OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY • U.S. DEPARTMENT OF ENERGY

2000 BTS CORE DATABOOK

OFFICE OF
BUILDING TECHNOLOGY
STATE AND COMMUNITY PROGRAMS

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DOE's Office of Building Technology,
State and Community Programs

BTS Core Databook

The Department of Energy's Office of Building Technology, State and Community Programs (BTS) has developed this Core Databook to provide a current and accurate set of comprehensive buildings-related data and to promote the use of such data for consistency throughout BTS programs. Created under BTS's Evaluation and Planning Program, the Databook is considered an evolving document. The Databook 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
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
OBE	BTS's Office of Building Equipment

Key Terminology
(continued)

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-^{o}F)$^{-1}$
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-^{o}F)
VOC	Volatile organic compounds

Buildings-Related Internet Addresses

Federal Government and International Organizations

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

National Laboratories and Research Organizations

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

Buildings-Related Internet Addresses (continued)

Magazines, Journals, and On-Line Newsletters

Air Conditioning, Heating and Refrigeration News . . . . . http://www.achrnews.com
Appliance Magazine . . . . . http://www.appliance.com
Appliance Manufacturer Magazine . . . . . http://www.ammagazine.com
Builder Magazine . . . . . http://www.builderonline.com
Building Standards . . . . . http://www.icbo.org/Building_Standards_Online
Buildings Magazine . . . . . http://www.buildings.com
Building Operating Management . . . . . http://www.facilitiesnet.com
Center for Renewable Energy and Sustainable Technology . . . . . http://solstice.crest.org
Contracting Business . . . . . http://www.contractingbusiness.com
Energy Central . . . . . http://www.energycentral.com
Energy Decisions . . . . . http://www.facilitiesnet.com
Energy Design Update . . . . . http://www.cutter.com/edu
Energy User News . . . . . http://www.energyusernews.com
Engineered Systems . . . . . http://www.esmagazine.com
Environmental Design & Construction . . . . . http://www.edcmag.com
Environmental Building New . . . . . http://www.ebuild.com
Facilities, Design, and Management . . . . . http://www.fdm.com
Heating, Piping, and Air Conditioning . . . . . http://www.hpac.com
Home Furnishings Network . . . . . http://www.hfnmag.com
Home Power Magazine . . . . . http://www.homepower.com
Home Energy . . . . . http://www.homeenergy.org/tocs.html
Journal of Light Construction . . . . . http://www.jlconline.com
Remodeling Online, Residential Architect . . . . . http://www.remodeling.hw.net
Solar Today . . . . . http://www.solartoday.com

Code Groups

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

Buildings-Related Internet Addresses (continued)

Professional, Industry, and Not-for-Profit Associations

Affordable Comfort, Incorporate http://www.affordablecomfort.org/home1.html
Air-Conditioning and Refrigeration Institute . . . . . http://www.ari.org
Air Conditioning Contractors of America . . . . . http://www.acca.org
Alternative Fluorocarbons Environmental Acceptability Study . . . . . http://www.afeas.org
American Architectural Manufacturers Association . . . . . http://www.aamanet.org
American Council for an Energy Efficient Economy . . . . . http://www.aceee.org
American Gas Association . . . . . http://www.aga.org
American Gas Cooling Center . . . . . http://www.agcc.org
American Institute of Architects . . . . . http://www.aiaonline.com
American Society of Heating, Refrigerating and Air-Conditioning Engineers . . . . . http://www.ashrae.org
American Society of Mechanical Engineers . . . . . http://www.asme.org
American Solar Energy Society . . . . . http://www.ases.org
Association of Energy Engineers . . . . . http://www.aeecenter.org
Association of Higher Education Facilities Officers . . . . . http://www.appa.org
Association of Home Appliances Manufacturers . . . . . http://www.aham.org
Building Owners and Managers Association . . . . . http://www.boma.org
Edison Electric Institute . . . . . http://www.eei.org
Energy Efficient Building Association . . . . . http://www.eeba.org
Gas Appliance Manufacturers Association . . . . . http://www.gamanet.org
Habitat for Humanity International . . . . . http://www.habitat.org
International Facility Management Association . . . . . http://www.ifma.org
Manufactured Housing Institute . . . . . http://www.mfghome.org/home.html
National Association of Demolition Contractors . . . . . http://www.demolitionassociation.com
National Association of Energy Service Companies . . . . . http://www.naesco.org
National Association of Home Builders . . . . . http://www.nahb.com
National Association of Housing and Redevelopment Officials . . . . . http://www.nahro.org
National Association of State Energy Officials . . . . . http://www.naseo.org
National Center for Appropriate Technology . . . . . http://www.ncat.org
Natural Resources Defense Council . . . . . http://www.nrdc.org
Residential Energy Service Network . . . . . http://www.natresnet.org
Solar Energy Industry Association . . . . . http://www.seia.org
Weatherization Assistance Program Technical Assistance Center . . . . . http://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%	0.9	5%	**15.9**
1990	10.1	61%	4.5	27%	1.3	8%	0.1	0%	0.6	4%	**16.5**
1998	**12.4**	**66%**	**4.6**	**25%**	**1.4**	**7%**	**0.1**	**0%**	**0.4**	**2%**	**18.8**
2000	13.0	65%	5.0	25%	1.4	7%	0.1	0%	0.5	2%	**19.9**
2010	14.5	67%	5.5	25%	1.3	6%	0.1	0%	0.5	2%	**21.7**
2020	15.5	67%	5.9	25%	1.1	5%	0.1	0%	0.5	2%	**23.0**

Commercial Consumption

	Elec		NGas		Oil		Coal		Renew		**Total**
1980	6.5	62%	2.7	25%	1.3	12%	0.1	1%	0.0	0%	**10.6**
1990	9.1	71%	2.7	21%	0.9	7%	0.1	1%	0.0	0%	**12.8**
1998	**11.5**	**75%**	**3.1**	**20%**	**0.6**	**4%**	**0.1**	**1%**	**0.1**	**1%**	**15.4**
2000	12.0	75%	3.3	20%	0.6	4%	0.1	1%	0.1	1%	**16.1**
2010	13.4	75%	3.6	20%	0.6	3%	0.1	1%	0.1	1%	**17.8**
2020	13.7	75%	3.8	21%	0.6	3%	0.1	1%	0.1	1%	**18.2**

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%	0.9	3%	**26.5**
1990	19.2	65%	7.2	25%	2.2	7%	0.2	1%	0.6	2%	**29.3**
1998	**23.9**	**70%**	**7.7**	**23%**	**2.0**	**6%**	**0.1**	**0%**	**0.5**	**1%**	**34.2**
2000	25.0	69%	8.3	23%	2.0	5%	0.2	0%	0.6	2%	**36.0**
2010	27.9	71%	9.0	23%	1.9	5%	0.2	0%	0.6	1%	**39.5**
2020	29.1	71%	9.6	23%	1.7	4%	0.2	0%	0.6	2%	**41.3**

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

	Gas	Oil	Coal	Renew	Nuclear	Electric Import
1980	37%	17%	28%	11%	6%	N.A.
1990	31%	10%	36%	9%	14%	N.A.
1998	**30%**	**8%**	**38%**	**10%**	**14%**	**1%**
2000	31%	7%	38%	9%	14%	1%
2010	34%	6%	39%	9%	12%	0%
2020	39%	5%	39%	9%	7%	0%

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%
1998	**20%**	**16%**	**36%**	**37%**	**27%**
2000	20%	16%	**37%**	36%	27%
2010	19%	16%	**35%**	35%	29%
2020	19%	15%	**34%**	35%	31%

5. Buildings Share of U.S. Electricity Consumption

	Res	Com	**Bldgs**	Indtry
1980	34%	27%	**61%**	39%
1990	34%	31%	**65%**	35%
1998	**35%**	**32%**	**67%**	**32%**
2000	35%	33%	**68%**	32%
2010	35%	33%	**68%**	31%
2020	36%	32%	**67%**	32%

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, 1998

Energy (quads and % of totals)

End Use	Residential		Commercial		**Buildings**	
Space Heat	6.0	32%	2.5	16%	**8.5**	**25%**
Space Cool	2.1	11%	1.9	13%	**4.0**	**12%**
Vent			0.9	6%	**0.9**	**3%**
Water Heat	2.9	15%	1.2	8%	**4.1**	**12%**
Lighting	1.3	7%	3.8	24%	**5.0**	**15%**
Refrigeration	1.9	10%	0.6	4%	**2.4**	**7%**
Wet Clean	1.0	5%			**1.0**	**3%**
Cooking	0.9	5%	0.3	2%	**1.2**	**4%**
Electronics	1.1	6%	1.1	7%	**2.3**	**7%**
Motors	0.2	1%			**0.2**	**1%**
Heat Appliances	0.4	2%			**0.4**	**1%**
Other	0.1	1%	1.2	8%	**1.3**	**4%**
Miscellaneous	1.0	5%	2.0	13%	**3.0**	**9%**
Total	18.8	100%	1.0	100%	**34.2**	**100%**

Expenditures ($1998 and % of totals)

End Use	Residential		Commercial		**Buildings**	
Space Heat	38.3	29%	13.0	13%	**51.3**	**23%**
Space Cool	15.3	12%	13.0	13%	**28.3**	**12%**
Vent			5.9	6%	**5.9**	**3%**
Water Heat	20.4	16%	6.8	7%	**27.2**	**12%**
Lighting	9.3	7%	25.4	26%	**34.7**	**15%**
Refrigeration	13.6	10%	3.9	4%	**17.4**	**8%**
Wet Clean	7.3	6%			**7.3**	**3%**
Cooking	6.6	5%	1.7	2%	**8.3**	**4%**
Electronics	8.3	6%	7.5	8%	**15.9**	**7%**
Motors	1.5	1%			**1.5**	**1%**
Heat Appliances	2.6	2%			**2.6**	**1%**
Other	0.9	1%	7.6	8%	**8.4**	**4%**
Miscellaneous	7.0	5%	12.3	13%	**19.4**	**8%**
Total	131.1	100%	97.0	100%	**228.1**	**100%**

8. Buildings Energy Prices and Expenditures

Prices ($1998/10^6 Btu)

	Residential Buildings				Commercial Buildings				Bldgs
	Elec	NGas	Petro	Avg	Elec	NGas	Petro	Avg	Avg
1980	29.36	6.73	13.57	14.17	30.02	6.21	10.54	14.90	14.46
1990	27.65	6.78	10.70	14.70	25.53	5.66	7.12	14.65	14.68
1998	**23.58**	**6.60**	**7.48**	**13.37**	**21.76**	**5.26**	**4.55**	**13.27**	**13.33**
2000	23.05	6.68	9.45	13.37	21.19	5.47	6.20	13.22	13.31
2010	21.67	6.57	9.73	13.14	18.65	5.53	6.27	12.26	12.77
2020	21.33	6.36	10.04	13.15	18.17	5.50	6.49	12.12	12.71

Petroleum includes distillate and residual fuel oils, LPG, kerosene, and motor gasoline.
1998 average electricity cost: resid. $0.080/kWh, comm. $0.074/kWh, and Bldgs. $0.077/kWh.

Expenditures ($1998 billion)

	Residential Buildings				Commercial Buildings				Bldgs
	Elec	NGas	Petro	Total	Elec	NGas	Petro	Total	Total
1980	71.9	32.7	23.7	**128.3**	57.2	16.6	13.6	**87.3**	215.7
1990	87.1	30.6	13.5	**131.2**	73.0	15.3	6.5	**94.7**	226.0
1998	**90.4**	**30.4**	**10.1**	**130.9**	**77.6**	**16.4**	**3.0**	**96.9**	**227.8**
2000	93.2	33.7	12.9	**139.8**	79.3	18.0	3.7	**101.1**	240.9
2010	102.0	35.8	12.2	**150.0**	81.3	19.8	3.9	**105.0**	255.0
2020	113.0	37.3	11.5	**161.8**	84.9	20.6	3.9	**109.5**	271.3

Expenditures exclude wood and coal costs. 1998 U.S. energy expenditures were $538.3 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
1998	**102.8**	**14%**	**82.6**	**99.5**	**182.5**
2000	105.4	18%	N/A	103.9	188.7
2010	117.1	32%	N/A	101.6	185.0
2020	127.5	44%	N/A	100.5	180.2

1998 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	102.0	199.4
1998	**61.2**	**13%**	**4.6**	**121.7**	**251.2**
2000	63.3	18%	N/A	123.4	254.0
2010	70.9	38%	N/A	123.3	250.8
2020	73.8	53%	N/A	124.8	246.5

1996 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 ($1998)

	Residential ($/Household)	Commercial ($/SF)
1980	1,611	1.72
1990	1,393	1.47
1998	**1,274**	**1.58**
2000	1,327	1.60
2010	1,280	1.48
2020	1,268	1.48

12. Carbon 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	309.8	149.9	459.8	34%	8%
1998	**368.5**	**152.6**	**521.0**	**35%**	**8%**
2000	400.1	161.8	561.9	36%	9%
2010	462.6	169.8	632.5	35%	8%
2020	509.3	175.8	685.1	35%	7%

Buildings emissions equal emissions of Japan and United Kingdom combined.
1998 U.S. emissions = 1,480 MMTCE. 1996 Global emissions = 6,175 MMTCE.

13. EPA Emissions for U.S. Buildings, 1998

(10^3 short tons)

	Buildings			Bldgs % of
	Wood/*Site* Fossil	Elec	Total	U.S. Emiss
SO2	609	8857	9466	48%
NOx	1117	4090	5207	21%
CO	3843	279	4122	5%
VOCs	678	36	714.2	4%
PM-2.5	476	106	581.9	7%
PM-10	544	202	746.4	2%
Lead	416	46	461.6	12%

14. Value of New, Improvement & Repair Building Construction ($1998 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	133.8	128.9	262.7	5.1%	86.5	N.A.	N.A.	N.A.
1985	168.8	180.8	349.6	5.8%	115.3	112.0	227.3	3.8%
1990	158.7	178.5	337.2	4.9%	129.0	111.8	240.8	3.5%
1998	**218.0**	**210.7**	**428.7**	**5.0%**	**120.7**	**99.9**	**220.6**	**2.6%**

1998 U.S. GDP = $8.5 trillion.

15. 1998 Housing Sales Price ($1998)

Housing Type	Median
New Single-Family	152,500
Existing Single-Family	128,400
New Mobile Home	43,800

Excludes land costs

16. Residential New Single-Family Housing Completed

	# of Units	Average SF
1980	957,000	1,730
1990	966,000	2,080
1998	**1,159,700**	**2,190**

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.	3,862	119,300	
1998	**158**	**4,504**	**134,100**	(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 1997 Energy Burdens

	Mean Individual	Median Individual	Mean Group
All Hholds	6.8%	3.8%	2.8%
Fed Elgble Hhold	14.1%	9.0%	9.0%
Fed Ineligible Hhold	3.3%	2.8%	2.3%

Average income of a Federally eligible household was $12,500 in 1997.

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

Over 5 million homes have been weatherized under DOE.
DOE Weatherization saves an average of 13-34% on home energy bills with a cost-benefit ratio of 1.8.
In Program Year 1989, costs per weatherized units were $1,550 for single-family and small multi-family dwellings, and $1,000 for dwellings in large multi-family buildings.

21. 1994 U.S. Private Investment into Construction R&D

Sector	Percent of Sales
Average Construction R&D (1)	< 0.5
Housing (materials/components)	1.7
Construction materials	1.0
Construction machinery	3.0
U.S. Industry Average	3.5
International Industry Composite	4.3

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

22. 1998 Five Largest Residential Homebuilders

Homebuilder	Home Closings	% of Closings
Pulte Home Corporation	20,359	1.4%
Kaufman and Broad Home Corporati	15,213	1.0%
D.R. Horton	15,168	1.0%
Centex Corporation	13,759	0.9%
Lennar Corp.	10,777	0.7%
Total of Top Five	75,276	5.1%
Habitat for Humanity	3,641	0.25%

1998 total U.S. new home closings was 1.47 million. 1998 total share of top 100 builders was 20.4%. Top 400 builders built 42% of 1996 new homes.

The summary tables correspond to the following tables in Chapters 1 through 7 of the BTS Core 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.**	1.2.4, 1.2.6, 1.3.4, 1.3.6,	**12.**	3.1.1	**16.**	2.1.6	**20.**	7.1.1, 7.1.3
3.	1.1.4	**7.**	1.1.6, 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, 7.2.2	**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 1980-Year
1980	7.52	28%	3.04	11%	0.15	1%	0.88	3%	4.35	10.60	14.95	56%	26.53	100%	-
1990	7.22	25%	2.17	7%	0.16	1%	0.63	2%	6.01	13.16	19.17	65%	29.35	100%	1.0%
1998	**7.72**	**23%**	**1.97**	**6%**	**0.14**	**0%**	**0.50**	**1%**	**7.40**	**16.46 (4)**	**23.86**	**70%**	**34.19**	**100%**	1.4%
2000	8.34	23%	1.98	5%	0.15	0%	0.56	2%	7.78	17.21	25.00	69%	36.02	100%	1.5%
2010	9.04	23%	1.87	5%	0.16	0%	0.59	1%	9.06	18.80	27.86	71%	39.51	100%	1.3%
2020	9.61	23%	1.75	4%	0.16	0%	0.62	2%	9.97	19.16	29.13	71%	41.27	100%	1.1%

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) 1998 *site*-to-source electricity conversion = 3.22.

Source(s): EIA, State Energy Data Report 1997, Sept. 1999, Tables 12 - 15, p. 22-25 for 1980 and 1990; EIA, Annual Energy Outlook (AEO) 2000, Dec.1999, Table A2, p. 119-121 for 1998-2020 and Table A18, p. 141 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%	84.0
1998	**20%**	**16%**	**36%**	**37%**	**27%**	**100%**	**94.9**
2000	20%	16%	**37%**	36%	27%	100%	98.2
2010	19%	16%	**35%**	35%	29%	100%	111.3
2020	19%	15%	**34%**	35%	31%	100%	121.0

Note(s): 1) Buildings-related energy consumption in the industrial sector in 1991 was 1.96 of 31.76 quads; for comparison, 1998 industrial sector energy use was 34.84 quads. 2) Renewables are not included in the 1980 data.

Source(s): EIA, State Energy Data Report 1997, Sept. 1999, Tables 12 - 15, p. 22-25 for 1980 and 1990; EIA, AEO 2000, Dec.1999, Table A2, p. 119-121 for 1998-2020 data and Table A18, p. 141 for non-marketed renewable energy.

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

	Residential	Commercial	**Total Buildings**	Industry	TOTAL	U.S. Electricity *Delivered* Total (quads)
1980	34%	27%	**61%**	39%	100%	7.1
1990	34%	31%	**65%**	35%	100%	9.3
1998 (1)	**35%**	**32%**	**67%**	**32%**	**100%**	**11.0**
2000	35%	33%	**68%**	32%	100%	11.5
2010	35%	33%	**68%**	31%	100%	13.3
2020	36%	32%	**67%**	32%	100%	14.8

Note(s): 1) The Transportation sector accounted for 0.6% of electricity consumption in 1998, and 1% in 2010 and 2020. In 1998, Buildings accounted for 78% (or $168 billion) of total U.S. electricity expenditures.

