U.S. DEPARTMENT OF ENERGY

OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY

2002 BUILDINGS ENERGY DATABOOK

DOE's Office of Energy Efficiency
and Renewable Energy

Buildings Energy Databook

The United States Department of Energy's Office of Energy Efficiency and Renewable Energy has developed this Buildings Energy Databook to provide a current and accurate set of comprehensive buildings-related data and to promote the use of such data for consistency throughout DOE programs. The Databook is considered an evolving document as it will be will be periodically updated and additional data will be incorporated. Users are requested to submit additional data (e.g., more current, widely accepted, and/or better documented data) and suggested changes to the contacts below. Please provide full source references along with all data.

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Key Terminology

AAMA	American Architectural Manufacturers Association
ACEEE	American Council for an Energy Efficient Economy
AEO	EIA's *Annual Energy Outlook*
AFEAS	Alternative Fluorocarbons Environmental Acceptability Study
AFUE	Annual Fuel Utilization Efficiency
AHAM	Association of Home Appliance Manufacturers
ARI	Air-Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BED	BTS's Office of Building Equipment (formerly the Building Equipment Division)
BNL	Brookhaven National Laboratory
BTS	DOE's Office of Building Technology, State and Community Programs
CBECS	EIA's Commercial Building Energy Consumption Survey
CF	Cubic feet
CFC	Chlorofluorocarbon
CO	Carbon monoxide
CO_2	Carbon dioxide
COP	Coefficient of Performance (dimensionless, heating/cooling capacity (Btu) over electric input (Btu))
CPS	Bureau of the Census' Current Population Survey
Delivered	Refers to energy used on *site* (including purchased electricity)
DOC	U.S. Department of Commerce
DOE	U.S. Department of Energy
DSM	Demand-Side Management
EER	Energy Efficiency Ratio (Btu/watt-hour)
EF	Energy Factor
EIA	DOE's Energy Information Administration
EPA	U.S. Environmental Protection Agency

Key Terminology
(continued)

ESCO	Energy Service Company
FEMP	DOE's Federal Energy Management Program
FT2	Square Feet
FY	Fiscal Year
GAMA	Gas Appliance Manufacturers Association
GDP	Gross Domestic Product
GHG	Greenhouse Gas(es)
GWP	Global Warming Potential
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
HHS	U.S. Department of Health and Human Services
HSPF	Heating Season Performance Factor (Btu/watt-hour)
HUD	U.S. Department of Housing and Urban Development
HVAC/R	Heating, ventilating, and air-conditioning/refrigeration
IEA	International Energy Agency
LBNL	Lawrence Berkeley National Laboratory
LIHEAP	HHS' Low Income Home Energy Assistance Program
LPG	Liquid Petroleum Gas
MEF	Modified Energy Factor
MMT	Million metric tons
MMTCE	Million metric tons of carbon equivalent (Includes only energy consumption effects, unless otherwise noted.)
NAHB	National Association of Home Builders
NAIMA	North American Insulation Manufacturers Association
NEMS	National Energy Modeling System
NWWDA	National Wood Window and Door Association
NO_x	Nitrogen oxide

Key Terminology
(continued)

OBE	BTS's Office of Building Equipment
OBT	DOE's Office of Building Technology, State and Community Programs (formerly the Office of Building Technologies)
ODP	Ozone Depletion Potential
ORNL	Oak Ridge National Laboratory
PM-2.5	Particulate matter of aerodynamic diameter less than 2.5 microns
PM-10	Particulate matter of aerodynamic diameter less than 10 microns
PNNL	Pacific Northwest National Laboratory
Primary	Refers to energy used at the source (including fuel input to electric power plants)
PY	Program Year
Quad	Quadrillion Btu (10^15 Btu)
R-value	Thermal resistance measured in (Btu/Hr-ft^2-^oF)$^{-1}$
RECS	EIA's Residential Energy Consumption Survey
SDHW	Solar domestic hot water
SEDS	State Energy Data System
SEER	Seasonal Energy Efficiency Ratio (Btu/watt-hour)
SEF	Solar Energy Factor
SF	Square feet
SIC	Standard Industrial Classification
Site	Refers to energy used on *site* (i.e., *delivered)*
SO_2	Sulfur dioxide
SRCC	Solar Rating & Certification Corporation
TSP	Total Suspended Particulate
U-value	Thermal conductance measured in (Btu/Hr-ft^2-^oF)
VOC	Volatile organic compounds

Buildings-Related Internet Addresses

Federal Government and International Organizations

Office of Building Technology, State and Community Programs . . . . . www.eren.doe.gov/buildings
Energy Efficiency & Renewable Energy Network . . . . . www.eren.doe.gov
Energy Information Administration . . . . . www.eia.doe.gov
United States Environmental Protection Agency . . . . . www.epa.gov
ENERGY STAR . . . . . www.energystar.gov
U.S. Housing and Urban Development Department . . . . . www.hud.org
U.S. Housing and Urban Development Department User . . . . . www.huduser.org
Partnership for Advancing Technology in Housing . . . . . www.pathnet.org
U.S. Census Bureau . . . . . www.census.gov
U.S. Census Bureau Housing Topics . . . . . www.census.gov/hhes/www/housing.html
Census Bureau Economic Programs . . . . . www.census.gov/ftp/pub/econ/www
International Energy Agency, Energy Conservation in
Buildings and Community Systems . . . . . www.ecbcs.org
Intergovernmental Panel on Climate Change . . . . . www.ipcc.ch

National Laboratories and Research Organizations

Brookhaven National Laboratory . . . . . www.bnl.gov
Building and Fire Research Laboratory (National
Institute of Standards and Technology) . . . . . www.bfrl.nist.gov
Buildings Technology Center (Oak Ridge National Laboratory) . . . . . www.ornl.gov/btc
Environmental Energy Technologies Division (Lawrence
Berkeley National Laboratory) . . . . . http://eande.lbl.gov
Florida Solar Energy Center . . . . . www.fsec.ucf.edu
National Association of Home Builders Research Center . . . . . www.nahbrc.org
Lighting Research Center . . . . . www.lrc.rpi.edu
National Renewable Energy Laboratory . . . . . www.nrel.gov
Pacific Northwest National Laboratory Buildings Program . . . . . www.pnl.gov/buildings/
Renewable Resource Data Center (National Renewable
Energy Laboratory) . . . . . http://rredc.nrel.gov
Gas Technology Institute . . . . . www.gri.org
Electric Power Research Institute . . . . . www.epri.com

Buildings-Related Internet Addresses (continued)

Magazines, Journals, and On-Line Newsletters

Air Conditioning, Heating and Refrigeration News . . . . . www.achrnews.com
Appliance Magazine . . . . . www.appliance.com
Appliance Manufacturer Magazine . . . . . www.ammagazine.com
Builder Magazine . . . . . www.builderonline.com
Building Standards . . . . . www.icbo.org/Building_Standards_Online
Buildings Magazine . . . . . www.buildings.com
Building Operating Management . . . . . www.facilitiesnet.com/bom
Center for Renewable Energy and Sustainable Technology . . . . . www.crest.org
Contracting Business Interactive . . . . . www.contractingbusiness.com
Energy Central Electric Power Information Resource . . . . . www.energycentral.com
Energy User News . . . . . www.energyusernews.com
Engineered Systems . . . . . www.esmagazine.com
Environmental Design & Construction . . . . . www.edcmag.com
Environmental Building News . . . . . www.buildinggreen.com
Facilities Design & Management . . . . . www.fdm.com
Heating/Piping/Air Conditioning (HPAC Engineering) . . . . . www.hpac.com
Home Furnishings News . . . . . www.hfnmag.com
Home Power Magazine . . . . . www.homepower.com
Home Energy . . . . . www.homeenergy.org/tocs.html
The Journal of Light Construction . . . . . www.jlconline.com
Remodeling Online . . . . . www.remodeling.hw.net
Residential Architect . . . . . http://ra.hw.net
Solar Today . . . . . www.solartoday.org

Code Groups

American National Standards Institute . . . . . www.ansi.org
American Society for Testing and Materials . . . . . www.astm.org
Building Officials and Code Administrators International . . . . . www.bocai.org
International Code Council . . . . . www.intlcode.org
International Conference of Building Officials . . . . . www.icbo.org
National Conference of States on Building Codes and Standards, Inc. . . . . www.ncsbcs.org
National Fire Protection Association International . . . . . www.nfpa.org
Southern Building Code Congress International . . . . . www.sbcci.org

Buildings-Related Internet Addresses (continued)

Professional, Industry, and Not-for-Profit Associations

Affordable Comfort Incorporated . . . . . www.affordablecomfort.org
Air-Conditioning & Refrigeration Institute . . . . . www.ari.org
Air Conditioning Contractors of America . . . . . www.acca.org
Alternative Fluorocarbons Environmental Acceptability Study . . . . . www.afeas.org
American Architectural Manufacturers Association . . . . . www.aamanet.org
American Council for an Energy-Efficient Economy . . . . . www.aceee.org
American Gas Association . . . . . www.aga.org
American Institute of Architects . . . . . www.e-architect.com
American Society of Heating, Refrigerating and Air-Conditioning Engineers . . . . . www.ashrae.org
American Society of Mechanical Engineers . . . . . www.asme.org
American Solar Energy Society . . . . . www.ases.org
The Association of Energy Engineers . . . . . www.aeecenter.org
Association of Higher Education Facilities Officers . . . . . www.appa.org
Association of Home Appliance Manufacturers . . . . . www.aham.org
Building Owners and Managers Association . . . . . www.boma.org
Edison Electric Institute . . . . . www.eei.org
Energy & Environmental Building Association . . . . . www.eeba.org
Gas Appliance Manufacturers Association . . . . . www.gamanet.org
Habitat for Humanity International . . . . . www.habitat.org
International Facility Management Association . . . . . www.ifma.org
Manufactured Housing Institute . . . . . www.mfghome.org
National Association of Demolition Contractors . . . . . www.demolitionassociation.com
National Association of Energy Service Companies . . . . . www.naesco.org
National Association of Home Builders . . . . . www.nahb.com
National Association of Housing and Redevelopment Officials . . . . . www.nahro.org
National Association of State Energy Officials . . . . . www.naseo.org
National Center for Appropriate Technology . . . . . www.ncat.org
Natural Resources Defense Council . . . . . www.nrdc.org
Residential Energy Service Network . . . . . www.natresnet.org
Solar Energy Industries Association . . . . . www.seia.org
Weatherization Assistance Program Technical Assistance Center . . . . . www.waptac.org

1. U.S. Residential and Commercial Buildings Primary Energy Consumption (quads and % of totals)

Residential Consumption

	Elec		NGas		Oil		Coal		Renew		**Total**
1980	8.4	53%	4.9	30%	1.7	11%	0.1	0%	N.A.		**15.9**
1990	10.1	61%	4.5	27%	1.3	8%	0.1	0%	0.6	4%	**16.5**
2000	**12.9**	**65%**	**5.1**	**26%**	**1.4**	**7%**	**0.0**	**0%**	**0.5**	**2%**	**19.9**
2005	14.3	66%	5.5	25%	1.4	6%	0.0	0%	0.5	2%	**21.8**
2010	14.8	66%	5.7	25%	1.3	6%	0.1	0%	0.5	2%	**22.3**
2020	16.4	67%	6.2	25%	1.2	5%	0.0	0%	0.5	2%	**24.4**

Commercial Consumption

	Elec		NGas		Oil		Coal		Renew		**Total**
1980	6.5	62%	2.7	25%	1.3	12%	0.1	1%	N.A.		**10.6**
1990	9.1	71%	2.7	21%	0.9	7%	0.1	1%	0.0	0%	**12.9**
2000	**12.3**	**75%**	**3.4**	**20%**	**0.7**	**4%**	**0.1**	**0%**	**0.1**	**1%**	**16.5**
2005	13.8	75%	3.8	20%	0.7	4%	0.1	0%	0.1	1%	**18.5**
2010	15.1	75%	4.0	20%	0.7	3%	0.1	0%	0.1	1%	**20.0**
2020	17.7	76%	4.6	20%	0.7	3%	0.1	0%	0.1	0%	**23.2**

2. U.S. Buildings Primary Energy Consumption (quads and % of total)

	Elec		NGas		Oil		Coal		Renew		**Total**
1980	15.0	56%	7.5	28%	3.0	11%	0.1	1%	N.A.		**26.5**
1990	19.2	65%	7.2	25%	2.2	7%	0.2	1%	0.6	2%	**29.4**
2000	**25.2**	**69%**	**8.5**	**23%**	**2.0**	**6%**	**0.1**	**0%**	**0.6**	**2%**	**36.4**
2005	28.2	70%	9.3	23%	2.0	5%	0.1	0%	0.6	1%	**40.2**
2010	29.9	71%	9.7	23%	2.0	5%	0.1	0%	0.6	1%	**42.3**
2020	34.1	72%	10.8	23%	1.9	4%	0.1	0%	0.6	1%	**47.6**

3. U.S. Buildings Generic Quad (% of total)

	Gas	Oil	Coal	Renew	Nuclear	Electric Import
1980	37%	17%	29%	11%	6%	N.A.
1990	31%	10%	36%	9%	14%	N.A.
2000	**31%**	**7%**	**37%**	**8%**	**15%**	**1%**
2005	33%	6%	38%	8%	14%	1%
2010	35%	5%	38%	9%	13%	1%
2020	38%	4%	37%	9%	11%	1%

4. Buildings Share of U.S. Primary Energy Consumption

	Res	Com	**Bldgs**	Indtry	Trans
1980	20%	14%	**34%**	41%	25%
1990	20%	15%	**35%**	38%	27%
2000	**20%**	**17%**	**37%**	**36%**	**28%**
2005	20%	17%	**37%**	34%	28%
2010	19%	17%	**37%**	34%	29%
2020	19%	18%	**36%**	33%	30%

5. Buildings Share of U.S. Electricity Consumption

	Res	Com	**Bldgs**	Indtry	Trans
1980	34%	27%	**61%**	39%	0%
1990	34%	31%	**65%**	35%	0%
2000	**35%**	**33%**	**68%**	**31%**	**1%**
2005	36%	34%	**70%**	29%	1%
2010	35%	35%	**70%**	29%	1%
2020	34%	37%	**71%**	29%	1%

6. 1991 Industrial Buildings-Related *Delivered* & Primary Energy Consumption (quad)

	Vent	Space Heat	Space Cool	Light	Total
Delivered	0.087	0.774	0.085	0.170	1.116
Primary	0.270	0.890	0.280	0.520	1.960

7. U.S. Buildings Primary Energy and Expenditure End-Use Splits, 2000

Energy (quads and % of totals)

End Use	Residential		Commercial		**Buildings**	
Space Heating	6.6	33%	2.6	16%	**9.3**	**25%**
Space Cooling	2.0	10%	1.9	12%	**4.0**	**11%**
Ventilation			0.9	5%	**0.9**	**2%**
Water Heating	3.0	15%	1.2	7%	**4.2**	**12%**
Lighting	1.2	6%	3.9	24%	**5.1**	**14%**
Refrigeration	1.7	9%	0.6	4%	**2.3**	**6%**
Wet Clean	0.9	5%			**0.9**	**3%**
Cooking	0.9	5%	0.3	2%	**1.2**	**3%**
Electronics	1.0	5%	1.0	6%	**2.0**	**5%**
Computers	0.1	1%	0.5	3%	**0.6**	**2%**
Other	0.7	3%	1.3	8%	**2.0**	**6%**
Adjust to SEDS			2.2	13%	**3.9**	**11%**
Total	19.9	100%	16.5	100%	**36.4**	**100%**

Expenditures ($2000 and % of totals)

End Use	Residential		Commercial		**Buildings**	
Space Heating	50.3	33%	16.4	15%	66.72	25%
Space Cooling	15.8	10%	13.4	12%	29.11	11%
Ventilation			6.1	5%	6.1	2%
Water Heating	23.4	15%	7.9	7%	31.36	12%
Lighting	9.0	6%	27.3	24%	36.37	14%
Refrigeration	13.4	9%	4.1	4%	17.53	7%
Wet Clean	7.3	5%			7.3	3%
Cooking	7.2	5%	2.0	2%	9.2	3%
Electronics	7.5	5%	7.0	6%	14.5	5%
Computers	1.1	1%	3.5	3%	4.5	2%
Other	5.1	3%	9.2	8%	14.3	5%
Adjust to SEDS	13.2	9%	14.9	13%	28.1	11%
Total	153.3	100%	111.9	100%	234.4	100%

8. Buildings Energy Prices and Expenditures

Prices ($2000/10^6 Btu)

	Residential Buildings				Commercial Buildings				Bldgs
	Elec	NGas	Petro	Avg	Elec	NGas	Petro	Avg	Avg
1980	29.45	6.75	13.61	14.21	30.10	6.22	10.57	14.95	14.50
1990	28.38	6.96	10.90	15.07	26.20	5.81	7.30	15.04	15.06
2000	**24.36**	**7.64**	**10.78**	**14.48**	**22.11**	**6.23**	**7.19**	**14.13**	**14.33**
2005	22.38	6.85	9.45	13.39	20.40	5.58	6.10	13.04	13.24
2010	22.41	6.73	9.84	13.55	19.87	5.51	6.36	12.97	13.29
2020	22.55	6.97	10.41	14.09	20.33	5.86	6.91	13.65	13.89

Petroleum includes distillate and residual fuel oils, LPG, kerosene, and motor gasoline.
2000 average electricity cost: resid. $0.079/kWh, comm. $0.075/kWh, and Bldgs. $0.077/kWh.

Expenditures ($2000 billion)

	Residential Buildings				Commercial Buildings				Bldgs
	Elec	NGas	Petro	Total	Elec	NGas	Petro	Total	Total
1980	47.5	21.6	15.7	**84.8**	37.8	10.9	9.0	**57.8**	142.6
1990	89.5	31.4	13.8	**134.7**	74.9	15.7	6.6	**97.2**	231.9
2000	**99.2**	**39.2**	**14.8**	**153.2**	**86.3**	**20.9**	**4.5**	**111.8**	**265.0**
2005	103.4	37.8	13.0	**154.2**	90.9	21.1	4.1	**116.1**	270.3
2010	110.3	38.2	12.8	**161.4**	100.0	22.3	4.4	**126.6**	288.0
2020	128.6	42.9	12.5	**183.9**	124.7	27.2	4.9	**156.8**	340.7

Expenditures exclude wood and coal costs. 2000 U.S. energy expenditures were $729.6 billion.

9. Energy Consumption Intensities, by Year

Residential

	Number of Hhold (10^6)	% Post-90 Hholds	Bldgs (10^6)	*Delivered* Energy Use (10^6Btu/Hhold)	Primary Energy Use (10^6Btu/Hhold)
1980	79.6	N.A.	65.5	125.2	200.0
1990	94.2	N.A.	74.2	102.3	175.5
2000	**105.2**	**18%**	**82.6**	**105.2**	**188.8**
2005	110.4	25%	N/A	108.6	196.6
2010	116.0	32%	N/A	106.9	191.8
2020	127.1	44%	N/A	106.6	190.9

2000 number of buildings actually from 1997.
1997 households: 73% single-family, 21% multi-family, and 6% mobile homes.
1997 *delivered* energy use: 83% single-family, 13% multi-family, and 5% mobile homes.

Commercial

	Floorspace (10^9 SF)	% Post-90 SF	Bldgs (10^6)	*Delivered* Energy Use (10^3Btu/SF)	Primary Energy Use (10^3Btu/SF)
1980	50.9	N.A.	3.1	117.2	208.3
1990	64.3	N.A.	4.5	102.6	200.0
2000	**64.5**	**19%**	**4.6**	**125.1**	**255.7**
2005	71.7	33%	N/A	126.2	257.1
2010	77.5	43%	N/A	127.8	257.6
2020	89.6	61%	N/A	130.0	258.8

2000 number of buildings actually from 1995.
1995 floorspace: 22% mercantile & service, 18% office, 14% warehouse, and 13% education. 1995 *delivered* energy use: 19% office, 18% mercantile & service, 12% education, and 11% health care.

10. Residential (1997) and Commercial (1995) Vintages

Residential	% of Hholds	Commercial	% of SF
1949 or Before	28%	Prior to 1919	6%
1950 to 1959	12%	1920 to 1959	27%
1960 to 1969	14%	1960 to 1979	38%
1970 to 1979	19%	1980 to 1989	21%
1980 to 1989	17%	1990 to 1995	8%
1990 to 1997	10%		

11. Stock Energy Expenditures ($2000)

	Residential ($/Household)	Commercial ($/SF)
1980	1,616	1.72
1990	1,430	1.51
2000	**1,458**	**1.74**
2005	1,396	1.62
2010	1,391	1.63
2020	1,447	1.75

12. Carbon Dioxide Emissions for U.S. Buildings

(10^6 metric tons of carbon/yr)

	Buildings			Bldgs % of	Bldgs % of
	Elec	*Site* Fossil	Total	U.S. Emiss	Global Emiss
1980	255.2	172.0	427.1	33%	9%
1990	317.4	149.9	467.3	35%	8%
2000	**399.6**	**164.2**	**563.7**	**36%**	**9%**
2005	445.8	175.9	621.7	37%	9%
2010	481.8	181.3	663.1	36%	8%
2020	557.6	195.2	752.8	36%	8%

Buildings emissions equal emissions of Japan and United Kingdom combined.
2000 U.S. emissions = 1,561 MMTCE. 1999 Global emissions = 6,097 MMTCE.

13. EPA Emissions for U.S. Buildings, 2000

(10^6 short tons)

	Buildings			Bldgs % of
	Wood/*Site* Fossil	Elec	Total	U.S. Emiss
SO2	0.59	7.77	8.364	46%
NOx	1.16	3.59	4.754	19%
CO	2.92	0.30	3.228	3%
VOCs	0.96	0.04	1.00	5%
PM-2.5	0.46	0.10	0.554	7%
PM-10	0.48	0.18	0.667	3%
Lead	0.41	0.05	0.461	11%

14. Value of New, Improvement & Repair Building Construction ($2000 billion)

	Value of New Construction			Bldgs % of	Value of Improvement & Repair			Bldgs % of
	Resid	Comm	Bldgs	U.S. GDP	Resid	Comm	Bldgs	U.S. GDP
1980	134.2	129.3	263.5	5.0%	86.8	N.A.	N.A.	N.A.
1985	170.6	182.7	353.3	5.8%	116.5	113.2	229.7	3.8%
1990	162.9	183.2	346.1	4.8%	132.4	114.8	247.1	3.4%
1995	191.9	167.9	359.9	4.5%	130.0	113.0	243.1	3.0%
2000	**270.1**	**254.0**	**524.0**	**5.3%**	**151.7**	**113.2**	**264.9**	**2.7%**

2000 U.S. GDP = $9.96 trillion.

15. 1998 Cost Breakdown of a 2,150 Square Foot, New Single Family Home ($2000)

	Cost	Percent
Finished Lot	55,434	24%
Construction Cost	128,853	55%
Financing	4,419	2%
Overhead & General Expenses	13,419	6%
Marketing	3,294	1%
Sales Commission	7,924	3%
Profit	21,584	9%

16. Residential New Single-Family Housing Completed

	# of Units	Average SF
1980	957,000	1,730
1990	966,000	2,080
2000	**1,241,800**	**2,266**

1980 SF extrapolated from 1978 and 1981 data.

17. Design and Construction Employment

	Employees (thousands)		Builders	
	Architects	Construction (1)	(companies)	
1980	N.A.	3,065	93,600	
1990	N.A.	3,861	119,300	
2000	**215**	**5,183**	**134,079**	(2)

1) Excludes industrial building and heavy construction.
2) Builders is for 1997. Builders exclude homebuilding establishments without payrolls, estimated by NAHB at an additional 210,000 in 1992.

18. FY 2000 Energy Burdens

	Mean Individual	Median Individual	Mean Group
All Hholds	6.1%	3.5%	2.4%
Fed Eligible Hhold	12.1%	7.9%	7.7%
Fed Ineligible Hhold	3.0%	2.6%	2.0%

Average income of a Federally eligible household was $14,270 in 2000.

19. Construction Waste

2 to 7 tons for each new single-family detached house.
Average of 4 pounds per square foot for new single-family detached house.
30 to 35 million tons of building construction, renovation, and demolition waste each year.
Construction of typical 2,000 sq.ft. home results in 4 tons of waste (wood/paper: 46%, drywall: 25%, masonry: 13%, other: 17%, hazardous material: 1%)

20. Weatherization Facts

5.2 million homes were weatherized under DOE through FY 2000 with an additional 209,200 homes weatherized in FY 2000.
DOE Weatherization saves an average of 13-34% on home energy bills with a cost-benefit ratio of 2.1.
Legislation enacted in 2000 for the DOE Weatherization program requires states spend no more than an average of $2,500 per household. States use energy audits to determine the best weatherization measures.

21. 1999 U.S. Private Investment into Construction R&D

Sector	Percent of Sales
Average Construction R&D (1)	1.7
Heavy Construction	0.3
Housing (lumber& wood products)	0.4
Special Trade Construction	0.2
Construction materials	1.0
Construction machinery	3.4
Building Technology	
Appliances	1.8
Lighting	1.2
HVAC	1.4
U.S. Industry Average	3.1
International Industry Composite	4.3

1) Includes bridges, roads, buildings, dams, etc.

22. 2001 Five Largest Residential Homebuilders

Homebuilder	Home Closings	% of Closings
Centex Corporation	26,060	1.7%
Lennar Corporation	23,899	1.5%
Pulte Homes	22,915	1.5%
D.R. Horton	22,772	1.4%
KB Home	21,486	1.4%
Total of Top Five	117,132	7.5%
Habitat for Humanity	3,641	0.23%

2001 total U.S. new home closings was 1.57 million. 2000 total share of top 100 builders was 14.0%. 1996 total share of top 400 builders was 42%.

The summary tables correspond to the following tables in Chapters 1 through 7 of the Buildings Energy Databook

1.	1.2.1, 1.3.1	**5.**	1.1.3, 1.5.1	**8.**	4.1.1, 4.1.2	**11.**	4.2.2, 4.3.2	**15.**	4.2.8	**19.**	3.4.1, 3.4.2
2.	1.1.1	**6.**	1.3.11	**9.**	1.2.5, 1.2.7, 1.3.4, 1.3.6,	**12.**	3.1.1	**16.**	2.1.6	**20.**	7.1.1, 7.1.3, 7.1.6
3.	1.1.4	**7.**	1.1.7, 1.2.3, 1.3.3,		2.1.1, 2.1.2, 2.2.1, 2.2.2	**13.**	3.3.1	**17.**	4.6.1	**21.**	4.5.4
4.	1.1.2		4.1.4, 4.2.1, & 4.3.1	**10.**	2.1.5, 2.2.6	**14.**	4.5.2, 4.5.3, 5.1.2	**18.**	4.2.7, 7.1.1	**22.**	5.1.1

1.1.1 U.S. Residential and Commercial Buildings Total Primary Energy Consumption (quads and percent of total) (1)

	Natural Gas		Petroleum (2)		Coal		Renewable(3)		Electricity Sales	Electricity Losses	Electricity Total		TOTAL (3)		Growth Rate 1990-Year
1980	7.52	28%	3.04	11%	0.15	1%	0.88	3%	4.35	10.60	14.95	56%	26.53	100%	-1.0%
1990	7.22	25%	2.17	7%	0.16	1%	0.64	2%	6.01	13.16	19.17	65%	29.36	100%	-
2000	**8.50**	**23%**	**2.04**	**6%**	**0.11**	**0%**	**0.57**	**2%**	**7.98**	**17.21 (4)**	**25.19**	**69%**	**36.41**	**100%**	2.2%
2005	9.30	23%	2.04	5%	0.11	0%	0.58	1%	9.08	19.09	28.17	70%	40.21	100%	2.1%
2010	9.72	23%	2.00	5%	0.12	0%	0.60	1%	9.95	19.91	29.86	71%	42.30	100%	1.8%
2020	10.79	23%	1.91	4%	0.13	0%	0.63	1%	11.84	22.26	34.09	72%	47.56	100%	1.6%

Note(s): 1) See Table 1.3.11 for buildings-related energy consumption in industrial buildings. 2) Petroleum includes distillate and residual fuels, liquefied petroleum gas, kerosene, and motor gasoline. 3) Includes *site* marketed and non-marketed renewable energy in Table 1.1.5. 4) 2000 *site* -to-source electricity conversion = 3.16.

Source(s): EIA, State Energy Data Report 1999, May 2001, Tables 12 - 15, p. 22-25 for 1980 and 1990; and EIA, Annual Energy Outlook (AEO) 2002, Dec. 2001, Table A2, p. 126-128 for 2000-2020 and Table A18, p. 148 for non-marketed renewable energy.

1.1.2 Buildings Share of U.S. Primary Energy Consumption (percent) (1)

	Residential	Commercial	**Total Buildings**	Industry	Transportation	TOTAL	Total Consumption (quads)
1980 (2)	20%	14%	**34%**	41%	25%	100%	78.5
1990	20%	15%	**35%**	38%	27%	100%	84.1
2000	**20%**	**17%**	**37%**	**36%**	**28%**	**100%**	**99.4**
2005	20%	17%	**37%**	34%	28%	100%	107.7
2010	19%	17%	**37%**	34%	29%	100%	115.7
2020	19%	18%	**36%**	33%	30%	100%	131.0

Note(s): 1) Buildings-related energy consumption in the industrial sector in 1991 was 1.96 of 31.76 quads; for comparison, 2000 industrial sector energy use was 35.50 quads. 2) Renewables are not included in the 1980 data.

Source(s): EIA, State Energy Data Report 1999, May 2001, Tables 12 - 15, p. 22-25 for 1980 and 1990; and EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128 for 2000-2020 data and Table A18, p. 148 for non-marketed renewable energy.

1.1.3 Buildings Share of U.S. Electricity Consumption (percent)

	Residential	Commercial	**Total Buildings**	Industry	Transportation	TOTAL	U.S. Electricity *Delivered* Total (quads)
1980	34%	27%	**61%**	39%	0%	100%	7.1
1990	34%	31%	**65%**	35%	0%	100%	9.3
2000 (1)	**35%**	**33%**	**68%**	**31%**	**1%**	**100%**	**11.7**
2005	36%	34%	**70%**	29%	1%	100%	12.9
2010	35%	35%	**70%**	29%	1%	100%	14.2
2020	34%	37%	**71%**	29%	1%	100%	16.8

Note(s): 1) Buildings accounted for 79% (or $186 billion) of total U.S. electricity expenditures.

Source(s): EIA, State Energy Data Report 1999, May 2001, Tables 12-15, p. 22-25 for 1980 and 1990; and EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128 for 2000-2020 consumption, Table A3, p. 129-130 for 2000 expenditures.

1.1.4 Shares of U.S. Buildings Generic Quad (percent) (1)

				Renewables				Net	
	Natural Gas	Petroleum	Coal	Hydro.	Other	Total	Nuclear	Electric Imports	Total
1980	37%	17%	29%	7%	4%	11%	6%	(2)	100%
1990	31%	10%	36%	6%	3%	9%	14%	(2)	100%
2000	**31%**	**7%**	**37%**	**5%**	**3%**	**8%**	**15%**	**1%**	**100%**
2005	33%	6%	38%	5%	3%	8%	14%	1%	100%
2010	35%	5%	38%	5%	4%	9%	13%	1%	100%
2020	38%	4%	37%	5%	4%	9%	11%	1%	100%

Note(s): 1) A generic quad is primary energy apportioned between the various primary fuels according to their relative consumption. See Table 6.1.1 for further explanation. See Table 1.3.11 for buildings-related energy consumption in industrial buildings. 2) Electric imports included in renewables.

Source(s): EIA, State Energy Data Report 1999, May 2001, Tables 12-15, p. 22-25 for 1980 and 1990; and EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128 for 2000-2020 consumption and Table A18, p. 148 for non-marketed renewable energy.

1.1.5 U.S. Buildings *Site* Renewable Energy Consumption (quads) (1)

	Wood (2)	Solar Thermal (3)	Solar PV(3)	GHP (4)	Total
1980	0.8810	0.0000	N.A.	0.0000	0.8810
1990	0.5820	0.0560	N.A.	0.0090	0.6470
2000	**0.5040**	**0.0476**	**0.0001**	**0.0172**	**0.5689**
2005	0.5089	0.0533	0.0008	0.0220	0.5850
2010	0.5137	0.0562	0.0028	0.0270	0.5997
2020	0.5256	0.0623	0.0033	0.0422	0.6334

Note(s): 1) Does not include renewable energy consumed by electric utilities (including hydroelectric). 2) Includes wood and wood waste, municipal solid waste, and other biomass used by the commercial sector to cogenerate electricity. 3) Includes only solar energy. 4) GHP = Ground-Coupled Heat Pumps.

Source(s): EIA, State Energy Data Report 1999, May 2001, Table 12-13, p. 22-23 for 1980 and 1990; and EIA, AEO 2002, Dec. 2001, Table A18, p. 148 for 2000-2020. p. 150 for 1999-2020.

1.1.6 World Primary Energy Consumption and Population, by Country/Region

	Energy Consumption (Quad)				Population (million)				Annual Growth Rate 1990-1999		Annual Growth Rate 1999-2010	
Region/Country	1990	1999		2010	1990	1999		2010	Energy	Pop.	Energy	Pop.
United States	84.0	97.0	25.4%	115.6	255	273	4.6%	300	1.6%	0.8%	1.6%	0.9%
Western Europe (1)	59.8	66.0	17.3%	74.7	377	389	6.5%	391	1.1%	0.3%	1.1%	0.0%
Former Soviet Union	61.0	39.2	10.3%	48.0	290	292	4.9%	283	-4.8%	0.1%	1.9%	-0.3%
Other Asia	21.1	33.0	8.6%	47.8	812	964	16.1%	1152	5.1%	1.9%	3.4%	1.6%
China	27.0	31.9	8.4%	55.1	1155	1265	21.2%	1366	1.9%	1.0%	5.1%	0.7%
Japan	17.9	21.7	5.7%	24.2	124	127	2.1%	128	2.2%	0.3%	1.0%	0.1%
Central & S. America	13.7	19.8	5.2%	28.3	354	410	6.9%	477	4.2%	1.6%	3.3%	1.4%
Middle East	13.1	19.3	5.1%	26.3	191	236	4.0%	295	4.4%	2.4%	2.9%	2.0%
Canada	10.9	12.5	3.3%	14.8	28	30	0.5%	33	1.5%	0.8%	1.5%	0.9%
India	7.8	12.2	3.2%	18.2	845	993	16.6%	1164	5.1%	1.8%	3.7%	1.5%
Africa	9.3	11.8	3.1%	15.7	619	775	13.0%	997	2.7%	2.5%	2.6%	2.3%
Eastern Europe	15.3	11.2	2.9%	13.8	122	121	2.0%	119	-3.4%	-0.1%	1.9%	-0.2%
Mexico	5.0	6.1	1.6%	10.0	83	97	1.6%	113	2.2%	1.7%	4.6%	1.4%
World Total	346.2	381.9	100%	492.6	5255	5972	100%	7199	1.1%	1.4%	2.3%	1.7%

Note(s): 1) Germany consumed 14.0 quads, France 10.3 quads, United Kingdom 9.9 quads, and Italy 8.0 quads.

Source(s): EIA, International Energy Outlook 2002, March 2002, Table A1, p. 179 and Table A16, p. 196.

