California Energy Commission

Modeling Efficiency in the Energy Commission Demand Forecast: Summary of Current Methods

Workshop for the Integrated Energy Policy Report

August 12, 2008

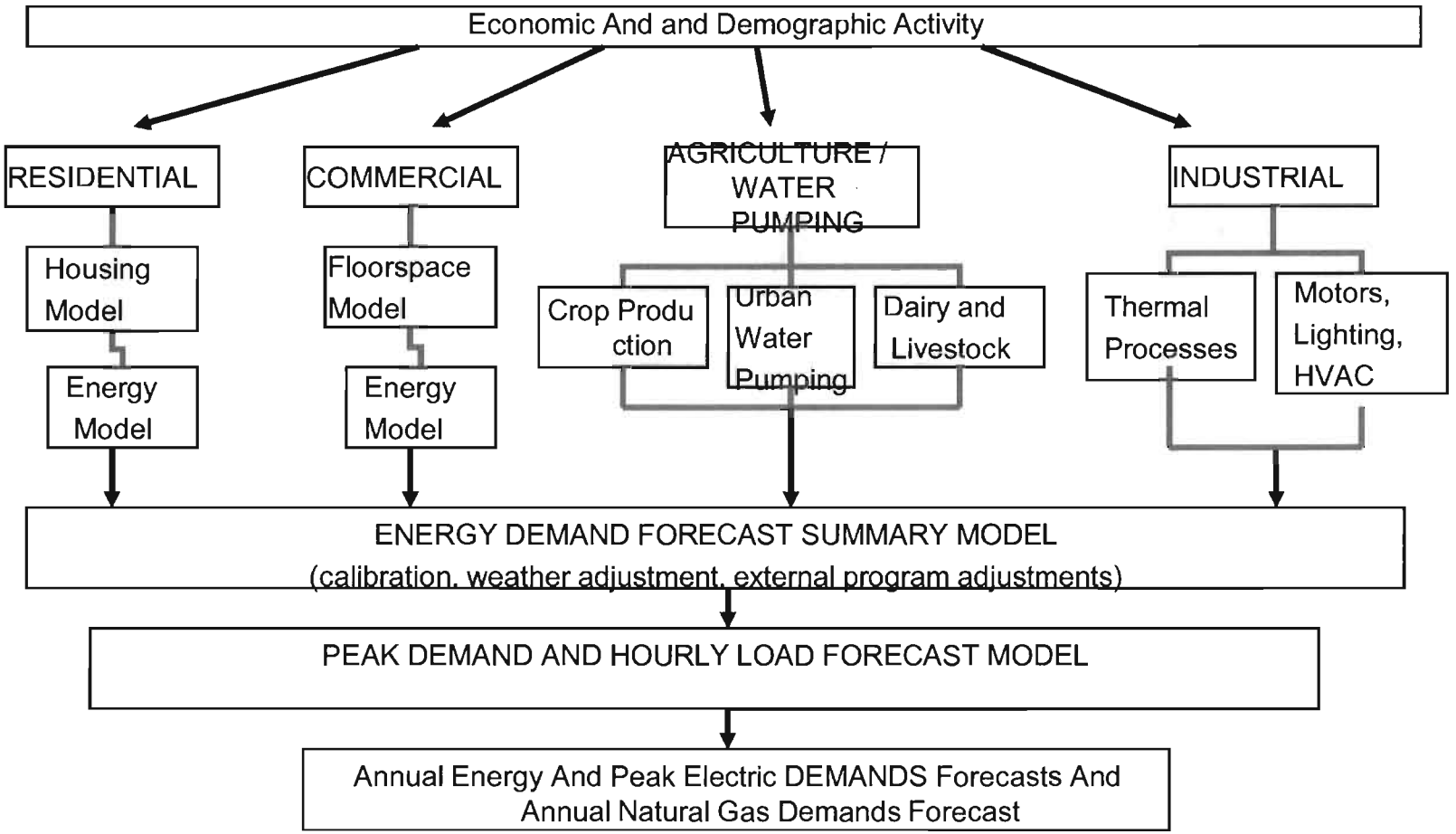
Demand Analysis Office

California Energy Commission

Purpose of Staff Presentation

- Review of CEC Model Structure
- Review of Historic and Forecast Standards Impact Quantification
- Explanation of Additional Conservation Program measurement procedures
- Data Requirements for more detailed attribution of forecasted conservation savings

