Appendix B-1: Policy pathways

This appendix contains write-ups of specific policies in addition to detailed policy penetration tables.

Policy Penetrations

Tables B-1.1.mod through B-1.4.adv give details on our assumptions about the penetrations of each of the various policies we consider. Residential HVAC is treated separately, because of its complexity. The tables for residential HVAC are first, followed by residential non-HVAC, followed by those for the commercial sector. Penetrations of policies affecting residential HVAC end-uses are described in Tables B-1.1.mod and B-1.1.adv (for homes built before 2000) and in Tables B-1.2.mod and B-1.2.adv (for new homes). Penetrations of policies affecting residential non-HVAC end-uses are described in Tables B-1.3.mod and B-1.3.adv. All commercial building end-use penetrations are described in Tables B-1.4.mod and B-1.4.adv.

Care should be taken in interpreting the policy penetrations, as they are defined differently for different end-uses and, in the case of residential HVAC end-uses, for different home vintages. Also, because different policies affect the same market segment, it was often necessary to adjust penetrations or savings in order to avoid double-counting the energy savings. In particular, we had to address the effect on existing programs, such as ENERGY STAR, when new equipment standards come into effect. We adopted the practice of attributing energy savings to mandatory programs, such as standards and building energy codes, before calculating savings for other policies. When the savings for a policy are affected by a standard or code, we essentially analyze the policy as several different policies according to the baseline that applies (e.g., year 2000 new equipment, 2004 standard, 2010 standard, etc.). Guides to interpreting the policy penetrations are provided in the pages preceding Table B-1.1.mod, Table B-1.3.mod, and Table B-1.4.mod, for residential HVAC, residential non-HVAC and commercial end-uses, respectively. Further details can be found in the notes of each table.

Index to the Tables in Appendix B-1

Table Number	Title of Table
B-1.1.mod	Existing Residential Buildings Moderate Case Market Penetrations for HVAC Equipment Programs
B-1.1.adv	Existing Residential Buildings Advanced Case Market Penetrations for HVAC Equipment Programs
B-1.2.mod	New Residential Building HVAC End Use Moderate Case Market Penetrations
B-1.2.adv	New Residential Building HVAC End Use Advanced Case Market Penetrations
B-1.3mod	Residential non-HVAC policy penetration rates, moderate case
B-1.3adv	Residential non-HVAC policy penetration rates, advanced case
B-1.4mod	Commercial policy penetration rates, moderate case
B-1.4adv	Commercial policy penetration rates, advanced case

Introduction to the Residential HVAC Program Penetration Tables (Tables B-1.1.mod – B-1.2.adv)

Penetrations of the various policies considered in this analysis for the residential building HVAC (space heating and cooling) end uses are presented in Tables B-1.1.mod, B-1.1.adv, B-1.2.mod, and B-1.2.adv. Residential buildings were divided into "new" and "existing" categories[1] for purposes of this analysis. Penetrations of policies affecting existing home HVAC end uses are presented in Tables B-1.1.mod (Moderate case) and B-1.1.adv (Advanced case). New home HVAC end use policy penetrations are presented in Tables B-1.2.mod (Moderate case) and B-1.2.adv (Advanced case). Only the residential heating and cooling end uses are included in these tables. See Tables B-1.3.mod through B-1.4.adv for penetrations of the policies affecting residential non-HVAC end uses and commercial buildings.

Assumptions and sources of the penetration forecasts are documented in the footnotes of each table.

Avoiding Double Counting

Because different policies affect the same market segment, it was often necessary to adjust penetrations or savings to avoid double-counting the energy savings. We adopted the practice of attributing energy savings to mandatory programs, such as standards and building energy codes, before calculating savings for other policies. When the savings for a policy are affected by a standard or code, we essentially analyze the policy as several different policies according to the baseline that applies (e.g., year 2000 new equipment, 2006 standard, etc.).

Existing Homes

The existing home penetrations for each policy are presented by end use and equipment type. The existing home penetrations are assumed to apply to all house types (single-family, multifamily, and manufactured homes). In some cases, policies were assumed to apply to only a subset of homes (e.g., single-family homes in the South) because the policy was most cost-effective in those situations. See Tables C-1.2.mod and C-1.2.adv in Appendix C-1 for further details.

The existing residential building HVAC penetrations in these tables are only for programs that affect HVAC equipment replacements. We did not address policies to improve the shell of existing residential buildings in this analysis. The program penetration in each year is the number of equipment replacements due to the program, as

[1] "New" homes are defined as all homes built during the forecast period (2000-2020), including homes that were built to replace existing homes that decayed during that period. "Existing" homes are defined as all homes that were built prior to the year 2000. The stock of new and existing homes decreases over time, due to natural decay. The decay rate is 0.4% per annum, from the NEMS model. All house types (single-family, multifamily, and manufactured homes) are included in the analysis.

a percent of all the equipment replacements in the stock of homes built before 2000[2] that would occur naturally in that year. The policy penetrations include only those replacements that are over and above the frozen efficiency penetration in 2000 of replacement equipment of given (i.e., program) efficiency. For example, condensing gas furnaces already have a substantial (around 25%) market penetration, so we reduced the maximum policy penetration of ENERGY STAR condensing gas furnaces by the amount of penetration of that technology in the frozen efficiency case.

New Homes

The new home penetrations for each policy are presented by house type. The penetrations apply to all fuel and equipment types equally. Some policies, such as Building America, only apply to single-family homes. Other policies, such as ENERGY STAR New Homes, officially apply to all house types, but the penetration of ENERGY STAR single-family homes is likely to be much greater than that of ENERGY STAR multifamily homes, so we analyzed the penetrations of each house type separately for the ENERGY STAR program. The new home tax credit applies only to single-family and manufactured homes. We assumed the program penetration for each of these house types would be the same. The NAECA standards for HVAC equipment are included in the new home analysis, just as they are in the existing home analysis, but are not shown in the new home tables. See the existing home penetration tables for documentation of the NAECA standards that occur during the forecast period.

New residential building HVAC program penetrations are defined as the percent of all homes of the specified house type built in each year that were affected by the program. We used annual housing starts by house type and equipment type from the CEF-NEMS reference case in this analysis.

Mandatory programs, such as building codes and NAECA standards, were assumed to be implemented first, before any implementation of the non-mandatory programs. Energy savings due to the non-mandatory programs were reduced by the savings due to the mandatory programs (i.e., energy saved by a voluntary program was calculated using a new baseline energy consumption in each year that accounts for the implementation of the mandatory programs). We arbitrarily chose to have building codes implemented first, followed by the NAECA standards.

The penetrations of non-mandatory programs (all programs except NAECA standards and building codes) are assumed to be independent of other non-mandatory programs. That is, each new home affected by a non-mandatory program is attributed to only that program, not to any others. Thus, even though a Building America home by definition qualifies as an ENERGY STAR home, it is not counted as an ENERGY STAR home in the penetrations. This is because we have already taken into account the relationship between programs in forecasting penetration rates and have attributed the penetrations accordingly between the various programs.

[2] and still standing in that year

All of the non-mandatory policies for new homes are whole-house policies (that is, they affect both building shell and HVAC equipment). Policies that target only the HVAC equipment, such as the Treasury Department's equipment tax credits and the ENERGY STAR HVAC equipment program, were applied only to existing homes, not to new homes. This was primarily a decision based on ease of accounting, however, we believe it is a reasonable assumption. An ENERGY STAR new home may or may not contain ENERGY STAR-labeled HVAC equipment, but if it does, we attribute it to the efforts of the Homes program rather than to the HVAC program. A homebuilder may install equipment that meets the ENERGY STAR or tax credit requirements, but we preferred to allocate the penetration of these programs entirely to existing homes. In the case of existing homes, the homeowner has a financial interest in the utility bill savings (as opposed to the homebuilder, who may or may not receive a higher profit from the installation of the costlier high-efficiency equipment). We assumed that builders looking for a greater profit would be more likely to participate in a whole-house program (such as ENERGY STAR new homes, the new home tax credit, or Building America), which would allow them to market the whole house as being more energy-efficient, rather than providing just an equipment upgrade. An ENERGY STAR home also may be easier for the builder to sell because it qualifies for lower mortgage interest rates.

Table B-1.1.mod: Existing Residential Buildings Moderate Case Market Penetrations for HVAC Equipment Programs

End Use	Equipment[1]	Policy	Notes	Annual Penetration Rate[2]																			
				2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Electric Heating																								
	Resistance	Utility or other program	3	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	ASHP	See programs listed under Electric Cooling																						
Electric Cooling																								
	CAC, ASHP	NAECA Standard 2006	4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	CAC, ASHP	Tax Credit (10%)	5	4.0%	8.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	CAC, ASHP	Tax Credit (20%)	5	0.5%	1.4%	2.7%	3.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	CAC	ENERGY STAR HVAC, before 2006 Standard	6	3.5%	4.3%	5.1%	6.0%	6.8%	7.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	CAC	ENERGY STAR HVAC, after 2006 Standard	6	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	1.9%	3.3%	4.7%	6.1%	7.5%	8.9%	10.3%	11.6%	13.0%	14.4%	15.8%	17.2%	18.6%	20.0%
	ASHP	ENERGY STAR HVAC, before 2006 Standard	6	3.5%	4.3%	5.1%	6.0%	6.8%	7.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	ASHP	ENERGY STAR HVAC, after 2006 Standard	6	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	1.9%	3.3%	4.7%	6.1%	7.5%	8.9%	10.3%	11.6%	13.0%	14.4%	15.8%	17.2%	18.6%	20.0%
	RAC	NAECA Standard 2001	7	0.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	RAC	NAECA Standard 2010	8	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	RAC	ENERGY STAR HVAC, before 2001 Standard	9	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	RAC	ENERGY STAR HVAC, before 2010 Standard	9	0.0%	1.0%	2.0%	3.0%	4.0%	5.0%	6.0%	7.0%	8.0%	9.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	RAC	ENERGY STAR HVAC, after 2010 Standard	9	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	2.0%	3.0%	4.0%	5.0%	6.0%	7.0%	8.0%	9.0%	10.0%	10.0%
Electric Cooling -- Sum of all program penetrations except NAECA standards																								
	CAC		10	8.0%	13.7%	7.9%	9.1%	6.8%	7.6%	0.5%	1.9%	3.3%	4.7%	6.1%	7.5%	8.9%	10.3%	11.6%	13.0%	14.4%	15.8%	17.2%	18.6%	20.0%
	ASHP		10	8.0%	13.7%	7.9%	9.1%	6.8%	7.6%	0.5%	1.9%	3.3%	4.7%	6.1%	7.5%	8.9%	10.3%	11.6%	13.0%	14.4%	15.8%	17.2%	18.6%	20.0%
	RAC		10	1.0%	1.0%	2.0%	3.0%	4.0%	5.0%	6.0%	7.0%	8.0%	9.0%	1.0%	2.0%	3.0%	4.0%	5.0%	6.0%	7.0%	8.0%	9.0%	10.0%	10.0%
Gas Heating																								
	GFRN	ENERGY STAR HVAC	11, 15	3.5%	3.8%	4.2%	4.6%	4.9%	5.3%	5.7%	6.1%	6.4%	6.8%	7.2%	7.5%	7.9%	8.3%	8.6%	9.0%	9.4%	9.7%	10.1%	10.5%	10.9%
	GBLR	ENERGY STAR HVAC	12, 15	3.5%	3.9%	4.3%	4.8%	5.2%	5.6%	6.0%	6.5%	6.9%	7.3%	7.8%	8.2%	8.6%	9.1%	9.5%	9.9%	10.3%	10.8%	11.2%	11.6%	12.1%
Oil Heating																								
	OFRN	ENERGY STAR HVAC	13, 15	3.5%	4.2%	5.0%	5.7%	6.4%	7.2%	7.9%	8.7%	9.4%	10.2%	10.9%	11.7%	12.4%	13.1%	13.9%	14.6%	15.4%	16.1%	16.9%	17.6%	18.4%
	OBLR	ENERGY STAR HVAC	14, 15	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%

Notes

1 Equipment codes: CAC-central air conditioner; ASHP-electric air source heat pump; GFRN-gas central furnace; OFRN-oil central furnace; OBLR-oil boiler; GBLR-gas boiler; RAC-room air conditioner; Resistance-electric furnace or other electric non-heat pump heating equipment.

2 Penetration rates in this table are only for existing home programs that affect HVAC equipment. We did not address programs affecting shell improvements in existing residential buildings. The penetration rate in the table is the percent of all naturally-occurring replacements of the specified HVAC equipment in the stock of homes built before 2000 (i.e., in "existing homes") that is due to the program in each year. The program penetration rates only include replacements that are over and above the frozen efficiency penetration in 2000 of replacement equipment equal to the program efficiency. Program penetration rates apply to all house types.

3 We assume in the moderate case that there are no programs offering rebates or other incentives for existing homes to switch from electric furnace with CAC to an electric heat pump.

4 A new heat pump and CAC standard analysis has been completed but is pending approval. We assume that it will be finalized sometime in the year 2000 and the new standards will take effect on January 1, 2006. We assume the new standards will be 12 SEER for central air conditioners and 7.4 HSPF/12 SEER for heat pumps.

5 Valid dates and efficiencies are from the latest Treasury Department proposals (US DOT (1999)). Penetration rates for the 10% credit are based in part on the fact that in 1997, 16% of purchases were at the 12 SEER level (Richey 1999), and half of those purchases (8%) would be likely to take the tax credit for the 13.5 SEER rather than buy 12 SEER. We assume that the 8% penetration would only be achieved in the last year of the program (2001). Penetration in the first year of the program is assumed to be half of the final year penetration. Penetration rates for the 20% tax credit are based on Richey and Koomey (1998). The penetration forecast for the 20% tax credit in the last two years of our four-year program is assumed to be 50% of the estimated penetration in years three and four of a five-year, 20% tax credit program for HPs and CACs of 15 SEER efficiency. For the first two years of the program, we assumed significantly smaller penetrations than 50% of Richey and Koomey's year 1-2 estimates,

Table B-1.1.mod Notes, continued

in order to give the program time to ramp up. Penetrations of the CAC and heat pump tax credit programs are assumed to be identical.

6 ENERGY STAR CAC and heat pump penetrations are based on the latest EPA ENERGY STAR program penetration forecast (LBNL spreadsheets dated June 1999, US EPA 1999c). In the first year only, we assumed the penetration would be the same as the EPA forecast. We assumed that, by 2005, a penetration equal to 50% of the EPA program penetration forecast for 2005 could be achieved in the Moderate case. For both 2000 and 2005, the ENERGY STAR HVAC program penetration was used; it is distinct from (i.e., in addition to) the penetration of ENERGY STAR equipment due to the ENERGY STAR New Homes Program. The penetration forecast between 2000 and 2005 is a linear interpolation. The EPA forecast was only used up to 2006, when we assume that a new NAECA standard takes effect and that the ENERGY STAR level is increased to 14 SEER (see Table C-1.1.mod). Program penetration rates for 2006-2020 are LBNL estimates.

7 A new NAECA standard for RACs has been passed and will take effect on October 1, 2000. In the CEF-NEMS reference case, this standard is assumed to begin on January 1, 2001. We assumed a start date of Jan 1, 2001 in the Moderate and Advanced cases in order to be consistent with the reference case.

8 We assume the NAECA standard for RACs will be updated and a new standard set at 10.5 EER (on average over all sizes). We assume the new standard will take effect on January 1, 2010.

9 We assume that the ENERGY STAR program continues to increase its efficiency requirements for RAC in response to new NAECA standards. Thus, we included 3 levels of ENERGY STAR RAC to reflect the 3 levels of NAECA standards in effect during the forecast period: current, valid in 2000; the Oct 1, 2000 standard (which we account for starting in 2001); and the projected 2010 standard. See Table C-1.1.mod for the ENERGY STAR RAC efficiency level assumptions. The ENERGY STAR room A/C program is administered by DOE, but we did not use the DOE forecast because it assumes a flat penetration rate (15% of sales), and only one efficiency level, over the forecast period. The RAC penetration rates in the table are LBNL estimates.

10 Sum of the penetration rates for all programs that affect the electric cooling end use, with the exception of NAECA standards. The programs that are included in the sum are: tax credits, utility/other programs, and the ENERGY STAR HVAC program.

11 ENERGY STAR gas furnace maximum achievable penetration (over and above the frozen efficiency penetration of 90 AFUE gas furnace replacements) in the Moderate case is assumed to be half of the maximum penetration in the Advanced case (see Table B-1.1.adv for details). The maximum penetration is assumed to be achieved in 2020. The penetration in 2000 is assumed to be the same as in the Advanced case. Penetrations between 2000 and 2020 were linearly interpolated.

12 ENERGY STAR gas boiler maximum achievable penetration (over and above the frozen efficiency penetration of 86 AFUE gas boiler replacements) in the Moderate case is assumed to be half of the maximum penetration in the Advanced case. The penetration forecast from 2000 through 2005 is assumed to be half of the Advanced case penetrations in those years. See Table B-1.1.adv for details. Penetrations from 2006 through 2019 are LBNL estimates. The maximum achievable penetration is assumed to be achieved only in 2020.

13 ENERGY STAR oil furnace maximum achievable penetration (over and above the frozen efficiency penetration of 90 AFUE oil furnace replacements) in the Moderate case is assumed to be half of the maximum penetration in the Advanced case (see Table B-1.1.adv for details). The maximum penetration is assumed to be achieved in 2020. The penetration in 2000 is assumed to be the same as in the Advanced case. Penetrations between 2000 and 2020 were linearly interpolated.

14 ENERGY STAR oil boiler penetration (over and above the frozen efficiency penetration of 86 AFUE oil boiler replacements) is assumed to be flat during the forecast period. The EPA forecast for ENERGY STAR oil boilers is 10% from 2000-2010 (see Table B-1.1.adv for details), which we assumed would continue out to 2020 in the Moderate case.

15 We assume that the NAECA standards for furnaces and boilers will not be updated during the forecast period. While it may be cost-effective in most applications to improve the NAECA standard AFUE for gas furnaces from 78 to 80, the frozen efficiency in 2000 for gas furnaces is already well above 80 AFUE, so that a future NAECA standard of 80 AFUE would have no effect on this analysis. Efficiencies over 80 AFUE tend to require modifications in replacement applications that make them generally not cost-effective except in colder climates, therefore we assumed it was unlikely that a NAECA standard above 80 AFUE would occur during the forecast period.

Table B-1.1.adv: Existing Residential Buildings Advanced Case Market Penetrations for HVAC Equipment Programs

End Use	Equipment[1]	Policy	Notes	Annual Penetration Rate[2]																			
				2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Electric Heating																								
	Resistance	Utility or other program	3	1.0%	1.6%	2.2%	2.8%	3.5%	4.1%	4.7%	5.3%	5.9%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%
	ASHP	See programs listed under Electric Cooling																						
Electric Cooling																								
	CAC, ASHP	NAECA Standard 2006	4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	CAC, ASHP	Tax Credit (10%)	5	4.0%	8.0%	12.0%	16.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	CAC, ASHP	Tax Credit (20%)	5	1.0%	3.5%	7.8%	8.6%	9.3%	10.0%	10.6%	11.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	CAC	ENERGY STAR HVAC, before 2006 Standard	6	3.5%	5.6%	7.4%	9.8%	12.5%	15.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	CAC	ENERGY STAR HVAC, after 2006 Standard	6	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	3.8%	6.6%	9.4%	12.1%	14.9%	17.7%	20.5%	23.3%	26.1%	28.9%	31.6%	34.4%	37.2%	40.0%
	ASHP	ENERGY STAR HVAC, before 2006 Standard	7	3.5%	5.6%	7.4%	9.8%	12.4%	12.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	ASHP	ENERGY STAR HVAC, after 2006 Standard	7	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	3.8%	6.6%	9.4%	12.1%	14.9%	17.7%	20.5%	23.3%	26.1%	28.9%	31.6%	34.4%	37.2%	40.0%
	RAC	NAECA Standard 2001	8	0.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	RAC	NAECA Standard 2010	9	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	RAC	ENERGY STAR HVAC, before 2001 Standard	10	2.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	RAC	ENERGY STAR HVAC, before 2010 Standard	10	0.0%	2.4%	3.9%	5.2%	6.9%	8.8%	10.7%	13.1%	16.1%	19.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	RAC	ENERGY STAR HVAC, after 2010 Standard	10	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	3.9%	5.2%	6.9%	8.8%	10.7%	13.1%	16.1%	19.0%	21.4%	23.1%
Electric Cooling -- Sum of all program penetrations except NAECA standards																								
	CAC		11	8.5%	17.1%	27.2%	34.4%	21.8%	25.3%	11.6%	14.9%	6.6%	9.4%	12.1%	14.9%	17.7%	20.5%	23.3%	26.1%	28.9%	31.6%	34.4%	37.2%	40.0%
	ASHP		11	8.5%	17.1%	27.2%	34.4%	21.7%	22.4%	11.6%	14.9%	6.6%	9.4%	12.1%	14.9%	17.7%	20.5%	23.3%	26.1%	28.9%	31.6%	34.4%	37.2%	40.0%
	RAC		11	2.4%	2.4%	3.9%	5.2%	6.9%	8.8%	10.7%	13.1%	16.1%	19.0%	2.4%	3.9%	5.2%	6.9%	8.8%	10.7%	13.1%	16.1%	19.0%	21.4%	23.1%
Gas Heating																								
	GFRN	ENERGY STAR HVAC	12, 16	3.5%	5.6%	7.4%	9.8%	12.5%	15.3%	18.8%	21.7%	21.7%	21.7%	21.7%	21.7%	21.7%	21.7%	21.7%	21.7%	21.7%	21.7%	21.7%	21.7%	21.7%
	GBLR	ENERGY STAR HVAC	13, 16	3.5%	5.6%	7.4%	9.8%	12.5%	15.3%	18.8%	23.0%	23.1%	23.2%	23.3%	23.4%	23.4%	23.5%	23.6%	23.7%	23.8%	23.9%	24.0%	24.0%	24.1%
Oil Heating																								
	OFRN	ENERGY STAR HVAC	14, 16	3.5%	5.6%	7.4%	9.8%	12.5%	15.3%	18.8%	23.0%	27.1%	30.6%	33.0%	33.4%	33.8%	34.1%	34.5%	34.9%	35.2%	35.6%	36.0%	36.3%	36.7%
	OBLR	ENERGY STAR HVAC	15, 16	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.1%	10.2%	10.4%	10.5%	10.6%	10.7%	10.8%	10.9%	11.1%	11.2%

Notes

1 Equipment codes: CAC-central air conditioner; ASHP-electric air source heat pump; GFRN-gas central furnace; OFRN-oil central furnace; OBLR-oil boiler; GBLR-gas boiler; RAC-room air conditioner; Resistance-electric furnace or other electric non-heat pump heating equipment.

2 Penetration rates in this table are only for existing home programs that affect HVAC equipment. We did not address programs affecting shell improvements in existing residential buildings. The penetration rate in the table is the percent of all naturally-occurring replacements of the specified HVAC equipment in the stock of homes built before 2000 (i.e., in "existing homes") that is due to the program in each year. The program penetration rates only include replacements that are over and above the frozen efficiency penetration in 2000 of replacement equipment equal to the program efficiency. Program penetration rates apply to all house types.

