

Market Trends, Barriers and Solutions Related to Climate Appropriate Cooling

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WCEC Affiliates Forum, May 19 2015



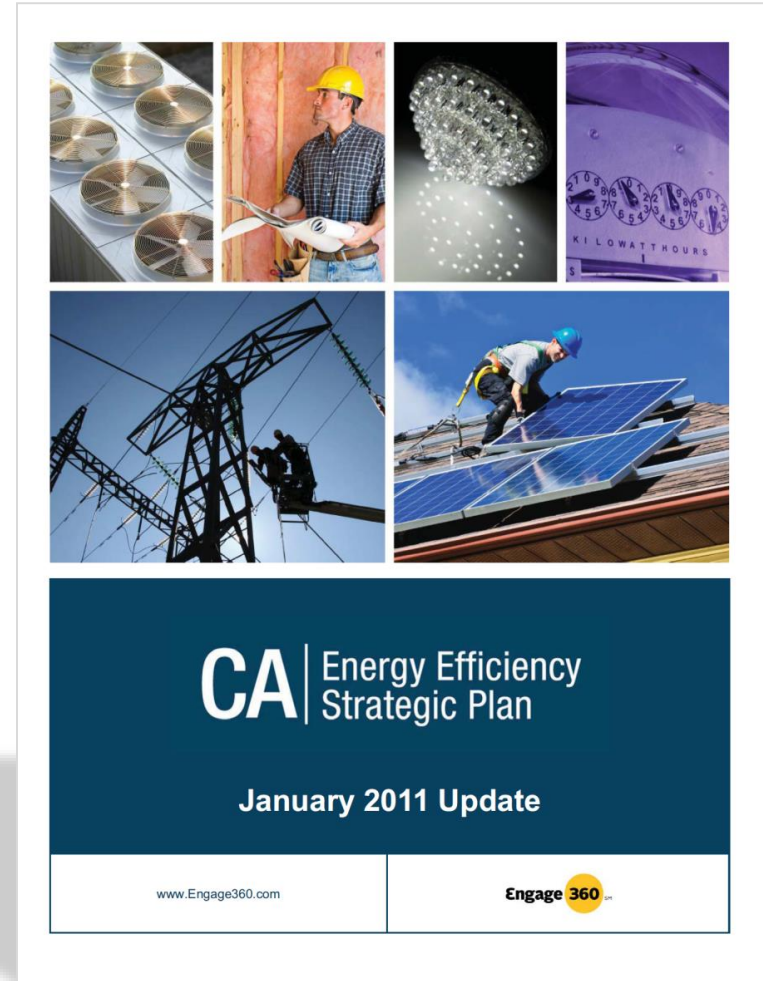
Introductions

- Dale Thompson
Engineer, Los Angeles Department of Water and Power
- Dr. Chun-cheng Piao
Vice President , Technology Alliances, Daikin US Corp
- David Hungerford
Senior Scientist, California Energy Commission
- Steve Slayzak
Vice President of Technology, Coolerado Corporation
- Dr. Nick DesChamps
Munters
- Paul Raftery, PhD.
Research Scientist, Center for the Built Environment, UC Berkeley