Source(s): EIA, State Energy Data Report 1997, Sept. 1999, Tables 12-15, p. 22-25 for 1980 and 1990; EIA, AEO 2000, Dec.1999, Table A2, p. 119-121 for 1998-2020 consumption, Table A3, p. 122-123 for 1998 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%	28%	7%	4%	11%	6%	(2)	100%
1990	31%	10%	36%	7%	3%	9%	14%	(2)	100%
1998	**30%**	**8%**	**38%**	**7%**	**3%**	**10%**	**14%**	**1%**	**100%**
2000	31%	7%	38%	6%	3%	9%	14%	1%	100%
2010	34%	6%	39%	5%	4%	9%	12%	0%	100%
2020	39%	5%	39%	5%	4%	9%	7%	0%	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 1997, Sept. 1999, Tables 12-15, p. 22-25 for 1980 and 1990; EIA, AEO 2000, Dec.1999, Table A2, p. 119-121 for 1998-2020 consumption and Table A18, p. 141 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	0.8800	0.0000	N.A.	N.A.	0.8800
1990	0.5820	0.0480	N.A.	0.0030	0.6330
1998	**0.4628**	**0.0235**	**0.0001**	**0.0145**	**0.5010**
2000	0.5112	0.0288	0.0003	0.0157	0.5560
2010	0.5184	0.0304	0.0104	0.0307	0.5899
2020	0.5317	0.0308	0.0139	0.0474	0.6238

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. Includes energy displaced in space heating and cooling applications.

Source(s): EIA, State Energy Data Report 1997, Sept. 1999, Table 12-13, p. 22-23 for 1980 and 1990; and EIA, AEO 2000, Dec.1999, Table A18, p. 141 for 1998-2020.

1.1.6 1997 World Primary Energy Consumption and Population, by Country/Region (1)

	Energy Consumption (Quad)				Population (million)				Annual Growth Rate	
Region/Country	1997		2010		1997		2010		Energy	Population
United States (1)	94.2	24.8%	111.3	22.3%	268	4.6%	298	4.4%	1.3%	0.8%
Former Soviet Union	40.8	10.7%	47.3	9.5%	292	5.0%	294	4.3%	1.1%	0.0%
China	36.7	9.7%	68.1	13.6%	1244	21.2%	1373	20.2%	4.9%	0.7%
Other Western Europe	29.5	7.8%	33.5	6.7%	187	3.2%	187	2.7%	1.0%	0.0%
Japan	21.3	5.6%	24.1	4.8%	126	2.1%	127	1.9%	1.0%	0.1%
Other Asia	19.3	5.1%	27.2	5.4%	909	15.5%	1082	15.9%	2.7%	1.3%
Central and South America	18.3	4.8%	30.1	6.0%	398	6.8%	478	7.0%	3.9%	1.3%
Middle East	17.9	4.7%	26.2	5.2%	229	3.9%	295	4.3%	3.0%	1.8%
Germany	14.2	3.7%	15.9	3.3%	82	1.4%	82	1.2%	0.9%	0.0%
Eastern Europe	12.5	3.3%	15.6	3.1%	121	2.1%	121	1.8%	1.7%	0.0%
Canada	12.5	3.3%	15.0	3.0%	30	0.5%	34	0.5%	1.4%	0.9%
India	11.8	3.1%	20.4	4.1%	966	16.5%	1152	16.9%	4.3%	1.3%
Africa	11.4	3.0%	15.8	3.2%	731	12.5%	973	14.3%	2.5%	2.1%
France	10.4	2.7%	11.8	2.4%	58	1.0%	61	0.9%	1.0%	0.4%
United Kingdom	9.9	2.6%	11.4	2.3%	59	1.0%	59	0.9%	1.1%	0.0%
South Korea	7.5	2.0%	10.7	2.1%	46	0.8%	50	0.7%	2.8%	0.6%
Mexico	5.8	1.5%	8.7	1.7%	94	1.6%	113	1.7%	3.2%	1.3%
Other	5.9	1.6%	7.1	1.4%	28	0.5%	30	0.4%	1.4%	0.5%
Total	379.9	100%	500.2	100%	5868	100%	6809	100%	2.1%	1.1%

Note(s): 1) In 1997, U.S. Buildings consumed 34.3 quads.

Source(s): EIA, International Energy Outlook 2000, March 2000, Table A1, p. 169 and Table A16, p. 186; and EIA, AEO 2000, Dec. 1999, Table A2, p. 119-121.

1.1.7 1998 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)	4.42	1.04	0.27	0.28	0.40	0.64	7.04	39.7%	2.05	8.45	24.7%
Space Cooling (7)	0.02					1.24	1.26	7.1%	4.00	4.02	11.7%
Ventilation (8)						0.27	0.27	1.5%	0.87	0.87	2.5%
Water Heating (9)	1.88	0.22	0.10		0.02	0.58	2.80	15.8%	1.87	4.09	12.0%
Lighting						1.56	1.56	8.8%	5.03	5.03	14.7%
Refrigeration (10)						0.75	0.75	4.2%	2.43	2.43	7.1%
Wet Clean (11)	0.06					0.29	0.36	2.0%	0.94	1.01	3.0%
Cooking	0.39		0.03			0.25	0.66	3.7%	0.79	1.21	3.5%
Electronics (12)						0.70	0.70	3.9%	2.25	2.25	6.6%
Motors (13)						0.06	0.06	0.3%	0.20	0.20	0.6%
Heating Appliances (14)						0.11	0.11	0.6%	0.35	0.35	1.0%
Other (15)	0.26	0.02	0.08	0.03	0.08	0.26	0.73	4.1%	0.84	1.31	3.8%
Miscellaneous (16)	0.70	0.05				0.69	1.43	8.1%	2.22	2.96	8.7%
Total	7.72	1.32	0.48	0.31	0.50	7.40	17.73	100%	23.86	34.19	100%

Note(s): 1) See Table 1.3.11 for buildings-related energy consumption in industrial buildings. 2) Includes distillate fuel oil (1.22 quad) and residual fuel oil (0.11 quad). 3) Kerosene (0.14 quad) and coal (0.14 quad) are assumed attributable to space heating. Motor gasoline (0.03 quad) assumed attributable to other end-uses. 4) Comprised of wood space heating (0.38 quad), geothermal (0.01 quad) (includes space heating), solar water heating (0.02 quad), biomass consumption (0.08 quad), and solar pv (less than 0.001 quad). 5) *Site* -to-source electricity conversion (due to generation and transmission losses) = 3.22. 6) Includes furnace fans (0.21 quad), natural gas district services (0.31 quad), distillate oil district services (0.06 quad), and electric district services (0.11 quad). 7) Includes natural gas district services (0.002 quad) and electric district services (less than 0.001 quad). 8) Commercial only; residential fan and pump energy use included proportionately in space heating and cooling. 9) Includes natural gas district services (0.15 quad), distillate fuel oil district services (0.03 quad), and electric district services (0.07 quad). 10) Includes refrigerators (1.45 quad) and freezers (0.40 quad). Includes commercial refrigeration. 11) Includes clothes washers (0.10 quad), natural gas clothes dryers (0.06 quad), electric clothes dryers (0.70 quad) , and dishwashers (0.15 quad). Does not include water heating energy. 12) Includes color television (0.38 quad), personal computers (0.44 quad), and other office equipment (1.43 quad). 13) Includes residential devices whose energy consumption is driven by motors. 14) Includes residential appliances such as electric blankets, irons, waterbed heaters, and hair dryers. 15) Includes residential swimming pool heaters, outdoor grills, and natural gas outdoor lighting. Includes commercial service station equipment, emergency electric generators, natural gas-driven pumps, natural gas lighting, automated teller machines, telecommunications equipment, medical equipment and some manufacturing performed in commercial buildings. 16) Energy attributable to the buildings sector, but not directly to specific end-uses (Adjustment to SEDS).

Source(s): EIA, AEO 2000, Dec. 1999, Tables A2, p. 119-121, Table A4, p. 124-125, Table A5, p. 126-127, and Table A18, p. 141; EIA, National Energy Modeling System for AEO 2000, Dec. 1999; BTS/A.D. Little, Electricity Consumption by Small End-Uses in Residential Buildings, Appendix A for residential electric end-uses; BTS/A.D. Little, Energy Consumption Characteristics of Commercial Building HVAC Systems, Volume II: Thermal Distribution, Auxiliary Equipment, and Ventilation, October 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 1980-Year
1980	4.86	30%	1.75	11%	0.06	0%	0.86	5%	2.45	5.96		8.41	53%	15.93	100%	-
1990	4.52	27%	1.27	8%	0.06	0%	0.63	4%	3.15	6.90		10.05	61%	16.53	100%	0.4%
1998	**4.61**	**25%**	**1.36**	**7%**	**0.06**	**0%**	**0.40**	**2%**	**3.83**	**8.53**	**(3)**	**12.36**	**66%**	**18.79**	**100%**	0.9%
2000	5.04	25%	1.37	7%	0.06	0%	0.45	2%	4.04	8.94		12.98	65%	19.91	100%	1.1%
2010	5.46	25%	1.25	6%	0.05	0%	0.48	2%	4.70	9.76		14.46	67%	21.70	100%	1.0%
2020	5.86	25%	1.15	5%	0.05	0%	0.51	2%	5.30	10.18		15.47	67%	23.04	100%	0.9%

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) 1998 *site* -to-source electricity conversion = 3.22.

Source(s): EIA, State Energy Data Report 1997, Sept. 1999, Tables 12 - 15, p. 22-25 for 1980 and 1990; EIA, AEO 2000, Dec. 1999, Table A2, p. 119-121 for 1998-2020 consumption and Table A18, p. 141 for non-marketed renewable energy.

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

	Wood (2)	Solar Thermal (2)	Solar PV (2)	GHP (3)	Total
1980	0.8590	0.0000	N.A.	N.A.	0.8590
1990	0.5820	0.0480	N.A.	N.A.	0.6300
1998	**0.3846**	**0.0051**	**0.0000**	**0.0145**	**0.4042**
2000	0.4329	0.0050	0.0000	0.0157	0.4537
2010	0.4402	0.0048	0.0010	0.0307	0.4766
2020	0.4534	0.0046	0.0037	0.0474	0.5091

Note(s): 1) Does not include renewable energy consumed by electric utilities (including hydroelectric). 2) Includes only solar energy. 3) GHP = Ground-Coupled Heat Pumps. Includes energy displaced in space heating and cooling applications.

Source(s): EIA, State Energy Data Report 1997, Sept. 1999, Table 12, p. 22 for 1980 and 1990; and EIA, AEO 2000, Dec.1999, Table A18, p. 141 for 1998-2020.

1.2.3 1998 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)	3.01	0.71	0.27	0.16	0.40	0.45	4.99	48.7%	1.44	5.99	31.9%
Space Cooling (6)	0.00					0.65	0.65	6.3%	2.09	2.09	11.1%
Water Heating (7)	1.23	0.13	0.10		0.01	0.44	1.91	18.6%	1.42	2.89	15.4%
Lighting						0.39	0.39	3.8%	1.27	1.27	6.7%
Refrigeration (8)						0.57	0.57	5.6%	1.85	1.85	9.9%
Wet Clean (9)	0.06					0.29	0.36	3.5%	0.94	1.01	5.4%
Cooking (10)	0.18		0.03			0.22	0.43	4.2%	0.70	0.91	4.8%
Electronics (11)						0.35	0.35	3.4%	1.14	1.14	6.1%
Motors (12)						0.06	0.06	0.6%	0.20	0.20	1.1%
Heating Appliances (13)						0.11	0.11	1.1%	0.35	0.35	1.9%
Other (14)	0.11	0.00	0.01		0.00		0.12	1.2%		0.12	0.7%
Miscellaneous (15)						0.30	0.30	2.9%	0.96	0.96	5.1%
Total	4.61	0.84	0.41	0.16	0.40	3.83	10.26	100%	12.36	18.79	100%

Note(s): 1) Includes 0.84 quads distillate fuel oil. 2) Kerosene (0.10 quad) and coal (0.06 quad) are assumed attributable to space heating. 3) Comprised of 0.38 quad wood (space heating), 0.01 quad geothermal (assumed space heating), 0.01 quad solar (water heating), and pv electric generation (other) (less than 0.001 quad). 4) *Site*-to-source electricity conversion (due to generation and transmission losses) = 3.22. 5) Fan (0.21 quad) and pump energy use included. 6) Fan energy use included. 7) Includes electric recreational water heating (0.12 quad). 8) Includes refrigerators (1.45 quad) and freezers (0.40 quad). 9) Includes clothes washers (0.10 quad), natural gas clothes dryers (0.06 quad), electric clothes dryers (0.70 quad), and dishwashers (0.15 quad). Does not include water heating energy. 10) Includes microwaves (0.15 quad) and other "small" electric cooking appliances. 11) Includes color televisions (0.38 quad), personal computers (0.18 quad), and other electronics (0.58 quad). 12) Includes devices whose energy consumption is driven by motors. 13) Includes appliances such as electric blankets, irons, waterbed heaters, and hairdryers. 14) Includes swimming pool heaters,outdoor grills, and natural gas outdoor lighting. 15) Energy attributable to the residential buildings sector, but not directly to specific end-uses.

Source(s): EIA, AEO 2000, Dec. 1999, Tables A2, p. 119-121, Table A4, p. 1124-125, and Table A18, p. 141; 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	200.0
1990	94.2	N.A.	9.6	102.3	16.5	175.5
1998	**102.8**	**14%**	**10.2**	**99.5**	**18.8**	**182.5**
2000	105.4	18%	10.9	103.9	19.9	188.7
2010	117.1	32%	11.9	101.6	21.7	185.0
2020	127.5	44%	12.8	100.5	23.0	180.2

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

Source(s): EIA, State Energy Data Report 1997, Sept. 1999, Table 12, p. 22 for 1980 and 1990; EIA, AEO 2000, Dec. 1999, Tables A2 and A4, p. 119-121, and p. 124-125 for 1998-2020; U.S. DOC, Statistical Abstract of the United States 1999, Oct. 1999, Table No. 1210, p. 728 for 1980 and 1990 households.

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**	**83%**
- Detached	58.4	117.9	42.2	73%
- Attached	64.4	94.4	40.5	9%
Multi-Family:	**67.3**	**59.9**	**31.5**	**13%**
- 2 to 4 units	93.2	91.5	28.4	5%
- 5 or more units	56.7	48.6	40.7	8%
Mobile Homes	**80.0**	**79.5**	**23.7**	**5%**
				100%

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**	**72.53**	**29.4**	**23%**
- Public Housing	62.7	50.99	25.3	2%
- Not Public Housing	70.9	74.78	29.8	22%
				100%

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

1.2.9 Aggregate Residential Building Component Loads (1)

	Loads (quads) and Percent of Total Loads			
Component	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 1999, 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

	Consumption (10^3 Btu/SF)		Consumption (10^6 Btu/Hhold)		Consumption (10^6 Btu/Member)	
Building Type	Pre-1990	1990-1997	Pre-1990	1990-1997	Pre-1990	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 1980-Year
1980	2.67	25%	1.29	12%	0.09	1%	0.02	**0%**	1.91	4.64		6.54	62%	10.61	100%	-
1990	2.70	21%	0.91	7%	0.09	1%	0.00	**0%**	2.86	6.26		9.12	71%	12.82	100%	1.9%
1998	**3.11**	**20%**	**0.61**	**4%**	**0.09**	**1%**	**0.10**	**1%**	**3.56**	**7.93**	**(5)**	**11.49**	**75%**	**15.40**	100%	2.1%
2000	3.30	20%	0.61	4%	0.09	1%	0.10	1%	3.74	8.27		12.02	75%	16.11	100%	2.1%
2010	3.58	20%	0.62	3%	0.10	1%	0.11	1%	4.36	9.04		13.39	75%	17.81	100%	1.7%
2020	3.75	21%	0.60	3%	0.10	1%	0.11	1%	4.68	8.98		13.66	75%	18.23	100%	1.4%

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) 1980 and 1990 Renewables are estimated at below 0.01 quads. 5) 1998 *site* -to-source electricity conversion = 3.22.

Source(s): EIA, State Energy Data Report 1997, Sept. 1999, Table 13, p. 28 for 1980 and 1990; EIA, AEO 2000, Dec. 1999, Table A2, p. 119-121 for 1998-2020 and Table A18, p. 141 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
1998	**0.0783**	**0.0184**	**0.0001**	**0.0000**	**0.0968**
2000	0.0783	0.0238	0.0003	0.0000	0.1023
2010	0.0783	0.0256	0.0094	0.0000	0.1133
2020	0.0783	0.0262	0.0102	0.0000	0.1147

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. Includes energy displaced in space heating and cooling applications.

Source(s): EIA, State Energy Data Report 1997, Sept. 1999, Table 12-13, p. 22-23 for 1980 and 1990; and EIA, AEO 2000, Dec.1999, Table A18, p. 141 for 1998-2020.

1.3.3 1998 Commercial 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)	1.41	0.33		0.12		0.19	2.04	27.4%	0.61	2.46	16.0%
Space Cooling (7)	0.01					0.592	0.61	8.1%	1.91	1.92	12.5%
Ventilation						0.27	0.27	3.6%	0.87	0.87	5.7%
Water Heating (8)	0.64	0.09			0.02	0.14	0.89	11.9%	0.45	1.20	7.8%
Lighting						1.17	1.17	15.6%	3.76	3.76	24.4%
Refrigeration						0.18	0.18	2.4%	0.57	0.57	3.7%
Cooking	0.20					0.03	0.23	3.1%	0.10	0.30	1.9%
Office Equipment						0.35	0.35	4.6%	1.12	1.12	7.3%
Other (9)	0.15	0.02	0.07	0.03	0.08	0.26	0.60	8.1%	0.84	1.19	7.7%
Miscellaneous (10)	0.70	0.05				0.39	1.13	15.2%	1.26	2.00	13.0%
Total	3.11	0.48	0.07	0.14	0.10	3.56	7.47	100%	11.49	15.40	100%

Note(s): 1) See Table 1.3.11 for buildings-related energy consumption in the industrial sector. 2) Includes (0.38 quad) distillate fuel oil and (0.11 quad) residual fuel oil. 3) Kerosene (0.03 quad) and coal (0.09 quad) are assumed attributable to space heating. Motor gasoline (0.03 quad) assumed attributable to other end-uses. 4) Comprised of solar water heating (0.02 quad), and biomass electric generation (0.003 quad). 5) *Site*-to-source electricity conversion (due to generation and transmission losses) = 3.22. 6) Includes natural gas district services (0.27 quad), distillate oil district services (0.06 quad), and electric district services (0.11 quad). 7) Includes natural gas district services (0.002 quad) and electric district services (less than 0.001 quad). 8) Includes natural gas district services (0.13 quad), distillate fuel oil district services (0.02 quad), and electric district services (0.07 quad). 9) Includes commercial service gas station equipment, emergency electric generators, cogenerators, natural gas-driven pumps, natural gas lighting, automated teller machines, telecommunications equipment, medical equipment and some manufacturing performed in commercial buildings. 10) Energy attributable by EIA to the commercial buildings sector but not directly to specific end-uses (Adjustment to SEDS).