Staff Forecast Structure



Efficiency Programs

- Most program impacts modeled explicitly in the Residential and Commercial Models
- Past impacts are incorporated implicitly in other sectors through calibration to actual energy use
- Historic and Projected impacts from committed efficiency programs not modeled in specific sector models are accounted for in the Summary Model
- Future staff work will allow explicit incorporation in the Industrial Model

Residential Model

- End-use model that forecasts residential energy use (electricity and natural gas) based on projections of number of households, appliance saturations, and appliance unit energy consumption (UEC)
- Incorporates the bulk of residential efficiency program impacts, through the introduction of building and appliance standards and various retrofit programs
- Efficiency program impacts are handled through adjustments to the UECs, given assumptions on penetration and compliance
- Sorting out impacts from individual programs requires adjusting for price and other market effects

Commercial Model

- End-use model that forecasts commercial energy use (electricity and natural gas) by projecting commercial floor space, portion of floor space devoted to each end-use, and end-use energy intensity (EUI)
- Incorporates the bulk of commercial efficiency program impacts, through the introduction of building and appliance standards and federal school and hospital programs
- Efficiency program impacts are handled through adjustments to the EUIs, given assumptions on penetration and compliance
- Sorting out impacts from individual programs requires adjusting for price and other market effects

Summary Model

- Combines the energy forecasts from all of the individual sectors
- Combined forecast adjusted for weather, unclassified consumption, and additional committed efficiency programs; calibrated to historical data
- Additional efficiency adjustment accounts for utility and public agency committed programs not easily incorporated in sector models
- Programs include master metering, industrial energy management and incentives, new construction, and various retrofit , among others
- To quantify programs, first-year impacts are assigned a useful measure life, then a degradation factor is applied to each year of useful life to account for poor maintenance or equipment failure.

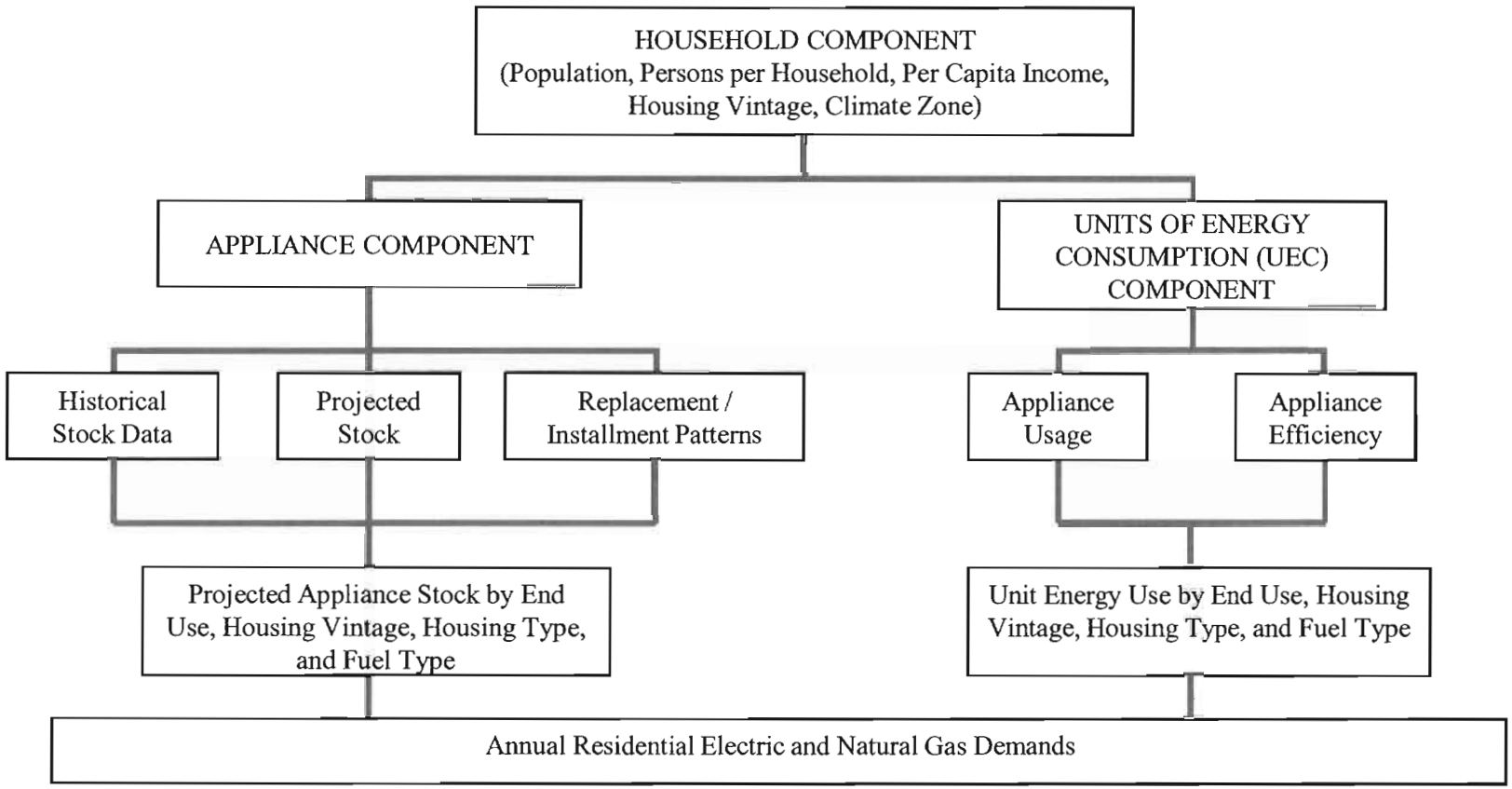
Additional Documentation of Methods and Assumptions

