

# High Performance Homes: Savings Potential, Cost Effectiveness and Policy Options

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Presentation at the Fourth Annual  
SWEEP Regional Energy Efficiency Workshop

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# Overview

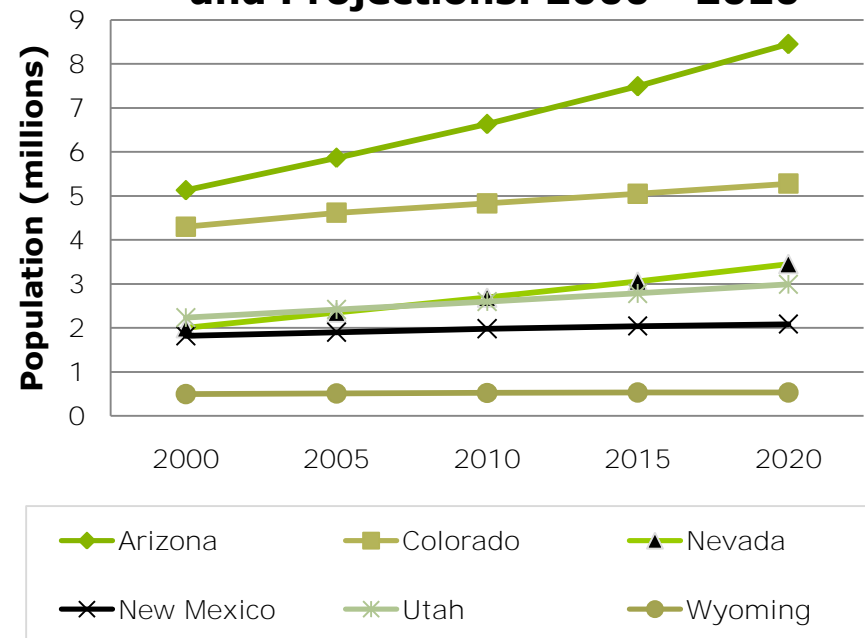
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- ❑ Background: New Homes in the Southwest
- ❑ Purpose and Scope of SWEEP study
- ❑ Results and key findings
- ❑ Policy Recommendations for Utilities, States and Local Governments
- ❑ Issues for Discussion

# Background: New Homes in the Southwest

- The six-state Southwest region is experiencing rapid growth
  - 150,000 new single-family homes per year
  - ~2 million new homes expected to be built between 2008-2020
  - Growth rates triple national average in parts of Arizona and Nevada
- Electricity demand rising at 4% per year; peak demand increasing even faster

**Southwest Population Estimates and Projections: 2000 - 2020**



Source  
U.S. Census Population Estimates and Projections, 2004-2030

# New Homes are Going Green

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- Growing market for energy efficient homes
  - Homebuyers are motivated by energy, cost savings opportunities:
    - EE is #1 priority for green homebuyers (NAHB 10/07)
    - About 50% of buyers willing to pay more for green homes
      - Shelton Group (2006): WTP up to \$2,500 premium for EE features
  
- Homebuilders see high-performance as market opportunity
  - Homes sell faster, higher customer satisfaction
  - **Fewer warranty, 'call-back' issues**
  - Better sales in market downturns; differentiates communities/homes
  
- State, local governments are raising the bar
  - Climate change plans with GHG goals: Arizona, New Mexico, Utah, Colorado
  - Austin, TX adopts zero energy homes building energy code & targets
  - Albuquerque, NM adopts mandatory Green Building Ordinance
  - Boulder, CO updating Green Points program
  - California PUC adopts goal of 100% Net-Zero Energy Homes by 2020

<sup>1</sup> McGraw-Hill Construction. 2007 Market Research Study: The Preferences of Green Home Buyers

<http://www.construction.com/AboutUs/2007/GreenHomescustomersurveyApril2007.pdf>

2. Shelton Group, 2006. <http://www.nbnnews.com/NBN/issues/2007-04-09/Front+Page/index.html>

and Oct. 2007: <http://www.energypulse.org/PDFs/EP07-GreenHomes.pdf>

# Can it be done?

# ...YES!

- ❑ ENERGY STAR Homes & Communities (up to 30% savings)
  - Las Vegas, Nevada (70% market share)
  - Daybreak, Utah (Kennecott Land)
  - Stapleton at Denver (Forest City Enterprises)
  
- ❑ Best Practice Homes (30 – 40% savings)
  - Artistic Homes, Albuquerque, NM
  - Aspen Homes and McStain Neighborhoods, CO
  - Ence Homes, UT
  - Guaranteed Performance / Tax Credit Homes, Tucson Electric Power
  
