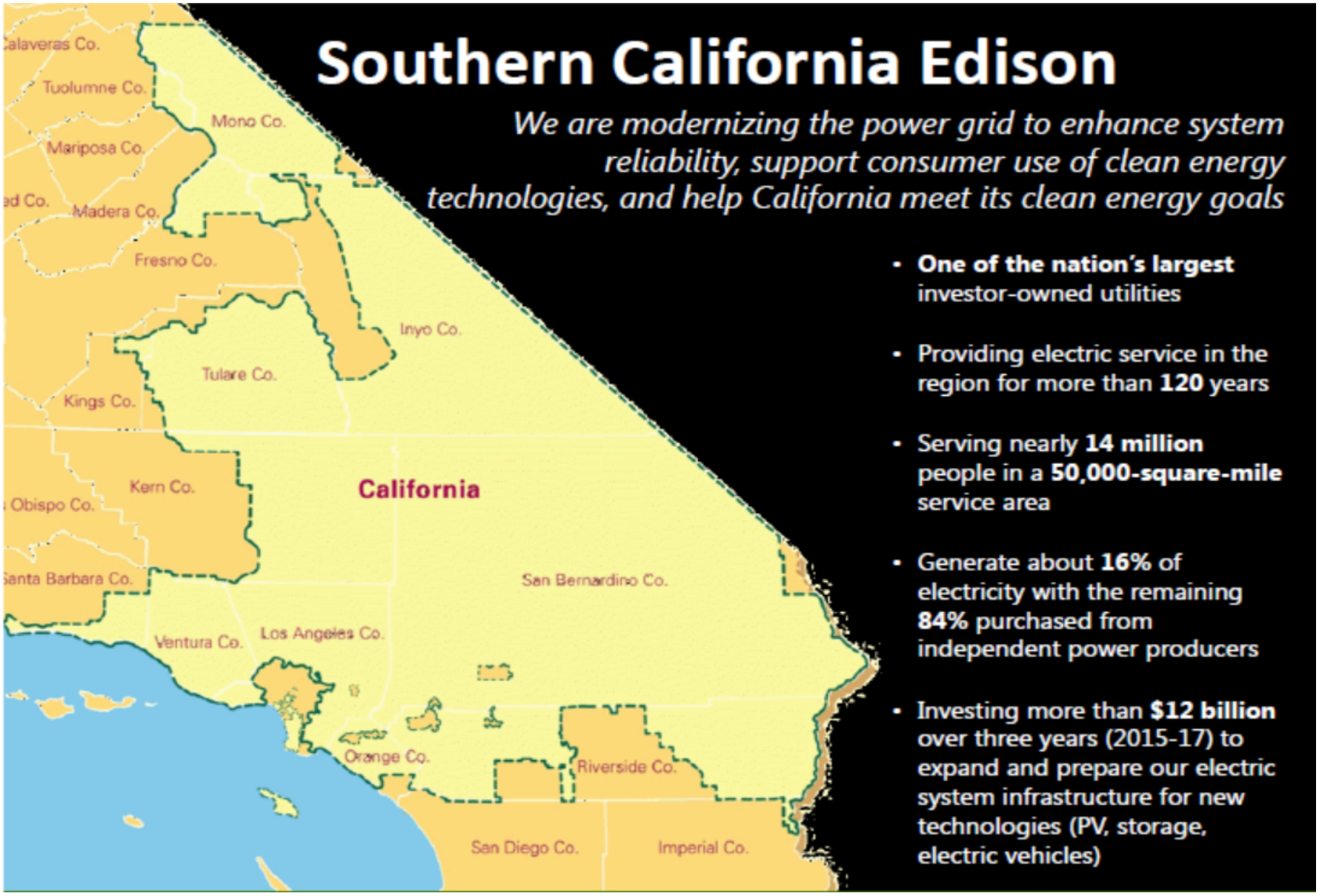
May 10, 2018 – **UCSB EEI Technology Update**

About SCE


Southern California Edison
We are modernizing the power grid to enhance system reliability, support consumer use of clean energy technologies, and help California meet its clean energy goals
• One of the nation's largest investor-owned utilities
• Providing electric service in the region for more than 120 years
• Serving nearly 14 million people in a 50,000-square-mile service area
• Generate about 16% of electricity with the remaining 84% purchased from independent power producers
• Investing more than $12 billion over three years (2015-17) to expand and prepare our electric system infrastructure for new technologies (PV, storage, electric vehicles)
Calaveras Co.
Tuolumne Co.
Mono Co.
Mariposa Co.
Madera Co.
Fresno Co.
Inyo Co.
Tulare Co.
Kings Co.
Kern Co.
California
Obispo Co.
Santa Barbara Co.
San Bernardino Co.
Ventura Co.
Los Angeles Co.
Orange Co.
Riverside Co.
San Diego Co.
Imperial Co.

SCE strategy

Build the next generation energy company that delivers superior value to customers and enables a clean energy future, focusing on four areas:

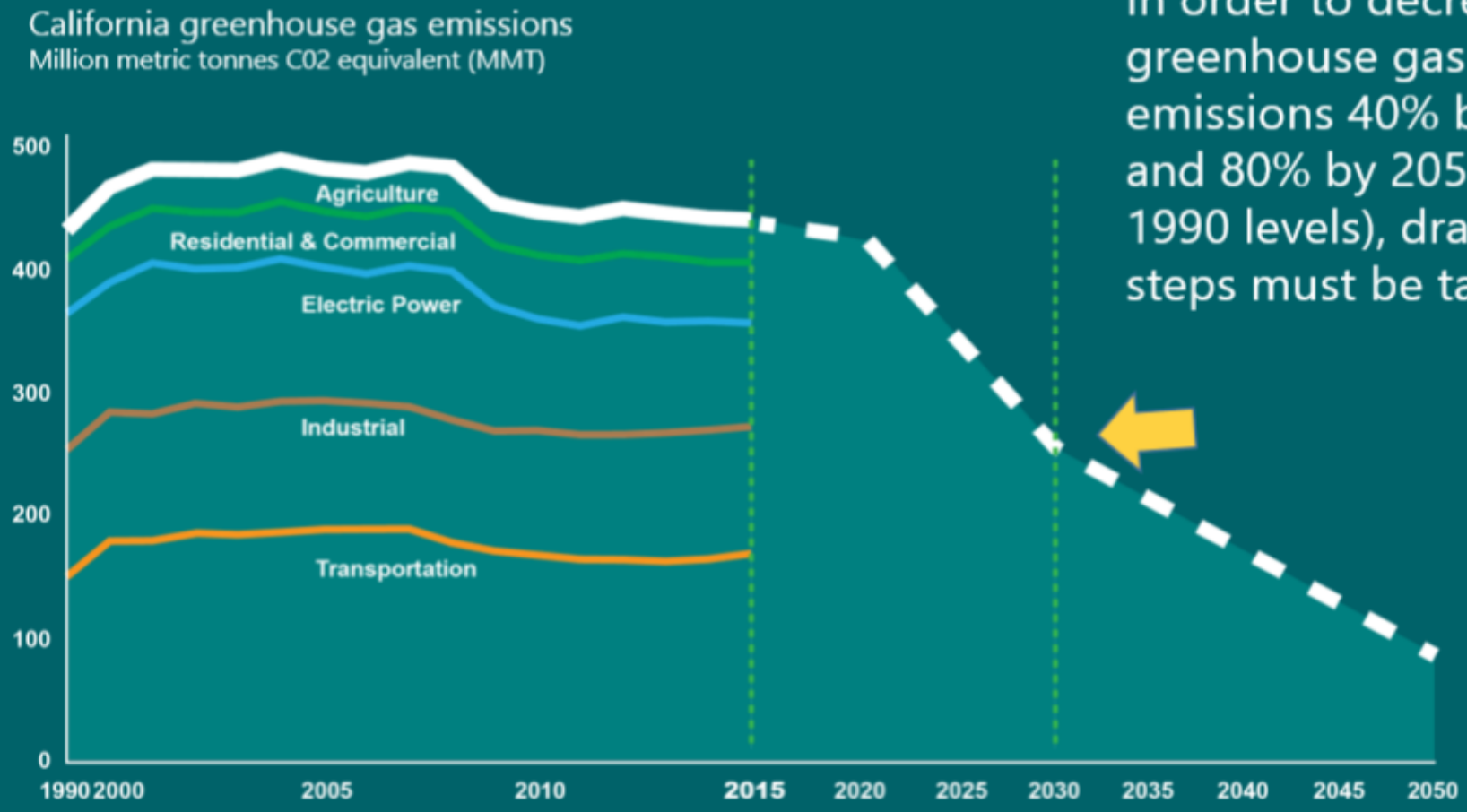
Cleaning the power system

Strengthening and modernizing the grid

Helping customers make cleaner energy choices

Achieving operational and service excellence

California's greenhouse gas emissions must decline



In order to decrease greenhouse gas emissions 40% by 2030 and 80% by 2050 (below 1990 levels), dramatic steps must be taken.

Source: Air Resource Board

SCE's Clean Power and the Electrification Pathway

- Southern California Edison's integrated blueprint for California to reduce GHG emissions and air pollutants.
- Realizing the blueprint will reduce the threat of climate change and improve public health related to air quality.
- It is a systematic approach and each measure is integrated with — and depends upon — the success of the others.
- To be successful, California must approach implementation as an integrated package, applying resources across the board where most effective.

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THE CLEAN POWER AND ELECTRIFICATION PATHWAY
Realizing California's Environmental Goals
November 2017

Figure 1: Meeting California's GHG Reduction Goals *(Source: California Air Resources Board [CARB])*

This paper presents Southern California Edison's integrated blueprint for California to reduce greenhouse gas emissions and air pollutants. Realizing the blueprint will reduce the threat of climate change and improve public health related to air quality. It is a systematic approach and each measure is integrated with — and depends upon — the success of the others. To be successful, California must approach implementation as an integrated package, applying resources across the board where most effective.

EXECUTIVE SUMMARY

Climate change and air pollution pose serious threats. Climate change effects, such as sea level rise and longer, more intense heat waves, are now occurring. In California, while significant progress has been made, too many communities continue to experience asthma and other air-quality-related health issues.

California continues its leadership in addressing climate change and air pollution. The state's greenhouse gas (GHG) goals call for a 40 percent reduction in GHG emissions from 1990 levels by 2030 and an 80 percent reduction by 2050 (Figure 1). Air quality goals include a 90 percent reduction in emissions of nitrogen oxides from 2010 levels in some of the state's most polluted areas by 2032. Meeting these ambitious clean energy and clean air goals requires fundamental changes over the next 12 years and beyond.

The electric sector is at the forefront of the fight against climate change in California and today accounts for only 19 percent of the state's GHG emissions. The transportation sector (including fuel refining) and fossil fuels used in space and water heating now produce almost three times as many GHG emissions as the electric sector and more than 80 percent of the air pollution in California.

The Clean Power and Electrification Pathway is an integrated approach to reduce GHG emissions and air pollution by taking action in three California economic sectors: electricity, transportation and buildings. It builds on existing state policies and uses a combination of measures to produce the most cost-effective and feasible path forward among the options studied.

The Pathway will help California achieve its climate goals and significantly reduce today's health-harming air pollution in local communities. It also has strong potential to create highly-skilled, middle-income jobs.