Source(s): EIA, AEO 2000, Dec. 1999, Tables A2, p. 119-121, Table A5, p. 126-127, and Table A18, p. 141; EIA, National Energy Modeling System for AEO 2000, Dec. 1999; BTS/A.D. Little, Energy Consumption Characteristics of Commercial Building HVAC Systems, Volume II: Thermal Distribution, Auxiliary Equipment, and Ventilation, October 1999, p. 1-2, 5-25, 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 per SF (10^3 Btu/SF)	Primary Energy Consumption Total (quads)	Primary Energy 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	102.0	12.8	199.4
1998	**(3)**	**61.2**	**13%**	**7.5**	**121.7**	**15.4**	251.2
2000	(3)	63.3	18%	7.8	123.4	16.1	254.0
2010	(3)	70.9	38%	8.7	123.3	17.8	250.8
2020	(3)	73.81	53%	9.2	124.8	18.2	246.5

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 1997, Sept. 1999, Table 13, p. 23 for 1980 and 1990; EIA, AEO 1994, Jan. 1994, Table A5, p. 62 for 1990 floorspace; EIA, AEO 2000, Dec. 1999, Tables A2 and A5, p. 119-121 and 126-127 for 1998-2020.

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
Mercantile and Service	155.3	19%	Health Care	422.6	10%
Office	227.2	23%	Food Service	487.8	6%
Warehouse and Storage	76.3	6%	Food Sales	585.7	4%
Education	136.8	10%	Public Order/Safety	142.4	2%
Public Assembly	169.7	6%	Vacant (2)	49.1	2%
Lodging	235.2	8%	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)

	Loads (quads) and Percent of Total Loads			
Component	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, November 1999, 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 31.79 quads; for comparison, 1998 industrial primary energy consumption was 34.84 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 1997, Table 14, p. 24 for industrial sector note; EIA, AEO 2000, Table A2, p. 119-121; DOE/BTS Memorandum, AEO98 Data Clarification for Building Energy Analysts, May 13, 1998.

1.4.1 FY 1998 Federal Primary Energy Consumption

Buildings and Facilities	**0.72 quads**
Vehicles/Equipment/Energy-Intensive Operations	0.78 quads (mostly jet fuel and diesel)
Total Federal Government Consumption	1.49 quads

Source(s): DOE/FEMP, Annual Report to Congress on FEMP (Draft), Mar. 20, 2000, Table 1-A, p. 11 for total consumption and Table 4-A, p. 47 for buildings consumption.

1.4.2 FY 1998 Federal Building Energy Use Shares, by Fuel Type, and by Agency

Fuel Type	*Site* Percent	Primary Percent	Agency	Primary Percent		FY 1998 Quads
Electricity	42.9%	71.9%	Defense	59.9%	Total *Delivered*	
Natural Gas	35.3%	17.4%	Postal	7.8%	Energy Consumption =	0.35
Fuel Oil	10.7%	5.3%	DOE	6.8%	Total Primary	
Coal	5.5%	2.7%	VA	6.8%	Energy Consumption =	0.72
Other	5.6%	2.8%	GSA	4.8%		
	100%	100%	Other	13.8%		
				100%		

Note(s): See Table 2.3.1 for floorspace.

Source(s): DOE/FEMP, Annual Report to Congress on FEMP (Draft), Mar. 20, 2000, Tables 6-B, p. 53 for fuel types, and Table 4-A, p. 47 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	139.6	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	115.8
FY 1989	133.1	FY 1998	113.7
FY 1990	129.8	FY 2000 (3)	111.7
FY 1991	126.0	FY 2005 (4)	97.7
FY 1992	129.2	FY 2010 (4)	90.7
FY 1993	126.1		

Note(s): 1) See Table 2.3.1 for floorspace. 2) Exceeds the National Energy Conservation Policy Act goal of 125,600 Btu/SF. 3) Executive Order 12759 and EPAct goals. 4) Executive Order 13123 goal.

Source(s): DOE/FEMP for FY 1986-1989 energy consumption and FY 1986-1997 floorspace; DOE/FEMP, Annual Report to Congress on FEMP (Draft), Mar. 20, 2000, Table 4-B, p. 48 for FY 1985, 1990-1998 energy consumption, and Table 7-A, p. 56 for FY 1985 and 1998 floorspace.

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

	Residential	Commercial	**Total Buildings**	Industry	TOTAL	U.S. Electricity *Delivered* Total (quads)
1980	34%	27%	**61%**	39%	100%	7.1
1990	34%	31%	**65%**	35%	100%	9.3
1998 (1)	**35%**	**32%**	**67%**	**32%**	**100%**	**11.0**
2000	35%	33%	**68%**	32%	100%	11.5
2010	35%	33%	**68%**	31%	100%	13.3
2020	36%	32%	**67%**	32%	100%	14.8

Note(s): 1) The Transportation sector accounted for 0.6% of electricity consumption in 1998, and 1% in 2010 and 2020. In 1998, Buildings accounted for 78% (or $168 billion) of total U.S. electricity expenditures.

Source(s): EIA, State Energy Data Report 1997, Sept. 1999, Tables 12 -16, p. 22-26 for 1980 and 1990; EIA, AEO 2000, Dec. 1999, Table A2, p. 119-121 for 1998-2020 consumption, and Table A3, p. 122-123 for 1998 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%
1998	**11%**	**3%**	**53%**	**9%**	**2%**	**12%**	**20%**	**1%**	**100%**
2000	11%	2%	54%	8%	3%	11%	20%	1%	100%
2010	16%	1%	55%	8%	3%	11%	16%	1%	100%
2020	22%	1%	55%	7%	4%	11%	11%	0%	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 1997, Sept. 1999, Tables 16, p. 26 for 1980 and 1990; EIA, AEO 2000 Dec. 1999, Table A2, p. 119-121 for 1998-2020 consumption.

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	3.04	0.21	3.25	6.16	(1)	29.61
1998	**3.75**	**1.23**	**19.00**	**3.33**	**0.79**	**4.12**	**7.19**	**0.31**	**35.60**
2000	4.21	0.88	19.94	3.09	0.94	4.02	7.35	0.42	36.82
2010	6.60	0.48	22.54	3.09	1.33	4.43	6.70	0.26	41.00
2020	9.46	0.37	24.01	3.08	1.67	4.75	4.56	0.21	43.35

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 1997, Sept. 1999, Tables 16, p. 26 for 1980 and 1990; EIA, AEO 2000, Dec. 1999, Table A2, p. 119-121 for 1998-2020 consumption and Table A18, p. 141 for renewables.

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
1998	**102.8**	**14%**	**82.6 (3)**	**168.8 (3)**	**271**	**2.6**
2000	105.4	18%	N.A.	N.A.	275	2.6
2010	117.1	32%	N.A.	N.A.	298	2.5
2020	127.5	44%	N.A.	N.A.	323	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 United States 1999, Oct. 1999, No. 1210, p. 728 for number of households (1980/1990), No. 2-3, p. 8-9 for 1980-2020 populations; EIA, AEO 2000, Dec. 1999, Table A4, p. 124-125 for households (1998-2020); EIA, NEMS for AEO 2000 (unpublished data) for 1990-2020 housing starts; EIA, Buildings and Energy in the 1980's, June 1995, Table 2.1, p. 23 for total number of residential buildings and floorspace in 1980 and 1990; and EIA, RECS 1997 for 1997 number of 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	27.5%
1950 to 1959	12.3%
1960 to 1969	14.2%
1970 to 1979	19.3%
1980 to 1989	17.1%
1990 to 1997	9.6%
	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
1978	1369	1755	498	902	280	2147
1979	1301	N.A.	570	N.A.	280	2151
1980	957	N.A.	545	N.A.	234	1736
1981	818	1720	448	980	208	1474
1982	631	N.A.	374	N.A.	234	1239
1983	924	N.A.	466	N.A.	278	1668
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	446	990	224	1755
1989	1026	2035	397	1000	203	1626
1990	966	2080	343	1005	195	1504
1991	838	2075	254	1020	174	1266
1992	964	2095	194	1040	212	1370
1993	1039	2095	153	1065	242	1435
1994	1160	2100	187	1035	291	1639
1995	1066	2095	247	1080	319	1632
1996	1129	2120	284	1070	339	1751
1997	1116	2150	284	1095	338	1739
1998	1160	2190	315	1065	369	1843

Source(s): NAHB, Housing Market Statistics, May 1995, p. 28 for 1978-1985 single- and multi-family home completions and p. 29 for 1978-1979 mobile home placements; DOC, Current Construction Reports: Housing Completions, C22/98-10, Table 1, p. 3 for 1986-1989 single- and multi-family completions; DOC, Current Construction Reports: Housing Completions, C22/99-12, Table 1, p. 3 for 1990-1998 single- and multi-family completions; DOC, Manufactured Housing Statistics: Manufactured Homes Placements for 1980-1998 mobile home placements; NAHB, Housing Economics, March 1995, Table 1, p. 10 for 1978-1993 single- and multi-family homes square footage; and DOC, Current Construction Reports: Characteristics of New Housing, C25/98-A, Table 16, p. 37 for 1994-98 single-family square footage and Table 18, p. 44 for 1994-98 multi-family square footage.

2.1.7 Materials Used in the Construction of a 2,085 Sq. Ft. New Single-Family Home, 1995

13,127 board-feet of lumber	12 interior doors
6,212 square feet of sheathing	7 closet doors
14 tons of concrete	2 garage doors
2,325 square feet of exterior siding material	1 fireplace
3,100 square feet of roofing material	3 toilets; 2 bathtubs; 1 shower stall
3,061 square feet of insulation	3 bathroom sinks
6,144 square feet of interior wall material	13 kitchen cabinets; 2 other cabinets
2,100 square feet of interior ceiling material	1 kitchen sink
120 linear feet of ducting	1 range; 1 refrigerator; 1 dishwasher; 1 garbage disposer; 1 range hood
15 windows	1 washer; 1 dryer
5 exterior doors (4 hinged, 1 sliding)	1 heating and cooling system
2,085 square feet of flooring material	

Source(s): NAHB, 1997 Housing Facts, Figures and Trends, 1997, p. 8.

2.1.8 1998 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	116	10%	16	6%	15	4%	147
Midwest	244	21%	47	17%	58	16%	349
South	517	45%	142	52%	246	67%	905
West	283	24%	69	25%	50	14%	402
Total	1,160	100%	274	100%	369	100%	1,803

Note(s): 1) Excludes buildings with 2-4 units.

Source(s): DOC, Current Construction Reports: Housing Completions, C22/99-12, Table 2, p. 4 for household completions; DOC, Manufactured Housing Statistics, Manufactured Home Placements by Region, Sept. 1999 for mobile home placements.

2.1.9 1998 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	104	10%	9	20%	4	12%	116
Midwest	217	20%	18	41%	8	24%	244
South	486	45%	13	30%	18	53%	517
West	274	25%	4	9%	4	12%	283
Total	1,081	100%	44	100%	34	100%	1,160

Source(s): DOC, Current Construction Reports: Characteristics of New Housing 1998, C25/98-A, Table 5, p. 10.

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)
1998 (5)	**61.2**	**13%**	**4.6 (6)**
2000 (5)	63.3	18%	N.A.
2010 (5)	70.9	38%	N.A.
2020 (5)	73.8	53%	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 2000, Dec. 1999, Table A5, p. 126-127 for 1998-2020 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%	Food Sales	1%
Office	18%	Lodging	6%	Public Order/Safety	2%
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) (years)
Prior to 1919	6.2%	Source	
1920 to 1959	27.2%	EIA	59
1960 to 1979	37.8%	PNNL	90
1980 to 1989	20.8%		
1990 to 1995	7.9%		
	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 2000, Jan. 2000, p. 28 for EIA building lifetime; 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)

	Average Floorspace/Building (1000 SF)		
Building Type	Pre-1990	1990-1995	All
Mercantile and Service	25.84	11.26	9.87
Office	15.07	12.87	14.86
Warehouse/Storage	16.46	6.67	14.62
Education	25.84	17.70	25.05
Public Assembly	N.A.	N.A.	12.11
Lodging	N.A.	N.A.	22.90
Health Care	N.A.	N.A.	22.22
Food Service	N.A.	N.A.	4.75
Food Sales	N.A.	N.A.	4.69
Public Order and Safety	N.A.	N.A.	14.61
Vacant (2)	N.A.	N.A.	18.48

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; 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

Agency	1998 Percent of Total Floorspace
Defense	65.5%
Postal	10.5%
GSA	6.1%
VA	5.0%
DOE	2.6%
Other	10.3%
	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 1986-1997; DOE/FEMP, Annual Report to Congress on FEMP (Draft), Mar. 20, 2000, Table 7-A, p. 56 for FY 1985 and FY 1998 data.

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

	Buildings				U.S.				
	Site Fossil	Electricity	Total	Growth Rate 1980-Year	Total	Growth Rate 1980-Year	Buildings % of Total U.S.	Buildings % of Total Global	
1980	172.0	255.2	427.1	-	1281.7	-	33%	9%	
1990	149.9	309.8	459.8	0.7%	1345.3	0.5%	34%	8%	
1998 (2)	**152.6**	**368.5**	**521.0**	**1.1%**	**1485.4**	**0.8%**	35%	**8%**	**(3)**
2000	161.8	400.1	561.9	1.4%	1552.4	1.0%	36%	9%	
2010	169.8	462.6	632.5	1.3%	1786.6	1.1%	35%	8%	
2020	175.8	509.3	685.1	1.2%	1979.2	1.1%	35%	7%	

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) U.S. buildings approximately equal the carbon emissions of Japan and the United Kingdom combined. 3) Global emissions for 1997. Total 1997 U.S. emissions = 1,480 Million Metric Tons of Carbon Equivalent (MMTCE). Total 1997 global emissions = 6,175 MMTCE.

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. 1998, Oct. 1999, Tables 7-11, p. 23-25 for 1990; EIA, AEO 2000, Dec. 1999, Table A19, p. 142 for 1998-2020 U.S. emissions; EIA, International Energy Outlook 2000, March 2000, Table A10, p. 179 for 1990-2020 global emissions; ORNL, Global CO2 Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring: 1751-1995, Jan. 1998 for 1980 global emissions.

3.1.2 1998 Buildings End-Use Carbon Splits, by Fuel Type (10^6 metric tons of carbon) (1)

	Natural	Petroleum (2)								
	Gas	Distil.	Resid.	LPG	Oth(3)	Total	Coal	Electricity (4)	Total	Percent
Space Heating (5)	63.6	18.5	2.3	4.5	2.6	28.0	3.7	31.4	126.7	24.3%
Space Cooling	0.2							60.8	61.1	11.7%
Ventilation (6)								13.4	13.4	2.6%
Water Heating	27.0	4.3		1.7		6.0		28.8	61.9	11.9%
Lighting								77.4	77.4	14.9%
Refrigeration (7)								37.5	37.5	7.2%
Wet Clean (8)	0.9							14.6	15.5	3.0%
Cooking	5.6			0.5		0.5		11.8	17.9	3.4%
Electronics (9)								34.2	34.2	6.6%
Motors (10)								2.9	2.9	0.5%
Heating Appliances (11)								5.0	5.0	1.0%
Other (12)	3.8	0.4		1.4	0.5	2.3		13.0	19.1	3.7%
Miscellaneous (13)	10.1	0.9				0.9		37.6	48.6	9.3%
Total	111.2	24.1	2.3	8.1	3.2	37.7	3.7	368.5	521.0	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. 2) Carbon coefficients calculated from EIA, AEO 2000. Varies 1% or less from EIA, Emissions of Greenhouse Gases in the U.S. 1998. 3) Includes kerosene space (2.6 MMTCE) heating and motor gasoline miscellaneous uses (0.5 MMTCE). 4) Excludes electricity imports from utility consumption. 5) Includes residential furnace fans (3.2 MMTCE). 6) Commercial only; residential fan and pump energy use included proportionately in space heating and cooling. 7) Includes clothes washers (1.6 MMTCE), natural gas clothes dryers (0.9 MMTCE), electric clothes dryers (10.9 MMTCE), and dishwashers (2.2 MMTCE). Does not include water heating energy. 8) Includes refrigerators (22.4 MMTCE) and freezers (6.2 MMTCE). 9) Includes color television (5.9 MMTCE), personal computers (6.9 MMTCE), and other office equipment (21.3 MMTCE). 10) Includes residential devices whose energy consumption is driven by motors. 11) Includes residential appliances such as electric blankets, irons, waterbed heaters, and hair dryers. 12) Includes residential swimming pool heaters, outdoor grills, and natural gas outdoor lighting. Includes commercial service station equipment, emergency electric generators, cogenerators, natural gas-driven pumps, natural gas lighting, automated teller machines, telecommunications equipment, medical equipment, and some manufacturing performed in commercial buildings. 13) Emissions attributable to the buildings sector, but not directly to specific end-uses (Adjustment to SEDS).

Source(s): EIA, Annual Energy Outlook 2000, Dec. 1999, Table A2, p. 119-121, Table A4, p. 124-125 and Table A5, p. 126-127 for energy consumption, and Table A19, p. 142 for emissions; EIA, National Energy Modeling System for AEO 2000, Dec. 1999; EIA, Emissions of Greenhouse Gases in the U.S. 1998, Oct. 1999, Table B1, p. 104 for petroleum carbon coefficients; BTS/A.D. Little, Electricity Consumption by Small End-Uses in Residential Buildings, August 1998, Appendix A for residential electric end-uses; and A.D. Little/BTS, Energy Consumption Characterisitics of Commercial Building HVAC Systems, Volume II: Thermal Distribution, Auxiliary Equipment, and Ventilation, October 1999, p. 1-2.