CPUC Big Bold Programmatic Initiatives

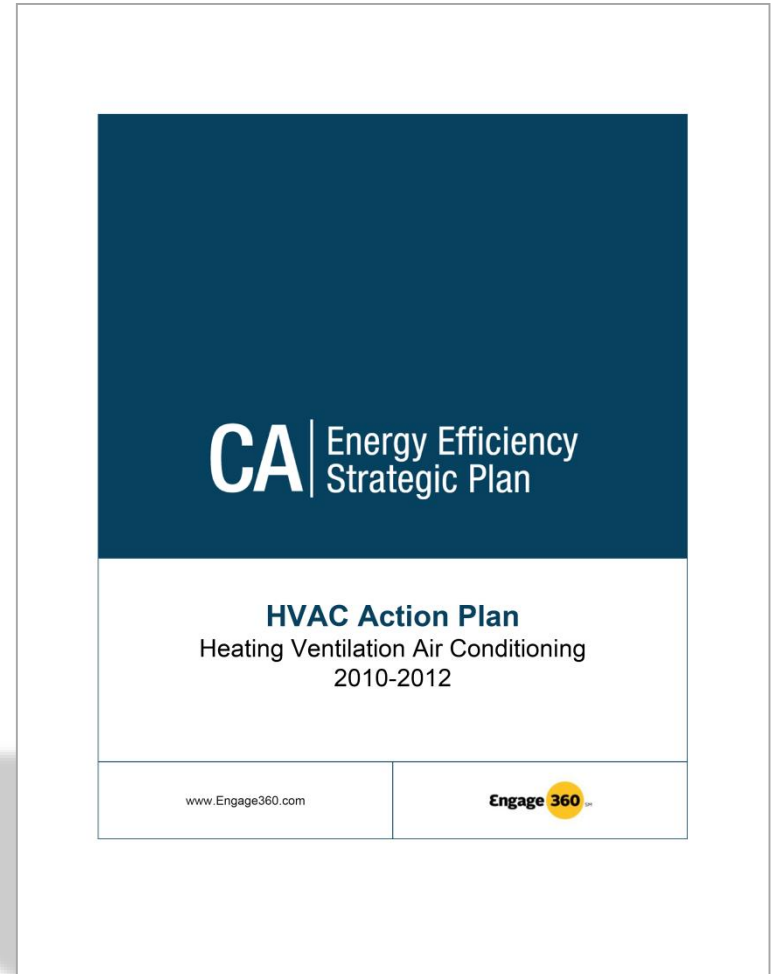
CA Energy Efficiency Strategic Plan

1. All new residential construction in California will be zero net energy by 2020;
2. All new commercial construction in California will be zero net energy by 2030;
3. *Heating, Ventilation and Air Conditioning (HVAC) will be transformed to ensure that its energy performance is optimal for California's climate; and*
4. All eligible low-income customers will be given the opportunity to participate in the low income energy efficiency program by 2020.