3 We assume in the advanced case that programs funded by lines charges will offer rebates or other incentives for existing homes to switch from electric furnace with CAC to an electric heat pump. We evaluated two heat pump efficiencies: the year 2000 frozen efficiency (valid from 2000-2005), and the new NAECA standard of 2006 (from 2006-2020). Penetrations are LBNL estimates based on the following assumptions:
- It is cost-effective to replace the electric resistance heater and CAC with a heat pump in single-family and manufactured homes, in 80% of such cases in the south and 20% of such cases in the north. The cost-effectiveness in the north is less because heat pumps are less efficient and can have operating problems in colder climates. We also assume that it is only cost-effective to replace electric resistance heaters with heat pumps if the home already has a CAC (because duct work is already present in those cases, eliminating the high cost of adding duct work).

Table B-1.1.adv Notes, continued

- For multifamily homes, we assume it is cost-effective to replace the electric resistance heater and CAC with a heat pump in 30% of such cases in the south, and only 5% in the north. The percentages are lower for multifamily because fewer units are owner-occupied and/or have occupant paying their own utilities, both criteria which were used to determine the cost-effectiveness of switching to a heat pump.
- Percent of homes with CAC by region and house type are from the a query of the 1990 RECS electronic database (US DOE 1993a).
- Percent of multifamily units that are owner-occupied and/or have occupant paying their own utilities is from the 1993 RECS survey (US DOE 1995a, Table 3.3a, p.42).
- We assumed a maximum achievable penetration of 6.5%, which is 25% of the amount we calculated based on the cost-effectiveness assumptions listed above. The ramp-up from 1% in 2000 to the 6.5% level in 2009 is linear. We assume that the maximum level is reached in 2009 and stays constant out to 2020.
- The program penetration in each year is applied to all existing homes with electric resistance heaters that retire naturally in that year. We assume that the central air conditioner will retire naturally at the same time as the electric heating unit. This assumes that the CAC and the heater were originally installed at the same time, and since the average lifetime of an electric heater is almost exactly twice that of a CAC (23.5 years and 12 years, respectively, from an input file used by the NEMS model), when the heater retires, the CAC will retire also (or be very close to retirement). Thus we assume that we incur no additional cost due to an early retirement of the CAC unit.

4 We assume that the NAECA standards for central air conditioners and electric heat pumps will be updated to 12 SEER, and the new standard will take effect on January 1, 2006.

5 Tax credit penetrations for electric air source heat pumps and central air conditioners are assumed to be the same. The number of years that the tax credit program operates is assumed to be twice as much as the latest Treasury Department proposal (US DOT (1999)); i.e., the 10% tax credit level would apply for 4 years, not 2, and the 20% tax credit would apply for 8 years, not 4.
The advanced scenario tax credit penetration rates for the 20% rebate (15 SEER) equipment was interpolated from the results of an LBNL analysis of tax rebates (Richey and Koomey (1998)). We used results for a 20% rebate on a 15 SEER residential heat pump, lasting either 5 years or 10 years, and interpolated the resulting penetration rate forecasts to estimate an 8 year tax credit. However, we only used the last 6 years of this interpolated forecast; we assume significantly lower penetration rates than Richey and Koomey in the first two years of the program in order to allow time for the program to ramp up. We used Richey and Koomey's heat pump results to estimate the penetration of both heat pumps and CAC, because the CAC results were almost identical to the HP results. Tax credit penetration rates for the 13.5 SEER, 10% rebate were estimated based on discussion with Cooper Richey of LBNL (Richey and Koomey 1998 did not evaluate the 13.5 SEER efficiency case). Penetration rates for the 13.5 SEER program are based in part on the fact that in 1997, 16% of units sold were at the 12 SEER level (Richey 1999). We assumed that in the last year of the program, all of those purchasers (16%) would be likely to take the tax credit for the 13.5 SEER rather than buy 12 SEER. The penetration is assumed to increase quickly over the 4 years of the program, from 4% in the first year to 16% in the last year.

6 ENERGY STAR CAC penetrations from 2000 through 2005 are 100% of the latest EPA ENERGY STAR program penetration forecast for CAC (LBNL spreadsheets dated June 1999, US EPA 1999c).
The ENERGY STAR HVAC program penetration was used; it is distinct from (i.e., in addition to) the penetration of ENERGY STAR equipment due to the ENERGY STAR New Homes program. EPA's ENERGY STAR HVAC program penetrations were only used up to 2006. In 2006, we assume a new NAECA standard takes effect and the ENERGY STAR level for CACs increases to 14 SEER (see Table C-1.1.adv). Program penetrations from 2006-2020 are LBNL estimates.

7 ENERGY STAR heat pump penetrations from 2000 through 2003 are 100% of the latest EPA ENERGY STAR program penetration forecast (LBNL spreadsheets dated June 1999, US EPA 1999c).
The ENERGY STAR HVAC program penetration was used; it is distinct from (i.e., in addition to) the penetration of ENERGY STAR equipment due to the ENERGY STAR New Homes program.
We assume that the ENERGY STAR heat pumps are only cost-effective in 12.4% of all existing homes (see Table C-1.2.adv for more details), and that the maximum cost-effective penetration is reached by 2004 and stays at this level through 2005. In 2006, we assume a new NAECA standard takes effect and the ENERGY STAR levels for heat pumps and CACs increase to 14 SEER (as described in Table C-1.1.adv). Program penetrations from 2006-2020 are LBNL estimates.

8 A new NAECA standard for RACs has been passed and will take effect on October 1, 2000. In the CEF-NEMS reference case, this standard is assumed to begin on January 1, 2001. We assumed a start date of Jan 1, 2001 in the Moderate and Advanced cases in order to be consistent with the reference case.

9 We assume the NAECA standard for RACs will be updated and a new standard set at 10.5 EER (on average over all sizes). We assume the new standard would take effect on January 1, 2010.

10 We assume that the ENERGY STAR program continues to increase its efficiency requirements for RAC in response to new NAECA standards. Thus, we included 3 levels of ENERGY STAR RAC to reflect the 3 levels of NAECA standards in effect during the forecast period: current, valid in 2000; the Oct 1, 2000 standard (which we account for in 2001); and the projected 2010 standard. See Table C-1.1.adv for assumptions about the ENERGY STAR RAC efficiency levels. The ENERGY STAR room A/C program is administered by DOE, but we did not use the DOE forecast because it assumes a flat penetration rate (15% of sales), and only one efficiency level, over the forecast period. The RAC penetrations in the table are LBNL estimates.

11 Sum of the penetration rates for all programs that affect the electric cooling end use, with the exception of NAECA standards. The programs that are included in the sum are: tax credits, utility/other programs, and the ENERGY STAR HVAC program.

12 The ENERGY STAR gas furnace efficiency level of 90 AFUE is assumed to be cost-effective only in single-family homes in colder climates (defined as climates with more than 4000 heating degree days (base 65F)). We estimated the percent of all existing homes with gas furnaces that are single-family and located in climate zones with > 4000 HDD to be 45.7%, from a query of the 1990 RECS survey electronic database (US DOE 1993a). From this number, we subtracted the percent of all gas furnace replacements in 1999 that were of efficiency 90 AFUE or higher (24% -- see Note below). We assume that all of the 90 AFUE or higher efficiency gas furnace replacements in the CEF-NEMS reference case in 2000 were installed in single-family homes in cold climates. Thus, the maximum feasible penetration for the ENERGY STAR HVAC program, as a percent of all house types, is 45.7% - 24%, or 21.7%. This is in addition to the 24% of replacements that are assumed in the frozen efficiency (CEF-NEMS reference) case, which we do not include, nor should we include, in the policy case. Our penetration forecast from 2000-2006 is 100% of the latest EPA ENERGY STAR program penetration forecast (LBNL spreadsheets dated June 1999, US EPA 1999c). The EPA forecast that we used includes only shipments due to the ENERGY STAR HVAC program (it does not include shipments due to the ENERGY STAR New Homes program). In 2007, EPA's ENERGY STAR HVAC program forecast exceeds the maximum feasible level of 21.7%, so we assumed that the maximum achievable penetration would be achieved in 2007 and remain at that level through 2020.
Note: An input file to the NEMS model provides shipment data for gas furnace replacements at 4 different efficiency levels. 90 AFUE was not one of the four efficiency levels, so we used data for the two efficiency levels nearest to 90 (88 AFUE and 96 AFUE). In the CEF-NEMS reference case, 70.4% of all gas furnace replacements of efficiency 88 AFUE or higher had efficiency of 88 AFUE, and the remaining 29.6% had efficiency of 96 AFUE. The shipment-weighted average efficiency for replacement units is thus (0.704*88+0.296*96), or 90.4 AFUE. 24% of all 1999 gas furnace replacements had an AFUE of 88 or higher in the CEF-NEMS reference case. Since the shipment-weighted average is close to 90 AFUE, we used 24% as our estimate of the percent of all replacements that would qualify for ENERGY STAR in the frozen efficiency case. This number is consistent with the latest EPA ENERGY STAR program penetration forecast (LBNL spreadsheets dated June 1999, US EPA 1999c), which assumes that 26% of all 90 AFUE or higher efficiency gas furnace shipments in 1999 were not due to the ENERGY STAR HVAC program.

Table B-1.1.adv Notes, continued

Another source (Suozzo 1998, p. 51) assumes the current market share of ENERGY STAR furnaces is 25%. No other shipment data by efficiency level were available.

13 The ENERGY STAR gas boiler efficiency level of 86 AFUE is assumed to be cost-effective only in some single- and multi-family homes in colder climates (defined as climates with more than 4000 heating degree days (base 65F)). The percent of all existing homes with gas boilers that are single-family and located in climate zones with > 4000 HDD is 34.0%, from a query of the 1990 RECS survey electronic database (US DOE 1993a). Also, from the same database, the percent of all existing homes with gas boilers that are multifamily and have over 4000 HDD is 49.3%. We assume in the Advanced case that the ENERGY STAR gas boiler program will be able to capture a maximum of 1/3 of the cold-climate multifamily annual replacements and 2/3 of the cold-climate single-family annual replacements. Thus, the maximum percent of feasible applications is (1/3)*49.3+(2/3)*34.0%, or 39.1%. From this number, we subtracted our estimate of the current market share of ENERGY STAR gas boilers in cold climates (15%, see note below) to obtain our maximum penetration rate of 24.1%, which we assume will be achieved in 2020. Our penetration forecast from 2000-2007 is 100% of the latest EPA ENERGY STAR program penetration forecast (US EPA 1999c). This forecast includes only shipments due to the ENERGY STAR HVAC program (it does not include shipments due to the ENERGY STAR New Homes program). In 2008, EPA's ENERGY STAR HVAC program forecast exceeds the maximum feasible penetration, therefore we could not use the forecast after 2007. The penetrations between 2007 and 2020 were linearly interpolated.
Note: An input file used by the NEMS model provides shipment data for gas boiler replacements at 3 different efficiency levels. The closest NEMS efficiencies to the ENERGY STAR efficiency of 86 AFUE were 80 AFUE and 95 AFUE. The replacement market penetration of gas boilers in 1999 is 9.7% for 95 AFUE and 19% for 80 AFUE in the CEF-NEMS reference case. The market penetration of 86 AFUE gas boilers in the latest EPA ENERGY STAR program penetration forecast (LBNL spreadsheets dated June 1999, US EPA 1999c) is 2.9% in 1999. We chose to use the higher of the two estimates (CEF-NEMS), and roughly interpolated between the two closest NEMS efficiency levels to obtain our estimate that 86 AFUE units have a market penetration of 15% in 1999 in the reference case. No other shipment data by efficiency level were available.

14 The ENERGY STAR oil furnace efficiency level of 90 AFUE is assumed to be cost-effective only in single-family homes in colder climates (defined as climates with more than 4000 heating degree days (base 65F)). (It may be cost-effective in multifamily homes in colder climates, but less than 6% of oil furnaces in climates with more than 4000 HDD are found in multifamily buildings (US DOE 1993a), so we ignored this.) The percent of all existing homes with oil furnaces that are single-family and located in climate zones with > 4000 HDD is 59.5%, from a query of the 1990 RECS survey electronic database (US DOE 1993a). From this number, we subtracted the percent of all oil furnace replacements in 1999 that were of efficiency 90 AFUE or higher (2.9% -- see Note below). We assume in the Advanced case that the ENERGY STAR oil furnace program will be able to capture a maximum of 2/3 of the cold-climate single-family replacements in each year. Thus, the maximum feasible penetration for the ENERGY STAR program, as a percent of all house types, is (2/3)*59.5% - 2.9%, or 36.7%. Our penetration forecast from 2000-2010 is 100% of the latest EPA ENERGY STAR program penetration forecast (US EPA 1999c). This forecast includes only shipments due to the ENERGY STAR HVAC program (it does not include shipments due to the ENERGY STAR New Homes program).
The EPA forecast was only available out to 2010. After 2010, we assumed a linear increase in penetration up to the maximum penetration, which we assumed would be achieved in 2020.
Note: The current market penetration of ENERGY STAR oil furnaces is 2.9% in 1999, from the latest EPA ENERGY STAR program penetration forecast (LBNL spreadsheets dated June 1999, US EPA 1999c). We assume that all of the ENERGY STAR oil furnace replacements in 1999 were installed in single-family homes in cold climates, thus we subtract the full 2.9% from our feasible penetration. Shipments of 90 AFUE or higher efficiency oil furnaces were not available in the CEF-NEMS model. The CEF-NEMS reference case assumes there are no oil furnaces above 87 AFUE. No other shipment data by efficiency were available.

15 The ENERGY STAR oil boiler efficiency level of 86 AFUE is assumed to be cost-effective only in some single- and multi-family homes in colder climates (defined as climates with more than 4000 heating degree days (base 65F)). The percent of all existing homes with oil boilers that are single-family and located in climate zones with > 4000 HDD is 52.4%, from a query of the 1990 RECS survey electronic database (US DOE 1993a). Also, from the same database, the percent of all existing homes with oil boilers that are multifamily and have over 4000 HDD is 27.8%. We assume in the Advanced case that the ENERGY STAR gas boiler program will be able to capture a maximum of 1/3 of the cold-climate multifamily annual replacements and 2/3 of the cold-climate single-family annual replacements. Thus, the maximum percent of feasible applications is (1/3)*27.8+(2/3)*52.4%, or 44.2%. From this number, we subtracted our estimate of the current market share of ENERGY STAR gas boilers in cold climates (33%, see note below) to obtain our maximum penetration rate of 11.2%. Our penetration forecast from 2000-2010 is 100% of the latest EPA ENERGY STAR program penetration forecast (US EPA 1999c). This forecast includes only shipments due to the ENERGY STAR HVAC program (it does not include shipments due to the ENERGY STAR New Homes program). The EPA forecast was only available out to 2010.
After 2010, we assumed a linear increase in penetration up to the maximum penetration, which we assumed would be achieved in 2020.
Note: An input file to the NEMS model provides shipments of oil boiler replacements at 3 different efficiency levels. The closest NEMS efficiencies to the ENERGY STAR efficiency of 86 AFUE were 80 AFUE and 95 AFUE. The replacement market penetration of oil boilers in 1999 is 11.2% for 95 AFUE and 19.2% for 80 AFUE in the CEF-NEMS reference case. This is a total of 30.4% of replacements that have an efficiency of 80 or higher, with a shipment-weighted efficiency of 85.5, which is very near the ENERGY STAR level. The market penetration of 86 AFUE oil boilers in the latest EPA ENERGY STAR program penetration forecast (LBNL spreadsheets dated June 1999, US EPA 1999c) is 33% in 1999. This is close to the penetration in the CEF-NEMS reference case. To be conservative, we chose to use the higher of the two estimates (33%), and we assumed that all of the 1999 replacements were in cold climates, so we subtract the full 33% from our maximum feasible penetration estimate. No other shipment data by efficiency level were available.

16 We assume that the NAECA standards for furnaces and boilers will not be updated during the forecast period. While it may be cost-effective in most applications to improve the NAECA standard AFUE for gas furnaces from 78 to 80, the frozen efficiency in 2000 for gas furnaces is already well above 80 AFUE, so that a future NAECA standard of 80 AFUE would have no effect on this analysis. Efficiencies over 80 AFUE tend to require modifications in replacement applications that make them generally not cost-effective except in colder climates, therefore we assumed it was unlikely that a NAECA standard above 80 AFUE would occur during the forecast period.

Table B-1.2.mod: New Residential Building HVAC End Use Moderate Case Market Penetrations

Program		House	Notes	Annual Penetration Rate[2]																			
Name	Effic. Level	Type[1]		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mandatory Programs																							
Building Code	1993 or 1995 MEC	SF, MF, MH	3, 4	26.5%	27.0%	27.4%	27.7%	28.0%	28.1%	28.2%	28.3%	28.4%	28.4%	28.9%	29.7%	30.5%	31.2%	32.0%	32.8%	33.6%	34.4%	35.2%	36.0%	36.8%
Building Code	1998 IECC	SF, MF, MH	3, 5	6.2%	6.3%	6.4%	6.7%	7.0%	7.5%	8.0%	8.5%	9.0%	9.5%	9.6%	9.9%	10.2%	10.4%	10.7%	10.9%	11.2%	11.5%	11.7%	12.0%	12.3%
Building Code	future IECC	SF, MF, MH	3, 6	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Voluntary Programs (not including R&D effect) [1,2]																							
Building America	30%-50% better than 1993 MEC	SF	7	0.1%	0.1%	0.2%	0.4%	0.6%	0.9%	1.4%	1.4%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.9%	1.9%	1.9%	2.1%	2.3%	2.5%
ENERGY STAR New Homes	30% better than 1993 MEC	SF	9	1.1%	2.0%	2.9%	3.8%	4.7%	5.4%	6.0%	6.3%	6.3%	6.3%	6.3%	6.3%	6.4%	6.7%	7.3%	7.7%	8.8%	9.9%	10.8%	11.6%	12.5%
ENERGY STAR New Homes	30% better than 1993 MEC	MH	10	0.1%	0.6%	1.1%	1.6%	2.1%	2.4%	2.6%	2.7%	2.7%	2.7%	2.7%	2.7%	2.7%	2.7%	2.9%	3.0%	3.5%	3.9%	4.4%	4.6%	5.0%
ENERGY STAR New Homes	30% better than 1993 MEC	MF	11	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.7%	1.1%	1.2%	1.3%	1.3%	1.4%	1.5%	1.5%	1.5%	1.9%	2.0%	2.2%	2.5%
Tax Credit for new homes																							
Tax Credit (new homes)	30% better than 1998 IECC	SF, MH	8	0.73%	0.89%	0.04%	0.04%	0.04%	0.04%	0.04%	0.04%	0.04%	0.04%	0.04%	0.04%	0.04%	0.04%	0.04%	0.04%	0.04%	0.04%	0.04%	0.04%	0.04%
Tax Credit (new homes)	40% better than 1998 IECC	SF, MH	8	0.20%	0.24%	1.23%	0.06%	0.06%	0.06%	0.06%	0.06%	0.06%	0.06%	0.06%	0.06%	0.06%	0.06%	0.06%	0.06%	0.06%	0.06%	0.06%	0.06%	0.06%
Tax Credit (new homes)	50% better than 1998 IECC	SF, MH	8	0.05%	0.06%	0.31%	1.99%	2.66%	0.13%	0.13%	0.13%	0.13%	0.13%	0.13%	0.13%	0.13%	0.13%	0.13%	0.13%	0.13%	0.13%	0.13%	0.13%	0.13%
Sum of Voluntary and Tax Credit Programs																							
Single-Family	-	SF	13	2.2%	3.3%	4.7%	6.3%	8.1%	6.5%	7.6%	8.0%	8.4%	8.4%	8.4%	8.3%	8.5%	8.8%	9.4%	9.8%	10.9%	12.1%	13.1%	14.1%	15.2%
Manfuactured	-	MH	13	1.1%	1.8%	2.7%	3.7%	4.8%	2.6%	2.9%	3.0%	3.0%	2.9%	2.9%	2.9%	2.9%	2.9%	3.1%	3.2%	3.7%	4.1%	4.6%	4.8%	5.2%
Multifamily	-	MF	13	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.7%	1.1%	1.2%	1.3%	1.3%	1.4%	1.5%	1.5%	1.5%	1.9%	2.0%	2.2%	2.5%
Increased R&D Funding for Whole-House Measures [1,4]																							
Building America	30%-50% better than 1993 MEC	SF	15	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.5%	0.8%	1.5%	1.7%	1.9%	3.5%	4.2%	4.9%	5.6%	6.3%	7.0%	7.7%	8.2%	9.0%	10.0%
ENERGY STAR New Homes	30% better than 1993 MEC	SF	16	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.5%	1.0%	1.9%	2.8%	4.2%	5.5%	6.6%	7.8%	8.7%	9.8%	10.2%	10.6%	11.2%	11.9%	12.5%
ENERGY STAR New Homes	30% better than 1993 MEC	MH	16	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.4%	0.8%	1.3%	1.8%	2.3%	2.8%	3.3%	3.8%	4.1%	4.5%	4.5%	4.6%	4.6%	4.9%	5.0%
ENERGY STAR New Homes	30% better than 1993 MEC	MF	16	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.5%	0.8%	1.1%	1.3%	1.7%	2.0%	2.0%	2.2%	2.4%	2.5%

Notes

1 Program penetration rates apply only to the house type(s) specified. SF=Single-family, MF=Multi-family, MH=Manufactured Home.

2 Annual penetration rate is the percent of new homes of specified house type built in each year that were affected by the program. Building codes are a mandatory program, thus they were assumed to be implemented first, before any voluntary program implementation. Energy savings due to the voluntary programs were reduced by the savings due to the mandatory programs (i.e., energy saved by a voluntary program was calculated using a new baseline energy consumption in each year that accounts for the implementation of the mandatory programs).
Voluntary program penetration rates are independent of other voluntary programs, i.e., each new home affected by a voluntary program is assumed to be affected by only one program. So, even though a Building America home by definition qualifies as an ENERGY STAR home, it was not counted as an ENERGY STAR home in the penetration rates. This is because we have already taken into account the relationship between programs in forecasting penetration rates and have attributed the penetrations accordingly between programs.
Programs that target HVAC equipment only, such as the Treasury Department's equipment tax credits and the ENERGY STAR HVAC equipment program, were included only in the existing home analysis, not in the new home analysis. Builders are responsible for choosing the equipment efficiency in a new home, and we assumed that builders would be more likely to participate in a whole-house program (such as ENERGY STAR new homes, the tax credit for new homes, or Building America) so they can market the whole house as being more energy-efficient, rather than providing just an equipment upgrade. Homeowners, however, were assumed to be much more likely than builders to participate in equipment programs because they will reap the benefits of the additional cost every month in the form of lower utility bills.

3 We estimated that the current percentage of all housing starts in the U.S. that are affected by a building code having a stringency equal to the 1993 Model Energy Code (MEC) or higher to be 47%. This was based on the current state-level adoption of codes from the Building Codes Assistance Project (BCAP 1999). States and localities that have currently adopted standards lower than the 1993 MEC were ignored since these codes are not much more stringent than current construction practices. States and jurisdictions that have developed their own codes that are more stringent than the 1995 MEC were assumed to be equivalent to the 1998 IECC. We weighted the state-level code penetrations by the privately-owned housing starts by state in 1997 from the US Bureau of the Census (1997).
We used the 47% penetration as our base case level, and forecasted increased adoption of 1993 MEC or better codes such that by 2010, 55% of all housing starts

Table B.1.2.mod Notes, continued

would be subject to such codes, increasing to 70% of housing starts in 2020, in the Moderate case. Additionally, we assumed that the enforcement of building codes was only 70% on average - i.e., 30% of homes in states or jurisdictions that require these codes will get away with not building to code requirements. The complete penetration forecast from 2000-2020 is shown below.