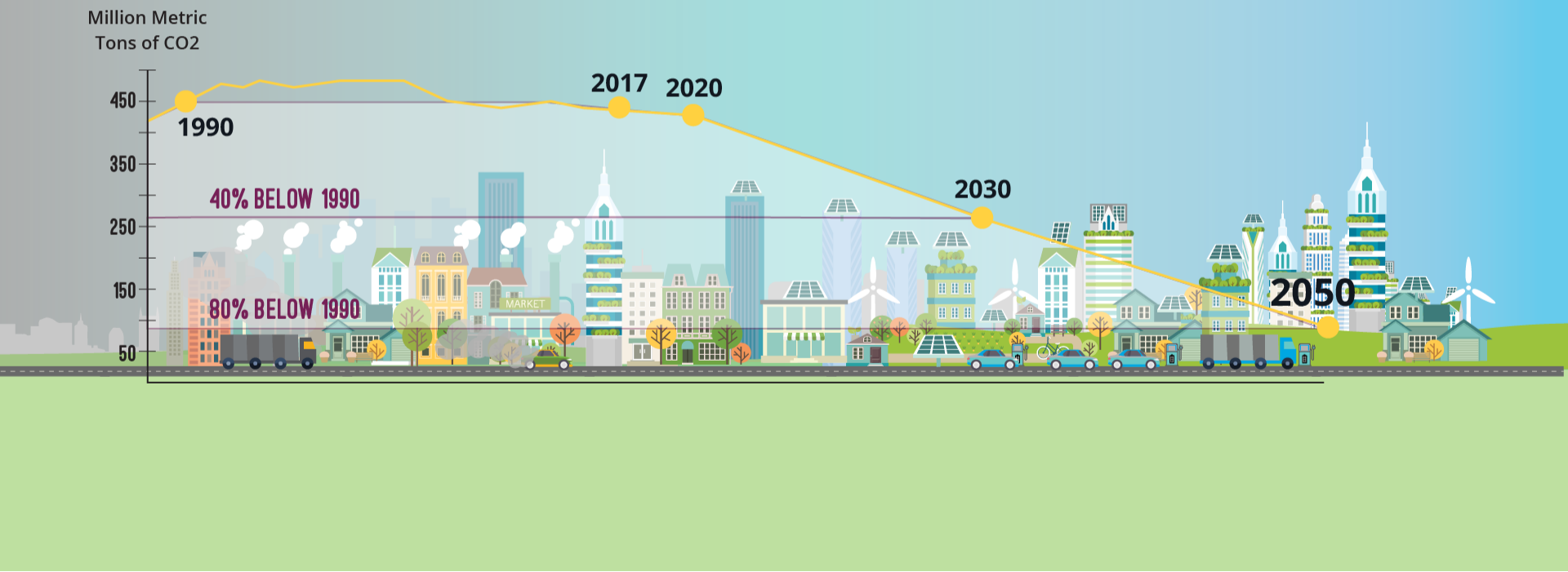
By 2030, it calls for:

- an electric grid supplied by 80 percent carbon-free energy;
- more than 7 million electric vehicles on California roads; and
- using electricity to power nearly one-third of space and water heaters, in increasingly energy-efficient buildings.

(Continued)

Goals to improve

- California set a goal to **reduce emissions 40%** below 1990 levels by 2030, and 80% by 2050.



If we want to get to **zero emissions**, eventually we have to **replace** many of the things we rely on today that require combustion.

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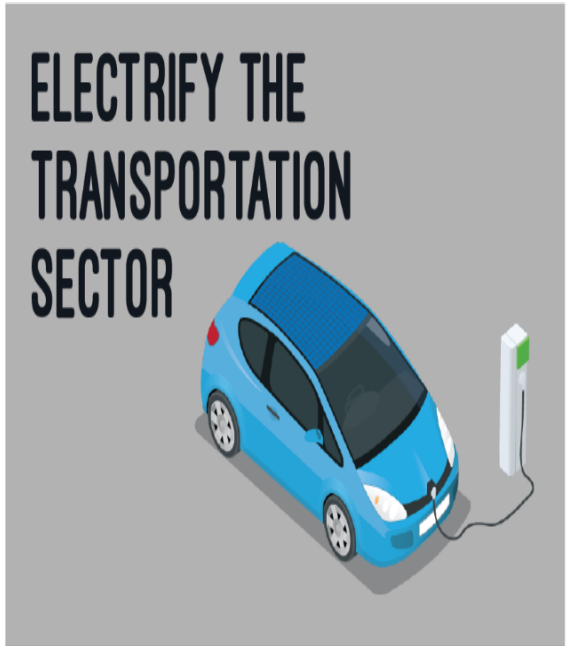
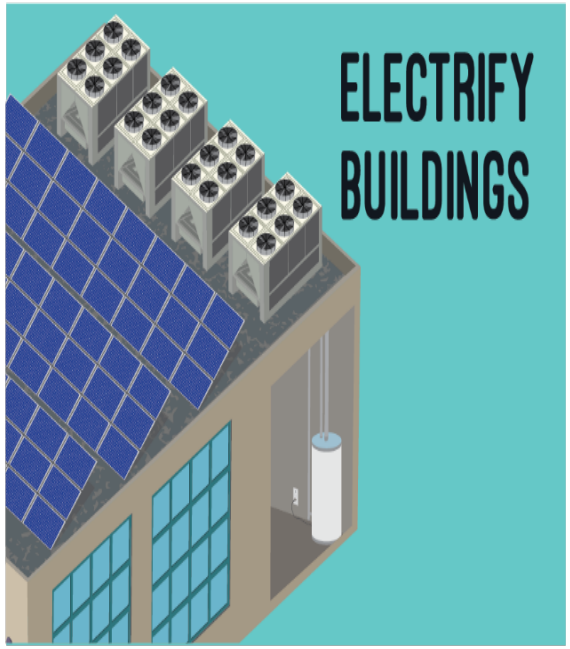
SCE's integrated solution





Clean the power grid. And electrify.