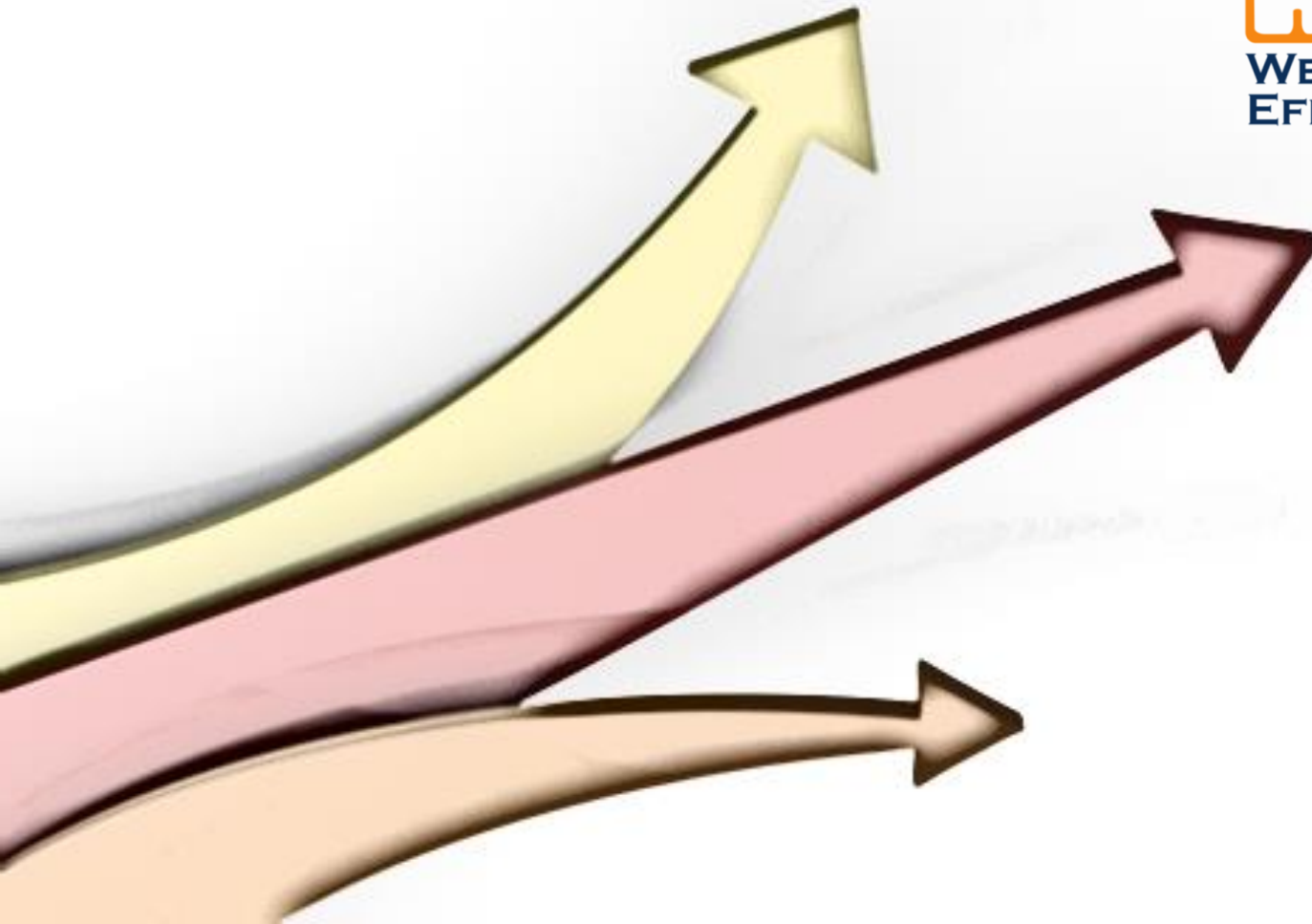
CA EE Strategic Plan: HVAC Action Plan

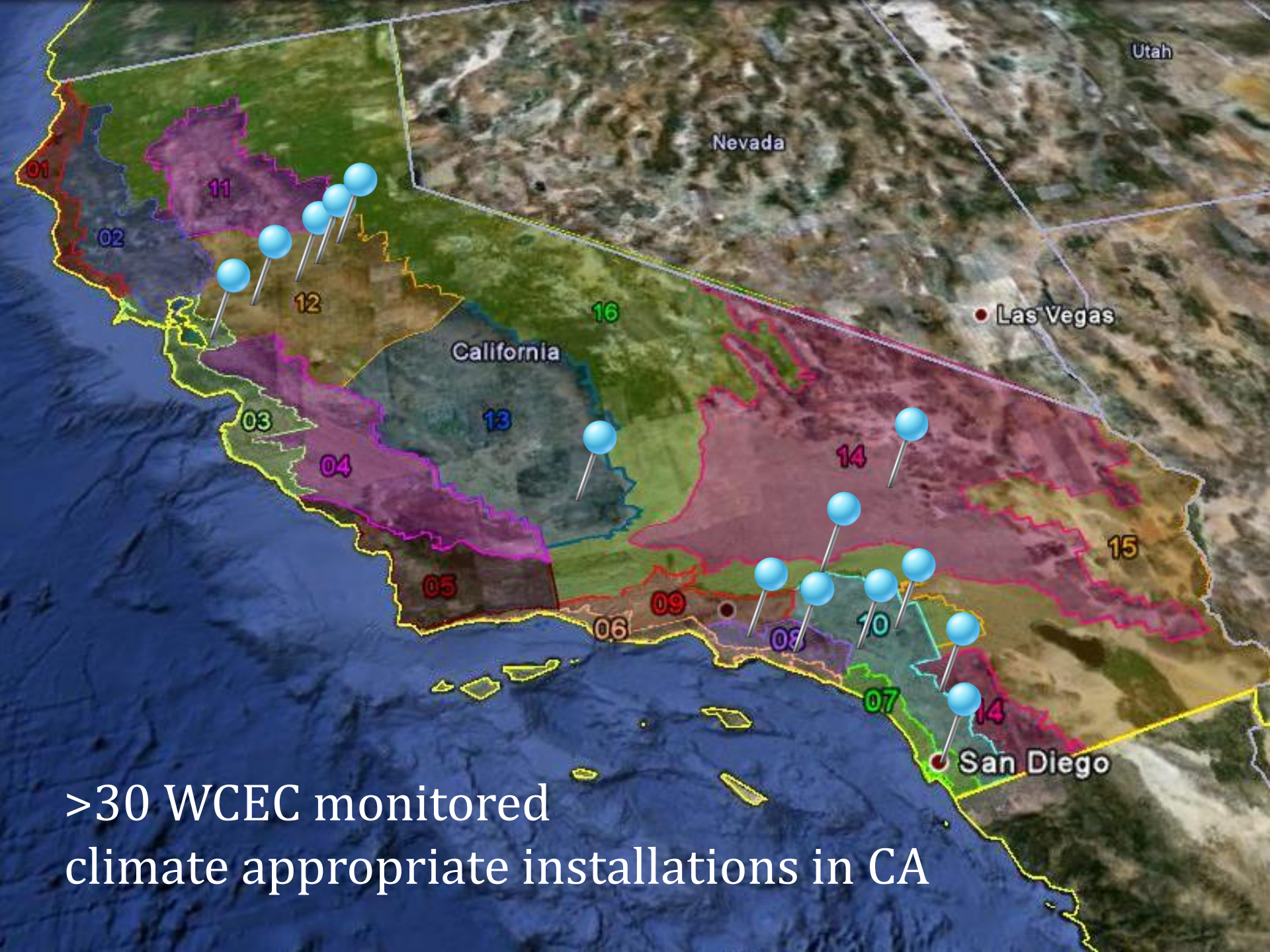
- Accelerate market penetration of “*climate appropriate*” HVAC
 - 15% penetration by 2015
 - 70% penetration by 2020
- Priorities for 2013-2020
 - Advocate “climate optimized” commercial standards
 - Establish pathways for more efficient HVAC equipment; including:
 - VRF equipment
 - Hybrid evaporative
 - “...these products should be strongly supported in reach and green codes, utility programs, and government purchasing programs.”



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>30 WCEC monitored
climate appropriate installations in CA

Recently Published Technical Reports

- **Munters EPX 5000 at Whole Foods in San Ramon**
Climate Appropriate Cooling for a Grocery Store: Hybrid Unitary DOAS System in San Ramon
- **Munters EPX 5000 Laboratory Test**
Western Cooling Challenge Laboratory Performance Results: Munters EPX 5000 Hybrid DOAS
- **Climate Wizard + Conden-So-Cool Lab Test**
Laboratory Performance Results: Indirect Evaporative Air Conditioning & Condenser Pre-Cooling as Climate Appropriate Retrofits for Packaged Rooftop Units
- **Trane Voyager DualCool at Ontario Mills & Marie Callender's Ontario**
Performance Evaluation for Hybrid Rooftop Air Conditioners with Dual Evap. Pre-Cooling