Most recent detailed documentation of historic standards and programs

- Electricity Impacts From Historical, Existing, or Committed Statewide Demand Side Management (DSM) Programs, Staff Paper by Dennis Smith, publication # CEC-200-1995-901, March 1995. Posted August 7, 2008. (PDF file, 52 pages, 1.6 MB
- California Energy Demand: 1995-2015, Volume XI: Committed Demand Side Management Program Savings, Staff Report by Tom Gorin, Richard Rohrer, publication # P300-95-014, July 1995. Posted August 7, 2008. (PDF file, 154 pages, 1.5 MB)

Residential Model Components and Conservation Assumptions

Residential Energy Forecast Model



Benchmarks for Savings Estimates

- Savings estimates in appliances (due to standards and programs) are benchmarked to pre-1978 efficiencies.
- Savings estimates in building shell improvements for heating and cooling are benchmarked to pre-1975 construction practices.
- Savings for heating and cooling are a combination of both building shell improvements and appliance improvements.
- Savings are quantified by iteratively executing the Commercial and Residential Models and successively removing the effect of each standard and/or efficiency program.

Basic Savings Calculation Method (Residential)

Residential Scenario #	Scenario Name	Forecast Input Values	Savings Calculation
1	Baseline	All programs in place for all historic and forecast years	
2	2002 standards	Efficiencies frozen at 2001 levels for 2002 - 2018 period	2- 1
3	1998 standards	Efficiencies frozen at 1997 levels for 1998 – 2018 period	3-2
4	1992 standards	Efficiencies frozen at 1991 levels for 1992 – 2018 period	4-3
5	1984 standards	Efficiencies frozen at 1983 levels of 1984 – 2018 period	5-4
6	Retrofit programs	Retrofit weatherization measures removed from pre 78 vintage homes	6-5
7	1978 standards	Efficiencies frozen at 1977 levels for 1978-2018 period	7-6
8	Price impacts and other measures	Efficiencies and prices held constant at 1975 level for 1976-2018 period	8-7