3.1.3 1998 Residential Energy End-Use Carbon Splits, by Fuel Type (10^6 metric tons of carbon) (1)

	Natural	Petroleum (2)							
	Gas	Distil.	LPG	Kerosene	Total	Coal	Electricity (3)	Total	Percent
Space Heating (4)	43.3	13.6	4.4	2.0	20.0	1.5	22.2	86.9	30.7%
Space Cooling (5)	0.0						32.0	32.0	11.3%
Water Heating (6)	17.8	2.5	1.6		4.2		21.8	43.7	15.4%
Lighting							19.4	19.4	6.8%
Refrigeration (7)							28.6	28.6	10.1%
Wet Clean (8)	0.9						14.6	15.5	5.5%
Cooking (9)	2.7		0.5		0.5		10.4	13.5	4.8%
Electronics (10)							16.9	16.9	6.0%
Motors (11)							2.9	2.9	1.0%
Heating Appliances (12)							5.0	5.0	1.8%
Other (13)	1.6	0.0	0.2		0.2			1.8	0.6%
Miscellaneous (14)							17.3	17.3	6.1%
Total	66.3	16.1	6.7	2.0	24.8	1.5	191.0	283.5	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. 2) Carbon coefficients calculated from EIA, AEO 2000. Varies 1% or less from EIA, Emissions of Greenhouse Gases in the U.S. 1998. 3) Excludes electricity imports from utility consumption. 4) Includes furnace fans (3.2 MMTCE). 5) Residential fan and pump energy use included proportionately in space heating and cooling. 6) Includes recreational water heating (1.7 MMTCE). 7) Includes refrigerators (22.4 MMTCE) and freezers (6.2 MMTCE). 8) Includes clothes washers (1.6 MMTCE), natural gas clothes dryers (0.9 MMTCE), electric clothes dryers (10.9 MMTCE), and dishwashers (2.2 MMTCE). Does not include water heating energy. 9) Includes microwaves (2.2 MMTCE) and other small electric cooking appliances (3.0 MMTCE). 10) Includes color television (5.9 MMTCE), personal computers (2.6 MMTCE), and other office equipment (8.3 MMTCE). 11) Includes residential devices whose energy consumption is driven by motors. 12) Includes residential appliances such as electric blankets, irons, waterbed heaters, and hair dryers. 13) Includes residential swimming pool heaters, outdoor grills, and natural gas outdoor lighting. 14) Emissions attributable to the buildings sector, but not directly to specific end-uses (Adjustment to SEDS).

Source(s): EIA, Annual Energy Outlook 2000, Dec. 1999, Table A2, p. 119-121, Table A4, p. 124-125 and Table A5, p. 126-127 for energy consumption, and Table A19, p. 142 for emissions; EIA, National Energy Modeling System for AEO 2000, Dec. 1999; EIA, Emissions of Greenhouse Gases in the U.S. 1998, Oct. 1999, Table B1, p. 104 for petroleum carbon coefficients; and BTS/A.D. Little, Electricity Consumption by Small End-Uses in Residential Buildings, August 1998, Appendix A for residential electric end-uses.

3.1.4 1998 Commercial End-Use Carbon Splits, by Fuel Type (10^6 metric tons of carbon) (1)

	Natural	Petroleum (2)								
	Gas	Distil.	Resid.	LPG	Oth(3)	Total	Coal	Electricity (4)	Total	Percent
Space Heating	20.3	4.8	2.4		0.7	7.9	2.2	9.2	39.5	16.7%
Space Cooling	0.2							28.9	29.1	12.2%
Ventilation								13.4	13.4	5.6%
Water Heating	9.3	1.9				1.9		7.0	18.1	7.6%
Lighting								58.1	58.1	24.5%
Refrigeration								8.9	8.9	3.7%
Cooking	2.9							1.5	4.4	1.9%
Office Equipment (5)								17.3	17.3	7.3%
Other (6)	2.1	0.4		1.3	0.6	2.2		13.0	17.4	7.3%
Miscellaneous (7)	10.1	1.0				1.0		20.3	31.4	13.2%
Total	44.9	8.0	2.4	1.3	1.2	12.9	2.2	177.5	237.5	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. 2) Carbon coefficients calculated from EIA, AEO 2000. Varies 1% or less from EIA, Emissions of Greenhouse Gases in the U.S. 1998. 3) Includes kerosene space (2.6 MMTCE) heating and motor gasoline miscellaneous uses (0.5 MMTCE). 4) Excludes electricity imports from utility consumption. 5) Includes personal computers (4.2 MMTCE) and other office equipment (13.1 MMTCE). 6) Includes commercial service station equipment, emergency electric generators, cogenerators, natural gas-driven pumps, natural gas lighting, automated teller machines, telecommunications equipment, medical equipment, and some manufacturing performed in commercial buildings. 7) Emissions attributable to the buildings sector, but not directly to specific end-uses (Adjustment to SEDS).

Source(s): EIA, Annual Energy Outlook 2000, Dec. 1999, Table A2, p. 119-121, Table A4, p. 124-125 and Table A5, p. 126-127 for energy consumption, and Table A19, p. 142 for emissions; EIA, National Energy Modeling System for AEO 2000, Dec. 1999; EIA, Emissions of Greenhouse Gases in the U.S. 1998, Oct. 1999, Table B1, p. 104 for petroleum carbon coefficients; and A.D. Little/BTS, Energy Consumption Characterisitics of Commercial Building HVAC Systems, Volume II: Thermal Distribution, Auxiliary Equipment, and Ventilation, October 1999, p. 1-2.

3.1.5 1997 Nations/Regions Carbon Emissions (1)

Nation/Region	Emissions (10^6 metric tons of carbon)	Percentage Change (1990 to 1997)	Nation/Region	Emissions (10^6 metric tons of carbon)	Percentage Change (1990 to 1997)
United States (2)	1,480	10%	Eastern Europe	231	-24%
China	822	33%	Central & S. America	225	29%
Former Soviet Union	646	-38%	Africa	214	19%
Other Western Europe	426	7%	United Kingdom	156	-6%
Other Asia	348	50%	Canada	142	12%
Japan	297	8%	South Korea	116	90%
Middle East	297	30%	France	102	-1%
India	236	54%	Mexico	94	16%
Germany	234	-12%	Other	109	21%
1991 Kuwaiti Oil Fires	130		World	6,175	6%

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. 2) In 1997, U.S. Buildings sector accounted for 521 MMTCE (35% of total U.S., 8% of total world).

Source(s): EIA, International Energy Outlook 2000, March 2000, Table A10, p. 179; and EIA, AEO 2000, Dec. 1999, Table A19, p. 136 for Notes 1 and 2.

3.1.6 1998 Carbon Emissions Coefficients for Buildings (10^6 metric tons of carbon per quad) (1)

	All Buildings	Residential Buildings	Commercial Buildings
Coal			
Average	25.62	25.79	25.52
Natural Gas			
Average	14.40	14.40	14.40
Petroleum Products			
Distillate Fuel Oil/Diesel	19.95	-	-
Kerosene	19.72	-	-
Motor Gasoline	19.33	-	-
Liquefied Petroleum Gas	16.99	-	-
Residual Fuel Oil	21.49	-	-
Average	19.16	18.28	21.09
Electricity (2)			
Average - Primary (3)	15.58	15.58	15.58
Average - *Site* (4)	50.23	50.23	50.23
All Fuels (2)			
Average - Primary	15.33	15.18	15.52
Average - *Site*	29.56	27.73	31.91

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) Excludes electricity imports from utility consumption. Includes nuclear and renewable (including hydroelectric) generated electricity. 3) Use this coefficient to estimate carbon emissions resulting from the consumption of energy by electric generators. 4) Use this coefficient to estimate carbon emissions resulting from the consumption of electricity by end-users.

Source(s): EIA, Emissions of Greenhouse Gases in the U.S. 1998, Oct. 1999, Table B1, p. 104 for petroleum carbon emission coefficients; and EIA, AEO 2000, Dec. 1999, Table A2, p. 119-121 for consumption data, and Table A19, p. 142 for carbon emissions data.

3.1.7 1998 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	0.1	0.0	0.1
Natural Gas	7.4	5.0	12.4
Coal	0.0	0.1	0.1
Wood	2.2	0.0	2.2
Electricity (2)	7.7	7.1	14.8
Total	17.3	12.2	29.5

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 21 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. 1998, Oct. 1999, Table 14, p. 36 for coal mining emissions, Table 15, p. 36 for oil and gas operations emissions, and Table 16, p. 37 for stationary combustion emissions; and EIA, AEO 2000, Dec. 1999, Table A2, p. 119-121 for energy consumption.

3.2.1 Estimated 1994 U.S. Sales and Emissions of Halocarbons (thousand metric tons)

Compound	100-Year Global Warming Potential (CO2 = 1)	Ozone Depletion Potential (Relative to CFC-11)	1994 U.S. Sales (1)	1994 Emissions	Principal Uses
Chlorofluorocarbons					
CFC-11	1320	1.00	7.3	37.0	Blowing Agent, Chillers
CFC-12 (2)	6650	1.00	40.0	58.0	Auto A/C, Chillers, & Blowing Agent
CFC-113	9300	0.80	N.A.	9.0	Solvent
CFC-114	9300	1.00	N.A.	N.A.	Solvent
CFC-115 (3)	9300	0.60	N.A.	N.A.	Solvent, Refrigerant
Hydrochlorofluorocarbons					
HCFC-22 (3)	1350	0.06	97.3	71	Residential A/C
HCFC-123	93	0.02	N.A.	2.0	Refrigerant
HCFC-124	480	0.02	N.A.	N.A.	Sterilant
HCFC-141b	270	0.11	N.A.	7.0	CFC Replacement
HCFC-142b	1650	0.07	N.A.	15.0	CFC Replacement
Bromofluorocarbons					
Halon-1211	N.A.	3.00	N.A.	N.A.	Fire Extinguishers
Halon-1301	-31400	10.00	<4.0	N.A.	Fire Extinguishers
Hydrofluorocarbons					
HFC-23	11700	0.00	N.A.	3	HCFC Byproduct
HFC-125	2800	0.00	N.A.	N.A.	CFC/HCFC replacement
HFC-134a	1300	0.00	26.0	N.A.	Auto A/C, Refrigeration
HFC-152a (2)	140	0.00	N.A.	1	Aerosol Propellant
HFC-227ea	2900	0.00	N.A.	N.A.	CFC Replacement

Note(s): 1) In 1985, U.S. sales of CFCs were 297,000 metric tons. In 1990, U.S. sales of CFCs were 208,000 metric tons. 1 metric ton = 2205 pounds. 2) R-500: 74% CFC-12 and 26% HFC-152a. 3) R-502: 49% HCFC-22 and 51% CFC-115.

Source(s): EIA, Emissions of Greenhouse Gases in the U.S. 1997, Oct. 1998, Table 31, p. 61 for emissions; EIA, Emissions of Greenhouse Gases in the U.S. 1995, Oct. 1996, Table 31, p. 53 for sales, global warming potentials, and uses; EPA for halon ODPs; AFEAS' Internet Homepage, Atmospheric Chlorine: CFCs and Alternative Fluorocarbons, Feb. 1997 for remaining ODPs; EIA, Emissions of Greeenhouse Gases in the U.S. 1985-1990, Sept. 1993, Table 42, p. 52 for 1985 U.S. sales; ASHRAE, 1993 ASHRAE Handbook: Fundamental, p. 16.3 for Notes 2 and 3.

3.2.2 U.S. and Global CFC and HCFC Production (thousand metric tons) (1)

	U.S. Production			World Production		
	CFC-11	CFC-12	HCFC-22	CFC-11	CFC-12	HCFC-22
1985	73	128	99	327	376	153
1986	91	147	124	350	398	165
1987	101	167	129	382	425	173
1988	101	175	147	376	421	204
1989	88	177	148	302	380	220
1990	61	94	138	233	231	214
1991	45	77	142	213	225	237
1992	45	72	141	186	216	246
1993	33	85	132	147	215	241
1994	27	64	139	60	134	239
1995	N.A.	N.A.	N.A.	33	83	243
1996	0	0	N.A.	22	49	271
1997	0	0	N.A.	19	33	251
1998	0	0	N.A.	15	33	261

Note(s): 1) For 1985-1994, sales closely followed quantities of production.

Source(s): AFEAS, Annual Global Fluorocarbon Production, 2000 for world production; and Air Conditioning, Heating and Refrigeration News, April 10, 1995, p. 16 and 18 for U.S. production.

3.2.3 Estimated U.S. Emissions of Halocarbons, 1987-1996 (thousand metric tons of gas)

Gas	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998(1)
Chlorofluorocarbons												
CFC-11	85	85	80	54	48	45	45	37	36	27	25	20
CFC-12	110	110	114	113	104	81	79	58	52	36	23	9
CFC-113	83	83	78	26	21	17	17	9	9	N.A.	N.A.	N.A.
Other CFCs (2)	N.A.	N.A.	N.A.	9	8	7	7	5	5	4	3	3
Halons	N.A.	N.A.	N.A.	3	3	3	3	2	3	3	2	2
Hydrochlorofluorocarbons												
HCFC-22	68	74	76	80	80	80	71	71	74	77	80	78
HCFC-123	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2	N.A.	N.A.	N.A.	0
HCFC-141b	N.A.	0	0	0	0	0	2	7	12	14	12	15
HCFC-142b	N.A.	0	0	0	0	4	9	15	21	28	28	36
Other HCFCs (3)	N.A.	N.A.	N.A.	0	0	1	3	6	7	7	8	9
Hydrofluorocarbons												
HFC-23	4	5	5	3	3	3	3	3	2	3	3	3
HFC-134a	N.A.	N.A.	N.A.	1	1	1	3	5	10	14	18	19
HFC-152a	N.A.	N.A.	N.A.	3	3	N.A.	1	1	1	1	1	0
Other HFCs	N.A.	N.A.	N.A.	0	0	N.A.	1	4	8	10	12	0

Note(s): 1) Preliminary. 2) In 1995, CFC-114 = 0.5 thousand metric tons and CFC-115 = 0.1 thousand metric tons. 3) Includes HCFC-123 and HCFC-124 for 1988-1996; and HCFC-123, HCFC-124, HCFC-141b, and HCFC-142b for 1987.

Source(s): EIA, Emissions of Greenhouse Gases in the U.S. 1998, Oct. 1999, Table 28, p. 59 for 1990-1998; EIA, Emissions of Greenhouse Gases in the U.S. 1996, Oct. 1997, Table 32, p. 54 for 1989; EIA, Emissions of Greenhouse Gases in the U.S. 1995, Oct. 1996, Table 32, p. 54 for 1988; EIA, Emissions of Greenhouse Gases in the U.S. 1985-1994, Oct. 1995, Table 34, p. 54 for 1987.

3.2.4 1998 World Sales of Selected Refrigerants, by End-Use (percent)

End-use	CFC-11	CFC-12	HCFC-22	HCFC-141b	HCFC-142b	HFC-134a
Blowing Agent	58%	4%	4%	89%	98%	8%
Refrigerant	26%	81%	92%	0%	2%	86%
Aerosol	11%	9%	4%	9%	0%	1%
Other	5%	7%	0%	1%	1%	5%
Total	100%	100%	100%	100%	100%	100%

Source(s): AFEAS, Production and Sales of Fluorocarbons, 2000.

3.2.5 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 (2)	517	3,271	3,788	44%
2001 (2)	507	3,359	3,866	49%
2002 (2)	488	3,765	4,253	54%
Total	8,536	34,887	43,423	

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, Replacement and Conversion of CFC Chillers, March 29, 2000; ARI, Survey Estimates Long Use of CFC Chillers Nearly Two-Thirds of Units Still in Place, April 15, 1999; ARI's Internet Home Page, 1998 Chiller Survey, April 8, 1998; ARI's Internet Home Page, 1997 Chiller Survey, April 9, 1997; Air Conditioning, Heating and Refrigeration News, April 8, 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.

3.3.1 1998 EPA Emission Summary Table for U.S Buildings Energy Consumption (thousand short tons) (1)

	Buildings				Buildings Percent
	Wood/*Site* Fossil	Electricity	Total	U.S. Total	of U.S. Total
SO2	609	8,857 (2)	9,466	19,647	48%
NOx	1,117	4,090	5,207	24,454	21%
CO	3,843	279	4,122	89,454	5%
VOCs	678	36	714	17,917	4%
PM-2.5	476	106	582	8,311	7%
PM-10	544	202	746	34,741	2%
Lead	416	46	462	3,973	12%

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 11% lower for 1998 than 1994 estimates since Phase I of the 1990 Clean Air Act Amendments began in 1995.

Source(s): EIA, AEO 2000, Dec. 1999, Table A2, p. 119-121; EPA, National Air Pollutant Emission Trends, 1900-1998, Mar. 2000, Tables A-1, A-2, A-3, A-4, A-5, A-6 and A-8 for 1998 data.

3.3.2 1998 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	1.197	(2)	0.072	(2)	0.371
NOx	0.553	0.089	0.128	(2)	0.171
CO	0.038	(2)	(2)	(2)	0.012

Commercial

	Electricity (1)	Gas	Oil(3)	Coal	Electricity (per primary quad) (1)
SO2	1.197	(2)	0.449	(2)	0.371
NOx	0.553	0.075	0.126	(2)	0.171
CO	0.038	(2)	(2)	(2)	0.012

All Buildings

	Electricity (1)	Gas	Oil(3)	Coal	Electricity (per primary quad) (1)
SO2	1.197	(2)	0.189	(2)	0.371
NOx	0.553	0.083	0.127	(2)	0.171
CO	0.038	(2)	(2)	(2)	0.012

Note(s): 1) Emissions of SO2 are 11% lower for 1998 than 1994 estimates since Phase I of the 1990 Clean Air Act Amendments began in 1995. 2) Data not available, significant enough, or reliable. 3) Oil includes distillate and residual fuel oils, LPG, motor gasoline, and kerosene.

Source(s): EPA, National Air Pollutant Emission Trends, 1900-1998, Mar. 2000, Tables A-1, A-2, & A-4 for emissions; EIA, AEO 2000, Dec. 1999, Table A2, p. 119-121 for energy 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 ($1998/10^6 Btu) (1)

	Residential Buildings				Commercial Buildings				Buildings
	Electricity	Natural Gas	Petroleum (2)	Avg	Electricity	Natural Gas	Petroleum (2)	Avg	Average (3)
1980	29.36	6.73	13.57	14.17	30.02	6.21	10.54	14.90	14.46
1990	27.65	6.78	10.70	14.70	25.53	5.66	7.12	14.65	14.68
1998	**23.58 (4)**	**6.60**	**7.48 (5)**	**13.37**	**21.76 (6)**	**5.26**	**4.55 (7)**	**13.27**	**13.33**
2000	23.05	6.68	9.45	13.37	21.19	5.47	6.20	13.22	13.31
2010	21.67	6.57	9.73	13.14	18.65	5.53	6.27	12.26	12.77
2020	21.33	6.36	10.04	13.15	18.17	5.50	6.49	12.12	12.71

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 1998, Buildings average electricity price was $22.71/10^6 Btu (or $0.077/kWh), average natural gas price was $6.06/10^6 Btu ($6.24/1000 CF), and petroleum was $6.57/10^6 Btu (78.7¢/gal.). Averages do not include wood or coal prices. 4) Equals $0.080/kWh. 5) Distillate fuel: 84.9¢/gal., LPG: $0.90/gal., kerosene: $1.01/gal. 6) Equals $0.074/kWh. 7) Distillate fuel: 54.4¢/gal., residual fuel: 37.3¢/gal., LPG: 82.0¢/gal., kerosene: 77.4¢/gal., motor gasoline: $1.20/gal.