- **Development of Prototype 'Hybrid Black Box Model' for EnergyPlus**
Title 24 Credit for Efficient Evaporative Cooling
- **DualCool Retrofits at Target in Palmdale**
Performance Evaluation for Dual-Evaporative Pre-Cooling Retrofit in Palmdale, CA
- **Coolerado & Climate Wizard at Walmart**
Side-by-Side Evaluation of Two Indirect Evaporative Air Conditioners Added to Existing Packaged RTU
- **EvaporCool at Cox Communications in Rancho Santa Margarita**
Field Evaluation of an Evaporative Condenser Air Pre-Cooler Added to a Packaged RTU for a Data Center
- **Market Barriers and Solutions for Climate Appropriate HVAC**
Market Barriers to Widespread Diffusion of Climate-Appropriate HVAC Retrofit Technologies
- **Daikin Rebel at Harley Davidson of Sacramento**
Field Evaluation of Daikin Rebel Advanced HP - RTU
- **Laboratory Testing of Dew Point Fluid Coolers**
Sub Wet-Bulb Evaporative Chiller (Nexajoule)
Sub Wet-Bulb Evaporative Chiller (Tsingua)
(in progress)
- **Laboratory Testing of Evaporative Condenser Air Pre-Coolers**
Evaporative Condenser Air Pre-Coolers
- **Laboratory testing of Climate Appropriate advantages for variable speed fan and compressor retrofits for RTUs**
Laboratory Testing of Variable Speed Compressor and Fan Controls for RTU Optimization