- ❑ Zero Energy Homes (50 – 60% savings)
  - Clarum, Premier, and Lennar (Sacramento and SF Bay Area, CA)
  - Shea Homes, San Diego, CA
  - Harvard Communities, Stapleton at Denver
  - Oshara Village, Santa Fe, NM
  - John Wesley Miller Homes, Tucson, AZ
  - Aaron Needham Homes, UT
  
- ❑ Eliminates 50-70% of summer peak load



McStain Neighborhoods, CO (McStain)



Premier Homes, Sacramento, CA (SMUD)

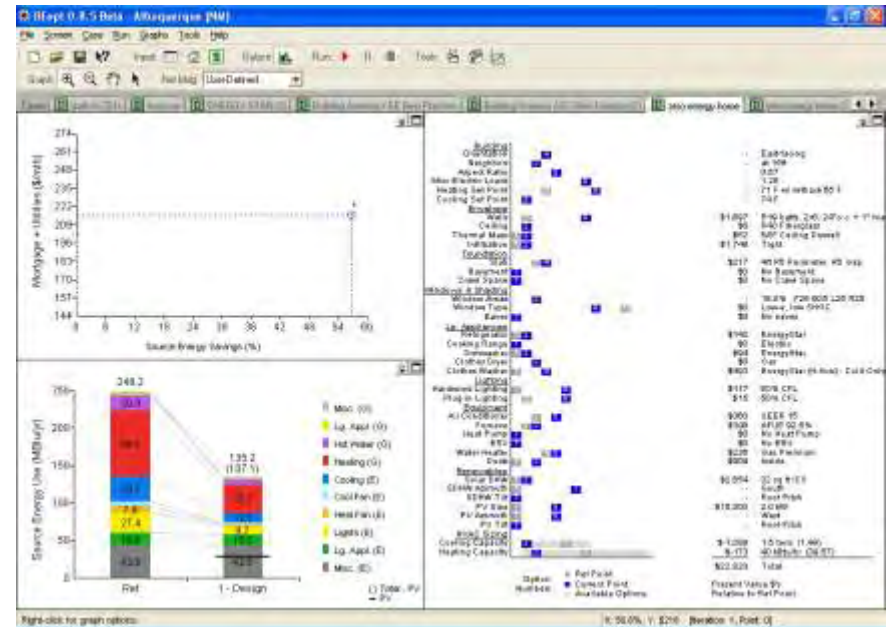
# Purpose and scope of SWEEP study

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- Analyze the savings potential and cost effectiveness of high performance homes in the Southwest
  - Arizona, Colorado, Nevada, New Mexico, Utah
- Identify strategies for overcoming market, institutional and technical barriers
- Recommend policy options and programs for utilities, states and local governments

# NREL BEopt Model

- BEopt is designed to
  - Find optimal building designs along the path to net zero energy homes, and
  - Facilitate analysis of the incremental cost and tradeoffs of high-performance building designs.
  - Includes hourly energy simulation data, EE/RE measures, and cost libraries