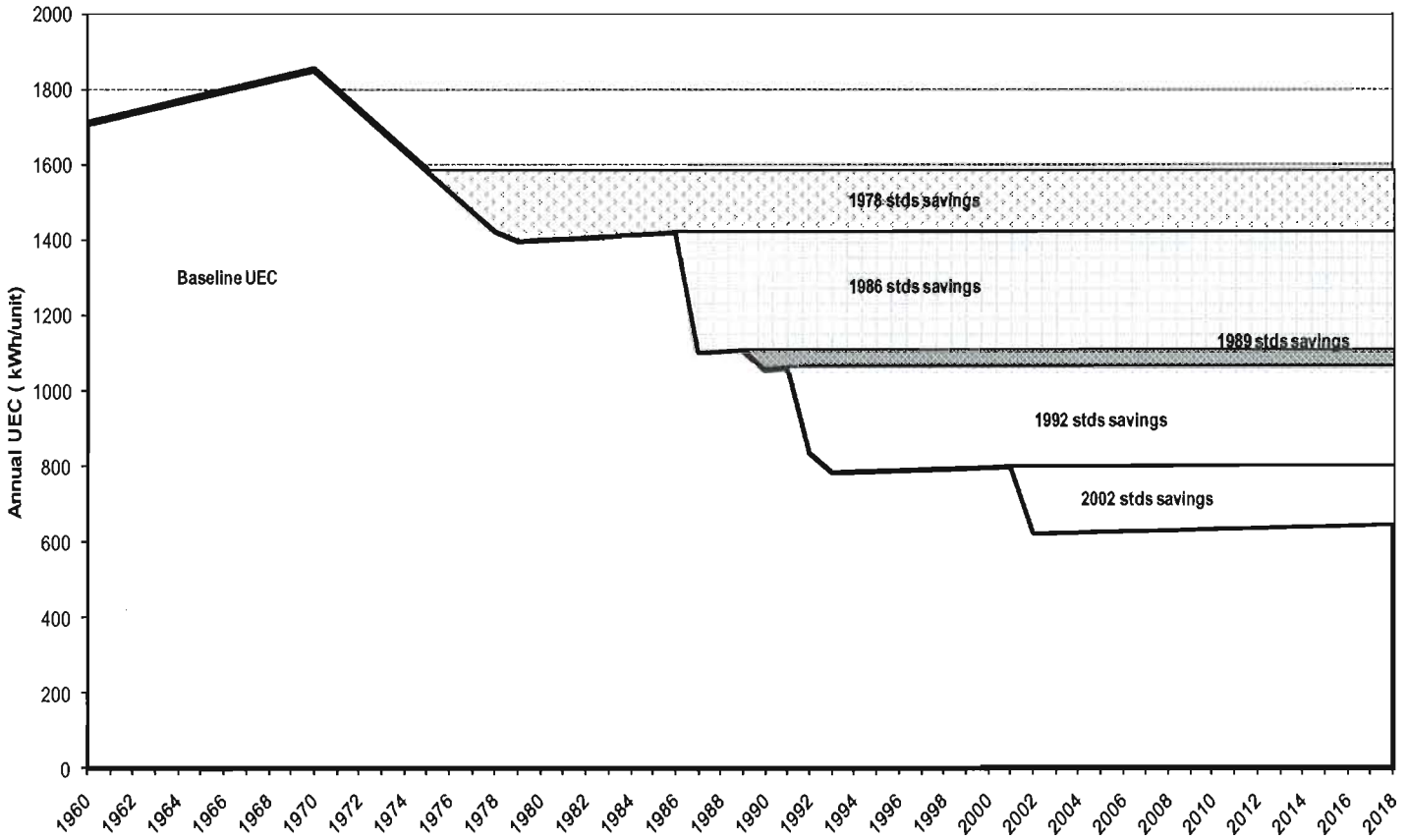
End-Uses Affected by Appliance Standards
(Appliances are tracked and decayed by year of purchase)

- Refrigerators (Standard and Frost Free)
- Freezers
- Room Air Conditioners
- Dishwasher Motors
- Dishwasher (water use)
- Clothes Washer (water use)
- Water Heaters
-