Source(s): EIA, State Energy Price and Expenditures Report 1997, July 2000, p. 14-15 for 1980, 1990 and prices for note; EIA, State Energy Data Report 1997, Sept. 1999, Tables 12-13, p. 22-23; EIA, AEO 2000, Dec. 1999, Table A3, p. 122-123 for 1998-2020 and Tables A12 and A14, p. 135 and 137 for prices; EIA, Annual Energy Review 1998, July 1999, Appendix E, p. 337 for price deflators.

4.1.2 Buildings Aggregate Energy Expenditures, by Year and Major Fuel Type ($1998 billion) (1)

	Residential Buildings				Commercial Buildings				Total Building
	Electricity	Natural Gas	Petroleum (2)	Total	Electricity	Natural Gas	Petroleum (2)	Total	Expenditures
1980	71.9	32.7	23.7	128.3	57.2	16.6	13.6	87.3	215.7
1990	87.1	30.6	13.5	131.2	73.0	15.3	6.5	94.7	226.0
1998	**90.4**	**30.4**	**10.1**	**130.9**	**77.6**	**16.4**	**3.0**	**96.9**	**227.8**
2000	93.2	33.7	12.9	139.8	79.3	18.0	3.7	101.1	240.9
2010	102.0	35.8	12.2	150.0	81.3	19.8	3.9	105.0	255.0
2020	113.0	37.3	11.5	161.8	84.9	20.6	3.9	109.5	271.3

Note(s): 1) Excludes expenditures from buildings-related energy consumption in the industrial sector. Expenditures exclude wood and coal costs. 1998 U.S. energy expenditures were $538.3 billion. 2) Petroleum products include distillate fuel oil, residual fuel oil, LPG, kerosene, and motor gasoline.

Source(s): EIA, State Energy Price and Expenditures Report 1997, July 2000, p. 14-15 for 1980 and 1990; EIA, AEO 2000, Dec. 1999, Table A2, p. 119-121 and Table A3, p. 122-123 for 1998-2020; and EIA, Annual Energy Review 1998, July 1999, Appendix E, p. 337 for price deflators.

4.1.3 FY 1998 Federal Buildings Energy Prices and Expenditures, by Fuel Type ($1998)

Fuel Type	Average Fuel Prices ($/million Btu)		Total Expenditures ($million) (2)
Electricity	17.08 (1)		2,562.3
Natural Gas	3.98		490.2
Fuel Oil	5.11		190.6
Coal	2.01		38.5
Purchased Steam	13.94		218.5
LPG/Propane	8.67		26.0
Other	4.11		4.1
Average	10.10	Total	3,530.3

Note(s): 1) $0.058/kWh. 2) Energy used in buildings FY 98 accounted for 41.5% of the total Federal energy bill.

Source(s): DOE, Annual Report to Congress on FEMP (Draft), Mar. 20, 2000, p. 53 for buildings expenditures, and p. 14 for Federal energy expenditures.

4.1.4 1998 Buildings Energy End-Use Expenditure Splits, by Fuel Type ($1998 billion) (1)

	Natural	Petroleum								
	Gas	Distil.	Resid.	LPG	Oth(2)	Total	Coal	Electricity	Total	Percent
Space Heating (3)	27.3	5.2	0.3	2.8	0.9	9.2	0.3	14.6	51.3	22.5%
Space Cooling	0.1							28.2	28.3	12.4%
Ventilation (4)								5.9	5.9	2.6%
Water Heating (5)	11.5	1.2		1.0		2.2		13.4	27.2	11.9%
Lighting								34.7	34.7	15.2%
Refrigeration (6)								17.4	17.4	7.6%
Wet Clean (7)	0.4							6.9	7.3	3.2%
Cooking	2.3			0.3		0.3		5.7	8.3	3.7%
Electronics (8)								15.9	15.9	7.0%
Motors (9)								1.5	1.5	0.6%
Heating Appliances (10)								2.6	2.6	1.1%
Other (11)	1.5	0.1		0.9	0.3	1.2		5.7	8.4	3.7%
Miscellaneous (12)	3.7	0.2				0.2		15.5	19.4	8.5%
Total	46.8	6.6	0.3	5.0	1.1	13.0	0.3	168.0	228.1	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 ($0.9 billion) and motor gasoline other uses ($0.3 billion). 3) Includes furnace fans ($1.5 billion). 4) Commercial only; residential fan and pump energy use included proportionately in space heating and cooling. 5) Includes residential recreation water heating ($0.9 billion). 6) Includes refrigerators ($10.6 billion) and freezers ($2.9 billion). 7) Includes clothes washers ($0.7 billion), natural gas clothes dryers ($0.4 billion), electric clothes dryers ($5.1 billion), and dishwashers ($1.1 billion). 8) Includes color televisions ($2.8 billion), personal computers ($3.1 billion), and other electronics ($9.9 billion). 9) Includes residential devices whose energy consumption is driven by motors. 10) Includes residential appliances such as electric blankets, irons, waterbed heaters, and hair dryers. 11) Includes residential swimming pool heaters, outdoor grills, and natural gas outdoor lighting. Includes commercial service station equipment, emergency electric generators, cogenerators, district services, natural gas-driven pumps, natural gas lighting, automated teller machines, telecommunications equipment, medical equipment, and some manufacturing performed in commercial buildings. 12) Expenditures attributable to the buildings sector, but not directly to specific end-uses (Adjustment to SEDS).

Source(s): EIA, Annual Energy Outlook 2000, Dec. 1999, Table A2, p. 119-121, Table A3, p. 122-123 for prices, Table A4, p. 124-125 for residential energy consumption, and Table A5, p. 126-127 for commercial energy consumption; EIA, National Energy Modeling System for AEO 2000, Dec. 1999; EIA, State Energy Price and Expenditure Report 1997, July 2000, p. 14-15 for coal and minor petroleum prices; EIA, Annual Energy Review 1998, July 1999, Appendix E, p. 337 for price deflators; BTS/A.D. Little, Electricity Consumption by Small End-Uses in Residential Buildings, Appendix A for residential electric end-uses; and BTS/A.D. Little, Energy Consumption Characteristics of Commercial Building HVAC Systems, Vollume II: Thermal Distribution, Auxilary Equipment, and Ventilation, October 1999, p. 1-2 and 5-25 - 5-26 for commercial ventilation.

4.1.5 Implicit Price Deflators

Year	Implicit Price Deflator	Year	Implicit Price Deflator
1980	0.60	1990	0.94
1981	0.66	1991	0.97
1982	0.70	1992	1.00
1983	0.73	1993	1.03
1984	0.76	1994	1.05
1985	0.79	1995	1.08
1986	0.81	1996	1.10
1987	0.83	1997	1.12
1988	0.86	1998	1.13
1989	0.90		

Source(s): EIA, Annual Energy Review 1998, July 1999, Appendix E, p. 337.

4.2.1 1998 Residential Energy End-Use Expenditure Splits, by Fuel Type ($1998 billion) (1)

	Natural Gas	Petroleum				Coal	Electricity	Total	Percent
		Distil.	LPG	Kerosene	Total				
Space Heating (2)	19.8	4.3	2.8	0.7	7.8	0.1	10.5	38.3	29.2%
Space Cooling (3)	0.0						15.3	15.3	11.7%
Water Heating (4)	8.1	0.8	1.0		1.8		10.4	20.4	15.6%
Lighting							9.3	9.3	7.1%
Refrigeration (5)							13.6	13.6	10.3%
Wet Clean (6)	0.4						6.9	7.3	5.6%
Cooking	1.2		0.3		0.3		5.1	6.6	5.0%
Electronics (7)							8.3	8.3	6.4%
Motors (8)							1.5	1.5	1.1%
Heating Appliances (9)							2.6	2.6	2.0%
Other (10)	0.8	0.0	0.1		0.1		0.0	0.9	0.7%
Miscellaneous (11)	0.0	0.0			0.0		7.0	7.0	5.4%
Total	30.4	5.2	4.3	0.7	10.1	0.1	90.4	131.1	100%

Note(s): 1) Expenditures include coal and exclude wood (unlike Table 4.1.2). 2) Includes furnace fans ($1.5 billion). 3) Fan energy use included. 4) Includes residential recreation water heating ($0.9 billion). 5) Includes refrigerators ($10.6 billion) and freezers ($2.9 billion). 6) Includes clothes washers ($0.7 billion), natural gas clothes dryers ($0.4 billion), electric clothes dryers ($5.1 billion), and dishwashers ($1.1 billion). 7) Includes color televisions ($2.8 billion), personal computers ($1.3 billion), and other electronics ($4.3 billion). 8) Includes residential devices whose energy consumption is driven by motors. 9) Includes residential appliances such as electric blankets, irons, waterbed heaters, and hair dryers. 10) Includes residential swimming pool heaters, outdoor grills, and natural gas outdoor lighting. 11) Expenditures attributable to the buildings sector, but not directly to specific end-uses (Adjustment to SEDS).

Source(s): EIA, Annual Energy Outlook 2000, Dec. 1999, Table A2, p. 119-121, Table A3, p. 122-123 for prices, and Table A4, p. 124-125 for residential energy consumption; EIA, State Energy Price and Expenditure Report 1997, July 2000, p. 14 for coal and minor petroleum prices; EIA, Annual Energy Review 1998, July 1999, Appendix E, p. 337 for price deflators; BTS/A.D. Little, Electricity Consumption by Small End-Uses in Residential Buildings, Appendix A for electric end-uses.

4.2.2 Average Annual Energy Expenditures per Household, by Year ($1998)

1980	1,611
1990	1,393
1998	**1,274**
2000	1,327
2010	1,280
2020	1,268

Source(s): EIA, State Energy Price and Expenditures Report 1997, July 2000, p. 14 for 1980 and 1990; EIA, AEO 2000, Dec. 1999, Table A2, p. 119-121, Table A4, p. 124-125 for consumption, Table A3, p. 122-123 for prices 1998-2020; EIA, Annual Energy Review 1998, July 1999, Appendix E, p. 337 for price deflators; and DOC, Statistical Abstract of the United States 1999, Oct. 1999, Table No. 1210, p. 728 for 1980 and 1990 occupied units.

4.2.3 1997 Energy Expenditures per Household, by Housing Type and Square Footage ($1998)

	Per Household	Per Square Foot
Single Family	**1,507**	**0.78**
-Detached	1,544	0.77
-Attached	1,268	0.87
Multi-Family	**856**	**0.96**
Mobile Home	**1,218**	**1.22**

Source(s): Data taken originally from EIA, 1997 Residential Energy Consumption Survey, 2000; EIA, Annual Energy Review 1998, July 1999, Appendix E, p. 337 for price inflators.

4.2.4 1997 Energy Expenditures per Household, by Census Region ($1998)

Northeast	1,660
Midwest	1,410
South	1,341
West	1,023

Source(s): Data taken originally from EIA, 1997 Residential Energy Consumption Survey, 2000; EIA, Annual Energy Review 1998, July 1999, Appendix E, p. 337 for price inflators.

4.2.5 1997 Household Energy Expenditures, by Vintage ($1998)

Year	Per Household	Per Square Foot	Per Household Member	Percent of Residential Sector Expenditures
Prior to 1980	1,355	0.85	531	74%
1980 to 1986	1,263	0.77	501	11%
1987 to 1989	1,436	0.74	516	5%
1990 to 1995	1,399	0.68	500	9%
1996 to 1997	1,274	0.60	409	1%
				100%
Average	1,351	0.79	522	

Source(s): Data taken originally from EIA, 1997 Residential Energy Consumption Survey, 2000; EIA, Annual Energy Review 1998, July 1999, Appendix E, p. 337 for price inflators.

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

	Households		Energy Expenditures	
Family Income/Year	Number(10^6)	Percent	By Household	By Household Member
Less than $5,000	3.8	4%	1,028	456
$5,000 to $7,499	5.1	5%	941	527
$7,500 to $9,999	4.5	4%	1,034	499
$10,000 to $14,999	10.3	10%	1,063	462
$15,000 to $19,999	10.4	10%	1,182	484
$20,000 to $24,999	8.4	8%	1,233	520
$25,000 to $34,999	15.6	15%	1,276	493
$35,000 to $49,999	15.5	15%	1,394	512
$50,000 or $74,999	16.4	16%	1,599	543
$75,000 or More	11.5	11%	1,835	592
Total	101.5	100%		

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 1997 (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%	6.8%	3.8%	2.8%
Federally Eligible	13.0%	14.4%	N.A.	10.1%	14.1%	9.0%	9.0%
Federally Ineligible	4.0%	3.5%	N.A.	N.A.	3.3%	2.8%	2.3%
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 1993, adjusted to reflect FY 1997, HDD, CDD, and fuel prices.

Source(s): HHS, LIHEAP Home Energy Notebook FY 1997, Sept. 1999, Tables A-2a to A-2c, p. 50-52 for FY1997 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 Housing Sales Prices ($1998)

Housing Type	Median Sales Price	
New Single-Family	152,500	
Existing Single-Family	128,400	
New Mobile Homes	43,800	(1)

Note(s): 1) Average sales price. Excludes land costs.

Source(s): DOC, Statistical Abstract of the United States 1999, Oct. 1999, Tables 1203-1205, p. 725-726.

4.2.9 1998 Cost Breakdown of a 2,150 Square Foot, New Single-Family Home ($1998) (1)

	Cost	Percent	Construction Cost	Cost	Percent
Finished Lot	53,516	24%	Inspection/Fees	3,497	3%
Construction Cost	124,276	55%	Shell/Frame	86,168	69%
Financing	4,266	2%	Equipment	20,064	16%
Overhead & General Expenses	12,955	6%	Property Features	14,547	12%
Marketing	3,180	1%	Total	124,276	100%
Sales Commission	7,650	3%			
Profit	20,837	9%			
Total	226,680	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.

Source(s): NAHB, The Truth About Regulatory Barriers to Housing Affordability, 1999, p. 4.

4.3.1 1998 Commercial Energy End-Use Expenditure Splits, by Fuel Type ($1998 billion) (1)

	Natural	Petroleum								
	Gas	Distil.	Resid.	LPG	Oth(2)	Total	Coal	Electricity	Total	Percent
Space Heating	7.4	0.9	0.3		0.2	1.3	0.1	4.1	13.0	13.4%
Space Cooling	0.1							12.9	13.0	13.4%
Ventilation								5.9	5.9	6.1%
Water Heating	3.4	0.3				0.3		3.1	6.8	7.0%
Lighting								25.4	25.4	26.2%
Refrigeration								3.9	3.9	4.0%
Cooking	1.1							0.7	1.7	1.8%
Electronics (3)								7.5	7.5	7.8%
Other (4)	0.8	0.1		0.8	0.3	1.1		5.7	7.6	7.8%
Miscellaneous (5)	3.7	0.2				0.2		8.5	12.3	12.7%
Total	16.4	1.5	0.3	0.8	0.5	3.0	0.1	77.6	97.0	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 personal computers ($1.8 billion), and other electronics ($5.7 billion). 4) Includes commercial service station equipment, emergency electric generators, cogenerators, district services, natural gas-driven pumps, natural gas lighting, automated teller machines, telecommunications equipment, medical equipment, and some manufacturing performed in commercial buildings. 5) Expenditures attributable to the buildings sector, but not directly to specific end-uses (Adjustment to SEDS).

Source(s): EIA, Annual Energy Outlook 2000, Dec. 1999, Table A2, p. 119-121, Table A3, p. 122-123 for prices, and Table A5, p. 126-127 for energy consumption; EIA, National Energy Modeling System for AEO 2000, Dec. 1999; EIA, State Energy Price and Expenditure Report 1997, July 2000, p. 15 for coal and minor petroleum prices; EIA, Annual Energy Review 1998, July 1999, Appendix E, p. 337 for price deflators; and BTS/A.D. Little, Energy Consumption Characteristics of Commercial Building HVAC Systems, Vollume II: Thermal Distribution, Auxilary Equipment, and Ventilation, October 1999, p. 1-2 and 5-25 - 5-26 for commercial ventilation.

4.3.2 Average Annual Energy Expenditures per Square Foot of Commercial Floorspace, by Year ($1998)

1980	1.72
1990	1.47
1998	**1.58**
2000	1.60
2010	1.48
2020	1.48

Source(s): EIA, State Energy Price and Expenditures Report 1997, July 2000, p. 15 for 1980 and 1990; EIA, AEO 2000, Dec. 1999, Table A2, p. 119-121 and Table A5, p. 126-127 for consumption, Table A3, p. 122-123 for prices for 1998-2020; and EIA, Annual Energy Review 1998, July 1999, Appendix E, p. 337 for price deflators; EIA, AEO 1994, Jan. 1994, Table A5, p. 62 for 1990 floorspace.

4.3.3 1995 Energy Expenditures per Square Foot of Commercial Floorspace and per Building, by Building Type ($1998)

	per Square Foot	per Building (10^3)		per Square Foot	per Building (10^3)
Food Sales	4.31	20.2	Public Order and Safety	1.28	18.7
Food Service	3.73	17.7	Mercantile and Service	1.15	11.4
Health Care	2.37	52.5	Education	0.96	24.2
Office	1.58	23.6	Warehouse and Storage	0.59	8.5
Lodging	1.48	33.9	Vacant (1)	0.40	3.9
Public Assembly	1.32	16.0			

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 1998, July 1999, Appendix E, p. 337 for price deflators.

4.3.4 1995 Energy Expenditures per Square Foot of Commercial Floorspace, by Vintage ($1998)

Prior to 1980	1.19
1980 to 1989	1.36
1990 to 1995	1.52
Average	1.25

Source(s): EIA, Commercial Buildings Energy Consumption and Expenditures 1995, Apr. 1998, Table 4; and EIA, Annual Energy Review 1998, July 1999, Appendix E, p. 337 for price inflators.

4.4.1 Annual Energy Expenditures per Gross Square Foot of Federal Floorspace Stock, by Year ($1998)

FY 1985	1.70
FY 1998	1.15

Note(s): Total Federal buildings and facilities energy expenditures in FY 1998 were $3.53 billion (in $1998).
Source(s): DOE/FEMP, Annual Report to Congress on FEMP (Draft), Mar. 20, 2000, Table 6-B, p. 53 for energy costs and Table 7-A, p. 56 for floorspace.

4.4.2 Expenditures on Federal Buildings Energy Conservation and Capital Equipment ($million)

FY 1985	258.6	FY 1990	59.4	FY 1995	288.3
FY 1986	194.1	FY 1991	114.0	FY 1996	179.2
FY 1987	57.6	FY 1992	145.1	FY 1997	200.4
FY 1988	65.6	FY 1993	120.9	FY 1998	261.3
FY 1989	52.2	FY 1994	230.2	FY 1999 (1)	274.5

Note(s): 1) Projected.
Source(s): DOE/FEMP, Annual Report to Congress on FEMP (Draft), Mar. 20, 2000, Table 3-A, p. 28.