# Scenarios Analyzed

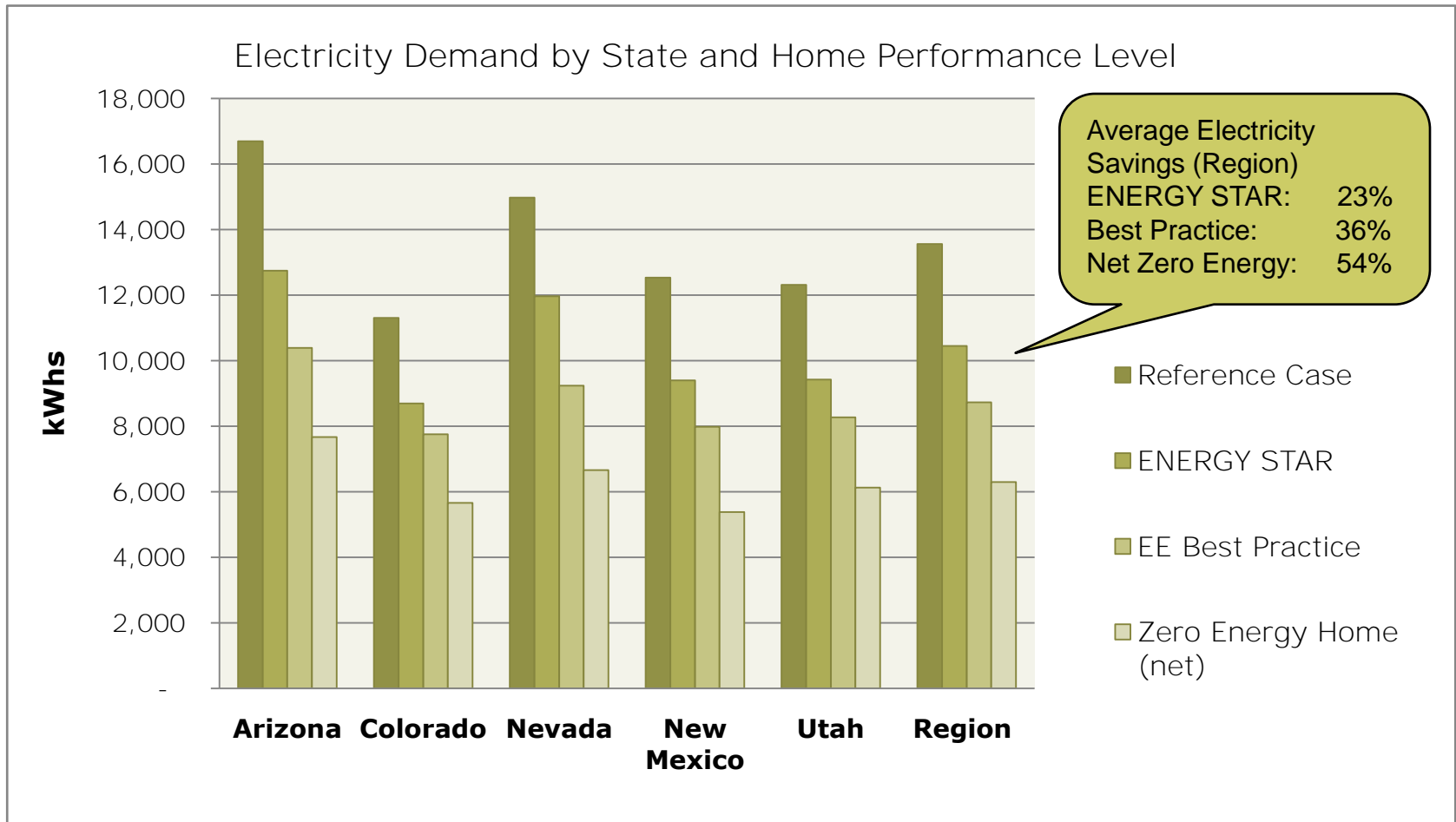
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- Reference case
  - New homes built to current state/local code (IECC 2003 or IECC 2006)
  - ENERGY STAR market penetration levels (by state) at current levels
- High efficiency scenario:
  - By 2020, within each state
    - 50% ENERGY STAR Homes
    - 20% Best Practice Homes
    - 20% Net Zero-Energy Homes
    - 10% Code-built Homes