1.1.7 2000 U.S. Buildings Energy End-Use Splits, by Fuel Type (quads) (1)

	Natural Gas	Fuel Oil (2)	LPG	Other Fuel(3)	Renw. En.(4)	*Site* Electric	*Site* Total	*Site* Percent	Primary Electric (5)	Primary Total	Primary Percent
Space Heating (6)	4.97	1.07	0.33	0.23	0.44	0.71	7.75	40.4%	2.23	9.27	25.5%
Lighting						1.61	1.61	8.4%	5.08	5.08	13.9%
Water Heating	1.98	0.20	0.10		0.05	0.59	2.92	15.2%	1.87	4.20	11.5%
Space Cooling	0.02					1.25	1.26	6.6%	3.94	3.95	10.9%
Refrigeration (7)						0.74	0.74	3.8%	2.33	2.33	6.4%
Electronics (8)						0.63	0.63	3.3%	1.98	1.98	5.4%
Cooking	0.41		0.03			0.25	0.68	3.6%	0.78	1.22	3.4%
Wet Clean (9)	0.07					0.28	0.35	1.8%	0.88	0.95	2.6%
Ventilation (10)						0.28	0.28	1.4%	0.87	0.87	2.4%
Computers						0.20	0.20	1.0%	0.64	0.64	1.7%
Other (11)	0.27	0.02	0.09	0.03	0.08	0.48	0.97	5.1%	1.52	2.01	5.5%
Adjust to SEDS (12)	0.80	0.04				0.98	1.82	9.5%	3.09	3.93	10.8%
Total	8.50	1.34	0.55	0.26	0.57	7.98	19.19	100%	25.19	36.41	100%

Note(s): 1) See Table 1.3.11 for buildings-related energy consumption in industrial buildings. 2) Includes (1.20 quad) distillate fuel oil (and 0.14 quad) residual fuel oil. 3) Kerosene (0.13 quad) and coal (0.11 quad) are assumed attributable to space heating. Motor gasoline (0.03 quad) assumed attributable to other end-uses. 4) Comprised of (0.50 quad) wood space heating, (0.02 quad) geothermal (includes space heating), (0.04 quad) solar water heating, and less than (0.001 quad) solar pv. 5) *Site* -to-source electricity conversion (due to generation and transmission losses) = 3.16. 6) Includes (0.17 quad) furnace fans. 7) Includes (1.34 quad) refrigerators and (.25 quad) freezers. Includes commercial refrigeration. 8) Includes (0.28 quad) color television and (1.48 quad) other office equipment. 9) Includes (0.07 quad) clothes washers, (0.07 quad) natural gas clothes dryers, (0.49 quad) electric clothes dryers, and (0.05 quad) dishwashers. Does not include water heating energy. 10) Commercial only; residential fan and pump energy use included proportionately in space heating and cooling. 11) Includes residential small electric devices, heating elements, motors, swimming pool heaters, hot tub heaters outdoor grills and natural gas outdoor lighting. Includes commercial service station equipment, automated teller machines, telecommunications equipment, medical equipment, pumps, lighting, emergency electric generators, and manufacturing performed in commercial buildings. 12) Energy adjustment EIA uses to relieve discrepancies between data sources. Energy attributable to the residential and commercial buildings sector, but not directly to specific end-uses.

Source(s): EIA, AEO 2002, Dec. 2001, Tables A2, p. 126-128, Table A4, p. 131-132, Table A5, p. 133-134, and Table A18, p. 148; EIA, National Energy Modeling System for AEO 2002, Dec. 2001; BTS/A.D. Little, Electricity Consumption by Small End-Uses in Residential Buildings, Aug. 1998, Appendix A for residential electric end-uses; and BTS/A.D. Little, Energy Consumption Characteristics of Commercial Building HVAC Systems, Volume II: Thermal Distribution, Auxiliary Equipment, and Ventilation, Oct. 1999, p. 1-2 and 5-25 - 5-26.

1.2.1 Residential Primary Energy Consumption, by Year and Fuel Type (quads and percents of total)

	Natural Gas		Petroleum (1)		Coal		Renewable(2)		Electricity Sales	Electricity Losses		Electricity Total		TOTAL (2)		Growth Rate 1990-Year
1980	4.86	30%	1.75	11%	0.06	0%	0.86	5%	2.45	5.96		8.41	53%	15.93	100%	-0.4%
1990	4.52	27%	1.27	8%	0.06	0%	0.64	4%	3.15	6.90		10.05	61%	16.54	100%	-
2000	**5.14**	**26%**	**1.38**	**7%**	**0.04**	**0%**	**0.47**	**2%**	**4.07**	**8.79**	**(3)**	**12.86**	**65%**	**19.89**	**100%**	1.9%
2005	5.53	25%	1.37	6%	0.05	0%	0.48	2%	4.62	9.72		14.34	66%	21.76	100%	1.8%
2010	5.68	25%	1.30	6%	0.05	0%	0.49	2%	4.92	9.85		14.77	66%	22.30	100%	1.5%
2020	6.15	25%	1.20	5%	0.05	0%	0.52	2%	5.70	10.72		16.43	67%	24.35	100%	1.3%

Note(s): 1) Petroleum includes distillate and residual fuels, liquefied petroleum gas, kerosene, and motor gasoline. 2) Includes *site* marketed and non-marketed renewable energy. 3) 2000 *site* -to-source electricity conversion = 3.16.

Source(s): EIA, State Energy Data Report 1999, May 2001, Tables 12 - 15, p. 22-25 for 1980 and 1990; and EIA, AEO 2002, Dec. 2001, Table A2, p.126-128 for 2000-2020 consumption and Table A18, p. 148 for non-marketed renewable energy.

1.2.2 Residential *Site* Renewable Energy Consumption (quads) (1)

	Wood	Solar Thermal (2)	Solar PV(2)	GHP (3)	Total
1980	0.8600	0.0000	N.A.	0.0000	0.8600
1990	0.5820	0.0560	N.A.	0.0060	0.6440
2000	**0.4251**	**0.0242**	**0.0000**	**0.0172**	**0.4665**
2005	0.4301	0.0270	0.0001	0.0220	0.4792
2010	0.4349	0.0298	0.0009	0.0270	0.4926
2020	0.4467	0.0347	0.0011	0.0422	0.5247

Note(s): 1) Does not include renewable energy consumed by electric utilities (including hydroelectric). 2) Includes only solar energy. Commercial sector cannot be separated out for 1980-1990. 3) GHP = Ground-Coupled Heat Pumps.

Source(s): EIA, State Energy Data Report 1999, May 2001, Table 12, p. 22 for 1980 and 1990; and EIA, AEO 2002, Dec. 2001, Table A18, p. 148 for 2000-2020.

1.2.3 2000 Residential Energy End-Use Splits, by Fuel Type (quads)

	Natural Gas	Fuel Oil (1)	LPG	Other Fuel(2)	Renw. En.(3)	*Site* Electric	*Site* Total	*Site* Percent	Primary Electric (4)	Primary Total	Primary Percent
Space Heating (5)	3.44	0.70	0.33	0.13	0.44	0.50	5.55	50.0%	1.59	6.64	33.4%
Water Heating (6)	1.32	0.12	0.10		0.02	0.45	2.01	18.1%	1.41	2.97	14.9%
Space Cooling (7)	0.00					0.65	0.65	5.8%	2.04	2.04	10.3%
Refrigeration (8)						0.55	0.55	4.9%	1.73	1.73	8.7%
Lighting						0.37	0.37	3.3%	1.17	1.17	5.9%
Electronics (9)						0.31	0.31	2.8%	0.98	0.98	4.9%
Wet Clean (10)	0.07					0.28	0.35	3.1%	0.88	0.95	4.8%
Cooking (11)	0.20		0.03			0.22	0.44	4.0%	0.68	0.91	4.6%
Computers						0.04	0.04	0.4%	0.14	0.14	0.7%
Other (12)	0.12	0.00	0.01		0.00	0.17	0.29	2.7%	0.53	0.66	3.3%
Adjust to SEDS (13)						0.54	0.54	4.9%	1.71	1.71	8.6%
Total	5.14	0.83	0.47	0.13	0.47	4.07	11.10	100%	12.86	19.89	100%

Note(s): 1) Includes 0.83 quads distillate fuel oil. 2) Kerosene (0.07 quad) and coal (0.06 quad) are assumed attributable to space heating. 3) Comprised of 0.43 quad wood (space heating), 0.02 quad geothermal (assumed space heating), 0.02 quad solar (water heating), and less than 0.001 quad pv electric generation (other). 4) *Site* -to-source electricity conversion (due to generation and transmission losses) = 3.16. 5) Fan (0.25 quad) and pump energy use included. 6) Includes electric recreational water heating (0.12 quad). 7) Fan energy use included. 8) Includes (1.36 quad) refrigerators and (0.37 quad) freezers. 9) Includes (0.42 quad) color televisions and (0.56 quad) other electronics. 10) Includes (0.10 quad) clothes washers, (0.07 quad) natural gas clothes dryers, (0.71 quad) electric clothes dryers, and (0.07 quad) dishwashers. Does not include water heating energy. 11) Includes (0.15 quad) microwaves and other "small" electric cooking appliances. 12) Includes small electric devices, heating elements, motors, swimming pool heaters, hot tub heaters, outdoor grills, and natural gas outdoor lighting. 13) Includes energy that is an adjustment to SEDS. This energy is attributable to the residential buildings sector, but not directly to specific end-uses.

Source(s): EIA, AEO 2002, Dec. 2001, Tables A2, p. 126-128, Table A4, p. 131-132, and Table A18, p. 149; and BTS/A.D. Little, Electricity Consumption by Small End-Uses in Residential Buildings, Appendix A for electric end-uses.

1.2.4 Residential *Delivered* and Primary Energy Consumption Intensities, by Year

	Number of Households (10^6)	Percent Post-1990 Households (1)	*Delivered* Energy Consumption Total (quads)	*Delivered* Energy Consumption Per Household (10^6 Btu/Hhold)	Primary Energy Consumption Total (quads)	Primary Energy Consumption Per Household (10^6 Btu/Hhold)
1980	79.6	N.A.	10.0	125.2	15.9	200
1990	94.2	N.A.	9.6	102.3	16.5	175.5
2000	**105.2**	**18%**	**11.1**	**105.2**	**19.8**	**188.8**
2005	110.4	25%	12.0	108.6	21.7	196.6
2010	116.0	32%	12.4	106.9	22.2	191.8
2020	127.1	44%	13.5	106.6	24.3	190.9

Note(s): 1) Percent of houses built after December 31, 1989.

Source(s): EIA, State Energy Data Report 1999, May 2001, Table 12, p. 22 for 1980 and 1990; EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128 and Table A4, p. 131-132 for 2000-2020, and Table A20, p. 150 for households; DOC, Statistical Abstract of the United States 2000, Dec. 2000, Table No. 1207, p. 718 for 1980 and 1990 households; and DOC, Statistical Abstractof the United States 2001, May 2002, Table N. 948 p. 601 for 2000 values.

1.2.5 1997 Residential *Delivered* Energy Consumption Intensities, by Vintage

Year	Per Square Foot (10^3 Btu)	Per Household (10^6 Btu)	Per Household Member (10^6 Btu)	Percent of Total Consumption
Prior to 1980	66.8	106.3	41.6	77%
1980 to 1986	46.4	76.4	30.3	9%
1987 to 1989	48.4	93.9	33.7	5%
1990 to 1995	45.3	93.8	33.5	8%
1996 to 1997	46.6	100.2	32.2	1%
Average	60.7	101.0	39.0	

Source(s): Data taken from EIA, 1997 Residential Energy Consumption Survey.

1.2.6 1997 Residential *Delivered* Energy Consumption Intensities, by Housing Type

Type	Per Square Foot (10^3 Btu)	Per Household (10^6 Btu)	Per Household Members (10^6 Btu)	Percent of Total Consumption
Single-Family:	**59.0**	**114.7**	**42.0**	**82.6%**
- Detached	58.4	117.9	42.2	73.4%
- Attached	64.4	94.4	40.5	9.2%
Multi-Family:	**67.3**	**59.9**	**31.5**	**12.5%**
- 2 to 4 units	93.2	91.5	28.4	5.0%
- 5 or more units	56.7	48.6	40.7	7.5%
Mobile Homes	**80.0**	**79.5**	**23.7**	**4.9%**
				100.0%

Source(s): Data taken from EIA, 1997 Residential Energy Consumption Survey.

1.2.7 1997 Residential *Delivered* Energy Consumption Intensities, by Census Region

Region	Per Square Foot (10^3 Btu)	Per Household (10^6 Btu)	Per Household Members (10^6 Btu)	Percent of Total Consumption
Northeast	68.8	120.6	48.2	23%
Midwest	69.9	134.0	51.5	31%
South	53.6	83.9	32.8	29%
West	51.0	74.9	27.8	16%
				100%

Source(s): Data taken from EIA, 1997 Residential Energy Consumption Survey.

1.2.8 1997 Residential *Delivered* Energy Consumption Intensities, by Ownership of Unit

Ownership	Per Square Foot (10^3 Btu)	Per Household (10^6 Btu)	Per Household Members (10^6 Btu)	Percent of Total Consumption
Owned	**58.3**	**114.7**	**43.3**	**77%**
Rented	**70.3**	**72.5**	**29.4**	**23%**
- Public Housing	62.7	51.0	25.3	2%
- Not Public Housing	70.9	74.8	29.8	22%
				100%

Source(s): Data taken from EIA, 1997 Residential Energy Consumption Survey.

1.2.9 Aggregate Residential Building Component Loads (1)

Component	Loads (quads) and Percent of Total Loads: Heating		Cooling	
Roof	-0.65	12%	0.16	14%
Walls	-1.00	19%	0.11	10%
Foundation	-0.76	15%	-0.07	-
Infiltration	-1.47	28%	0.19	16%
Windows (conduction)	-1.34	26%	0.01	1%
Windows (solar gain)	0.43	-	0.37	32%
Internal Gains	0.79	-	0.31	27%
NET Load	-3.99	100%	1.08	100%

Note(s): 1) "Loads" represents the thermal energy losses/gains that when combined will be offset by a building's heating/cooling system to maintain a set interior temperature (which then equals *site* energy).

Source(s): LBNL, Residential Heating and Cooling Loads Component Analysis, November 1998, Figure P-1, P-1 and Appendix C: Component Loads Data Tables.

1.2.10 1997 Residential *Delivered* Energy Consumption Intensities, by Principal Building Type and Vintage

Building Type	Consumption (10^3 Btu/SF) Pre-1990	Consumption (10^3 Btu/SF) 1990-1997	Consumption (10^6 Btu/Hhold) Pre-1990	Consumption (10^6 Btu/Hhold) 1990-1997	Consumption (10^6 Btu/Member) Pre-1990	Consumption (10^6 Btu/Member) 1990-1997
Single-Family	**60.9**	**45.1**	**115.4**	**108.4**	**42.6**	**36.8**
- Detached	60.2	44.8	118.5	112.8	42.9	36.8
- Attached	66.0	48.0	96.1	76.0	40.7	37.3
Multi-Family	**69.0**	**42.6**	**61.1**	**40.8**	**28.8**	**22.4**
- 2 to 4 units	94.4	50.4	92.8	46.0	41.3	20.1
- 5 or more units	58.0	41.5	49.3	40.0	23.7	22.8
Mobile Homes	**92.2**	**50.6**	**81.7**	**70.9**	**50.5**	**45.2**

Source(s): Data taken from EIA, 1997 Residential Energy Consumption Survey.

1.3.1 Commercial Primary Energy Consumption, by Year and Fuel Type (quads and percents of total) (1)

	Natural Gas		Petroleum (2)		Coal		Renewable(3)		Electricity Sales	Electricity Losses		Electricity Total		TOTAL (3)		Growth Rate 1990-Year
1980	2.67	25%	1.29	12%	0.09	1%	0.02	**0%**	1.91	4.64		6.54	62%	10.61	100%	-1.9%
1990	2.70	21%	0.91	7%	0.09	1%	0.04	**0%**	2.86	6.26		9.12	71%	12.86	100%	**-**
2000	**3.36**	**20%**	**0.65**	**4%**	**0.07**	**0%**	**0.10**	**1%**	**3.90**	**8.42**	**(4)**	**12.33**	**75%**	**16.51**	**100%**	**2.5%**
2005	3.77	20%	0.67	4%	0.07	0%	0.11	1%	4.46	9.38		13.83	75%	18.45	100%	2.4%
2010	4.04	20%	0.69	3%	0.07	0%	0.11	1%	5.03	10.06		15.10	75%	20.00	100%	2.2%
2020	4.64	20%	0.71	3%	0.08	0%	0.11	0%	6.13	11.53		17.67	76%	23.21	100%	2.0%

Note(s): 1) See Table 1.3.11 for buildings-related energy consumption in the industrial sector. 2) Petroleum includes distillate and residual fuels, liquefied petroleum gas, kerosene, and motor gasoline. 3) Includes *site* marketed and non-marketed renewable energy. 4) 2000 *site* -to-source electricity conversion = 3.16.

Source(s): EIA, State Energy Data Report 1999, May 2001, Table 13, p. 23 for 1980 and 1990; and EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128 for 2000-2020 and Table A18, p. 148 for non-marketed renewable energy.

1.3.2 Commercial *Site* Renewable Energy Consumption (quads) (1)

	Wood (2)	Solar Thermal (3)	Solar PV(3)	GHP (4)	Total
1980	0.0210	N.A.	N.A.	N.A.	0.0210
1990	N.A.	N.A.	N.A.	0.0030	0.0030
2000	**0.0788**	**0.0234**	**0.0001**	**N.A.**	**0.1024**
2005	0.0788	0.0263	0.0006	N.A.	0.1057
2010	0.0788	0.0264	0.0018	N.A.	0.1071
2020	0.0788	0.0276	0.0022	N.A.	0.1087

Note(s): 1) Does not include renewable energy consumed by electric utilities (including hydroelectric). 2) Includes wood and wood waste, municipal solid waste, and other biomass used by the commercial sector to cogenerate electricity. 3) Includes only solar energy. 4) GHP = Ground-Coupled Heat Pumps.

Source(s): EIA, State Energy Data Report 1999, May 2001, Table 12-13, p. 22-23 for 1980 and 1990; and EIA, AEO 2002, Dec. 2001, Table A18, p. 148 for 2000-2020.

1.3.3 2000 Commercial Energy End-Use Splits, by Fuel Type (quads) (1)

	Natural Gas	Fuel Oil (2)	LPG	Other Fuel(3)	Renw. En.(4)	*Site* Electric	*Site* Total	*Site* Percent	Primary Electric (5)	Primary Total	Primary Percent
Lighting						1.24	1.24	18.1%	3.91	3.91	23.7%
Space Heating	1.53	0.37		0.09		0.20	2.20	32.1%	0.64	2.63	15.9%
Space Cooling	0.01					0.60	0.61	9.0%	1.89	1.91	11.6%
Water Heating	0.66	0.08			0.02	0.15	0.91	13.3%	0.46	1.23	7.4%
Office Equipment						0.32	0.32	4.6%	1.00	1.00	6.1%
Ventilation						0.28	0.28	4.0%	0.87	0.87	5.3%
Refrigeration						0.19	0.19	2.7%	0.59	0.59	3.6%
Computers						0.16	0.16	2.3%	0.49	0.49	3.0%
Cooking	0.21					0.03	0.24	3.5%	0.10	0.31	1.9%
Other (6)	0.15	0.02	0.08	0.03	0.08	0.31	0.67	9.8%	0.99	1.35	8.2%
Adjust to SEDS (7)	0.80	0.04				0.44	1.28	18.7%	1.38	2.22	13.5%
Total	3.36	0.51	0.08	0.12	0.10	3.90	6.85	100%	8.42	16.51	100%

Note(s): 1) See Table 1.3.11 for buildings-related energy consumption in industrial buildings. 2) Includes (0.36 quad) distillate fuel oil and (0.10 quad) residual fuel oil. 3) Kerosene (0.03 quad) and coal (0.07 quad) are assumed attributable to space heating. Motor gasoline (0.03 quad) assumed attributable to other end-uses. 4) Includes (0.02 quad) solar water heating, (0.08 quad) biomass, and less than (0.001 quad) solar pv. 5) *Site* -to-source electricity conversion (due to generation and transmission losses) = 3.16. 6) Includes service station equipment, automated teller machines, telecommunications equipment, medical equipment, pumps, lighting, emergency electric generators, manufacturing performed in commercial buildings. 7) Energy adjustment EIA uses to relieve discrepancies between data sources. Energy attributable to the commercial buildings sector, but not directly to specific end-uses.

Source(s): EIA, AEO 2002, Dec. 2001, Tables A2, p. 126-128, Table A4, p. 131-132, Table A5, p. 133-134, and Table A18, p. 148; EIA, National Energy Modeling System for AEO 2002, Dec. 2001; and BTS/A.D. Little, Energy Consumption Characteristics of Commercial Building HVAC Systems, Volume II: Thermal Distribution, Auxiliary Equipment, and Ventilation, Oct. 1999, p. 1-2 and 5-26.

1.3.4 Commercial *Delivered* and Primary Energy Consumption Intensities, by Year (1)

		Floorspace (10^9 SF)	Percent Post-1990 Floorspace (2)	*Delivered* Energy Consumption Total (quads)	*Delivered* Energy Consumption Consumption per SF (10^3 Btu/SF)	Primary Energy Consumption Total (quads)	Primary Energy Consumption Consumption per SF (10^3 Btu/SF)
1980		50.9	N.A.	6.0	117.2	10.6	208.3
1990		64.3	N.A.	6.6	102.6	12.9	200.0
2000	**(3)**	**64.5**	**19%**	**8.1**	**125.1**	**16.5**	**255.7**
2005	(3)	71.7	33%	9.0	126.2	18.4	257.1
2010	(3)	77.5	43%	9.9	127.8	20.0	257.6
2020	(3)	89.6	61%	11.6	130.0	23.2	258.8

Note(s): 1) See Tables 1.3.11 and 2.2.8 for buildings-related energy consumption and floorspace of the industrial sector. 2) Percent built after December 31, 1989. 3) EIA now excludes parking garages and commercial buildings on multibuilding manufacturing facilities from the commercial buildings sector.

Source(s): EIA, State Energy Data Report 1999, May 2001, Table 13, p. 23 for 1980 and 1990; EIA, AEO 1994, Jan. 1994, Table A5, p. 62 for 1990 floorspace; and EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128 and Table A5, p. 133-134 for 2000-2020.

1.3.5 1995 Commercial *Delivered* Energy Consumption Intensities, by Vintage (1)

Year Constructed	Consumption Per Square Foot (10^3 Btu/SF)	Percent of Total Consumption
Prior to 1980	90.2	70.9%
1980 to 1989	86.5	19.9%
1990 to 1995	104.7	9.1%
		100%
Average	90.6	

Note(s): 1) Parking garages and commercial buildings on multibuilding manufacturing facilities are excluded from CBECS 1995.

Source(s): EIA, Commercial Building Energy Consumption and Expenditures 1995, April 1998, Table 3.

1.3.6 1995 Commercial *Delivered* End-Use Energy Consumption Intensities, by Principal Building Type (1)

	Consumption (10^3 Btu/SF)					
Building Type	Space Heating	Space Cooling	Water Heating	Lighting	Total (2)	Percent of Total Consumption
Office	24.3	9.1	8.7	28.1	97.2	19%
Mercantile and Service	30.6	5.8	5.1	23.4	76.4	18%
Education	32.8	4.8	17.4	15.8	79.3	12%
Health Care	55.2	9.9	63.0	39.3	240.4	11%
Lodging	22.7	8.1	51.4	23.2	127.3	9%
Public Assembly	53.6	6.3	17.5	21.9	113.7	8%
Food Service	30.9	19.5	27.5	37.0	245.5	6%
Warehouse and Storage	15.7	0.9	2.0	9.8	38.3	6%
Food Sales	27.5	13.4	9.1	33.9	213.5	3%
Vacant (3)	38.0	1.4	5.5	4.5	30.1	3%
Public Order and Safety	27.8	6.1	23.4	16.4	97.2	2%
Other (4)	59.6	9.3	15.3	26.7	172.2	3%
All Buildings	29.0	6.0	13.8	20.4	90.5	100%

Note(s): 1) Further detail can be found in Table 7.4.1. Parking garages and commercial buildings on multibuilding manufacturing facilities are excluded from CBECS 1995. 2) Includes all end-uses. 3) Includes vacant and religious worship. 4) Includes mixed uses, hangars, crematoriums, laboratories, and other.

Source(s): EIA, Commercial Building Energy Consumption and Expenditures 1995, April 1998, Table EU-2, p. 311.

1.3.7 1995 Commercial Primary Energy Consumption Intensities, by Principal Building Type (1)

Building Type	Consumption (10^3 Btu/SF)	Percent of Total Consumption	Building Type	Consumption (10^3 Btu/SF)	Percent of Total Consumption
Office	227.2	23%	Public Assembly	169.7	6%
Mercantile and Service	155.3	19%	Food Service	487.8	6%
Education	136.8	10%	Food Sales	585.7	4%
Health Care	422.6	10%	Public Order/Safety	142.4	2%
Lodging	235.2	8%	Vacant (2)	49.1	2%
Warehouse and Storage	76.3	6%	Other (3)	281.9	3%
					100%

Note(s): 1) Parking garages and commercial buildings on multibuilding manufacturing facilities are excluded from CBECS 1995.
2) Includes vacant and religious worship. 3) Includes mixed uses, hangars, crematoriums, laboratories, and other.
Source(s): EIA, Commercial Building Energy Consumption and Expenditures 1995, April 1998, Table 1.

1.3.8 1995 Commercial *Delivered* Energy Consumption Intensities, by Ownership of Unit (1)

Ownership	Consumption (10^3 Btu/SF)	Percent of Total Consumption
Nongovernment Owned	**84.6**	**74.2%**
Owner-Occupied	92.4	61.8%
Nonowner-Occupied	66.7	12.2%
Government Owned	**113.6**	**25.8%**
		100%

Note(s): 1) Parking garages and commercial buildings on multibuilding manufacturing facilities are excluded from CBECS 1995.
Source(s): EIA, Commercial Buildings Energy Consumption and Expenditures 1995, April 1998, Table 3.

1.3.9 Aggregate Commercial Building Component Loads (1)

Component	Loads (quads) and Percent of Total Loads			
	Heating		Cooling	
Roof	-0.103	12%	0.014	1%
Walls (2)	-0.174	21%	-0.008	-
Foundation	-0.093	11%	-0.058	-
Infiltration	-0.152	18%	-0.041	-
Ventilation	-0.129	15%	-0.045	-
Windows (conduction)	-0.188	22%	-0.085	-
Windows (solar gain)	0.114	-	0.386	32%
Internal Gains				
Lights	0.196	-	0.505	42%
Equipment (electrical)	0.048	-	0.207	17%
Equip. (non-electrical)	0.001	-	0.006	1%
People	0.038	-	0.082	7%
NET Load	-0.442	100%	0.963	100%

Note(s): 1) "Loads" represents the thermal energy losses/gains that, when combined, will be offset by a building's heating/cooling system to maintain a set interior temperature (which then equals *site* energy). 2) Includes common interior walls between buildings.
Source(s): LBNL, Commercial Heating and Cooling Loads Component Analysis, June 1998, Table 24, p. 45 and Figure 3, p. 61.

1.3.10 1995 Commercial *Delivered* Energy Consumption Intensities, by Principal Building Type and Vintage (1)

	Consumption (10^3 Btu/SF)	
Building Type	Pre-1990	1990-1995
Education	80.0	68.7
Food Sales	198.5	N.A.
Food Service	223.0	N.A.
Health Care	244.8	199.7
Lodging	128.5	110.4
Mercantile and Service	75.7	84.5
Office	98.2	84.5
Public Assembly	111.0	138.2
Public Order and Safety	94.0	N.A.
Warehouse and Storage	36.6	55.8
Vacant (2)	29.9	N.A.

Note(s): 1) See Table 1.3.4 for primary versus *delivered* energy consumption. Parking garages and commercial buildings on multibuilding manufacturing facilities are excluded from CBECS 1995. 2) Includes vacant and religious worship.

Source(s): EIA, Commercial Building Energy Consumption and Expenditures 1995, April 1998, Table 8.

1.3.11 1991 Buildings-Related *Delivered* and Primary Energy Consumption in Industrial Sector (10^12 Btu)

SIC Group	Manufacturing Industry	Ventilation	Space Heating	Space Cooling	Lighting	Total
20	Food	10.9	110.8	11.4	12.5	145.6
21	Tobacco	0.5	5.9	0.6	N.A.	7.0
22	Textiles	3.4	37.3	3.7	9.2	53.6
23	Apparel	1.7	13.5	1.6	3.6	20.4
24	Lumber	1.1	7.8	1.0	3.3	13.2
25	Furniture	1.5	12.8	1.4	2.1	17.8
26	Paper	5.1	53.9	5.4	9.2	73.6
27	Printing	5.4	27.9	4.2	8.2	45.7
28	Chemicals	7.9	76.9	8.1	15.4	108.3
29	Refining	1.5	15.5	1.6	4.0	22.6
30	Rubber	3.2	28.3	3.1	9.4	44.0
31	Leather	0.5	5.4	0.5	N.A.	6.4
32	Stone, Clay, Glass	2.1	19.7	2.1	5.1	29.0
33	Primary Metals	4.9	51	5.2	16.3	77.4
34	Fabricated Metals	6.6	61.3	6.6	11.8	86.3
35	Industrial Machinery	7.4	54	6.6	16.3	84.3
36	Electronic Equipment	6.0	44.6	5.4	13.7	69.7
37	Transportation Equipment	10.8	101	10.8	19.1	141.7
38	Instruments	5.2	39.6	4.8	8.4	58.0
39	Miscellaneous Manufacturing	1.0	7.2	0.9	2.2	11.3
	Delivered Total	86.9	774.3	85.1	169.9	1,116.2
	Primary Total	270.0	890.0	280.0	520.0	1,960.0

Note(s): Total buildings-related (i.e., non-process) primary energy consumption in the industrial sector in 1991 was 1.96 of 31.80 quads; for comparison, 2000 industrial primary energy consumption was 35.50 quads.

Source(s): PNNL, An Analysis of Buildings-Related Energy Use in Manufacturing, PNNL-11499, April 1997, Table 4.1, p. 4.2; EIA, State Energy Data Report 1999, May 2001, Table 14, p. 24 for industrial sector note; EIA, AEO 2002, Table A2, p. 126-128; and DOE/BTS Memorandum, AEO98 Data Clarification for Building Energy Analysts, May 13, 1998.

1.4.1 FY 2000 Federal Primary Energy Consumption

Buildings and Facilities	**0.63 quads**	
Vehicles/Equipment/Energy-Intensive Operations	0.76 quads	(mostly jet fuel and diesel)
Total Federal Government Consumption	1.39 quads	

Source(s): DOE/FEMP, Annual Report to Congress on FEMP (draft), June 6, 2002, Table 1-A, p. 11 for total consumption and Table 5-A, p. 68 for buildings consumption.

1.4.2 FY 2000 Federal Building Energy Use Shares, by Fuel Type, and by Agency

Fuel Type	*Site* Percent	Primary Percent	Agency	Primary Percent		FY 2000 Quads
Electricity	44.7%	71.7%	Defense	61.8%	Total *Delivered*	
Natural Gas	33.9%	17.3%	Postal	9.4%	Energy Consumption =	0.33
Fuel Oil	9.7%	5.0%	DOE	6.6%	Total Primary	
Coal	5.9%	3.0%	VA	7.2%	Energy Consumption =	0.63
Other	5.8%	3.0%	GSA	4.5%		
	100%	100%	Other	10.6%		
				100%		

Note(s): See Table 2.3.1 for floorspace.

Source(s): DOE/FEMP, Annual Report to Congress on FEMP (draft), June 6 , 2002, Table 7-B, p. 78 for fuel types, and Table 5-A, p. 68 for agency consumption.

1.4.3 Federal Building *Delivered* Energy Consumption Intensities, by Year (1)

Year	Consumption per Gross Square Foot (10^3 Btu/SF)	Year	Consumption per Gross Square Foot (10^3 Btu/SF)
FY 1985	139.4	FY 1994	124.2
FY 1986	132.3	FY 1995 (2)	120.7
FY 1987	137.4	FY 1996	118.6
FY 1988	137.2	FY 1997	116.6
FY 1989	133.1	FY 1998	110.8
FY 1990	130.6	FY 1999	109.7
FY 1991	126.8	FY 2000	106.7
FY 1992	129.2	FY 2005 (3)	97.6
FY 1993	126.1	FY 2010 (3)	90.6

Note(s): 1) See Table 2.3.1 for floorspace. 2) Exceeds the National Energy Conservation Policy Act goal of 125,700 Btu/SF.
3) Executive Order 13123 goal.

Source(s): DOE/FEMP, Annual Report to Congress on FEMP (draft), June 6, 2002, Table 5-B, p. 70 for 1985 and 1990-2000 energy consumption and Table 8-A, p. 83 for 1985,1999 and 2000 floorspace; and DOE/FEMP for remaining data.

1.5.1 Buildings Share of U.S. Electricity Consumption/Sales (percent)

	Residential	Commercial	**Total Buildings**	Industry	Transportation	TOTAL	U.S. Electricity *Delivered* Total (quads)
1980	34%	27%	**61%**	39%	0%	100%	7.1
1990	34%	31%	**65%**	35%	0%	100%	9.3
2000 (1)	**35%**	**33%**	**68%**	**31%**	**1%**	**100%**	**11.7**
2005	36%	34%	**70%**	29%	1%	100%	12.9
2010	35%	35%	**70%**	29%	1%	100%	14.2
2020	34%	37%	**71%**	29%	1%	100%	16.8

Note(s): 1) Buildings accounted for 79% (or $186 billion) of total U.S. electricity expenditures.

Source(s): EIA, State Energy Data Report 1999, May 2001, Tables 12 -16, p. 22-26 for 1980 and 1990; and EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128 for 2000-2020 consumption, and Table A3, p. 129-130 for 2000 expenditures.

1.5.2 U.S. Electricity Generation Input Fuel Shares (percent)

				Renewables				Net	
	Natural Gas	Petroleum	Coal	Hydro.	Oth(2)	Total	Nuclear	Electric Imports	Total
1980	16%	11%	50%	13%	0%	13%	11%	(1)	100%
1990	10%	4%	54%	10%	1%	11%	21%	(1)	100%
2000	**12%**	**3%**	**53%**	**8%**	**2%**	**10%**	**22%**	**1%**	**100%**
2005	14%	1%	53%	8%	3%	10%	20%	1%	100%
2010	16%	0%	53%	7%	3%	10%	18%	1%	100%
2020	22%	1%	51%	6%	4%	10%	16%	1%	100%

Note(s): 1) Electric imports included in renewables. 2) Includes geothermal, municipal solid waste, biomass, solar thermal, solar photovoltaic, and wind.

Source(s): EIA, State Energy Data Report 1999, May 2001, Table 16, p. 26 for 1980 and 1990; and EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128 for 2000-2020 consumption and Table A18, p. 148 for renewables.

1.5.3 U.S. Electricity Generation Input Fuel Consumption (quads)

				Renewables				Net	
	Natural Gas	Petroleum	Coal	Hydro.	Oth(2)	Total	Nuclear	Electric Imports	Total
1980	3.80	2.63	12.16	3.09	0.11	3.20	2.74	(1)	24.53
1990	2.86	1.25	16.09	3.01	0.21	3.22	6.16	(1)	29.58
2000	**4.32**	**0.93**	**19.69**	**2.82**	**0.73**	**3.55**	**8.03**	**0.38**	**36.92**
2005	5.58	0.32	21.44	3.12	1.06	4.18	8.10	0.54	40.16
2010	6.98	0.21	22.80	3.11	1.34	4.46	7.87	0.38	42.69
2020	10.49	0.28	24.67	3.10	1.84	4.94	7.49	0.44	48.32

Note(s): 1) Electric imports included in renewables. 2) Includes geothermal, municipal solid waste, biomass, solar thermal, solar photovoltaic, and wind.

Source(s): EIA, State Energy Data Report 1999, May 2001, Table 16, p. 26 for 1980 and 1990; and EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128 for 2000-2020 consumption and Table A18, p. 148 for renewables.

1.5.4 U.S. Electric Utility and Nonutility Net Summer Electricity Generation Capacity (GW)

Electric Generator	1990	2000	2005	2010	2020
Coal Steam	300	305	304	306	329
Other Fossil Steam	144	135	127	116	113
Combined Cycle	7	31	60	140	214
Combustion Turbine/Diesel	46	78	105	129	178
Nuclear Power	100	98	98	94	88
Pumped Storage	18	19	20	20	20
Fuel Cells	0	0	0	0	0
Conv. Hydropower	75	79	80	80	80
Geothermal	3	3	3	4	5
Municipal Solid Waste	2	3	4	4	4
Biomass	7	1	2	2	2
Solar Thermal	0	0	0	0	0
Solar Photovoltaic	0	0	0	0	0
Wind	2	2	7	8	9
Total	703	754	809	906	1062
Distributed Generation	N.A.	0	1	5	19

Source(s): EIA, AEO 1994, Table A9, p. 66 and Table A16, p. 73 for 1990; and EIA, AEO 2002, Dec. 2001, Table A9, p. 138-139 and Table A17, p. 147 for 2000-2020.

1.5.5 U.S. Utility and Nonutility Cumulative Power Plant Additions Needed to Meet Future Electricity Demand (1)

Electric Generator	Typical New Plant Capacity (MW)		Number of New Power Plants to Meet Demand 2005	2010	2020
Coal Steam	428		2	14	73
Other Fossil Steam	428		0	0	0
Combined Cycle	400		71	271	456
Combustion Turbine/Diesel	160		199	358	685
Nuclear Power	600		0	0	0
Pumped Storage	135	(2)	2	2	2
Fuel Cells	10		6	16	25
Conventional Hydropower	24	(2)	20	25	25
Geothermal	50		4	14	49
Municipal Solid Waste	30		22	34	49
Wood and Other Biomass	100		2	3	6
Solar Thermal	100		0	0	1
Solar Photovoltaic	5		8	20	53
Wind	50		88	105	133
Total			424	863	1557
Distributed Generation	160		5	32	119

Note(s): 1) Cumulative additions after December 31, 1999. 2) Based on current stock averaged capacity.