4.5.1 Estimated Value of All U.S. Construction Relative to the GDP ($1998)

- 1998 estimated value of all U.S. construction is $1,071 billion (including renovation; heavy construction; public works; residential, commercial, and industrial new construction; and non-contract work).
- Compared to the $8.5 trillion U.S. gross domestic product (GDP), all construction holds a 12.6% share.
- In 1998, residential and commercial building renovation (valued at $221 billion) and new building construction (valued at $466 billion) is estimated to account for just over 70% (or around $756 billion, including an additional $70 billion for non-contract work) of the $1,071 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 1998,1998, Table 6-6, p. 6-9 for commerical renovation; DOC, Current Construction Reports: Expenditures for Residential Improvements and Repairs, C50, July 1999, Table 2 for residential renovation; DOC, Current Construction Reports: Value of Construction Put in Place, C30, Jan. 1999, Table 1, p. 3 for new construction; and EIA, Annual Energy Review 1998, July 1999, Appendix E, p. 337 for price deflators.

4.5.2 Value of New Building Construction Relative to GDP, by Year ($1998 billion)

	Value of New Construction Put in Place				Bldgs. Percent of
	Residential	Commercial (1)	All Bldgs. (1)	GDP	Total U.S. GDP
1980	133.8	128.9	262.7	5,201	5.1%
1985	168.8	180.8	349.6	6,000	5.8%
1990	158.7	178.5	337.2	6,916	4.9%
1995	175.7	161.5	337.2	7,620	4.4%
1998	218.0	210.7	428.7	8,511	5.0%

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 and 1998; and EIA, Annual Energy Review 1998, July 1999, Appendix E, p. 337 for GDP and price deflators.

4.5.3 Value of Building Improvements and Repairs Relative to GDP, by Year ($1998 billion) (1)

	Value of Improvements and Repairs				Bldgs. Percent of
	Residential	Commercial	All Bldgs.	GDP	Total U.S. GDP
1980	86.5	N.A.	N.A.	5,201	N.A.
1985	115.3	112.0	227.3	6,000	3.8%
1990	129.0	111.8	240.8	6,916	3.5%
1995	117.1	101.8	218.9	7,620	2.9%
1998	120.7	99.9 (2)	220.6	8,511	2.6%

Note(s): 1) Improvements includes additions, alterations, reconstruction, and major replacements. Repairs include maintenance. 2) 1996.

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 1995-1998; 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 1995-1996 commercial; EIA, Annual Energy Review 1998, July 1999, Appendix E, p. 337 for GDP and price deflators.

4.5.4 1994 U.S. Private Investment into Construction R&D

Sector	Percent of Sales
Average Construction R&D (1)	**< 0.5**
Housing (materials and components)	1.7
Construction materials	1.0
Construction machinery	3.0
U.S. Industry Average (2)	**3.5**
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): Business Week, Blue-Sky Research Comes Down to Earth, July 3, 1995, p. 78 for the Housing and Industry values; Business Week, R&D Scoreboard, July 3, 1995, p. 1 for U.S. industry average; 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; and The Civil Engineering Research Foundation, 1994 for remaining values.

4.6.1 Buildings Design and Construction Trades, by Year

	Employees, in thousands	
	Architects (1)	Construction (2)
1980	N.A.	3065
1990	N.A.	3862
1998 (5)	158	4504

	Number of Residential Builder Establishments with Payrolls, in thousands (3)			
	New Construction	Remodeling	Both	Total (4)
1982	14.4	21.7	57.5	93.6
1987	38.4	32.8	48.1	119.3
1992	36.3	43.3	51.0	130.6
1997	46.6	33.6	52.1	134.1

Note(s): 1) Includes landscape architects. 2) Does not include industrial building or heavy construction (e.g., dam and bridge building). In 1998, 76% of the employment shown is considered for "production". The entire U.S. construction industry employs an estimated 10 million people, including manufacturing. 3) In 1998, NAHB report having 182,000 members, one-third of which were builders. 4) Excludes homebuilding establishments without payrolls, estimated by NAHB at an additional 210,000 in 1992. 5) For 1996, 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. 1999, Oct. 1999, Table 672, p. 424 for architect employment, Tables 690, p. 436-438 and Table 1190, p. 719 for construction employment; DOC, Statistical Abstract of the United States 1994, Oct. 1994, Table 1125, p. 725 for 1987 data; DOC, 1997 Economic Census: Construction - Industry Summary, EC97C23IS, Jan. 2000, Tables 1-2, p. 7-8 for industrial builders; DOC, 1997 Economic Census: Contruction - Single-Family Housing Construction, EC97C-2332A, Nov. 1999, Table 10, p. 14 for residential builder establishments; NAHB, Housing Economics, May 1995, Table 2, p. 14 for residential builder establishments, originally from DOC; NAHB Research Center, www.nahbrc.org, 1999 for 1998 NAHB membership; NAHB, 1997 Housing Facts, Figures and Trends, 1997, p. 35 for Note 4 and p. 13 for Note 5; National Science and Technology Council, Construction & Building: Federal Research and Development in Support of the U.S. Construction Industry, 1995 for number of employees in entire U.S. construction industry;

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

Industry	1980	1985	1990	1993	1995	1997
Air Conditioning and Refrigeration Equipment (incl. warm-air furnaces): SIC 3585						
- Total Employment	118.4	122.8	126.9	119.0	136.3	140.1
- Production Workers	81.6	87.2	92.4	87.4	102.4	106.3
Plumbing, Heating, and Air-Conditioning Contractors: SIC 171						
- Total Employment	532.8	605.1	649.2	616.6	736.5	790.9
- Construction Workers	400.4	447.3	476.7	449.1	542.4	584.0
Wholesalers of Hardware, Plumbing and Heating Equipment: SIC 507						
- Total Employment	242.7	254.1	283.8	270.0	288.2	303.4

Source(s): ARI, 1999 Statistical Profile of the Air-Conditioning, Refrigeration, and Heating Industry (from U.S. Bureau of Labor Statistics), Jan. 1999, p. 9, 10, 12, 13, and 15.

4.6.3 Solar-Thermal-Related Manufacturing Trades, by Year

Number of jobs in 1993:	7,801
Number of jobs in 1994:	8,000
Number of jobs in 1995:	7,682
Number of jobs in 1996:	4,756
Number of jobs in 1997:	3,662
Number of jobs in 1998:	4,119

Source(s): EIA, Renewable Energy Annual 1999, Mar. 2000, p. 23; EIA, Renewable Energy Annual 1995, Dec. 1995, p. 102; and EIA, Solar Collector Manufacturing Activity 1993, p. 11.

5.1.1 1998 Five Largest Residential Homebuilders

Homebuilder	Number of Home Closings (1)	Gross Revenue ($million)	Market Share of Total New Home Closings (%) (2)
Pulte Home Corporation	20,359	3,005	1.38%
Kaufman and Broad Home Corporation	15,213	2,499	1.03%
D.R. Horton	15,168	2,421	1.03%
Centex Corporation	13,759	4,749	0.93%
Lennar Corp.	10,777	2,417	0.73%
Total of Top Five	75,276	15,091	5.11%
Habitat for Humanity (3)	3,641	N.A.	0.25%

Note(s): 1) 1998 total U.S. new home closings were 1.47 million (includes single-family and multi-family). 2) Total share of closings of top 100 builders was 20.4%. 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 1800 worldwide affiliates completed 13,682 homes in FY 1999.

Source(s): Builder Magazine, May 1998, p. 102; 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; DOC, Current Construction Reports: Housing Completions, Dec. 1998, C22/98-10, Table 1, p. 3 for total closings.

5.1.2 Value of New Building Construction, by Year ($1998 billion)

	Residential	Commercial	All Bldgs.
1980	133.8	128.9	262.7
1985	168.8	180.8	349.6
1990	158.7	178.5	337.2
1995	175.7	161.5	337.2
1998 (1)	218.0	210.7	428.7

Note(s): 1) In 1998, new Buildings construction accounted for 5.0% of the $8.5 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 1995-1998 and Note 1; and EIA, Annual Energy Review 1998, July 1999, Appendix E, p. 337 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
1982	272	46	239	586	1,143
1983	399	62	295	810	1,566
1984	491	73	295	899	1,758
1985	540	77	283	909	1,809
1986	591	87	245	959	1,882
1987	581	86	233	882	1,782
1988	565	91	218	820	1,694
1989	502	81	202	776	1,561
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 (3)

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 1998 gross sales was $9.13 billion (includes some commercial modular/factory-built component sales). For 1998, Automated Builder total estimates exceeded Census new housing completion data by 17%, since these estimates include some multi-family and small commercial units.

Source(s): Automated Builder Magazine, Jan. 1992, p. 12 for 1981-1983 data; Jan. 1995, p. 30 for 1984 data; Jan. 1996, p. 30 for 1985 data; Jan. 1997, p. 18 for 1986 data; Jan. 1997 for 1987 data; Jan. 1998 for 1988-1998 data; and Dec. 1999, p. 36 for sales volume.

5.2.2 1998 Top Five Manufacturers of Panelized Homes (including pre-cut homes) (1)

Company	Units Produced	Gross Sales Volume ($million)	Market Share of Top 41 Company Sales (2)	Number of Employees
Wausau Homes	4,877	184.4	40%	N.A.
Lindal Cedar Homes	480	37.7	8%	N.A.
Nu-Fab Bldg. Product Ltd.	450	32.0	7%	N.A.
Barden & Robeson	850	30.0	6%	N.A.
Linwood Homes Ltd.	362	25.5	5%	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 41 IH producers responding to the survey. In 1998, surveyed panelized home sales were estimated at $466.6 million and 11,279 housing units produced.

Source(s): Automated Builder Magazine, June 1999, p. 40-43.

5.2.3 1998 Top Five Manufacturers of Modular Homes (1)

Company	Units Produced	Gross Sales Volume ($million)	Market Share of Top 45 Company Sales (2)	Number of Employees
All American Homes, Inc.	2,511	130.3	17%	1223
Excel Homes	3,550	67.4	9%	475
Nanticoke Homes	1,013	64.4	9%	800
Nationwide Homes	3,533	57.5	8%	470
Muncy Homes, Inc.	863	45.8	6%	390

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 45 IH producers responding to the survey. In 1998, surveyed modular home sales were estimated at $753 million and 24,680 units produced. The top 45 companies responding to the survey employ roughly 18,482 people.

Source(s): Automated Builder Magazine, May 1999, p. 52-55.

5.2.4 1998 Top Five Manufacturers of HUD-Code (Mobile) Homes (1)

Company	Units Produced	Gross Sales Volume ($million)	Market Share of Top 24 Company Sales (2)	Number of Employees
Champion Enterprises, Inc.	111,270	1,840	32.4%	15,000
Fleetwood Enterprises, Inc	105,747	1,560	27.4%	N.A.
Clayton Homes	41,646	638	11.2%	7,300
American Homestar	12,373	458	8.1%	5,000
Patriot Homes	13,728	249	4.4%	1,982

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 24 IH producers responding to the survey. In 1998, surveyed HUD-Code home sales were estimated at $5.75 billion and 348,158 units. The top 24 IH producers responding to the survey employ 48,705 people.

Source(s): Automated Builder Magazine, October 1999, p. 38-40.

5.2.5 1998 Top Five Manufacturers of Factory-Fabricated Components (trusses, wall panels, doors) (1)

Company	Gross Sales Volume ($million)	Market Share of Top 100 Company Sales (2)	Number of Employees (3)
Universal Forest Products	1250.0	24.8%	3500
Trussway	145.2	2.9%	900
R & D Thiel / CCA	93.5	1.9%	495
Schuck Component Syst.	70.0	1.4%	325
84 Components	47.0	0.9%	350

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 100 IH producers responding to the survey. In 1998, surveyed component sales was estimated at $5.04 billion. 3) The top 100 companies employ a total of 14,580 people at their plants.

Source(s): Automated Builder Magazine, September 1999, p. 56-62.

5.2.6 1998 Number of Industrialized Housing Manufacturers versus Production Companies (stick-builders)

Type	Number of Companies
Panelized	170
Modular (1)	200
HUD-Code	90
Production Builders	7,000
Component Manufacturers	~2,200

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

Source(s): Automated Builder Magazine, Jan. 1999, p. 8.

5.2.7 1998 HUD-Code (Mobile) Home Shipments, by Census Region and Top Five States (percent of national total)

Region		Top Five States	
Northeast	4%	Texas	12.1%
Midwest	16%	North Carolina	8.9%
South	67%	Georgia	6.0%
West	14%	Florida	5.4%
	100%	South Carolina	5.4%

Source(s): DOC, Manufactured Housing Statistics, Manufactured Homes Placements by Region for regional data; Automated Builder, Apr. 1999 p. 20-21 for states.

5.3.1 Value of Building Improvements and Repairs, by Sector ($1998 billion) (1)

	Value of Improvements and Repairs		
	Residential	Commercial	All Bldgs.
1980	86.5	N.A.	N.A.
1985	115.3	112.0	227.3
1990	129.0	111.8	240.8
1995	117.1	101.8	218.9
1998	120.7 (2)	99.9 (3)	220.6

Note(s): 1) Improvements includes additions, alterations, reconstruction, and major replacements. Repairs include maintenance. 2) Includes 67% Improvements and 33% Maintenance & Repairs. 3) Actually 1996. Includes 58% Improvements and 42% 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 1995-1998; 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 1995-1996 commercial; EIA, Annual Energy Review 1998, July 1999, Appendix E, p. 337 for price deflators.

5.3.2 1994-1995 Professional and Do-It-Yourself Improvements by Homeowners, by Project (1)

	Professional Installation			DIY Installation		
	Homeowners	Total Expenditures	Mean Expenditures	Homeowners	Total Expenditures	Mean Expenditures
Repair/Improvement	(10^6)	($10^9)	($)	(1000)	($10^9)	($)
Kitchen Remodeled	2.07	11.4	5499	2.10	4.7	2229
Bathroom Remodeled or Added	2.15	13.9	6457	2.82	5.9	2094
Additions Built	3.31	18.0	5451	3.48	7.7	2225
Exterior Improvements	4.99	16.7	3353	4.33	5.9	1371
Disaster Repairs	0.99	7.8	7851	0.27	1.2	4602
Roof Replacement	3.66	12.0	3286	0.82	1.3	1568
Siding Replaced or Added	1.29	6.3	4859	0.47	0.8	1756
Plumbing Replacement	1.07	1.0	914	0.75	0.2	311
Electric System Replacement	2.32	1.5	637	1.34	0.4	268
Windows/Doors Installed	4.24	7.5	1769	3.31	2.2	671
Insulation Added	0.98	0.6	626	1.45	0.4	247
Flooring/Paneling/Ceiling Replacement	4.07	6.0	1482	2.90	1.6	537
HVAC Replacement	3.85	10.5	2713	0.58	0.9	1577
Appliance/Major Equipment Replacement	4.86	1.8	377	3.77	1.0	256
Total	22.81	116.0	5086	16.72	34.6	2070

Note(s): Expenditures are $33.5 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.

5.4.1 Insulation Shipments, by Type (million pounds)

Type	1980	1982	1985	1989	1990	1992	1993	1989 Value of Shipments ($million current)	
Mineral Fiber (glass/wool)	2622	2261	2855	3013	N.A.	N.A.	3100 (1)	1,984	(2)
Cellulose	N.A.	1380	N.A.	N.A.	N.A.	N.A.	N.A.	96	(3)
Perlite/Vermiculite	N.A.	N.A.	N.A.	N.A.	N.A.	22	N.A.	2	
Rigid Foam Boards	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	1	N.A.	
Reflective Insulation (4)	N.A.	N.A.	N.A.	N.A.	50	N.A.	N.A.	5	(3)

Note(s): 1) Fiberglass insulation only in 1993. Insulation sold in 1992 used approximately 50% recycled material. In 1993, almost 75% of insulation production is used in the residential sector. 2) Nov. 1992 U.S. Census data reports $3,220 million for 1989 (and $2,777 million for 1991), which conflicts with their Jul. 1990 data. 3) 1990 data. 4) In million square feet.

Source(s): DOC, Current Industrial Reports: Glass Fibers, Jul. 1990, Table 1 for 1980-1989 mineral fiber data; In-cide Technologies, Inc., 1990 Cellulose Industry Survey, for cellulose data; Bureau of Mines, Mineral Industry Surveys, 1993 for 1992 perlite data; Energy Design Update, Feb. 1991, p. 2 for 1993; Reflective Insulation Manufacturers Association for reflective insulation data; NAIMA, Insulation Bulletin, July 1993 for Note 1 recycled material; and NAIMA, Green and Competitive: The Energy, Environmental, and Economic Benefits of Fiber Glass and Mineral Wool Insulation Products, June 1996, p. 9 for Note 1 residential use.

5.4.2 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.

5.4.3 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.

5.4.4 1996 Industry Use Shares of Mineral Fiber (Glass/Wool) Insulation (1)

Insulating Buildings (2)	74.8%
Industrial, Equipment, and Appliance Insulation	23.1%
Unknown	2.1%
	100%

Note(s): 1) Based on value of shipments. 2) Including industrial.

Source(s): DOC, 1996 Annual Survey of Manufacturers: Value of Product Shipments, Feb. 1998, p. 2-22.

5.4.5 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	1997	1985	1990	1997	1985	1990	1997
Aluminum (2)	9.5	5.9	3.7	7.2	3.6	3.6	16.7	9.5	7.3
Wood (3)	8.6	9.4	12.0	6.6	7.6	9.6	15.2	17.0	21.6
Vinyl	0.2	1.2	7.3	3.3	7.1	12.1	3.5	8.3	19.4
Other	0.2	0.1	0.3	0.2	0.1	0.3	0.4	0.2	0.6
Total	18.5	16.6	23.3	17.3	18.4	25.6	35.8	35.0	48.9

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, Industrial Statistical Review and Forecast 1998, 1999, Table 6, p. 6 for 1997; 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	1997	1985	1990	1997	1985	1990	1997
Aluminum	16.3	9.9	8.0	2.6	1.9	2.6	18.9	1.9	10.6
Wood	1.0	0.5	2.0	0.1	0.4	0.8	1.1	0.4	2.8
Other (1)	N.A.	0.1	0.3	0.7	0.1	0.1	0.7	0.1	0.4
Total	17.3	10.5	10.3	3.4	2.4	3.5	20.7	2.4	13.8

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; and American Architectural Manufacturers Association, Industrial Statistical Review and Forecast 1998, 1999, Table 7, p. 7 for 1997.

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	1997	1990	1997	1990	1997	1990	1997	1990	1997
New Construction										
Architectural Windows (2)	9	4	14	16	22	22	14	15	59	57
Curtain Wall	6	6	7	10	11	17	8	12	32	45
Store Front	6	9	7	12	15	13	9	14	40	48
Total	21	19	31	38	48	52	31	41	131	150
Remodeling/Replacement										
Architectural Windows (2)	6	19	11	30	24	49	14	27	55	125
Curtain Wall	3	5	3	4	5	11	6	13	17	33
Store Front	6	13	9	21	21	25	16	23	52	82
Total	15	37	23	55	50	85	36	63	124	240
Total										
Architectural Windows (2)	15	23	25	46	46	71	28	42	114	182
Curtain Wall	9	11	10	14	16	28	14	25	49	78
Store Front	12	22	19	33	36	38	25	37	92	130
Total	36	56	54	93	98	137	67	104	255	390

Note(s): 1) "Usage" is a good indication of sales. 2) Residential-type window.