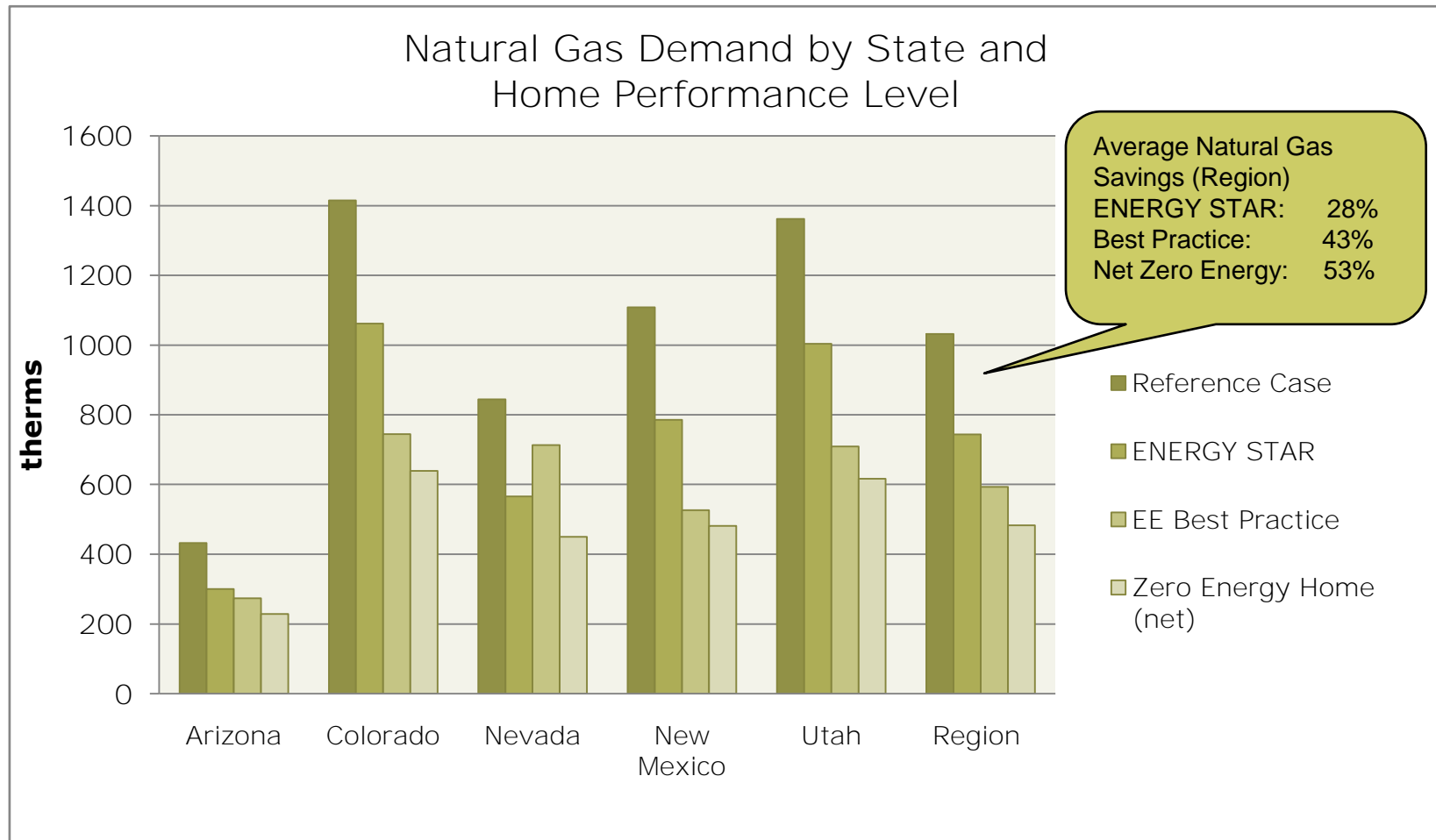
# Home Performance Levels and Features

Category	Reference Case	ENERGY STAR	Best Practice	Net Zero-Energy Home
Infiltration	Typical	Tight	Tight	Same as BP
Insulation	IECC 2006	IECC 2006	R19 w/1" foam, 2x6 studs; R50 ceiling (cold); 5/8" drywall; 4ft R-10 ext. (cold)	Same as BP
HVAC	SEER 13 – 5 tons / 80% AFUE furnace – 120 kBtu	SEER 14 – 4 tons / 80% AFUE furnace – 80 kBtu	SEER 15 – 2.5 tons / 92.5% AFUE – 60 kBtu	Same as BP
Ducts	Typical	Improved	Inside Conditioned Space	Same as BP
Windows	Low-e, high SHGC	Low-e, std-SHGC	Low-e, low-SHGC	Same as BP
Appliances	Standard	ENERGY STAR DW, RF, CW	ENERGY STAR DW, RF, CW	Same as BP
Lighting	10% CFLs	30% CFLs	50% CFLs	Same as BP
Water heating	Standard gas	Standard gas	Gas tankless	Gas premium or Gas tankless
Renewable energy	--	--	--	<ul style="list-style-type: none"> <li>• 2 kW PV</li> <li>• Solar thermal hot-water</li> </ul>