Source(s): EIA, AEO 2002, Dec. 2001, Table A9, p. 138-139 and Table A17, p. 147; EIA, Assumption to the AEO 2002, Dec. 2001, Table 38, p. 68; and EIA, Inventory of Electric Utility Power Plants in the U.S. 1999, Sept. 2000, Table 1, p. 9.

2.1.1 Total Number of Households and Buildings, Floorspace, and Household Size, by Year

	Households (millions)	Percent Post-1990 Households (1)	Buildings (millions)	Floorspace (billion sf)	U.S. Population (millions)	Average Household Size (2)
1980	79.6	N/A	65.5	142.5	228	2.9
1990	94.2	N/A	74.2	169.2	250	2.7
2000	**105.2**	**18%**	**82.6 (3)**	**168.8 (3)**	**275**	**2.6**
2005	110.4	25%	N.A.	N.A.	288	2.6
2010	116.0	32%	N.A.	N.A.	300	2.6
2020	127.1	44%	N.A.	N.A.	312	2.5

Note(s): 1) Percent built after December 31, 1989. 2) Number of residents. 3) Number of buildings and floorspace in 1997; for comparison, 1997 households = 101.5 million; percentage of floorspace: 85% single-family, 11% multi-family, and 4% manufactured housing.

Source(s): DOC, Statistical Abstract of the U.S. 2001, May 2002, No. 947, p. 601 for number of households (1980/1990), No. 2-3, p. 8-9 for populations; EIA, AEO 2002,Dec. 2001, Table A4, p. 131-132 for households (2000-2020); EIA, NEMS for AEO 2002 (unpublished data) for 1990-2020 housing starts; EIA, Buildings and Energy in the 1980's, June 1995, Table 2.1, p. 23 for residential buildings and floorspace in 1980 and 1990; and EIA, RECS 1997 for 1997 buildings and floorspace.

2.1.2 Share of Households, by Housing Type, and by Type of Ownership as of 1997 (percent)

Housing Type	Owned	Rented	Total
Single-Family:	**60.3%**	**12.4%**	**72.7%**
-Detached	54.8%	8.0%	62.8%
-Attached	5.4%	4.4%	9.9%
Multi-Family:	**2.1%**	**19.0%**	**21.1%**
- 2 to 4 units	0.9%	4.6%	5.5%
- 5 or more units	1.2%	14.4%	15.6%
Mobile Homes	**5.2%**	**1.1%**	**6.3%**
	67.6%	32.5%	100%

Source(s): EIA, A Look at Residential Energy Consumption in 1997, Nov. 1999, Table HC1-2a, p. 35.

2.1.3 Share of Households, by Census Region and Vintage as of 1997 (percent)

Region	Prior to 1960	1970 to 1979	1980 to 1989	1990 to 1997	Total
Northeast	13.4%	2.6%	2.3%	1.2%	19.4%
Midwest	15.0%	3.9%	2.9%	2.0%	23.8%
South	15.0%	7.7%	8.1%	4.5%	35.3%
West	10.7%	5.0%	3.8%	1.9%	21.5%
					100%

Source(s): EIA, A Look at Residential Energy Consumption in 1997, Nov. 1999, Table HC1-2a, p. 34.

2.1.4 Residential Floorspace (heated square feet) as of 1997 (percent of total households)

Fewer than 600	8.5%
600 to 999	23.3%
1,000 to 1,599	32.9%
1,600 to 1,999	16.6%
2,000 to 2,399	8.5%
2,400 to 2,999	5.7%
3,000 or more	4.4%
	100%

Note(s): The 1997 average new single-family housing floorspace was 2,150 square feet.

Source(s): EIA, A Look at Residential Energy Consumption in 1997, Table HC1-2a, p. 34; DOC, Current Construction Reports: Characteristics of New Housing: 1997, C25/97-A, Table 16, p. 37 for average new square footage.

2.1.5 Housing Vintage as of 1997

Vintage	
1949 or Before	28%
1950 to 1959	12%
1960 to 1969	14%
1970 to 1979	19%
1980 to 1989	17%
1990 to 1997	10%
	100%

Source(s): EIA, A Look at Residential Energy Consumption in 1997, Nov. 1999, Table HC1-2a, p. 34.

2.1.6 Construction Statistics of New Homes Completed/Placed

	Single-Family		Multi-Family		Mobile Homes	Total
	1000 Units	Average SF	1000 Units	Average SF	1000 Units	1000 Units
1980	957	N.A.	545	N.A.	234	1735
1981	819	1720	447	980	229	1495
1982	632	N.A.	374	N.A.	234	1240
1983	924	N.A.	467	N.A.	278	1669
1984	1025	N.A.	627	N.A.	288	1940
1985	1073	N.A.	631	N.A.	283	1987
1986	1120	1825	636	911	256	2012
1987	1123	N.A.	546	N.A.	239	1908
1988	1085	1995	445	990	224	1754
1989	1026	2035	397	1000	203	1626
1990	966	2080	342	1005	195	1503
1991	838	2075	253	1020	174	1265
1992	964	2095	194	1040	212	1370
1993	1039	2095	153	1065	242	1435
1994	1160	2100	187	1035	291	1638
1995	1066	2095	247	1080	319	1632
1996	1129	2120	284	1070	338	1751
1997	1116	2150	284	1095	336	1737
1998	1160	2190	315	1065	374	1848
1999	1270	2225	335	1105	338	1943
2000	1242	2266	332	1092	273	1847
2001	1256	N.A.	315	N.A.	192	1763

Source(s): DOC, Residential Construction Data- New Privately Owned Housing Units Completed for 1999-2001 single and multi-family unit values; DOC, Current Construction Reports: Housing Completions - Annual Data, March 2001 for 1980-1998 single- and multi-family units; DOC, Manufactured Housing Statistics: Manufactured Homes Placements by Region, Nov. 2000 for 1980-1993 mobile homes; DOC, Manufactured Housing Statistics: Manufactured Homes Placements by Region, May 2002 for 1999-2001 data; NAHB, Housing Economics, March 1995 for 1981-1993 average floorspace; DOC, Current Construction Reports: Characteristics of New Housing, C25/98-A, Table 16, p. 37 and Table 18, p. 44 for 1994 floorspace; DOC, Current Construction Reports: Characteristics of New Housing, C25/99-A, Table 16, p. 37 and Table 18, p. 44 for 1995-1999 floorspace; and DOC Current Construction Reports: Characteristics of New Housing, C25/00-A p. 132 for 2000 floorspace.

2.1.7 Materials Used in the Construction of a 2,082 Sq. Ft. New Single-Family Home, 2000

13,837 board-feet of lumber	12 interior doors
11,550 square feet of sheathing	6 closet doors
16.92 tons of concrete	2 garage doors
3,011 square feet of exterior siding material	1 fireplace
2,841 square feet of roofing material	3 toilets; 2 bathtubs; 1 shower stall
3,061 square feet of insulation	3 bathroom sinks
5,550 square feet of interior wall material	14 kitchen cabinets; 4 other cabinets
2,117 square feet of interior ceiling material	1 kitchen sink
226 linear feet of ducting	1 range; 1 refrigerator; 1 dishwasher; 1 garbage disposer; 1 range hood
18 windows	1 washer; 1 dryer
4 exterior doors (3 hinged, 1 sliding)	1 heating and cooling system
2,082 square feet of flooring material	

Source(s): NAHB, 2001 Housing Facts, Figures and Trends, June 2001, p. 15.; D&R International for appliances and HVAC.

2.1.8 2000 New Homes Completed/Placed, by Census Region (thousand units and percent of total units by housing type)

	Single-Family		Multi-Family (1)		Mobile Homes		
Region	Units	% of Total	Units	% of Total	Units	% of Total	Total
Northeast	120	10%	26	8%	14	5%	160
Midwest	269	22%	66	20%	46	17%	380
South	566	46%	164	49%	178	65%	908
West	287	23%	77	23%	35	13%	399
Total	1,242	100%	333	100%	273	100%	1,847

Source(s): DOC, Current Construction Reports: Housing Completions, C22/01-01, Table 2, p. 4 for single- and multi-family; and DOC, Manufactured Housing Statistics, Manufactured Homes Placements by Region and Size of Home, March 2001 for mobile home placements.

2.1.9 2000 Construction Method of Single-Family Homes, by Region (thousand units and percent of total units by construction method)

	Stick Built		Modular		Panelized/Precut		
Region	Units	% of Total	Units	% of Total	Units	% of Total	Total
Northeast	105	9%	11	27%	5	13%	120
Midwest	243	21%	16	39%	10	26%	269
South	536	46%	11	27%	19	49%	566
West	279	24%	3	7%	5	13%	286
Total	1,163	100%	40	100%	39	100%	1,241

Source(s): DOC, Current Construction Reports: Characteristics of New Housing 2000, C25/00-A, p. 25.

2.2.1 Total Commercial Floorspace and Number of Buildings, by Year (1)

	Commercial Sector Floorspace (10^9 square feet)	Percent Post-1990 Floorspace (3)	Buildings (10^6)
1980	50.9 (2)	N.A.	3.1 (4)
1990	64.3	N.A.	4.5 (4)
2000 (5)	**64.5**	**19%**	**4.6 (6)**
2005 (5)	71.7	33%	N.A.
2010 (5)	77.5	43%	N.A.
2020 (5)	89.6	61%	N.A.

Note(s): 1) Excludes floorspace of industrial buildings (see Table 2.2.8). 2) Based on PNNL calculations. 3) Percent built after January 1, 1990. 4) Actually for previous year. 5) EIA now excludes parking garages and commercial buildings on multibuilding manufacturing facilities from the commercial building sector. 6) Data is from 1995. In 1995, commercial building floorspace = 58.8 billion square feet.

Source(s): EIA, AEO 1994, Jan. 1994, Table A5, p. 62 for 1990 floorspace; EIA, AEO 2002, Dec. 2001, Table A5, p. 133-134 for 2000-2020 floorspace; EIA, Commercial Building Characteristics 1989, June 1991, Table A4, p. 17 for 1990 number of buildings; EIA, Commercial Building Characteristics 1995, Oct. 1997, Table 1 for 1995 number of buildings and floorspace; and EIA, Buildings and Energy in the 1980's, June 1995, Table 2.1, p. 23 for number of buildings in 1980.

2.2.2 Principal Commercial Building Types as of 1995 (percent of total floor space) (1)

Mercantile and Service	22%	Public Assembly	7%	Public Order/Safety	2%
Office	18%	Lodging	6%	Food Sales	1%
Warehouse/Storage	14%	Health Care	4%	Vacant (2)	9%
Education	13%	Food Service	2%	Other (3)	2%
					100%

Note(s): 1) For primary energy intensities by building type, see Table 1.3.7. Total CBECS 1995 commercial building floorspace is 58.8 billion square feet. 2) Includes vacant (4%) and religious worship (5%). 3) Includes mixed uses, hangars, crematoriums, laboratories, and other.

Source(s): EIA, Commercial Building Characteristics 1995, Oct. 1997, Table 2.

2.2.3 Number of Floors and Type of Ownership as of 1995 (percent of total floorspace) (1)

Floors		Ownership	
One	42%	**Nongovernment Owned**	**79%**
Two	24%	Owner-Occupied	61%
Three	12%	Nonowner-Occupied	16%
Four to Nine	15%	Unoccupied	2%
Ten or More	7%	**Government Owned**	**21%**
	100%	Federal	3%
		State	4%
		Local	13%
			100%

Note(s): 1) Excludes floorspace of industrial buildings.

Source(s): EIA, Commercial Building Characteristics 1995, Oct. 1997, Table 2 for floors and Table 17 for ownership.

2.2.4 Share of Commercial Floorspace, by Census Region and Vintage as of 1995 (percent) (1)

Region	Prior to 1980	1980 to 1989	1990 to 1995	Total
Northeast	15%	4%	1%	20%
Midwest	19%	4%	2%	24%
South	23%	9%	3%	35%
West	14%	4%	2%	20%
				100%

Note(s): 1) Excludes floorspace of industrial buildings.
Source(s): EIA, Commercial Building Characteristics 1995, Oct. 1997, Table 3.

2.2.5 Commercial Building Size as of 1995 (percent of total floorspace) (1)

Square Foot Range	Percent
1,001 to 5,000	10.8%
5,001 to 10,000	12.8%
10,001 to 25,000	19.8%
25,001 to 50,000	13.1%
50,001 to 100,000	13.6%
100,001 to 200,000	11.5%
200,001 to 500,000	9.4%
Over 500,000	9.0%
	100%

Note(s): 1) Excludes floorspace of industrial buildings.
Source(s): EIA, Commercial Building Characteristics 1995, Oct. 1997, Table 2.

2.2.6 Commercial Building Vintage (as of 1995) and Lifetimes (1)

	Percent of Total Floorspace	Median Lifetimes (2) Source	(years)
Prior to 1919	6%	EIA	59
1920 to 1959	27%	PNNL	90
1960 to 1979	38%		
1980 to 1989	21%		
1990 to 1995	8%		
	100%		

Note(s): 1) Excludes floorspace of industrial buildings. 2) One-half of buildings of a given vintage are retired (demolished) by the median lifetime.
Source(s): EIA, Commercial Building Characteristics 1995, Oct. 1997, Table 3 for vintages; EIA, Assumptions for the Annual Energy Outlook 2002, Dec. 2001, p. 28 for EIA building lifetime; and BNL, BTS Evaluation and Planning Report, Jun. 1994 p. 5-3 for PNNL lifetime.

2.2.7 1995 Average Commercial Building Floorspace, by Principal Building Type and Vintage (1)

Building Type	Average Floorspace/Building (1000 SF) Pre-1990	1990-1995	All
Mercantile and Service	25.8	11.3	9.9
Office	15.1	12.9	14.9
Warehouse/Storage	16.5	6.7	14.6
Education	25.8	17.7	25.0
Public Assembly	N.A.	N.A.	12.1
Lodging	N.A.	N.A.	22.9
Health Care	N.A.	N.A.	22.2
Food Service	N.A.	N.A.	4.7
Food Sales	N.A.	N.A.	4.7
Public Order and Safety	N.A.	N.A.	14.6
Vacant (2)	N.A.	N.A.	18.5

Note(s): 1) Parking garages and commercial buildings on multibuilding manufacturing facilities are excluded from CBECS 1995. 2) Includes vacant and religious worship.

Source(s): EIA, Commercial Building Energy Consumption and Expenditures 1995, April 1998, Tables 3 and 8; and EIA, Commercial Buildings Characteristics 1995, Table A10, p. 70 for buildings.

2.2.8 1991 Industrial Building Floorspace (10^6 square feet)

SIC	Manufacturing Industry	Office Floorspace	Non-Office Floorspace	Total Floorspace
20	Food	203	1,207	1,410
21	Tobacco	6	51	56
22	Textiles	42	581	623
23	Apparel	73	451	523
24	Lumber	53	1,135	1,187
25	Furniture	49	521	569
26	Paper	72	827	899
27	Printing	351	477	827
28	Chemical	185	714	899
29	Refining	20	105	125
30	Rubber	97	768	865
31	Leather	9	44	53
32	Stone, Clay	57	808	864
33	Primary Metals	81	1,121	1,202
34	Fabricated Metals	182	1,175	1,357
35	Industrial Machinery	337	1,149	1,485
36	Electronic Equipment	266	629	894
37	Transportation	289	776	1,065
38	Instruments	225	170	395
39	Misc. Manufacturing	52	190	242
	Total	2,641	12,898	15,539

Source(s): PNNL, An Analysis of Buildings-Related Energy Use in Manufacturing, PNNL-11499, April 1997, Table 4.3, p. 4.4.

2.3.1 Federal Building Gross Floorspace, by Year and by Agency

	Floorspace (10^9 square feet)
FY 1985	3.37
FY 1986	3.38
FY 1987	3.40
FY 1988	3.23
FY 1989	3.30
FY 1990	3.40
FY 1991	3.21
FY 1992	3.20
FY 1993	3.20
FY 1994	3.11
FY 1995	3.04
FY 1996	3.03
FY 1997	3.02
FY 1998	3.07
FY 1999	3.07
FY 2000	3.06

Agency	2000 Percent of Total Floorspace
Defense	65%
Postal	11%
GSA	6%
VA	5%
DOE	3%
Other	10%
	100%

Note(s): The Federal Government owns/operates over 500,000 buildings, including 422,000 housing structures (for the military) and 51,000 non-residential buildings.

Source(s): DOE/FEMP for FY 1986-1998; DOE/FEMP, Annual Report to Congress on FEMP, May 10, 2001, Table 7-A, p. 56 for FY 1999; and DOE/FEMP, Annual Report to Congress on FEMP (draft), June 6, 2002, Table 8-A, p. 83 for FY 1985 and FY 2000 data.

3.1.1 Carbon Dioxide Emissions for U.S. Buildings, by Year (10^6 metric tons of carbon) (1)

	Buildings				U.S.			
	Site Fossil	Electricity	Total	Growth Rate 1990-Year	Total	Growth Rate 1990-Year	Buildings % of Total U.S.	Buildings % of Total Global
1980	172.0	255.2	427.1	-0.9%	1281.7	-0.5%	33%	9%
1990	149.9	317.4	467.3	-	1351.7	-	35%	8%
2000	**164.2 (2)**	**399.6 (2)**	**563.7**	**1.9%**	**1561.7**	**1.5%**	**36%**	**9% (3)**
2005	175.9	445.8	621.7	1.9%	1693.5	1.5%	37%	9%
2010	181.3	481.8	663.1	1.8%	1834.7	1.5%	36%	8%
2020	195.2	557.6	752.8	1.6%	2087.8	1.5%	36%	8%

Note(s): 1) Excludes emissions of buildings-related energy consumption in the industrial sector. Emissions assume complete combustion from energy consumption and exclude energy production activities such as gas flaring, coal mining, and cement production. 2) Emissions differ from EIA, AEO 2002, Dec. 2001, Table A19, p. 149 by less than 1%. U.S. buildings approximately equal the carbon emissions of Japan and the United Kingdom combined. 3) Global emissions for 1999.

Source(s): EIA, Emissions of Greenhouse Gases in the U.S. 1985-1990, Sept. 1993, Appendix B, Tables B1-B5, p. 73-74 for 1980; EIA, Emissions of Greenhouse Gases in the U.S. 2000, Nov. 2001, Tables 6-10, p. 29-31 for 1990; EIA, Assumptions to the AEO 2002, Dec. 2001, Table 2, p.8 for fossil fuel carbon coefficients; EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128 for 2000 energy consumption and Table A19, p. 149 for 2000-2020 U.S. emissions; EIA, International Energy Outlook 2002, March 2002, Table A10, p. 185 for 1990-2020 global emissions; and ORNL, Global CO2 Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring: 1751-1995, Jan. 1998 for 1980 global emissions.

3.1.2 2000 Buildings Energy End-Use Carbon Dioxide Splits, by Fuel Type (10^6 metric tons of carbon equivalent) (1)

	Natural	Petroleum								
	Gas	Distil.	Resid.	LPG	Oth(2)	Total	Coal	Electricity (3)	Total	Percent
Space Heating (4)	71.5	18.5	2.9	5.6	2.3	29.3	2.9	35.0	138.7	24.6%
Lighting								80.5	80.5	14.3%
Water Heating	28.5	4.0		1.7		5.7		29.7	63.9	11.3%
Space Cooling	0.2							61.6	61.8	11.0%
Refrigeration (5)								36.9	36.9	6.5%
Electronics (6)								31.3	31.3	5.6%
Cooking	5.8			0.5		0.5		12.4	18.8	3.3%
Wet Clean (7)	1.0							13.9	14.9	2.6%
Ventilation (8)								13.8	13.8	2.4%
Computers								10.1	10.1	1.8%
Other (9)	3.9	0.9		1.6	0.5	3.0		24.1	31.0	5.5%
Adjust to SEDS (10)	11.5	0.3				0.3		50.2	62.0	11.0%
Total	122.4	23.7	2.9	9.4	2.8	38.9	2.9	399.6	563.7	100%

Note(s): 1) Excludes emissions of buildings-related energy consumption in the industrial sector. Emissions assume complete combustion from energy consumption, excluding gas flaring, coal mining, and cement production. Emissions exclude wood since it is assumed that the carbon released from combustion is reabsorbed in a future carbon cycle. Carbon emissions calculated from EIA, Assumptions to the AEO 2002 and differ by as much as 5% from EIA, AEO 2002, Table A19. Buildings sector total varies by 0.5% from EIA, AEO 2002. 2) Includes kerosene space (2.5 MMTCE) heating and motor gasoline other uses (0.5 MMTCE). 3) Excludes electricity imports from utility consumption. 4) Includes residential furnace fans (3.9 MMTCE). 5) Includes refrigerators (21.1 MMTCE) and freezers (5.8 MMTCE). 6) Includes color television (6.6 MMTCE) and other office equipment. 7) Includes clothes washers (1.5 MMTCE), natural gas clothes dryers (1.1 MMTCE), electric clothes dryers (11.54 MMTCE), and dishwashers (1.1 MMTCE). Does not include water heating energy. 8) Commercial only; residential fan and pump energy use included proportionately in space heating and cooling. 9) Includes residential small electric devices, heating elements, motors, swimming pool heaters, hot tub heaters, outdoor grills and natural gas outdoor lighting. Includes commercial service station equipment, automated teller machines, telecommunications equipment, medical equipment, pumps, lighting, emergency electric generators, and manufacturing performed in commercial buildings. 10) Emissions related to an energy adjustment EIA uses to relieve discrepancies between data sources. Energy attributable to the residential and commercial buildings sectors, but not directly to specific end-uses.

Source(s): EIA, Annual Energy Outlook 2002, Dec. 2001, Table A2, p. 126-128, Table A4, p. 131-132 and Table A5, p. 133-134 for energy consumption, and Table A19, p. 149 for emissions; EIA, National Energy Modeling System for AEO 2002, Dec. 2001; EIA, Assumptions to the AEO 2002, Dec. 2001, p. 8 for emission coefficients; BTS/A.D. Little, Electricity Consumption by Small End-Uses in Residential Buildings, Aug. 1998, Appendix A for residential electric end-uses; and BTS/A.D. Little, Energy Consumption Characteristics of Commercial Building HVAC Systems, Volume II: Thermal Distribution, Auxiliary Equipment, and Ventilation, Oct. 1999, p. 1-2.

3.1.3 2000 Residential Energy End-Use Carbon Dioxide Splits, by Fuel Type (10^6 metric tons of carbon equivalent) (1)

	Natural	Petroleum							
	Gas	Distil.	LPG	Kerosene	Total	Coal	Electricity (2)	Total	Percent
Space Heating (3)	49.5	13.9	5.6	1.8	21.2	1.1	25.2	97.1	31.8%
Water Heating	18.9	2.4	1.7		4.1		22.3	45.4	14.9%
Space Cooling	0.0						32.4	32.4	10.6%
Refrigeration (4)							27.5	27.5	9.0%
Lighting							18.5	18.5	6.1%
Electronics (5)							15.5	15.5	5.1%
Wet Clean (6)	1.0						13.9	14.9	4.9%
Cooking	2.8		0.5		0.5		10.8	14.2	4.7%
Computers							2.2	2.2	0.7%
Other (7)	1.7	0.0	0.2		0.2		8.4	10.3	3.4%
Adjust to SEDS (8)	0.0				0.0		27.1	27.1	8.9%
Total	74.0	16.3	8.0	1.8	26.1	1.1	204.0	305.1	100%

Note(s): 1) Excludes emissions of buildings-related energy consumption in the industrial sector. Emissions assume complete combustion from energy consumption, excluding gas flaring, coal mining, and cement production. Emissions exclude wood since it is assumed that the carbon released from combustion is reabsorbed in a future carbon cycle. Carbon emissions calculated from EIA, Assumptions to the AEO 2002 and differ by as much as 5% from EIA, AEO 2002, Table A19. Sector total varies by 0.5% from EIA, AEO 2002. 2) Excludes electricity imports from utility consumption. 3) Includes residential furnace fans (3.9 MMTCE). 4) Includes refrigerators (21.8 MMTCE) and freezers (5.9 MMTCE). 5) Includes color television (6.6 MMTCE) and other office equipment (8.3 MMTCE). 6) Includes clothes washers (1.5 MMTCE), natural gas clothes dryers (1.1 MMTCE), electric clothes dryers (11.3 MMTCE), and dishwashers (1.1 MMTCE). Does not include water heating energy. 7) Includes residential small electric devices, heating elements, motors, swimming pool heaters, hot tub heaters, and outdoor grills. 8) Emissions related to an energy adjustment EIA uses to relieve discrepancies between data sources. Energy attributable to the residential buildings sector, but not directly to specific end-uses.

Source(s): EIA, Annual Energy Outlook 2002, Dec. 2001, Table A2, p. 126-128, and Table A4, p. 131-132 for energy consumption, and Table A19, p. 149 for emissions; EIA, Assumptions to the AEO 2002, Dec. 2001, p. 8 for emission coefficients; BTS/A.D. Little, Electricity Consumption by Small End-Uses in Residential Buildings, Aug. 1998, Appendix A for small electric end-uses.

3.1.4 2000 Commercial Energy End-Use Carbon Dioxide Splits, by Fuel Type (10^6 metric tons of carbon equivalent) (1)

	Natural	Petroleum								
	Gas	Distil.	Resid.	LPG	Oth(2)	Total	Coal	Electricity (3)	Total	Percent
Lighting								62.0	62.0	24.0%
Space Heating	22.0	4.6	2.9		0.5	8.1	1.7	9.8	41.6	16.1%
Space Cooling	0.2							29.2	29.4	11.4%
Water Heating	9.5	1.6				1.6		7.4	18.5	7.2%
Electronics								15.9	15.9	6.1%
Ventilation								13.8	13.8	5.3%
Refrigeration								9.4	9.4	3.6%
Computers								7.8	7.8	3.0%
Cooking	3.0					0.0		1.6	4.6	1.8%
Other (4)	2.2	0.9		1.4	0.5	2.8		15.7	20.7	8.0%
Adjust to SEDS (5)	11.5	0.3				0.3		23.2	35.0	13.5%
Total	48.4	7.4	2.9	1.4	1.1	12.8	1.7	195.6	258.6	100%

Note(s): 1) Excludes emissions of buildings-related energy consumption in the industrial sector. Emissions assume complete combustion from energy consumption, excluding gas flaring, coal mining, and cement production. Emissions exclude wood since it is assumed that the carbon released from combustion is reabsorbed in a future carbon cycle. Carbon emissions calculated from EIA, Assumptions to the AEO 2002 and differ by as much as 5% from EIA, AEO 2002, Table A18. Sector total varies by 0.5% from EIA, AEO 2002. 2) Includes kerosene space (0.5 MMTCE) heating and motor gasoline other uses (0.6 MMTCE). 3) Excludes electricity imports from utility consumption. 4) Includes service station equipment, automated teller machines, telecommunications equipment, medical equipment, pumps, lighting, emergency electric generators, and manufacturing in commercial buildings. 5) Emissions related to energy adjustment EIA uses to relieve discrepancies between data sources. Energy attributable to the commercial sector, but not to specific end-uses.

Source(s): EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128, and Table A5, p. 133-134 for energy consumption, and Table A19, p. 149 for emissions; EIA, NEMS for AEO 2002, Dec. 2001; EIA, Assumptions to the AEO 2002, Dec. 2001, p. 8 for emissions coefficients; and BTS/A.D. Little, Energy Consumption Characteristics of Commercial Building HVAC Systems, Volume II: Thermal Distribution, Auxiliary Equipment, and Ventilation, Oct. 1999, p. 1-2.

3.1.5 World Carbon Dioxide Emissions (1)

	Emissions (10^6 metric tons of carbon)				Annual Growth Rate	
Nation/Region	1990	1999		2010	1990-1999	1999-2010
United States	1,352	1,517	24.9%	1,835	1.5%	1.6%
Western Europe	930	940	15.4%	1,045	0.5%	0.7%
China	617	669	11.0%	1,127	2.4%	5.0%
Former Soviet Union	1,036	607	10.0%	745	-2.7%	1.7%
Other Asia	372	565	9.3%	511	1.0%	3.4%
Middle East	231	330	5.4%	439	3.2%	3.4%
Japan	269	307	5.0%	343	1.3%	1.0%
Central & S. America	178	249	4.1%	377	3.3%	5.4%
India	153	242	4.0%	349	4.5%	3.2%
Africa	179	218	3.6%	287	2.4%	2.3%
Eastern Europe	301	203	3.3%	233	-2.0%	1.0%
Canada	126	150	2.5%	173	1.6%	1.6%
Mexico	84	101	1.7%	164	3.1%	4.4%
World Total	5,821	6,097	100%	7,910	1.3%	2.4%

Note(s): 1) Emissions assume complete combustion from energy consumption, excluding gas flaring, coal mining, and cement production. See Table 1.1.6 for Energy and Population.

Source(s): EIA, International Energy Outlook 2002, March 2002, Table A10, p. 189; and EIA, AEO 2002, Dec. 2001, Table A19, p. 149 for Note 1.

3.1.6 2000 Methane Emissions for U.S. Buildings Energy Production, by Fuel Type (10^6 metric tons of carbon equivalent) (1)

Fuel Type	Residential	Commercial	Buildings Total
Petroleum	0.2	0.1	0.3
Natural Gas	8.1	5.3	13.4
Coal	0.0	0.1	0.1
Wood	2.2	0.0	2.2
Electricity (2)	7.5	7.2	14.7
Total	18.0	12.7	30.7

Note(s): 1) Sources of emissions include oil and gas production, processing, and distribution; coal mining; and utility and *site* combustion. Carbon equivalent units are calculated by converting methane emissions to carbon dioxide emissions (methane's global warming potential is 23 times that of carbon dioxide) and carbon dioxide to carbon. 2) Emissions of electricity generators attributable to the buildings sector.

Source(s): EIA, Emissions of Greenhouse Gases in the U.S. 2000, November 2001, Table 14, p. 41 for energy production emissions, and Table 18, p. 44 for stationary combustion emissions; and EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128 for energy consumption.

3.1.7 2000 Carbon Dioxide Emission Coefficients for Buildings (10^6 metric tons of carbon per quad) (1)

	All Buildings	Residential Buildings	Commercial Buildings
Coal			
Average (2)	25.74	25.74	25.74
Natural Gas			
Average (2)	14.40	14.40	14.40
Petroleum Products			
Distillate Fuel Oil/Diesel	19.75	-	-
Kerosene	19.52	-	-
Motor Gasoline	19.15	-	-
Liquefied Petroleum Gas	17.09	-	-
Residual Fuel Oil	21.28	-	-
Average (2)	19.11	18.83	19.70
Electricity Consumption (3)			
Average - Primary (4)	16.03	16.03	16.03
Average - *Site* (5)	50.62	50.62	50.62
New Generation			
Gas Combined Cycle - *Site* (6)	33.14	33.14	33.14
Gas Combustion Turbine - *Site* (6)	49.51	49.51	49.51
Stock Gas Generator - *Site* (7)	43.80	43.80	43.80
All Fuels (3)			
Average - Primary	15.60	15.44	15.78
Average - *Site*	29.60	27.59	32.14

Note(s): 1) Emissions assume complete combustion from energy consumption, excluding gas flaring, coal mining, and cement production. The combustion of fossil fuels produces carbon in the form of carbon dioxide and carbon monoxide; however, carbon monoxide emissions oxidize in a relatively short time to form carbon dioxide. 2) Coefficients do not match total emissions reported in the AEO 2002 and were adjusted using Assumptions to the AEO 2002. 3) Excludes electricity imports from utility consumption. Includes nuclear and renewable (including hydroelectric) generated electricity. 4) Use this coefficient to estimate carbon emissions resulting from the consumption of energy by electric generators. 5) Use this coefficient to estimate carbon emissions resulting from the consumption of electricity by end-users. 6) Use this coefficient to estimate emissions of the next-built (2002) natural gas-fired, electric generator resulting from the consumption of electricity by end-users. 7) Use this coefficient to estimate emissions of existing natural gas-fired, electric generators resulting from the consumption of electricity by end-users.

Source(s): EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128, Table A8, p. 137, Table A18, p. 148 for consumption and Table A19, p. 149 for emissions;
EIA, Assumptions to the AEO 2002, Dec. 2001, Table 2, p. 8 for coefficients and Table 43, p. 75 for generator efficiencies;
EIA, AER 2000, Diagram 5, p. 217 for T&D losses.

3.2.1 Halocarbon Environmental Coefficients and Principal Uses

Compound	100-Year Global Warming Potential (CO2 = 1)	Ozone Depletion Potential (Relative to CFC-11)	Principal Uses
Chlorofluorocarbons			
CFC-11	4600	1.00	Blowing Agent, Chillers
CFC-12 (1)	10600	1.00	Auto A/C, Chillers, & Blowing Agent
CFC-113	6000	0.80	Solvent
CFC-114	9800	1.00	Solvent
CFC-115 (2)	7200	0.60	Solvent, Refrigerant
Hydrochlorofluorocarbons			
HCFC-22 (2)	1700	0.06	Residential A/C
HCFC-123	120	0.02	Refrigerant
HCFC-124	620	0.02	Sterilant
HCFC-141b	700	0.11	CFC Replacement
HCFC-142b	2400	0.07	CFC Replacement
Bromofluorocarbons			
Halon-1211	1300	3.00	Fire Extinguishers
Halon-1301	6900	10.00	Fire Extinguishers
Hydrofluorocarbons			
HFC-23	12000	0.00	HCFC Byproduct
HFC-125	3400	0.00	CFC/HCFC replacement
HFC-134a	1300	0.00	Auto A/C, Refrigeration
HFC-152a (1)	120	0.00	Aerosol Propellant
HFC-227ea	3500	0.00	CFC Replacement

Note(s): 1) R-500: 74% CFC-12 and 26% HFC-152a. 2) R-502: 49% HCFC-22 and 51% CFC-115.

Source(s): Intergovernmental Panel for Climate Change, Climate Change 2001: The Scientific Basis, January 2001, Table 3, p. 47 for global warming potentials and uses; EPA for halon ODPs; 'AFEAS' Internet Homepage, Atmospheric Chlorine: CFCs and Alternative Fluorocarbons, Feb. 1997 for remaining ODPs; and ASHRAE, 1993 ASHRAE Handbook: Fundamental, p. 16.3 for Notes 1 and 2.

3.2.2 Conversion and Replacements of Centrifugal CFC Chillers

	Conversions	Replacements	Total	Cumulative Percent of 1992 Chillers (1)
Pre-1995	2,304	7,208	9,512	12%
1995	1,198	3,915	5,113	18%
1996	1,311	3,045	4,356	24%
1997	815	3,913	4,728	30%
1998	905	3,326	4,231	35%
1999	491	3,085	3,576	39%
2000	913	3,235	4,148	45%
2001	452	3,324	3,776	49%
2002 (2)	360	3,433	3,793	54%
2003 (2)	310	3,558	3,868	59%
2004 (2)	265	3,203	3,468	61%
Total	9,324	41,245	50,569	

Note(s): 1) In 1992, approximately 80,000 centrifugal CFC chillers were in service, of which 82% used CFC-11, 12% CFC-12, and 6% CFC-113, CFC-114, or R-500. 2) Projected.

Source(s): ARI, Half-way Mark in Sight for Replacement and Conversion of CFC Chiller Used for Air Conditioning of Buildings, April 11, 2001; ARI, Replacement and Conversion of CFC Chillers Dipped in 1999 Assuring Steady Demand for Non-CFC Units for a Decade, March 29, 2000; ARI, Survey Estimates Long Use of CFC Chillers Nearly Two-Thirds of Units Still in Place, April 15, 1999; ARI, CFCs Widely Used to Cool Buildings Despite 28-Month Ban on Production, April 8, 1998; ARI, 1997 Chiller Survey, April 9, 1997; Air Conditioning, Heating and Refrigeration News, April 1996, p. 1; and ARI's Internet Home Page, Chiller Manufacturer Survey Confirms Slow Pace of Conversion and Replacements of CFC Chillers, April 12, 1995.