Climate Appropriate HVAC delivers major energy savings

- Laboratory test for **Munters EPX 5000 DOAS** indicates **20% savings** for whole building HVAC peak demand. Field evaluation confirms major savings.
- Side-by-Side field evaluation of **Climate Wizard & Coolerado** achieves **EER=40+ at peak, EER=80+ at part load**
- Field evaluations for **DualCool** as new installation and retrofit show **40% energy savings at peak**, consistent with laboratory testing.
- **Indirect evaporative cooling** for small data centers measures **40-70% daily kWh savings**
- Laboratory test of **Climate Wizard + RTU** shows **65% savings** for annual cooling energy consumption **85% savings at part load**
- **Condenser pre-cooling** can **reduce peak demand by as much as 27%**, and deployed in conjunction with variable speed fan and compressor operation promises **38% savings**.

*So how will we accelerate
broader adoption?*

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| TECHNOLOGY TOPICS |
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SIDE MANAGEMENT |
E V A P O R A T I V E
TECHNOLOGIES |
RADIANT COOLING |
MULTI-TENNANT LIGHT
COMMERCIAL |

Lunch and Research Poster Sessions

- Tracer Gas Airflow Measurement System - *Caton Mande*
- Rainwater for Evap. Systems - *Nasim Tajmand*
- Aerosol Sealing of Building Envelopes - *Curtis Harrington*
- Sub Wet-bulb Chillers - *Jose Garcia*
- Phase-Change Materials - *Kris Karas*
- RTU Retrofits - *Theresa Pistoichini & Robert McMurry*
- Honda Smart Home - *Jonathan Woolley*



Honda Smart Home

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Water use for evaporative cooling