	Forecasted Annual Penetration Rate of Building Codes equivalent to 1993 MEC or better (Moderate Case)																				
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Not including enforcement	47%	48%	48%	49%	50%	51%	52%	53%	53%	54%	55%	57%	58%	60%	61%	63%	64%	66%	67%	69%	70%
Including 70% enforcement rate	33%	33%	34%	34%	35%	36%	36%	37%	37%	38%	39%	40%	41%	42%	43%	44%	45%	46%	47%	48%	49%

The penetration forecast of 1993 MEC or better codes was attributed to the 3 different code levels (1993/1995 MEC, 1998 IECC, and future IECC) as shown in the following table. Source: LBNL assumptions.
In the Moderate case, we assume the IECC code will not be updated during the forecast period.

	Estimated Percent of Housing Starts Subject to 1993 MEC or Better Codes by Building Code Level (Moderate Case)																				
Building Code Level	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1993 or 1995 MEC	81%	81%	81%	81%	80%	79%	78%	77%	76%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%
1998 IECC	19%	19%	19%	20%	20%	21%	22%	23%	24%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
Future IECC	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

The final penetration rates shown in Table B-1.2.mod were calculated by multiplying the "Including 70% enforcement rate" forecast by the 'Estimated percent of housing starts subject to 1993 MEC or better codes by building code level". For example, the forecasted penetration of the 1998 IECC code in 2009 is 38% * 25% = 9.5%.

4 Penetration forecast of percent of all housetypes subject to either the 1993 or 1995 version of the CABO Model Energy Code. 1993 and 1995 MEC are for the most part identical in the areas that affect energy consumption. For simplicity, we aggregated these two codes.

5 Penetration forecast of percent of all housetypes subject to the 1998 International Code Council's International Energy Conservation Code (IECC).

6 Penetration forecast of percent of all housetypes subject to a future, substantial update, of the International Code Council's International Energy Conservation Code (IECC). In the Moderate case, we assume the IECC code will not be updated during the forecast period.

7 Building America program penetration rates from 2000-2010 were assumed to be 50% of DOE's official penetration forecast (Anderson 1999). The DOE forecasted penetration was higher in 2009 than in 2010, and we were unable to obtain a reason from DOE for this anomaly, so we reduced the 2009 penetration rate in order to make the forecast more smooth. The forecast shown assumes current levels of R&D funding. We assume there will be an increase in R&D funding for whole-house efficiency measures which will increase the penetration of homes built to the Building America efficiency level; we assume this will start to have an effect on the market in 2005. The additional penetration due to increases in R&D funding is shown separately in this table (see Note 14). The total penetration in 2005-2010 is still 50% of the DOE forecast, however it has been divided up between R&D and the DOE program (based on LBNL estimates). The penetration forecast from 2011-2020 is based on LBNL estimates. (DOE did not forecast beyond 2010.)

8 The forecasted total tax credit penetration for new homes (for all tax credit levels) was based on the U.S. Treasury Department forecast of the total number of homes in the program (Auten 1999). The program was assumed to apply only to single-family and manufactured housing starts based on discussion with the Treasury Department. We assumed in the Moderate case that 50% of the Treasury Department forecast could be achieved (the penetration forecast in the table above include the 50% achievability factor).
Additionally, we assumed that the tax credit program would contribute to a small amount of market transformation. That is, we assume that some builders would continue to build homes to the tax credit levels after the program ends, due to demand established in part by the program. We account for this residual effect of the program by assuming that all tax credit program levels would have a constant residual penetration rate from the end of each program out to 2020. The residual rate was assumed to be 5% of the penetration rate achieved in the final year of each level of the program. Thus, the residual penetration of the 40% better than IECC level is 5% of the forecasted penetration rate in 2002 (1.2%), or 0.06%. The residual penetrations vary by program efficiency level.
The Treasury Department's forecast of total number of homes in the program were estimated by LBNL to be apportioned to the program's three efficiency levels (30% more efficient than the 1998 IECC, 40% more efficient than the 1998 IECC, and 50% more efficient than the 1998 IECC), as shown in the table below. These assumptions apply to the Moderate and Advanced cases.

Program	Program Efficiency Level		
Year(s)	30% >	40% >	50% >
2000, 2001	75%	20%	5%
2002	-	80%	20%
2003, 2004	-	-	100%

The program, as proposed by the Treasury Department, consists of three efficiency levels, all based on the 1998 IECC code. The program offers the three levels during different time periods. The levels are: 30% better than IECC, available only in 2000 and 2001; 40% better than IECC, available for three years from 2000 through 2002; and 50% better than IECC, available for 5 years (from 2000 through 2004). Program years and efficiency levels are from the U.S. Treasury Department proposals (US DOT 1999). For the years in which more than one program level is available, we estimated the percent of homes built to each level. For example, in the first two years of the program (when program participants can choose from all three efficiency levels), we assumed that 75% of homes in the program would be built to the 30% better than IECC level, 20% to the 40% better than IECC level, and the remaining 5% to the 50% better than IECC level.

9 The penetration forecast for single-family ENERGY STAR new homes in the Moderate case is assumed to be considerably lower than EPA's forecast. EPA forecasts that, by 2012, 75% of all new single family starts will comply with the current ENERGY STAR new home program requirements and be attributable to the ENERGY STAR program (in EPA's forecast, an additional 25% of new homes in 2012 would comply with the ENERGY STAR requirements, but should be attributed to programs other than ENERGY STAR). For the Moderate case, we assume a lower penetration forecast. We assume that 25% of new single-family homes will comply with current ENERGY STAR requirements by 2020. We assume that half of this penetration (12.5% out of 25%) will be attributable to the ENERGY STAR program and the other half will be attributable to the increased R&D funding. The increased R&D funding program forecast is shown separately in the table (see Note 16).

10 The ENERGY STAR manufactured home forecast is based on LBNL estimates. (No EPA forecast was available.) By 2020, we assume that 10% of all new manufactured homes will comply with the current ENERGY STAR guidelines, but only half of the 10% penetration may be attributed to the EPA ENERGY STAR program. The remaining half is assumed to occur because of a program which increases R&D funding for whole-house efficiency measures. The increased R&D funding program penetration forecast is shown separately in the table. See Notes 14 and 16 for more information on the R&D funding program.

Table B.1.2.mod Notes, continued

11 The ENERGY STAR program applies to all single-family and manufactured homes, but to multifamily homes only if the unit is in a building 3 stories high or less and the unit is individually heated and cooled. LBNL estimated from a combination of C-25 (U.S. Bureau of the Census 1998) and 1993 RECS data (US DOE 1995a) that 50% of multifamily units built each year would qualify for the ENERGY STAR program under the current guidelines (see "Note: " below for the derivation of this number). Our penetration forecast for ENERGY STAR multifamily units is based on LBNL estimates (no EPA forecast is available for multifamily). We assumed that by 2020, 9.8% of eligible new multifamily homes would be built to ENERGY STAR requirements, and that this penetration would be achieved only through a combination of the EPA program and increased R&D funding. Since we assume that only 50% of all new MF units would be eligible for the ENERGY STAR program, the penetration in 2020 is actually 4.9%, as a percent of all new multifamily units. We assumed that half of the penetration in 2020 (2.45% out of the 4.9% total) would be attributed to the ENERGY STAR program, while the other half would be attributable to the increased funding for R&D. See note 16 for more information about the increased R&D funding program, whose forecast is shown separately in this table.

Note: From the C-25 data, we obtained the number of multifamily housing starts in 1997 that were condos or apartments (the C-25 data set only has this information for buildings that have 5 or more units, but we assumed the relative percentage of condo vs apartment units applied equally to all buildings regardless of number of units). Also from the C-25 data, we obtained the percent of apartment unit starts in 1997 for which the electricity or gas bills were not included in the rent. We assumed that if the utility bill was not included in the rent, then the units were individually metered, thus individually heated and cooled. The C-25 data did not include metering information for condominium units, so we assumed that 95% of fuel-heated and 95% of electric-heated condominium units are individually metered. In addition, we assumed that 90% of new condominium units and 50% of new apartment units are in buildings of 3 stories or less (no data on this was available in C-25 or RECS). The C-25 for 1997 new multifamily units estimates that 45% of new multifamily units are fuel-heated and 55% are electric-heated (US Bureau of the Census 1998). We calculated our eligibility estimate of 50% by putting together all of this information.

12 These are the penetration rates due to the ENERGY STAR and Building America programs, assuming current R&D funding levels. They do not include additional penetrations for these programs which were attributed to increased levels of funding for R&D (see Note 14).

13 This is the sum of the voluntary and tax credit program penetrations in the Moderate case. The following programs are summed: tax credits, ENERGY STAR new homes, and Building America. Penetrations are presented by house type. Additional penetrations due to increased levels of R&D funding (see Note 14) were not included.

14 In the Moderate Case, we assume there is a 50% increase in R&D funding for new home efficiency improvements over current funding levels. We assume that the increased funding begins to have an effect in the year 2005. We assume that the funding increase will bring down the incremental costs (see Table C-1.4.mod) and, as a consequence, increase the penetration rates of new homes that meet the ENERGY STAR and Building America efficiency levels above what the penetrations would have been without increased R&D funding. We assume that increased R&D funding will not affect building code penetration levels because building code efficiency levels are too low to be significantly affected by R&D. While we recognize that increased R&D funding is likely to increase the penetration of new home tax credits, we did not include this in our analysis. Here we show the additional penetration rate for the ENERGY STAR and Building America programs that is attributable to the increase in R&D funding but not directly to the program.

15 This is the penetration rate for the Building America program that is due solely to a 50% increase in R&D funding for whole-house efficiency measures over current funding levels. The penetration forecast is an LBNL estimate. Increased R&D funding is assumed to have an effect on the market starting in the year 2005.

16 This is the penetration forecast for the ENERGY STAR new home program that is due solely to a 50% increase in R&D funding for whole-house efficiency measures over current funding levels. The penetration forecasts are LBNL estimates. Increased R&D funding is assumed to have an effect on the single-family and manufactured housing markets starting in 2005, and starting in 2010 for multifamily homes. (The ENERGY STAR multifamily home program is assumed to start in 2007 in the Moderate case; we assume a lag time of 3 years before the increase in R&D funding will begin to affect the ENERGY STAR multifamily homes.)

Table B-1.2.adv: New Residential Building HVAC End Use Advanced Case Market Penetrations

Program		House	Notes	Annual Penetration Rate[2]																			
Name	Effic. Level	Type[1]		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mandatory Programs																							
Building Code	1993 or 1995 MEC	SF, MF, MH	3, 4	26.5%	27.3%	27.8%	28.4%	28.8%	29.1%	29.1%	29.0%	28.9%	29.2%	28.5%	28.1%	27.7%	27.1%	26.4%	25.7%	24.9%	24.0%	23.0%	21.9%	20.7%
Building Code	1998 IECC	SF, MF, MH	3, 5	6.2%	6.3%	6.7%	7.1%	7.6%	8.2%	9.2%	10.2%	11.2%	11.5%	11.8%	12.2%	12.5%	12.9%	13.3%	13.7%	14.1%	14.5%	14.9%	15.3%	15.7%
Building Code	future IECC	SF, MF, MH	3, 6	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	1.7%	3.1%	4.6%	6.2%	7.8%	9.6%	11.4%	13.3%	15.3%	17.4%	19.6%
Voluntary Programs (not including R&D effect) [1,2]																							
Building America	30%-50% better than 1993 MEC	SF	7	0.1%	0.2%	0.3%	0.7%	1.0%	1.4%	2.4%	2.4%	2.9%	2.9%	2.9%	3.5%	3.5%	3.7%	3.9%	4.0%	4.2%	4.9%	4.9%	5.0%	5.0%
ENERGY STAR New Homes	30% better than 1993 MEC	SF	9	2.3%	2.7%	3.3%	4.0%	5.4%	6.1%	7.2%	9.7%	12.4%	15.0%	15.0%	16.0%	17.0%	19.0%	22.0%	24.5%	27.0%	29.9%	32.3%	34.9%	37.5%
ENERGY STAR New Homes	30% better than 1993 MEC	MH	10	0.3%	3.3%	6.2%	9.2%	12.2%	14.9%	17.6%	20.1%	21.1%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	23.5%	25.0%	26.5%	28.2%	30.0%
ENERGY STAR New Homes	30% better than 1993 MEC	MF	11	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	1.1%	1.7%	2.1%	2.3%	2.4%	3.0%	3.4%	3.6%	3.9%	4.4%	4.8%	5.2%	5.8%	6.3%
Tax Credit for new homes																							
Tax Credit (new homes)	30% better than 1998 IECC	SF, MH	8	1.17%	1.43%	1.84%	2.39%	0.12%	0.12%	0.12%	0.12%	0.12%	0.12%	0.12%	0.12%	0.12%	0.12%	0.12%	0.12%	0.12%	0.12%	0.12%	0.12%	0.12%
Tax Credit (new homes)	40% better than 1998 IECC	SF, MH	8	0.31%	0.38%	0.49%	0.64%	3.41%	4.69%	0.23%	0.23%	0.23%	0.23%	0.23%	0.23%	0.23%	0.23%	0.23%	0.23%	0.23%	0.23%	0.23%	0.23%	0.23%
Tax Credit (new homes)	50% better than 1998 IECC	SF, MH	8	0.08%	0.10%	0.12%	0.16%	0.85%	1.17%	7.80%	8.15%	9.18%	10.25%	0.51%	0.51%	0.51%	0.51%	0.51%	0.51%	0.51%	0.51%	0.51%	0.51%	0.51%
Sum of Voluntary and Tax Credit Programs																							
Single-Family	-	SF	13	3.9%	4.8%	6.1%	7.9%	10.8%	13.5%	17.8%	20.6%	24.8%	28.5%	18.7%	20.4%	21.4%	23.5%	26.8%	29.3%	32.1%	35.7%	38.0%	40.8%	43.4%
Manfuactured	-	MH	13	1.9%	5.2%	8.7%	12.4%	16.6%	20.8%	25.8%	28.6%	30.6%	32.6%	22.9%	22.9%	22.9%	22.9%	22.9%	22.9%	24.4%	25.9%	27.4%	29.1%	30.9%
Multifamily	-	MF	13	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	1.1%	1.7%	2.1%	2.3%	2.4%	3.0%	3.4%	3.6%	3.9%	4.4%	4.8%	5.2%	5.8%	6.3%
Increased R&D Funding for Whole-House Measures [1,4]																							
Building America	30%-50% better than 1993 MEC	SF	15	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.6%	1.1%	2.4%	2.7%	3.1%	5.0%	6.1%	7.1%	8.0%	9.1%	10.0%	10.4%	11.6%	13.0%	15.0%
ENERGY STAR New Homes	30% better than 1993 MEC	SF	16	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.8%	1.3%	2.6%	5.0%	10.0%	14.0%	18.0%	21.0%	23.0%	25.5%	28.0%	30.1%	32.7%	35.1%	37.5%
ENERGY STAR New Homes	30% better than 1993 MEC	MH	16	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.5%	1.0%	3.0%	5.0%	8.0%	11.0%	14.0%	17.0%	20.0%	23.0%	24.5%	26.0%	27.5%	28.8%	30.0%
ENERGY STAR New Homes	30% better than 1993 MEC	MF	16	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.7%	1.4%	2.2%	2.4%	2.9%	3.5%	4.1%	4.5%	5.0%	5.4%	5.7%	6.3%

Notes

1 Program penetration rates apply only to the house type(s) specified. SF=Single-family, MF=Multi-family, MH=Manufactured Home.

2 Annual penetration rate is the percent of new homes of specified house type built in each year that were affected by the program. Building codes are a mandatory program, thus they were assumed to be implemented first, before any voluntary program implementation. Energy savings due to the voluntary programs were reduced by the savings due to the mandatory programs (i.e., energy saved by a voluntary program was calculated using a new baseline energy consumption in each year that accounts for the implementation of the mandatory programs).
Voluntary program penetration rates are independent of other voluntary programs, i.e., each new home affected by a voluntary program is assumed to be affected by only one program. So, even though a Building America home by definition qualifies as an ENERGY STAR home, it was not counted as an ENERGY STAR home in the penetration rates. This is because we have already taken into account the relationship between programs in forecasting penetration rates and have attributed the penetrations accordingly between programs.
Programs that target HVAC equipment only, such as the Treasury Department's equipment tax credits and the ENERGY STAR HVAC equipment program, were included only in the existing home analysis, not in the new home analysis. Builders are responsible for choosing the equipment efficiency in a new home, and we assumed that builders would be more likely to participate in a whole-house program (such as ENERGY STAR new homes, the tax credit for new homes, or Building America) so they can market the whole house as being more energy-efficient, rather than providing just an equipment upgrade. Homeowners, however, were assumed to be much more likely than builders to participate in equipment programs because they will reap the benefits of the additional cost every month in the form of lower utility bills.

3 We estimated that the current percentage of all housing starts in the U.S. that are affected by a building code having a stringency equal to the 1993 Model Energy Code (MEC) or higher to be 47%. This was based on the current state-level adoption of codes from the Building Codes Assistance Project (BCAP 1999). States and localities that have currently adopted standards lower than the 1993 MEC were ignored since these codes are not much more stringent than current construction practices. States and jurisdictions that have developed their own codes that are more stringent than the 1995 MEC were assumed to be equivalent to the 1998 IECC. We weighted the state-level code penetrations by the privately-owned housing starts by state in 1997 from the US Bureau of the Census (1997).
We used the 47% penetration as our base case level, and forecasted increased adoption of 1993 MEC or better codes such that by 2010, 60% of all housing starts would be subject to such codes, increasing to 80% of housing starts in 2020, in the Advanced case. Additionally, we assumed that the enforcement of building codes was only 70% on average - i.e., 30% of

Table B.1.2.adv Notes, continued

homes in states or jurisdictions that require these codes will get away with not building to code requirements. The complete penetration forecast from 2000-2020 is shown below.

	Forecasted Annual Penetration Rate of Building Codes equivalent to 1993 MEC or better (Advanced Case)																				
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Not including enforcement	47%	48%	49%	51%	52%	53%	55%	56%	57%	59%	60%	62%	64%	66%	68%	70%	72%	74%	76%	78%	80%
Including 70% enforcement rate	33%	34%	35%	35%	36%	37%	38%	39%	40%	41%	42%	43%	45%	46%	48%	49%	50%	52%	53%	55%	56%

The penetration forecast of 1993 MEC or better codes was attributed to the 3 different code levels (1993/1995 MEC, 1998 IECC, and future IECC) as shown in the following table. Source: LBNL assumptions.
In the Advanced case, we assume the IECC code will be updated sometime before 2009 but will begin to be adopted by some states and jurisdictions in 2009.

	Estimated Percent of Housing Starts Subject to 1993 MEC or Better Codes by Building Code Level (Advanced Case)																				
Building Code Level	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1993 or 1995 MEC	81%	81%	81%	80%	79%	78%	76%	74%	72%	71%	68%	65%	62%	59%	56%	52%	49%	46%	43%	40%	37%
1998 IECC	19%	19%	20%	20%	21%	22%	24%	26%	28%	28%	28%	28%	28%	28%	28%	28%	28%	28%	28%	28%	28%
Future IECC	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	4%	7%	10%	13%	16%	20%	23%	26%	29%	32%	35%

The final penetration rates shown in Table B-1.2.adv were calculated by multiplying the "Including 70% enforcement rate" forecast by the 'Estimated percent of housing starts subject to 1993 MEC or better codes by building code level". For example, the forecasted penetration of the 1998 IECC code in 2009 is 41% * 28% = 11.5%.

4 Penetration forecast of percent of all housetypes subject to either the 1993 or 1995 version of the CABO Model Energy Code. 1993 and 1995 MEC are for the most part identical in the areas that affect energy consumption. For simplicity, we aggregated these two codes.

5 Penetration forecast of percent of all housetypes subject to the 1998 International Code Council's International Energy Conservation Code (IECC).

6 Penetration forecast of percent of all housetypes subject to a future, substantial update, of the International Code Council's International Energy Conservation Code (IECC). In the Advanced case, we assume the IECC code will be updated sometime before 2009 but will begin to be adopted by some states and jurisdictions in 2009.

7 Building America program penetration rates from 2000-2010 were assumed to be 80% of DOE's official penetration forecast (Anderson 1999). The DOE forecasted penetration was higher in 2009 than in 2010, and we were unable to obtain a reason from DOE for this anomaly, so we reduced the 2009 penetration rate in order to make the forecast more smooth. The forecast shown assumes current levels of R&D funding. We assume there will be an increase in R&D funding for whole-house efficiency measures which will increase the penetration of homes built to the Building America efficiency level; we assume this will start to have an effect on the market in 2005. The additional penetration due to increases in R&D funding is shown separately in this table (see Note 14). The total penetration between 2005 and 2010 is still 80% of the DOE forecast, however it has been divided up between R&D and the DOE program (based on LBNL estimates). The penetration forecast from 2011-2020 is based on LBNL estimates. (DOE did not forecast beyond 2010.)

8 The forecasted total tax credit penetration for new homes (for all tax credit levels) is based on the U.S. Treasury Department forecast of the total number of homes in the program (Auten 1999). The program was assumed to apply only to single-family and manufactured housing starts based on discussion with the Treasury Department. We assumed in the Advanced case that 80% of the Treasury Department forecast could be achieved (the penetration forecast in the table above include the 80% achievability factor).
Additionally, we assumed that the tax credit program would contribute to a small amount of market transformation. That is, we assume that some builders would continue to build homes to the tax credit levels after the program ends, due to demand established in part by the program. We account for this residual effect of the program by assuming that all tax credit program levels would have a constant residual penetration rate from the end of each program out to 2020. The residual rate was assumed to be 5% of the penetration rate achieved in the final year of each level of the program. Thus, the residual penetration of the 40% better than IECC level is 5% of the forecasted penetration rate in 2005 (4.7%), or 0.2%. The residual penetrations vary by program efficiency level.
The Treasury Department's forecast of total number of homes in the program were estimated by LBNL to be apportioned to the program's three efficiency levels (30% more efficient than the 1998 IECC, 40% more efficient than the 1998 IECC, and 50% more efficient than the 1998 IECC), as shown in the table below. These assumptions apply to the Moderate and Advanced cases.

Program	Program Efficiency Level		
Year(s)	30% >	40% >	50% >
2000-2003	75%	20%	5%
2004-2005	-	80%	20%
2006-2009	-	-	100%

The program, as proposed by the Treasury Department, consists of three efficiency levels, all based on the 1998 IECC code. The program offers the three levels during different time periods. The levels are: 30% better than IECC, available only in 2000 and 2001; 40% better than IECC, available for three years from 2000 through 2002; and 50% better than IECC, available for 5 years (from 2000 through 2004). Program years and efficiency levels are from the U.S. Treasury Department proposals (US DOT 1999). For the Advanced case, we assumed that the Treasury Department would extend the program years beyond the current proposal. We assumed the program efficiency levels would remain the same as in the current proposal. We doubled the number of years of each tax credit level, so that level 1 is offered from 2000 through 2003, level 2 from 2000 through 2005, and level 3 from 2000 through 2009. For the years in which more than one program level is available, we estimated the percent of homes built to each level. For example, in the first four years of the program (when program participants can choose from all three efficiency levels), we assumed that 75% of homes in the program would be built to the 30% better than IECC level, 20% to the 40% better than IECC level, and the remaining 5% to the 50% better than IECC level.