3.2.3 Estimated U.S. Emissions of Halocarbons, 1987-2000 (10^6 metric tons of carbon equivalent)

Gas	1987	1990	1995	1998	1999	2000 (1)
Chlorofluorocarbons						
CFC-11	107	67	45	31	30	9
CFC-12	318	326	150	61	40	172
CFC-113	136	43	14	0	0	0
CFC-114	N.A.	13	4	0	N.A.	N.A.
CFC-115	N.A.	8	6	5	N.A.	N.A.
Bromofluorocarbons						
Halon-1211	N.A.	0	0	0	N.A.	N.A.
Halon-1301	N.A.	3	3	4	N.A.	N.A.
Hydrochlorofluorocarbons						
HCFC-22	32	37	34	35	34	37
HCFC-123	N.A.	0	0	0	N.A.	N.A.
HCFC-124	0	0	1	1	N.A.	N.A.
HCFC-141b	N.A.	0	4	5	6	2
HCFC-142b	N.A.	0	5	6	7	4
Hydrofluorocarbons						
HFC-23	13	10	8	11	9	9
HFC-125	N.A.	0	0	1	1	1
HFC-134a	N.A.	0	5	10	11	12
Cumulative	605	508	279	170	138	245

Note(s): 1) Preliminary.

Source(s): Intergovernmental Panel for Climate Change, Climate Change 2001: The Scientific Basis, January 2001, Table 3, p. 47 for 1999 and 2000 GWPs; EIA, Emissions of Greenhouse Gases in the U.S. 1999, Oct. 2000, Table D-2, www.eia.doe.gov for 1999 emissions; EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks:1990–1998, Table ES-6, p. ES-9 for HFCs and Annex L, Table L-1, p. L-2 for 1990-1998 ozone depleting; refrigerants; EIA, Emissions of Greenhouse Gases in the U.S. 1998, Oct. 1999, Table 28, p. 59 for 1990-1998; and EIA, Emissions of Greenhouse Gases in the U.S. 1985-1994, Oct. 1995, Table 34, p. 54 for 1987.

3.3.1 2000 EPA Emission Summary Table for U.S. Buildings Energy Consumption (thousand short tons) (1)

	Buildings				Buildings Percent
	Wood/SiteFossil	Electricity	Total	U.S. Total	of U.S. Total
SO2	593	7,771 (2)	8,364	18,201	46%
NOx	1,161	3,593	4,754	24,899	19%
CO	2,924	304	3,228	109,342	3%
VOCs	957	44	1,001	20,384	5%
PM-2.5	458	96	554	7,746	7%
PM-10	483	184	667	24,875	3%
Lead	412	49	461	4,228	11%

Note(s): 1) Excludes emissions of buildings-related energy consumption in the industrial sector. VOCs = volatile organic compounds; PM-10 = particulate matter less than 10 micrometers in aerodynamic diameter. PM-2.5 = particulate matter less than 2.5 micrometers in aerodynamic diameter. CO and VOCs site fossil emissions mostly from wood burning. 2) Emissions of SO2 are 17% lower for 2000 than 1994 estimates since Phase II of the 1990 Clean Air Act Amendments began in 2000. Buildings Energy Consumption related to SO2 emissions dropped 16% from 1994 to 2000.

Source(s): EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128; and EPA/OAQPS, National Air Pollutant Emission Trends, September 2002 Tables A-2 to A-8; and EIA Annual Energy Review 2000, August 2001, p. 241 for 1994 electricity consumption.

3.3.2 2000 EPA Criteria Pollutant Emissions Coefficients (million short tons/delivered quad, unless otherwise noted)

Residential

	Electricity (1)	Gas	Oil(3)	Coal	Electricity (per primary quad) (1)
SO2	0.974	(2)	0.069	(2)	0.309
NOx	0.450	0.084	0.122	(2)	0.143
CO	0.038	(2)	(2)	(2)	0.012

Commercial

	Electricity (1)	Gas	Oil(3)	Coal	Electricity (per primary quad) (1)
SO2	0.974	(2)	0.387	(2)	0.309
NOx	0.450	0.080	0.123	(2)	0.143
CO	0.038	(2)	(2)	(2)	0.012

All Buildings

	Electricity (1)	Gas	Oil(3)	Coal	Electricity (per primary quad) (1)
SO2	0.974	(2)	0.171	(2)	0.309
NOx	0.450	0.082	0.122	(2)	0.143
CO	0.038	(2)	(2)	(2)	0.012

Note(s): 1) Emissions of SO2 are 17% lower for 2000 than 1994 estimates since Phase II of the 1990 Clean Air Act Amendments began in 2000. Buildings Energy Consumption related SO2 emissions dropped 9% from 1994 to 2000. 2) Data not available, significant enough, or reliable. 3) Oil includes distillate and residual fuel oils, LPG, motor gasoline, and kerosene.

Source(s): EPA/OAQPS, 2000 National Air Pollutant Emission Trends, September 2002 for emissions; EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128 for energy consumption; and EIA Annual Energy Review 2000, August 2001, p. 241 for 1994 electricity consumption.

3.4.1 Characteristics of U.S. Construction Waste

- 2 to 7 tons of waste (a rough average of 4 pounds of waste per square foot) are generated during the construction of a new single-family detached house.
- 15 to 70 pounds of hazardous waste are generated during the construction of a detached, single-family house. Hazardous wastes include paint, caulk, roofing cement, aerosols, solvents, adhesives, oils, and greases.
- Each year, U.S. builders produce between 30 and 35 million tons of construction, renovation, and demolition (C&D) waste
- Annual C&D debris accounts for roughly 24% of the municipal solid waste stream.
- Wastes include wood (27% of total) and other (at 73% of total, including cardboard and paper; drywall/plaster; insulation; siding; roofing; metal; concrete, asphalt, masonry, bricks, and dirt rubble; waterproofing materials; and landscaping material).
- As much as 95% of buildings-related construction waste is recyclable, and most materials are clean and unmixed.

Source(s): First International Sustainable Construction Conference Proceedings, Construction Waste Management and Recycling Strategies in the U.S., Nov. 1994, p. 689; Fine Homebuilding, Construction Waste, Feb./Mar. 1995, p. 70-75; NAHB, Housing Economics, Mar. 1995, p. 12-13; and Cost Engineering, Cost-Effective Waste Minimization for Construction Managers, Vol. 37/No. 1, Jan. 1995, p. 31-39.

3.4.2 "Typical" Construction Waste Estimated for a 2,000-Square-Foot Home (1)

	Weight		
Material	(pounds)	(percent)	Volume (cu. yd.) (2)
Solid sawn wood	1,600	20%	6
Engineered wood	1,400	18%	5
Drywall	2,000	25%	6
Cardboard (OCC)	600	8%	20
Metals	150	2%	1
Vinyl (PVC) (3)	150	2%	1
Masonry (4)	1,000	13%	1
Hazardous Materials	50	1%	-
Other	1,050	13%	11
Total	8,000	100%	50

Note(s): 1) See Table 2.1.7 for materials used in the construction of a new single-family home. 2) Volumes are highly variable due to compressibility and captured air space in waste materials. 3) Assuming 3 sides of exterior clad in vinyl siding. 4) Assuming a brick veneer on home's front facade.

Source(s): NAHB's Internet Home Page, Residential Construction Waste: From Disposal to Management, Oct. 1996.

3.4.3 1996 Construction and Demolition Debris Generated from Construction Activities and Debris Generation Rates

	Debris (million tons)			Debris Generation Rates (lbs/ sq. ft.)	
	Residential	Commercial	Buildings	Residential	Commercial
New Construction	6.6	4.3	10.8	4.38	3.89
Demolition	19.7	45.1	64.8	115	155
Renovation	31.9	28.0	59.9	N/A	N/A
Total	58.2	77.4	135.5		

Source(s): EPA/OSW, Characterization of Buildings-Related Construction and Demolition Debris in the United States, June 1998, Tables 3-6, p. 2-3 - 2-8, and Table 8, p. 2-11.

4.1.1 Building Energy Prices, by Year and Major Fuel Type ($2000/10^6 Btu) (1)

	Residential Buildings				Commercial Buildings				Buildings
	Electricity	Natural Gas	Petroleum (2)	Avg	Electricity	Natural Gas	Petroleum (2)	Avg	Average (3)
1980	29.45	6.75	13.61	14.21	30.10	6.22	10.57	14.95	14.50
1990	28.38	6.96	10.90	15.07	26.20	5.81	7.30	15.04	15.06
2000	**24.36 (4)**	**7.64**	**10.78 (5)**	**14.48**	**22.11 (6)**	**6.23**	**7.19 (7)**	**14.13**	**14.33**
2005	22.38	6.85	9.45	13.39	20.40	5.58	6.10	13.04	13.24
2010	22.41	6.73	9.84	13.55	19.87	5.51	6.36	12.97	13.29
2020	22.55	6.97	10.41	14.09	20.33	5.86	6.91	13.65	13.89

Note(s): 1) Excludes expenditures from buildings-related energy consumption in the industrial sector. 2) Petroleum products include distillate fuel, oil, residual fuel oil, LPG, kerosene, and motor gasoline. 3) In 2000, Buildings average electricity price was $23.28/10^6 Btu (or $0.079/kWh), average natural gas price was $7.08/10^6 Btu ($7.29/1000 CF), and petroleum was $9.65/10^6 Btu ($1.33/gal.). Averages do not include wood or coal prices. 4) Equals $0.083/kWh. 5) Distillate fuel: $0.87/gal., LPG: $0.81/gal., kerosene: $0.85/gal. 6) Equals $0.055/kWh. 7) Distillate fuel: $0.61/gal., residual fuel: $0.39/gal., LPG: $0.89/gal., kerosene: $0.84/gal., motor gasoline: $1.24/gal.

Source(s): EIA, State Energy Price and Expenditures Report 1999, July 2000, p. 14-15 for 1980, 1990 and prices for note; EIA, State Energy Data Report 1999, May 2001, Tables 12-13, p. 22-23; EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128, Table A3, p. 129-130, Table A12, p. 142, and Table A14, p. 144 for 2000-2020 consumption and prices; and EIA, Annual Energy Review 2000, Aug. 2001, Appendix E, p. 351 for price deflators.

4.1.2 Buildings Aggregate Energy Expenditures, by Year and Major Fuel Type ($2000 billion) (1)

	Residential Buildings				Commercial Buildings				Total Building
	Electricity	Natural Gas	Petroleum (2)	Total	Electricity	Natural Gas	Petroleum (2)	Total	Expenditures
1980	72.1	32.8	23.8	128.7	57.4	16.6	13.6	87.6	216.3
1990	89.5	31.4	13.8	134.7	74.9	15.7	6.6	97.2	231.9
2000	**99.2**	**39.2**	**14.8**	**153.2**	**86.3**	**20.9**	**4.5**	**111.8**	**265.0**
2005	103.4	37.8	13.0	154.2	90.9	21.1	4.1	116.1	270.3
2010	110.3	38.2	12.8	161.4	100.0	22.3	4.4	126.6	288.0
2020	128.6	42.9	12.5	183.9	124.7	27.2	4.9	156.8	340.7

Note(s): 1) Excludes expenditures from buildings-related energy consumption in the industrial sector. Expenditures exclude wood and coal. 2000 U.S. energy expenditures were $729.6 billion, approximately 25% greater than 1999 due to 30% price increases of petroleum product and natural gas. 2) Petroleum products include distillate fuel oil, residual fuel oil, LPG, kerosene, and motor gasoline.

Source(s): EIA, State Energy Price and Expenditures Report 1999, November 2001, p. 14-15 for 1980 and 1990; EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128 and Table A3, p. 129-130 for 2000-2020; and EIA, Annual Energy Review 2000, Aug. 2001, Appendix E, p. 351 for price deflators.

4.1.3 FY 2000 Federal Buildings Energy Prices and Expenditures, by Fuel Type ($2000)

Fuel Type	Average Fuel Prices ($/million Btu)		Total Expenditures ($million) (2)
Electricity	17.17 (1)		2,509.6
Natural Gas	4.42		489.9
Fuel Oil	4.86		154.7
Coal	2.05		39.2
Purchased Steam	11.62		170.6
LPG/Propane	8.06		17.6
Other	4.17		8.4
Average	10.37	Total	3,390.2

Note(s): 1) $0.059/kWh. 2) Energy used in buildings FY 2000 accounted for 45.8% of the total Federal energy bill.

Source(s): DOE, Annual Report to Congress on FEMP (draft), June 6, 2002, p. 78 for buildings expenditures, and p. 13 for Federal energy expenditures.

4.1.4 2000 Buildings Energy End-Use Expenditure Splits, by Fuel Type ($2000 billion) (1)

	Natural	Petroleum								
	Gas	Distil.	Resid.	LPG	Oth(2)	Total	Coal	Electricity	Total	Percent
Space Heating (3)	35.8	8.3	0.5	4.5	0.8	14.0	0.2	16.7	66.7	25.2%
Lighting								36.4	36.4	13.7%
Water Heating (4)	14.2	1.7		1.4		3.1		14.1	31.4	11.8%
Space Cooling	0.1							29.0	29.1	11.0%
Refrigeration (5)								17.5	17.5	6.6%
Electronics (6)								14.5	14.5	5.5%
Cooking	2.8			0.4		0.4		6.0	9.2	3.5%
Wet Clean (7)	0.5							6.8	7.3	2.8%
Ventilation (8)								6.1	6.1	2.3%
Computers								4.5	4.5	1.7%
Other (9)	1.8	0.1		1.0	0.3	1.5		11.0	14.3	5.4%
Adjust to SEDS (10)	5.0	0.3				0.3		22.8	28.1	10.6%
Total	60.2	10.4	0.5	7.3	1.1	19.3	0.2	185.5	265.2	100%

Note(s): 1) Excludes expenditures from buildings-related energy consumption in the industrial sector. Expenditures include coal and exclude wood (unlike Table 4.1.2). 2) Includes kerosene space heating ($0.8 billion) and motor gasoline other uses ($0.3 billion). 3) Includes furnace fans ($1.9 billion). 4) Includes residential recreation water heating ($0.9 billion). 5) Includes refrigerators ($10.5 billion) and freezers ($2.9 billion). 6) Includes color televisions ($3.2 billion) and other electronics ($10.4 billion). 7) Includes clothes washers ($0.7 billion), natural gas clothes dryers ($0.5 billion), electric clothes dryers ($5.5 billion) and dishwashers ($.5 billion). 8) Commercial only; residential fan and pump energy use included proportionately in space heating and cooling. ($0.5 billion). 9) Includes residential small electric devices, heating elements, motors, swimming pool heaters, hot tub heaters, outdoor grills, and natural gas outdoor lighting. Includes commercial services station equipment, automated teller machines, telecommunications equipment, medical equipment, pumps, lighting, emergency electric generators, manufacturing performed in commercial buildings. 10) Expenditures related to an energy adjustment EIA uses to relieve discrepancies between data sources. Energy attributable to the residential and commercial buildings sectors, but not directly to specific end-uses.

Source(s): EIA, Annual Energy Outlook 2002, Dec. 2001, Table A2, p. 126-128, Table A3, p. 129-130 for prices, Table A4, p. 131-132 for residential energy consumption, and Table A5, p. 133-134 for commercial energy consumption; EIA, National Energy Modeling System for AEO 2002, Dec. 2001; EIA, State Energy Price and Expenditure Report 1999, November 2001, p. 14-15 for coal and minor petroleum prices; EIA, Annual Energy Review 2000, Aug. 2001, Appendix E, p. 351 for price deflators; BTS/A.D. Little, Electricity Consumption by Small End-Uses in Residential Buildings, Aug. 1998, Appendix A for residential electric end-uses; and BTS/A.D. Little, Energy Consumption Characteristics of Commercial Building HVAC Systems, Volume II: Thermal Distribution, Auxiliary Equipment, and Ventilation, Oct. 1999, p. 1-2, 5-25 and 5-26 for commercial ventilation.

4.1.5 Implicit Price Deflators (1996 = 1.00)

Year	Implicit Price Deflator	Year	Implicit Price Deflator	Year	Implicit Price Deflator
1980	0.57	1990	0.87	2000	1.07
1981	0.62	1991	0.90		
1982	0.66	1992	0.92		
1983	0.69	1993	0.94		
1984	0.71	1994	0.96		
1985	0.74	1995	0.98		
1986	0.75	1996	1.00		
1987	0.78	1997	1.02		
1988	0.80	1998	1.03		
1989	0.83	1999	1.05		

Source(s): EIA, Annual Energy Review 2000, Aug. 2001, Appendix E, p. 351.

4.2.1 2000 Residential Energy End-Use Expenditure Splits, by Fuel Type ($2000 billion) (1)

	Natural	Petroleum							
	Gas	Distil.	LPG	Kerosene	Total	Coal	Electricity	Total	Percent
Space Heating (2)	26.3	6.6	4.5	0.6	11.7	0.1	12.3	50.3	32.8%
Water Heating (3)	10.0	1.1	1.4		2.5		10.9	23.4	15.3%
Space Cooling (4)	0.0						15.8	15.8	10.3%
Refrigeration (5)							13.4	13.4	8.7%
Lighting							9.0	9.0	5.9%
Wet Clean (6)	0.5						6.8	7.3	4.8%
Cooking	1.5		0.4		0.4		5.3	7.2	4.7%
Electronics (7)							7.5	7.5	4.9%
Computers							1.1	1.1	0.7%
Other (8)	0.9	0.0	0.1		0.1		4.1	5.1	3.3%
Adjust to SEDS (9)							13.2	13.2	8.6%
Total	39.2	7.8	6.4	0.6	14.8	0.1	99.2	153.3	100%

Note(s): 1) Expenditures include coal and exclude wood (unlike Table 4.1.2). 2) Includes furnace fans ($1.9 billion). 3) Includes residential recreation water heating ($0.9 billion). 4) Fan energy use included. 5) Includes refrigerators ($10.5 billion) and freezers ($2.9 billion). 6) Includes clothes washers ($0.7 billion), natural gas clothes dryers ($0.5 billion), electric clothes dryers ($5.5 billion), and dishwashers ($0.5 billion). 7) Includes color televisions ($3.2 billion) and other electronics ($4.0 billion). 8) Includes small electric devices, heating elements, motors, swimming pool heaters, hot tub heaters, outdoor grills, and natural gas outdoor lighting. 9) Expenditures related to an energy adjustment EIA uses to relieve discrepancies between data sources. Energy attributable to the residential building sector, but not directly to specific end-uses.

Source(s): EIA, Annual Energy Outlook 2002, Dec. 2001, Table A2, p. 126-128, Table A3, p. 129-130 for prices, and Table A4, p. 131-132 for residential energy; EIA, State Energy Price and Expenditure Report 1999, November 2001, p. 14-15 for coal and minor petroleum prices; EIA, Annual Energy Review 2000, August 2001, Appendix E, p. 351 for price deflators; and BTS/A.D. Little, Electricity Consumption by Small End-Uses in Residential Buildings, Aug. 1998, Appendix A for residential electric end-uses.

4.2.2 Average Annual Energy Expenditures per Household, by Year ($2000)

1980	1,616
1990	1,430
2000	**1,458**
2005	1,396
2010	1,391
2020	1,447

Source(s): EIA, State Energy Price and Expenditures Report 1999, November 2001, p. 14 for 1980 and 1990; EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128, Table A4, p. 131-132 for consumption, Table A3, p. 129-130 for prices 2000-2020; EIA, Annual Energy Review 2000, Aug. 2001, Appendix E, p. 351 for price deflators; and DOC, Statistical Abstract of the United States 2001, May 2002, Table No. 947, p. 601 for 1980 and 1990 occupied units.

4.2.3 1997 Energy Expenditures per Household, by Housing Type and Square Footage ($2000)

	Per Household	Per Square Foot
Single Family	**1,565**	**0.81**
-Detached	1,604	0.80
-Attached	1,317	0.90
Multi-Family	**889**	**1.00**
Mobile Home	**1,265**	**1.27**

Source(s): Data taken originally from EIA, 1997 Residential Energy Consumption Survey, 2000; and EIA, Annual Energy Review 2000, Aug. 2001, Appendix E, p. 351 for price inflators.

4.2.4 1997 Energy Expenditures per Household, by Census Region ($2000)

Northeast	1,724
Midwest	1,464
South	1,393
West	1,062

Source(s): Data taken originally from EIA, 1997 Residential Energy Consumption Survey, 2000; and EIA, Annual Energy Review 2000, Aug. 2001, Appendix E, p. 351 for price inflators.

4.2.5 1997 Household Energy Expenditures, by Vintage ($2000)

Year	Per Household	Per Square Foot	Per Household Member	Percent of Residential Sector Expenditures
Prior to 1980	1,408	0.88	552	74%
1980 to 1986	1,312	0.80	520	11%
1987 to 1989	1,491	0.77	536	5%
1990 to 1995	1,453	0.70	519	9%
1996 to 1997	1,324	0.62	425	1%
				100%
Average	1,403	0.82	542	

Source(s): Data taken originally from EIA, 1997 Residential Energy Consumption Survey, 2000; and EIA, Annual Energy Review 2000, Aug. 2001, Appendix E, p. 351 for price inflators.

4.2.6 1997 Households and Energy Expenditures, by Income Level ($1997)

	Households		Energy Expenditures by		Percent of Income for
Family Income/Year	Number(10^6)	Percent	Household	Household Member	Energy Expenditures (1)
Less than $5,000	3.8	4%	1,028	456	32%
$5,000 to $7,499	5.1	5%	942	527	15%
$7,500 to $9,999	4.5	4%	1,034	499	12%
$10,000 to $14,999	10.3	10%	1,063	462	9%
$15,000 to $19,999	10.4	10%	1,182	484	7%
$20,000 to $24,999	8.4	8%	1,233	520	6%
$25,000 to $34,999	15.6	15%	1,276	493	4%
$35,000 to $49,999	15.5	15%	1,394	512	3%
$50,000 to $74,999	16.4	16%	1,599	543	3%
$75,000 or More	11.5	11%	1,835	592	2%
Total	101.5	100%			3%

Note(s): 1) See Tables 4.2.7 and 7.1.10 for more on energy burdens.

Source(s): Data taken originally from EIA, 1997 Residential Energy Consumption Survey, 2000.

4.2.7 Energy Burden Definitions and Residential Energy Burdens, by Weatherization Eligibility and Year (1)

Energy burden is an important statistic for policy makers who are considering the need for energy assistance. Energy burden can be defined broadly as the burden placed on household incomes by the cost of energy, or more simply the ratio of energy expenditures to income for a household. However, there are different ways to compute energy burden, and different interpretations and uses of the energy burden statistics. DOE Weatherization primarily uses mean individual burden and mean group burden since these statistics provide data on how an "average" individual household fares against an "average" group of households (that is, how burdens are distributed for the population). DOE Weatherization (and HHS) also uses the median individual burden which shows the burden of a "typical" individual.

	1987	1990			FY 2000 (2)		
	Mean Group	Mean Indvdl	Mean Indvdl	Mean Group	Mean Indvdl	Mdn Indvdl	Mean Group
Total US Households	4.0%	6.8%	N.A.	3.2%	6.1%	3.5%	2.4%
Federally Eligible	13.0%	14.4%	N.A.	10.1%	12.1%	7.9%	7.7%
Federally Ineligible	4.0%	3.5%	N.A.	N.A.	3.0%	2.6%	2.0%
Below 125% Poverty Line	13.0%	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

Note(s): 1) See Section 7.1 for more on low-income housing. 2) Data are derived from RECS 1997, adjusted to reflect FY 2000, HDD, CDD, and fuel prices.

Source(s): HHS, LIHEAP Home Energy Notebook FY 2000, April 2002, Tables A-2a to A-2c, p. 48-50 for FY2000 burdens; HHS, LIHEAP Report to Congress FY 1995, Aug. 1997, p. 55 for energy burden definitions; HHS, Characterizing the Impact of Energy Expenditures on Low Income Households: An Analysis of Alternative National Energy Burden Statistics, November 1994, p. vii-ix for burdens; ORNL, Scope of the of the Weatherization Assistance Program: Profile of the Population in Need, Mar. 1994, p. xii for mean individual and mean group burdens and p. xi. for 1990 Federally ineligible mean individual burden; and EIA, Household Energy Consumption and Expenditures 1987, Oct. 1989, Table 13, p. 48-50 for 1987 mean group burdens.

4.2.8 1998 Cost Breakdown of a 2,150 Square Foot, New Single-Family Home ($2000) (1)

	Cost	Percent
Finished Lot	55,434	24%
Construction Cost		
Inspection/Fees	3,622	2%
Shell/Frame		
Framing	26,528	11%
Windows/Doors	8,811	4%
Exterior Finish	9,697	4%
Foundation	13,837	6%
Wall/Finish Trim	24,199	10%
Flooring	6,185	3%
Equipment		
Plumbing	7,580	3%
Electrical Wiring	4,836	2%
Lighting Fixtures	1,338	1%
HVAC	5,293	2%
Appliances	1,857	1%
Property Features	15,068	6%
Financing	4,419	2%
Overhead & General Expenses	13,419	6%
Marketing	3,294	1%
Sales Commission	7,924	3%
Profit	21,584	9%
Total	234,928	100%

Note(s): 1) Based on a NAHB survey asking builders to provide a detailed breakdown of the cost of constructing a 2,150-sq.ft. house with 3 or 4 bedrooms on a 7,500- to 10,000-sq.ft. lot. Average sales price of a new home in 42 surveyed markets was $226,680 (in $1998).

Source(s): NAHB, The Truth About Regulatory Barriers to Housing Affordability, 1999, p. 4; and EIA, Annual Energy Review 2000, Aug. 2001, Appendix E, p. 351 for price inflators.

4.3.1 2000 Commercial Energy End-Use Expenditure Splits, by Fuel Type ($2000 billion) (1)

	Natural Gas	Petroleum					Coal	Electricity	Total	Percent
		Distil.	Resid.	LPG	Oth(2)	Total				
Lighting								27.3	27.3	24.4%
Space Heating	9.5	1.7	0.5		0.2	2.3	0.1	4.5	16.4	14.7%
Space Cooling	0.1							13.3	13.4	11.9%
Water Heating	4.1	0.6				0.6		3.3	7.9	7.1%
Electronics								7.0	7.0	6.3%
Ventilation								6.1	6.1	5.4%
Refrigeration								4.1	4.1	3.7%
Computers								3.5	3.5	3.1%
Cooking	1.3					0.0		0.7	2.0	1.8%
Other (3)	1.0	0.1		0.9	0.3	1.3		6.9	9.2	8.2%
Adjust to SEDS (4)	5.0	0.3				0.3		9.7	14.9	13.4%
Total	20.9	2.7	0.5	0.9	0.5	4.5	0.1	86.3	111.9	100%

Note(s): 1) Excludes expenditures from buildings-related energy consumption in the industrial sector. Expenditures include coal and exclude wood (unlike Table 4.1.2). 2) Includes kerosene space heating ($0.2 billion) and motor gasoline other uses ($0.3 billion). 3) Includes service station equipment, automated teller machines, medical equipment, telecommunications equipment, pumps, lighting, emergency electric generators, and manufacturing performed in commercial buildings. 4) Expenditures related to an energy adjustment EIA uses to relieve discrepancies between data sources. Energy attributable to the commercial buildings sector, but not directly to specific end-uses.

Source(s): EIA, Annual Energy Outlook 2002, Dec. 2001, Table A2, p. 126-128, Table A3, p. 129-130 for prices, and Table A5, p. 133-134 for commercial energy consumption; EIA, National Energy Modeling System for AEO 2002, Dec. 2001; EIA, State Energy Price and Expenditure Report 1999, November 2001, p. 14-15 for coal and minor petroleum prices; EIA, Annual Energy Review 2000, Aug. 2001, Appendix E, p. 351 for price deflators; and BTS/A.D. Little, Energy Consumption Characteristics of Commercial Building HVAC Systems, Volume II: Thermal Distribution, Auxiliary Equipment, and Ventilation Oct. 1999, p. 1-2, 5-25 and 5-26 for commercial ventilation.

4.3.2 Average Annual Energy Expenditures per Square Foot of Commercial Floorspace, by Year ($2000)

1980	1.72
1990	1.51
2000	**1.74**
2005	1.62
2010	1.63
2020	1.75

Source(s): EIA, State Energy Price and Expenditures Report 1999, November 2001, p. 15 for 1980 and 1990; EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128 and Table A5, p. 133-134 for consumption, Table A3, p. 129-130 for prices for 2000-2020; EIA, Annual Energy Review 2000, Aug. 2001, Appendix E, p. 351 for price deflators; EIA, AEO 1994, Jan. 1994, Table A5, p. 62 for 1990 floorspace; and PNNL for 1980 floorspace.

4.3.3 1995 Energy Expenditures per Square Foot of Commercial Floorspace and per Building, by Building Type ($2000)

	per Square Foot	per Building (10^3)		per Square Foot	per Building (10^3)
Food Sales	4.48	21.0	Public Order and Safety	1.33	19.4
Food Service	3.88	18.4	Mercantile and Service	1.20	11.9
Health Care	2.46	54.6	Education	1.00	25.2
Office	1.65	24.5	Warehouse and Storage	0.61	8.8
Lodging	1.54	35.2	Vacant (1)	0.42	4.1
Public Assembly	1.37	16.7			

Note(s): 1) Includes vacant and religious worship.

Source(s): EIA, Commercial Buildings Energy Consumption and Expenditures 1995, Apr. 1998, Table 4; and EIA, Annual Energy Review 2000, Aug. 2001, Appendix E, p. 351 for price deflators.

4.3.4 1995 Energy Expenditures per Square Foot of Commercial Floorspace, by Vintage ($2000)

Prior to 1980	1.23
1980 to 1989	1.42
1990 to 1995	1.58
Average	1.30

Source(s): EIA, Commercial Buildings Energy Consumption and Expenditures 1995, Apr. 1998, Table 4; and EIA, Annual Energy Review 2000, Aug. 2001, Appendix E, p. 351 for price inflators.

4.4.1 Annual Energy Expenditures per Gross Square Foot of Federal Floorspace Stock, by Year ($2000)

FY 1985	1.66
FY 2000	1.11

Note(s): Total Federal buildings and facilities energy expenditures in FY 2000 were $3.39 billion (in $2000).
Source(s): DOE/FEMP, Annual Report to Congress on FEMP (draft), June 6, 2002, Table 7-B, p. 78 for energy costs and Table 8-A, p. 83 for floorspace.

4.4.2 Direct Appropriations on Federal Buildings Energy Conservation Retrofits and Capital Equipment ($2000 million)

FY 1985	375.3	FY 1991	135.9	FY 1997	210.1
FY 1986	275.8	FY 1992	168.9	FY 1998	270.7
FY 1987	79.4	FY 1993	137.4	FY 1999	209.4
FY 1988	87.5	FY 1994	256.4	FY 2000	121.1
FY 1989	67.0	FY 1995	314.1		
FY 1990	73.4	FY 1996	191.7		

Source(s): DOE/FEMP, Annual Report to Congress on FEMP (draft), June 6, 2002, Table 4-B, p. 33.

4.5.1 Estimated Value of All U.S. Construction Relative to the GDP ($2000)

- 2000 estimated value of all U.S. construction is $1,313 billion (including renovation; heavy construction; public works; residential, commercial, and industrial new construction; and non-contract work).
- Compared to the $10 trillion U.S. gross domestic product (GDP), all construction holds a 13.2% share.
- In 2000, residential and commercial building renovation (valued at $265 billion) and new building construction (valued at $562 billion) is estimated to account for just over 70% (or around $927 billion, including an additional $99 billion for non-contract work) of the $1,313 billion.

Source(s): National Science and Technology Council, Construction & Building: Interagency Program for Technical Advancement in Construction and Building, 1999, p. 5; National Science and Technology Council, Construction & Building: Federal Research and Development in Support of the U.S. Construction Industry,1995, p. 5 for value of total U.S. construction and non-contract work; DOC, U.S. Industry and Trade Outlook 1998, Table 6-6, p. 6-9 for commercial renovation; DOC, Current Construction Reports: Expenditures for Residential Improvements and Repairs, C50, May 2001, Table 2, p. 4 for residential renovation; DOC, Current Construction Reports: Value of Construction Put in Place, C30, December 2001, Table 1, p. 3 for new construction; and EIA, Annual Energy Review 2000, Aug. 2001, Appendix E, p. 351 for price deflators.

4.5.2 Value of New Building Construction Relative to GDP, by Year ($2000 billion)

	Value of New Construction Put in Place				Bldgs. Percent of
	Residential	Commercial (1)	All Bldgs. (1)	GDP	Total U.S. GDP
1980	134.2	129.3	263.5	5,240	5.0%
1985	170.6	182.7	353.3	6,113	5.8%
1990	162.9	183.2	346.1	7,172	4.8%
1995	191.9	167.9	359.9	8,066	4.5%
2000	270.1	254.0	524.0	9,963	5.3%

Note(s): 1) New buildings construction differs from Table 4.5.1 by excluding industrial building construction.

Source(s): DOC, Current Construction Reports: Value of New Construction Put in Place, C30, Feb. 1996, Table 1, p. 7-9 for 1980-1990; DOC, Current Construction Reports: Value of Construction Put in Place, C30, Feb. 2000, Table 1, p. 3 for 1995; DOC, Current Construction Reports: Value Put in Place, C30, December 2001, Table 1, p. 3 for 2000; and EIA, Annual Energy Review 2000, Aug. 2001, Appendix E, p. 351 for GDP and price deflators.

4.5.3 Value of Building Improvements and Repairs Relative to GDP, by Year ($2000 billion) (1)

	Value of Improvements and Repairs				Bldgs. Percent of
	Residential	Commercial	All Bldgs.	GDP	Total U.S. GDP
1980	86.8	N.A.	N.A.	5,240	N.A.
1985	116.5	113.2 (2)	229.7	6,113	3.8%
1990	132.4	114.8 (3)	247.1	7,172	3.4%
1995	130.0	113.0	243.1	8,066	3.0%
2000	151.7	113.2 (4)	264.9	9,963	2.7%

Note(s): 1) Improvements includes additions, alterations, reconstruction, and major replacements. Repairs include maintenance. 2) 1986. 3) 1989. 4) 1997.

Source(s): NAHB, 1997 Housing Facts, Figures and Trends, 1997, p.33 for residential 1980-1985; DOC, Current Construction Reports: Expenditures for Residential Improvements and Repairs, C50, Feb. 1998, Table 1, p. 3 for 1990; DOC, Current Construction Reports: Expenditures for Residential Improvements and Repairs, C50, July 1999, Table 2, p. 4 for 1995; DOC, Current Construction Reports: Expenditures for Residential Improvements and Repairs, C50, Dec. 2001, Table 1, p. 3 for 2000; DOC, Current Construction Reports: Expenditures for Nonresidential Improvements and Repairs: 1992, CSS/92, Sept. 1994, Table A, p. 2 for 1986-1990 expenditures; DOC, U.S. Industry and Trade Outlook 1998, Table 6-6, p. 6-9 for 1995-1997 commercial; and EIA, Annual Energy Review 2000, Aug. 2001, Appendix E, p. 351 for GDP and price deflators.

4.5.4 1999 U.S. Private Investment into Construction R&D

Sector	Percent of Sales		Percent of Sales
Average Construction R&D (1)	**1.7**	**Building Technology**	
Heavy Construction	0.3	Appliances	1.8
Housing (lumber and wood products)	0.4	Lighting	1.2
Special Trade Construction	0.2	HVAC	1.4
Construction Materials	1.0		
Construction Machinery	3.4		
U.S. Industry Average (2)	**3.1**		
International Industry Composite (3)	**4.3**		

Note(s): 1) Includes all construction (e.g., bridges, roads, dams, buildings, etc.). 2) Japan's industry average was 2.7% in 1995. 3) For 1991; U.S. industry average was 3.6% in 1991.

Source(s): National Science Foundation Research and Development in Industry 1999, January 2000, p. 63 Table A20; Business Week, R&D Scoreboard, June 29, 1992, p. 106 for international composite; Government of Japan, Statistics Bureau, Management and Coordination Agency, Quick Report on the Survey of Research and Development, p. 28 for 1995 Japanese industry average; Schonfield & Associates, R&D Ratios and Budgets, 2001 for remaining R&D values.

4.6.1 Buildings Design and Construction Trades, by Year

	Employees, in thousands			Number of Residential Builder Establishments with Payrolls, in thousands (2)			
	Architects	Construction (1)		New Construction	Remodeling	Both	Total (3)
1980	N.A.	3065	1982	14.4	21.7	57.5	93.6
1990	N.A.	3861	1987	38.4	32.8	48.1	119.3
2000 (4)	215	5183	1992	36.3	43.3	51.0	130.6
			1997	46.6	33.6	52.1	134.1

Note(s): 1) Does not include industrial building or heavy construction (e.g., dam and bridge building). In 1999, 76% of the employment shown is considered for "production". The entire U.S. construction industry employs an estimated 10 million people, including manufacturing. 2) In 2000, NAHB report having 200,000 members, one-third of which were builders. 3) Excludes homebuilding establishments without payrolls, estimated by NAHB at an additional 210,000 in 1992. 4) NAHB reports that 2,448 full-time jobs in construction and related industries are generated from the construction of every 1,000 single-family homes and 1,030 jobs are created from the construction of every 1,000 multi-family units.