# Electricity Savings by Home Performance Level



# Natural Gas Savings by Home Performance Level

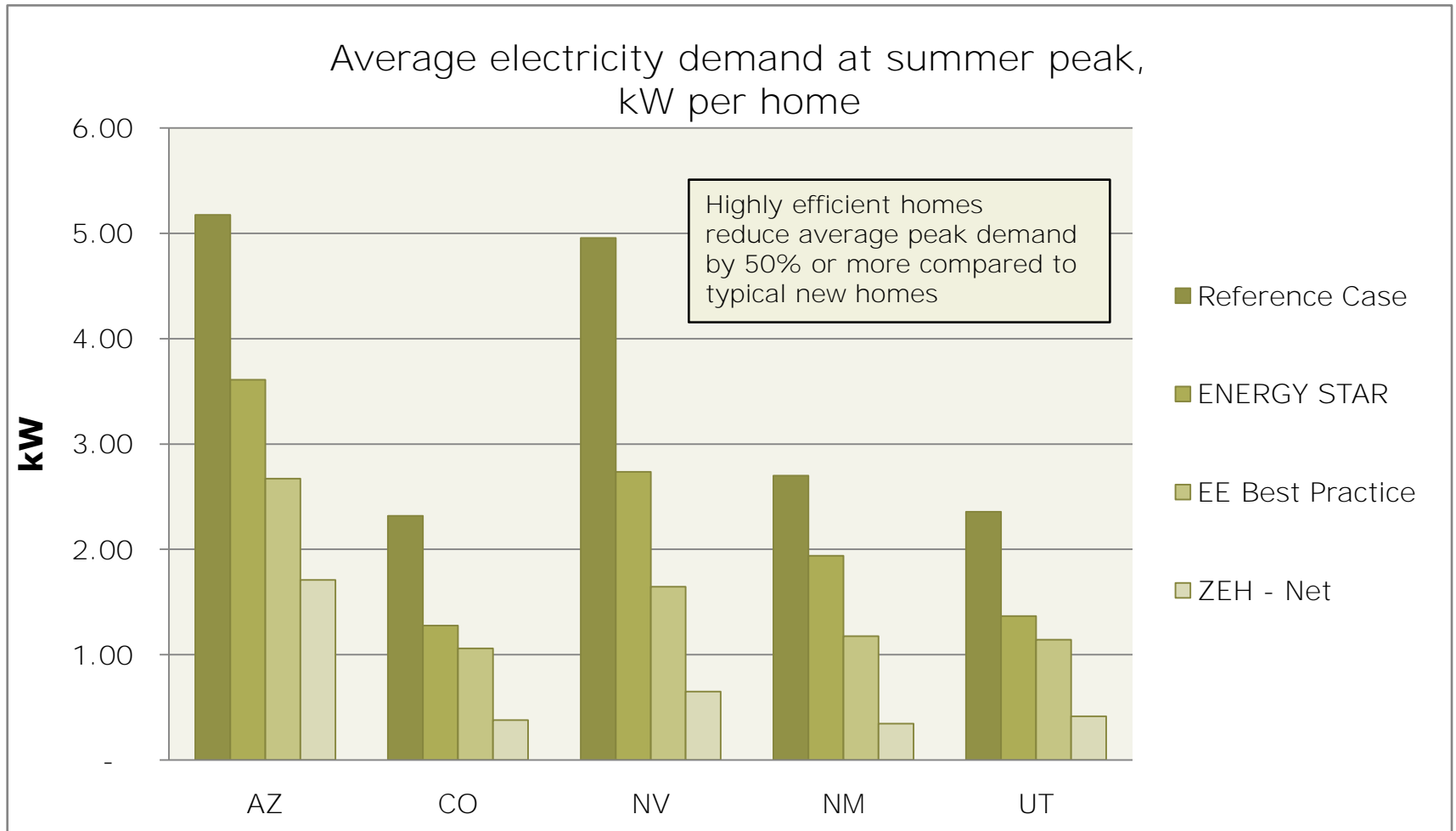


# Peak electricity demand savings

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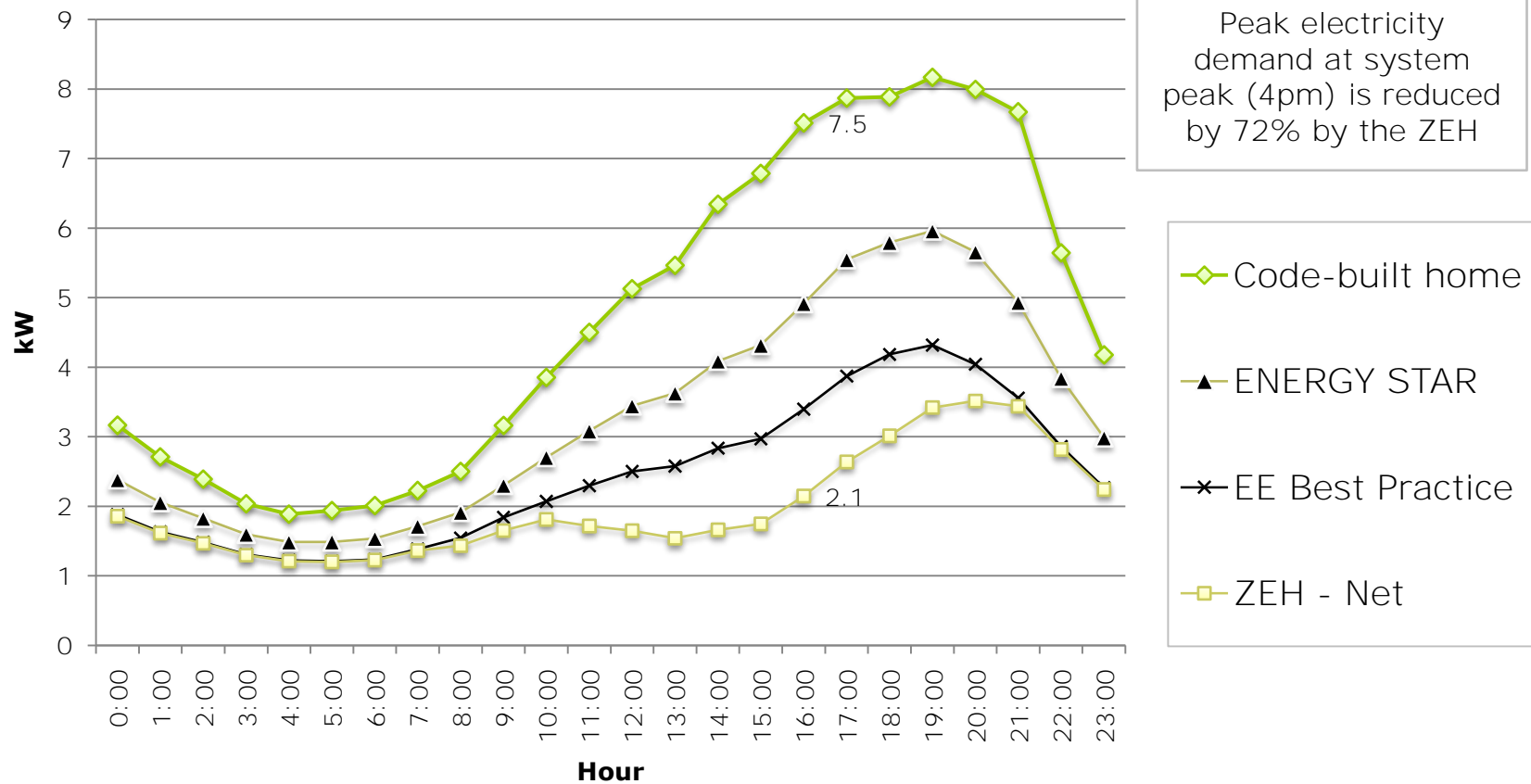
- Best practice and zero energy homes achieve significant reductions in peak load
  - Best Practice: 50 – 67% reduction in average hourly summertime peak load
  - Net-ZEH: 60-80% peak savings
- Example: Premier Gardens, Sacramento
  - SMUD utility partnership with home builders, PV industry
    - Highly efficient homes with 2 kW PV system
    - 60% reduction in electricity costs and up to 65% reduction in peak electricity demand