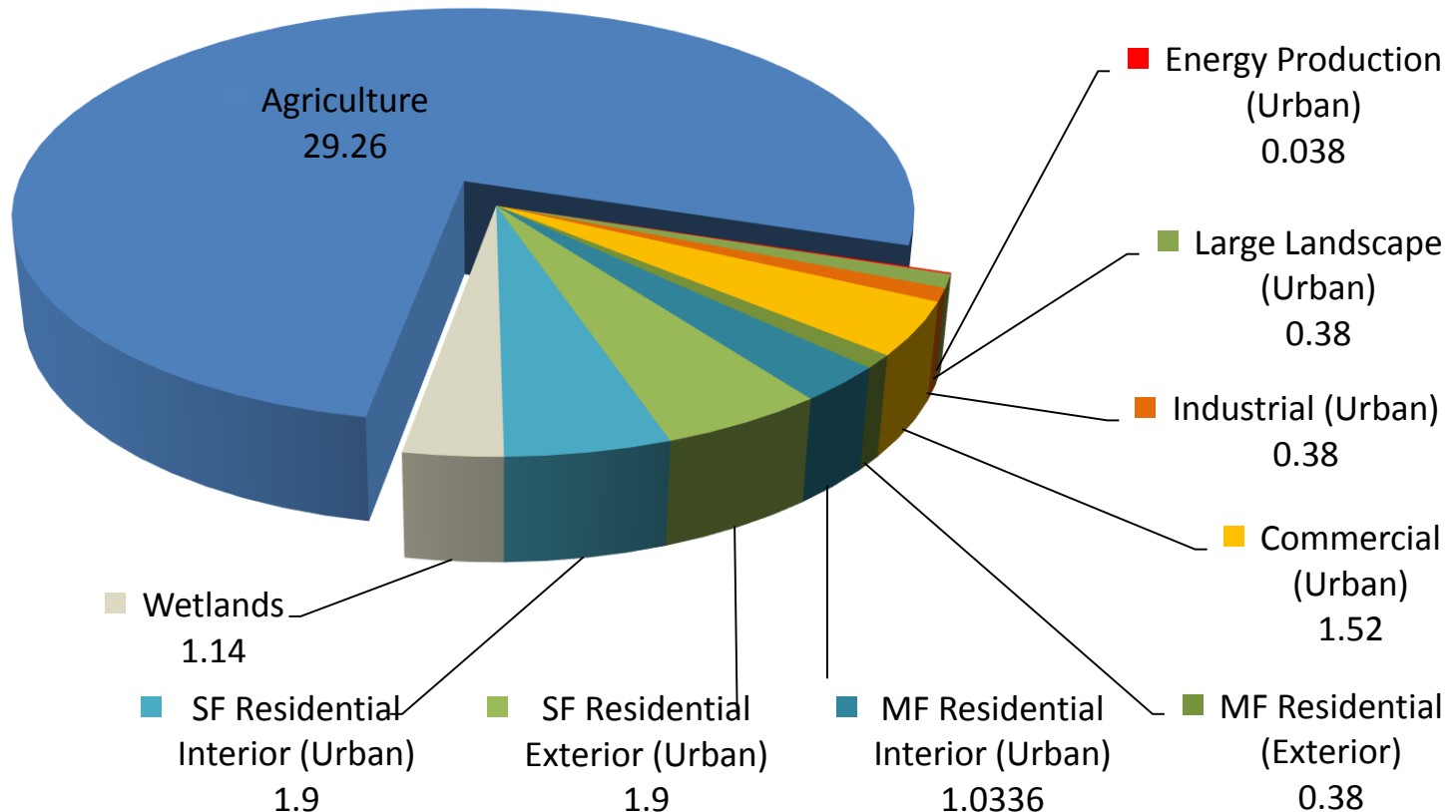
- Technical efforts should continue to improve water use efficiency for evaporative solutions; however:
- Onsite consumption partially offset by water savings for reduced generation:
 - Recent evaluations of various technologies show water use of 5-10 gal/kWh savings
 - California average water use for electricity generation is ~1.4 gal/kWh
 - Thermal generation estimated at <1 gal/kWh
 - Hydro electric generation estimated >10 gal/kWh
 - Water use intensity for generation varies widely by region
- Estimate of water costs amount to 1-10% of the value of energy savings (not counting demand charges), depending on region, technology, and application.

Water use for evaporative cooling

- If all commercial buildings in California used indirect evaporative cooling
 - Annual electricity savings = 4,000 GWh
 - GHG emissions reduced = 2.77 MTonCO₂e
 - Equivalent to 600,000 automobiles
 - Annual water use = 0.11 Million Acre Feet
 - 0.3% of all (non environmental) applied water use in California
 - Equivalent to 3% of all urban landscape uses



Applied Water Uses in California (non environmental) *Million Acre Feet*



Opportunities for Alternate Water Sources

- Rainwater capture and storage or onsite greywater reuse
- Desalination
 - Desalination produces 70-100 gallons per kWh consumed
 - Climate appropriate solutions consume 2-6 gallons/ kWh saved
 - Desalination could have a load leveling effect, by operating at night and using water to reduce peak demand in the day



New Report on Market Barriers for Climate Appropriate HVAC Technologies

- Explores the motivations, needs, and constraints of a range of market actors
- Identifies market barriers and other factors impeding adoption and promotion of downstream climate-appropriate HVAC retrofit technologies
- Identifies opportunities to address, reduce, eliminate or circumvent market barriers in order to increase adoption.