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The Need for New Energy Technologies

- Our utility grids are getting more complex
- Our customers are expecting more choices & more support
- Markets & technologies are moving faster than in the past
- DERs (Distributed Energy Resources) are coming in a wave
- Utilities & customers have resource challenges & cost pressures

So how do we find these technologies for our customers?

- We want to tap into the tech “market wisdom”
- In CA we utilize our Emerging Technologies Programs to identify and support new customer-side technologies.
- We leverage 3rd-parties extensively to make these programs successful.

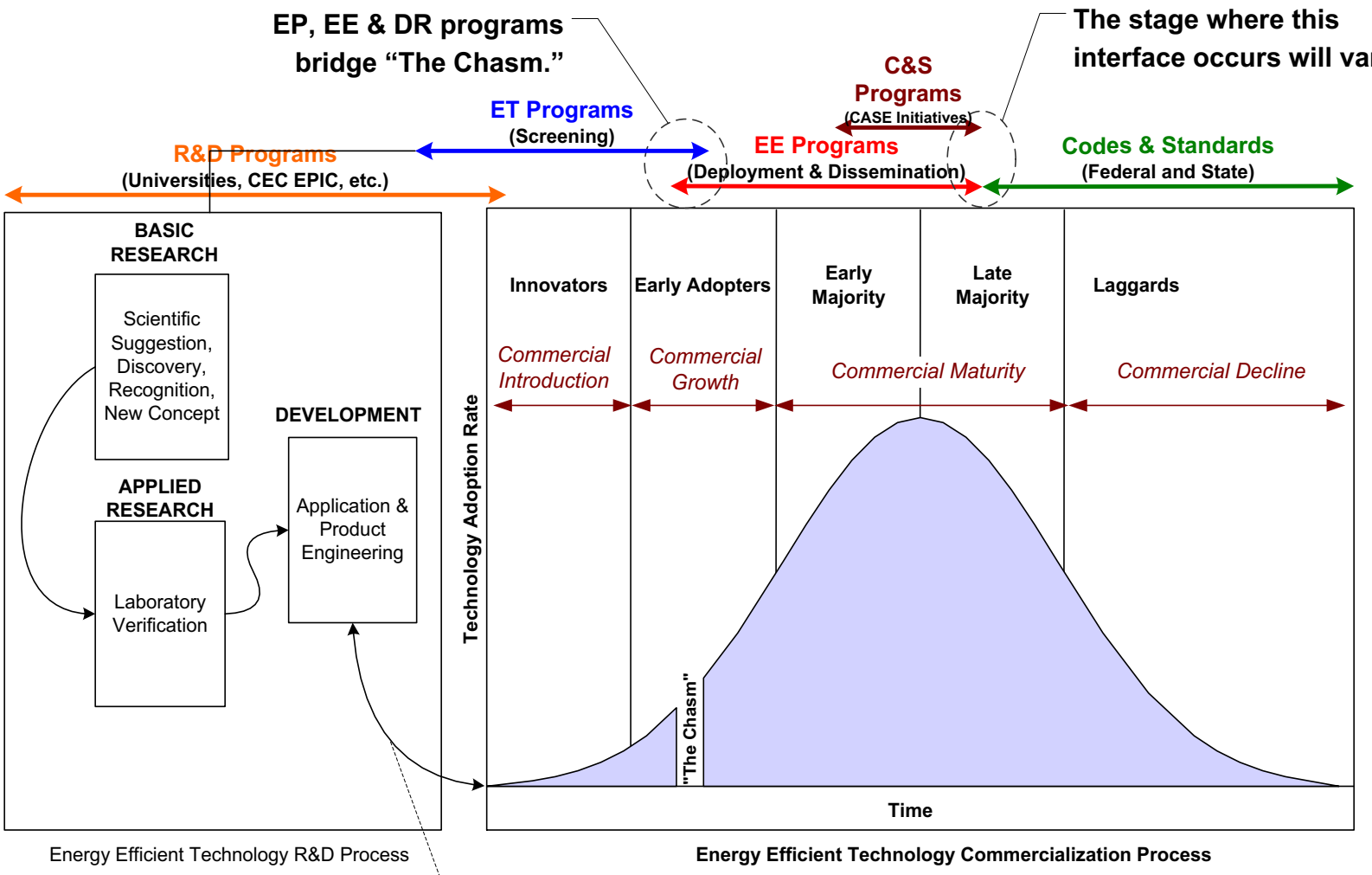
What kind of 3rd-parties are we working with?

- Entrepreneurs & Start-up firms
- Technology developers
- Universities & other laboratories
- Manufacturers
- Engineering Firms
- Consultants