# Peak Electric Demand



# Peak Electric Demand: Phoenix

Simulated hourly electricity demand: code-built home versus high performance home, Phoenix, AZ  
July 10, 2001



# Cost Effectiveness

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- Each level cost-effective
  - Average annual energy bill savings: \$700 - \$1,500
  - Incremental cost
    - ENERGY STAR: 1% (~ \$2,500 - 3,600)
      - Includes full ENERGY STAR appliance package
    - Best Practice: 2-3% (~ \$3,500 - \$6,500)
    - ZEH, no incentives: 8 - 10% (~ \$21k - \$26k)
    - ZEH with fed, utility incentives: 4-6%
  - ~\$1,100 annual net savings (mortgage + utilities) in Best Practice scenario
  - Higher material costs offset by design changes
    - Downsize HVAC systems
    - Reduce amount of lumber via 2x6 framing

# Energy Savings

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State	Annual Savings, 2020		Cumulative electricity savings (GWh)	Avoided Peak Demand (MW)	Cumulative Natural gas savings (million therms)
	Electric (GWhs)	Natural Gas (million therms)			
Arizona	183	5.4	1,159	592	34
Colorado	94	16.4	606	293	106
Nevada	69	2.1	425	309	13
New Mexico	25	3.0	166	68	20
Utah	56	8.7	354	153	55
<b>Region</b>	<b>427</b>	<b>35.5</b>	<b>2,710</b>	<b>1,416</b>	<b>228</b>

# Cumulative Net Economic Benefits 2008 – 2020

**Millions of 2008 \$, lifetime savings**

State	Energy Efficiency Measures Only			Energy Efficiency and Renewable Energy Measures		
	Total investment	Net economic benefits	Benefit – cost ratio	Total investment	Net economic benefits	Benefit – cost ratio
Arizona	401	1,296	3.2	1,034	1,455	1.4
Colorado	443	1,409	3.2	974	1,493	1.5
Nevada	279	583	3.1	905	699	1.2
New Mexico	94	338	3.6	191	366	1.9
Utah	229	757	3.3	538	802	1.5
<b>Region</b>	<b>\$1,446</b>	<b>\$4,383</b>	<b>3.3</b>	<b>3,642</b>	<b>4,815</b>	<b>1.5</b>

# Environmental Benefits

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- Emissions of greenhouse gases and air pollutants
  - CO<sub>2</sub> reduced by 2.4 million tons between 2008 and 2020
  - SO<sub>2</sub> and NO<sub>x</sub> emissions reduced by 410 tons and 985 tons, respectively.
- Electricity from PV
  - >500 GWhs of electricity generated by renewables (2 kW solar PV)
  - Supplies 25-30% of electricity for a ZEH

# Findings

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- ❑ High performance homes deliver energy, economic and environmental benefits
  - Reduce electricity, peak demand by 50% or more
  - Achieve net savings for homebuyers
  - Cost-effective in all SW states
- ❑ Consumers are interested in buying highly efficient homes
  - EE features becoming a selling point, but must be credible, and demonstrate cost-effectiveness to homebuyers
  - Many lack awareness of home energy performance and features
- ❑ Market, technical and financial barriers pose challenges for builders
  - Utility, state and local programs and incentives play an important role in overcoming these barriers