9 The penetration forecast for single-family ENERGY STAR new homes in the Advanced case is loosely based on EPA's forecast. EPA forecasts that, by 2012, 75% of all new single family starts will comply with the current ENERGY STAR new home program requirements and be attributable to the ENERGY STAR program (in EPA's forecast, an additional 25% of new homes in 2012 would comply with the ENERGY STAR requirements, but should be attributed to programs other than ENERGY STAR). In the Advanced case, we assume that the 75% penetration level will be reached, but in 2020, not 2012, and only with the help of additional R&D funding (which we assume begins to have an effect in 2005 - see Note 14). We assume that the total penetration of 75% in 2020 is due to a combination of the EPA program and to the increased R&D funding. We estimate that half of the 75% penetration in 2020 is attributable to the EPA program alone (i.e., in the absence of increased R&D funding) and the remaining half is attributable to the increased R&D funding. The increased R&D funding penetration is shown separately in the table. We used EPA's penetration forecast for the year 2000 as a starting point; the rest of the forecast is based on LBNL estimates.

10 The ENERGY STAR manufactured home forecast is based on LBNL estimates. (No EPA forecast was available.) By 2020, we assume that 60% of all new manufactured homes will comply with the current ENERGY STAR guidelines, but that only half of the 60% penetration may be attributed to the EPA ENERGY STAR program. The remaining half is assumed to occur because of a program which increases R&D funding for whole-house efficiency measures. See Notes 14 and 16 for more information on the increased R&D funding program.

Table B.1.2.adv Notes, continued

11 The ENERGY STAR program applies to all single-family and manufactured homes, but to multifamily buildings only if the building is under 4 stories and the unit is individually heated and cooled.
LBNL estimated from a combination of C-25 (U.S. Bureau of the Census 1998) and 1993 RECS data (US DOE 1995a) that 50% of multifamily units built each year would qualify for the ENERGY STAR program under the current guidelines (see "Note: " below for the derivation of this number). Our penetration forecast for ENERGY STAR multifamily units is based on LBNL estimates (no EPA forecast is available for multifamily). We assumed that by 2020, 25% of eligible new multifamily homes would be built to ENERGY STAR requirements, and that this penetration would be achieved only through a combination of the EPA program and increased R&D funding. Since we assume that only 50% of all new MF units would be eligible for the ENERGY STAR program, the penetration in 2020 is actually 12.5%, as a percent of all new multifamily units. We assumed that half of the penetration in 2020 (6.25% out of the 12.5% total) would be attributed to the ENERGY STAR program, and the other half would be attributable to the increased funding for R&D. See note 16 for more information on the R&D forecast for multifamily homes.

Note: From the C-25 data, we obtained the number of multifamily housing starts in 1997 that were condos or apartments (the C-25 data set only has this information for buildings that have 5 or more units, but we assumed the relative percentage of condo vs apartment units applied equally to all buildings regardless of number of units). Also from the C-25 data, we obtained the percent of apartment unit starts in 1997 for which the electricity or gas bills were not included in the rent. We assumed that if the utility bill was not included in the rent, then the units were individually metered, thus individually heated and cooled. The C-25 data did not include metering information for condominium units, so we assumed that 95% of fuel-heated and 95% of electric-heated condominium units are individually metered. In addition, we assumed that 90% of new condominium units and 50% of new apartment units are in buildings of 3 stories or less (no data on this was available in C-25 or RECS). The C-25 for 1997 new multifamily units estimates that 45% of new multifamily units are fuel-heated and 55% are electric-heated (US Bureau of the Census 1998). We calculated our eligibility estimate of 50% by putting together all of this information.

12 These are the penetration rates due to the ENERGY STAR and Building America programs, assuming current R&D funding levels. They do not include additional penetrations for these programs which were attributed to increased levels of funding for R&D (see Note 14).

13 This is the sum of the voluntary and tax credit program penetrations in the Advanced case. The following programs are summed: tax credits, ENERGY STAR new homes, and Building America. Penetrations are presented by house type. Additional penetrations due to increased levels of R&D funding (see Note 14) were not included.

14 In the Advanced Case, we assume there is a 100% increase in R&D funding for new home efficiency improvements over current funding levels. We assume that the increased funding begins to have an effect in the year 2005. We assume that the funding increase will bring down the incremental costs (see Table C-1.4.adv) and, as a consequence, increase the penetration rates of new homes that meet the ENERGY STAR and Building America efficiency levels above what the penetrations would have been without increased R&D funding. We assume that increased R&D funding will not affect building code penetration levels because building code efficiency levels are too low to be significantly affected by R&D. While we recognize that increased R&D funding is likely to increase the penetration of new home tax credits, we did not include this in our analysis. Here we show the additional penetration rate for the ENERGY STAR and Building America programs that is attributable to the increase in R&D funding but not directly to the program.

15 This is the penetration rate for the Building America program that is due solely to a 100% increase in R&D funding for whole-house efficiency measures over current funding levels. The penetration forecast is an LBNL estimate. Increased R&D funding is assumed to have an effect on the market starting in the year 2005.

16 This is the penetration forecast for the ENERGY STAR new home program that is due solely to a 100% increase in R&D funding for whole-house efficiency measures over current funding levels. The penetration forecasts are LBNL estimates. Increased R&D funding is assumed to have an effect on the single-family and manufactured housing markets starting in 2005, and starting in 2008 for multifamily homes. (The ENERGY STAR multifamily home program is assumed to start in 2005 in the Advanced case; we assume a lag time of 3 years before the increase in R&D funding will begin to affect the ENERGY STAR multifamily homes.)

Introduction to the Residential non-HVAC Penetration Tables
(Tables B-1.3mod and B-1.3adv)

Penetration of the various policies considered in this analysis for residential non-HVAC end uses are presented in Tables B-1.3mod and B-1.3adv (moderate and advanced case assumptions, respectively. Policies are listed by end-use, so the same policy may appear several times (e.g. clothes washer standards appear under electric water heating, clothes washer machine energy and gas water heating).

Penetrations

The penetrations presented in Table B-1.3mod, B-1.3adv for the various polices are not necessarily what the reader would assume, and care should be taken in interpreting and especially in comparing them. The most intuitive way to think about penetrations is as a percent of shipments: eight percent of refrigerators sold in 2000 are ENERGY STAR refrigerators sold due to the ENERGY STAR program. In some cases, however, we segmented the market to target only high-use applications. In these cases, the percent of energy affected could be much higher than the percent of units affected. Since ultimately it was the percent of energy affected that interested us, we present here the penetration in terms of percent of energy.

This problem arose with the residential lighting end-use. Our policies were based on compact fluorescent lamp technology, and because of their high first cost they are not cost effective in very low use fixtures. Furthermore, lighting fixture use is highly skewed—a large percentage of lighting energy is concentrated in a small percentage of fixtures (Vorsatz, et al 1997). Many fixtures (often those in closets, attics, etc.) are used rarely or only briefly. We assumed that CFL lamps and CFL fixtures would be used in cost effective (i.e. high use) applications and would therefore affect a disproportionate share of lighting energy compared to replacing an average lamp or fixture. For the Energy Star fixtures program we looked at the percent of energy consumed by fixtures used 3 or more hours per day (cost effective applications) and made a judgement about what fraction of that energy might be affected by the program. The penetrations shown in Table B-1.3 (mod and adv) should be read as percent of lighting energy for all lighting policies. For more information on how the lighting market was segmented in the analysis, see the introduction to tables C-1.6mod and C-1.6adv.

Several policies affecting water heating apply to only new buildings (ENERGY STAR Homes, Building America and whole-house tax credits). These penetrations should be read as percent of new homes built. New and existing homes are accounted for separately in our model; savings from these programs are applied to energy in new homes only.

Percent of End-Use Energy Affected

In order to accurately calculate the effect of a policy in a given year, we had to calculate the percent of end-use energy affected by a policy in that year. To do this we first calculated the percent of the stock affected by the policy using our shipment penetrations, product lifetimes and a simple retirement function. In cases where the technology affected by the policy coincided with the end-use, such as clothes washer motors, this was sufficient to describe the percent of energy affected. When the technology was different from the end-use, it was necessary to perform an

additional transformation. We describe this process for several end-uses below. More information is provided in the footnotes to each table.

Electric water heating presented particular problems. Water heating energy is affected by measures affecting water heaters (electric water heater standards, Energy Star heat pump water heaters), and also by measures affecting water use (Energy Star dishwashers, clothes washer standards). To analyze a clothes washer policy, we cannot simply look at the policy penetration with respect to clothes washers. We are really interested in the percent of water heaters affected by the clothes washer policy. Since only 81% of homes have clothes washers, we use this factor to weight the stock penetration of high efficiency clothes washers. So if 48% of the clothes washer stock in 2010 are horizontal axis washers due to standards, 39% (= 81%*48%) of electric water heating homes are affected by that policy. To calculate the percent of water heating energy saved by the policy, we multiply the percent of electric water heating homes affected by the percent of household water heating energy saved by a horizontal axis washer.

As noted above, several policies affecting water heating apply to only new buildings (ENERGY STAR Homes, Building America and whole-house tax credits). The percent of end-use energy affected applies only to energy use in homes built after 2000.

Avoiding Double-Counting

In many cases multiple policies affect the same end use. To avoid double counting, we had to establish rules for how savings would be divided between policies. Mandatory programs, such as equipment standards, were given primacy. Standards are assumed to affect 100% of a certain type of equipment and are credited with the full savings of moving from a baseline unit to a unit just meeting the standard. Any non-mandatory policy is considered to be in addition to standards (if any). Savings are calculated relative to the standard in place. If a non-mandatory policy affects 40% of an equipment type and saves 15% of the energy of a baseline unit, but standards are in place that effect 100% of equipment and save 10% over a baseline unit, the non-mandatory program is credited with saving 5% of baseline energy on 40% of the equipment. A single non-mandatory policy may therefore have multiple baselines if standards are updated once or more while the policy is in place. Because the energy savings change when the baseline changes, we treat each policy/baseline combination separately in our analysis. The penetrations for each policy/baseline combination are listed separately in these tables.

Table B-1.3mod. Residential Buildings Moderate Case Market Penetrations--Non-HVAC

Fuel	End-Use	Policy	Notes	Baseline[1]	Shipment penetration, except where otherwise noted[2]									% of Frozen Efficiency End-Use Energy Affected[3]	
					2000	2001	2002	2003	2004	2005	2010	2015	2020	2010	2020
Electric															
	Water heating														
		ENERGY STAR CW	4	2000 new EWH/2000 new CW	18.4%	22.4%	26.3%	30.3%	0.0%	0.0%	0.0%	0.0%	0.0%	5.4%	0.4%
		ENERGY STAR CW	4	2000 new EWH/2004 CW Std	0.0%	0.0%	0.0%	0.0%	33.1%	36.0%	0.0%	0.0%	0.0%	6.0%	2.4%
		ENERGY STAR DW	5	2000 new EWH/2000 new DW	5.0%	6.7%	8.3%	10.0%	11.7%	13.3%	21.5%	29.0%	35.0%	6.1%	15.2%
		ENERGY STAR HPWH	6	2004 standard EWH	0.0%	0.0%	0.0%	0.0%	1.0%	1.2%	2.0%	5.5%	9.0%	1.0%	5.6%
		ENERGY STAR Homes	7	2000 new EWH	0.7%	1.4%	2.0%	2.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%	0.3%
		ENERGY STAR Homes	7	2004 standard EWH	0.0%	0.0%	0.0%	0.0%	3.2%	3.8%	6.7%	9.8%	12.5%	3.1%	6.5%
		Building America	8	2000 new EWH	0.0%	0.1%	0.1%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Building America	8	2004 std EWH	0.0%	0.0%	0.0%	0.0%	0.4%	0.6%	2.0%	3.8%	4.8%	0.8%	2.3%
		Whole House Tax Credit I	9	2000 new EWH	0.6%	0.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
		Whole House Tax Credit I	9	2004 std EWH	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Whole House Tax Credit II	9	2000 new EWH	0.2%	0.7%	1.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.1%
		Whole House Tax Credit II	9	2004 std EWH	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%
		Whole House Tax Credit III	9	2000 new EWH	0.0%	0.0%	0.2%	1.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.1%
		Whole House Tax Credit III	9	2004 std EWH	0.0%	0.0%	0.0%	0.0%	2.1%	0.1%	0.1%	0.1%	0.1%	0.3%	0.2%
		ENERGY STAR Homes R&D	10	2004 std EWH	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	1.7%	3.6%	0.0%	1.0%
		Building America R&D	11	2004 std EWH	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.6%	1.5%	0.0%	0.4%
		2004 EWH Std	12	2000 new EWH	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	100%	100%	66.7%	100%
		CW 2004 standard	13	2000 new EWH/2000 new CW	0.0%	0.0%	0.0%	0.0%	100%	100%	0.0%	0.0%	0.0%	16.7%	6.6%
		CW 2007 Horiz. Axis Std	14	2000 new EWH/2000 new CW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	22.3%	72.9%
		Utility HPWH	15	2000 new EWH	0.0%	0.0%	0.2%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Utility HPWH	15	2004 standard EWH	0.0%	0.0%	0.0%	0.0%	0.4%	0.5%	1.5%	2.0%	2.0%	0.6%	1.9%
		Tax Credit HPWH	16	2000 new EWH	0.0%	0.0%	0.1%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Tax Credit HPWH	16	2004 standard EWH	0.0%	0.0%	0.0%	0.0%	0.7%	0.8%	0.9%	0.8%	0.8%	0.6%	1.2%
		HPWH R&D	17	2004 standard EWH	0.0%	0.0%	0.0%	1.4%	1.6%	3.0%	3.0%	3.0%	3.0%	2.0%	4.1%
	Refrigeration														
		2001 Refrigerator Std	18	2000 new Refrigerator	0.0%	100%	100%	100%	100%	100%	100%	100%	100%	51.3%	93.1%
		Utility Rebate	19	2000 new Refrigerator	10.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.2%
		Utility Rebate	19	2001 standard Refrigerator	0.0%	5.8%	6.5%	7.3%	8.0%	8.8%	12.5%	16.3%	20.0%	4.7%	12.5%
		ENERGY STAR Refrig.	20	2000 new Refrigerator	8.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.2%
		ENERGY STAR Refrig.	20	2001 standard Refrigerator	0.0%	4.8%	5.6%	6.4%	7.2%	8.0%	12.0%	16.0%	20.0%	4.3%	12.1%
	Cooking		21		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table B-1.3mod (continued). Residential Buildings Moderate Case Market Penetrations--Non-HVAC

Fuel	End-Use	Policy	Notes	Baseline[1]	Shipment penetration, except where otherwise noted[2] 2000	2001	2002	2003	2004	2005	2010	2015	2020	% of Frozen Efficiency End-Use Energy Affected[3] 2010	2020
Electric															
	Clothes Dryers		22		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Freezers														
		2001 Std	23	2000 new freezer	0.0%	100%	100%	100%	100%	100%	100%	100%	100%	51.3%	93.1%
	Lighting														
	torchieres														
		R&D--CFL Torchiere	24	300 W Halogen torchiere	3.0%	5.3%	7.7%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
		E* Res Ltg Fixture Prog	25	300 W Halogen torchiere	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.5%	13.3%	20.0%	3.4%	16.8%
		CFL R&D--Fixtures Effect	26	300 W Halogen torchiere	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.7%	2.3%	3.0%	0.3%	2.7%
	other														
		E* Res Ltg Fixture Prog	27	Fixtures uses >3 hrs/day	10.0%	11.5%	12.9%	14.4%	15.9%	17.4%	24.8%	32.2%	39.6%	15.5%	31.1%
		CFL R&D--Fixtures Effect	28	Fixtures used 2-3 hrs/day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.5%	3.2%	4.0%	0.2%	2.8%
		Mini-HID lamps R&D	29	100 W inc. lamp used 1500 hrs/yr	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	5.0%	10.0%	0.1%	4.2%
	Clothes Washers														
		ENERGY STAR CW	30	2000 new CW	7.0%	8.5%	10.0%	11.5%	0.0%	0.0%	0.0%	0.0%	0.0%	2.5%	0.2%
		ENERGY STAR CW	30	2004 CW interim stds	0.0%	0.0%	0.0%	0.0%	12.6%	13.7%	0.0%	0.0%	0.0%	2.8%	1.1%
		CW 2004 standard	31	2000 new CW	0.0%	0.0%	0.0%	0.0%	100%	100%	0.0%	0.0%	0.0%	20.7%	8.1%
		CW 2007 Horiz. Axis Std	32	2000 new CW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	27.6%	90.1%
	Dishwashers		33		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Color Televisions														
		ENERGY STAR TVs	34	2000 new TV	20.0%	25.0%	30.0%	35.0%	40.0%	45.0%	66.4%	73.2%	80.0%	41.4%	72.2%
	Personal Computers		35		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Furnace Fans		36		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Other Uses														
	coils		37		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	motors														
		Ceiling Fans	38		0.0%	3.0%	4.9%	6.8%	8.7%	10.6%	20.0%	22.5%	25.0%	1.2%	3.3%
		Pool Pumps	39		0.0%	3.0%	3.8%	4.6%	5.3%	6.1%	10.0%	11.5%	13.0%	1.3%	1.9%
	electronics														
		ENERGY STAR VCR	40		10.0%	14.0%	18.0%	22.0%	26.0%	30.0%	50.0%	62.5%	75.0%	3.9%	8.6%
		ENERGY STAR Audio	41		5.0%	10.0%	10.6%	11.1%	11.7%	12.2%	15.0%	27.5%	40.0%	2.6%	6.2%
		ENERGY STAR Settop	42		3.0%	6.4%	9.8%	13.2%	16.6%	20.0%	30.0%	50.0%	70.0%	4.2%	11.4%
		ENERGY STAR Telephony	43		5.0%	7.5%	10.0%	12.5%	15.0%	17.5%	30.0%	50.0%	70.0%	1.5%	4.0%

Table B-1.3mod (continued). Residential Buildings Moderate Case Market Penetrations--Non-HVAC

Fuel	End-Use	Policy	Notes	Baseline[1]	Shipment penetration, except where otherwise noted[2]									% of Frozen Efficiency End-Use Energy Affected[3]	
					2000	2001	2002	2003	2004	2005	2010	2015	2020	2010	2020
Electric															
	Other Uses														
		electronics													
		ENERGY STAR MWave	44		0.0%	5.0%	7.2%	9.4%	11.7%	13.9%	25.0%	37.5%	50.0%	2.1%	6.1%
Gas															
	Water heating														
		ENERGY STAR CW	45	2000 new GWH/2000 new CW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		ENERGY STAR CW	45	2000 new GWH/2004 CW std	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		ENERGY STAR DW	46	2000 new GWH/2000 new DW	5.0%	6.7%	8.3%	10.0%	11.7%	13.3%	21.5%	29.0%	35.0%	6.1%	15.2%
		ENERGY STAR Homes	7	2000 new GWH	0.7%	1.3%	2.0%	2.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.3%
		ENERGY STAR Homes	7	2004 GWH Std	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Building America	8	2000 new GWH, E* home	0.0%	0.1%	0.1%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Building America	8	2004 GWH Std, E* home	0.0%	0.0%	0.0%	0.0%	0.4%	0.7%	2.1%	4.2%	5.4%	1.0%	2.5%
		Whole House Tax Credit I	9	2000 new GWH, E* home	0.6%	0.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
		Whole House Tax Credit I	9	2004 GWH Std, E* home	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Whole House Tax Credit II	9	2000 new GWH, E* home	0.2%	0.7%	1.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.1%
		Whole House Tax Credit II	9	2004 GWH Std, E* home	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%
		Whole House Tax Credit III	9	2000 new GWH, E* home	0.0%	0.0%	0.2%	1.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.1%
		Whole House Tax Credit III	9	2004 GWH Std, E* home	0.0%	0.0%	0.0%	0.0%	2.1%	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%
		GWH Std	47	2000 new GWH	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	100%	100%	48.3%	98.3%
		CW Std Stage 1	48	2004 GWH Std/2000 new CW	0.0%	0.0%	0.0%	0.0%	100%	100%	0.0%	0.0%	0.0%	16.7%	6.6%
		CW 2007 Horiz. Axis Std	49	2004 GWH Std/2000 new CW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	22.3%	72.9%
		Tax Cr for 0.65 EF NGWH	50	2000 new GWH	1.4%	2.4%	0.8%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%
		Tax Cr for 0.65 EF NGWH	50	2004 GWH Std	0.0%	0.0%	0.0%	0.0%	0.4%	0.4%	0.4%	0.4%	0.4%	0.2%	0.4%
		Tax Cr for 0.80 EF NGWH	51	2000 new GWH	0.2%	0.4%	0.6%	0.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
		Tax Cr for 0.80 EF NGWH	51	2004 GWH Std	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Cooking		52		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Clothes Dryers		53		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Other Uses		54		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes to Table B-1.3mod
Residential Buildings Moderate Case Market Penetrations--Non-HVAC

1 Because different policies affect the same market segment, it was often necessary to adjust penetrations or savings in order to avoid double counting. In particular, we had to address the effect on existing programs, such as ENERGY STAR, when new equipment standards come into effect. We adopted the practice of attributing savings to mandatory programs, such as standards, before calculating savings for other policies. When the savings for a policy are affected by a standard, we essentially analyze the policy as several different policies according to the baseline that applies (year 2000 new equipment, 2004 standard, 2010 standard). For example, the ENERGY STAR Homes program appears twice under electric water heating. The first appearance lists "2000 new EWH" as the baseline, indicating that the baseline water heating UEC is for a typical new electric water heater in year 2000. The second entry lists "2004 standard EWH" as the baseline indicating that the savings corresponding to these penetrations ere calculated relative to the new electric water heating standard in 2004.

2 For most products, penetrations are the percent of a product shipped affected by a policy (e.g. the percent of clothes washers shipped that are ENERGY STAR). In the case of new homes programs (ENERGY STAR Homes, Building America, and whole-house tax credits) the penetrations given are the percent of new homes built to the criteria of the program.

3 Because the goal of this analysis was to measure to what extent a policy affects energy in a given end-use, we report the percent of frozen efficiency end-use energy affected by a policy rather than the stock penetration of a particular technology. In many cases the stock penetration is the same as the percent of energy affected. However, consider the electric water heating end-use: It is affected by policies affecting water heaters (e.g. water heater standards), water use (e.g. clothes washers), and homes (e.g. Building America). The stock penetration of horizontal axis clothes washers, by itself, says little about what impact the policy will ultimately have on electric water heating. We therefore weight the stock penetrations for clothes washers by the percent of homes with clothes washers (80.9%, Koomey et al 1999b). This weighted value gives the percent of frozen-efficiency water heater energy affected by the policy. In the case of new homes programs (ENERGY STAR Homes, Building America, and whole-house tax credits) this value represents only the percent of energy use in new homes affected by the policy.