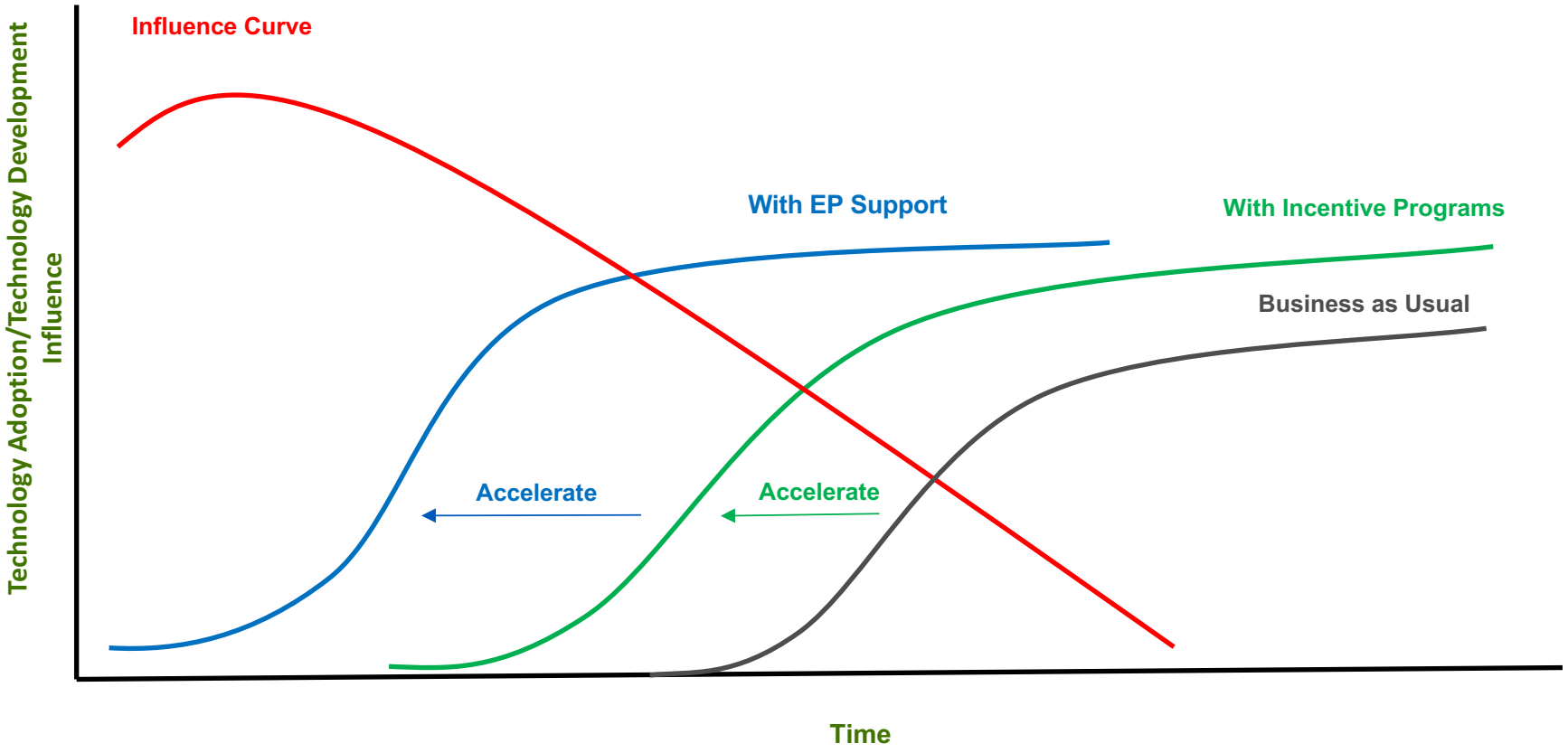
SCE Emerging Products (EP) Group and Core Activities

- Emerging Technologies Program looks at new EE (Energy Efficiency) technology
- Emerging Markets Program looks at new DR (Demand Response) technology
- Many EP projects combine both; all of them focus on our program core competencies
  - Assessment and validation of technologies and solutions
  - Demonstrations, Scaled Field Placements, and Showcases of potential new solutions