# Recommendations for Utilities

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- ❑ Offer a 3-tiered incentives package to builders
  - ENERGY STAR: \$350 - \$500
    - Where market share is < 50%
  - Best Practice: \$750 - \$1,000
  - Net Zero-Energy
    - ❑ EE: \$750 - \$1,000 and RE: \$4,000 - \$8,000
- ❑ Coordinate EE and RE incentive programs
  - Efficiency first, then solar
- ❑ Educate, train building / real estate industry about high performance home features
- ❑ Measure, document performance and savings
- ❑ Develop programs to reduce plug loads through rebates, education and behavior programs

# Recommendations for States

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- ❑ **Adopt 'foundation' policies that promote EE and RE**
  - e.g., update building codes; statewide EE goal, RPS w/ net metering
- ❑ Develop a new homes program that provides technical assistance, training, and education on high performance home design & construction practices
- ❑ Provide tax credits and incentives for highly efficient homes
  - Income tax credits
  - Property tax exemptions
  - PV buydowns
- ❑ Partner with utilities and builders to quantify and publicize the benefits of high performance homes
- ❑ Provide high-level recognition to communities and builders

# Recommendations for Local Governments

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- ❑ Develop a green building program with minimum EE requirements
- ❑ Provide incentives to builders
  - e.g., per home incentives, density bonuses, permit fee waivers, prioritized plan checks, inspections
- ❑ Educate, train new homes industry, trades
- ❑ Provide recognition to high-performing builders
  - Mayoral events, local newspaper ads, promotional materials

# Implementation Issues

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- Utility programs
  - Builder training, marketing support and design support
  - Incentive tiers for beyond-code performance
  - Monitoring and evaluation
- **Supporting technology & design 'leapfrog' opportunities**
  - Thermal envelope and HVAC – solar heating/cooling?
  - Advanced lighting systems and controls
  - Plug loads and homeowner behavioral responses
  - Other opportunities?
- Potential Next steps
  - Regional workshop on zero energy homes
  - State/Local government technical assistance, outreach
  - Tech. assistance to builders and code officials
  - Educate realtors and appraisers

# **SWEEP:**

*Dedicated to More Efficient Energy Use in the Southwest*

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Report available online at:

[www.swenergy.org/hph/](http://www.swenergy.org/hph/)

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Southwest Energy Efficiency Project (SWEEP)

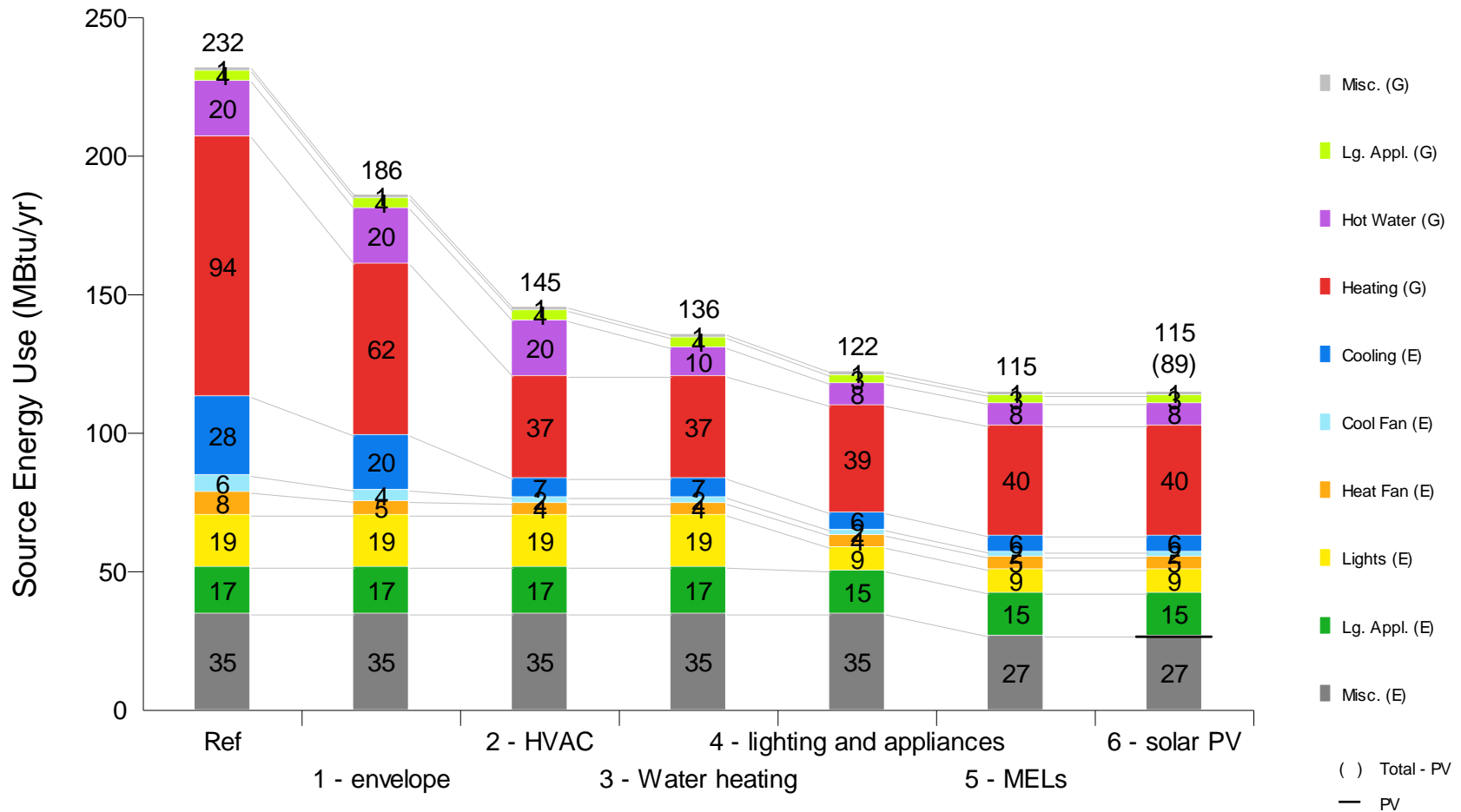
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# Extra Slides