4 ENERGY STAR clothes washers are assumed to be horizontal axis or equivalent efficiency (hereafter "horizontal axis"). Market penetration of ENERGY STAR clothes washers is expected to increase from 7% in 2000 to 12% in 2003 and 14.8% in 2006 (percent of clothes washer sales). Because horizontal axis washers, at current market prices, are cost effective in electric water heater homes but not in gas water heating homes, we assume that all ENERGY STAR washers sold are installed in electric water heating homes. We divided the market share of ENERGY STAR clothes washers (percent of clothes washer sales) by 38% (% of homes with electric water heating, Koomey et al, 1994) to get the penetration of clothes washers with respect to electric water heating homes. The ENERGY STAR program is assumed to be discontinued when a horizontal axis standard goes into effect in 2007. To obtain the percent of frozen efficiency electric water heating energy affected in 2010 and 2020, we weighted the stock penetration of ENERGY STAR clothes washers by the percent of homes that have a clothes washer (80.9%, Koomey et al, 1999b).

5 Shipment penetrations increase from 5% of dishwasher sales in 2000 to 20% in 2009 and 35% in 2020. To obtain the percent of frozen efficiency water heating energy affected, stock penetrations were weighted by the percent of homes with dishwashers (57%, Koomey et al., 1999b).

6 Although no program currently exists, we speculate that in 2004 DOE will introduce an ENERGY STAR water heater program to promote heat pump water heaters. Penetration levels were developed jointly with penetrations of HPWH due to utility programs, tax credits, and R&D. Target penetrations for all programs together were 0.2% in 2002, 5% in 2010 and 15% in 2020 (LBNL/PNNL analysis). The ENERGY STAR program is assumed to begin in 2004, and penetrations are assumed to increase to 2% in 2010 and 9% in 2020.

7 Penetration for ENERGY STAR Homes were taken from the HVAC analysis. Please see Table B-1.2mod for more information. Note that these

Notes to Table B-1.3mod (continued)

penetrations apply to new homes only and the penetrations are therefore not comparable to programs affecting existing homes.

8 Penetration for Building America were taken from the HVAC analysis. Please see Table B-1.2mod for more information. Note that these penetrations apply to new homes only and the penetrations are therefore not comparable to programs affecting existing homes.

9 Penetration for whole house tax credits were taken from the HVAC analysis. Please see Table B-1.2mod for more information. Note that these penetrations apply to new homes only and the penetrations are therefore not comparable to programs affecting existing homes.

10 The ENERGY STAR Homes program is expected to have an R&D effect as production methods improve. Penetrations for ENERGY STAR Homes R&D should be regarded as incremental to the ENERGY STAR Homes program. These penetrations were taken from the HVAC analysis. Please see Table B-1.2mod for more information. Note that these penetrations apply to new homes only and the penetrations are therefore not comparable to programs affecting existing homes.

11 The Building America program is expected to have an R&D effect as production methods improve and new techniques are developed. Penetrations for Building America R&D should be regarded as incremental to the ENERGY STAR Homes program. These penetrations were taken from the HVAC analysis. Please see Table B-1.2mod for more information. Note that these penetrations apply to new homes only and the penetrations are therefore not comparable to programs affecting existing homes.

12 The electric water heater standard is tightened in 2004 to reduce standby losses. Penetrations are assumed to be 100% from 2004 onward.

13 Clothes washer standards are expected to be tightened starting in 2004. Because a horizontal axis standard remains controversial, for the moderate case we assume that DOE will set an interim standard. We assume this interim standard goes into effect in 2004 and is replaced by a horizontal axis standard in 2007. We assume 100% market penetration for standards. To obtain the percent of frozen efficiency electric water heating energy affected in 2010 and 2020, we weighted the stock penetration of horizontal-axis clothes washers by the percent of homes that have a clothes washer (80.9%, Koomey et al, 1999b).

14 We expect that DOE will eventually succeed in finalizing a horizontal axis clothes washer standard. This standard is assumed to go into effect in 2007 in the moderate case. We assume 100% market penetration for standards. To obtain the percent of frozen efficiency electric water heating energy affected in 2010 and 2020, we weighted the stock penetration by the percent of homes with clothes washers (80.9%, Koomey et al., 1999b).

15 Utilities promote the use of heat pump water heaters through the use of rebates and informational campaigns. Penetration levels were developed jointly with penetrations of HPWH due to the ENERGY STAR water heater program, tax credits for heat pump water heaters, and R&D. Target penetrations for all programs were 0.2% in 2002, 5% in 2010 and 15% in 2020 (LBNL/PNNL analysis). Utility program penetrations are assumed to increase to 2% by 2014 and remain flat thereafter. Rebates are assumed to be equal to 5% of the purchase price. We assume that funds for these incentives come from "lines charges" created as the utility system is restructured (we assume half of regions adopt lines charges).

16 Tax credits for heat pump water heaters in the moderate case are assumed to be for 20 percent of the purchase price and last from December 31, 1999, until January 1, 2004 (US DOT, 1999). Market penetration trends were adapted from Richey and Koomey (1998), but their forecast was determined to be too aggressive (LBNL/PNNL analysis indicated that manufacturers would not be able to ramp up production quickly). Penetrations were developed jointly with penetrations of HPWHs due to the ENERGY STAR water heater program, utility programs and R&D. Target penetrations for all programs were 0.2% in 2002, 5% in 2010 and 15% in 2020 (LBNL/PNNL analysis).The forecast includes market transformation effects which persist beyond the end of the tax credit.

17 We expect that government-funded R&D will reduce the cost of heat pump water heaters. In the moderate case, we assume that R&D will reduce the incremental cost of heat pump water heaters by 50% by 2010. R&D was analyzed jointly with tax credits, ENERGY STAR, and utility rebate programs

Notes to Table B-1.3mod (continued)

(we assume negligible baseline penetrations of HPWHs). Target penetrations for all programs were 0.2% in 2002, 5% in 2010 and 15% in 2020 (LBNL/PNNL analysis). The penetration for HPWHs ramps up from 0% in 2002 to 3% in 2005 and remains flat thereafter.

18 New refrigerator standards are scheduled to come into effect in 2001. The 2001 standards are assumed to affect 100% of shipments.

19 Market penetrations for refrigerator utility programs are initially 10% but drop to 6% when the 2001 standard comes in (because the efficiency requirement for the utility rebate becomes more stringent). Penetration increases to 20% by 2020. Rebates are assumed to be equal to the full incremental cost. We assume that funds for these incentives come from "lines charges" created as the utility system is restructured (we assume half of regions adopt lines charges).

20 Each time the standard is tightened the ENERGY STAR criterion is also, so we assume the market penetration of ENERGY STAR units (sales) falls each time the standard is tightened. Market penetrations are initially 8% but drop to 5% when the 2001 standard comes in, then increase to 20% by 2020.

21 No policies were considered for electric cooking equipment.

22 No policies were considered for electric clothes dryers.

23 New freezer standards are scheduled to come into effect in 2001. The 2001 standards are assumed to have 100% market penetration.

24 Compact fluorescent torchieres were developed at Lawrence Berkeley National Laboratory as replacement for low-efficiency halogen torchieres. Since then, CFL torchieres have become widely available at retailers and costs have fallen significantly. Because of their higher costs, we expect the market penetration to top out at 10% in the absence of any other programs.

25 Because CFL torchieres qualify under the ENERGY STAR fixtures program, we expect there to be continued efforts to promote the technology. We expect the market penetration of these fixtures due to the ENERGY STAR fixtures program to increase to 40% of torchieres sold by 2020.

26 Government-funded R&D is expected to decrease the cost of CFLs by 10% by 2010. This will reduce the cost of CFL torchieres, since we assume that the fixtures are sold with a ballast. Lower equipment costs will increase the effectiveness of other CFL programs, including ENERGY STAR fixtures. We assume that R&D will increase market penetration by 10%. We therefore multiply by 0.1 the total penetration of CFL torchieres due to LBNL's development of the technology and ENERGY STAR's promotional efforts to obtain the additional penetration due to R&D.

27 Because compact fluorescent lamps are not generally effective in low use fixtures, the ENERGY STAR Fixtures Program is assumed to target high-use fixtures (>3 hrs per day). These fixtures account for 62% of lighting energy (Wenzel et al, 1997). Our penetrations here therefore represent percent of lighting energy rather than percent of units shipped. To estimate market penetration for the moderate case, we asked what percent of fixtures are very high use (>6 hours per day). Forty percent of total lighting energy is used by fixtures used 6 or more hours per day. We used 40% as our estimated penetration of ENERGY STAR Fixtures in 2020 in the moderate case, up from 10% of lighting energy in 2000. Note that although we used the energy use of very high use fixtures as a benchmark, we do not literally expect to capture 100% of the very high use market (the energy savings used are for all cost-effective applications). Rather, we expect that some fraction of new fixture sales, representing 40% of energy use in new fixtures in the reference case, will be replaced by ENERGY STAR fixtures.

28 Government-funded R&D is expected to decrease the cost of CFLs by 25% by 2010. This will reduce the cost of CFL fixtures, since we assume that the fixtures are sold with a ballast. Lower equipment costs expand the range of applications where CFL fixtures are cost effective--that is, they can be used in lower use areas. We assume that R&D will increase market penetration by 10%. We therefore multiply by 0.1 the total penetration of CFL fixtures due to ENERGY STAR to obtain the additional penetration due to R&D.

29 Government-funded R&D is expected to make mini-HIDs a viable replacement for incandescent lamps. Nadel et al. (1998) indicate that 21% of

Notes to Table B-1.3mod (continued)

lighting applications are feasible for the technology. For the advanced case, we assume 1% penetration in 2010, 5% in 2015, and 10% in 2020, with penetrations increasing linearly between these points (LBNL/PNNL estimate).

30 ENERGY STAR clothes washers are assumed to be horizontal axis or equivalent efficiency. Market penetration of ENERGY STAR clothes washers is expected to increase to 12% of clothes washer sales by the time standards come into effect in 2004. The ENERGY STAR program is assumed to be discontinued when a horizontal axis standard goes into effect in 2007. Note that this end-use category includes only clothes washer machine energy, not total clothes washing energy, which as usually reported includes water heating energy and may include dryer energy. The shipment penetration used for this end-use is the same underlying penetration used for clothes washers in the electric water heating end-use (see note 4). In this case, the end-use, clothes washers, corresponds to the technology affected by the policy, so it is not necessary to weight the stock penetration by the percent of homes with clothes washers to obtain the percent of end-use energy affected.

31 Clothes washer standards are expected to be tightened starting in 2004. Because a horizontal axis standard remains controversial, for the moderate case we assume that DOE will set an interim standard. We assume 100% market penetration for standards. Note that this is the same underlying penetration used for clothes washers in the electric water heating end-use (see note 13). In this case, the end-use, clothes washers, corresponds to the technology affected by the policy, so it is not necessary to weight the penetration by the percent of homes with clothes washers to obtain the percent of end-use energy affected.

32 We expect that DOE will eventually succeed in finalizing a horizontal axis clothes washer standard. This standard is assumed to go into effect in 2007 in the moderate case. We assume 100% market penetration for standards. Note that this end-use category includes only clothes washer machine energy, not total clothes washing energy, which as usually reported includes water heating energy and may include dryer energy. Water heating and dryer energy due to clothes washers is reported separately under the water heating and clothes dryer end-uses. The shipment penetration used for this end-use is the same underlying penetration used for clothes washers in the electric water heating end-use (see note 14). In this case, the end-use, clothes washers, corresponds to the technology affected by the policy, so it is not necessary to weight the penetration by the percent of homes with clothes washers to obtain the percent of end-use energy affected.

33 No policies were considered for dishwasher motors.

34 Market penetration of ENERGY STAR TVs is assumed to grow from 20% in 2000 to 80% in 2020. The program is assumed to continue throughout the period with no changes to efficiency requirements.

35 No policies were considered for personal computers. The ENERGY STAR computer program was assumed to be fully included in AEO99.

36 No policies were considered for furnace fans.

37 No policies were considered for miscellaneous heating coils.

38 The Florida Solar Energy Center with AeroVironment developed an innovative ceiling fan blade design. The technology has been licensed to a manufacturer and a modified design (Su and Zambrano 1999) is expected to be on the market sometime in 2000 (FSEC 1999). We projected that the design could capture 20% of the ceiling fan market by 2010 and 25% by 2020. To obtain the percent of frozen efficiency miscellaneous motor energy affected, we weighted the stock penetration by the percent of miscellaneous motor energy attributable to ceiling fans, which we estimate to be 16.8% based on data from Sanchez et al. (1998).

39 Pool pumps were targeted because they make up a fairly large share of miscellaneous motor energy. For analytical purposes, the program was conceived of as an ENERGY STAR-type voluntary program. Market penetration is expected to increase to 10% of pool pumps in 2010 and 13% in 2020. To obtain the percent of frozen efficiency miscellaneous motor energy affected, we weighted the stock penetration by the percent of

Notes to Table B-1.3mod (continued)

miscellaneous motor energy attributable to pool pumps, which we estimate to be 15.5% based on data from Sanchez et al. (1998).

40 Market penetration of ENERGY STAR VCRs is assumed to grow from 10% in 2000 to 50% in 2010 and 75% in 2020. VCR stock penetrations were weighted by the share of miscellaneous electronics energy attributable to VCRs (14% based on data from Sanchez et al 1998) to obtain the percent of frozen efficiency miscellaneous electronics energy affected by the policy in 2010 and 2020.

41 Market penetration of ENERGY STAR units is assumed to grow from 5% in 2000 to 15% in 2010 and 40% in 2020. Audio equipment stock penetrations were weighted by the share of miscellaneous electronics energy attributable to audio equipment(19.7% based on data from Sanchez et al, 1998) to obtain the percent of frozen efficiency miscellaneous electronics energy affected by the policy in 2010 and 2020.

42 We assume that EPA will launch a settop box program (for cable boxes and satellite receivers) in 2000. Market penetration of ENERGY STAR devices is assumed to increase from 3% in 2000 to 30% in 2010 and 70% in 2020. Settop Box stock penetrations were weighted by the share of the miscellaneous electronics energy attributable to settop boxes (22.7% based on data from Sanchez et al, 1998) to obtain the percent of frozen efficiency miscellaneous electronics energy affected by the policy in 2010 and 2020.

43 We assume that EPA will launch a telephony program (for cordless phones, answering machines, etc.) in 2000. Market penetration of ENERGY STAR devices is assumed to increase from 5% in 2000 to 30% in 2010 and 70% in 2020. Telephony stock penetrations were weighted by the share of miscellaneous electronics energy attributable to telephony (7.3% based on data from Sanchez et al, 1998) to obtain the percent of frozen efficiency miscellaneous electronics energy affected by the policy in 2010 and 2020.

44 We assume that EPA will launch a microwave oven program in 2001. Market penetration of ENERGY STAR devices is assumed to increase from 5% in 2001 to 25% in 2010 and 50% in 2020. Microwave stock penetrations were weighted by the share of miscellaneous electronics energy attributable to microwaves (17.4% based on data from Sanchez et al, 1998) to obtain the percent of frozen efficiency miscellaneous electronics energy affected by policy.

45 ENERGY STAR clothes washers are not cost effective at current market prices in gas water heating homes. We therefore assume zero penetration.

46 Penetration of ENERGY STAR dishwashers increases to 20% of dishwasher sales in 2010 when dishwasher standards come in. Stock penetrations were multiplied by the percent of homes with dishwashers (57%, Koomey et al., 1999b) to obtain the percent of frozen efficiency gas water heating energy affected by the policy in 2010 and 2020.

47 The market penetrations for a gas water heater standard are assumed to be 100% from 2004 through the end of the analysis period.

48 Clothes washer standards are expected to be tightened starting in 2004. Because a horizontal axis standard remains controversial, in the moderate case we assume that DOE will set an interim standard. We assume 100% market penetration for standards. To obtain the percent of frozen efficiency gas water heating energy affected by this measure, we weighted the clothes washer stock penetration by the percent of homes with clothes washers (80.9%, Koomey et al., 1999b).

49 We expect that DOE will eventually succeed in finalizing a horizontal axis clothes washer standard. This standard is assumed to go into effect in 2007 in the moderate case. We assume 100% market penetration for standards. To obtain the percent of frozen efficiency gas water heating energy affected by the policy we weighted the stock penetration of horizontal-axis washers by the percent of homes with clothes washers (Koomey et al., 1994).

50 Tax credits for 0.65 EF gas water heaters are assumed to be for 10 percent of the purchase price for the period December 31, 1999 to January 1, 2002 (US DOT, 1999). Market penetrations were adapted from Richey and Koomey (1998).

51 Tax credits for 0.80 EF gas water heaters in the moderate case are assumed to be for 20 percent of the purchase price and last from December 31,

Notes to Table B-1.3mod (continued)

1999 through January 1, 2004. These water heaters are quite expensive and are cost effective only in homes that use a great deal of hot water--more than three times the hot water use of the average home. Based on an LBNL analysis of hot water use data, we concluded that such homes comprise less than 0.4% of all homes and account for 1.4% of total hot water use. We take the share of total hot water use as a proxy for the share of gas water heating energy and estimate that the penetration of the tax credit program might affect half of cost effective homes. When the new gas water heating standard, 0.62 EF, becomes effective in 2004, the consumer choice is now between a 0.62 EF water heater and a 0.80 water heater--which is not as cost effective an invesment as choosing an 0.80 EF over an 0.56 EF water heater (our baseline efficiency). The market segment for which the investment in an 0.80 EF water heater is cost effective becomes even smaller under the standard. Penetrations are reduced still further to reflect the smaller market segment. Penetrations persist beyond the expiration of the actual tax credit due to market transformation.

52 No policies were considered for gas cooking.

53 No policies were considered for gas clothes dryers.

54 No policies were considered for gas other uses.

Table B-1.3adv. Residential Buildings Advanced Case Market Penetrations--Non-HVAC

Fuel	End-Use	Policy	Notes	Baseline[1]	Shipment penetration, except where otherwise noted[2]									% of Frozen Efficiency End-Use Energy Affected[3]	
					2000	2001	2002	2003	2004	2005	2010	2015	2020	2010	2020
Electric															
	Water heating														
		ENERGY STAR CW	4	2000 new EWH/2000 new CW	18.4%	22.4%	26.3%	30.3%	0.0%	0.0%	0.0%	0.0%	0.0%	5.4%	0.4%
		ENERGY STAR DW	5	2000 new EWH/2000 new DW	5.0%	6.7%	8.3%	10.0%	11.7%	13.3%	0.0%	0.0%	0.0%	5.2%	1.9%
		ENERGY STAR HPWH	6	2004 standard EWH	0.0%	0.0%	0.0%	0.0%	0.2%	0.5%	1.8%	8.4%	15.0%	0.7%	8.6%
		ENERGY STAR Homes	7	2000 new EWH	0.0%	1.5%	2.3%	3.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%	0.3%
		ENERGY STAR Homes	7	2004 standard EWH	0.0%	0.0%	0.0%	0.0%	4.1%	5.4%	16.5%	21.4%	26.8%	5.7%	13.8%
		Building America	8	2000 new EWH	0.1%	0.1%	0.2%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
		Building America	8	2004 standard EWH	0.0%	0.0%	0.0%	0.0%	0.6%	1.0%	3.2%	5.8%	6.1%	1.3%	3.3%
		Whole House Tax Cr. I	9	2000 new EWH	0.9%	1.1%	1.5%	1.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.3%
		Whole House Tax Cr. I	9	2004 standard EWH	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
		Whole House Tax Cr. II	9	2000 new EWH	0.3%	0.3%	0.4%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
		Whole House Tax Cr. II	9	2004 standard EWH	0.0%	0.0%	0.0%	0.0%	2.7%	3.6%	0.2%	0.2%	0.1%	0.6%	0.4%
		Whole House Tax Cr. III	9	2000 new EWH	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Whole House Tax Cr. III	9	2004 standard EWH	0.0%	0.0%	0.0%	0.0%	0.7%	0.9%	0.4%	0.3%	0.3%	2.5%	1.5%
		ENERGY STAR Homes R&D	10	2004 standard EWH	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.7%	13.4%	19.6%	0.2%	6.5%
		Building America R&D	11	2004 standard EWH	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.9%	2.9%	0.0%	0.8%
		2004 EWH Std	12	2000 new EWH	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	100%	100%	66.7%	100%
		CW Horizontal Axis Std	13	2000 new EWH/2000 new CW	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	100%	100%	39.1%	79.5%
		DW Standard	14	2000 new EWH/2000 new DW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	4.2%	45.6%
		Utiltiy HPWH	15	2000 new EWH	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		Utility HPWH	15	2004 standard EWH	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.7%	4.5%	8.0%	0.2%	4.7%
		Tax Credit HPWH	16	2000 new EWH	0.0%	0.0%	0.1%	0.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
		Tax Credit HPWH	16	2004 standard EWH	0.0%	0.0%	0.0%	0.0%	1.4%	1.6%	1.9%	1.7%	1.7%	1.2%	1.7%
		HPWH R&D	17	2004 standard EWH	0.0%	0.0%	0.0%	1.1%	1.7%	3.0%	6.0%	6.0%	6.0%	2.8%	5.9%
		Util. Fuel Switching Prog.	18		0.3%	0.4%	0.5%	0.5%	0.6%	0.7%	1.1%	1.0%	0.9%	0.8%	1.7%
	Refrigeration														
		2001 Refrigerator Std	19	2000 new Refrigerator	0.0%	100%	100%	100%	100%	100%	0.0%	0.0%	0.0%	46.2%	36.7%
		Utility Rebate	20	2000 new Refrigerator	10.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.2%
		Utility Rebate	20	2001 standard Refrigerator	0.0%	5.8%	6.5%	7.3%	8.0%	8.8%	0.0%	0.0%	0.0%	4.0%	3.4%
		ENERGY STAR Refrig.	21	2000 new Refrigerator	8.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.2%
		ENERGY STAR Refrig.	21	2001 standard Refrigerator	0.0%	4.8%	5.6%	6.4%	7.2%	8.0%	0.0%	0.0%	0.0%	3.7%	3.1%
		ENERGY STAR Refrig.	21	2010 standard Refrigerator	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table B-1.3adv (continued). Residential Buildings Advanced Case Market Penetrations--Non-HVAC