Source(s): DOC, Statistical Abstract of the U.S. 2001, May 2002, Table 593, p. 380 for architect employment, Table 609, p. 393; DOC, 1992 Census of Construction Activities: U.S. Summary, CC92-I-27, Jan. 1996, p. 27-5 for construction employees; DOC, 1997 Economic Census: Construction - Industry Summary, EC97C23IS, Jan. 2000, Table 2, p. 8 for industrial builders; DOC, 1997 Economic Census: Construction - Single-Family Housing Construction, EC97C-2332A, Nov. 1999, Table 10, p. 14 for 1997 builder establishments; NAHB, Housing Economics, May 1995, Table 2, p. 14 for 1982-1992 builder establishments; National Science and Technology Council, Construction & Building: Federal Research and Development in Support of the U.S. Construction Industry for construction employees in Note 1; NAHB, Housing at the Millennium: Facts, Figures, and Trends, May 2000, p. 21 for Note 2; and NAHB, 1997 Housing Facts, Figures and Trends, 1997, p. 35 for Note 3 and p. 13 for Note 4.

4.6.2 Heating, Cooling, and Ventilation Equipment Trades, by Year (1000 employees)

Industry	1980	1985	1990	1995	2000
Air Conditioning and Refrigeration Equipment (incl. warm-air furnaces): SIC 3585					
- Total Employment	118.4	122.8	126.9	138.6	148.4
- Production Workers	81.6	87.2	92.4	104.3	110.5
Plumbing, Heating, and Air-Conditioning Contractors: SIC 171					
- Total Employment	532.8	605.1	649.2	715.7	936.5
- Construction Workers	400.4	447.3	476.7	527.9	693.4
Wholesalers of Hardware, Plumbing and Heating Equipment: SIC 507					
- Total Employment	242.7	254.1	283.8	288.7	319.1

Source(s): ARI, Statistical Profile of the Air-Conditioning, Refrigeration, and Heating Industry (from U.S. Bureau of Labor Statistics), April 2001, Table 3, p. 10, Table 4, p. 11, Table 5, p. 13, Table 6, p. 14, and Table 8, p. 16 for 1980 to 1990 data; Bureau of Labor Statistics Data Queries for 1995-2000 data.

5.1.1 2001 Five Largest Residential Homebuilders

Homebuilder	Number of Home Closings (1)	Gross Revenue ($million)	Market Share of Total New Home Closings (%) (2)
Centex Corporation	26,060	7,757	1.66%
Lennar Corporation	23,899	6,029	1.52%
Pulte Homes	22,915	5,560	1.46%
D.R. Horton	22,772	4,728	1.45%
KB Home	21,486	4,574	1.37%
Total of Top Five	117,132	28,648	7.46%
Habitat for Humanity (3)	3,641	N.A.	0.23%

Note(s): 1) 2001 total U.S. new home closings were 1.57 million (includes single-family and multi-family). 2) Total share of closings of top 100 builders was 14%. The top 400 builders accounted for 42% of 1996 home sales. According to NAHB, its builder members construct about 80% of all housing built in the U.S. in a typical year. 3) Habitat for Humanity International plans to build 100,000 homes internationally between 2000 and 2005. Habitat for Humanity's 1,900 worldwide affiliates completed 13,760 homes in FY 2001.

Source(s): Builder Magazine, May 2002, Builder 100; NREL for top 400 portion of Note 3; and NAHB, 1997 Housing Facts, Figures and Trends, 1997, p. 35 for NAHB portion of Note 3; and DOC, Current Construction Reports: Housing Completions, Jan. 2001, C22/01-01, Table 1, p. 3 for total closings.

5.1.2 Value of New Building Construction, by Year ($2000 billion)

	Residential	Commercial	All Bldgs.
1980	134.2	129.3	263.5
1985	170.6	182.7	353.3
1990	162.9	183.2	346.1
1995	191.9	167.9	359.9
2000 (1)	270.1	254.0	524.0

Note(s): 1) In 2000, new Buildings construction accounted for 2.7% of the $9.97 trillion U.S. GDP. Refer to Chapter 2 for more new building statistics.

Source(s): DOC, Current Construction Reports: Value of New Construction Put in Place, C30, Feb. 1996, Table 1 p. 7-9 for 1980-1990; DOC, Current Construction Reports: Value of New Construction Put in Place, C30, Feb. 2000, Table 1 p. 3 for 1995; DOC, Current Construction Reports: Value of New Construction Put in Place, C30, May 2002, Table 1, p. 3 for 2000-2001 and Note 1; and EIA, Annual Energy Review 2000, Aug. 2001, Appendix E, p. 351 for price deflators.

5.2.1 Industrialized Housing Production versus Stick-Built, by Year (1000 units)

Year	Panelized Units (1)	Modular Units	HUD-Code Units (mobile homes) (2)	Production Units (stick-built)	Total	
1981	315	52	241	810	1,418	
1985	540	77	283	909	1,809	
1990	494	79	195	662	1,436	
1991	450	74	171	503	1,198	
1992	504	84	206	528	1,318	
1993	548	91	233	559	1,431	
1994	625	109	304	632	1,670	
1995	679	109	340	627	1,755	
1996	740	112	390	696	1,918	
1997	762	124	353	698	1,937	
1998	793	140	373	792	2,098	
1999	801	163	348	889	2,201	
2000	841	148	268	960	2,217	(3)
2001	877	166	192	984	2,219	

Note(s): 1) Includes pre-cut homes (e.g., log cabins). 2) Statistics completed by the National Conference of States on Building Codes and Standards. The Automated Builder Magazine numbers shown for HUD-Code (mobile home) units are within 5% of U.S. Census data. 3) Top 100 industrialized builders' total 2000 gross sales was $8 billion (includes some commercial modular/factory-built component sales). For 2000, Automated Builder total estimates exceeded Census new housing completion data by 15%, since these estimates include some multi-family and small commercial units.

Source(s): Automated Builder Magazine, Jan. 1992, p. 12 for 1981; Jan. 1996, p. 30 for 1985; Jan. 2001, p. 15 for 1990; Jan. 2002, p. 19 for 1991-2001; Dec. 2000, p. 33 for sales volume.

5.2.2 2001 Top Five Manufacturers of Panelized Homes (including pre-cut homes) (1)

Company	Units Produced	Gross Sales Volume ($million)	Market Share of Top 40 Company Sales (2)	Number of Employees
Wausau Homes	4,100	183.0	46%	N.A.
Barden and Robeson	1,000	37.0	9%	N.A.
Brunsell Lumber	200	30.0	8%	N.A.
Cardinal Homes	197	12.0	3%	N.A.
Long Built Homes	40	10.0	3%	N.A.

Note(s): 1) Data based on mail-in surveys from manufacturers which may not be entirely complete. 2) Market shares based on total gross sales volume of producers of only panelized homes included in the list of the top 40 IH producers responding to the survey. In 2001, surveyed panelized home sales were estimated at $396.4 million and 9,878 housing units produced.

Source(s): Automated Builder Magazine, June 2002, p. 32.

5.2.3 2001 Top Five Manufacturers of Modular Homes (1)

Company	Units Produced	Gross Sales Volume ($million)	Market Share of Top 39 Company Sales (2)	Number of Employees
Genesis Homes	4,760	164.7	20%	1900
New Era Building Group	3,850	88.5	11%	690
Excel Homes	3,500	86.0	10%	650
Muncy Homes, Inc.	3,593	65.8	8%	515
Nationwide Homes	N.A.	57.0	7%	550

Note(s): 1) Data based on mail-in surveys from manufacturers which may not be entirely complete. 2) Market shares based on total gross sales volume of the modular home producers included in the list of the top 39 IH producers responding to the survey. In 2001, surveyed modular home sales were estimated at $834 million and 32,413 units produced. The top 39 companies responding to the survey employ roughly 8,600 people.

Source(s): Automated Builder Magazine, May 2002, p. 34-36.

5.2.4 2000 Top Five Manufacturers of HUD-Code (Mobile) Homes (1)

Company	Units Produced	Gross Sales Volume ($million)	Market Share of Top 27 Company Sales (2)	Number of Employees
Champion Enterprises, Inc.	86,749	1,490	24%	12,000
Oakwood Homes	41,123	1,170	19%	8,986
Fleetwood Enterprises, Inc	78,384	1,150	19%	5,435
CMH Manufacturing	29,718	492	8%	3,500
Skyline Homes	11,719	394	6%	3,000

Note(s): 1) Data based on mail-in surveys from manufacturers which may not be entirely complete. 2) Gross sales volumes may include sales from units other than HUD-Code homes for companies active in multiple housing markets. Market shares based on total gross sales volume of the HUD-Code home producers included in the list of the top 27 IH producers responding to the survey. In 2000, surveyed HUD-Code home sales were estimated at $6.2 billion and 322,303 units. The top 27 IH producers responding to the survey employ 43,150 people.

Source(s): Automated Builder Magazine, October 2001, p. 30-31.

5.2.5 2000 Top Five Manufacturers of Factory-Fabricated Components (trusses, wall panels, doors) (1)

Company	Gross Sales Volume ($million)	Market Share of Top 60 Company Sales (2)	Number of Employees (3)
Stark Truss	85.0	13%	800
Raymond Building Supply	42.0	6%	240
Automated Bldg. Comp's	40.5	6%	320
Littfin Lumber Co.	38.8	6%	340
Nascor	28.0	4%	175

Note(s): 1) Data based on mail-in surveys from manufacturers which may not be entirely complete. 2) Market shares based on total gross sales volume of producers of only components included in the list of the top 60 IH producers responding to the survey. In 2000, surveyed component sales was estimated at $657.8 million. 3) The top 60 companies employ a total of 6,300 people at their plants.

Source(s): Automated Builder Magazine, September 2001, p. 32-35.

5.2.6 2000 Number of Industrialized Housing Manufacturers versus Production Companies (stick-builders)

Type	Number of Companies
Panelized	3,750
Modular (1)	200
HUD-Code	90
Production Builders	7,000
Component Manufacturers	2200
Special (Commercial) Units	170

Note(s): 1) 170 of these companies also produce panelized homes.

Source(s): Automated Builder Magazine, Jan. 2001, p. 15.

5.2.7 2000 HUD-Code (Mobile) Home Shipments, by Census Region and Top Five States (percent of national total)

Region		Top Five States	
Northeast	5%	Texas	11.1%
Midwest	17%	North Carolina	12.5%
South	65%	Tennessee	5.2%
West	13%	Florida	4.6%
	100%	Georgia	4.6%

Source(s): DOC, Manufactured Housing Statistics, 2000 New Manufactured Homes Placed by Size of Home, by State, Jan. 2002.

5.3.1 Value of Building Improvements and Repairs, by Sector ($2000 billion) (1)

	Value of Improvements and Repairs		
	Residential	Commercial	All Bldgs.
1980	86.8	N.A.	N.A.
1985	116.5	113.2 (2)	229.7
1990	132.4	114.8 (3)	247.1
1995	130.0	113.0	243.1
2000	151.7 (4)	113.2 (5)	264.9

Note(s): 1) Improvements includes additions, alterations, reconstruction, and major replacements. Repairs include maintenance. 2) 1986. 3) 1989. 4) Includes 72% Improvements and 28% Maintenance & Repairs. 5) Data is 1997. Includes 57% Improvements and 43% Maintenance and Repairs.

Source(s): NAHB, 1997 Housing Facts, Figures and Trends, 1997, p.33 for residential 1980-1985; DOC, Current Construction Reports: Expenditures for Residential Improvements and Repairs, C50, Feb. 1998, Table 1, p. 3 for 1990; DOC Current Construction Reports: Expenditures for Residential Improvements and Repairs, C50, July 1999, Table 2, p. 4 for 1995; DOC, Current Construction Reports: Expenditures for Residential Improvements and Repairs, C50, Dec. 2001, Table 2, p. 4 for 2000; DOC, Current Construction Reports: Expenditures for Nonresidential Improvements and Repairs: 1992, CSS/92, Sept. 1994, Table A, p. 2 for 1986-1990 expenditures; DOC, U.S. Industry and Trade Outlook 1998, Table 6-6, p. 6-9 for 1995-1997 commercial; and EIA, Annual Energy Review 2000, Aug. 2001, Appendix E, p. 351 for price deflators.

5.3.2 1994-1995 Professional and Do-It-Yourself Improvements by Homeowners, by Project ($2000)

	Professional Installation			DIY Installation		
Repair/Improvement	Homeowners (10^6)	Total Expenditures ($10^9)	Mean Expenditures ($)	Homeowners (1000)	Total Expenditures ($10^9)	Mean Expenditures ($)
Kitchen Remodeled	2.07	12.6	6,058	2.10	5.2	2,456
Bathroom Remodeled or Added	2.15	15.3	7,113	2.82	6.5	2,307
Additions Built	3.31	19.8	6,005	3.48	8.5	2,451
Exterior Improvements	4.99	18.4	3,694	4.33	6.5	1,510
Disaster Repairs	0.99	8.6	8,649	0.27	1.3	5,070
Roof Replacement	3.66	13.2	3,620	0.82	1.4	1,727
Siding Replaced or Added	1.29	6.9	5,353	0.47	0.9	1,934
Plumbing Replacement	1.07	1.1	1,007	0.75	0.2	343
Electric System Replacement	2.32	1.7	702	1.34	0.4	295
Windows/Doors Installed	4.24	8.3	1,949	3.31	2.4	739
Insulation Added	0.98	0.7	690	1.45	0.4	272
Flooring/Paneling/Ceiling Replacement	4.07	6.6	1,633	2.90	1.8	592
HVAC Replacement	3.85	11.6	2,989	0.58	1.0	1,737
Appliance/Major Equipment Replacement	4.86	2.0	415	3.77	1.1	282
Total	22.81	127.8	5,603	16.72	38.1	2,280

Note(s): Expenditures are $35.9 billion higher than in Table 4.5.3 and 5.3.1. This discrepancy is due to sampling methods used by HUD for the American Housing Survey and DOC in the Survey of Expenditures for Residential Improvements and Repairs.

Source(s): Joint Center for Housing Studies of Harvard University, Improving America's Housing, Table A.3, p. 42; and EIA, Annual Energy Review 2000, Aug. 2001, Appendix E, p. 351 for price deflators.

5.3.3 Single-Family Residential Renovations by Age of Home

	Year Home was Built					
	Pre-1946	1946-60	1961-73	1974-80	1981-98	1999 or later
Remodel kitchen	60%	57%	54%	60%	44%	8%
Remodel bathroom	59%	52%	59%	55%	40%	4%
Add room(s)	29%	18%	14%	24%	21%	15%
Complete exterior facelift	21%	15%	15%	16%	9%	4%
Finish room in basement	14%	10%	6%	12%	16%	65%
Redesign/Restructure	14%	8%	11%	10%	5%	4%
Enclose porch/patio/breezeway	12%	7%	12%	13%	9%	4%
Add interior bathroom	8%	7%	6%	7%	6%	27%
Add a sun room	4%	6%	3%	4%	5%	8%

Note(s): Data based on a national study of 819 consumers who have remodeled their home within the past 12 months or will in the next 12 months.
Source(s): Professional Remodeler, Consumer Research: What Consumers Want, September 2002, p. 44-50.

5.4.1 1996 Top Manufacturers of Mineral Fiber (Glass/Wool) Insulation

Company	Gross Sales Volume ($million)	Market Share (percent) (1)
Owens-Corning Fiberglass Corp.	3,612	67%
Johns Manville	1,278	24%
Knauf Fiber Glass	140	3%
Dryvit Systems Inc.	75	1%
CTA Insulation	71	1%
BP Chemicals Hitco	62	1%
Other	153	3%
	5,391	100%

Note(s): 1) Percent of sales value of top 29 companies.
Source(s): Ward's Business Directory of U.S. Private and Public Companies 1997.

5.4.2 1997 Builder Insulation Demand, by Type

Insulation Type	Market Share
Fiberglass-Batts	72%
Fiberglass-Blown	15%
Cellulose-Blown	7%
Plastic Foam	4%
Rockwool	1%
Other	1%
	100%

Source(s): Builder Magazine, April 1999, p. 257.

5.4.3 2000 Industry Use Shares of Mineral Fiber (Glass/Wool) Insulation (1)

Insulating Buildings (2)	72.1%
Industrial, Equipment, and Appliance Insulation	24.5%
Unknown	3.4%
	100%

Note(s): 1) Based on value of shipments. 2) Including industrial.
Source(s): DOC, 2000 Annual Survey of Manufacturers: Value of Product Shipments, Feb. 2002, p. 54.

5.4.4 Thermal Performance of Insulation

	R-Value per Inch (1)			R-Value per Inch (1)
Fiberglass (2)			Perlite/Vermiculite	
Batts	3.1 - 4.3	(3)	Loose-Fill	2.1 - 3.7
Loose-Fill	2.5 - 3.7		Foam Boards	
Spray-Applied	3.7 - 3.9		Expanded Polystyrene	3.9 - 4.4
Rock Wool (2)			Polyisocyanurate/	
Loose-Fill	2.5 - 3.7		Polyurethane	5.6 - 7.0
Cellulose			Phenolic	4.4 - 8.2
Loose-Fill	3.1 - 3.7		Reflective Insulation	2 - 17
Spray-Applied	2.9 - 3.5		Vacuum Powder Insulation	25 - 30
			Vacuum Insulation Panel	20 - 100

Note(s): 1) Hr-ft2-F/Btu-in. Does not include the effects of aging and settling. 2) Mineral fiber. 3) System R-value depends on heat-flow direction and number of air spaces.
Source(s): ASHRAE, 1997 ASHRAE Handbook: Fundamentals, p. 24-4, 22-5; DOE, Insulation Fact Sheet, Jan 1988, p. 6; Journal of Thermal Insulation, 1987, p. 81-95; ORNL, ORNL/SUB/88-SA835/1, 1990; ORNL, Science and Technology for a Sustainable Energy Future, March 1995, p. 17; and ORNL for vacuum insulation panel.

5.5.1 Residential Prime Window Sales, by Type (million units) (1)

	New Construction				Remodeling/Replacement				Total Construction			
Type	1985	1990	1995	2001	1985	1990	1995	2001	1985	1990	1995	2001
Aluminum (2)	9.5	5.9	4.7	3.0	7.2	3.6	3.9	3.5	16.7	9.5	8.6	6.5
Wood (3)	8.6	9.4	11.6	13.1	6.6	7.6	9.4	10.5	15.2	17.0	21.0	23.6
Vinyl	0.2	1.2	4.8	9.6	3.3	7.1	9.6	15.9	3.5	8.3	14.4	25.5
Other	0.2	0.1	0.3	0.5	0.2	0.1	0.2	0.3	0.4	0.2	0.5	0.7
Total	18.5	16.6	21.4	26.2	17.3	18.4	23.1	30.2	35.8	35.0	44.5	56.3

Note(s): 1) Average window life span is 35 to 45 years. 2) In 1993, 65% of aluminum-framed windows were thermally broken. 3) Includes vinyl-clad and metal-clad units.

Source(s): AAMA/Ducker Research, Industry Statistical Review and Forecast 1992, 1993 for 1985 and Note 2; AAMA/NWWDA/Ducker Research, Industry Statistical Review and Forecast 1996, 1997, Table 6, p. 6 for 1990; American Architectural Manufacturers Association/Window & Door Manufacturers Association, 2000 AAMA/WDMA Industry Statistical Review and Forecast, Feb. 2001, p. 6 for 1995; 2001 AAMA/WDMA Industry Statistical Review and Forecast, March 2002, p. 6 for 2001; and LBNL, Savings from Energy Efficient Windows, Apr. 1993, p. 6 for window life span.

5.5.2 Residential Storm Window and Door Shipments, by Type (million units)

	Windows				Doors				Total			
Type	1985	1990	1995	2001	1985	1990	1995	2001	1985	1990	1995	2001
Aluminum	16.3	9.9	9.2	7.9	2.6	1.9	3.8	4.1	18.9	1.9	13.0	12.0
Wood	1.0	0.5	1.8	2.3	0.1	0.4	1.3	1.5	1.1	0.4	3.1	3.8
Other (1)	N.A.	0.1	0.3	0.3	0.7	0.1	0.1	0.1	0.7	0.1	0.4	0.4
Total	17.3	10.5	11.3	10.4	3.4	2.4	5.2	5.7	20.7	2.4	16.5	16.2

Note(s): 1) "Other" includes metal over wood/foam core or vinyl, etc.

Source(s): AAMA/Ducker Research, Industry Statistical Review and Forecast 1992, 1993 for 1985; AAMA/NWWDA/Ducker Research, Industry Statistical Review and Forecast 1996, 1997, Table 7, p.7 for 1990; American Architectural Manufacturers Association/Window & Door Manufacturers Association, 2000 AAMA/WDMA Industry Statistical Review and Forecast, Feb. 2001, p. 7 for 1995; and 2001 AAMA/WDMA Industry Statistical Review and Forecast, March 2002, p. 6 for 2001.

5.5.3 Nonresidential Window Usage, by Type and Census Region (million square feet of vision area) (1)

	Northeast		Midwest		South		West		Total	
Type	1990	2001	1990	2001	1990	2001	1990	2001	1990	2001
New Construction										
Commercial Windows (2)	9	35	14	31	22	49	14	32	59	148
Curtain Wall	6	16	7	13	11	23	8	17	32	69
Store Front	6	21	7	20	15	41	9	25	40	107
Total	21	72	31	64	48	114	31	75	131	324
Remodeling/Replacement										
Commercial Windows (2)	6	26	11	22	24	27	14	16	55	91
Curtain Wall	3	3	3	3	5	5	6	4	17	14
Store Front	6	9	9	9	21	18	16	11	52	47
Total	15	38	23	34	50	50	36	30	124	153
Total										
Commercial Windows (2)	15	62	25	53	46	78	28	48	114	240
Curtain Wall	9	19	10	15	16	28	14	21	49	83
Store Front	12	30	19	29	36	59	25	36	92	154
Total	36	110	54	98	98	164	67	105	255	477

Note(s): 1) "Usage" is a good indication of sales. 2) Formerly referred to as Architectural. Includes both shop fabricated (true architectural) and *site* fabricated products.

Source(s): AAMA/Ducker Research, Industry Statistical Review and Forecast 1992, 1993 for 1990; and American Architectural Manufacturers Association/ Window & Door Manufacturers Association 2001 Industry Statistical Review and Forecast, March. 2002, p. 17 for 2001.

5.5.4 Insulating Glass Historical Penetration, by Sector (percent of total U.S. usage) (1)

Sector	1985	1990	1995	1998	2000
Residential	73%	86%	89%	91%	92%
Nonresidential	63%	80%	84%	84%	86%

Note(s): 1) "Usage" is a good indication of sales. Includes double- and triple-pane sealed units.

Source(s): Ducker Research, Industry Statistical Review and Forecast 1992, 1993 for 1985; AAMA/Ducker Research, Industry Statistical Review and Forecast 1992, 1993 for 1990; American Architectural Manufacturers Association/Window & Door Manufacturers Association, 2000 AAMA/WDMA Industry Statistical Review and Forecast, Feb. 2001, p. 12 for 1995; and 2001 AAMA/WDMA Industry Statistical Review and Forecast, March 2002, p.12 for 1998-2000.

5.5.5 Residential Prime Window Stock and Sales, by Type

	Existing U.S. Stock	Sales (million units) (1)				
Type	(% of households)	1980	1985	1990	1991	1996
Single-Pane	63.6%	8.6	9.7	4.9	4.3	3.9
Double-Pane	33.7%	15.0	25.0	19.9	19.0	27.2
Double-Pane, Low-e	1.8%	0.0	0.4	8.3	7.2	16.6
Triple Pane	0.8%	1.6	1.2	1.5	1.7	(2)
Triple-Pane, Low-e	0.1%	0.0	0.0	1.0	1.6	(2)
Total (3)	100%	25.2	36.3	35.6	33.8	47.7

Note(s): 1) Residential windows available in 1999 had an average U-Value of 0.47 and a SHGC of 0.45. Low-e window sales accounted for 26% of the market in 1991, 35% in 1993, and 35% in 1996. 2) Included in double-pane and double-pane, low-e. 3) LBNL 1985 and 1990 totals differ slightly (by ~1%) from Ducker Research values in other tables.

Source(s): PNNL, Electronic Residential Energy Consumption Survey-1993 (data taken originally from EIA, RECS 1993) for existing stock data; LBNL, Savings from Energy Efficient Windows, Apr. 1993, p. 42 for sales data; LBNL, From the Lab to the Marketplace, Mar. 1995, p. 10 for 1993 data in Note 1; Ducker Research Company, Study to Quantify and Profile the U.S. Market for Residential and Light Commercial Windows and the Technology for High-Performance Windows, Dec. 1997, p. 27 for 1996 sales; and NFRC, Directory of Certified Products, Dec. 1999, U-Factor Chart from www.nfrc.org for Note 1.

5.5.6 1995 Nonresidential Window Stock and Usage, by Type (1)

	Existing U.S. Stock	Glass Area Usage	
Type	(% of buildings)	(million sf)	(% of sf)
Single-Pane	59%	39	16%
Insulating Glass (2)	41%	311	84%
Total	100%	350	100%
Clear	**74%**	**126**	**36%**
Tinted	**26%**	**140**	**40%**
Reflective	**(3)**	**24**	**7%**
Low-e	**(3)**	**60**	**17%**
- Non-gas-filled	N.A.	4	1%
- Gas-filled	N.A.	56	16%
Total	**100%**	**350**	**100%**

Note(s): 1) "Usage" is a good indication of sales. 2) Includes double- and triple-pane sealed units (and stock glazing with storm windows). 3) Included as part of the "Tinted" category.

Source(s): EIA, Commercial Buildings Characteristics 1995, Oct. 1997, Table 42 for stock data; American Architectural Manufacturers Association/Window & Door Manufacturers Association, 2000 AAMA/WDMA Industry Statistical Review and Forecast, Feb. 2001, p. 12 for usage values; and AAMA/NWWDA, Study of the U.S. Market for Windows and Doors, 1996, p. 64 and 69 for glass-type vision area.

5.5.7 Typical Thermal Performance of Residential Windows, by Type (1)

	U-Value (2)	Solar Heat Gain Coefficient (2)
Single-Pane	0.93-1.23	0.69-0.84
Single-Pane, Tinted	0.90-1.21	0.50-0.61
Double-Pane	0.49-0.73	0.62-0.76
Double-Pane, Tinted	0.48-0.73	0.40-0.54
Double-Pane, Low-e, Gas-fill	0.34-0.42	0.48-0.58
Double-Pane, Spectrally Selective Low-e, Gas-fill	0.32	0.35
Triple Pane	0.38-0.60	0.54-0.68
Triple-Pane, 2 Low-e, Gas-fill	0.24	0.40

Note(s): 1) Residential windows available in 1999 had an average U-Value of 0.47 and a SHGC of 0.45. 2) U-Value and SHGC are whole-window values calculated using Window 4.0 and standard assumptions about frame and glazing dimensions. Ranges reflect differences in frame material and design; aluminum-frame windows are on the higher end of the ranges, while wood- and vinyl-framed windows have the lowest values.

Source(s): ACEEE, 1996 ACEEE Proceedings, The National Energy Requirements of Residential Windows in the U.S.: Today and Tomorrow, Summer 1996, p. 10.48-10.50; and NFRC, Directory of Certified Products, Dec. 1999, U-Factor Chart from www.nfrc.org for Note 1.

5.6.1 U.S. Heating and Air Conditioning System Manufacturer Shipments, by Type (including exports)

Equipment Type	1985 (1000s)	1990 (1000s)	2000 (1000s)	2000 Value of Shipments ($million) (7)
Air Conditioners (1)	**2,470.0**	**2,928.0**	**5,346.0**	**4,629**
Heat Pumps	**885.0**	**948.0**	**1,408.9**	**1,132**
Air-to-Air Heat Pumps	820.0	808.0	1,339.4	1,025
Water-Source Heat Pumps (2)	65.0	140.0	69.5	107
Chillers (3)	**11.8**	**15.0**	**33.9**	**1,304**
Reciprocating	8.2	9.8	24.9	N.A.
Centrifugal/Screw	3.5	5.0	9.0	N.A.
Absorption	0.1	0.2	N.A.	N.A.
Furnaces	**2,335.0**	**2,367.9**	**3,680.7**	**N.A.**
Gas-Fired (4)	1,822.0	1,950.5	3,104.2	1,360
Electric	366.0	279.0	455.0	N.A.
Oil-Fired (5)	147.0	138.5	121.5	77
Boilers (6)	**305.2**	**328.7**	**368.4**	**N.A.**

Note(s): 1) Includes exports and gas air conditioners (gas units <10,000 units/yr) and rooftop equipment. It excludes heat pumps, packaged terminal A/C units, and room air conditioners. Approximately 95% of unitary air conditioners shipped are 5.5 tons or less (65,000 Btu/Hr). ~70% residential and ~30% commercial applications. 2) Includes ground-source heat pumps (GSHPs), which numbered around 35,600 units shipped in 2000. 3) Chiller value of shipments are based on Census unit shipment data, which is 9,100 units higher than the industry data shown. 4) Gas-fired furnace value of shipments are based on Census unit shipment data, which is about 19,300 units higher than the industry data shown. 5) Oil-fired furnace value of shipments are based on Census unit shipment data, which is approximately 10,800 units higher than the industry data shown. 6) 61% of boiler shipments were gas-fired and 39% were oil-fired. 7) Total 2000 value of shipments for refrigeration, air-conditioning, and heating equipment was $22.2 billion, including industrial and excluding boilers and electric furnaces.

Source(s): The Air Conditioning, Heating and Refrigeration News: Statistical Panorama, April 16, 1996, p. 8-9 for 1985-1990 shipment data; Appliance, May 2001, p. 51-54 for 2000 shipments; Appliance Manufacturer, Feb. 1998 for electric furnace; ARI, Statistical Profile of the Air-Conditioning, Refrigeration, and Heating Industry, 2001, Table 22, p. 32 for centrifugal/screw chiller shipments; ARI, Kool Fax, Mar. 2000, p.4 for reciprocating chiller shipments; EIA, Survey of Geothermal Heat Pump Shipments, July 2002, table 35 for GSHP shipment data; DOC, Current Industrial Reports: Refrigeration, Air Conditioning and Warm Air Heating Equipment, MA35M, Sept. 2000, Table 2 for value of shipments; and GAMA, Statistics for the Month of December 2001, Feb. 2002, p. 4-6 for the 2000 furnaces and boilers.

5.6.2 Minimum Efficiency Standards for Residential Heating and Cooling Equipment

			Typical Maximum Energy Use for Space Heating a Single-Family Residence (2)							
			1992				2006			
	Minimum Efficiency (1)		New		Existing		New		Existing	
Heating Equipment	1992	2006	North	South	North	South	North	South	North	South
Natural Gas, Furnace	78 AFUE	78 AFUE	1170	445	1489	771	1170	445	1489	771
Oil, Boiler	80 AFUE	80 AFUE	731	N.A.	930	422	731	N.A.	930	422
Electric, Heat Pump	6.8 HSPF	7.4 HSPF	12923	4685	11232	5546	11875	4305	10321	5097

			Typical Maximum Electricity Use for Space Cooling a Single-Family Residence							
			1992				2006			
	Minimum Efficiency (3)		New		Existing		New			
Cooling Equipment	1992	2006	North	South	North	South	North	South	North	South
Central Air-Conditioning	10 SEER	12 SEER	1113	2543	1000	3743	927	2119	833	3119
Electric, Heat Pump	10 SEER	12 SEER	1100	2414	813	2657	917	2012	677	2214

Note(s): 1) AFUE = Annual Fuel Utilization Efficiency. HSPF = Heating Season Performance Factor. 2) Gas use is in therms. Oil use is in gallons. Electricity use is in kWh. 3) SEER = Seasonal Energy Efficiency Ratio.

Source(s): DOC/GPO, Title 10, Chapter 2, Part 430, Section 430.32, Jan 1, 2001, p. 259 for efficiencies; LBNL, Energy Data Sourcebook for the U.S. Residential Sector, Sept. 1997, Table 3.20, p. 52-53 and Table 3.21, p. 58; and Federal Register, Energy Conservation Program for Consumer Products: Central Air Conditioners and Heat Pumps Energy Conservation Standards, Vol. 66 No. 7, April 20, 2001, p. 20191 for proposed AC standard.

5.6.3 Residential Furnace Efficiencies (percent of units shipped) (1)

Gas-Fired				Oil-Fired			
AFUE Range	1985	AFUE Range	2000	AFUE Range	1985	AFUE Range	2000
Below 65%	15%	75% to 88%	76%	Below 75%	10%	75% to 88%	100%
65% to 71%	44%	88% and Over	24%	75% to 80 %	56%	88% and Over	0%
71% to 80%	10%		100%	Over 80%	35%		100%
80% to 86%	19%				100%		
over 86%	12%						
	100%						

Average shipped in 1985 (2):	74% AFUE	Average shipped in 1985 (2):	79% AFUE
Average shipped in 1995:	84% AFUE	Average shipped in 1995:	81% AFUE
Best Available in 1981:	85% AFUE	Best Available in 1981:	85% AFUE
Best Available in 2001:	97% AFUE	Best Available in 2001:	87% AFUE

Note(s): 1) Federal appliance standards effective January 1, 1992 require a minimum of 78% AFUE for furnaces. 2) Includes boilers.

Source(s): GAMA's Internet Home Page for 2000 AFUE ranges; GAMA News, Feb. 24, 1987 for 1985 AFUE ranges; LBNL for average shipped AFUE; and GAMA, Consumer's Directory of Certified Efficiency Ratings, October 2001, p. 11 and 79 for 2000 best-available AFUEs.

5.6.4 Residential Boiler Efficiencies (1)

Gas-Fired Boilers		Oil-Fired Boilers	
Average shipped in 1985 (2):	74% AFUE	Average shipped in 1985 (2):	79% AFUE
Best Available in 1981:	81% AFUE	Best Available in 1981:	86% AFUE
Best Available in 2001:	95% AFUE	Best Available in 2001:	89% AFUE

Note(s): 1) Federal appliance standards effective January 1, 1992 require a minimum of 80% AFUE (except gas-fired steam boiler which must have a 75% AFUE or higher). 2) Includes furnaces.

Source(s): GAMA, Consumer's Directory of Certified Efficiency Ratings for Residential Heating and Water Heating Equipment, October 2001, p. 92 and 113 for best-available AFUE; and GAMA for 1985 average AFUEs.

5.6.5 Residential Air Conditioner and Heat Pump Cooling Efficiencies (1)

Equipment Type	Efficiency Parameter	2000 U.S. Average New Efficiency	2000 Best-Available New Efficiency
Air Conditioners	SEER	10.95	18 and over
Heat Pump - Cooling			
Air-Source	SEER	11.21	17 and over
Ground-Source	EER	13.50	22 and over
Heat Pump - Heating			
Air-Source	HSPF	7.50	9.80
Ground-Source	COP	3.40	4.00

Note(s): 1) Federal appliance standards effective January 1, 1992 require a minimum SEER of 10.

Source(s): ARI ratings for best-available in 2000; ARI, Statistical Profile of the Air-Conditioning, Refrigeration, and Heating Industry, Apr. 2001, p. 28 for shipment-weighted SEERs; and EIA, Technology Forecast Updates, October 2001 for heat pump data.

5.6.6 Commercial Equipment Efficiencies

Equipment Type	Efficiency Parameter	1995 Stock Efficiency	2000 U.S. Average New Efficiency	2000 Best-Available New Efficiency
Chiller				
Reciprocating	COP	2.5	2.9	3.5
Centrifugal	COP	4.6	5.2	7.5
Gas-Fired Absorbtion	COP	1.0	1.0	N.A.
Gas-Fired Engine Driven	COP	1.0	2.0	N.A.
Rooftop A/C	COP	2.1	2.6	4.3
Rooftop Heat Pump	EER	12	10	12
Boilers				
Gas-Fired	Thermal Efficiency	75	80	87
Oil-Fired	Thermal Efficiency	78	83	88
Electric	Thermal Efficiency	98	98	98
Gas-Fired Furnace	AFUE	75	80	92
Water Heater				
Gas-Fired	Thermal Efficiency	76	80	94
Electric Resistance	Thermal Efficiency	96	98	98
Gas-Fired Instantaneous	Thermal Efficiency	75	80	90

Source(s): EIA/Arthur D. Little, Inc., Technology Forecast Updates, Final Report, Sept. October 2001, p. 36-60.