Source(s): AAMA/Ducker Research, Industry Statistical Review and Forecast 1992, 1993 for 1990; AAMA/WDMA/Ducker Research, Industrial Statistical Review and Forecast 1998, 1999, Table 13, p. 17 for 1997.

5.5.4 1994 Residential Buildings Existing Window Stock, by Census Region

Region	Stock (10^9 SF)
Residential	
Northeast	4.2
Midwest	5.1
South	6.5
West	3.5
Total	19.2 (1)

Note(s): 1) Average window area equals 12% of floorspace. The average single-family detached house has 12 windows. In 1993, there were 1.2 billion windows in U.S. housing units.

Source(s): LBNL and ACEEE, 1996 ACEEE Proceedings, The National Energy Requirements of Residential Windows in the U.S.: Today and Tomorrow, Summer 1996, p. 10.47-10.58; and EIA, Housing Characteristics 1993, June 1995, p. xvii for Note.

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

Sector	1985	1990	1991	1992	1993	1994	1995	1996	1997
Residential	73%	86%	87%	88%	88%	89%	89%	90%	90%
Nonresidential	63%	80%	81%	81%	82%	83%	84%	84%	84%

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; AAMA/WDMA/Ducker Research, Industrial Statistical Review and Forecast 1998, 1999, p. 12 for 1991-1997.

5.5.6 Residential Prime Window Stock and Sales, by Type

Type	Existing U.S. Stock (% of households)	Sales (million units) (1) 1980	1985	1990	1991
Single-Pane	63.7	8.6	9.7	4.9	4.3
Double-Pane	33.7	15.0	25.0	16.0	15.0
Double-Pane, Low-e	1.7	0.0	0.4	0.2	0.2
Double-Pane, Gas-fill	(2)	0.0	0.0	3.9	4.0
Double-Pane, Low-e, Gas-fill	(2)	0.0	0.0	8.1	7.0
Triple Pane	0.9	1.6	1.2	1.5	1.7
Triple-Pane, 2 Low-e, Gas-fill	(2)	0.0	0.0	1.0	1.6
Total (2)	100	25.2	36.3	35.6	33.8

Note(s): 1) Low-e window sales accounted for 26% of the market in 1991 and 35% in 1993. 2) Included in other categories. 3) LBNL 1985 and 1990 totals differ slightly (by ~1%) from Ducker Research values in other tables.

Source(s): EIA, Housing Characteristics 1993, June 1995, Table 3.28b, p. 165 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 the 1993 data in Note 1.

5.5.7 1995 Nonresidential Window Stock and Usage, by Type (1)

Type	Existing U.S. Stock (% of buildings)	Glass Area Usage (million sf)	Glass Area Usage (% 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; AAMA/WDMA/Ducker Research, Industrial Statistical Review and Forecast 1998, 1999, 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.

5.5.8 1990 Window Manufacturer Data

	Market Share (1)	Average U-Value Sold
15 Large Manufacturers	30%	0.4
100 Medium Manufacturers	50%	0.6
1,000 Small Manufacturers	20%	0.7

Note(s): 1) Based on value of shipments.

Source(s): BTS Window Program Manager, March 1994.

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

	U-Value	Solar Heat Gain Coefficient
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) 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.

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

Equipment Type	1985 (1000s)	1990 (1000s)	1998 (1000s)	1998 Value of Shipments ($million) (7)
Air Conditioners (1)	**2,470.0**	**2,928.0**	**4,980.3**	**4,341**
Heat Pumps	**885.0**	**948.0**	**1,379.8**	**1,184**
Air-to-Air Heat Pumps	820.0	808.0	1,259.7	1,054
Water-Source Heat Pumps (2)	65.0	140.0	120.1	130
Chillers (3)	**11.8**	**15.0**	**23.8**	**1,151**
Reciprocating	8.2	9.8	14.8	N.A.
Centrifugal/Screw	3.5	5.0	8.6	N.A.
Absorption	0.1	0.2	0.4	N.A.
Furnaces	**2,335.0**	**2,367.0**	**3,560.4**	**N.A.**
Gas-Fired (4)	1,822.0	1,950.0	2,977.4	1,437
Electric	366.0	279.0	455.0	N.A.
Oil-Fired (5)	147.0	138.0	128.0	104
Boilers (6)	**305.2**	**328.7**	**333.2**	**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 tons or less (60,000 Btu/Hr). ~70% residential and ~30% commercial applications. 2) Includes ground-source heat pumps (GSHPs), which numbered around 38,000 units shipped in 1998. 3) Chiller value of shipments are based on Census unit shipment data, which is 8,600 units higher than the industry data shown. 4) Gas-fired furnace value of shipments are based on Census unit shipment data, which is 433,000 units higher than the industry data shown. 5) Oil-fired furnace value of shipments are based on Census unit shipment data, which is 13,600 units higher than the industry data shown. 6) 56% of boiler shipments were gas-fired and 44% were oil-fired. 7) Total 1998 value of shipments for refrigeration, air-conditioning, and heating equipment was $20.9 billion, including industrial and excluding boiler 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 Manufacturer, March 2000, p. 11 and Feb. 1998 for 1998 shipments; ARI, 1999 Statistical Profile of the Air-Conditioning, Refrigeration, and Heating Industry, 1999, Table 22, p. 31 for centrifugal/screw chiller shipments; ARI, Hot Shipments in a Cool Month, March 17, 2000 for reciprocating chiller shipments; EIA, Renewable Energy Annual 1999, Mar. 2000, Table 35, p. 31 for GSHP shipment data; DOC, Current Industrial Reports: Refrigeration, Air Conditioning, and Warm Air Heating Equipment, MA35M, May 2000, Table 2 for value of shipments.

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

Gas-Fired

AFUE Range	1985	AFUE Range	1999
Below 65%	15%	Under 80%	4%
65% to 71%	44%	80% to 88%	73%
71% to 80%	10%	Over 88%	23%
80% to 86%	19%		100%
over 86%	12%		
	100%		

Average shipped in 1985 (2):	74% AFUE
Average shipped in 1995:	84% AFUE
Best Available in 1981:	85% AFUE
Best Available in 1999:	97% AFUE

Oil-Fired

AFUE Range	1985	AFUE Range	1999
Below 75%	10%	Under 80%	0%
75% to 80 %	56%	80% to 87%	100%
Over 80%	35%		100%
	100%		

Average shipped in 1985 (2):	79% AFUE
Average shipped in 1995:	81% AFUE
Best Available in 1981:	85% AFUE
Best Available in 1999:	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 1999 AFUE ranges; GAMA News, Feb. 24, 1987 for 1985 AFUE ranges; LBNL for average shipped AFUE; GAMA, Consumer's Directory of Certified Efficiency Ratings, Oct. 1999, p. 12-13 and 94-95 for 1999 best-available AFUEs.

5.6.3 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 1999:	95% AFUE	Best Available in 1999:	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, Oct. 1999, p. 109 and 126 for best-available AFUE. GAMA for 1985 average AFUEs.

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

SEER Range	1992 Percent of Units Shipped	Shipment-Weighted Average Data		Best Available in 1999	
Below 10	15%	1985 Air Conditioners	8.82 SEER	Air Conditioners	17 SEER and over
10 to 11	70%	1985 Heat Pumps (2)	8.56 SEER	Heat Pumps (2)	
11 to 12	7%			Air-Source	17 SEER and over
Over 12	8%	1990 Air Conditioners	9.31 SEER	Ground-Source	20 EER and over
	100%	1990 Heat Pumps (2)	9.46 SEER	Heat Pumps (3)	
				Air-Source	9 HSPF
		1997 Air Conditioners	10.66 SEER	Ground-Source	4.0 COP
		1997 Heat Pumps (2)	10.97 SEER		
		1998 Heat Pumps (3)	7.50 HSPF		

Note(s): 1) Federal appliance standards effective January 1, 1992 require a minimum SEER of 10. 2) Cooling. 3) Heating.

Source(s): The Air Conditioning, Heating and Refrigeration News: Statistical Panorama 1993, Mar. 29, 1993, p. 38 for 1992 SEER ranges; ARI ratings for best-available in 1999; ARI, 1999 Statistical Profile, Jan. 1999, p. 28 for shipment-weighted average SEERs; EIA, Technology Forecast Updates, Sept. 2, 1998, p. 22 for heat pump HSPF.

5.6.5 Commercial Equipment Efficiencies

Equipment Type	Efficiency Parameter	1995 Stock Efficiency	1998 U.S. Average New Efficiency	1998 Best-Available New Efficiency
Chiller				
Reciprocating	COP	2.5	3.2	3.2
Centrifugal	COP	4.6	5.9	7.3
Gas-Fired Absorbtion	COP	1.0	1.0	
Gas-Fired Engine Driven	COP	1.0	2.0	
Rooftop A/C	COP	2.1	2.5	3.4
Rooftop Heat Pump	EER	12	12	15
Boilers				
Gas-Fired	Thermal Efficiency	75	80	90
Oil-Fired	Thermal Efficiency	78	83	87
Electric	Thermal Efficiency	98	98	98
Gas-Fired Furnace	AFUE	75	77	92
Water Heater				
Gas-Fired	Thermal Efficiency	76	80	96
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. 1998, p. 36-60.

5.6.6 1998 Air-Conditioner/Heat Pump Manufacturer Market Shares (by percentage of products produced)

Company	Market Share (%)
Carrier	22%
Goodman	17%
Trane	13%
Rheem	12%
Lennox	10%
International Comfort Products	9%
York	7%
Others	10%
	100%

Total Units Shipped: 5,359,858 (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. 1999, p. 76.

5.6.7 1998 Gas Furnace Manufacturer Market Shares (by percentage of products produced)

Company	Market Share (%)
Carrier	23%
Goodman	17%
Rheem	13%
Lennox	12%
International Comfort Products	10%
Trane	10%
York	7%
Others	8%
	100%

Total Units Shipped: 2,977,434

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sep. 1999, p. 76.

5.6.8 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 2000
Central Air Conditioners	**9 - 21**	**15**	**9**	**2,469,887**
Heat Pumps	**9 - 18**	**14**	**8**	**884,203**
Furnaces				**2,471,860**
Electric	11 -30	21	11	283,200
Gas-Fired	15 - 20	21	12	2,085,160
Oil-Fired	13 - 23	18	N.A.	103,500
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. 1999, p. 79 for service and average lifetimes, and units to be replaced; ASHRAE, 1995 ASHRAE Handbook: HVAC Applications, Table 3, p. 33.4 for boilers service lifetimes; EIA, Housing Characteristics 1990, May 1992, Table 7, p. 24 for 1990 average stock ages.

5.6.9 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-Water	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, 1995 ASHRAE Handbook: HVAC Applications, Table 3, p. 33.4 for median service lifetimes; EIA, Commercial Building Characteristics 1989, June 1991, Tables 90-91, p. 176-177 for average stock age.

5.6.10 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.

5.6.11 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; EIA, Housing Characteristics 1987, May 1989, Table 14, p. 33.

5.6.12 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.

5.7.1 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 1990 Quantity of Ducts and Hot-Water Piping Installed in New Single-Family-Detached Residences, by Distribution System Type and Census Region (million linear feet)

Ducts	Northeast/ North Central	South/West
Metal Rectangular	**20.1**	**12.5**
- Uninsulated	14.1	3.8
- Insulated	6.0	8.7
Metal Round	**11.3**	**15.2**
Fiberglass Flexible	**3.2**	**24.9**
Fiberglass Rigid	**2.3**	**13.2**
Hydronic Piping and Fin-Tube	**9.0**	**1.0**

Source(s): BTS Program Manager, Sep. 1993, data adapted from industry sources.

5.7.3 Average Efficiency of Existing Residential Thermal Distribution Systems (1)

Forced-Air	
Ducts in Unconditioned Spaces	65%
Ducts in Partially Conditioned Spaces	80%
Ducts in Conditioned Spaces	95%
Hydronic (hot water)	90-95%

Note(s): 1) "Efficiency" is defined as the share of heating or cooling service successfully *delivered* to the conditioned space.

Source(s): BTS Program Manager, Sep. 1993, data based on reported literature.

5.7.4 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	1998	1998 Value of Shipments ($million)
Solar Thermal Collectors	19,398	11,409	7,756	28.4
Residential	N.A.	5,851	7,165	N.A.
Commercial	N.A.	295	517	N.A.
Industrial	N.A.	(2)	62	N.A.
Utility	N.A.	5,236	10	N.A.
Other	N.A.	26	3	N.A.
Photovoltaics	6,897 kW (3)	13,837 kW	50,562 kW	185.0

Note(s): 1) Includes imports and exports; 1998 solar thermal collector imports were 2,206,000 square feet, and exports were 360,000 square feet. 2) Industrial is included in Other. 3) Actually 1982 data.

Source(s): EIA, Renewable Energy Annual 1999, Mar. 2000, Tables 16 and 23 for 1998 shipments and Tables 15 and 27 for value of shipments; EIA, Annual Energy Review 1991, June 1992, Table 111, p. 251 for 1990 data by sector; EIA, Annual Energy Review 1994, July 1995, Tables 10.4 and 10.6, p. 271 and 275 for 1980 and 1990 (revised) total shipment data.

5.8.2 1998 Thermal Solar Collector Shipments, by End Use (including imports and exports) (1)

Type	1000 Square Feet
Pool Heating	7,201
Hot Water	463
Space Heating	67
Space Cooling	-
Combined Space/Water Heating	15
Process Heating	-
Electricity Generation	10
Total	7,756 (2)

Note(s): 1) 5% of shipments are exported. 2) Approximately 15,000 systems in 1998.

Source(s): EIA, Renewable Energy Annual 1999, Mar. 2000, Table 16, p. 21, Table 12, p. 18 for Note 1 and Table 17, p. 22 for Note 2.

5.8.3 1998 Top Five Destinations of Thermal Solar Collector Shipments

State or Territory	Percent of U.S. Unit Shipments
Florida	45%
California	22%
Arizona	6%
Nevada	4%
Hawaii	4%

Source(s): EIA, Renewable Energy Annual 1999, Mar. 2000, Table 11, p. 17.

5.8.4 Thermal Solar Collector Manufacturer Statistics

- Number of Manufacturers in 1998: 28
- Percentage of Shipped Solar Collectors Produced by Top 5 Manufacturers: 89%
- Percentage of Shipped Solar Collectors Produced by Top 10 Manufacturers: 97%

Source(s): EIA, Renewable Energy Annual 1999, Mar. 2000, Tables 17 and 19, p. 22.

5.8.5 Thermal Solar Collector System Characteristics

- Typical solar domestic hot-water (SDHW) systems cost between $1,500 to $3,000 installed.
- 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; BTS Active Solar Program Manager for remaining information.

5.9.1 1993 Residential Lighting Stock (1)

Lamp Type	Stock Lamps (millon)	Percent
Incandescent (2)	351.5	67%
Fluorescent (3)	42.9	8%
Compact Fluorescent	55.3	11%
Halogen	72.8	14%
Total	522.5	100%

Household Members	Number of Rooms (Lamps used/household) 3-4	5-6	7-8
1-2	3-4	5-6	6-7
3-4	4-5	5-6	7-8
5 or more	5	6-7	8

Note(s): 1) This table provides data for lamps used for more than 1 hour per day. The average hours in use of any lamp is 6 hrs. A lamp generally refers to 1 bulb. In 1993, the average household consumed 940.5 kWh of electricity for lighting. 2) 87% of all lamps used for 15 minutes or more per day are incandescent. 3) 21% of all lamps used more than 12 hours per day are fluorescent.

Source(s): EIA, Housing Characteristics 1993, June 1995, Table 3.22, p. 128-130e; and EIA, Energy Consumption Series, Residential Lighting: Use and Potential Savings, Sept. 1996, p. 9 for data, and p. 5 and 7 for notes.

5.9.2 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.

5.9.3 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.

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

Lighting Fixture Type	1985	1990	1998
Residential	786.8	827.6	1,031.8
Commercial/Institutional (except spotlight)	1,832.3	2,379.7	3,175.0
Industrial	389.2	529.4	727.8
Vehicular (1)	1,001.2	1,620.7	N.A.
Outdoor	905.5	1,061.5	1,776.0

Note(s): 1) Data for vehicular lighting fixtures was discontinued in 1992.
Source(s): DOC, Current Industrial Reports: Electric Lighting Fixtures, MA335L(98)-1, March 2000, Table 1.

5.9.5 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.

5.9.6 Shipments of Fluorescent Lamp Ballasts

	Standard Magnetic Type (1)		Electronic Type		Total		
	Quantity	Value	Quantity	Value	Quantity	Value	Electronic Type as a %
Year	(million)	($million)	(million)	($million)	(million)	($million)	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%
1987	74.3	420.9	0.7	15.1	74.9	436.0	1%
1988	74.6	450.9	1.1	25.5	75.7	476.4	1%
1989	76.3	481.5	1.4	39.8	77.7	521.3	2%
1990	78.4	546.3	3.0	69.3	81.4	615.6	4%
1991	80.4	538.3	8.3	180.0	88.7	718.3	9%
1992	83.7	537.7	13.3	274.6	97.0	812.3	14%
1993	82.9	523.0	24.5	446.5	107.4	969.5	23%
1994	83.5	550.0	24.6	390.8	108.1	940.7	23%
1995	72.4	495.2	32.9	507.0	105.3	1,002.2	31%
1996	67.0	457.8	30.3	451.4	97.3	909.2	31%
1997	67.4	412.4	36.5	494.0	103.9	906.4	35%
1998	63.9	401.4	39.8	512.8	103.7	914.3	38%

Note(s): 1) Standard magnetic type includes uncorrected and corrected power-factor type ballasts.
Source(s): DOC, Current Industrial Reports: Fluorescent Lamp Ballasts, MQ36C(98)-5, June 1999, Table 1.

5.9.7 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; 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)	1998 (1000)	1998 Value of Shipments ($million)
Refrigerator/Freezers (1)	6,510	7,101	8,774	4,266.0
Freezers (chest and upright)	1,222	1,296	1,627	393.3
Refrigerated Display Cases	97	101	160 (2)	1,373.6 (3)
Unit Coolers	139	178	220	158.0
Ice-Making Machines	203	171	296	434.9

Note(s): 1) Refrigerator/freezers include imports of units 6.5 cubic feet and over. 2) 1995 3) 1994 in $1998.

Source(s): AHAM, 2000 Major Home Appliance Industry Fact Book (draft), 2000, Table 7, p. 12, and Table 8 for refrigerator/freezer and freezers; The Air Conditioning, Heating and Refrigeration News, March 29, 1993, p. 18 for 1986 display case shipments, April 11, 1994 for 1990 display case shipments, Nov. 11, 1996, p. 19 for 1995 display case shipments, and April 10, 1995, p. 19 for display case value of shipments, November 11, 1995, p. 19 for 1986 and 1990 unit cooler and ice-making machine shipments; DOC, Current Industrial Reports: Air-Conditioning and Refrigeration Equipment, MA333M(98)-1, April 2000, Table 2 for 1998 unit cooler and ice-making machine data; and EIA, Annual Energy Review 1998, July 1999, Appendix E, p. 337 for price deflator.