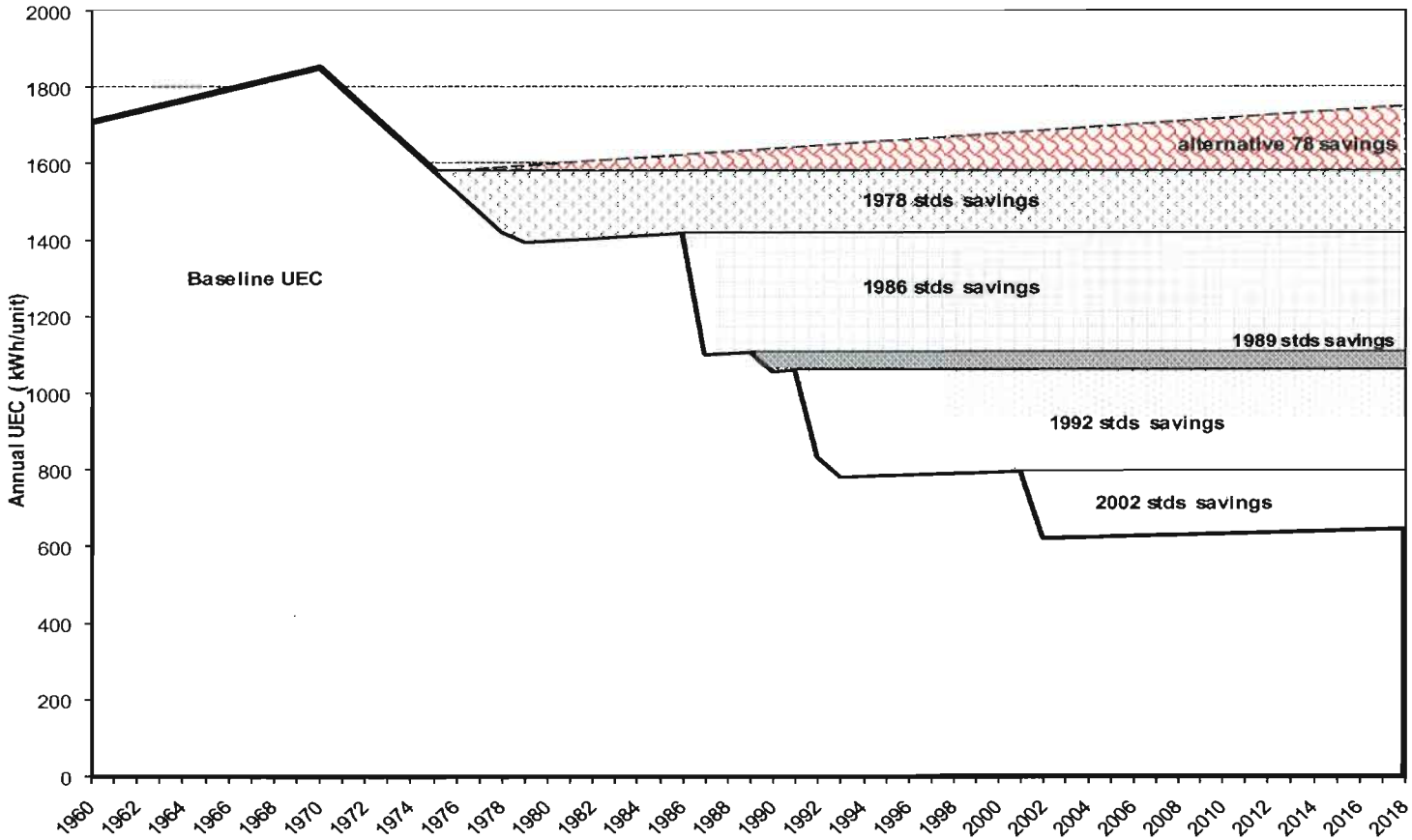
Normalized Use per Appliance Due to Standards
(relative to year shown in yellow)

	year	pre 1960	1970	1978	1980	1983	1987	1990	1992	2001+
frost-free refrigerators	reduction factor	1.200	1.300	1.000	0.880	0.730	0.682	0.652	0.517	0.542
	year	pre 1960	1970	1978	1980	1986	1987	1989	1990	1992+
standard refrigerators	reduction factor	1.100	1.150	1.000	0.940	0.935	0.916	0.916	0.870	0.674
	year	pre 1979	1979	1983	1986	1987	1989	1990+		
freezers	reduction factor	1.000	0.940	0.825	0.800	0.773	0.773	0.652		
	year	pre 1981	1984+							
dish washer motor	reduction factor	1.000	0.900							
	year	pre 1980	1980+							
room A/C	reduction factor	1.000	0.820							
	year	pre 1980	1982	1987	1988	1991	1992	2005	2006+	
central A/C	reduction factor	1.000	0.770	0.770	0.740	0.740	0.672	0.672	0.517	
	year	pre 1981	1981+							
electric space heat	reduction factor	1.000	0.500							
	year	pre 1980	1981	1991	1992+					
gas space heat	reduction factor	1.000	0.900	0.900	0.865					