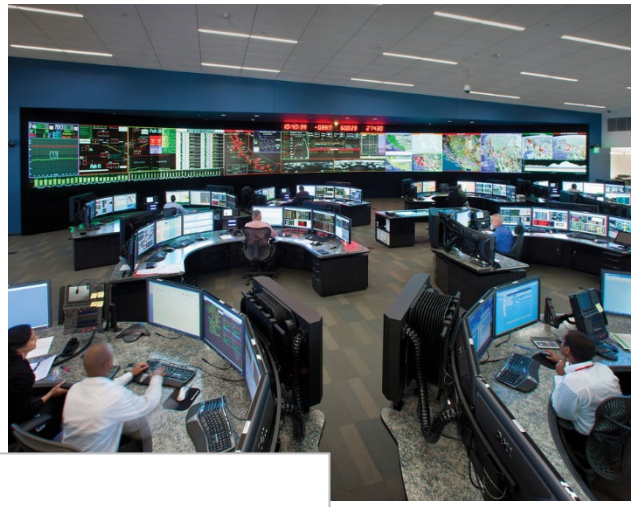
California Demand Side Mgmt Framework

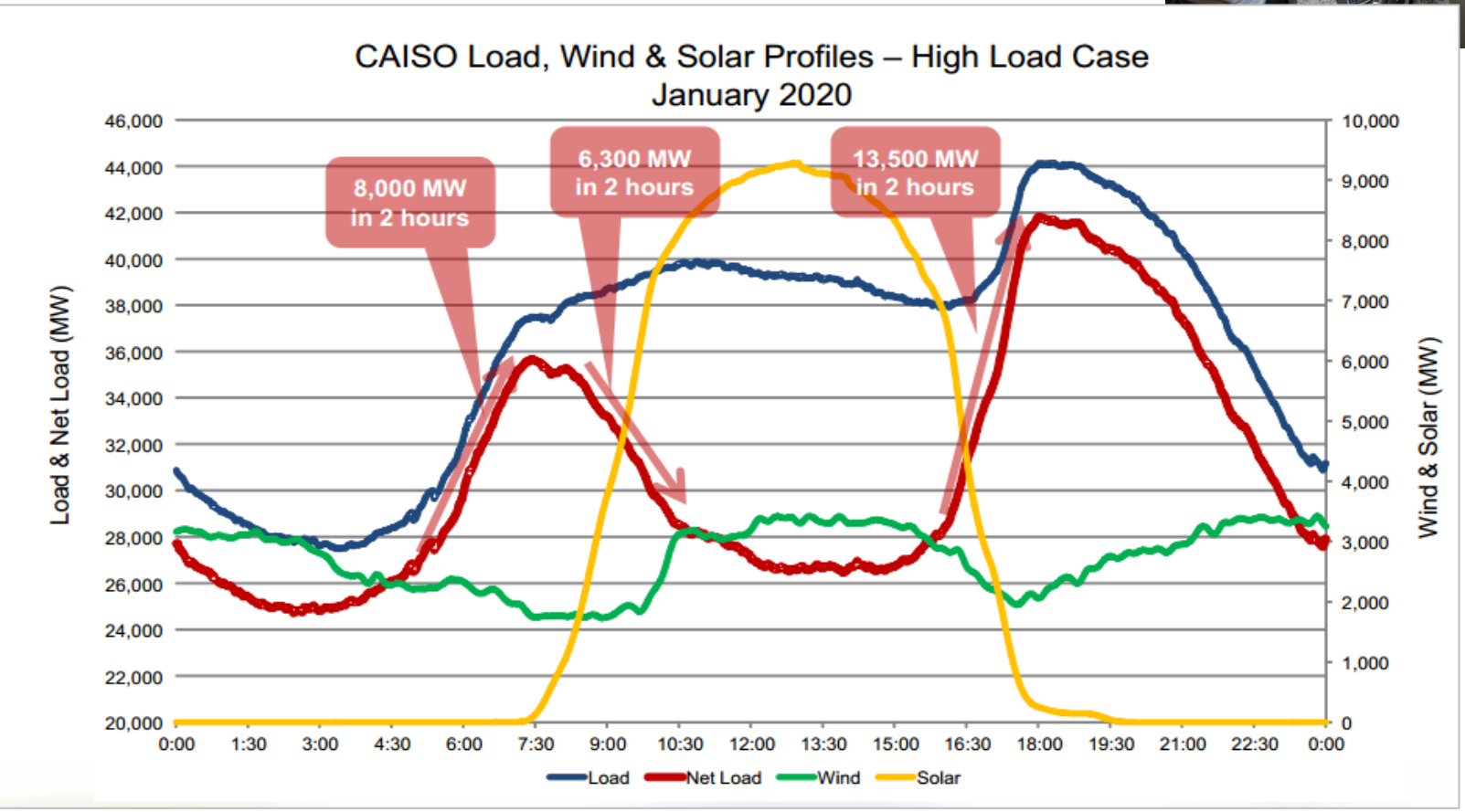


Technology Influence and Adoption Life Cycle – Conceptual



California Drivers for Utility Grid Load Management

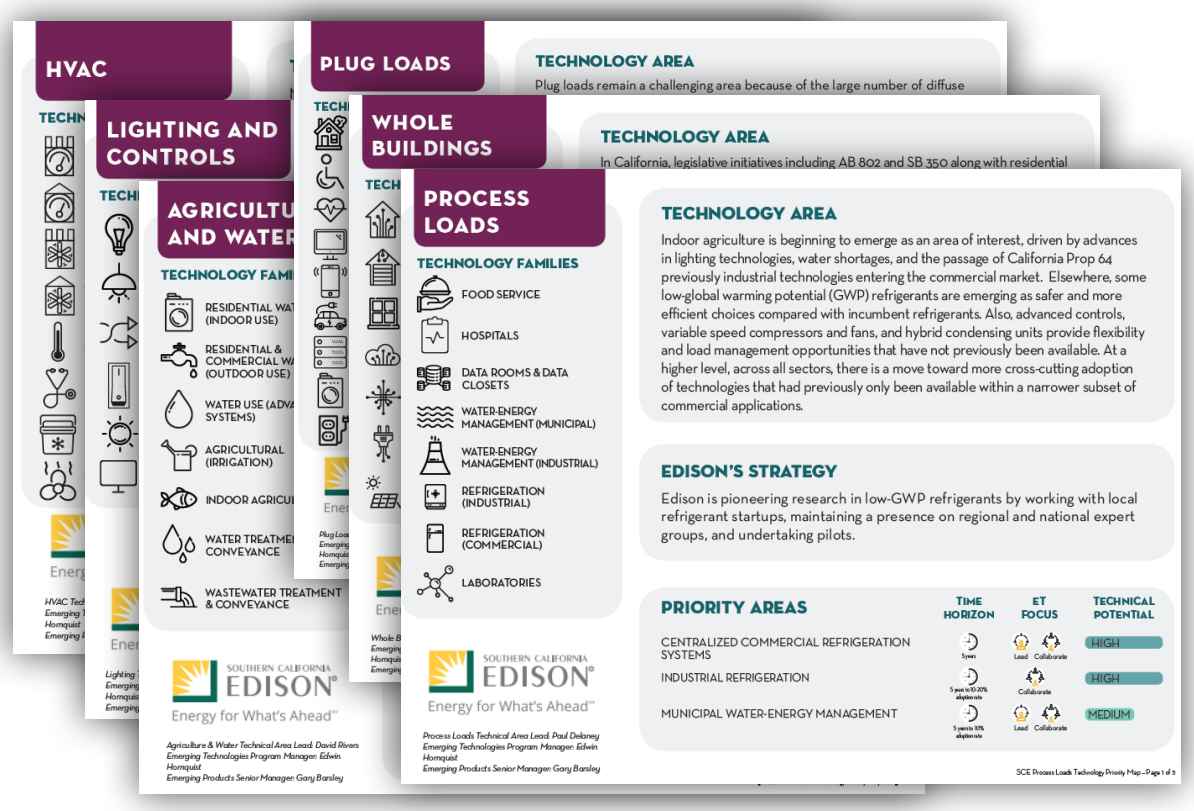




About the SCE Technology Priority Maps (TPM)