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# Path to Net-Zero Energy



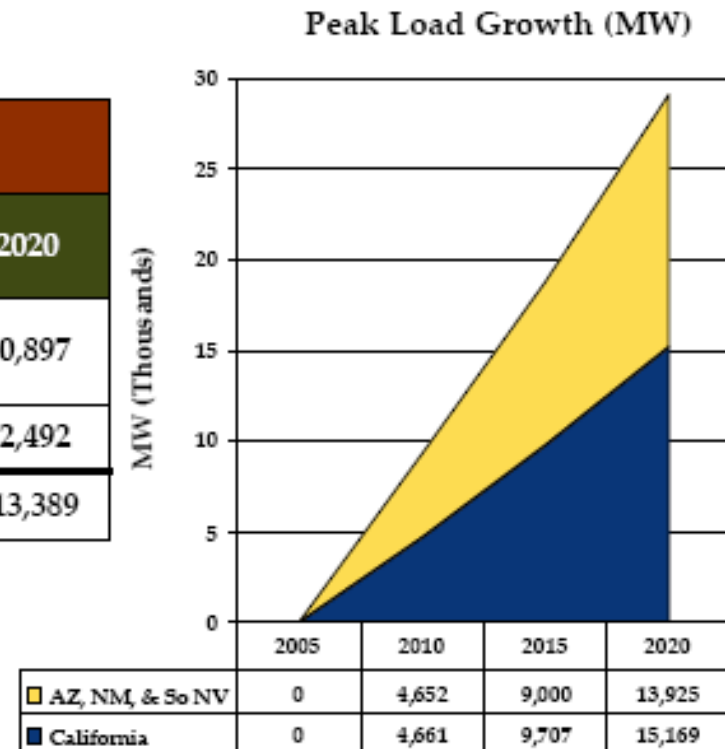
# Incremental costs and net savings

State	Incremental cost			Net savings, annual (\$) **		
	ENERGY STAR	Best Practice	Zero Energy Home*	ENERGY STAR	Best Practice	Zero Energy Home
Arizona (Phoenix)	\$3,218	\$3,474	\$15,210	\$552	\$946	\$767
Colorado (Denver)	\$2,917	\$6,588	\$19,895	\$432	\$616	\$271
Nevada (Las Vegas)	\$3,236	\$5,547	\$16,231	\$550	\$961	\$960
Nevada (Reno)	\$3,653	\$5,640	\$18,491	\$139	\$262	\$97
New Mexico (Albuquerque)	\$2,464	\$5,539	\$16,629	\$763	\$884	\$834
Utah (Salt Lake City)	\$2,946	\$6,588	\$19,331	\$434	\$636	\$247

# Peak Load Growth Growing 2,000 MW per year

NERC Sub-Region	Expected Peak Load (MW) 2005-2020			
	2005	2010	2015	2020
AZ, NM, South NV	26,972	31,624	35,972	40,897
CA	57,324	61,985	67,031	72,492
<b>Total</b>	<b>84,296</b>	<b>93,609</b>	<b>103,003</b>	<b>113,389</b>

Peak growth in the desert southwest is forecasted to be nearly the same as CA.



Source: WECC, CA Energy Commission, NCI Analysis

Figure 8. Peak Load Growth in the Southwest