Example of Frost-Free Refrigerator Forecast and Savings Calculation



Example of Alternative Frost-Free Refrigerator Savings Calculation



End-Uses Affected by Both Building and Appliance Standards

(Households are tracked and decayed by year of construction)

- Space Heating (electric and natural gas)
- Central Air Conditioning
- Water Heating (from measures providing reductions in water use)

Reductions in Building Shell Heating Requirements (per square foot) Attributed to Residential Building Standards

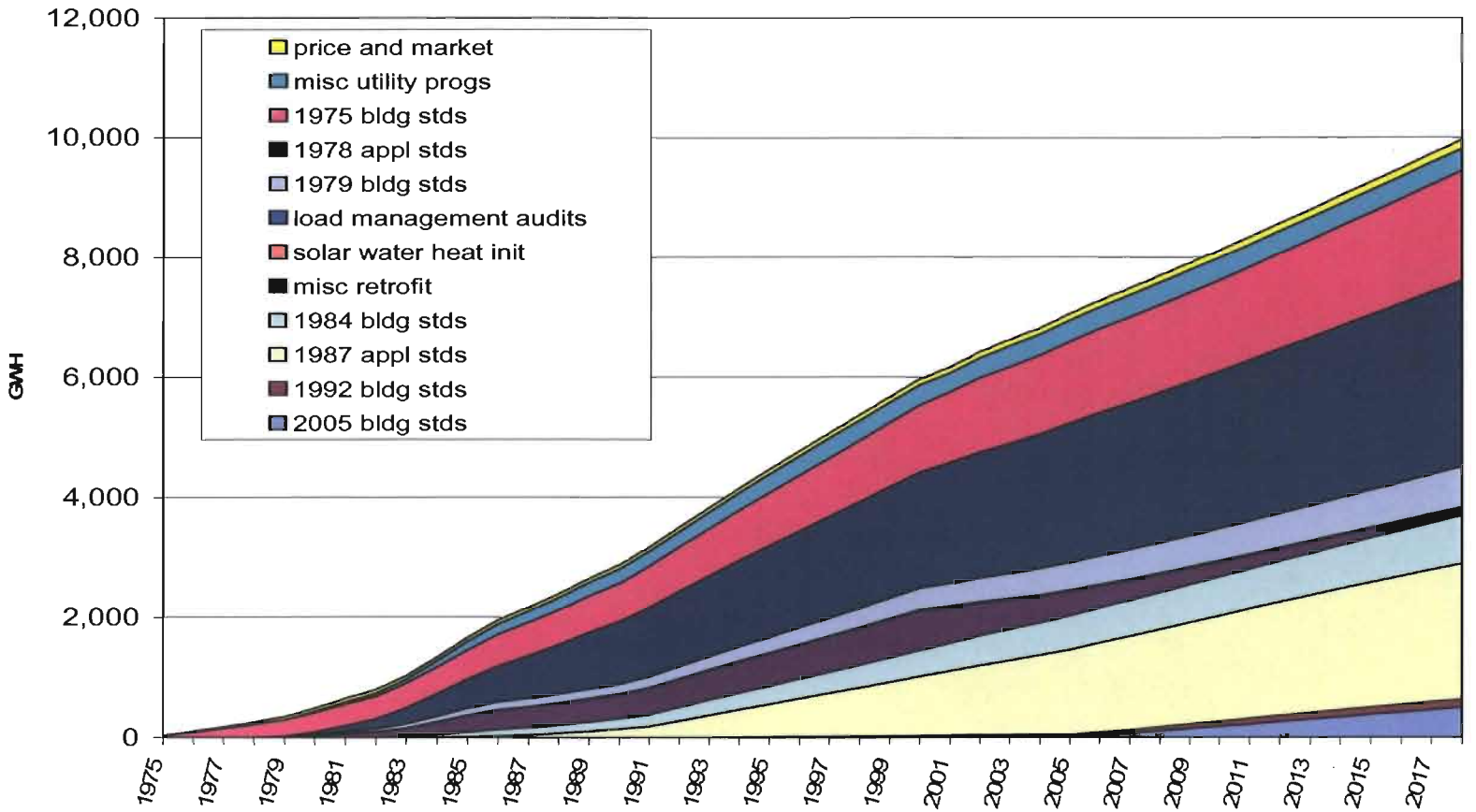
			Housing Vintage				
Forecast Zone	Utility	Region	pre 1975	1975-78	1979-82	1983-92	1993+
1	PG&E	North Coast and Mountain	1.0000	0.800	0.711	0.455	0.423
2	PG&E	Sacramento	1.0000	0.833	0.738	0.478	0.430
3	PG&E	North and South Valley	1.0000	0.833	0.739	0.472	0.425
4	PG&E	East Bay	1.0000	0.833	0.727	0.427	0.410
5	PG&E	San Francisco	1.0000	0.833	0.724	0.412	0.396
6	SMUD	Sacramento	1.0000	0.833	0.753	0.494	0.445
7	SCE	Southern San Joaquin	1.0000	0.833	0.705	0.441	0.396
8	SCE	Coastal LA Basin	1.0000	0.833	0.694	0.468	0.449
9	SCE	Inland LA Basin	1.0000	0.833	0.701	0.490	0.470
10	SCE	Inland Empire	1.0000	0.833	0.713	0.524	0.503
11	LADWP	Coastal LA	1.0000	0.833	0.694	0.483	0.464
12	LADWP	Inland LA	1.0000	0.833	0.689	0.482	0.462
13	SDG&E	San Diego	1.0000	0.833	0.689	0.462	0.444