Need

- To create an outcome-based, long-term vision for Emerging Technology (ET) efforts at SCE



Goals

- Strategically guide SCE's ET research efforts in the most efficient manner over the next 8 years
- Align our ET focus with key SCE priorities such as GHG reduction
- Increase the effectiveness of SCE's development of new technologies into viable measures
- Optimize internal resources and identify opportunities for strategic partnerships

Development Process

SCE Emerging Products group developed a comprehensive vision for 6 technology areas:

- Lighting and Controls
- HVAC
- Water and Agriculture
- Process Loads
- Whole Buildings
- Plug Loads

- These were further broken down into 45 technology families and 200+ individual technology types or areas of focus

Development Process

For each of the 200+ technologies, the ET team outlined:

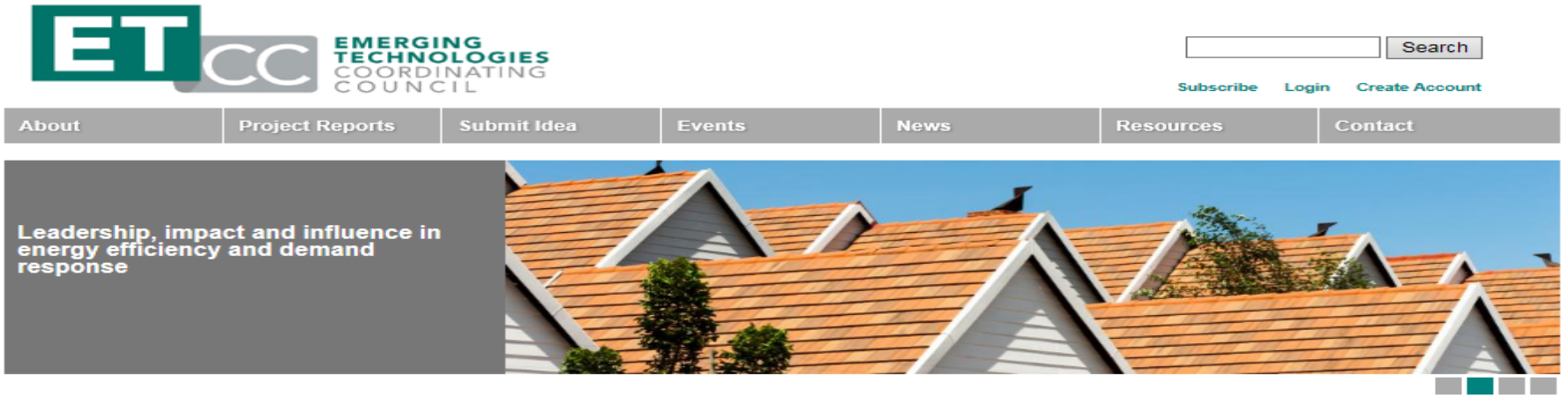
- Current state of the technology
- Desired end state and time to achieve end state
- Marketplace drivers
- Barriers to widespread adoption
- Technology milestones and specific ETP interventions to achieve those milestones
- Strategic SCE alignment
- Technical potential
- Collaboration strategy

Development Process

- Data and analysis went through a peer review process
- 16 industry leaders and subject matter experts
  - 8 peer reviewers from Edison, 8 external reviewers

ET Information Dissemination Efforts

Emerging Technologies Coordinating Council (ETCC) - WWW.ETCC-CA.COM



Sample EP Project – Energy Efficient Refrigeration Supporting GHG Reduction

Cold Storage Facility – South Gate

Key Electric Technologies/Features

- 6 Highly efficient Low Charge Ammonia System (GWP of <1)
  - ~15-20% more efficiency than baseline system
  - Replaces R-22 refrigerant system with GWP equivalent to 1810
- Facility also includes electric plugs for tractor trailer rigs to connect refrigeration units

Sample EP Project – Whole Building Demonstration

Low Income Multi Family ZNE New Construction in Pomona

Key Electric Technologies

- Ultra efficient Ductless mini split heat pumps
- All electric kitchens – Energy Star Appliances
- 34 KW PV array / space for up to 90 KW
- 30kW-60kWh Lithium Ion Battery

Sample EP Project – Building Electrification

Representative electric water heating products:

Typical New

Example: Rheem electric resistance storage water heater

High Efficiency

Example: AO Smith Vortex HPWH

Ultra-High Efficiency

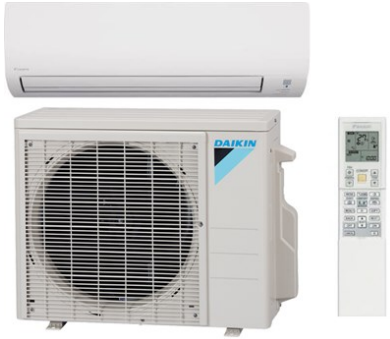
Example: Sanden residential (43 gal) CO_2 split HPWH

Representative electric space heating/cooling products:

Ultra-High Efficiency

Example: Carrier Infinity 20 ducted split heat pump

Residential ductless heat pump (mini- or multi-split)