5.6.7 2000 Air-Conditioner/Heat Pump Manufacturer Market Shares (by percentage of products produced)

Company	Market Share (%)
Carrier	30%
Goodman	16%
American Standard (Trane)	14%
Lennox	12%
Rheem	11%
York	6%
Nordyne	6%
Others	5%
	100%

Total Units Shipped: 6,685,461 (1)

Note(s): 1) Does not include water-source or ground-source heat pumps.

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sep. 2001, p. 51.

5.6.8 2000 Gas Furnace Manufacturer Market Shares (by percentage of products produced)

Company	Market Share (%)
Carrier	32%
Goodman	17%
Lennox	16%
Rheem	12%
American Standard (Trane)	12%
York	5%
Nordyne	5%
Others	1%
	100%

Total Units Shipped: 3,109,612

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sep. 2001, p. 51.

5.6.9 Major Residential HVAC Equipment Lifetimes, Ages, and Replacement Picture

Equipment Type	Typical Service Lifetime Range	Average Lifetime	1990 Average Stock Age	Units to be Replaced During 2002
Central Air Conditioners	**10 - 20**	**15**	**9**	**2,671,427**
Heat Pumps	**6 - 21**	**14**	**8**	**914,432**
Furnaces				**2,102,765**
Electric	11 - 23	17	11	354,435
Gas-Fired	10 - 30	20	12	1,547,790
Oil-Fired	10 - 20	15	N.A.	200,540
Steam or Hot-Water Boilers (gas and oil)	**20 - 40**	**N.A.**	**14**	**N.A.**

Note(s): Replacement values include smaller commercial building units. Gas/oil furnaces include wall furnaces.

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sep. 2001, p. 55 for service and average lifetimes, and units to be replaced; ASHRAE, 1999 ASHRAE Handbook: HVAC Applications, Table 3, p. 35.3 for boilers service lifetimes; and EIA, Housing Characteristics 1990, May 1992, Table 7, p. 24 for 1990 average stock ages.

5.6.10 Major Commercial HVAC Equipment Lifetimes and Ages

Equipment Type	Median Lifetime	1989 Average Stock Age
Air Conditioners		11
Through-the-Wall	15	N.A.
Water-Cooled Package	15	N.A.
Roof-Top	15	N.A.
Chillers		15
Reciprocating	20	N.A.
Centrifugal	23	N.A.
Absorption	23	N.A.
Heat Pumps		N.A.
Air-to-Air	15	N.A.
Water-to-Air	19	N.A.
Furnaces (gas or oil)	18	N.A.
Boilers (gas or oil)		N.A.
Hot-Water	24-35	N.A.
Steam	25-30	N.A.
Unit Heaters		N.A.
Gas-Fired	13	N.A.
Oil-Fired	20	N.A.
Cooling Towers (metal or wood)	20	N.A.

Source(s): ASHRAE, 1999 ASHRAE Handbook: HVAC Applications, Table 3, p. 35.3 for median service lifetimes; and EIA, Commercial Building Characteristics 1989, June 1991, Tables 90-91, p. 176-177 for average stock age.

5.6.11 Main Residential Heating Fuel by Vintage as of 1997 (percent of total households)

Heating Fuel	1990 to 1997	1980 to 1989	1970 to 1979	1960 to 1969	1950 to 1959	1949 or Before
Natural Gas	49%	36%	42%	58%	65%	66%
Electricity	41%	54%	44%	24%	18%	8%
Fuel Oil	3%	3%	5%	11%	11%	17%
Other (1)	6%	7%	9%	7%	6%	9%
	100%	100%	100%	100%	100%	100%

Note(s): 1) Other includes wood, LPG, and kerosene.

Source(s): EIA, A Look at Residential Energy Consumption in 1997, Nov. 1999, Table HC3-2a, p. 55.

5.6.12 Main Residential Heating Equipment as of 1987, 1993, and 1997 (percent total households)

Equipment Type	1987	1993	1997
Natural Gas	**55%**	**53%**	**53%**
Central Warm-Air Furnace	35%	36%	38%
Steam or Hot-Water System	10%	9%	7%
Floor/Wall/Pipeless Furnace	6%	4%	4%
Room Heater/Other	4%	3%	4%
Electricity	**20%**	**26%**	**29%**
Central Warm-Air Furnace	8%	10%	11%
Heat Pump	5%	8%	10%
Built-In Electric Units	6%	7%	7%
Other	1%	1%	2%
Fuel Oil	**12%**	**11%**	**9%**
Steam or Hot-Water System	7%	6%	5%
Central Warm-Air Furnace	4%	5%	4%
Other	1%	0%	0%
Other	**13%**	**11%**	**9%**
	100%	**100%**	**100%**

Note(s): Other equipment includes wood, LPG, kerosene, other fuels, and none.

Source(s): EIA, A Look at Residential Energy Consumption in 1997, Nov. 1999, Table HC3-2a, p. 55; EIA, Housing Characteristics 1993, June 1995, Table 3.7b, p. 63; and EIA, Housing Characteristics 1987, May 1989, Table 14, p. 33.

5.6.13 Main Commercial Heating and Cooling Equipment as of 1995 (percent of total floorspace) (1)

Heating Equipment		Cooling Equipment	
Individual Space Heaters	29%	Packaged Air Conditioning Units	45%
Boilers	29%	Individual Air Conditioners	21%
Packaged Heating Units	29%	Central Chillers	19%
Furnaces	25%	Residential Central Air Conditioners	16%
Heat Pumps	10%	Heat Pumps	12%
District Heat	10%	District Chilled Water	4%
Other	11%	Swamp Coolers	4%
		Other	2%

Note(s): 1) Heating and cooling equipment percentages of floorspace add to over 100% since equipment shares floorspace.

Source(s): EIA, Commercial Building Characteristics 1995, Oct. 1997, Tables 34 and 36.

5.6.14 Main Commercial Primary Energy Use of Heating and Cooling Equipment as of 1995

Heating Equipment		Cooling Equipment	
Individual Space Heaters	2%	Pakaged Air Conditioning Units	54%
Boilers	21%	Room Air Condtioning	5%
Packaged Heating Units	25%	PTAC	3%
Furnaces	20%	Centrifugal Chillers	14%
Heat Pumps	5%	Reciprocating Chillers	12%
District Heat	7%	Rotary Screw Chillers	3%
Unit Heater	18%	Absorption Chillers	2%
PTHP & WLHP	2%	Heat Pump	7%
	100%		100%

Source(s): BTS/A.D. Little, Energy Consumption Characteristics of Commercial Building HVAC Systems, Volume 1: Chillers, Refrigerant Compressors, and Heating Systems, April 2001, Figure 5-5, p. 5-14 for cooling and Figure 5-10, p. 5-18 for heating.

5.7.1 1990 Existing Housing Stock, by Distribution System Type and Census Region (million units) (1)

Single-Family	Northeast/ North Central	South/West
Forced-Air	**22.2**	**18.1**
- Unconditioned space (2)	6.6	14.9
- Partially conditioned space (2)	7.6	2.7
- Conditioned space	8.0	0.5
Hydronic	**7.2**	**1.8**
Built-In Electric	**1.0**	**1.8**
Other or None	**4.6**	**14.4**
Multi-Family		
Forced-Air	**5.9**	**10.5**
Hydronic	**5.8**	**(3)**
Built-In Electric	**0.6**	**1.1**
Other or None	**(3)**	**(3)**
Mobile Home		
Forced-Air	**1.1**	**1.8**
Other or None	**0.8**	**1.4**

Note(s): 1) Housing stock in 1990 totaled 94 million units. 2) 34% of single-family houses have ducts in either fully or partially unconditioned spaces. 3) Less than 0.2 million units.

Source(s): BNL/LBNL, Energy Savings Potential for Advanced Thermal Distribution Technology in Residential and Small Commercial Buildings, July 1991, draft report, 1987 data revised to 1990 using RECS data.

5.7.2 Typical Commercial Building Thermal Energy Distribution Design Load Intensities (W/SF)

Distribution System Fans		**Other**	
Central System Supply Fans	0.3 - 1.0	Cooling Tower Fan	0.1 - 0.3
Central System Return Fans	0.1 - 0.4	Air-Cooled Chiller Condenser Fan	0.6
Terminal Box Fans	0.5	Exhaust Fans (2)	0.05 - 0.3
Fan-Coil Unit Fans (1)	0.1 - 0.3	Condenser Fans	0.6
Packaged or Split System Indoor Blower	0.6		
Pumps			
Chilled Water Pump	0.1 - 0.3		
Condenser Water Pump	0.1 - 0.2		
Heating Water Pump	0.1 - 0.2		

Note(s): 1) Unducted units are lower than those with some ductwork. 2) Strong dependence on building type.

Source(s): BTS/A.D. Little, Energy Consumption Characteristics of Commercial Building HVAC Systems, Volume II: Thermal Distribution, Auxiliary Equipment, and Ventilation, Oct. 1999, Table 3-1, p. 3-6.

5.8.1 Solar Collector Shipments, by Type and Market (thousand square feet, unless noted) (1)

Type	1980	1990	2000	2001	2001 Value of Shipments ($million)
Solar Thermal Collectors	19,398	11,409	8,354	11,189	32.4
Residential	N.A.	5,851	7,473	10,125	N.A.
Commercial	N.A.	295	810	1,012	N.A.
Industrial	N.A.	(2)	57	17	N.A.
Utility	N.A.	5,236	5	1	N.A.
Other	N.A.	26	10	35	N.A.
Photovoltaics (kW)	6,897 (3)	13,837	88,221	97,666	304.8

Note(s): 1) Includes imports and exports; 2001 solar thermal collector imports were 3.5 million square feet, and exports were 0.8 million square feet. 2) Industrial is included in Other. 3) Actually 1982 data.
Source(s): EIA, Renewable Energy Annual 2001, November 2002, Tables 18 and 25 for shipments, Tables 17 and 29 for value of shipments, and Table 14 for import/exports; EIA, Annual Energy Review 1991, June 1992, Table 111, p. 251 for 1990 data by sector; and EIA, Annual Energy Review 2000, Aug. 2001, Tables 10.3 and 10.5, p. 267 and 271 for 1980 and 1990 (revised) total shipment data.

5.8.2 2001 Thermal Solar Collector Shipments, by End Use (including imports and exports) (1)

Type	1000 Square Feet
Pool Heating	10,797
Hot Water	274
Space Heating	70
Space Cooling	-
Combined Space/Water Heating	12
Process Heating	34
Electricity Generation	2
Total	11,189 (2)

Note(s): 1) 7.5% of shipments are exported. 2) Approximately 4,500 systems in 2001.
Source(s): EIA, Renewable Energy Annual 2001, November 2002, Table 18, p. 19, Table 14, p. 17 for Note 1 and Table 19, p. 20 for Note 2.

5.8.3 2001 Top Five Destinations of Thermal Solar Collector Shipments

State or Territory	Percent of U.S. Unit Shipments
Florida	44%
California	29%
Arizona	4%
Nevada	2%
Connecticut	1%

Source(s): EIA, Renewable Energy Annual 2001, November 2002, Table 14, p. 17.

5.8.4 Thermal Solar Collector Manufacturer Statistics

- Number of Manufacturers in 2001: 26
- Percentage of Shipped Solar Collectors Produced by Top 5 Manufacturers: 90% (1)
- Percentage of Shipped Solar Collectors Produced by Top 10 Manufacturers: 97%

Note(s): 1) Actually year 2000 percentages for top five and top ten manufacturers.
Source(s): EIA, Renewable Energy Annual 2001, November 2002, Table 19, p. 20; and EIA, 2000 Solar Thermal and Photovoltaic Collector Manufacturing Activities, July 2001, Tables 17, p. 20 and Table 19, p. 21 for percentages.

5.8.5 Thermal Solar Collector System Characteristics

- A SDHW system produces as much energy as a 2-kW photovoltaic system.
- SDHW systems range in efficiency from a solar energy factor (SEF) of 0.8 to 4.8 (1).
- Typical SDHW system collector area is 50 sf. Typical solar pool heating system collector area is 300 sf.

Note(s): 1) SEF is the hot water energy *delivered* by the system divided by the electric or gas energy input to the system.
Source(s): SRCC, Summary of SRCC Certified Solar Collector and Water Heating System Ratings, Apr. 2000 for SDHW SEFs.

5.9.1 2000 Total Lighting Technology Electricity Consumption, by Sector (10^9 kWh/year) (1)

	Residential		Commercial		Industrial		Other (2)		Total	
Incandescent										
Standard	176	87%	103	26%	2	2%	5	10%	287	38%
Halogen	6	3%	21	5%	0	0%	1	2%	28	4%
Fluorescent										
T5	N.A.		0	0%	0	0%	N.A.		0	0%
T8	N.A.		50	13%	23	21%	0	0%	71	9%
T12	N.A.		157	40%	49	45%	0	0%	206	27%
Compact	1	1%	13	3%	1	1%	N.A.		14	2%
Miscellaneous	18	9%	0	0%	0	0%	1	1%	19	3%
HID										
Mercury Vapor	1	0%	7	2%	3	3%	12	21%	22	3%
Metal Halide	N.A.		34	9%	25	23%	4	7%	62	8%
HP Sodium	0	0%	6	1%	5	5%	30	54%	41	5%
LP Sodium	N.A.		0	0%	0	0%	3	5%	3	0%
Total	202	100%	391	100%	108	100%	56	100%	756	100%

Note(s): 1) Lumen-hour is a measure of lighting output; Watt-hour is a measure of electrical input for lighting. A value of zero indicates less than 0.5 billion kWh/year. 2) Includes stationary aviation, billboard, and traffic and street lighting.

Source(s): BTS/Navigant Consulting, U.S. Lighting Market Characterization Phase I National Lighting Inventory and Energy Consumption Estimate, July 2002.

5.9.2 2000 Total Lighting Technology Light Output, by Sector (10^12 lumen-hour/year)(1)

	Residential		Commercial		Industrial		Other (2)		Total	
Incandescent										
Standard	2,504	66%	1,384	6%	22	0%	87	2%	3,997	10%
Halogen	102	3%	358	2%	8	0%	23	0%	491	1%
Fluorescent										
T5	N.A.		13	0%	0	0%	N.A.		13	0%
T8	N.A.		4,208	20%	1,925	24%	1	0%	6,134	16%
T12	N.A.		11,752	54%	3,781	47%	2	0%	15,535	41%
Compact	57	1%	735	3%	35	0%	N.A.		827	2%
Miscellaneous	1,103	29%	24	0%	3	0%	39	1%	1,169	3%
HID										
Mercury Vapor	23	1%	261	1%	149	2%	532	11%	965	3%
Metal Halide	N.A.		2,202	10%	1,605	20%	249	5%	4,055	11%
HP Sodium	8	0%	587	3%	562	7%	3,381	72%	4,539	12%
LP Sodium	N.A.		18	0%	4	0%	408	9%	430	1%
Total	3,797	100%	21,575	100%	8,100	100%	4,723	100%	38,194	100%

Note(s): 1) Lumen-hour is a measure of lighting output; Watt-hour is a measure of electrical input for lighting. A value of zero indicates less than 0.5 billion kWh/year. 2) Includes stationary aviation, billboard, and traffic and street lighting.

Source(s): BTS/Navigant Consulting, U.S. Lighting Market Characterization Phase I National Lighting Inventory and Energy Consumption Estimate, July 2002

5.9.3 2000 Lamp Wattage, Number of Lamps, and Hours of Usage (weighted average)

	Lamp Wattage (Watts per lamp)				Number of Lamps per Building			Hours of Usage per Day			
	Res	Com	Ind	Other (1)	Res	Com	Ind	Res	Com	Ind	Other
Incandescent											
Standard	66	88	115	115	37	70	12	2	9	14	8
Halogen	202	102	447	167	(2) 0	12	1	2	10	14	8
Fluorescent											
T5	N.A.	8	10	N.A.	N.A.	8	10	N.A.	13	18	N.A.
T8	N.A.	32	30	105	N.A.	32	30	N.A.	10	13	7
T12	N.A.	51	66	190	N.A.	51	66	N.A.	10	13	7
CFL	17	19	27	N.A.	17	19	27	2	11	14	N.A.
Miscellaneous	41	18	34	83	41	18	34	2	10	11	11
HID											
Mercury Vapor	179	331	409	239	0	1	8	3	10	12	11
Metal halide	N.A.	472	438	23	N.A.	4	47	N.A.	10	14	10
HP Sodium	79	260	394	216	0	1	12	3	10	13	11
LP Sodium	N.A.	104	90	180	N.A.	0	0	N.A.	10	12	12

Note(s): 1) Other includes stationary aviation, billboard, and traffic and street lighting. 2) A value of zero indicates less than 0.5.
Source(s): BTS/Navigant Consulting, U.S. Lighting Market Characterization Phase I National Lighting Inventory and Energy Consumption Estimate, July 2002.

5.9.4 1995 Lighting Energy Intensities, by Commercial Building Type

Building Types	Percent of Total Lighted Floorspace	Percent of Total Annual Lighting Energy	Annual Lighting End-Use Intensity per Total Lighted Floorspace (kWh/ft2)
Education	13.6%	10.1%	4.6
Food Sales	1.1%	1.8%	9.9
Food Service	2.4%	4.2%	10.8
Health Care	4.1%	7.7%	11.5
Lodging	6.4%	7.0%	6.8
Mercantile and Service	22.4%	24.8%	6.9
Office	18.6%	24.5%	8.2
Public Assembly	7.0%	7.2%	6.4
Public Order and Safety	2.3%	1.7%	4.8
Warehouse and Storage	14.0%	6.9%	2.9
Other	1.8%	2.2%	7.8
Vacant	6.2%	1.9%	1.3
	100%	100%	

Note(s): Total lighted floorspace in 1995 was 56.3 billion square feet.
Source(s): EIA, A Look at Commercial Buildings in 1995: Characteristics, Energy Consumption, and Energy Expenditures, Oct. 1998, Table BC-40, p. 187, Table EU-1, p. 306-310, and Table EU-2, p. 311-315.

5.9.5 1995 Lighted Floorspace for the Stock of Commercial Buildings, by Type of Lamp

Type of Lamp	Lighted Floorspace (million square feet) (1)	Percent of Lighted Floorspace
Standard Fluorescent (2)	54,183	96.0%
Compact Fluorescent	14,382	25.5%
Incandescent	35,883	63.6%
High-Intensity-Discharge	16,370	29.0%
Halogen	9,747	17.3%

Note(s): 1) The percentages of lighted floorspace total more than 100% since most floorspace is lighted by more than one type of lamp. The total lit floorspace in 1995 was 56.5 billion square feet. 2) In 1995, 48% of the existing commercial building stock lighted by fluorescent lamps used corrected power factor-type ballasts or electronic ballasts.
Source(s): EIA, Commercial Buildings Characteristics 1995, Oct. 1997, Table 40.

5.9.6 Value of Shipments of Electric Lighting Fixtures ($million)

Lighting Fixture Type	1985	1990	1999	2000
Residential	786.8	827.6	1,160.8	1,215.9
Commercial/Institutional (except spotlight)	1,832.3	2,379.7	3,457.5	3,487.1
Industrial	389.2	529.4	640.2	758.8
Vehicular (1)	1,001.2	1,620.7	N.A.	N.A.
Outdoor	905.5	1,061.5	1,905.4	1,929.0

Note(s): 1) Data for vehicular lighting fixtures was discontinued in 1992.
Source(s): DOC, Electric Lighting Fixtures MA 36L (00)-1 September 2001 for 2000; DOC, Current Industrial Reports: Electric Lighting Fixtures, MA335L(99)-1, December 2000, Table 1 for 1990-1999; and DOC, Current Industrial Reports: Electric Lighting Fixtures, MA36L, Oct. 1995, Table 1 for 1985.

5.9.7 1994 Shipments of Electric Lamps

		Shipments (Quantities in millions of lamps; Values in millions of dollars)					
		Total		Domestic		Export	
Type of Lamp	Companies	Quantity	Value	Quantity	Value	Quantity	Value
Incandescent (1)	14	1836.6	1090.6	1741.6	1016.6	95.0	74.0
Fluorescent	8	585.4	1002.3	517.3	902.6	68.2	99.7
Compact Fluorescent	4	35.8	134.8	26.1	107.4	9.7	27.4
High-Intensity-Discharge	9	28.8	330.3	25.0	288.8	3.8	41.5
Buildings Subtotal	N.A.	2486.7	2558.1	2309.9	2315.5	176.7	242.6
Other (non-Building)	N.A.	1076.6	488.0	990.7	432.4	85.9	55.6
Total	36	3563.3	3046.1	3300.7	2747.8	262.6	298.2

Note(s): 1) Incandescent data does not include photographic, Christmas tree, or miniature lamps (e.g., automotive, radio, and flashlight lamps).
Source(s): DOC, Current Industrial Reports: Electric Lamps - Summary for 1994, MQ36B, 1996, Table 2.

5.9.8 Shipments of Fluorescent Lamp Ballasts

	Standard Magnetic Type (1)		Electronic Type		Total		
Year	Quantity (million)	Value ($million)	Quantity (million)	Value ($million)	Quantity (million)	Value ($million)	Electronic Type as a % of Total Units Shipped
1985	70.1	398.9	N.A	N.A.	70.1	398.9	N.A.
1986	69.4	396.1	0.4	11.8	69.8	407.9	1%
1988	74.6	450.9	1.1	25.5	75.7	476.4	1%
1990	78.4	546.3	3.0	69.3	81.4	615.6	4%
1992	83.7	537.7	13.3	274.6	97.0	812.3	14%
1994	83.5	550.0	24.6	390.8	108.1	940.7	23%
1996	67.0	457.8	30.3	451.4	97.3	909.2	31%
1998	63.9	401.4	39.8	512.8	103.7	914.3	38%
2000	55.4	343.0	49.3	555.5	104.8	898.5	47%

Note(s): 1) Standard magnetic type includes uncorrected and corrected power-factor type ballasts.
Source(s): DOC Current Industrial Reports: Fluorescent Lamp Ballasts, MQ335C(00)-5, July 2001 for 2000; DOC, Current Industrial Reports: Fluorescent Lamp Ballasts, MQ36C(99)-5, July 2000, Table 1 for 1990-1999; and DOC, Current Industrial Reports: Fluorescent Lamp Ballasts, MQ36C(95), 1996, Table 1 for 1985-1989.

5.9.9 2000 U.S. Lumen-Hour Inventory, by Construction Activity

New Construction	1%
Replacement	27%
Retrofit	5%
Unchanged	67%
Total	100%

Source(s): BTS/A.D. Little, Energy Savings Potential of Solid State Lighting in General Lighting Applications, April 2001, Figure 2.2, p. 8.

5.9.10 Typical Efficacies and Lifetimes of Lamps (1)

Current Technology	Efficacy (lumens/watt)	Typical Rated Lifetime (hours)	CRI (2)
Incandescent	6-24	750-2,000	95+
Torchiere Halogen	2-14	2,000	95+
Tungsten-Halogen	18-33	2,000-4,000	95+
Mercury Vapor	25-50	24,000+	22-52
Fluorescent	50-100	7,500-24,000	49-92
Compact Fluorescent	50-80	10,000-20,000	82-86
Metal-Halide	50-115	6,000-20,000	65-92
High-Pressure Sodium	40-140	16,000-24,000	21-80
Low-Pressure Sodium	120-180	12,000-18,000	0-18

Note(s): 1) Theoretical maximum luminous efficacy of white light is 220 lumens/watt. 2) CRI = Color Rendition Index, which indicates a lamp's ability to show natural colors.

Source(s): Buildings Magazine, Apr. 1995, p. 66 for current technology; Home Energy, Jan./Feb. 1997, p. 13 for torchiere halogen efficacy; and DOE/EE, Advanced Lighting Guidelines: 1993, p. 7-4 for torchiere halogen lifetime and CRI.

5.10.1 Refrigeration System Shipments, by Type (including exports)

Appliance Type	1986 (1000)	1990 (1000)	2000 (1000)	2000 Value of Shipments ($million)
Refrigerator/Freezers (1)	6,261	7,317	9,462	5,268.9 (2)
Freezers (chest and upright)	1,236	1,328	2,007	N.A.
Refrigerated Display Cases	310	359	347	N.A.
Unit Coolers	139	178	207	158.8
Ice-Making Machines	203	171	385	555.7
Water Cooler	N.A.	253	348	249.2
Beverage Vending Machine	246	229	353	N.A.

Note(s): 1) Refrigerator/freezers include imports of units 6.5 cubic feet and over. 2) Does not include commercial products value.

Source(s): Appliance Magazine, 48th Annual Statistical Review, May 2001, p. 51-54 for refrigerator, freezer, refrigerated display cases, water cooler, and beverage vending machines shipments; AHAM, 2000 Major Home Appliance Industry Fact Book, Nov. 2000, Table 7, p. 10, and Table 8, p. 12 for refrigerator and freezer value of shipments; The Air Conditioning, Heating and Refrigeration News, November 11, 1995, p. 19 for 1986 and 1990 unit cooler and ice-making machine shipments; and DOC, Current Industrial Reports: Air-Conditioning and Refrigeration Equipment, MA333M(99)-1, Sept. 2000, Table 2 for 2000 unit cooler and ice-making machine data,

5.10.2 Other Major Appliance Shipments, by Type (including exports)

Appliance Type	1980 (1000)	1990 (1000)	2000 (1000)	2000 Value of Shipments ($million)
Room Air Conditioners	**3,203**	**3,799**	**6,496**	**1,144**
Ranges (total)	**4,069**	**5,873**	**8,202**	**2,959**
Electric Ranges	2,530	3,350	5,026	2,177
Gas Ranges	1,539	2,354	3,176	782
Microwave Ovens/Ranges	**3,608**	**7,693**	**12,644**	**N.A.**
Clothes Washers	**4,550**	**5,591**	**7,495**	**2,208**
Clothes Dryers (total)	**3,177**	**4,160**	**6,575**	**1,406**
Electric Dryers	2,494	3,190	5,095	N.A.
Gas Dryers	682	970	1,480	N.A.
Water Heaters (total)	**N.A.**	**N.A.**	**9,188**	**1,438**
Electric (1,2)	N.A.	N.A.	4,257	576
Gas and Oil (2)	N.A.	N.A.	4,907	844
Solar (3)	N.A.	N.A.	24	18
Office Equipment				
Personal Computers (4)	N.A.	N.A.	47,168	37,913
Host Computers (5)	N.A.	N.A.	2,913	22,366
Copiers	N.A.	N.A.	1,989	N.A.
Facsimile Machines	N.A.	N.A.	4,700	N.A.
Printers	N.A.	N.A.	27,945	N.A.

Note(s): 1) Heat pump water heaters sales were less than 2,000 units in 1994, down from its peak of 8,000 in 1985. 2) Includes residential and small commercial units. 3) Shipments and value of shipments of entire systems. 4) Includes workstations, laptops, and notebooks. 5) Includes super computers, mainframes, servers, and other host computers. Data is 1999 shipments and values.

Source(s): AHAM, 1990/1991 Major Home Appliance Industry Fact Book, Table 7, p. 10-11 for 1980 data except water heaters; AHAM, 2000 Major Home Appliance Industry Fact Book, 2000, Tables 7 and 8, for 1990 and 2000 data except water heaters; DOC, Current Industrial Reports: Major Household Appliances, MA335F(00)-1, Aug. 2000, for value of water heater shipments; EIA, 2000 Solar Thermal and Photovoltaic Collector Manufacturing Activities, July 2001, Table 17, p. 20 for solar water heater data; BTS/OBE, Market Disposition of High-Efficiency Water Heating Equipment, Nov. 1996, p. I-8 for HPWH note; DOC, Current Industrial Reports: Computers and Office and Accounting Machines, MA334R(00)-1, Sept. 2000, for computer data; and Appliance, 49th Annual Statistical Review, May 2002, p. 51-54 for 2000 office equipment shipments.

5.10.3 Minimum Efficiency Standards for Appliances and Equipment

Refrigerator-Freezers (Auto Defrost) (1)	Adjusted Volume (2) (Cu. Ft.)	Rated Maximum Electricity Use (kWh) 1990	1993	2001
Top freezer w/o through-the-door ice service and all-refrigerators—auto defrost	20.6	955	685	478
Side freezer w/o through-the-door ice service	25.1	1183	797	631
Bottom freezer w/o through-the-door ice service	25.1	1183	781	574
Top freezer w/ through-the-door ice service	18.2	1015	711	542
Side freezer w/ through-the-door ice service	28.5	1428	992	694

Freezers (1)	Adjusted Volume (2) (Cu. Ft.)	Rated Maximum Electricity Use (kWh) 1990	1993	2001
Upright Freezers w/ Manual Defrost	25.7	702	529	452
Upright Freezers w/ Automatic Defrost	30.0	1103	838	699
Chest Freezers and all other Freezers except Compact Freezers	24.8	590	433	389

Room Air-Conditioners (3)	Minimum EER 1990	2001	Typical Maximum Electricity Use (kWh) (4) 1990	2001
Less than 6,000 Btu/h	8.0	9.7	563	464
6,000 to 7,999 Btu/h	8.5	9.7	618	541
8,000 to 13,999 Btu/h	9.0	9.8	917	842
14,000 to 19,999 Btu/h	8.8	9.7	1449	1314
20,000 Btu/h or more	8.2	8.5	1829	1765

Clothes Dryers (3)	Minimum EF (lbs./kWh)	Typical Maximum Energy Use (5)
Electric, Standard	3.01	835
Gas	2.67	32

Clothes Washers (3)	Minimum EF (cu. Ft./kWh per cycle) 1994	Minimum Modified EF (cu. Ft./kWh per cycle) 2004	2007	Typical Maximum Electricity Use (kWh) (6)
Top Loading, Standard	1.18	1.04	1.26	1265
Front Loading	N.A.	1.04	1.26	731

Dishwashers (3)	Minimum EF (cycles/kWh)	Typical Maximum Electricity Use (kWh)
Standard Dishwasher	0.46	498

Water Heaters (7)	Minimum EF (8) 1990	1991	2004	Typical Maximum Energy Use (5) 1990	1991	2004
Gas-Fired	0.54	0.54	0.59	208	208	191
Oil-Fired	0.51	0.51	0.51	155	155	155
Electric Resistance	0.90	0.88	0.92	3456	3534	3380

Note(s): 1) DOE regulations mandate maximum electrical consumption for appliance based on its size. 2) AV = Adjusted Volume = Refrigerator Compartment + 1.63 * Freezer Compartment. 3) DOE regulations mandate minimum efficiency for appliance. 4) Electric use based on 750 hours of operation. 5) Electric use in kWh. Gas use in therms. Oil use in gallson. 6) Assumed electric water heating. 7) DOE regulations mandate minimum efficiency for appliance based on its size. 8) Based on 40 gallon tank.

Source(s): DOC/GPO, 2001 CFR, Title 10, Chapter 2, Part 430, Section 430.32, Jan. 1, 2001, p. 258-264 for minimum efficiencies; AHAM, 2000 Major Home Appliance Industry Factbook, Nov. 2000, Table 21, p. 28, for refrigerator and freezer sizes; DOE/EE, Final Rule TSD: Energy Efficiency Standards for Consumer Products: Clothes Washers, Dec. 2000, p. 10-8; LBNL, Energy Data Sourcebook for U.S. Residential Sector, May 1997, p. 102-103 for clothes dryers, p. 94 for dishwashers; DOE/EE, TSD: Energy Efficiency Standards for Consumer Products: Water Heaters, Apr. 2000, p. 9-14.

5.10.4 Refrigerator-Freezer Sizes and Energy Factors (shipment-weighted averages)

	Average Volume (cu. ft.)	Consumption/Unit (kWh/yr)	Best-Available (kWh/yr)
1972	18.2	1726	N.A.
1980	19.6	1278	N.A.
1985	19.5	1058	N.A.
1990	20.5	916	N.A.
1991	19.8	857	761
1992	19.8	821	N.A.
1993	20.1	660	631
1994	20.0	653	592
1995	20.0	649	555
1996	20.3	661	524
1997	20.4	669	524
1998	N.A.	N.A.	524
1999	20.6	690	559
2000	22.2	N.A.	523

Note(s): The average stock energy uses for refrigerator-freezers was 1220 kWh/yr in 1990 and 1319 kWh/yr in 1997.

Source(s): AHAM, 2000 Major Home Appliance Industry Fact Book, 2000, Table 25, p. 30 for volume and average consumption/unit; AHAM, 1991, 1003-1999 Directory of Certified Refrigerators and Freezers for 1993-1999 best-available data (at 19.6 or more cu.ft.); LBNL, Center for Building Science News, Summer 1995, p. 6 for 1990 portion of note; and EIA, A Look at Residential Energy Consumption in 1997, Nov. 1999, Table CE5-2c, p. 205 for 1997 portion of note.

5.10.5 Room Air Conditioner Capacities and Energy Efficiencies (shipment-weighted averages)

	Average Capacity (Btu/hr)	EER	Best-Available (EER)
1972	10,227	5.98	N.A.
1980	10,607	7.02	N.A.
1985	10,287	7.70	N.A.
1990	10,034	8.73	N.A.
1991	10,846	8.80	N.A.
1992	10,100	8.88	N.A.
1993	10,264	9.05	N.A.
1994	10,087	8.97	12.0
1995	10,099	9.03	12.0
1996	9,928	9.08	12.0
1997	10,015	9.09	12.0
1998	N.A.	N.A.	11.7
1999	9,596	8.99	11.7
2000	N.A.	N.A.	11.7

Source(s): AHAM, 1993 Major Home Appliance Industry Factbook, 1993, Table 24, p. 30 for 1972; AHAM, 2000 Major Appliance Industry Fact Book, Nov. 2000, Table 27, p. 32 for 1980-1999 average capacity and EER; and AHAM, 1994-1999 Directory of Certified Room Air Conditioners, Mar. 2000 for best available.

5.10.6 Water Heater Efficiencies

Residential Appliance Type	Efficiency Parameter (1)	2000 Stock Efficiency	Minimum New Efficiency (2)	2001 Best-Available New Efficiency
Electric Water Heaters	EF	0.88	0.88	0.95
Gas Water Heaters	EF	0.54	0.54	0.86
Oil Water Heaters	EF	0.53	0.51	0.68
Solar Water Heaters	SEF	N.A.	0.80	4.80

Commercial Appliance Type	Efficiency Parameter (1)	1992 Stock Efficiency	Minimum New Efficiency	1998 Best-Available New Efficiency
Electric Water Heaters	EF	0.75	None (3)	0.95
Gas Water Heaters	EF	0.65	0.78 (4)	0.86

Note(s): 1) EF = energy factor and SEF = solar energy factor, which is the hot water energy *delivered* by the solar system divided by the electric or gas energy input to the system. 2) Based on 40 gallon tank. 3) For tanks greater than 120 gallons or an input greater than 12 kW. 4) Thermal efficiency.

Source(s): EIA, Supplement to the AEO 2002, Dec. 2001, Table 21 for residential stock efficiencies; BTS/OBE, Characterization of Commercial Building Appliances, Aug.1993 for commercial efficiencies; BTS/OBE, Market Disposition of High-Efficiency Water Heating Equipment, Nov. 1996, Appendix A, p. A-1 for minimum efficiencies; GAMA, Consumer's Directory of Certified Efficiency Ratings for Residential Heating and Water Heating Equipment, Oct. 2000; BTS/A.D. Little, Energy Savings Potential of Solid State Lighting in General Lighting Applications, April 2001 for best-available efficiencies; and SRCC, Summary of SRCC Certified Solar Collector and Water Heating System Ratings, Apr. 2000, p. S-16 - S-20 for SEFs, Table 2.2, p.4.

5.10.7 Other Major Appliance Efficiencies

Residential Appliance Type	Efficiency Parameter (1)	1999 U.S. Average New Efficiency	2001 Best Available New Efficiency
Dishwashers	EF	0.51	1.50
Clothes Washers (2)	EF & MEF	1.47 EF	2.2 MEF

Commercial Appliance Type	Efficiency Parameter (1)	1999 U.S. Average New Efficiency	1992 Best Available New Efficiency
Cooking Equipment:			
Electric Appliances	EF	0.70	0.60 - 0.80
Gas Appliances	EF	0.51	0.30 - 0.65
Laundry Equipment:			
Electric Drying	EF/COP	0.98 (3)	3.30
Gas Drying	EF	0.36 (3)	0.55
Motors	EF	0.65 (3)	0.75
Office Equipment:			
Linear Power Supplies	EF	0.30 - 0.60 (3)	0.60
Switching Power Supplies	EF	0.80 - 0.95 (3)	0.95
Motors	EF	0.60 - 0.70 (3)	0.70

Note(s): 1) EF = Energy Factor. COP = Coefficient of Performance. 2) EF does not include remaining moisture content (RMC) of clothes. MEF includes RMC which shows how much the clothes dryer will be needed. 3) 1992.