Fuel	End-Use	Policy	Notes	Baseline[1]	Shipment penetration, except where otherwise noted[2]									% of Frozen Efficiency End-Use Energy Affected[3]	
					2000	2001	2002	2003	2004	2005	2010	2015	2020	2010	2020
Electric															
	Refrigeration														
		NAECA Std 2010	22	2000 new Refrigerator	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	5.1%	56.4%
	Cooking														
		Util. Fuel Switching Prog.	23		1.1%	1.5%	2.0%	2.4%	2.8%	3.2%	5.1%	4.8%	4.5%	1.8%	4.3%
	Clothes Dryers														
		Util. Fuel Switching Prog.	24		1.8%	2.5%	3.2%	3.9%	4.6%	5.3%	8.3%	7.7%	7.1%	3.3%	7.8%
	Freezers														
		2001 Freezer Standard	25	2000 new freezer	0.0%	100%	100%	100%	100%	100%	0.0%	0.0%	0.0%	46.2%	36.7%
		2010 Freezer Standard	26	2000 new freezer	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	5.1%	56.4%
	Lighting														
	torchieres														
		R&D--CFL Torchiere	27	300 W Halogen torchiere	3.0%	5.3%	7.7%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
		E* Res Ltg Fixture Prog	28	300 W Halogen torchiere	0.0%	0.0%	0.0%	0.1%	2.4%	4.8%	16.5%	28.3%	40.0%	11.0%	34.5%
		CFL R&D--Fixtures Effect	29	300 W Halogen torchiere	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.0%	5.7%	7.5%	0.7%	6.7%
	other														
		E* Res Ltg Fixture Prog	30	Fixtures uses >3 hrs/day	10.0%	12.9%	15.9%	18.9%	21.8%	24.8%	39.6%	50.8%	62.0%	22.2%	49.0%
		CFL R&D--Fixtures Effect	31	Fixtures used 1-3 hrs/day	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.9%	7.6%	9.3%	0.5%	6.7%
		Mini-HID lamps R&D	32	100 W inc. lamp used 1500 hrs/yr	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	5.0%	10.0%	20.0%	1.3%	9.5%
	Clothes Washers														
		ENERGY STAR CW	33	2000 new CW	7.0%	8.5%	10.0%	11.5%	0.0%	0.0%	0.0%	0.0%	0.0%	2.5%	0.2%
		CW Horiz. Axis Std	34	2000 new CW	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	100%	100%	48.3%	98.3%
	Dishwashers		35		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Color Televisions														
		ENERGY STAR TVs	36	2000 new TV	20.0%	25.0%	30.0%	35.0%	40.0%	45.0%	0.0%	0.0%	0.0%	35.6%	6.2%
		TV Standards	37	2000 new TV	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	8.7%	89.7%
		Global 1 Watt	38	2010 TV stds	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	70.0%	85.0%	85.0%	6.1%	74.4%
	Personal Computers		39		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Furnace Fans		40		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Other Uses														
	coils		41		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table B-1.3adv (continued). Residential Buildings Advanced Case Market Penetrations--Non-HVAC

Fuel	End-Use	Policy	Notes	Baseline[1]	Shipment penetration, except where otherwise noted[2] 2000	2001	2002	2003	2004	2005	2010	2015	2020	% of Frozen Efficiency End-Use Energy Affected[3] 2010	2020
Electric															
	Other Uses														
		motors													
			Global 1 W	38	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	35.0%	60.0%	85.0%	0.2%	2.6%
			Ceiling Fans	42	0.0%	3.0%	4.9%	6.8%	8.7%	10.6%	20.0%	22.5%	25.0%	1.2%	3.3%
			Pool Pumps	43	0.0%	3.0%	3.8%	4.6%	5.3%	6.1%	10.0%	11.5%	13.0%	1.3%	1.9%
		electronics													
			ENERGY STAR VCR	44	10.0%	14.0%	18.0%	22.0%	26.0%	30.0%	0.0%	0.0%	0.0%	3.3%	0.6%
			ENERGY STAR Audio	45	5.0%	6.0%	7.0%	8.0%	9.0%	10.0%	0.0%	0.0%	0.0%	1.9%	0.0%
			ENERGY STAR Settop	46	3.0%	5.8%	8.6%	11.3%	14.1%	16.9%	0.0%	0.0%	0.0%	3.2%	0.3%
			E STAR Telephony	47	5.0%	7.6%	10.1%	12.7%	15.2%	17.8%	0.0%	0.0%	0.0%	1.2%	0.0%
			ENERGY STAR MWave	48	0.0%	5.0%	7.3%	9.5%	11.8%	14.0%	0.0%	0.0%	0.0%	1.7%	0.5%
			Global 1 W	38	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	35.0%	60.0%	85.0%	4.2%	62.3%
Gas															
	Water heating														
			ENERGY STAR CW	49	2000 new GWH/2000 new CW	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			ENERGY STAR DW	50	2000 new GWH/2000 new DW	5.0%	6.7%	8.3%	10.0%	11.7%	13.3%	0.0%	0.0%	0.0%	5.2%	1.9%
			ENERGY STAR Homes	7	2000 new GWH	0.0%	1.4%	2.2%	3.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.3%
			ENERGY STAR Homes	7	2004 GWH Std	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Building America	8	2000 new GWH	0.1%	0.1%	0.2%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
			Building America	8	2004 GWH Std	0.0%	0.0%	0.0%	0.0%	0.6%	1.1%	3.3%	6.7%	8.1%	1.5%	3.9%
			Whole House Tax Cr. I	9	2000 new GWH	0.9%	1.1%	1.4%	1.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.2%
			Whole House Tax Cr. I	9	2004 GWH Std	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
			Whole House Tax Cr. II	9	2000 new GWH	0.2%	0.3%	0.4%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
			Whole House Tax Cr. II	9	2004 GWH Std	0.0%	0.0%	0.0%	0.0%	2.7%	3.7%	0.2%	0.2%	0.2%	0.7%	0.4%
			Whole House Tax Cr. III	9	2000 new GWH	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
			Whole House Tax Cr. III	9	2004 GWH Std	0.0%	0.0%	0.0%	0.0%	0.7%	0.9%	0.4%	0.4%	0.4%	2.9%	1.7%
			GWH Std	51	2000 new GWH	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	100%	100%	48.3%	98.3%
			CW Horizontal Axis Std	52	2004 GWH Std/2000 new CW	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	100%	100%	39.1%	79.5%
			DW Standard	53	2004 GWH Std	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	4.2%	45.6%
			Tax Cr for 0.65 EF NGWH	54	2000 new GWH	1.4%	2.4%	0.8%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%
			Tax Cr for 0.65 EF NGWH	54	2004 GWH Std	0.0%	0.0%	0.0%	0.0%	0.4%	0.4%	0.4%	0.4%	0.4%	0.2%	0.4%
			Tax Cr for 0.80 EF NGWH	55	2000 new GWH	0.3%	0.5%	0.7%	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%

Table B-1.3adv (continued). Residential Buildings Advanced Case Market Penetrations--Non-HVAC

Fuel	End-Use	Policy	Notes	Baseline[1]	Shipment penetration, except where otherwise noted[2]									% of Frozen Efficiency End-Use Energy Affected[3]	
					2000	2001	2002	2003	2004	2005	2010	2015	2020	2010	2020
Gas															
	Water Heating														
		Tax Cr for 0.80 EF NGWH	55	2004 GWH Std	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.0%	0.0%	0.1%	0.1%
	Cooking		56		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Clothes Dryers		57		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Other Uses		58		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes to Table B-1.3adv

Residential Buildings Advanced Case Market Penetrations--Non-HVAC

1 Because different policies affect the same market segment, it was often necessary to adjust penetrations or savings in order to avoid double counting. In particular, we had to address the effect on existing programs, such as ENERGY STAR, when new equipment standards come into effect. We adopted the practice of attributing savings to mandatory programs, such as standards, before calculating savings for other policies. When the savings for a policy are affected by a standard, we essentially analyze the policy as several different policies according to the baseline that applies (year 2000 new equipment, 2004 standard, 2010 standard). For example, the ENERGY STAR Homes program appears twice under electric water heating. The first appearance lists "2000 new EWH" as the baseline, indicating that the baseline water heating UEC is for a typical new electric water heater in year 2000. The second entry lists "2004 standard EWH" as the baseline indicating that the savings corresponding to these penetrations were calculated relative to the new electric water heating standard in 2004.

2 For most products, penetrations are the percent of a product shipped affected by a policy (e.g. the percent of clothes washers shipped that are ENERGY STAR). In the case of new homes programs (ENERGY STAR Homes, Building America, and whole-house tax credits) the penetrations given are the percent of new homes built to the criteria of the program. For fuel-switching programs, the penetration is the percent of homes that replace an electric appliance with a gas one.

3 Because the goal of this analysis was to measure to what extent a policy affects energy in a given end-use, we report the percent of frozen efficiency end-use energy affected by a policy rather than the stock penetration of a particular technology. In many cases the stock penetration is the same as the percent of energy affected. However, consider the electric water heating end-use: It is affected by policies affecting water heaters (e.g. water heater standards), water use (e.g. clothes washers), and homes (e.g. Building America). The stock penetration of horizontal axis clothes washers, by itself, says little about what impact the policy will ultimately have on electric water heating. We therefore weight the stock penetrations for clothes washers by the percent of homes with clothes washers (80.9%, Koomey et al 1999b). This weighted value gives the percent of frozen-efficiency water heater energy affected by the policy. In the case of new homes programs (ENERGY STAR Homes, Building America, and whole-house tax credits) this value represents only the percent of energy use in new homes affected by the policy.

4 ENERGY STAR clothes washers are assumed to be horizontal axis or equivalent efficiency (hereafter "horizontal axis"). Market penetration of ENERGY STAR clothes washers is expected to increase from 7% of clothes washers sold in 2000 to 12% by the time a horizontal axis standard come into effect in 2004. Because horizontal axis washers, at current market prices, are cost effective in electric water heater homes but not in gas water heating homes, we assume that all ENERGY STAR washers sold are installed in electric water heating homes. We divided the market share of ENERGY STAR clothes washers (percent of clothes washer sales) by 38% (% of homes with electric water heating, Koomey et al, 1994) to get the penetration of clothes washers with respect to electric water heating homes. The ENERGY STAR program is assumed to be discontinued when a horizontal axis standard goes into effect in 2007. To obtain the percent of frozen efficiency electric water heating energy affected in 2010 and 2020, we weighted the stock penetration of ENERGY STAR clothes washers by the percent of homes that have a clothes washer (80.9%, Koomey et al, 1999b).

5 Shipment penetrations of ENERGY STAR dishwashers increase to 20% of dishwasher sales in 2009 (dishwasher standards are tightened in 2010). To obtain the percent of frozen efficiency water heating energy affected, stock penetrations were weighted by the percent of homes with dishwashers (57%, Koomey et al., 1999b).

6 Although no program currently exists, we speculate that in 2004 DOE will introduce an ENERGY STAR water heater program to promote heat pump water heaters. Penetration levels were developed jointly with penetrations of HPWH due to utility program, tax credits and R&D. Target penetrations for all programs together were 0.2% in 2002, 5% in 2005, 10% in 2010 and 30% in 2020 (LBNL/PNNL analysis). Penetrations are assumed to increase

Notes to Table B-1.3adv (continued)

from 0.2% in 2004 to 1.8% in 2010 and 15% in 2020.

7 Penetration for ENERGY STAR Homes were taken from the HVAC analysis. Please see Table B-1.2adv for more information. Note that these penetrations apply to new homes only and the penetrations are therefore not comparable to programs affecting existing homes.

8 Penetration for Building America were taken from the HVAC analysis. Please see Table B-1.2adv for more information. Note that these penetrations apply to new homes only and the penetrations are therefore not comparable to programs affecting existing homes.

9 Penetration for whole house tax credits were taken from the HVAC analysis. Please see Table B-1.2adv for more information. Note that these penetrations apply to new homes only and the penetrations are therefore not comparable to programs affecting existing homes.

10 The ENERGY STAR Homes program is expected to have an R&D effect as production methods improve. Penetrations for ENERGY STAR Homes R&D should be regarded as incremental to the ENERGY STAR Homes program. These penetrations were taken from the HVAC analysis. Please see Table B-1.2adv for more information. Note that these penetrations apply to new homes only and the penetrations are therefore not comparable to programs affecting existing homes.

11 The Building America program is expected to have an R&D effect as production methods improve and new techniques are developed. Penetrations for Building America R&D should be regarded as incremental to the ENERGY STAR Homes program. These penetrations were taken from the HVAC analysis. Please see Table B-1.2adv for more information. Note that these penetrations apply to new homes only and the penetrations are therefore not comparable to programs affecting existing homes.

12 Electric water heater standard tightened to reduce standby losses. Penetrations are assumed to be 100% from 2004 onward.

13 We expect that DOE will eventually succeed in finalizing a horizontal axis clothes washer standard. This standard is assumed to go into effect in 2004 in the advanced case. We assume 100% market penetration for standards. To obtain the percent of frozen efficiency water heating energy affected by the policy we weighted the stock penetration of horizontal-axis clothes washers by the percent of homes with clothes washers (80.9%, Koomey et al., 1999b).

14 We assume that new dishwasher standards will go into effect in 2010. We assume 100% market penetration for standards. To obtain the percent of frozen efficiency water heating energy affected, stock penetrations were weighted by the percent of homes with dishwashers (57%, Koomey et al, 1999b).

15 Utilities promote the use of heat pump water heaters through the use of rebates and informational campaigns. Penetration levels were developed jointly with penetrations of HPWH due to the ENERGY STAR water heater program, tax credits for heat pump water heaters and R&D. Target penetrations for all programs were 0.2% in 2002, 5% in 2005, 10% in 2010 and 30% in 2020 (LBNL/PNNL analysis). Utility program penetrations are assumed to increase from 0.05% in 2003 to 8% in 2018 and remain flat thereafter. Rebates are assumed to be equal to 10% of the purchase price. We assume that the funds for these incentives come from "lines charges" created as the U.S. utility system is restructured (we assume half of regions adopt lines charges).

16 Tax credits for heat pump water heaters in the advanced case are assumed to be for 10 percent of the purchase price and last for 10 years. Market penetration trends were adapted from Richey and Koomey (1998), but their forecast was determined to be too aggressive (LBNL/PNNL analysis indicated that manufacturers would not be able to ramp up production quickly). Penetrations were developed jointly with penetrations of HPWHs due to the ENERGY STAR water heater program, utility programs and R&D. Target penetrations for all programs were 0.2% in 2002, 5% in 2005, 10% in 2010 and 30% in 2020 (LBNL/PNNL analysis). The forecast includes market transformation effects which persist beyond the end of the tax credit.

17 Investment in research and development is expected to reduce the cost of heat pump water heaters. Lower costs will increase effectiveness of other HPWH policies. We assume the cost reduction will result in a 10% increase in market penetration. We therefore sum the penetration of heat pump water heaters due to other programs (ENERGY STAR, utility programs and tax credits) and multiply by 0.1 to obtain the additional penetration due to

Notes to Table B-1.3adv (continued)

R&D. We expect that government-funded R&D will reduce the cost of heat pump water heaters. In the advanced case, we assume that R&D will reduce the incremental cost of heat pump water heaters by 50% by 2005. R&D was analyzed jointly with tax credits, ENERGY STAR, and utility rebate programs (we assume negligible baseline penetrations of HPWHs). Target penetrations for all programs were 0.2% in 2002, 5% in 2005, 10% in 2010 and 30% in 2020 (LBNL/PNNL analysis). The penetration for HPWHs ramps up from 0% in 2002 to 6% in 2010 and remains flat thereafter.

18 Utility fuel switching programs are assumed to be structured as an educational and marketing plan directed at all utility customers. The program penetration is assumed to increase to 25% by 2010, then level off. Since only 5 percent of customers are considered eligible for fuel switching (those with gas heat but electric water heaters, Koomey et al 1991), the program penetration is multiplied by the percent of eligible homes to get the percent of eligible customers affected.

19 Penetration for the 2001 refrigerator standard is assumed to be 100% until new standards go into effect in 2010.

20 Market penetrations for utility refrigerator programs are initially 10% but drop to 6% when the 2001 standard comes in (because the efficiency requirement for the utility rebate becomes more stringent). Penetration increases to 12% by 2009. After the refrigerator standard is tightened in 2010, we assume that utility rebate programs will be dropped. Rebates are assumed to be equal to the full incremental cost. We assume that the funds for these incentives come from "lines charges" created as the U.S. utility system is restructured (we assume half of regions adopt lines charges).

21 Each time the standard is tightened the ENERGY STAR criterion is also, so we assume the market penetration of ENERGY STAR units (sales) falls each time the standard is tightened. Market penetrations are initially 8% but drop to 5% when the 2001 standard comes in, then increase to 11% by 2009. With the arrival of new refrigerator standards in 2010, we assume that penetration of ENERGY STAR devices will fall to zero (the ENERGY STAR criterion, adjusted relative to the 2010 standard, is less than our estimate of the technical potential energy use for refrigerators).

22 We assume that NAECA standards for refrigerators will be tightened again in 2010. Market penetrations for standards are assumed to be 100%.

23 Utility fuel switching programs for cooking equipment are assumed to be structured as an educational and marketing plan directed at all utility customers. The program penetration is assumed to increase to 25% by 2010, then level off. Since only 22 percent of customers are considered eligible for fuel switching (those with gas heat but electric ranges, Koomey et al 1991), the program penetration is multiplied by the percent of eligible homes to get the percent of eligible customers affected. The effect of the policy on the percent of eligible homes is taken into account.

24 Utility fuel switching programs for clothes dryers are assumed to be structured as an educational and marketing plan directed at all utility customers. The program penetration is assumed to increase to 25% by 2010, then level off. Since only 36 percent of customers are considered eligible for fuel switching (those with gas heat but electric dryers, Koomey et al 1991), the program penetration is multiplied by the percent of eligible homes to get the percent of eligible customers affected. The effect of the policy on the percent of eligible homes is taken into account.

25 The 2001 freezer standards are assumed to have 100% market penetration until new standards go into effect in 2010.

26 We assume that NAECA standards for freezers will be tightened again in 2010. Market penetrations for standards are assumed to be 100%.

27 Compact fluorescent torchieres were developed at Lawrence Berkeley National Laboratory as replacement for low-efficiency halogen torchieres. Because of their higher costs, we expect the market penetration to top out at 10% in the absence of any other programs.

28 Because CFL torchieres qualify under the ENERGY STAR fixtures program, we expect there to be continued efforts to promote the technology. We expect the market penetration of these fixtures due to the ENERGY STAR fixtures program to increase to 40% of torchieres sold by 2020.

29 Government-funded R&D is expected to decrease the cost of CFLs by 40% by 2010. This will reduce the cost of CFL torchieres, since we assume that the fixtures are sold will a ballast. Lower equipment costs will increase the effectiveness of other CFL programs, including ENERGY STAR fixtures. We assume that R&D will increase market penetration by 15%. We therefore multiply by 0.15 the total penetration of CFL torchieres

Notes to Table B-1.3adv (continued)

due to LBNL's development of the technology and ENERGY STAR's promotional efforts to obtain the additional penetration due to R&D.

30 Because compact fluorescent lamps are not generally effective in low use fixtures, the ENERGY STAR Fixtures Program is assumed to target high-use fixtures (>3 hrs per day in the advanced case). Our penetrations here therefore represent percent of lighting energy rather than percent of units shipped. Fixtures used 6 or more hours per day account for 40% of total lighting energy and fixtures used 3 or more hours per day account for 62% (Wenzel et al, 1997). ENERGY STAR fixtures are expected to capture the market for high-use fixtures by 2020. We assume that the penetration will increase from 10% of lighting energy in 2000 to 40% in 2010 and 62% in 2020.

31 Government-funded R&D is expected to decrease the cost of CFLs by 20% by 2010. This will reduce the cost of CFL fixtures, since we assume that the fixtures are sold with a ballast. Lower equipment costs expand the range of applications where CFL fixtures are cost effective. We assume that R&D will increase market penetration by 15%. We therefore multiply the total penetration of CFL fixtures due to ENERGY STAR by 15% to obtain the additional penetration due to R&D.

32 Government-funded R&D is expected to make mini-HIDs a viable replacement for incandescent lamps. Nadel et al. (1998) indicate that 21% of lighting applications are feasible for the technology. For the advanced case, we assume 1% penetration in 2005, 5% in 2010, 10% in 2015, and 20% in 2020, with penetrations increasing linearly between these points (LBNL/PNNL estimate).

33 ENERGY STAR clothes washers are assumed to be horizontal axis or equivalent efficiency. Market penetration of ENERGY STAR clothes washers is expected to increase to 12% of clothes washer sales by the time a horizontal axis standard come into effect in 2004. The ENERGY STAR program is assumed to be discontinued when the horizontal axis standard goes into effect. Note that this end-use category includes only clothes washer machine energy, not total clothes washing energy, which as usually reported includes water heating energy and may include dryer energy. The shipments penetration used for this end-use is the same underlying penetration used for clothes washers in the electric water heating end-use (see note 4). In this case, the end-use, clothes washers, corresponds to the technology affected by the policy, so it is not necessary to weight the penetration by the percent of homes with clothes washers to obtain the percent of end-use energy affected.

34 We expect that DOE will eventually succeed in finalizing a horizontal axis clothes washer standard. This standard is assumed to go into effect in 2004 in the advanced case, and we assume 100% market penetration for thereafter. Note that this end-use category includes only clothes washer machine energy, not total clothes washing energy, which as usually reported includes water heating energy and may include dryer energy. Water heating and dryer energy due to clothes washers is reported separately under the water heating and clothes dryer end-uses. The shipment penetration used for this end-use is the same underlying penetration used for clothes washers in the electric water heating end-use (see note 13). In this case, the end-use, clothes washers, corresponds to the technology affected by the policy, so it is not necessary to weight the penetration by the percent of homes with clothes washers to obtain the percent of end-use energy affected.

35 No policies were considered for dishwasher motors.

36 Market penetration of ENERGY STAR TVs is assumed to grow from 20% in 2000 to 65% in 2009. The ENERGY STAR program is assumed to be extended with no change in the ENERGY STAR criterion energy consumption until 2010, when we assume the global one-watt initiative takes its place.

37 For the advanced case, we assume that DOE will issue television standards in 2010. Market penetrations for standards are assumed to be 100%.

38 The "global one-watt" initiative is an idea for reducing leaking electricity that has garnered international interest. Although the structure of such a plan is a matter for speculation, we can nonetheless calculate the effect of such a program. Many products would be affected including televisions, most miscellaneous electronics and some miscellaneous motors (such as those with electronic controls or battery chargers). The 2010 penetration assumed

Notes to Table B-1.3adv (continued)

for electronics and motors is 35%; for TVs it is 70%. For all products we expect penetration to increase to 85% of the market by 2020. Because the policy applies to only a subset of the miscellaneous motors and miscellaneous electronics end-uses, it was necessary to weight the stock penetration by the percent of each end-use attributable to "leaking" electricity. For miscellaneous electronics, we estimate the share of energy attributable to devices that leak at 92% based on data from Sanchez et al (1998). The percent of miscellaneous motor energy attributable to devices that leak is only 3.9%, also based on data from Sanchez, et al (1998). We assume that all TVs leak, therefore the global one-watt initiative applies to the entire end-use and no weighting was necessary.

39 No policies were considered for personal computers. The ENERGY STAR computer program was assumed to be fully included in AEO99.

40 No policies were considered for furnace fans.

41 No policies were considered for miscellaneous heating coils.

42 The Florida Solar Energy Center with AeroVironment developed an innovative ceiling fan blade design. The technology has been licensed to a manufacturer and a modified design (Su and Zambrano 1999) is expected to be on the market sometime in 2000 (FSEC 1999). We projected that market penetration of the design could increase from 3% of the ceiling fan market in 2001 to 20% in 2010 and 25% by 2020. To obtain the percent of frozen efficiency miscellaneous motor energy affected, we weighted the stock penetration by the percent of miscellaneous motor energy attributable to ceiling fans, which we estimate to be 16.8% based on data from Sanchez et al. (1998).