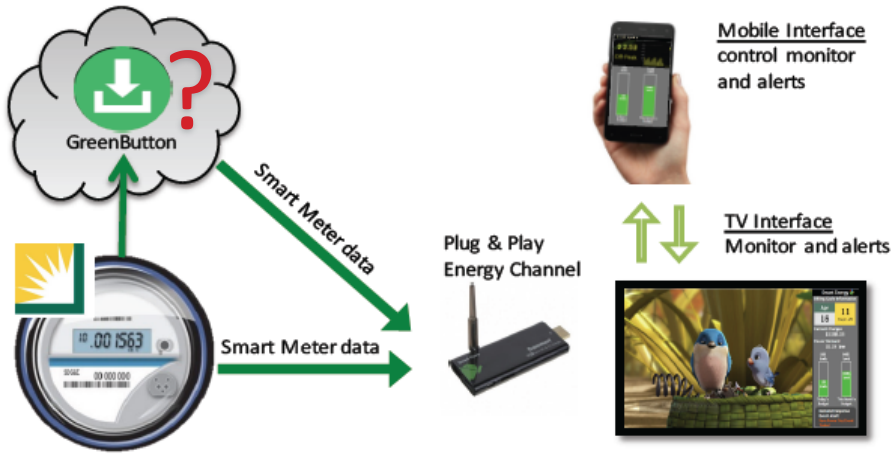
Example: Daikin ductless mini split – ideal for residential

Commercial ductless variable refrigerant flow (VRF) space conditioning

Example: LG VRF climates

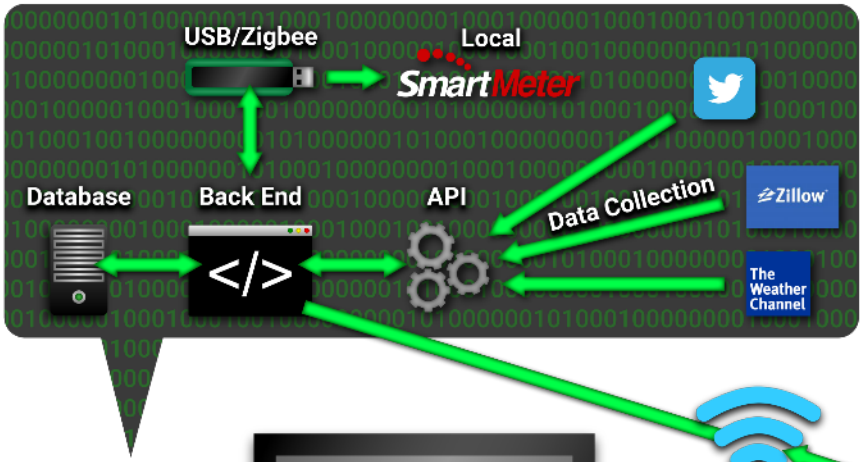
Sample EP project – Proof of Concept Lab Demo

- ET14SCE1180 – Energy Channel 2.0
  - One of 3 projects with the CalPlug Lab
    - Other projects include SIM Home and Strategic Roadmap of PlugLoads
  - Follow up to the Set-Top Box project
    - Further explore the additional opportunities of displaying real-time consumption data to the customer
  - Project Intended to:
    - 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

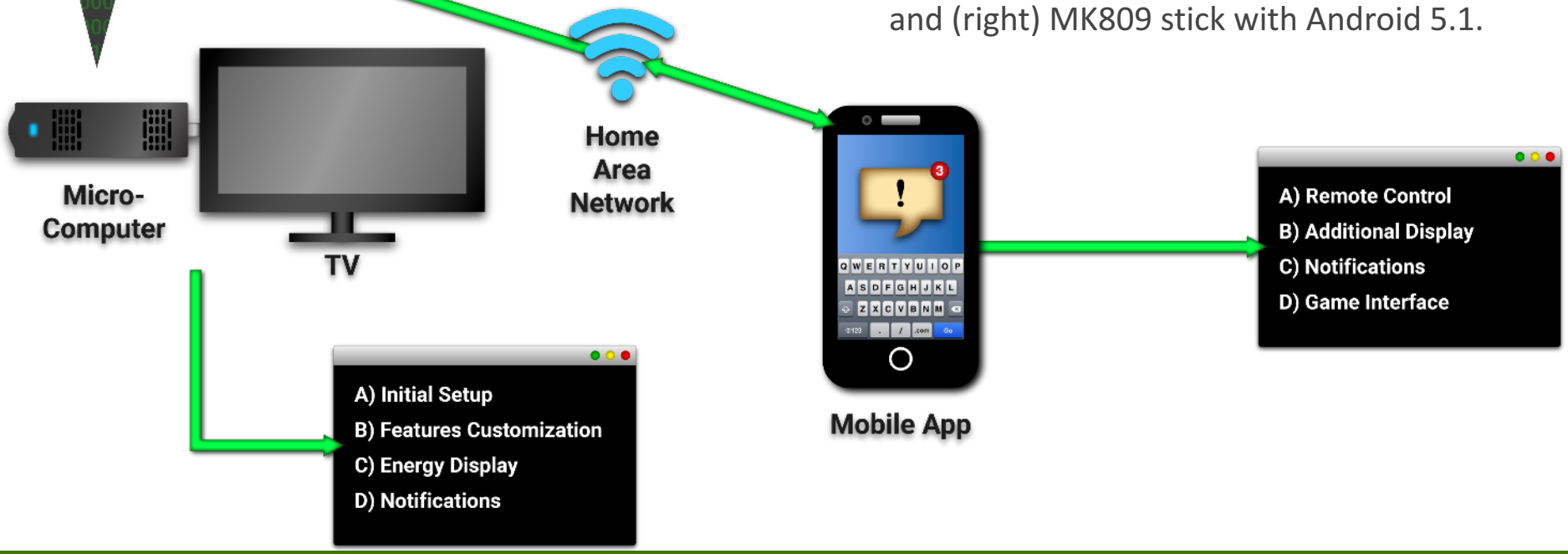


Energy Channel 2.0 Methods

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.



Thank you! Questions?

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