Source(s): AHAM, 2000 Major Home Appliance Industry Fact Book, Nov. 2000, Tables 29, p. 34 and Table 30, p. 35 for residential efficiencies; DOE/EPA, Energy Star Appliances, www.energystar.gov, July 2001 for best-available dishwashers and clothes washers; EIA, Assumptions to the AEO 2002, Dec. 2001, Table 22 for average cooking efficiency; and BTS/OBE, Characterization of Commercial Building Appliances, Aug. 1993 for commercial efficiencies.

5.10.8 2000 Room Air Conditioner Manufacturer Market Shares (by percentage of products produced)

Company	Market Share (%)
Fedders	22%
Electrolux (Frigidaire)	17%
Whirlpool	12%
LG Electronics/Goldstar	20%
Goodman/Amana	6%
Haier	6%
Matsushita	3%
Others	14%
	100%

Total Units Shipped: 6,496,400

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sept. 2001, p. 51.

5.10.9 2000 Refrigerator Manufacturer Market Shares (by percentage of products produced)

Company	Market Share (%)
GE	34%
Whirlpool	24%
Electrolux (Frigidaire)	21%
Maytag (Admiral)	14%
Goodman (Amana)	5%
Others	2%
	100%

Total Units Shipped: 9,216,600

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sept. 2001, p. 51.

5.10.10 2000 Range Manufacturer Market Shares (by percentage of products produced)

Company	Electric Market Share (%)	Gas Market Share (%)
GE	43%	32%
Whirlpool	22%	8%
Maytag	19%	27%
Electrolux (Frigidaire)	13%	21%
Peerless Premier	2%	4%
Goodman (Caloric)	1%	6%
Others		2%
	100%	100%

Total Electric Units Shipped: 5,026,000

Total Gas Units Shipped: 3,176,000

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sept. 2001, p. 51.

5.10.11 2000 Microwave Oven Manufacturer Market Shares (by percentage of products produced)

Company	Market Share (%)
Sharp	29%
Samsung	25%
LG Electronics/Goldstar	10%
Whirlpool	9%
Sanyo	8%
Matsushita	8%
Daewoo	5%
Others	6%
	100%

Total Units Shipped: 12,640,000

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sept. 2001, p. 51.

5.10.12 2000 Clothes Washer Manufacturer Market Shares (by percentage of products produced)

Company	Market Share (%)
Whirlpool	50%
Maytag	22%
GE	16%
Electrolux (Frigidaire)	10%
Goodman (Speed Queen)	2%
	100%

Total Units Shipped: 7,495,000

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sept. 2001, p. 51.

5.10.13 Sales of ENERGY STAR Labeled Appliances and Market Shares, by Year

	Room Air Conditioners			Refrigerators			Clothes Washer			Dishwashers		
	Energy Star			Energy Star			Energy Star			Energy Star		
	Sales	Market Share	Total Sales	Sales	Market Share	Total Sales	Sales	Market Share	Total Sales	Sales	Market Share	Total Sales
1997	474	12%	3,836	2,008	25%	7,924	226	4%	6,326	267	6%	4,653
1998	589	13%	4,528	1,705	19%	8,774	392	6%	6,835	961	19%	4,969
1999	835	13%	6,294	2,218	24%	9,099	624	9%	7,313	685	12%	5,542
2000	1,220	19%	6,450	2,533	27%	9,382	690	9%	7,420	611	11%	5,634
2001	600	12%	5,210	1,644	17%	9,500	768	10%	7,461	1,139	20%	5,728

Note(s): 1) Sales are in thousands of units.

Source(s): D&R International, 2002.

5.10.14 2000 Clothes Dryer Manufacturer Market Shares (by percentage of products produced)

Company	Electric Market Share (%)	Gas Market Share (%)
Whirlpool	54%	56%
Maytag	19%	21%
GE	16%	13%
Electrolux (Frigidaire)	8%	10%
Goodman (Speed Queen)	3%	0%
	100%	100%

Total Electric Units Shipped: 5,095,000

Total Gas Units Shipped: 1,480,000

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sept. 2001, p. 51.

5.10.15 2000 Water Heater Manufacturer Market Shares (by percentage of products produced)

Company	Market Share (%)
Rheem Manufacturing	40%
State Industries	19%
American Water Heater	14%
Bradford-White	14%
A.O. Smith	13%
	100%

Total Units Shipped: 9,164,440

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sept. 2001, p. 51.

5.10.16 2000 Facsimile and Copier Machine Manufacturer Market Shares (by percentage of products produced)

Company	Facsimile Machine Market Share (%)	Copier Market Share (%)
Hewlett-Packard	25%	-
Cannon	20%	33%
Brother	20%	-
Sharp	19%	10%
Panasonic	12%	-
Xerox	4%	26%
Mita	-	5%
Ricoh	-	5%
Others	-	21%
	100%	100%

Total Facsimile Machine Units Shipped:	3,495,000
Total Copier Units Shipped:	1,934,154

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sept. 2001, p. 51.

5.10.17 2000 Personal Computer Manufacturer Market Shares (by percentage of products produced)

Company	Desktop Computer Market Share (%)	Portable Computer Market Share (%)
Dell	20%	20%
Compaq	16%	15%
Hewlett-Packard	13%	6%
Gateway	10%	4%
IBM	4%	12%
Apple	4%	4%
eMachines	4%	-
Toshiba	-	12%
Sony	-	6%
Others	29%	21%
	100%	100%

Total Desktop Computer Units Shipped:	37,357,904
Total Portable Computer Units Shipped:	9,513,484

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sept. 2001, p. 51.

5.10.18 2000 Printer Manufacturer Market Shares (by percentage of products produced)

Company	Ink Jet Printer Market Share (%)	Laser Printer Market Share (%)	Dot Matrix Market Share (%)
Hewlett-Packard	44%	72%	-
Canon	16%	-	-
Lexmark	15%	-	10%
Epson	11%	-	29%
Apple	-	11%	-
Brother	-	6%	-
NEC	-	5%	-
Okidata	-	-	42%
Panasonic	-	-	9%
Others	13%	6%	10%
	100%	100%	100%

Total Ink Jet Units Shipped:	19,496,224
Total Laser Units Shipped:	1,786,119
Total Dot Matrix Units Shipped:	699,700

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sept. 2001, p. 51.

5.10.19 Major Residential and Small Commercial Appliance Lifetimes, Ages, and Replacement Picture

Appliance Type	Typical Service Lifetime Range (years)	Average Lifetime (years)	1997 Average Stock Age (years)	Units to be Replaced During 2001
Refrigerators (1)	10 - 20	15	8	6,080,500
Freezers	12 - 20	16	12	1,472,800
Room Air Conditioners	10 - 15	12	9	5,191,000
Microwave Ovens	8 - 15	11	N.A.	9,422,830
Ranges (2)				
Electric	12 - 18	15	N.A.	3,830,500
Gas	18 - 25	21	N.A.	1,538,200
Clothes Washers	8 - 16	12	N.A.	6,251,500
Clothes Dryers (electric and gas)	11 - 18	14	N.A.	4,428,000
Water Heaters				
Electric	7 - 15	11	9	3,226,321
Gas	7 - 10	9	9	4,241,300
Facsimile Machines	2 - 6	4	N.A.	5,529,000
Personal Computers (3)	2 - 5	4	N.A.	28,134,269
Portable Computers	3 - 5	4	N.A.	5,400,000

Note(s): 1) Excluding compact refrigerators. 2) Ranges include free-standing, built-in, high-oven and cooktop/oven combination units. 3) 2000.

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sep. 2001, p. 51 for service and average lifetimes and units to be replaced; Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sep. 1999, p. 80 for personal computers; EIA, A Look at Residential Energy Consumption in 1997, Nov. 1999, for 1997 average stock lifetimes, Table HC4-4a for room air-conditioners, and Table HC5-2a, for freezers, refrigerators, and water heaters.

5.10.20 Major Appliance Ownership (number of households in millions and percent of U.S. households)

	1982		1990		1996	
Appliance Type	Hholds	Percent	Hholds	Percent	Hholds	Percent
Room Air Conditioners	22.6	27%	30.2	32%	30.4	31%
Refrigerators	83.4	100%	91.2	98%	96.8	98%
Freezers	35.7	43%	42.4	45%	41.9	42%
Electric Ranges/Cooktops	48.4	58%	58.4	63%	65.3	66%
Gas Ranges/Cooktops	35.7	43%	36.1	39%	38.3	39%
Microwave Ovens	21.4	26%	77.2	83%	89.5	91%
Clothes Washers	61.5	74%	86.4	93%	94.3	95%
Electric Clothes Dryers	42.3	51%	56.1	60%	60.4	61%
Gas Clothes Dryers	12.3	15%	19.1	21%	21.1	21%
Personal Computers	N.A.	N.A.	N.A.	N.A.	43.5	44%
Total U.S. Households	83.6		94.0		98.9	

Source(s): AHAM, 2000 Major Home Appliance Industry Fact Book, Nov. 2000, Table 13, p. 21; Consumer Electronic Manufacturers Association's Home Page, 1999 for 1997 personal computers; EIA, AEO 1995, Jan. 1995, Table B4, p. 104 for 1990 total households.

6.1.1 Key Definitions

Quad: Quadrillion Btu (10^15 or 1,000,000,000,000,000 Btu)

Generic Quad for the Buildings Sector: One quad of primary energy consumed in the buildings sector (includes the residential and commercial sectors), apportioned between the various primary fuels used in the sector according to their relative consumption in a given year. To obtain this value, electricity is converted into its primary energy forms according to relative fuel contributions (or shares) used to produce electricity in the given year.

Electric Quad (Generic Quad for the Electric Utility Sector): One quad of primary energy consumed at electric utility power plants to supply electricity to end-users, shared among various fuels according to their relative contribution in a given year. (Note: The consumption of an electric quad results in the delivery of just under 1/3 the electric quad due to generation and transmission losses.)

Primary Energy: The total energy consumed by an end-user, including the energy used in the generation and transmission of electricity. Also referred to as "source" energy.

Delivered **Energy:** The energy consumed by an end-user on *site* , not including electricity generation and transmission losses.

6.1.2 Consumption Comparisons

One quad equals:

- 48 million short tons of coal
  - = enough coal to fill a train of railroad cars 4,450 miles long (about one and a half times across the U.S.)
- the coal input to 31 coal plants (600-MW each) in one year
- 974 billion cubic feet natural gas
- 8 billion gallons of gasoline = 22 days of U.S. gasoline use
  - = 17.3 million new passenger cars and light-duty trucks each driven 11,700 miles
  - = all new passenger cars and light-duty trucks sold each driven 11,700 miles
  - = 15.1 million stock passenger cars each driven 11,700 miles = 12% of all passenger cars each driven 11,700 miles
  - = all new passenger cars each making 5 round trips from New York to Los Angeles
  - = 7.1 million stock passenger cars driven once around the Equator
- 168 million barrels of crude oil = 17 days of U.S. imports = 165 days of oil flow in the Alaska pipeline at full capacity
  - = the amount of crude oil transported by 498 double-hulled supertankers
- 23 hours of world energy use
- average annual output *delivered* from 40 1,000-MW nuclear power plants
- average annual per capita consumption of 2.8 million people in the U.S.
- the approximate annual primary consumption of any one of the following states: Arizona, Arkansas, Colorado, Iowa, Kansas, Mississippi, or Oregon (1999)

Source(s): EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128, Table A7, p. 136, Table A8, p. 137, Table A11, p. 141 for consumption, Table H1, p. 251 for heat rates; EIA, State Energy Data Report 1999, May 2001, Table 9-10, p. 17-18; EIA, Inventory of Electric Utility Power Plants in the U.S. 1999, Nov. 1999, Table 1, p. 9; EIA, Inventory of Nonutility Electric Power Plants in the U.S. 1999, Nov. 2000, Table 1, p. 7; EIA, International Energy Outlook 2002, March 2002, Table A1, p. 179; DOC, Statistical Abstract of the United States 2001, May 2002, No. 1027, p. 649, No. 1031, p. 629, and No. 1050, p. 641; and Newport News Shipbuilding Website.

6.1.3 Carbon Emission Comparisons

One million metric ton of carbon equivalent equals:

- the combustion of 1.85 million short tons of coal
- the coal input to 1 coal plant (600-MW) in one year
- the combustion of 67 billion cubic feet natural gas
- the combustion of 427 million gallons of gasoline = the combustion of gasoline for 28 hours in the U.S.
  - = 1.0 million new cars each driven 11,700 miles
  - = 770 thousand new light trucks each driven 11,700 miles
  - = 0.5 million new passenger cars each making 5 round trips of New York to Los Angeles
  - = 0.5 million stock passenger cars driven once around the Equator
- the combustion of 9 million barrels of crude oil
- 86 minutes of world energy emissions
- 6 hours of U.S energy emissions
- 15 hours of U.S. Buildings energy emissions
- 29 hours of U.S. Residential energy emissions
- 34 hours of U.S. Commercial energy emissions
- 5 days of U.S. Buildings lighting energy emissions
- average annual per capita emissions of 175 thousand people in the U.S.
- the approximate emissions from cities approximately the size of any one of the following cities: Arlington, VA, Columbus, GA, Fort Wayne, IN, Grand Rapids, MI, Huntsville, AL, Irving, TX, Jackson, MS, Little Rock, AR, Newport News, VA, Orlando, FL, Salt Lake City, UT, San Bernardino, CA, Tacoma, WA

Source(s): EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128, Table A7, p. 136 for consumption, Table A19, p. 149 for emissions, and Table H1, p. 251 for heat rates; EIA, Inventory of Electric Utility Power Plants in the U.S. 1999, Sept. 2000, Table 1, p. 9; EIA, Inventory of Nonutility Electric Power Plants in the U.S. 1999, Nov. 2000, Table 1, p. 7; EIA, International Energy Outlook 2002, March 2002, Table A10, p. 189; EIA, Emissions of Greenhouse Gases in the U.S. 2000, Nov. 2001, Table B1; and DOC, Statistical Abstract of the United States 2001, Dec. 2000, No. 2, p. 7, No. 39, p. 39-42 for populations, and No. 1050, p. 641.

6.1.4 Average Annual Carbon Dioxide Emission for Various Functions

	Annual Unit Energy Consumption		Carbon Emissions (lb CO2)
Stock Refrigerator	1148	kWh - Electricity	1,600
Stock Electric Water Heater	2879	kWh - Electricity	4,000
Stock Gas Water Heater	24.5	million Btu - Natural Gas	2,900
Stock Oil Water Heater	31.4	million Btu - Fuel Oil	5,000
Single-Family Home	114.7	million Btu	25,600
Mobile Home	79.5	million Btu	17,700
Multi-Family Unit in Large Building	48.6	million Btu	10,800
Multi-Family Unit in Small Building	91.5	million Btu	20,400
School Building	1986	million Btu	516,100
Office Building	1445	million Btu	375,500
Passenger Car	444	gallons - Gasoline	8,600
Standard Pickup Truck	635	gallons - Gasoline	12,300
SUV- Small	513	gallons - Gasoline	9,900
SUV - Medium	660	gallons - Gasoline	12,700
SUV- Large	866	gallons - Gasoline	16,700
CAFE Car	842	gallons - Gasoline	16,300
CAFE Light Truck	921	gallons - Gasoline	17,800

Source(s): EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128 and Table A19, p. 149 for electricity emissions, and Table H1, p. 251 for gasoline heat rate; EIA, A Look at Residential Energy Consumption in 1997, Nov. 1999, Table CE4-2C, p. 181 for water heater energy consumption, Table HC5-2A, p. 74 for refrigerators and Table CE5-2C, p. 205 for refrigerator energy, and Table CE1-4c, p. 116 for household consumption; EIA, A Look at Commercial Buildings in 1995, Oct. 1998, Table CE-3, p. 214 for commercial buildings; ORNL, An Analysis of the Impact of Sport Utility Vehicles in the U.S., Aug. 2000, Figure 10, p. 12 for mpg and Table 2, p. 13 for mileage; ORNL, Transportation Energy Data Book: Edition 20, 2000, Table 10.4, p. 10-4 and Figure 10.1, p/ 10-2 for mileage and Table 7.16, p. 7-18 for efficiencies; and EIA, Assumptions to the Annual Energy Outlook 2002, Dec. 2001, Table 2, p.9 for carbon emissions.

6.2.1 1999 Utility Impacts of Saving an Electric Quad (1)

Plant fuel type	Utility Fuel Input Shares (%)	Average-sized Utility Unit (MW) in 1999	Aggregate Number of Units to Provide the Fuel's Share of the Electric Quad (2)
Natural Gas	11.8%	55	95
Petroleum	2.6%	20	80
Coal	53.9%	245	38
Nuclear	22.0%	1013	3
Renewable (3)	9.7%	25	109
Total	100%		324

Note(s): 1) This table displays the breakdown of electric power plants that could be eliminated by saving an electric quad, in exact proportion to the actual primary fuel shares for electricity produced nationwide in 1999. Use this table to estimate the avoided capacity implied by saving one electric quad. 2) Based on the fact that typical U.S. power plants operate less than fully loaded throughout the year. 3) Includes pumped storage.

Source(s): EIA, Inventory of Electric Utility Power Plants in the United States 1999, Sept. 2000, Table 1, p. 9; EIA, Inventory of Nonutility Electric Utility Power Plants in the United States 1999, Nov. 2000, Table 1, p. 7; and EIA, Annual Energy Outlook 2002, Dec. 2001, Table A2, p. 126-128 for consumption and Table A8, p. 137 for electricity supply.

6.2.2 Cost of an Electric Quad Used in the Buildings Sector ($2000 billion)

	2000	2005	2010	2020
Residential	7.71	7.21	7.47	7.83
Commercial	7.00	6.57	6.62	7.06
Buildings Sector	7.37	6.90	7.04	7.43

Note(s): This table provides the consumer cost of an electric quad. Use this table to estimate the savings to consumers when a primary quad is saved in the form of *delivered* electricity.

Source(s): EIA, Annual Energy Outlook 2002, Dec. 2001, Table A2, p. 126-128 and Table A3, p. 129-130.

6.2.3 Characteristics of New and Stock Generating Capacities, by Plant Type

New Plant Type	Installed Capital Costs (1999 thousand dollars per MW)	2000 Net Generation Heat Rate (Btu/kWh)	2010 Net Generation Heat Rate (Btu/kWh)	2000 Installed Capital Costs of a 500-MW Power Plant ($2000 million)
Pulverized Coal	1,119	9,386	9,087	560
Advanced Coal	1,338	7,869	6,968	669
Combined Cycle	456	7,618	7,000	228
Advanced Combined-Cycle	590	6,870	6,350	295
Combustion Turbine	339	11,380	10,600	170
Advanced Combustion Turbine	474	9,020	8,000	237
Fuel Cell	2,091	5,744	5,361	1,046

Stock Plant Type	2000	2005	2010	2020
Fossil Fuel Steam Heat Rate (Btu/kWh)	10,257	10,004	9,561	9,146
Nuclear Energy Heat Rate (Btu/kWh)	10,678	10,678	10,678	10,678

Note(s): This table provides comparisons of electric generating plants. Plant use of electricity is included; however, transmission and distribution losses of the electric grid are excluded.

Source(s): EIA, Assumptions for AEO 2002, Dec. 2001, Table 38, p. 68; and EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128, and Table A8, p. 137.

6.2.4 Electric Conversion Factors and Transmission and Distribution (T&D) Losses

	2000	2005	2010	2020
Average Utility Delivery Efficiency (1, 2)	31.7%	32.2%	33.3%	34.7%
Average Utility Delivery Ratio (Btu/kWh) (2, 3)	10,775	10,590	10,237	9,828

Transmission and Distribution (T&D) Losses as a:

Percent of Electric Generator Fuel Input	3.1%
Percent of Net Electricity Generated (4)	9.5%

Note(s): 1) Use these values to convert primary energy of electric generator fuel input to*delivered* energy. 2) Accounts for fuel conversion losses, plant use of electricity, and T&D losses. 3) Use these values to convert*delivered* electric energy to primary energy. 4) After fuel conversion losses and plant use of electricity.

Source(s): EIA, Annual Energy Outlook 2002, Dec. 2001, Table A2, p. 126-128 for generator consumption and Table A8, p. 137 for electricity sales; and EIA, Annual Energy Review 2000, August 2001, Diagram 5, p. 217.

6.3.1 Cost of a Generic Quad Used in the Buildings Sector ($2000 billion) (1)

	2000	2005	2010	2020
Residential	7.92	7.25	7.40	7.72
Commercial	6.82	6.32	6.36	6.78
Buildings Sector	7.38	6.81	6.89	7.24

Note(s): 1) See table 6.1.1 for generic quad definition. This table provides the consumer cost of a generic quad in the buildings sector. Use this table to estimate the average consumer cost savings resulting from the savings of a generic (primary) quad in the buildings sector.
Source(s): EIA, Annual Energy Outlook 2002, Dec. 2001, Table A2, p. 126-128 and Table A18, p. 148 for energy consumption, Table A3, p. 129-130 for energy prices.

6.3.2 Shares of U.S. Buildings Generic Quad (percent) (1)

					Renewables				Net	
		Natural Gas	Petroleum	Coal	Hydro.	Other	Total	Nuclear	Electric Imports	Total
2000	**(2)**	**31%**	**7%**	**37%**	**5%**	**3%**	**8%**	**15%**	**1%**	**100%**
2005		33%	6%	38%	5%	3%	9%	14%	1%	100%
2010		35%	5%	38%	5%	4%	9%	13%	1%	100%
2020		38%	4%	37%	5%	4%	9%	11%	1%	100%

Note(s): 1) See Table 6.1.1 for generic quad definition. 2) The total 2000 Buildings sector primary energy consumption was 36.34 quads. Excludes buildings-related energy consumption in the industrial sector.
Source(s): EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128 for energy consumption and Table A18, p. 148 for non-marketed renewable energy consumption.

6.3.3 Shares of U.S. Residential Buildings Generic Quad (percent) (1)

					Renewables				Net	
		Natural Gas	Petroleum	Coal	Hydro.	Other	Total	Nuclear	Electric Imports	Total
2000	**(2)**	**33%**	**9%**	**35%**	**5%**	**4%**	**9%**	**14%**	**1%**	**100%**
2005		35%	7%	35%	5%	4%	9%	13%	1%	100%
2010		36%	6%	36%	5%	4%	9%	12%	1%	100%
2020		40%	5%	35%	4%	5%	9%	11%	1%	100%

Note(s): 1) See Table 6.1.1 for generic quad definition. 2) The total 2000 Residential buildings sector primary energy consumption was 19.85 quads.
Source(s): EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128 for energy consumption and Table A18, p. 148 for non-marketed renewable energy consumption.

6.3.4 Shares of U.S. Commercial Buildings Generic Quad (percent) (1)

					Renewables				Net	
		Natural Gas	Petroleum	Coal	Hydro.	Other	Total	Nuclear	Electric Imports	Total
2000	**(2)**	**29%**	**6%**	**40%**	**6%**	**2%**	**8%**	**16%**	**1%**	**100%**
2005		31%	4%	40%	6%	3%	8%	15%	1%	100%
2010		33%	4%	41%	6%	3%	8%	14%	1%	100%
2020		37%	4%	39%	5%	3%	8%	12%	1%	100%

Note(s): 1) See Table 6.1.1 for generic quad definition. 2) The total 2000 Commercial buildings sector primary energy consumption was 16.49 quads. Excludes buildings-related energy consumption in the industrial sector.
Source(s): EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128 for energy consumption and Table A18, p. 148 for non-marketed renewable energy consumption.

6.4.1 Electric Quad Average Carbon Emissions with Average Stock Utility Fuel Mix and Projected New Marginal Capacity Fuel Mix (million metric tons) (1)

	Stock	Projected New Marginal Capacity		
	2000	2005	2010	2020
Petroleum	0.54	0.00	0.00	0.00
Natural Gas	1.67	5.20	5.91	7.17
Coal	13.81	11.88	11.89	10.26
Nuclear	0.00	0.00	0.00	0.00
Renewable Energy (2)	0.00	0.00	0.00	0.00
Total	16.03	17.08	17.80	17.43

Note(s): 1) This table provides estimates of the carbon emissions resulting from consumption of a primary quad at electric utilities. Projected (2005-2020) new marginal capacity emissions will result from natural gas- and coal-fired power plants and renewable energy technologies. Limited nuclear energy will be used to meet near-term demand growth. Electricity imports from utility consumption were ignored since this energy was produced outside of the U.S. "Average" means the weighted average of different fuels (e.g., petroleum is the average of residual and distillate fuel oils). The combustion of fossil fuels produces carbon in the form of carbon dioxide and carbon monoxide; however, carbon monoxide emissions oxidize in a relatively short time to form carbon dioxide. 2) Emissions exclude wood since it is assumed that the carbon released from combustion is reabsorbed in a future carbon cycle.

Source(s): EIA, Annual Energy Outlook 2002, Dec. 2001, Table A2, p. 126-128 and Table A19, p. 149.

6.4.2 Average Carbon Emissions from a Generic Quad in the Buildings Sector with Stock Fuel Mix and Projected Fuel Mix of New Marginal Utility Capacity and *Site* Energy Consumption (million metric tons) (1)

	Stock			Projected Fuel Mix of New Marginal Utility Capacity and *Site* Consumption								
	2000			2005			2010			2020		
	Resid.	Comm.	Bldgs.	Resid.	Comm.	Bldgs.	Resid.	Comm.	Bldgs.	Resid.	Comm.	Bldgs.
Electricity (2)	10.32	11.93	11.05	13.06	12.78	12.96	14.26	13.58	13.95	13.91	13.56	13.77
Petroleum	1.32	0.78	1.08	0.00	0.19	0.04	0.00	0.20	0.00	0.00	0.16	0.00
Natural Gas	3.74	2.96	3.39	2.65	2.73	2.70	2.82	2.49	2.64	2.92	2.55	2.71
Renew. En. (3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coal	0.06	0.11	0.08	0.03	0.00	0.01	0.08	0.02	0.04	0.00	0.04	0.03
Total	15.44	15.78	15.60	15.75	15.69	15.71	17.16	16.29	16.63	16.83	16.31	16.52

Note(s): 1) This table provides estimates of the carbon emissions resulting from consumption of a generic quad in the buildings sector, at current and projected fuel shares. Projected increases in *site* energy will be met primarily met by electricity, natural gas, renewable energy, and coal. Projected new marginal emissions will result from natural gas- and coal-fired power plants. Electricity imports from utility consumption were ignored since this energy was produced outside of the U.S. "Average" means the weighted average of different fuels (e.g., petroleum is the average of residual and distillate fuel oils, LPG, kerosene, and motor gasoline). The combustion of fossil fuels produces carbon in the form of carbon dioxide and carbon monoxide; however, carbon monoxide emissions oxidize in a relatively short time to form carbon dioxide. 2) Includes renewables. 3) Emissions exclude wood since it is assumed that the carbon released from combustion is reabsorbed in a future carbon cycle.

Source(s): EIA, Annual Energy Outlook 2002, Dec. 2001, Table A2, p. 126-128 and Table A18, p. 148 for energy consumption and Table A19, p. 149 for carbon emissions; and EIA, Assumptions to the AEO 2002, Dec. 2001, Table 2, p. 8.

7.1.1 Weatherization Population Facts

- Roughly 25% of Federally eligible households move in and out of poverty "classification" each year.
- The average income of Federally eligible households in FY 2000 was $14,270, based on RECS and Bureau of the Census' Current Population Survey (CPS) data.
- States target the neediest, especially the elderly, persons with disabilities, and families with children.
- Over 5 million homes have been weatherized under DOE.
- In FY 2000, the energy burden on Federally eligible households was slightly less than four times the burden on Federally ineligible households (12.1% versus 3.0%).
- DOE Weatherization saves an average of 13-34% on home energy bills (depending on main heating fuel). This equates to $2.10 in energy benefits being produced for every $1.00 invested; an additional $0.60 are produced in non-energy (societal) benefits.

Note(s): For weatherization eligibility terminology, see Table 7.1.10. For acronyms, see the Directory of this Databook.

Source(s): ORNL, Weatherization Works: Final Report on the National Weatherization Evaluation, Sept. 1994, p. 1 for migrating poor; ORNL, 1996 for targeting; HHS, LIHEAP Home Energy Notebook for FY 2000, April 2002, Table A-2a, p. 48 for Federally eligible average income Federally eligible and Federally ineligible burdens; ORNL, Progress Report of the National Weatherization Assistance Program, Sept. 1997, DOE, Weatherization Works, Progress Report of the National Weatherization Assistance Program, Feb. 1998; and ORNL, Weatherization Plus Progress Report: Poised to Move Forward, June 2001 for DOE weatherization savings; and BTS for remaining data.

7.1.2 Weatherization Program Facts

- In FY 2000, DOE contributed 31% to all Federal weatherization funding, LIHEAP 49%, and others 20%.
- The Federal Government's outlay for fuel subsidies runs from $4.0 to 4.4 billion per year. The major two agencies dispensing fuel subsidies are HUD and HHS (through LIHEAP).
- HUD spends over $3 billion annually to pay all or part of the total utility bills (including water/sewer) for about 4.3 million low-income households. Energy costs are typically 75% of total bills in these households, so HUD spends typically $2.25 billion on energy for these households.
- LIHEAP spends 85% of its funding for direct fuel subsidies and weatherization. Up to 15% can be spent for weatherization activities and the remainder is spent on fuel subsidies. A maximum of 25% of funding is available for weatherization activities if HHS approves a waiver. In FY 1995, 74% was spent on fuel subsidies and 10% on weatherization for 103,000 households of about 30 million eligible households. LIHEAP's budget for FY 1995 was $1.5 billion, FY 1997 is $1.0 billion.

Source(s): DOE/BTS, Weatherization Program Notice 00-2, Dec. 16, 1999 for agency weatherization funding and HUD data; HHS, LIHEAP Report to Congress FY 1995, Aug. 1997, p. vii for LIHEAP weatherized households and Table 5, p. 15 for LIHEAP cost splits; and EIA, Housing Characteristics 1993, June 1995, Table 3.1a, p. 26 for Federally eligible.

7.1.3 Weatherization Costs and Savings

- Legislation enacted in 2000 for the DOE Weatherization program requires that states spend no more than an average of $2,500 per household. All states are using energy audits to determine the most cost-effective weatherization measures.
- In spite of funding reductions which reduced production, technical advances have produced 80% higher energy savings on a per dwelling basis. Increases in energy savings were achieved through improvements in: diagnostic technology and techniques, weatherization materials and installation techniques, training, and audit tools.
- Total costs for all single-family and small multi-family dwellings weatherized in Program Year 1989 were $1,550/unit. (1)
- Total costs for all units in large multi-family buildings weatherized in Program Year 1989 were $1000/unit. (1)
- DOE Weatherization saves an average of 22% on home energy space heating bills with a range of 13-34%, a benefit-cost ratio of 2.1 and a societal benefit-cost ratio of 2.7. On average, weatherized residences that use natural gas save $300 per year. (1)

Note(s): 1) Program year is April 1-March 31.

Source(s): BTS, Weatherization Program Notice 00-1, Nov. 23, 1999 for average expenditures; ORNL, Description of the Weatherization Assistance Program in Larger Multifamily Buildings for Program Year 1989, Apr. 1993, p.26 for 1989 installed costs; ORNL, Weatherization Works: Final Report of the National Weatherization Evaluation, Sept. 1994, p 56 for FY 1989; and ORNL, Progress Report of the National Weatherization Assistance Program, Sept. 1997, DOE, Weatherization Works, Progress Report of the National Weatherization Assistance Program, Feb. 1998; and ORNL, Weatherization Plus Progress Report: Poised to Move Forward, June 2001 for DOE weatherization savings.

7.1.4 Residential Energy Burdens, by Weatherization Eligibility and Year

	1987	1990			FY 2000 (2)		
	Mean Group (1)	Mean Indvdl	Mdn Indvdl	Mean Group	Mean Indvdl	Mdn Indvdl	Mean Group
Total US Households	4.0%	6.8%	N.A.	3.2%	6.1%	3.5%	2.4%
Federally Eligible	**13.0%**	**14.4%**	**N.A.**	**10.1%**	**12.1%**	**7.9%**	**7.7%**
Federally Ineligible	4.0%	3.5%	N.A.	N.A.	3.0%	2.6%	2.0%
Below 125% Poverty Line	13.0%	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

Note(s): 1) Mean and median individual burdens not available. 2) Data are derived from RECS 1997, adjusted to reflect FY 2000 HDD, CDD, and fuel prices.

Source(s): EIA, Household Energy Consumption and Expenditures 1987, Oct. 1989, Table 13, p. 48-50 for 1987 mean group burdens; ORNL, The Scope of the Weatherization Program: Profile of the Population in Need, Mar. 1994, p. xi. for 1990 Federally ineligible mean individual burden; HHS, Characterizing the Impact of Energy Expenditures on Low Income Households: An Analysis of Alternative National Energy Burden Statistics, Nov. 1994, p. viii for 1990 Total U.S. Households and Federally eligible burdens; and HHS, LIHEAP Home Energy Notebook, FY2000, April 2002, Tables A-2a, A-2b, and A-2c, p. 48-50.

7.1.5 FY 2000 Residential Energy Burdens, by Region (1)

	Northeast			South			Midwest			West		
	Mean Indvdl	Mdn Indvdl	Mean Group	Mean Indvdl	Mdn Indvdl	Mean Group	Mean Indvdl	Mdn Indvdl	Mean Group	Mean Indvdl	Mdn Indvdl	Mean Group
Total U.S. Households	7.0%	4.2%	2.8%	6.4%	3.8%	2.5%	6.2%	3.4%	2.4%	4.7%	2.8%	1.8%
Federally Eligible	**14.0%**	**9.5%**	**8.8%**	**12.5%**	**8.4%**	**8.3%**	**13.8%**	**8.2%**	**7.9%**	**8.8%**	**5.7%**	**5.7%**
Federally Ineligible	3.6%	3.1%	2.3%	3.2%	2.7%	2.1%	2.9%	2.6%	2.0%	2.3%	2.0%	1.5%

Note(s): 1) Data are derived from RECS 1997, adjusted to reflect FY 2000 HDD, CDD, and fuel prices. See Table 7.1.4 for totals and Table 7.1.10 for definitions.

Source(s): HHS, LIHEAP Home Energy Notebook, FY2000, April 2002, Tables A-2a, A-2b, and A-2c, p. 48-50.

7.1.6 Weatherized Households and Households, by Weatherization Eligibility and Year (million)

	Weatherization Recipient (1)	Federally Eligible (2)	Federally Ineligible	Below 125% Poverty Line	Total Households
1977	0.03	N.A.	N.A.	N.A.	74.8
1980	0.18	N.A.	N.A.	N.A.	79.6
1985	0.30	N.A.	N.A.	N.A.	87.9
1987	0.31	N.A.	N.A.	18.2	90.5
1990	0.25	27.9	66.1	18.2	94.2
1991	0.23	N.A.	N.A.	N.A.	95.3
1992	0.22	N.A.	N.A.	N.A.	96.4
1993	0.21	30.7	65.9	19.4	96.6
1994	0.25	N.A.	N.A.	N.A.	98.7
1995	0.23	N.A.	N.A.	N.A.	100.0
1996	0.15	N.A.	N.A.	N.A.	101.0
1997	0.15	34.1	67.4	19.7	101.5
1998	0.16	N.A.	N.A.	N.A.	102.8
1999	0.16	N.A.	N.A.	N.A.	104.1
2000	0.16	N.A.	N.A.	N.A.	105.3
Total 1977-2000	5.04	N/A	N/A	N/A	N/A

Note(s): 1) Recipients are reported according to a DOE Weatherization Program Year of April 1-March 31. 2) Federally eligible for DOE and HHS (LIHEAP) Weatherization. Includes previously DOE and HHS weatherized units.

Source(s): DOE for weatherization recipients; EIA, Housing Characteristics 1987, May 1989, Table 9, p. 20 for 1987 data; EIA, Housing Characteristics 1990, May 1992, Table 17, p. 54-55 for 1990 data; EIA, Housing Characteristics 1993, June 1995, Table 3.3a, p. 38-42 for 1993 data; EIA, AEO 1996, Jan. 1996, Table A4, p. 82-83 for 1992 and 1994 households; EIA, AEO 1998, Dec. 1997, Table A4, p. 106-107 for 1995-1996 households; EIA, AEO 2001, Dec. 2000, Table A4, p. 133-134 for 1998-2000 households; EIA, A Look at Residential Energy Consumption in 1997, Nov. 1999, Table HC1-3a, p. 38-39; EIA, Residential Energy Consumption Survey 1997 for eligible households; and DOC, Income, Poverty, and Valuation of Noncash Benefits: 1994, April 1996, Table B-1, for 1986, 1988, 1989, and 1991 households.