43 Pool pumps were targeted because they make up a fairly large share of miscellaneous motor energy. For analytical purposes, the program was conceived of as an ENERGY STAR-type voluntary program. Market penetration is expected to increase from 3% in 2001 to 10% of pool pumps in 2010 and 13% in 2020. To obtain the percent of frozen efficiency miscellaneous motor energy affected, we weighted the stock penetration by the percent of miscellaneous motor energy attributable to pool pumps, which we estimate to be 15.5% based on data from Sanchez et al. (1998).

44 Market penetration of ENERGY STAR VCRs is assumed to grow from 10% in 2000 to 46% in 2009. VCR stock penetrations were weighted by the share of miscellaneous electronics energy attributable to VCRs (14% based on data from Sanchez et al, 1998) to obtain the percent of miscellaneous electronics energy affected in 2010 and 2020. The ENERGY STAR program is assumed to end in 2010 with the arrival of the global one-watt initiative.

45 Market penetration of ENERGY STAR audio equipment is assumed to grow from 5% in 2000 to 14% in 2009. Audio equipment stock penetrations were weighted by the share of miscellaneous electronics energy attributable to audio equipment (19.7% based on data from Sanchez et al, 1998) to obtain the percent of frozen efficiency miscellaneous electronics energy affected by the policy in 2010 and 2020. The ENERGY STAR program is assumed to end in 2010 with the arrival of the global one-watt initiative.

46 We assume that EPA will launch a settop box program (for cable boxes and satellite receivers) in 2000. Market penetration of ENERGY STAR devices is assumed to increase from 3% in 2000 to 28% in 2009. Settop Box stock penetrations were weighted by the share of the miscellaneous electronics energy attributable to settop boxes (22.7% based on data from Sanchez et al, 1998) to obtain the percent of frozen efficiency miscellaneous electronics energy affected in 2010 and 2020. The ENERGY STAR program is assumed to end in 2010 with the arrival of the global one-watt initiative.

47 We assume that EPA will launch a telephony program (for cordless phones, answering machines, etc.) in 2000. Market penetration of ENERGY STAR devices is assumed to increase from 5% in 2000 to 28% in 2009. Telephony stock penetrations were weighted by the share of miscellaneous electronics energy attributable to telephony (7.3% based on data from Sanchez et al, 1998) to obtain the percent of frozen efficiency miscellaneous electronics energy affected in 2010 and 2020. The ENERGY STAR program is assumed to end in 2010 with the arrival of the global one-watt initiative.

48 We assume that EPA will launch a microwave oven program in 2001. Market penetration of ENERGY STAR devices is assumed to increase from 5% in 2001 to 23% in 2009. Microwave stock penetrations were weighted by the share of miscellaneous electronics energy attributable to microwaves (17.4%

Notes to Table B-1.3adv (continued)

based on data from Sanchez et al, 1998) to obtain the percent of frozen efficiency miscellaneous electronics energy affected by the policy in 2010 and 2020. The ENERGY STAR program is assumed to end in 2010 with the arrival of the global one-watt initiative.

49 ENERGY STAR clothes washers are not cost effective at current market prices in gas water heating homes. We therefore assume zero penetration.

50 Penetrations of ENERGY STAR dishwashers increase to 20% of dishwasher sales in 2009. Stock penetrations were multiplied by the percent of homes with dishwashers (57%, Koomey et al., 1999b) to obtain the percent of frozen efficiency gas water heating energy affected by the policy in 2010 and 2020. The ENERGY STAR program is assumed to be discontinued when a new dishwasher standard goes into effect in 2010.

51 Market penetrations for gas water heater standards are assumed to be 100% from 2004 through the end of the analysis period.

52 We expect that DOE will eventually succeed in finalizing a horizontal axis clothes washer standard. This standard is assumed to go into effect in 2004 in the advanced case. We assume 100% market penetration for standards. To obtain the percent of frozen efficiency gas water heating energy affected by the policy, we weighted the stock penetration by the percent of homes with clothes washers (80.9%, Koomey et al., 1999b).

53 We assume that new dishwasher standards will go into effect in 2010. We assume 100% market penetration for standards. The stock penetration is weighted by the percent of homes with dishwashers (57%, Koomey et al 1999b) to obtain the percent of frozen efficiency gas water heating energy affected by the policy.

54 Tax credits for 0.65 EF gas water heaters are assumed to be for 10 percent of the purchase price for the period December 31, 1999 to January 1, 2002 (US DOT, 1999). Market penetrations were adapted from Richey and Koomey (1998).

55 Tax credits for 0.80 EF gas water heaters in the advanced case are assumed to be for 10 percent of the purchase price and last for 10 years. These water heaters are quite expensive and are cost effective only in homes that use a great deal of hot water--more than three times the hot water use of the average home. Based on an LBNL analysis of hot water use data, we concluded that such homes comprise less than 0.4% of all homes and account for 1.4% of total hot water use. Under the new 2004 standards the pool of cost effective applications is even smaller, at 0.12% of homes and 0.5% of water use. We take the share of total hot water use as a proxy for the share of gas water heating energy and estimate that the penetration of the tax credit program might affect 100% of cost effective homes after a ramp up period. Penetrations persist beyond the end of the actual tax credit due to a market transformation effect.

56 No policies were considered for gas cooking equipment.

57 No policies were considered for gas clothes dryers.

58 No policies were considered for gas other uses.

Introduction to the Commercial Penetration Tables (Tables B-1.4mod and B-1.4adv)

Penetration of the various policies considered in this analysis for commercial end uses are presented in Tables B-1.4mod and B-1.4adv (moderate and advanced case assumptions, respectively). Policies are listed by end-use, so the same policy may appear several times. For example, the ENERGY STAR Buildings/Rebuild America programs (which we lump together in assessing their effects) affect gas and electric heating, cooling, and water heating as well as electric ventilation and lighting. Whole building R&D (commercial sector) is assumed to affect both new and existing buildings. In the context of this analysis, "existing buildings" refers to those built in 1999 or before ("pre-2000") and "new buildings" are those built in 2000 or later ("post-1999"). Since we assume higher penetrations for new buildings, we present "whole building R&D-existing buildings" and "whole buildings R&D-new buildings" as if they were separate policies.

Penetrations for ENERGY STAR Buildings/Rebuild America and whole building R&D for existing buildings are expressed as a percent of existing commercial floorspace. Penetrations for whole building R&D for new buildings are expressed as a percent of buildings constructed in each year (the percent of energy affected in 2010 and 2020 applies to energy use in all post-1999 buildings). All other penetrations should be interpreted as the percent of end-use energy affected by a policy.

In many cases multiple policies affect the same end use. To avoid double counting, we had to establish rules for how savings would be divided between policies. Mandatory programs, such as equipment standards, were given primacy. Standards are assumed to affect 100% of a certain type of equipment and are credited with the full savings of moving from a baseline unit to a unit just meeting the standard. Any non-mandatory policy is considered to be on top of standards (if any). Savings are calculated relative to the standard in place. If a non-mandatory policy affects 40% of an equipment type and saves 15% of the energy of a baseline unit, but standards are in place that effect 100% of equipment and save 10% over a baseline unit, the non-mandatory program is credited with saving 5% of baseline energy on 40% of the equipment. A single non-mandatory policy may therefore have multiple baselines if standards are updated once or more while the policy is in place. Because the energy savings change when the baseline changes, we treat each policy/baseline combination separately in our analysis. The penetrations for each policy/baseline combination are listed separately in these tables.

Table B-1.4mod. Commercial Building Moderate Case Market Penetrations

Policy by Fuel and End-Use	Notes	Penetration[1]													% of Frozen Efficiency End-Use Energy Affected[2]	
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2015	2020	2010	2020
Electric																
Space heating																
Energy Star Bldgs/Rebuild America	*3*	0.5%	0.6%	0.7%	0.8%	0.8%	0.7%	0.7%	0.6%	0.6%	0.5%	0.5%	0.5%	0.3%	7.0%	8.9%
Whole Bldg R&D-existing bldgs	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.3%	0.4%	0.5%	0.6%	0.6%	0.6%	2.2%	9.2%
Whole Bldg R&D-new bldgs	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	4.0%	8.0%	10%	12%	14%	20%	20%	4.4%	10.8%
Commercial Bldg Codes	*5*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	8.0%	12%	0.2%	3.5%
Space cooling																
Energy Star Bldgs pre 2005 AC std	*3*	0.5%	0.7%	0.8%	0.8%	0.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.3%	4.3%
Energy Star Bldgs w/ 2005 AC std	*3*	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%	0.7%	0.7%	0.7%	0.6%	0.6%	0.6%	0.3%	3.9%	7.0%
2005 Comm'l Pkgd AC Stds	*6*	0.0%	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	100%	100%	100%	100%	100%	15.5%	37.4%
Whole Bldg R&D-existing bldgs w/ 2005 AC std	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.3%	0.4%	0.5%	0.6%	0.6%	0.6%	2.2%	9.2%
Whole Bldg R&D-new bldgs w/ 2005 AC std	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	4.0%	8.0%	10%	12%	14%	20%	20%	4.4%	10.8%
Commercial Bldg Codes w/ 2005 AC std	*5*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	8.0%	12%	0.2%	3.5%
Water heating																
Utility HPWH	*7*	0.0%	0.3%	0.6%	0.9%	1.2%	1.5%	1.8%	2.1%	2.4%	2.7%	3.0%	4.5%	6.0%	1.1%	3.7%
Energy Star Bldgs/Rebuild America	*3*	0.5%	0.7%	0.8%	0.8%	0.8%	0.8%	0.7%	0.7%	0.7%	0.6%	0.6%	0.6%	0.3%	7.9%	10.1%
Whole Bldg R&D-existing bldgs	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.3%	0.4%	0.5%	0.6%	0.6%	0.6%	2.2%	9.2%
Whole Bldg R&D-new bldgs	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	4.0%	8.0%	10%	12%	14%	20%	20%	4.4%	10.8%
Commercial Bldg Codes	*5*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	8.0%	12%	0.2%	3.5%
Ventilation																
Energy Star Bldgs/Rebuild America	*3*	0.5%	0.7%	0.8%	0.8%	0.8%	0.8%	0.7%	0.7%	0.7%	0.6%	0.6%	0.6%	0.3%	7.7%	10.0%
Whole Bldg R&D-existing bldgs	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.3%	0.4%	0.5%	0.6%	0.6%	0.6%	2.2%	9.2%
Whole Bldg R&D-new bldgs	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	4.0%	8.0%	10%	12%	14%	20%	20%	4.4%	10.8%
Commercial Bldg Codes	*5*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	8.0%	12%	0.2%	3.5%
Cooking		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lighting																
E* Bldgs/Rebuild America pre 2004 ballast std	*3*	1.0%	1.2%	1.2%	1.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.8%	0.0%
E* Bldgs/Rebuild America w/ 2004 ballast std	*3*	0.0%	0.0%	0.0%	0.0%	1.3%	1.3%	1.2%	1.2%	1.3%	1.3%	1.2%	1.2%	0.7%	7.8%	20.4%
2004 Ballast Standards	*8*	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	53.8%	100%
Whole Bldg R&D-existing bldgs w/ ballast std	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.3%	0.4%	0.5%	0.6%	0.6%	0.6%	2.2%	9.2%
Whole Bldg R&D-new bldgs w/ ballast std	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	4.0%	8.0%	10%	12%	14%	20%	20%	4.4%	10.8%
Commercial Bldg Codes w/ ballast std	*5*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	8.0%	12%	0.2%	3.5%

Table B-1.4mod (continued). Commercial Building Moderate Case Market Penetrations

Policy by Fuel and End-Use	Notes	Penetration[1]													% of Frozen Efficiency End-Use Energy Affected[2]	
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2015	2020	2010	2020
Electric																
Refrigeration																
E* Beverage Merchandisers	*9*	0.0%	0.0%	0.0%	5.0%	7.9%	11%	14%	16%	19%	22%	25%	28%	30%	0.3%	1.0%
E* Vending Machines	*10*	0.0%	0.0%	0.0%	5.0%	7.9%	11%	14%	16%	19%	22%	25%	28%	30%	0.8%	2.6%
Energy Star Ice Machines	*11*	0.0%	0.0%	0.0%	5.0%	7.9%	11%	14%	16%	19%	22%	25%	28%	30%	0.6%	2.0%
Office equip.-PCs		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Office equip.-non-PCs		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Other Uses																
Miscellaneous																
Energy Star Exit Signs	*12*	5.0%	11%	16%	22%	27%	33%	38%	44%	49%	55%	60%	70%	80%	3.7%	7.9%
Energy Star Transformers	*13*	9.0%	12%	15%	18%	21%	25%	28%	31%	34%	37%	40%	48%	55%	2.2%	6.0%
Energy Star Traffic Lights	*14*	0.0%	0%	0%	10%	17%	24%	31%	39%	46%	53%	60%	70%	80%	1.0%	2.7%
District Services		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Adjust to SEDs		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gas																
Space heating																
Energy Star Bldgs/Rebuild America	*3*	0.5%	0.6%	0.7%	0.8%	0.8%	0.7%	0.7%	0.6%	0.6%	0.5%	0.5%	0.5%	0.3%	7.0%	8.9%
Whole Bldg R&D-existing bldgs	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.3%	0.4%	0.5%	0.6%	0.6%	0.6%	2.2%	9.2%
Whole Bldg R&D-new bldgs	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	4.0%	8.0%	10%	12%	14%	20%	20%	4.4%	10.8%
Commercial Bldg Codes	*5*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	8.0%	12%	0.2%	3.5%
Space cooling																
Energy Star Bldgs/Rebuild America	*3*	0.5%	0.7%	0.8%	0.8%	0.9%	0.8%	0.7%	0.7%	0.7%	0.6%	0.6%	0.6%	0.3%	8.2%	11.3%
Whole Bldg R&D-existing bldgs	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.3%	0.4%	0.5%	0.6%	0.6%	0.6%	2.2%	9.2%
Whole Bldg R&D-new bldgs	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	4.0%	8.0%	10%	12%	14%	20%	20%	4.4%	10.8%
Commercial Bldg Codes	*5*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	8.0%	12%	0.2%	3.5%
Water heating																
Energy Star Bldgs/Rebuild America	*3*	0.5%	0.7%	0.8%	0.8%	0.8%	0.8%	0.7%	0.7%	0.7%	0.6%	0.6%	0.6%	0.3%	7.9%	10.1%
Whole Bldg R&D-existing bldgs	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.3%	0.4%	0.5%	0.6%	0.6%	0.6%	2.2%	9.2%
Whole Bldg R&D-new bldgs	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	4.0%	8.0%	10%	12%	14%	20%	20%	4.4%	10.8%
Commercial Bldg Codes	*5*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	8.0%	12%	0.2%	3.5%
Cooking		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table B-1.4mod (continued). Commercial Building Moderate Case Market Penetrations

Policy by Fuel and End-Use	Notes	Penetration[1]													% of Frozen Efficiency End-Use Energy Affected[2]	
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2015	2020	2010	2020
Gas																
Other Uses																
Misc		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
District Services		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cogen		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Adjust to SEDS		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes to Table B-1.4mod

Commercial Building Moderate Case Market Penetrations

1 For equipment, shipment penetrations are reported (the percent of units shipped that are high efficiency due to the policy). For whole buildings programs affecting existing buildings, the penetration for each end-use represents the percent of the floorstock existing in 2000 still existing in any year affected by efficiency improvements to that end-use each year. For whole building programs affecting new building, the penetration represents the percent of buildings built in that year affected by the policy.

2 Because the goal of this analysis was to measure to what extent a policy affects energy in a given end-use, we report the percent of end-use energy affected by a policy rather than the stock penetration of a particular technology (the stock penetration is calculated as cumulative shipment penetration less retirements). In many cases the stock penetration is the same as the percent of energy affected. However, consider the commercial refrigeration end-use: It is affected by policies affecting ice makers, refrigerated vending machines and beverage merchandisers. The stock penetration of high efficiency ice makers, by itself, says little about what impact the policy will have on commercial refrigeration as a whole. We therefore weight the stock penetration calculated for ice makers by the percent of commercial refrigeration due to ice makers (10% from Westphalen et al, 1996). This weighted value gives the percent of frozen-efficiency refrigeration energy affected by the policy. For programs affecting existing buildings only, this percentage applies only to energy in buildings built in 1999 or earlier. For programs affecting new buildings only, this percentage applies only to buildings built in 2000 or later. For a discussion of how the frozen efficiency baseline is used in the analysis, see Appendix D.

3 We analyze ENERGY STAR Buildings and Rebuild America jointly because the programs are complementary and similar in effect. Penetrations for heating, cooling, water heating, ventilation and lighting penetrations are derived from EPA forecasts of ENERGY STAR Building program participation (the EPA forecasts participation by phase of program, so some aggregation was performed to obtain savings by end-use). Penetrations represent the percent of total commercial floorspace that joined the ENERGY STAR Building Program in that year. For the moderate case, EPA's penetration estimates were reduced by 30%. Penetrations were reduced further because we attributed part of the ENERGY STAR Building penetration estimates to whole building R&D.

4 Whole building R&D programs are assumed to affect commercial construction practices as well as make other whole building policies less expensive and therefore increase their penetrations. In our analysis the only program affected by R&D is ENERGY STAR Buildings/Rebuild America. The penetration for the R&D program includes buildings built to ENERGY STAR efficiency levels attributable to a decrease in investment costs due to the R&D program or to changes in construction practices due to the R&D program. We assumed these R&D programs would affect a fraction of new (post-1999) buildings, increasing from 0% in 2004 to 20% in 2013 and remaining flat thereafter. A fraction of existing (pre-2000) buildings would also be converted each year, increasing from 0% in 2004 to 0.6% in 2010. Note that penetrations apply only to the market segment indicated; e.g. whole buildings R&D-new buildings penetrations are with respect to new (post-1999) buildings only.

5 Commercial building codes are expected to be adopted by 3% of regions beginning in 2010, increasing to 10% in 2015 and 15% in 2020. The code enforcement rate is assumed to be 80% (this is somewhat higher than for residential building codes because there is assumed to be greater oversight, both internal and external, for commercial buildings). Penetrations are with respect to new buildings only. The ASHRAE 90.1-1999 revision is not analyzed here because its effect, largely restricted to lighting, was already captured in the analysis by ballast efficiency standards

6 Commercial packaged a/c standards are assumed to affect 100% of commercial packaged a/c sold beginning in 2005. To calculate the percent of frozen efficiency electric cooling energy affected by standards, we calculated the stock penetrations for each policy in 2010 and 2020 and weighted them by the share of total electric cooling energy attributable to devices affected by the standard (40% from Suozzo and Nadel, 1998).

7 Suozzo and Nadel (1998) estimate that heat pump water heaters would be feasible in 12% of commercial water heating applications. Our penetrations assume that half of those feasible applications might be achievable by 2020.

Notes to Table B-1.4mod (continued)

8 Ballast standard penetration is assumed to be 100% from 2004 onward.

9 We assume that the market penetration for ENERGY STAR beverage merchandisers will grow from 5% of beverage merchandisers in 2003 to 25% in 2010 and 30% in 2020. To obtain the percent of frozen efficiency commercial refrigeration energy affected, stock penetrations were weighted by the beverage merchandiser share of commercial refrigeration energy (5%) from Westphalen et al (1996).

10 We assume that the market penetration for ENERGY STAR vending machines will grow from 5% of refrigerated vending machines in 2003 to 25% in 2010 and 30% in 2020. To obtain the percent of frozen efficiency commercial refrigeration energy affected, stock penetrations were weighted by the vending machine share of commercial refrigeration energy (13%) from Westphalen et al. (1996).

11 We assume that the market penetration for ENERGY STAR ice machines will grow from 5% of ice machines in 2003 to 25% in 2010 and 30% in 2020. To obtain the percent of frozen efficiency commercial refrigeration energy affected, stock penetrations were weighted by the ice machine share of commercial refrigeration energy (10%) from Westphalen et al. (1996).

12 Penetrations of ENERGY STAR exit signs increase from 5% in 2000 to 60% in 2010 and 80% in 2020. Penetrations apply to the approximately 75% of the market that is incandescent (Suozzo and Nadel 1998). To obtain the percent of frozen efficiency miscellaneous commercial electricity affected, stock penetrations were weighted by the incandescent exit sign share of commercial miscellaneous electricity (11%,based on stock and energy consumption data from Suozzo and Nadel, 1998).

13 The ENERGY STAR commercial and industrial transformer program aims to reduce transformer losses in commercial buildings. Because transformer data is reported by transformer type (low or medium voltage and dry type or liquid immersed) rather than by sector, we had to make some assumptions in order to determine commercial transformer energy use and shipments data. Electric League of the Pacific Northwest et al. (1998) report that low voltage equipment dominates the commercial sector, medium voltage equipment dominates the industrial sector, and almost all low voltage transformers are dry-type. We therefore used total low-voltage sales (from EPA's transformer program) as a proxy for commercial sales in estimating the stock of commercial transformers. EPA's estimates of energy savings assume an increase in efficiency from 95% to 98%. Suozzo and Nadel (1998), however, estimate that baseline transformer efficiency is 97.3%. In personal communication, Margaret Suozzo indicated that she felt EPA's 95% efficiency baseline was too low. We therefore used the efficiency estimates in Suozzo and Nadel with the average rating, average load factor and hours per year from EPA's transformer analysis (45 kVA, 35% and 8760 hours per year, respectively) to estimate baseline and ENERGY STAR transformer energy losses. EPA's ENERGY STAR transformer analysis projects market penetrations to grow to 60% by 2012 and remain flat thereafter. We assume a somewhat more modest growth, with penetrations increasing from 9% in 2000 to 40% in 2010 and 55% in 2020. The percent of commercial miscellaneous electricity that is due to transformer losses was calculated using our estimate of transformer unit energy losses with estimates of the current stock of commercial transformers. To obtain the percent of frozen efficiency miscellaneous commercial electricity affected, stock penetrations of ENERGY STAR transformers were weighted by the transformer loss share of miscellaneous electricity (24% based on above loss and load assumptions and a stock of 6 million transformers, estimated from EPA sales data).

14 The ENERGY STAR traffic lights program is proposed to promote the replacement of incandescent traffic lights with LED traffic lights. This is currently highly cost effective for red traffic lights, but less so for green and yellow lights because they have shorter duty cycles and green and yellow LEDs are more expensive than red. We assume that penetrations will grow from 10% in 2003 to 60% in 2010 to 80% in 2020. To estimate the percent of total commercial electricity that goes to traffic lights, we estimated total traffic light energy consumption using energy consumption and an estimate of the number of signalized intersections in the U.S. from Suozzo and Nadel (1998). To obtain the percent of frozen efficiency miscellaneous commercial electricity affected, stock penetrations of ENERGY STAR traffic lights were weighted by the traffic signal share of miscellaneous electricity (4%, based on stock and energy consumption data from Suozzo and Nadel, 1998).