Reductions in Building Shell Cooling Requirements (per square foot) Attributed to Residential Building Standards

			Housing Vintage				
Forecast Zone	Utility	Region	pre 1975	1975-78	1979-82	1983-92	1993+
1	PG&E	North Coast and Mountain	1.0000	0.909	0.875	0.719	0.719
2	PG&E	Sacramento	1.0000	0.909	0.883	0.689	0.675
3	PG&E	North and South Valley	1.0000	0.909	0.886	0.743	0.728
4	PG&E	East Bay	1.0000	0.909	0.881	0.692	0.685
5	PG&E	San Francisco	1.0000	0.909	0.873	0.740	0.740
6	SMUD	Sacramento	1.0000	0.909	0.851	0.603	0.603
7	SCE	Southern San Joaquin	1.0000	0.909	0.881	0.760	0.745
8	SCE	Coastal LA Basin	1.0000	0.909	0.909	0.809	0.801
9	SCE	Inland LA Basin	1.0000	0.909	0.908	0.812	0.796
10	SCE	Inland Empire	1.0000	0.909	0.894	0.794	0.778
11	LADWP	Coastal LA	1.0000	0.909	0.895	0.759	0.752
12	LADWP	Inland LA	1.0000	0.909	0.898	0.817	0.801
13	SDG&E	San Diego	1.0000	0.909	0.905	0.804	0.804

Conservation Impacts by Program

PG&E Residential



Stages of Additional Efficiency Program Measurement

- **Goals:** Developed from Potential Studies, Scenario Projects, etc.
- **Ex-ante Program Measurement:** Savings expected from a program in the planning stage.
- **Ex-post Program Measurement:** Actual savings from a program after it has been delivered (using Evaluation, Measurement, and Verification tools)
- **Attribution Measurement:** Attributing program savings vs. market, price or naturally occurring impacts (how the programs change the existing forecast)

Main Objectives of EM&V Projects

- Document and measure the impacts of a program and determine if it has met its goals with respect to being a reliable energy source
- To understand why the impacts occurred and determine ways to improve current programs and design future programs

Example of Impact Evaluation

- **2004-2005 Statewide Residential Retrofit Single-Family Energy Efficiency Rebate Program:** Although 97% of the non-lighting measures were found to be installed, only 76% of the CFLs had been installed. Based on the measured savings results, the program met 50% of its ex-ante gross savings goals.

Data Requirements for More Detailed Attribution of Savings

- Detail of new and existing programs at the measure, end-use and housing/building type level. In order to determine which end-uses to make adjustments to in the forecast models
- Detail on existing market share of appliances by efficiency level compared to program projections.
- More detail on existing level of use by appliance and the distribution of use.