7.1.7 1997 Households, Square Footage, by Income Level, Weatherization Eligibility, Household Type, and Ownership (million)

1997 Family Income	Total	**Federally Eligible**	Federally Ineligible	Below 125% Poverty Line	Single-Family	Multi-Family	Mobile Home	Own	Rent
Less than $5,000	3.8	**3.8**	0.0	3.8	1.9	1.5	0.4	1.2	2.5
$5,000 to $7,499	5.1	**5.1**	0.0	5.1	2.3	2.3	0.4	1.9	3.2
$7,500 to $9,999	4.5	**4.5**	0.0	4.1	2.4	1.8	0.3	2.1	2.4
$10,000 to $14,999	9.8	**9.8**	0.5	4.6	5.8	3.2	0.9	5.1	4.7
$15,000 to $19,999	6.1	**6.1**	4.3	1.5	4.3	1.1	0.6	3.8	2.2
$20,000 to $34,999	4.7	**4.7**	19.3	0.7	3.3	1.0	0.5	3.0	1.8
All Households	101.5	**34.1**	67.4	19.7	73.7	21.4	6.3	68.5	33.0
Federally Eligible					**20.1**	**11.0**	**3.0**	**17.1**	**17.0**
Federally Ineligible					53.7	10.4	3.3	51.3	16.1
Below 125% Poverty Line					10.5	7.3	1.9	8.2	11.5
Square Feet (billion)	168.8	**42.9**	125.9	22.9	143.5	19.1	6.3	134.7	34.1

Source(s): Data taken from EIA, 1997 Residential Energy Consumption Survey.

7.1.8 1997 Average Energy Expenditures per Household Member and per Square Foot, by Weatherization Eligibility ($2000)

	Per Household Member	Members/ Hhold	Per Square Foot	Square Feet/ Hhold
Total U.S. Households	543	2.6	0.84	1663
Federally Eligible	**448**	**2.7**	**0.95**	**1259**
Federally Ineligible	593	2.5	0.81	1868
Below 125% Poverty Line	413	2.8	0.99	1164

Source(s): Data taken from EIA, 1997 Residential Energy Consumption Survey; and EIA, Annual Energy Review 2000, Aug. 2001, Appendix E, p. 351 for implicit price deflators.

7.1.9 Program Definitions

DOE Weatherization: Department of Energy's Weatherization Assistance Program

DOE Weatherization Eligible Households: Households with incomes at or below 125% of the Federal poverty level, which varies by family size; however, a state may instead elect to use the LIHEAP income standard if its state LIHEAP income standard is at least 125% of the Federal poverty level. Data listed in this chapter includes previously DOE and HHS weatherized units. DOE Weatherization Eligible Households are a subset of Federally Eligible Households.

DOE Weatherization Recipient Households: Households that have received weatherization under DOE Weatherization funding.

Federally Eligible Households: Households with incomes below the Federal maximum standard of 150% of the poverty line or 60% of the state median income, whichever is higher.

HHS: Department of Health and Human Services

LIHEAP: HHS's Low Income Home Energy Assistance Program

LIHEAP Eligible Households: Households with incomes below the Federal maximum poverty income level, i.e., 150% of the Federal poverty guidelines or 60% of state median income, whichever is higher.

LIHEAP Recipient Households: Households that received fuel subsidies for home heating, cooling, or energy crisis benefits in the year previous to a particular household survey.

Source(s): ORNL, Scope of the Weatherization Assistance Program: Profile of the Population in Need, Mar. 1994, p. 1.2 for Weatherization eligible, Weatherization recipient, and LIHEAP eligible households; EIA, Housing Characteristics 1993, June 1995, p. 336 for Federally eligible for weatherization; and HHS, LIHEAP Report to Congress FY 2000, April 2002, Table E-1, p. 105 and Figure 1, p. iii for LIHEAP recipient household.

7.1.10 Energy Burden Definitions

Energy burden is an important statistic for policy makers who are considering the need for energy assistance. Energy burden can be defined broadly as the burden placed on household incomes by the cost of energy, or more simply the ratio of energy expenditures to income for a household However, there are different ways to compute energy burden, and different interpretations and uses of the energy burden statistics. DOE Weatherization primarily uses mean individual burden and mean group burden since these statistics provide data on how an "average" individual household fares against an "average" group of households (that is, how burdens are distributed for the population). DOE Weatherization (and HHS) also uses the median individual burden which shows the burden of a "typical" individual.

Mean Individual Burden: This statistic is calculated by first computing the energy burden for each household using RECS data and then taking a mean of the household-level energy burden estimates. *It furnishes the most complete information about how a burden is distributed for the population.*

Mean Group Burden: This statistic calculates energy expenditures for all households in the group and divides by the average of all income for the group. This statistic is calculated as the ratio between aggregate energy expenditures of a group (from RECS and CPS) and aggregate group income (from CPS).

Median Individual Burden: This statistic is computed by taking a median of the RECS household-level energy burden estimates (the point at which 50% of households have a higher burden value and 50% have a lower value).

Source(s): HHS, LIHEAP Report to Congress FY 2000, April 2002, p. 45 for energy burden definition; HHS, Characterizing the Impact of Energy Expenditures on Low Income Households: An Analysis of Alternative National Energy Burden Statistics, November 1994, p. vii and ix for burdens; and ORNL, Scope of the Weatherization Assistance Program: Profile of the Population in Need, Mar. 1994, p. xii for mean individual and mean group burdens.

7.2.1 Residential Stock Electric Appliance and Building Equipment Usage

		Power Draw (W) (1)		Annual Usage (hours/year)		Annual Consumption	Annual Cost
		Operating	Stand-by	Operating	Stand-by	(kWh/year)	($) (2)
Kitchen							
	Coffee Maker	219	0	421	0	90	7
	Dishwasher	(3) 0.332	0	(4) 365	0	120	10
	Microwave Oven	1500	3	72	8688	140	11
	Refrigerator-Freezer					940	76
	Freezer					680	55
Lighting							
	18-W Compact Fluorescent	18	0	1189	0	20	2
	60-W Incandescent Lamp	60	0	672	0	40	3
	100-W Incandescent Lamp	100	0	672	0	70	6
	Torchiere Lamp-Halogen	300	0	1460	0	440	36
Bedroom and Bathroom							
	Hair Dryer	710	0	50	0	40	3
	Waterbed Heater	350	0	3051	0	1070	87
Laundry Room							
	Clothes Dryer			(4) 359		1000	81
	Clothes Washer	(3) 0.276	0	(4) 392	0	110	9
Home Electronics							
	Cable Box	20	12	1456	7304	110	9
	Computer (CPU & Monitor)	182/30	0	1337/632	0	260	21
	Portable Stereo	7	2	526	5606	20	2
	Compact Stereo		12	964	7796	110	9
	Rack Stereo	53	12	1664	7096	150	12
	Color Television	83	5	2810	5950	(5) 260	21
	VCR	14	6	2424	6336	70	6
Heating and Cooling							
	Dehumidifier	600	0	1620	0	970	79
	Furnace Fan	295	0	1350	0	400	32
	Window Fan	30	0	270	0	10	1
Water Heating							
	Water Heater-Family of 4	4500	0	(6) 64	N.A.	4770	386
	Water Heater-Family of 2	4500	0	(6) 32	N.A.	2340	190
Miscellaneous							
	Clock/Radio	2	2	131	8629	20	2
	Lawn Mower	1500	0	20	0	30	2
	Pool Pump	1000	0	792	0	790	64
	Well Pump	725	0	115	0	80	6
Total Standby		0	57	0	8760	500	41

Note(s): 1) Power draw will vary due to appliance components and modes of operation. 2) $0.080/kWh. 3) Excludes water heating. Units are in kWh/cycle. 4) Cycles/year. 5) Energy consumption is not multiplicative for multiple units. Electricity consumption increases approximately 40 kWh per unit. 6) Gallons/day.

Source(s): BTS/A.D. Little, Electricity Consumption by Small End Uses in Residential Buildings, August 1998, Exhibit 6-8, p. 6-10 for coffee maker, cable box, clothes washer, computer, dehumidifier, dishwasher, furnace fan, microwave oven, pool pump, torchiere lamp-halogen, waterbed heater, and well pump; LBNL, Energy Data Sourcebook for the U.S. Residential Sector, LBNL-40297, September 1997, p. 100-102 for clothes dryers, Table 10.2, p. 108 for lighting, and p. 62-67 for water heaters; LBNL, Miscellaneous Electricity Use in the U.S. Residential Sector, LBNL-40295, April 1998, Appendix D, p. D-1-D-9 for hair dryer, window fan, and lawn mower; EIA, Supplement to AEO 2000, Dec. 1999, Table 21 for refrigerator and freezer; BTS/LBNL, Energy Use of Home Audio Products in the U.S., Dec. 1999, Table 4-9, 28 and p. 31-35 for audio electronics; BTS/LBNL, Energy Use of Televisions and Videocassette Recorders in the U.S., Mar. 1999, Tables 3-6 - 3-8, p. 19-22, and Tables 4-6 - 4-8, p. 32-34; GAMA, Consumer's Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment, April 2000 for water heater power draw; and LBNL for total standby.

7.2.2 Residential Stock Natural Gas Appliance Usage

	Average Capacity (10^3 Btu/hr)	Appliance Usage		Annual Consumption (10^6 Btu/year)	Annual Cost ($) (1)
Range	10			4.2	27
Clothes Dryer		(2)	359	4.3	28
Water Heating					
Water Heater-Family of 4	40	(3)	64	25.8	168
Water Heater-Family of 2	40	(3)	32	12.3	80

Note(s): 1) $0.652/therm. 2) Cycles/yr. 3) Gallons/day.

Source(s): A.D. Little, EIA-Technology Forecast Updates - Residential and Commercial Building Technologies - Reference Case, September 2, 1998, p. 30 for range and clothes dryer; LBNL, Energy Data Sourcebook for the U.S. Residential Sector, LBNL-40297, Sept. 1997, p. 62-67 for water heating; GAMA, Consumer's Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment, April 2002, for water heater capacity; and AGA, Gas Facts 1998, Dec. 1999, www.aga.org for range and clothes dryer consumption.

7.3.1 1997 *Delivered* Energy End-Uses for an Average Household, by Region (10^6 Btu/Hhold)

	Northeast	Midwest	South	West	National
Space Heating	76.0	82.3	30.8	30.9	52.0
Space Cooling	2.0	3.3	8.8	5.7	5.7
Water Heating	21.4	22.0	15.7	19.1	19.0
Appliances (1)	22.8	28.3	29.8	24.3	26.9
Total	122.2	0.0	85.1	78.7	103.6

Note(s): 1) Includes refrigerators, freezers, lights, televisions, toaster ovens, electric stove-tops, electric ovens, microwave ovens, gas stove-tops, gas ovens, natural gas grills, clothes washers and dryers, dishwashers, swimming pool and hot tub pumps and heaters, personal computers, laser printers, facsimile machines, photocopiers, waterbed heaters, heated aquariums, evaporative coolers, fans, portable space heater, humidifier, dehumidifier, and air cleaners.

Source(s): EIA, A Look at Residential Energy Consumption in 1997, Nov. 1999, Table CE1-13c, p. 121-122.

7.3.2 1997 End-Use Carbon Dioxide Splits for an Average Household, by Region (pounds of CO2)

	Northeast	Midwest	South	West	National
Space Heating	11,104	9,823	5,168	4,734	7,314
Space Cooling	671	1,320	3,575	1,882	2,368
Water Heating	3,584	3,296	3,528	3,169	3,437
Appliances (1)	8,159	10,099	11,307	8,741	9,847
Total	23,518	24,537	23,578	18,525	22,965

Note(s): 1) Includes refrigerators, freezers, lights, televisions, toaster ovens, electric stove-tops, electric ovens, microwave ovens, gas stove-tops, gas ovens, natural gas grills, clothes washers and dryers, dishwashers, swimming pool and hot tub pumps and heaters, personal computers, laser printers, facsimile machines, photocopiers, waterbed heaters, heated aquariums, evaporative coolers, fans, portable space heater, humidifier, dehumidifier, and air cleaners.

Source(s): EIA, A Look at Residential Energy Consumption in 1997, Nov. 1999, Tables CE(2-5)-(9-12)c; EIA, AEO 2002, Dec. 2001, Table A2, p. 126-128, Table A18, p. 148 for consumption data, and Table A19, p. 149 for emissions data; and EIA, Assumptions to the AEO 2002, Dec. 2001, Table 2, p. 8 for coefficients.

7.3.3 1997 Energy End-Use Expenditures for an Average Household, by Region ($2000)

	Northeast	Midwest	South	West	National
Space Heating	689	575	329	253	442
Space Cooling	78	85	211	134	147
Water Heating	244	188	213	177	206
Appliances (1)	752	645	662	590	660
Total	1763	1492	1415	1155	1454

Note(s): 1) Includes refrigerators, freezers, lights, televisions, toaster ovens, electric stove-tops, electric ovens, microwave ovens, gas stove-tops, gas ovens, natural gas grills, clothes washers and dryers, dishwashers, swimming pool and hot tub pumps and heaters, personal computers, laser printers, facsimile machines, photocopiers, waterbed heaters, heated aquariums, evaporative coolers, fans, portable space heater, humidifier, dehumidifier, and air cleaners.

Source(s): EIA, A Look at Residential Energy Consumption in 1997, Nov. 1999, Table CE1-13e, p. 130-131; EIA, Annual Energy Review 2000, Aug. 2001, Appendix E, p. 351 for price inflators.

7.3.4 Materials Used in the Construction of a 2,082 Sq. Ft. New Single-Family Home, 2000

13,837 board-feet of lumber	12 interior doors
11,550 square feet of sheathing	6 closet doors
16.92 tons of concrete	2 garage doors
3,011 square feet of exterior siding material	1 fireplace
2,841 square feet of roofing material	3 toilets; 2 bathtubs; 1 shower stall
3,061 square feet of insulation	3 bathroom sinks
5,550 square feet of interior wall material	14 kitchen cabinets; 4 other cabinets
2,117 square feet of interior ceiling material	1 kitchen sink
226 linear feet of ducting	1 range; 1 refrigerator; 1 dishwasher; 1 garbage disposer; 1 range hood
18 windows	1 washer; 1 dryer
4 exterior doors (3 hinged, 1 sliding)	1 heating and cooling system
2,082 square feet of flooring material	

Source(s): NAHB, 2001 Housing Facts, Figures and Trends, June 2001, p. 15.; D&R International for appliances and HVAC.

7.3.5 Characteristics of a Typical Single-Family Home (1)

Year Built		mid-1960s
Occupants		3
Floorspace		
Heated Floorspace		1946
Cooled Floorspace		1692
Garage		2-Car
Stories		1
Foundation		Basement
Total Rooms (2)		6
Bedrooms		3
Other Rooms		3
Full Bathroom		2
Half Bathroom		0
Window		
Area	(3)	224
Number	(4)	14
Type		Single-Pane
Frame		Nonmetal
Insulation (5)		
Ceiling/Roof		Yes
Walls		Yes
Lighting		N.A.

Space Heating		
Equipment		Central Warm-Air Furnace
Fuel		Natural Gas
Age (6)		13
Space Cooling (7)		Yes
Water Heating		
Size (8)		48
Fuel		Natural Gas
Age (6)		9
Refrigerator		
Number		1
Size (9)		19
Age (6)		9
Freezer		No
Electric Clothes Dryer		Yes
Electric Clothes Washer		Yes
Dishwasher		Yes
Range/Oven		Electric
Microwave Oven		Yes
Ceiling Fans		3
Computer		No (10)
Television		
Type		Color
Number		2

Note(s): 1) This is a weighted-average house that has combined characteristics of the nation's stock homes. Although the population of homes with similar traits may be few, these are likely to be the most common. 2) Excludes bathrooms. 3) 11.5% of floorspace. 4) Based on a nominal 3' X 5' window. 5) Typical insulation levels are "well" or "adequate." Levels of insulation will vary depending on climate. 6) Years. 7) Approximately 75% of single-family homes were air-conditioned with either central air-conditioning, room air-conditioning, or a heat pump. 8) Gallons. 9) Cubic Feet. 10) In 1997, 40% (29.2 million) households had a computer.

Source(s): EIA, A Look at Residential Energy Consumption in 1997, Nov. 1999, Table HC1-4a, p. 42-44, Table HC2-4a, p. 52, Table HC3-4a, p. 59-60, Table HC4-4a, p. 68-69, Table HC5-4a, p. 81-84, HC7-4a, p. 109; EIA, RECS 1997, Nov. 1999; and EIA, Housing Characteristics 1993, June 1995, Table 3.29a, p. 168-173.

7.4.1 Energy End-Use Intensities, by Building Activity (10^3 Btu/sq. ft.)

	Education	Food Sales	Food Service	Health Care	Lodging	Mercantile & Service	Office
Space Heating	32.8	27.5	30.9	55.2	22.7	30.6	24.3
Space Cooling	4.8	13.4	19.5	9.9	8.1	5.8	9.1
Ventilation	1.6	4.4	5.3	7.2	1.7	2.5	5.2
Water Heating	17.4	9.1	27.5	63.0	51.4	5.1	8.7
Lighting	15.8	33.9	37.0	39.3	23.2	23.4	28.1
Cooking	1.4	5.6	77.5	11.2	6.6	1.5	1.1
Refrigeration	1.0	110.9	31.6	4.7	2.3	0.9	0.4
Office Equipment	1.5	1.3	2.6	15.5	3.8	2.9	15.1
Other	2.9	7.4	13.7	34.4	7.5	3.7	5.2
Total	79.3	213.5	245.5	240.4	127.3	76.4	97.2

	Public Assembly	Public Order & Safety	Religious Worship	Warehouse & Storage	Other	Vacant	All Buildings
Space Heating	53.6	27.8	23.7	15.7	59.6	11.9	29.0
Space Cooling	6.3	6.1	1.9	0.9	9.3	0.6	6.0
Ventilation	3.5	2.3	0.9	0.3	8.3	0.3	2.8
Water Heating	17.5	23.4	3.2	2.0	15.3	2.4	13.8
Lighting	21.9	16.4	5.0	9.8	26.7	3.6	20.4
Cooking	2.8	NA	0.5	0.0	NA	NA	3.7
Refrigeration	1.8	0.2	0.6	1.7	0.7	0.2	3.1
Office Equipment	2.4	5.8	0.4	4.4	15.2	0.5	5.7
Other	3.8	12.7	1.1	3.4	35.9	1.9	6.1
Total	113.7	97.2	37.4	38.3	172.2	21.5	90.5

Source(s): EIA, A Look at Commercial Buildings in 1995: Characteristics, Energy Consumption, and Energy Expenditures, Oct. 1998, Table EU-2, p. 311.

7.4.2 Typical Office Building (1)

		Large (>= 25,000 ft2)	Small (<25,000 ft2)
Stock Floor Area (billion ft2)		8.22	4.29
Floor-Area Weighted Averages			
	Building Area (thousand ft2)	90-137	5.5-6.6
	Floors	6-7	1-2
SHELL			
	Percent Glass	40-50	15-20
	Window R-Value	1.39-1.71	1.34-1.99
	Window Shading Coefficient	0.69-0.8	0.71-0.82
	Wall R-Value	2.5-6.0	3.9-6.3
	Roof R-Value	9.1-12.6	10.5-13.3
	Wall Material	masonry	masonry
	Roof Material	built-up	built-up
OCCUPANCY			
	Average Occupancy (ft2/person)	390-460	420-470
	Weekday Hours (hrs/day)	12	11
	Weekend Hours (hrs/day)	5	4
EQUIPMENT			
	Average Power Density (W/ft2)	1	1
	Full Lighting Hours (hrs/year)	3580	3360
LIGHTING			
	Average Power Density (W/ft2)	1.3-1.8	1.7-2.2
	Full Lighting Hours (hrs/year)	4190	3340
SYSTEM AND PLANT			
	System and Distribution Type	Constant Volume w/ reheat	Packaged single-zone
		VAV w/ economizer	Packaged single-zone w/ economizer
	Heating Plant	Gas Boiler	Gas Furnace
	Cooling Plant	Hermetic Centrifugal Chiller	Direct Expansion
	Service Hot Water	Gas Boiler	Gas Water Heater

Note(s): 1) The prototypes are synthetic buildings compiled from statistical data from building surveys or conclusions from previous studies. The physical characteristics, system characteristics, and usage patterns are based upon various surveys, studies, engineering estimates, or engineering judgment.

Source(s): LBNL, Commercial Heating and Cooling Loads Component Analysis, June 1998, Table 10, p. 31.

7.4.3 Typical School Building (1) (2)

	Pre-1980	Post-1980
Stock Floor Area (billion ft2)	7.48	0.60
Floor-Area Weighted Averages		
Building Area (thousand ft2)	22-47	16-26
Floors	2	2
SHELL		
Percent Glass	27	18
Window R-Value	1.39-1.6	1.67-1.71
Window Shading Coefficient	0.80-0.83	0.71-0.73
Wall R-Value	2.7-3.4	5.3-5.7
Roof R-Value	10.1-10.9	12.6-13.3
Wall Material	masonry	masonry
Roof Material	built-up	built-up
OCCUPANCY		
Average Occupancy (ft2/person)	105	105
Weekday Hours (hrs/day)	8	8
Weekend Hours (hrs/day)	2	2
EQUIPMENT		
Average Power Density (W/ft2)	0.80	0.80
Full Equipment Hours (hrs/year)	1136	1136
LIGHTING		
Average Power Density (W/ft2)	1.8	1.7
Full Lighting Hours (hrs/year)	2436	2436
SYSTEM AND PLANT		
System and Distribution Type	6 (classrooms, gym, auditorium, dining, kitchen) Unit ventilators	1 central system packaged multi-zone w/ economizer
Heating Plant	Gas Boiler	Gas Boiler
Cooling Plant	Hermetic Centrifugal Chiller	Hermetic Centrifugal Chiller
Service Hot Water	Gas Boiler	Gas Boiler

Note(s): 1) The prototypes are synthetic buildings compiled from statistical data from building surveys or conclusions from previous studies. The physical characteristics, system characteristics, and usage patterns are based upon various surveys, studies, engineering estimates, or engineering judgment. (2) For additional data on Educational Facilities, see Section 7.5.

Source(s): LBNL, Commercial Heating and Cooling Loads Component Analysis, June 1998, Table 15, p. 36; and D&R for hours of occupancy.

7.4.4 Typical Mercantile & Service (Retail) Building (1)

		Retail (>= 25,000 ft2)	Retail (<25,000 ft2)
Stock Floor Area (billion ft2)		5.88	6.53
Floor-Area Weighted Averages			
	Building Area (thousand ft2)	80	5.3-6.4
	Floors	2	1
SHELL			
	Percent Glass	15	15
	Window R-Value	1.39-1.71	1.24-1.71
	Window Shading Coefficient	0.74-0.79	0.85
	Wall R-Value	3.1-6.4	2.5-6.6
	Roof R-Value	10.6-14.0	9.5-13.2
	Wall Material	masonry	masonry
	Roof Material	built-up	built-up
OCCUPANCY			
	Average Occupancy (ft2/person)	390-460	1635-2085
	Weekday Hours (hrs/day)	12	12
	Weekend Hours (hrs/day)	5	4
EQUIPMENT			
	Average Power Density (W/ft2)	0.40	0.50
	Full Equipment Hours (hrs/year)	4750-5850	3480
LIGHTING			
	Average Power Density (W/ft2)	1.6-2.1	1.7-2.2
	Full Lighting Hours (hrs/year)	4500-5245	3786-4412
SYSTEM AND PLANT			
	System and Distribution Type	Constant Volume w/ reheat	Packaged single-zone
		VAV w/ economizer	Packaged single-zone w/ economizer
	Heating Plant	Gas Boiler	Gas Furnace
	Cooling Plant	Hermetic Centrifugal Chiller	Direct Expansion
	Service Hot Water	Gas Boiler	Gas Water Heater

Note(s): 1) The prototypes are synthetic buildings compiled from statistical data from building surveys or conclusions from previous studies. The physical characteristics, system characteristics, and usage patterns are based upon various surveys, studies, engineering estimates, or engineering judgment.

Source(s): LBNL, Commercial Heating and Cooling Loads Component Analysis, June 1998, Table 11, p. 32.

7.4.5 Typical Hospital Building (1)

		Pre-1980	Post-1980
Stock Floor Area (billion ft2)		1.43	0.21
Floor-Area Weighted Averages			
	Building Area (thousand ft2)	66.2	156
	Floors	6	12
SHELL			
	Percent Glass	25	25
	Window R-Value	1.79	1.96
	Window Shading Coefficient	0.71	0.66
	Wall R-Value	0.3	6.9
	Roof R-Value	12.3	11.5
	Wall Material	masonry	masonry
	Roof Material	built-up	built-up
OCCUPANCY			
	Average Occupancy (ft2/person)	190	190
	Weekday Hours (hrs/day)	24	24
	Weekend Hours (hrs/day)	24	24
EQUIPMENT			
	Average Power Density (W/ft2)	2.20	2.20
	Full Equipment Hours (hrs/year)	6962	6962
LIGHTING			
	Average Power Density (W/ft2)	2.1	2.1
	Full Lighting Hours (hrs/year)	6752	6752
SYSTEM AND PLANT			
	System and Distribution Type	4-pipe fan-coil in rooms reheat in lobby & core single-zone reheat in kitchen dual-duct in kitchen	4-pipe fan-coil in rooms VAV in lobby & core single-zone reheat in kitchen dual-duct in kitchen
	Heating Plant	Gas Boiler	Gas Boiler
	Cooling Plant	Hermetic Centrifugal Chiller	Direct Expansion
	Service Hot Water	Gas Boiler	Gas Boiler

Note(s): 1) The prototypes are synthetic buildings compiled from statistical data from building surveys or conclusions from previous studies. The physical characteristics, system characteristics, and usage patterns are based upon various surveys, studies, engineering estimates, or engineering judgment.

Source(s): LBNL, Commercial Heating and Cooling Loads Component Analysis, June 1998, Table 14, p. 35.

7.5.1 Energy End-Use Intensities and Consumption of Educational Facilities (1)

Energy Consumption

	Energy Intensities (1000 Btu/ sq. ft.)	Total Consumption (trillion Btu)
Space Heating	32.8	254
Cooling	4.8	37
Ventilation	1.6	13
Water Heating	17.4	134
Lighting	15.8	122
Cooking	1.4	11
Refrigeration	1.0	8
Office Equipment	1.5	11
Other	2.9	22
Total	79.3	614

Note(s): 1) Educational Facilities include K-12 as well as higher education facilities.

Source(s): EIA, Commercial Building Energy Consumption and Expenditures 1995, April 1998, Table 1 for total energy consumption, Table 2 for energy intensities, and Table 4 for expenditures.

7.5.2 Number of Public K-12 Schools in the United States and Students per School, 2000-2001

Total Number of Schools in the U.S.

Regular (1)	84,596
Special	1,654
Vocational	345
Alternative	4,045
Total (2)	90,640

Average Number of Students per School (3)

Elementary	443
Middle	605
High	751
Other	270

Note(s): 1) Regular schools are those responsible for providing free public education for school age children residing wihin their jurisdiction. 2) Data is based on total number of schools reporting current student enrollment, which varies from the actual number of schools, 96,637. "Special" focuses primarily on special education with materials and instructional approaches to meet the needs of the students. A "vocational" school focuses on technical or career skills and training. An "alternative" school addresses the needs of students that typically cannot be met in a traditional school setting. 3) Averages are for "regular" schools.

Source(s): U.S. Department of Education/National Center for Educational Statistics (NCES), Statistical Analysis Report, Overview of Public Secondary and Elementary Schools and Districts: School year 2000-2001 (NCES 2002-356).

7.5.3 Distribution of Public K-12 Schools and Students by Community Type, 2000-2001

	Total Schools (1)		Total Students (millions)	
Large City	22,294	25%	13.78	29%
Urban Town	40,804	45%	23.38	50%
Rural	27,539	30%	9.75	21%
Total	90,637	100%	46.86	100%

Note(s): 1) Data is based on the total number of schools reporting current student enrollment which varies from the actual total number of schools, 96,637; therefore, total varies from total in 7.5.2. This data excludes three schools for which no locale codes could be assigned.

Source(s): U.S. Department of Education/National Center for Educational Statistics (NCES), Statistical Analysis Report, Overview of Public Secondary and Elementary Schools and Districts: School Year 2000-2001 (NCES 2002-356), May 2002.

7.5.4 National Enrollment and Expenditures for Public K-12 Facilities

	National Enrollment (millions)	Expenditures (billion $)	Expenditures per Pupil
1986	39.42	$213.4	$5,413
1990	40.54	$251.0	$6,190
1995	44.11	$274.5	$6,222
2000	46.86	$314.3	$6,708
2005	47.49	$367.0	$7,728
2010	47.18	$408.6	$8,661

Source(s): National Center for Educational Statistics (NCES), Projections of Educational Statistics to 2011, Table 33, February 2002.

7.5.5 Total Expenditures for K-12 Plant Operation and Maintenance by Function ($2000 billion)

	1990		1995		1998	
Salaries and Benefits	207.5	83%	262.2	83%	307.8	82%
Supplies	18.3	7%	23.2	7%	29.2	8%
Other	3.7	1%	3.2	1%	3.9	1%
Purchased Services	20.2	8%	26.7	8%	33.5	9%
O & M (1)	7.1		9.5		10.4	
Total	249.7	100%	315.3	100%	374.3	100%

Note(s): 1) Operation and maintenance services include salaries, benefits, supplies, and contractual fees for supervision of operations and maintenance, operating buildings (heating, lighting, ventilating, repair and replacement), care and upkeep of grounds and equipment, vehicle operation and maintenance (other than student transportation), security and other operations and maintenance services.

Source(s): U.S. Department of Education/National Center for Educational Statistics (NCES), Digest of Educational Statistics, Table 165, p. 189; EIA, Annual Energy Review 2000, Aug. 2001, Appendix E, p. 351 for price deflators.

7.5.6 National Median Costs and Characteristics for Construction of a New Public K-12 School (1)

	1999	2000	2001	2002
$/Sq. Ft.				
Elementary	$100	$102	$113	$113
Middle	$100	$108	$118	$123
High	$107	$105	$122	$119
$/Student				
Elementary	$11,478	$12,313	$12,583	$13,333
Middle	$14,500	$15,667	$16,667	$16,429
High	$20,000	$17,000	$17,778	$17,500
# Students				
Elementary	600	650	650	650
Middle	800	750	650	800
High	865	1,000	1,500	1,200
Building Size				
Elementary	72,000	73,000	70,500	70,000
Middle	113,000	101,800	100,000	105,000
High	152,000	175,000	210,000	160,000
Building Cost				
Elementary	$7,000	$7,818	$8,561	$8,500
Middle	$12,000	$12,000	$11,000	$13,000
High	$18,000	$18,900	$26,000	$20,087

Note(s): 1) School characteristics vary widely between urban/rural school districts. Data shown is median data for all new U.S. public K-12 school buildings.

Source(s): School Planning and Management, 2002 Construction Report, July 2002

7.5.7 New Construction and Renovations Expenditures for Public K-12 Schools (billion $)

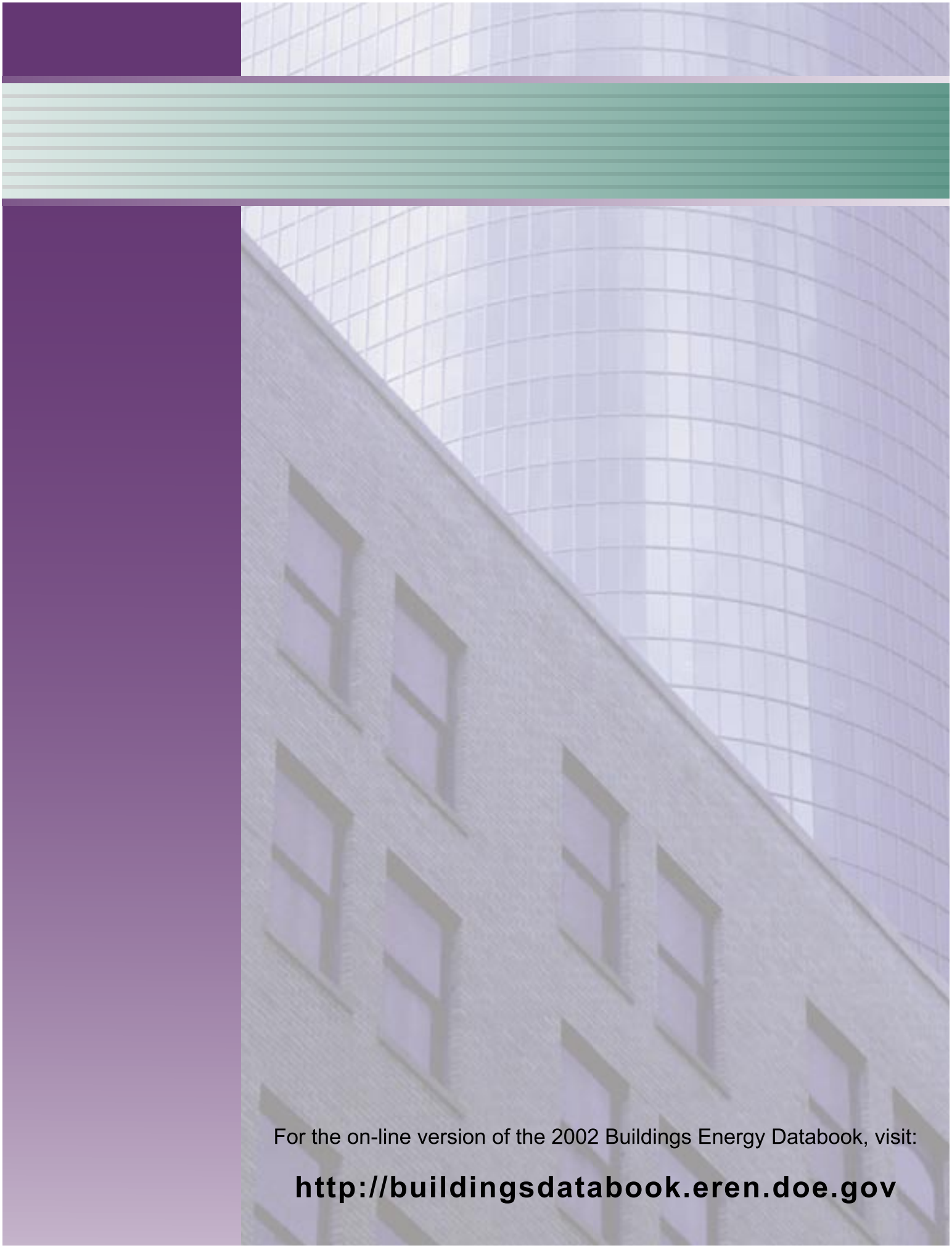
	1992	1995	1998	1999	2000	2001
New Schools	N.A.	N.A.	7.89	8.17	9.39	10.40
Additions	N.A.	N.A.	3.90	5.85	6.13	5.36
Renovations	N.A.	N.A.	3.67	3.95	5.64	4.58
Total	**10.73**	**10.42**	**15.46**	**17.96**	**21.16**	**20.34**

Source(s): American School and University Magazine, 28th Annual Official Education Report, p. 26, May 2002 for 1992 and 1995 data, www.asumag.com; and School Planning and Management 2002 Construction Report, July 2002 www.peterli.com/spm/special/constrpt/2002/2002rpt.cfm for 1998-2001 data.

7.5.8 Percentage of Public K-12 Schools with Inadequate Building Features, 1995 (1)

	Small	Medium	Large
Roofs	25.6	25.1	32
Framing, floors, and foundations	18.4	18.4	16.9
Exterior walls, finishes, windows and doors	26.1	25.7	28.2
Interior finishes	23.3	22.8	26.7
Plumbing	32.6	27.6	30.4
HVAC	35.9	35.3	38.5
Electrical power	27.8	25.4	26.6
Electrical lighting	25.4	24.3	26.3

Note(s): 1) Small school is defined as having 1-299 students, medium 300-599 students, and a large school has 600 or more students.
Source(s): U.S. GAO, Health, Education, and Human Services Division, America's Schools Report Differing Conditions, GAO/HEHS-96-103, June 1996, Table II.9, p. 45.



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