Table B-1.4adv. Commercial Building Advanced Case Market Penetrations

Policy by Fuel and End-Use	Notes	Penetration[1]													% of Frozen Efficiency End-Use Energy Affected[2]	
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2015	2020	2010	2020
Electric																
Space heating																
Energy Star Bldgs/Rebuild America	*3*	0.7%	0.8%	1.0%	1.1%	1.1%	1.1%	1.0%	0.8%	0.7%	0.6%	0.5%	0.6%	0.2%	9.6%	12.1%
Whole Building R&D-existing bldgs	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.3%	0.5%	0.7%	0.9%	1.0%	1.0%	1.0%	3.6%	15.3%
Whole Building R&D-new bldgs	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	6.0%	12%	15%	18%	21%	30%	30%	6.6%	16.2%
Commercial Building Codes	*5*	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	3.5%	4.6%	5.8%	6.9%	8.0%	12%	16%	2.8%	6.8%
Space cooling																
Energy Star Bldgs pre 2005 AC std	*3*	0.7%	0.9%	1.1%	1.2%	1.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.1%	6.1%
Energy Star Bldgs w/ 2005 AC std	*3*	0.0%	0.0%	0.0%	0.0%	0.0%	1.2%	1.1%	1.0%	0.8%	0.7%	0.0%	0.0%	0.0%	4.9%	7.1%
Energy Star Bldgs w/ 2010 AC std	*3*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%	0.7%	0.3%	0.3%	1.7%
2005 Commercial Packaged AC Stds	*6*	0.0%	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	100%	100%	0.0%	0.0%	0.0%	12.9%	9.0%
2010 Commercial Packaged AC Stds	*6*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	2.6%	28.4%
Whole Bldg R&D-existg bldgs w/ 2005 AC std	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.3%	0.5%	0.7%	0.9%	0.0%	0.0%	0.0%	2.5%	2.5%
Whole Bldg R&D-existg bldgs w/ 2010 AC std	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	1.0%	1.0%	1.0%	12.7%
Whole Bldg R&D-new bldgs w/ 2005 AC std	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	6.0%	12%	15%	18%	0.0%	0.0%	0.0%	4.6%	2.6%
Whole Bldg R&D-new bldgs w/ 2010 AC std	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	21%	30%	30%	1.9%	13.6%
Commercial Building Codes w/ 2005 AC std	*5*	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	3.5%	4.6%	5.8%	6.9%	0.0%	0.0%	0.0%	2.1%	1.2%
Commercial Building Codes w/ 2010 AC std	*5*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8.0%	12%	16%	0.7%	5.6%
Water heating																
Utility HPWH	*7*	0.0%	0.3%	0.6%	0.9%	1.2%	1.5%	1.8%	2.1%	2.4%	2.7%	3.0%	4.5%	6.0%	1.1%	3.7%
Energy Star Buildings/Rebuild America	*3*	0.8%	1.0%	1.2%	1.3%	1.3%	1.3%	1.2%	1.1%	1.0%	0.9%	0.8%	0.9%	0.4%	11.9%	15.0%
Whole Building R&D-existing bldgs	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.3%	0.5%	0.7%	0.9%	1.0%	1.0%	1.0%	3.6%	15.3%
Whole Building R&D-new bldgs	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	6.0%	12%	15%	18%	21%	30%	30%	6.6%	16.2%
Commercial Building Codes	*5*	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	3.5%	4.6%	5.8%	6.9%	8.0%	12%	16%	2.8%	6.8%
Ventilation																
Energy Star Buildings/Rebuild America	*3*	0.7%	0.9%	1.1%	1.2%	1.2%	1.2%	1.0%	0.9%	0.8%	0.7%	0.7%	0.7%	0.3%	10.5%	12.1%
Whole Bldg R&D-existing bldgs	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.3%	0.5%	0.7%	0.9%	1.0%	1.0%	1.0%	3.6%	15.3%
Whole Bldg R&D-new bldgs	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	6.0%	12%	15%	18%	21%	30%	30%	6.6%	16.2%
Commercial Building Codes	*5*	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	3.5%	4.6%	5.8%	6.9%	8.0%	12%	16%	2.8%	6.8%
Cooking		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lighting																
E* Bldgs/Rebuild America	*3*	1.4%	1.7%	1.8%	1.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8.3%	0.0%
E* Bldgs/Rebuild America w/ 2004 ballast std	*3*	0.0%	0.0%	0.0%	0.0%	1.8%	1.8%	1.7%	1.7%	1.7%	1.6%	1.6%	1.6%	0.8%	10.6%	26.9%

Table B-1.4adv (continued). Commercial Building Advanced Case Market Penetrations

Policy by Fuel and End-Use	Notes	Penetration[1]													% of Frozen Efficiency End-Use Energy Affected[2]	
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2015	2020	2010	2020
Electric																
Lighting																
Ballast Standards	*8*	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	53.8%	100%
Whole Bldg R&D-existing bldgs w/ 2004 ballast st	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.3%	0.5%	0.7%	0.9%	1.0%	1.0%	1.0%	3.6%	15.3%
Whole Bldg R&D-new bldgs w/ 2004 ballast std	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	6.0%	12%	15%	18%	21%	30%	30%	6.6%	16.2%
Commercial Building Codes w/ 2004 ballast std	*5*	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	3.5%	4.6%	5.8%	6.9%	8.0%	12%	16%	2.8%	6.8%
Refrigeration																
Energy Star Bevge Merchandisers	*9*	0.0%	0.0%	0.0%	5.0%	7.9%	11%	14%	16%	19%	22%	25%	28%	30%	0.3%	1.0%
Energy Star Vending Machines	*10*	0.0%	0.0%	0.0%	5.0%	7.9%	11%	14%	16%	19%	22%	25%	28%	30%	0.8%	2.6%
Energy Star Ice Machines	*11*	0.0%	0.0%	0.0%	5.0%	7.9%	11%	14%	16%	19%	22%	25%	28%	30%	0.6%	2.0%
Office equip.-PCs		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Office equip.-non-PCs		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Other Uses																
Miscellaneous																
Energy Star Exit Signs	*12*	5.0%	11%	16%	22%	27%	33%	38%	44%	49%	55%	60%	70%	80%	3.7%	7.9%
Energy Star Transformers	*13*	9.0%	12%	15%	18%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.4%
Energy Star Traffic Lights	*14*	0.0%	0.0%	0.0%	10%	17%	24%	31%	39%	46%	53%	60%	70%	80%	1.0%	2.7%
Transformer Standards	*15*	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	100%	100%	100%	100%	100%	100%	5.6%	13.6%
District Services		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Adjust to SEDs		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gas																
Space heating																
Energy Star Bldgs pre 2010 furn/boiler std	*3*	0.7%	0.8%	1.0%	1.1%	1.1%	1.1%	1.0%	0.8%	0.7%	0.6%	0.0%	0.0%	0.0%	9.2%	1.0%
Energy Star Bldgs w/ 2010 furn/boiler std	*3*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.6%	0.2%	0.5%	11.1%
2010 Gas Furnace and Boiler Stds	*16*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%	100%	100%	5.8%	63.9%
Whole Bldg R&D-existing bldgs pre 2010 furn std	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.3%	0.5%	0.7%	0.9%	0.0%	0.0%	0.0%	2.5%	2.5%
Whole Bldg R&D-extg bldgs w/ 2010 furn std	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	1.0%	1.0%	1.0%	12.7%
Whole Bldg R&D-new bldgs pre 2010 furn std	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	6.0%	12%	15%	18%	0.0%	0.0%	0.0%	4.6%	2.6%
Whole Bldg R&D-new bldgs w/ 2010 furn std	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	21%	30%	30%	1.9%	13.6%
Commercial Building Codes pre 2010 furn std	*5*	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	3.5%	4.6%	5.8%	6.9%	0.0%	0.0%	0.0%	2.1%	1.2%
Commercial Building Codes w/ 2010 furn std	*5*	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8.0%	12%	16%	0.7%	5.6%

Table B-1.4adv (continued). Commercial Building Advanced Case Market Penetrations

Policy by Fuel and End-Use	Notes	Penetration[1]													% of Frozen Efficiency End-Use Energy Affected[2]	
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2015	2020	2010	2020
Gas																
Space cooling																
Energy Star Buildings/Rebuild America	*3*	0.7%	0.9%	1.1%	1.2%	1.2%	1.2%	1.1%	1.0%	0.8%	0.7%	0.7%	0.7%	0.3%	11.3%	14.9%
Whole Bldg R&D-existing bldgs	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.3%	0.5%	0.7%	0.9%	1.0%	1.0%	1.0%	3.6%	15.3%
Whole Bldg R&D-new bldgs	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	6.0%	12%	15%	18%	21%	30%	30%	6.6%	16.2%
Commercial Building Codes	*5*	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	3.5%	4.6%	5.8%	6.9%	8%	12%	16%	2.8%	6.8%
Water heating																
Energy Star Buildings/Rebuild America	*3*	0.8%	1.0%	1.2%	1.3%	1.3%	1.3%	1.2%	1.1%	1.0%	0.9%	0.8%	0.9%	0.4%	11.9%	15.0%
Whole Bldg R&D-existing bldgs	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.3%	0.5%	0.7%	0.9%	1.0%	1.0%	1.0%	3.6%	15.3%
Whole Bldg R&D-new bldgs	*4*	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	6.0%	12%	15%	18%	21%	30%	30%	6.6%	16.2%
Commercial Building Codes	*5*	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	3.5%	4.6%	5.8%	6.9%	8%	12%	16%	2.8%	6.8%
Cooking		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Other Uses																
Misc		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
District Services		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cogen		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Adjust to SEDS		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes to Table B-1.4adv

Commercial Building Advanced Case Market Penetrations

1 For equipment, shipment penetrations are reported (the percent of units shipped that are high efficiency due to the policy). For whole buildings programs affecting existing buildings, the penetration for each end-use represents the percent of the floorstock existing in 2000 still existing in any year affected by efficiency improvements to that end-use each year. For whole building programs affecting new building, the penetration represents the percent of buildings built in that year affected by the policy.

2 Because the goal of this analysis was to measure to what extent a policy affects energy in a given end-use, we report the percent of end-use energy affected by a policy rather than the stock penetration of a particular technology (the stock penetration is calculated as cumulative shipment penetration less retirements). In many cases the stock penetration is the same as the percent of energy affected. However, consider the commercial refrigeration end-use: It is affected by policies affecting ice makers, refrigerated vending machines and beverage merchandisers. The stock penetration of high efficiency ice makers, by itself, says little about what impact the policy will have on commercial refrigeration as a whole. We therefore weight the stock penetration calculated for ice makers by the percent of commercial refrigeration due to ice makers (10% from Westphalen et al, 1996). This weighted value gives the percent of frozen-efficiency refrigeration energy affected by the policy. For programs affecting existing buildings only, this percentage applies only to energy in buildings built in 1999 or earlier. For programs affecting new buildings only, this percentage applies only to buildings built in 2000 or later. For a discussion of how the frozen efficiency baseline is used in the analysis, please refer to Appendix D.

3 We analyze ENERGY STAR Buildings and Rebuild America jointly because the programs are complementary and similar in effect. Penetrations for heating, cooling, water heating, ventilation and lighting penetrations are derived from EPA forecasts of ENERGY STAR Buildings program participation (the EPA forecasts participation by phase of program, so some aggregation was performed to obtain savings by end-use). Penetrations represent the percent of total commercial floorspace that joined the ENERGY STAR Building Program in that year. Penetrations were reduced from EPA's forecasts because we attributed part of the ENERGY STAR Building penetration estimates to whole building R&D.

4 Whole building R&D programs are assumed to affect commercial construction practices as well as make other whole building policies less expensive and therefore increase their penetrations. In our analysis the only program affected by R&D is ENERGY STAR Buildings/Rebuild America. The penetration for the R&D program includes buildings built to ENERGY STAR efficiency levels attributable to a decrease in investment costs due to the R&D program or to changes in construction practices due to the R&D program. We assumed these R&D programs would affect a fraction of new (post-1999) buildings, increasing from 0% in 2004 to 30% in 2013 and remaining flat thereafter. A fraction of existing (pre-2000) buildings would also be converted each year, increasing from 0% in 2004 to 1% in 2010. Note that penetrations apply only to the market segment indicated; e.g. whole buildings R&D-new buildings penetrations are with respect to new (post-1999) buildings only.

5 Commercial building codes are expected to be adopted by 3% of regions beginning in 2005, increasing to 10% in 2010 and 20% in 2020. The code enforcement rate is assumed to be 80% (this is somewhat higher than for residential building codes because there is assumed to be greater oversight, both internal and external, for commercial buildings). Penetrations are with respect to new buildings only. The ASHRAE 90.1-1999 revision is not analyzed here because its effect, largely restricted to lighting, was already captured in the analysis by ballast efficiency standards.

6 The 2005 commercial packaged a/c standard is assumed to affect 100% of commercial packaged a/c sold from 2005 to 2010. The 2010 standard affects 100% of units sold from 2010 onward. To calculate the percent of frozen efficiency electric cooling energy affected by standards, we calculated the stock penetrations in 2010 and 2020 for both policies and weighted them by the share of total electric cooling energy attributable to devices affected by the standard (40% from Suozzo and Nadel, 1998).

7 Suozzo and Nadel (1998) estimate that heat pump water heaters would be feasible in 12% of commercial water heating applications. Our penetrations

Notes to Table B-1.4adv (continued)

assume that half of all feasible applications might be achievable by 2020.

8 Ballast standards penetrations are assumed to be 100% from 2004 onward.

9 Market penetrations are expected to grow from 5% of beverage merchandisers in 2003 to 25% in 2010 and 30% in 2020. To obtain the percent of frozen efficiency commercial refrigeration energy affected, stock penetrations were weighted by the beverage merchandiser share of commercial refrigeration energy (5%) from Westphalen et al. (1996).

10 ENERGY STAR vending machine market penetration is expected to grow from 5%of vending machines in 2003 to 25% in 2010 and 30% in 2020. To obtain the percent of frozen efficiency commercial refrigeration energy affected, stock penetrations were weighted by the vending machine share of commercial refrigeration energy (13%) from Westphalen et al. (1996).

11 ENERGY STAR ice machines market penetrations are expected to grow from 5% of ice machines in 2003 to 25% in 2010 and 30% in 2020. To obtain the percent of frozen efficiency commercial refrigeration energy affected, stock penetrations were weighted by the ice machine share of commercial refrigeration energy (10%) from Westphalen et al (1996).

12 ENERGY STAR exit sign penetration increases from 5% in 2000 to 60% in 2010 and 80% in 2020. Penetrations apply to the approximately 75% of the market that is still incandescent (Suozzo and Nadel 1998). To obtain the percent of miscellaneous commercial electricity affected, stock penetrations were weighted by the incandescent exit sign share of commercial miscellaneous electricity (11%,based on stock and energy consumption data from Suozzo and Nadel, 1998).

13 The ENERGY STAR commercial and industrial transformer program aims to reduce transformer losses in commercial buildings. Because transformer data is reported by transformer type (low or medium voltage and dry type or liquid immersed) rather than by sector, we had to make some assumptions in order to determine commercial transformer energy use and shipments data. Electric League of the Pacific Northwest et al. (1998) report that low voltage equipment dominates the commercial sector, medium voltage equipment dominates the industrial sector, and almost all low voltage transformers are dry-type. We therefore used total low-voltage sales (from EPA's transformer program) as a proxy for commercial sales in estimating the stock of commercial transformers. EPA's estimates of energy savings assume an increase in efficiency from 95% to 98%. Suozzo and Nadel (1998), however, estimate that baseline transformer efficiency is 97.3%. In personal communication, Margaret Suozzo indicated that she felt EPA's 95% efficiency baseline was too low. We therefore used the efficiency estimates in Suozzo and Nadel with the average rating, average load factor and hours per year from EPA's transformer analysis (45 kVA, 35% and 8760 hours per year, respectively) to estimate baseline and ENERGY STAR transformer energy losses. EPA's ENERGY STAR transformer analysis projects market penetrations to grow from 9% in 2000 to 18% in 2003. The program is assumed to end when dry-type transformer standards go into effect in 2004. The percent of commercial miscellaneous electricity that is due to transformer losses was calculated using our estimate of unit transformer losses with estimates of the current stock of commercial transformers. To obtain the percent of frozen efficiency miscellaneous commercial electricity, stock penetrations of ENERGY STAR transformers were weighted by the transformer loss share of miscellaneous commercial electricity (24% based on above loss and load assumptions and a stock of 6 million transformers, estimated from EPA sales data).

14 The ENERGY STAR traffic lights program is proposed to promote the replacement of incandescent traffic lights with LED traffic lights. This is currently highly cost effective for red traffic lights, but less so for green and yellow lights because they have shorter duty cycles and green and yellow LEDs are more expensive than red. Penetrations are expected to grow from 10% of signalized intersections in 2003 to 60% in 2010 to 80% in 2020. To estimate the percent of total commercial electricity that goes to traffic lights, we estimated total traffic light energy consumption using unit energy consumption and an estimate of the number of signalized intersections in the U.S. from Suozzo and Nadel (1998). To obtain the percent of frozen efficiency

Notes to Table B-1.4adv (continued)

miscellaneous commercial electricity affected, stock penetrations of ENERGY STAR traffic lights were weighted by the traffic signal share of miscellaneous electricity (4%, based on stock and energy consumption data from Suozzo and Nadel, 1998).

15 Dry-type transformer standards are assumed to go into effect in 2004. Penetrations for standards are assumed to be 100% from 2004 onward. The percent of commercial miscellaneous affected by the standard was assumed to be the same as for ENERGY STAR transformers (see note 12).

16 It appears unlikely that gas furnace and boiler standards will be tightened in the near term (Suozzo and Nadel, 1998). We therefore consider such standards only in the advanced case, and even then only in 2010. Standards are assumed to affect 100% of units sold subject to the standard from 2010 onward. To obtain the percent of frozen efficiency gas heating energy affected by the standard, stock penetrations are calculated for units meeting standards, which are then weighted by the percent of gas heating affected by the standard (Suozzo and Nadel, 1998).

APPENDIX B-1 REFERENCES

Anderson, Ren. January 10, 1999. *Personal Communication:* "personal communication, e-mail."

Auten, Gerald. January, 1999. *Personal Communication:* "Personal communication with author of proposed whole house tax credit for U.S. Department of the Treasury."

BCAP. 1999. *Energy Conservation and Code Updates: Status of State Energy Codes*. Building Codes Assistance Project. last updated January 1999, http://www.energycodes.org/states/states.htm.

ELPN, CEE, ACEEE, and PEA. 1998. *Draft Proposal to NW Energy Efficiency Alliance for Promotion of Energy Efficient Transformers*. Electric League of the Pacific Northwest, Consortium for Energy Efficiency, Inc., American Council for an Energy-Efficient Economy, and Pacific Energy Associates, Inc. May.

FSEC. 1999. "The Gossamer Wind: What is so special about this fan?" Florida Solar Energy Center, http://www.fsec.ucf.edu/~bdac/PROTOTYPE/CFAN.htm.

Koomey, Jonathan, Celina Atkinson, Alan Meier, James E. McMahon, Stan Boghosian, Barbara Atkinson, Isaac Turiel, Mark D. Levine, Bruce Nordman, and Peter Chan. 1991. *The Potential for Electricity Efficiency Improvements in the U.S. Residential Sector*. Lawrence Berkeley Laboratory. LBL-30477. July.

Koomey, Jonathan G., Camilla Dunham, and James D. Lutz. 1994. *The Effect of Efficiency Standards on Water Use and Water Heating Energy Use in the U.S.: A Detailed End-use Treatment*. Berkeley, CA: Lawrence Berkeley Laboratory. LBL-35475. May.

Koomey, Jonathan G., Marla C. Sanchez, Diana Vorsatz, Richard E. Brown, and Celina S. Atkinson. 1999a. *Working Paper: The Potential for Natural Gas Efficiency Improvements in the U.S. Residential Sector*. Lawrence Berkeley Laboratory. DRAFT LBNL-38893. To be posted on the web in Fall 1999.

Koomey, Jonathan G., Diana Vorsatz, Richard E. Brown, Celina S. Atkinson, and Marla C. Sanchez. 1999b. *Working Paper: Updated Potential for Electricity Efficiency Improvements in the U.S. Residential Sector*. Lawrence Berkeley Laboratory. DRAFT LBNL-38894. To be posted on the web in Fall 1999.

Nadel, Steven, Leo Rainer, Michael Shepard, Margaret Suozzo, and Jennifer Thorne. 1998. *Emerging Energy-Saving Technologies and Practices for the Buildings Sector*. Washington, DC: American Council for an Energy-Efficient Economy. December.

Richey, R. Cooper. 1999. *Personal Communication:* "Personal communication with Cooper Richey of LBNL. Based on input data to the CEF-NEMS model."

Richey, R. Cooper, and Jonathan Koomey. 1998. *LBNL Analysis of Tax Rebates for High-Efficiency Equipment, memo to Jeremy Symons at EPA*. Berkeley, CA: Lawrence Berkeley National Laboratory. February 13, 1998.

Sanchez, Marla C., Jonathan G. Koomey, Mithra M. Moezzi, Alan K. Meier, and Wolfgang Huber. 1998. *Miscellaneous Electricity Use in the U.S. Residential Sector*. Berkeley, CA: Lawrence Berkeley National Laboratory. LBNL-40295. April.

Su, Guan H., and Tom Zambrano. January 14th, 1999. *Personal Communication:* "Information on the Gossamer Wind Ceiling Fan, Provided at a Building Energy Seminar at Lawrence Berkeley National Laboratory's Environmental Energy Technologies Division."

Suozzo, Margaret, and Steven Nadel. 1998. *Selecting Targets for Market Transformation Programs: A National Analysis*. Washington, DC: American Council for an Energy-Efficient Economy. August.

US Bureau of the Census. 1997. *Statistical Abstract of the United States: 1997*. Washington, DC: U.S. Department of Commerce, Bureau of the Census.

US Bureau of the Census. 1998. *Current Construction Reports--Characteristics of New Housing: 1997*. US Department of Commerce, Washington DC. C25/97-A.

US DOE. 1993a. *1990 Residential Energy Consumption Survey (RECS): Data Tapes*. Energy Information Administration. April.

US DOE. 1995a. *Residential Energy Consumption Survey (RECS): Housing Characteristics 1993*. EIA, Energy Information Administration, U.S. Department of Energy, Washington, DC. DOE/EIA-0314(93). June.

US DOT. 1999. *General Explanations of the Administration's Revenue Proposals*. Washington, DC: U.S. Department of the Treasury. February.

US EPA. June, 1999c. *Personal Communication:* "Spreadsheets developed by LBNL for the U.S. Environmental Protection Agency's ENERGY STAR programs. Contact Marla Sanchez at the United States EPA office in Washington D.C., telephone (202) 564-1248."

Vorsatz, Diana, and Jonathan G. Koomey. 1999. *Working Paper: The Potential for Efficiency Improvements in the U.S. Commercial Lighting Sector*. Lawrence Berkeley Laboratory. DRAFT LBNL-38895. To be posted on the web in Fall 1999.

Wenzel, Tom P., Jonathan G. Koomey, Gregory J. Rosenquist, Marla C. Sanchez, and James W. Hanford. 1997. *Energy Data Sourcebook for the U.S. Residential Sector*. Berkeley, CA: Lawrence Berkeley National Laboratory. LBNL-40297. September.

Westphalen, Detlef, Robert A. Zogg, Anthony F. Varone, and Matthew A. Foran. 1996. *Energy Savings Potential for Commercial Refrigeration Equipment*. Cambridge, MA: Prepared by Arthur D. Little, Inc. for the Building Equipment Division, Office of Building Technologies, US Department of Energy. ADL Reference No. 46230. June.