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

Appliance Type	1980 (1000)	1990 (1000)	1998 (1000)	1998 Value of Shipments ($million)
Room Air Conditioners	**3,203**	**3,799**	**4,403**	**1,184**
Ranges (total)	**4,069**	**5,873**	**7,589**	**2,807**
Electric Ranges	2,530	3,350	4,639	1,729
Gas Ranges	1,539	2,354	2,950	1,078
Microwave Ovens/Ranges	**3,608**	**7,693**	**10,365**	**1,352**
Clothes Washers	**4,550**	**5,591**	**6,835**	**2,151**
Clothes Dryers (total)	**3,177**	**4,160**	**5,739**	**1,455**
Electric Dryers	2,494	3,190	4,432	N.A.
Gas Dryers	682	970	1,307	N.A.
Water Heaters (total)	**N.A.**	**N.A.**	**9,036**	**1,367**
Electric (1,2)	N.A.	N.A.	4,171	541
Gas and Oil (2)	N.A.	N.A.	4,850	811
Solar (3)	N.A.	N.A.	15	15
Office Equipment				
Personal Computers (4)	N.A.	N.A.	20,427	41,729
Host Computers (5)	N.A.	N.A.	1,409	12,024
Copiers	N.A.	N.A.	1,928	N.A.
Facsimile Machines	N.A.	N.A.	5,569	N.A.
Printers	N.A.	N.A.	4,438	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.

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 (draft), 2000, Tables 7 and 8, for 1990 and 1998 data except water heaters; DOC, Current Industrial Reports: Major Household Appliances, MA335F(98)-1, Feb. 2000, for value of water heater shipments; EIA, Renewable Energy Annual 1999, Mar. 2000, Table 17, p. 22 for solar water heater data; BTS/OBE, Market Dispostion 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(98)-1, Dec. 1999, for computer data; and Appliance, A Portrait of the U.S. Appliance Industry 1999, Sept. 1999, p. 78 for 1998 office equipment shipments.

5.10.3 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

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

Source(s): AHAM, 2000 Major Home Appliance Industry Fact Book (draft), 2000, Table 25, p. 32 for volume and average consumption/unit; AHAM, 1991, 1993-1998 Directory of Certified Refrigerators and Freezers for 1993-1998 best-available data (at 19.6 or more cu.ft.); LBNL, Center for Building Science News, Summer 1995, p. 6 for note.

5.10.4 Commercial Refrigeration Efficiencies as of 1992

Appliance Type	Efficiency Parameter	U.S. Average New Efficiency	Best Available New Efficiency
Central Refrigeration:			
Frozen Food	COP	1.20	1.40
Fresh Food	COP	2.00	2.30
Unit Coolers:			
Frozen Food	COP	1.00	1.50
Fresh Food	COP	1.80	2.10
Icemakers	COP	0.60	0.80
Vending Machines/Water Coolers	COP	1.80	2.10

Source(s): BTS/OBE, Characterization of Commercial Building Appliances, Aug. 1993; and Arthur D. Little, Inc.

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

Source(s): AHAM, 2000 Major Appliance Industry Fact Book (draft), 2000, Table 27, p. 34 for average capacity and EER. AHAM, 1994, 1996, 1997 and 1998 Directory of Certified Room Air Conditioners, March 1998 for best-available EER and 1995 is assumed.

5.10.6 Water Heater Efficiencies

Residential Appliance Type	Efficiency Parameter (1)	1998 Stock Efficiency	Minimum New Efficiency	1999 Best-Available New Efficiency
Electric Water Heaters	EF	0.87	0.86	0.95
Gas Water Heaters	EF	0.54	0.54	0.65
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 (2)	0.95
Gas Water Heaters	EF	0.65	0.78 (3)	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) For tanks greater than 120 gallons or an input greater than 12kW. 3) Thermal efficiency.

Source(s): EIA, Supplement to the AEO 2000, Dec. 1999, 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. 1999 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.

5.10.7 Other Major Appliance Efficiencies

Residential Appliance Type	Efficiency Parameter	1998 U.S. Average New Efficiency	1995 Best Available New Efficiency
Dishwashers	EF	0.51	N.A.
Clothes Washers	EF	1.41	N.A.

Commercial Appliance Type	Efficiency Parameter	1992 U.S. Average New Efficiency	1992 Best Available New Efficiency
Cooking Equipment:			
Electric Appliances	EF	0.50 - 0.70	0.60 - 0.80
Gas Appliances	EF	0.25 - 0.50	0.30 - 0.65
Laundry Equipment:			
Electric Drying	EF/COP	0.98	3.30
Gas Drying	EF	0.36	0.55
Motors	EF	0.65	0.75
Office Equipment:			
Linear Power Supplies	EF	0.30 - 0.60	0.60
Switching Power Supplies	EF	0.80 - 0.95	0.95
Motors	EF	0.60 - 0.70	0.70

Note(s): EF = energy factor.

Source(s): BTS/OBE, Characterization of Commercial Building Appliances, Aug. 1993 for commercial efficiencies. AHAM, 2000 Major Home Appliance Industry Fact Book (draft), 2000, Tables 29, p. 36 and Table 30, p. 37 for residential efficiencies.

5.10.8 1998 Room Air Conditioner Manufacturer Market Shares (by percentage of products produced)

Company	Market Share (%)
Fedders	25%
Electrolux (Frigidaire)	21%
Whirlpool	18%
Goodman/Amana	7%
LG Electronics/Goldstar	7%
Matsushita	6%
Sharp	4%
Others	12%
	100%

Total Units Shipped: 4,403,400

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sept. 1999, p. 76.

5.10.9 1998 Refrigerator Manufacturer Market Shares (by percentage of products produced)

Company	Market Share (%)
GE	33%
Whirlpool	25%
Electrolux (Frigidaire)	20%
Maytag (Admiral)	11%
Goodman (Amana)	8%
Others	3%
	100%

Total Units Shipped: 8,773,500

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sept. 1999, p. 77.

5.10.10 1998 Range Manufacturer Market Shares (by percentage of products produced)

Company	Electric Market Share (%)	Gas Market Share (%)
GE	43%	28%
Whirlpool	21%	7%
Maytag	18%	25%
Electrolux (Frigidaire)	11%	20%
Goodman (Caloric)	2%	10%
Others	5%	10%
	100%	100%

Total Electric Units Shipped: 4,637,900

Total Gas Units Shipped: 2,950,500

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sept. 1999, p. 77.

5.10.11 1998 Microwave Oven Manufacturer Market Shares (by percentage of products produced)

Company	Market Share (%)
Sharp	29%
LG Electronics/Goldstar	17%
Matsushita	16%
Samsung	16%
Daewoo	8%
Sanyo	7%
Others	7%
	100%

Total Units Shipped: 10,365,000

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sept. 1999, p. 77.

5.10.12 1998 Clothes Washer Manufacturer Market Shares (by percentage of products produced)

Company	Market Share (%)
Whirlpool	53%
Maytag	21%
GE	15%
Electrolux (Frigidaire)	7%
Goodman (Speed Queen)	4%
	100%

Total Units Shipped: 7,023,950

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sept. 1999, p. 77.

5.10.13 1998 Clothes Dryer Manufacturer Market Shares (by percentage of products produced)

Company	Electric Market Share (%)	Gas Market Share (%)
Whirlpool	55%	51%
GE	18%	18%
Maytag	16%	22%
Electrolux (Frigidaire)	6%	8%
Goodman (Speed Queen)	5%	1%
	100%	100%

Total Electric Units Shipped: 4,482,200

Total Gas Units Shipped: 1,307,400

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sept. 1999, p. 77.

5.10.14 1998 Water Heater Manufacturer Market Shares (by percentage of products produced)

Company	Market Share (%)
State Industries	22%
Rheem Manufacturing	34%
Southcorp	16%
A.O. Smith	15%
Bradford-White	13%
	100%

Total Units Shipped: 8,833,654

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sept. 1999, p. 77.

5.10.15 1998 Facsimile and Copier Machine Manufacturer Market Shares (by percentage of products produced)

Company	Facsimile Machine Market Share (%)	Copier Market Share (%)
Brother	26%	-
Sharp	20%	10%
Panasonic	17%	-
Hewlett-Packard	17%	-
Cannon	12%	29%
Xerox	2%	28%
Mita	-	5%
Minolta	-	4%
Ricoh	-	4%
Others	7%	20%
	100%	100%

Total Facsimile Machine Units Shipped: 5,569,347

Total Copier Units Shipped: 1,927,600

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sept. 1999, p. 76.

5.10.16 1998 Personal Computer Manufacturer Market Shares (by percentage of products produced)

Company	Market Share (%)
Compaq	17%
Dell	13%
Gateway 2000	9%
Hewlett-Packard	9%
IBM	8%
Packard Bell/NEC	7%
Apple	5%
Acer America	3%
Micron	2%
DTK	1%
Others	27%
	100%

Total Units Shipped: 29,034,333

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sept. 1999, p. 78.

5.10.17 1998 Printer Manufacturer Market Shares (by percentage of products produced)

Company	Ink Jet Printer Market Share (%)	Laser Printer Market Share (%)	Other Printers Market Share (%)
Hewlett-Packard	48%	62%	-
Canon	19%	-	-
Epson	20%	-	30%
NEC	-	15%	-
Lexmark	8%	5%	15%
Okidata	-	2%	25%
Brother	-	1%	-
Apple	-	1%	-
Panasonic	-	0%	17%
Citizen	-	-	0%
Others	5%	14%	14%
	100%	100%	100%

Total Ink Jet Units Shipped: 15,111,805

Total Laser Units Shipped: 2,121,517

Total Dot Matrix Units Shipped: 804,510

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sept. 1999, p. 78.

5.10.18 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 2000
Refrigerators (1)	11-18	15	8	6,080,500
Freezers	12-20	16	12	1,535,800
Room Air Conditioners	7-13	11	9	5,091,100
Microwave Ovens	6-11	9	N.A.	8,334,550
Ranges (2)				
Electric	14-19	16	N.A.	3,167,600
Gas	14-21	17	N.A.	1,572,700
Clothes Washers	7-16	13	N.A.	6,348,200
Clothes Dryers (electric and gas)	11-18	14	N.A.	4,144,800
Water Heaters				
Electric	7-18	13	9	3,396,395
Gas	6-13	10	9	3,906,264
Facsimile Machines	3-9	6	N.A.	2,525,710
Personal Computers	2-5	3	N.A.	28,134,269

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

Source(s): Appliance Magazine, A Portrait of the U.S. Appliance Industry, Sep. 1999, p. 79 for service and average lifetimes and units to be replaced; 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.

5.10.19 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, 1997 Major Home Appliance Industry Fact Book, Oct. 1997, 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 28 coal plants (600-MW each) in one year
- 973 billion cubic feet natural gas
- 8 billion gallons of gasoline = 23 days of U.S. gasoline use (1998)
  - - 14.1 million new passenger cars and light-duty trucks each driven 14,200 miles
  - - all new passenger cars and light-duty trucks sold each driven 14,200 miles
  - - 12.4 million stock passenger cars each driven 14,200 miles = 10% of all passenger cars each driven 14,200 miles
  - - all new passenger cars each making 6 round trips from New York to Los Angeles
  - - 7.0 million stock passenger cars driven once around the Equator
- 172 million barrels of crude oil = 17 days of U.S. imports = 137 days of oil flow in the Alaska pipeline at full capacity (1998)
  - - the amount of crude oil transported by 498 double-hulled supertankers
- 23 hours of world energy use (1997)
- average annual output *delivered* from 46 1,000-MW nuclear power plants
- the energy released in 12,500 WW II-era nuclear bombs (20 kiloton each)
- 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 (1997)

Source(s): EIA, AEO 2000, Dec. 1999, Table A2, p. 119-121, Table A7, p. 129, Table A8, p. 130, Table A11, p. 134 for consumption, Table H1, p. 243 for heat rates; EIA, State Energy Data Report 1997, Sept. 1999, Table 9-10, p. 17-18; EIA, Inventory of Power Plants in the United States 1999, Nov. 1999, Table 1, p. 10; and EIA, International Energy Outlook 2000, March 2000, Table A1, p. 169; DOC, Statistical Abstract of the United States 1999, Oct. 1999, No. 1028, p. 638, No. 1053, p. 651, and No. 1054, p. 652; Newport News Shipbuilding Website.

6.1.3 Carbon Emission Comparisons

One million metric ton of carbon equivalent equals:

- 1.85 million short tons of coal
- the coal input to 1 coal plant (600-MW) in one year
- 67 billion cubic feet natural gas
- 427 million gallons of gasoline = 28 hours of U.S. gasoline use (1998)
  - 847 thousand new cars each driven 14,200 miles
  - 619 thousand new light trucks each driven 14,200 miles
  - 0.4 million new passenger cars each making 6 round trips of New York to Los Angeles
  - 0.5 million stock passenger cars driven once around the Equator
- 9 million barrels of crude oil
- 85 minutes of world energy emissions (1997)
- 6 hours of U.S energy emissions
- 17 hours of U.S Buildings energy emissions
- 31 hours of U.S Residential energy emissions
- 37 hours of U.S Commercial energy emissions
- 5 days of U.S Buildings lighting energy emissions
- average annual per capita emissions of 182 thousand people in the U.S.
- the approximate emissions from cities approximately the size of any one of the following cities: Amarillo, TX, Arlington, VA, Des Moines, IA, Glendale, AZ, Greensboro, NC, Little Rock, AR, Orlando, FL; Salt Lake City, UT; or Tacoma, WA

Source(s): EIA, AEO 2000, Dec. 1999, Table A2, p. 119-121, Table A7, p. 129 for consumption, Table A19, p. 142 for emissions, and Table H1, p. 243 for heat rates; EIA, Inventory of Power Plants in the United States 1999, Nov. 1999, Table 1, p. 10; EIA, International Energy Outlook 2000, March 2000, Table A10, p. 179; EIA, Emissions of Greenhouse Gases in the U.S. 1998, Oct. 1999, Table B1, p. 104; and DOC, Statistical Abstract of the United States 1999, Oct. 1999, No. 2, p. 8, No. 48, p. 48 for populations, and No. 1054, p. 652.

6.2.1 1998 Utility Impacts of Saving an Electric Quad (1)

Plant fuel type	Utility Fuel Input Shares (%)	Average-sized Utility Unit (MW) in 1998	Aggregate Number of Units to Provide the Fuel's Share of the Electric Quad (2)
Natural Gas	10.6%	64	60
Petroleum	3.5%	21	93
Coal	53.8%	272	33
Nuclear	20.4%	1007	3
Renewable (3)	11.7%	26	99
Total	100%		287

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 1998. 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 Power Plants in the United States 1999, Nov. 1999, Table 1, p. 10; EIA, Annual Energy Outlook 2000, Dec. 1999, Table A2, p. 119-121 for consumption, Table A8, p. 129 for electricity supply.

6.2.2 Cost of an Electric Quad Used in the Buildings Sector ($1998 billion)

	1998	2000	2010	2020
Residential	7.31	7.18	7.05	7.30
Commercial	6.75	6.60	6.07	6.22
Buildings Sector	7.04	6.90	6.58	6.79

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 2000, Dec. 1999, Table A2, p. 119-121 and Table A3, p. 122-123.

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

New Plant Type	Installed Capital Costs (1998 thousand dollars per MW)	1998 Net Generation Heat Rate (Btu/kWh)	2010 Net Generation Heat Rate (Btu/kWh)	1998 Installed Capital Costs of a 500-MW Power Plant ($1997 million)
Pulverized Coal	1,102	9,585	9,087	551
Advanced Coal	1,315	8,470	6,968	658
Oil/Gas Steam	1,012	9,500	9,500	506
Combined Cycle	449	8,030	7,000	225
Advanced Combined-Cycle	580	6,985	6,350	290
Combustion Turbine	332	11,900	10,600	166
Advanced Combustion Turbine	465	9,700	8,000	233
Fuel Cell	2,163	6,000	5,361	1082

Stock Plant Type	1998	2000	2010	2020
Fossil Fuel Steam Heat Rate (Btu/kWh)	10,626	10,565	9,986	9,427
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 2000, Dec. 1999, Table 37, p. 67; and EIA, AEO 2000, Dec. 1999, Table A2, p. 119-121, and Table A8, p. 129.

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

	1998	2000	2010	2020
Average Utility Delivery Efficiency (1, 2)	31.0%	31.1%	32.5%	34.2%
Average Utility Delivery Ratio (Btu/kWh) (2, 3)	11,001	10,958	10,488	9,966

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 2000, Dec. 1999, Table A2, p. 119-121 for generator consumption and Table A8, p. 129 for electricity sales; and EIA, Annual Energy Review 1998, July 1999, Diagram 5, p. 207.

6.3.1 Cost of a Generic Quad Used in the Buildings Sector ($1998 billion) (1)

	1998	2000	2010	2020
Residential	7.12	7.19	7.07	7.18
Commercial	6.31	6.30	5.93	6.03
Buildings Sector	6.73	6.79	6.54	6.66

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 2000, Dec. 1999, Table A2, p. 119-121 and Table A18, p. 141 for energy consumption and Table A3, p. 122-123 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
1998	**(2)** **30%**	**8%**	**38%**	**7%**	**3%**	**10%**	**14%**	**1%**	**100%**
2000	31%	7%	38%	6%	3%	9%	14%	1%	100%
2010	34%	6%	39%	5%	4%	9%	12%	0%	100%
2020	39%	5%	39%	5%	4%	9%	7%	0%	100%

Note(s): 1) See Table 6.1.1 for generic quad definition. The total 1998 Buildings sector primary energy consumption was 34.19 quads. Excludes buildings-related energy consumption in the industrial sector.

Source(s): EIA, AEO 2000, Dec.1999, Table A2, p. 119-121 for energy consumption and Table A18, p. 141 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
1998	**(2)** **31%**	**9%**	**35%**	**6%**	**4%**	**10%**	**13%**	**1%**	**100%**
2000	33%	9%	35%	5%	4%	9%	13%	1%	100%
2010	36%	7%	37%	5%	4%	9%	11%	0%	100%
2020	40%	6%	37%	5%	5%	10%	7%	0%	100%

Note(s): 1) See Table 6.1.1 for generic quad definition. 2) The total 1998 Residential buildings sector primary energy consumption was 18.79 quads.

Source(s): EIA, AEO 2000, Dec.1999, Table A2, p. 119-121 for energy consumption and Table A18, p. 141 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
1998	**(2)** **28%**	**7%**	**40%**	**7%**	**2%**	**9%**	**15%**	**1%**	**100%**
2000	29%	6%	41%	6%	3%	9%	15%	1%	100%
2010	32%	4%	42%	6%	3%	9%	12%	0%	100%
2020	37%	4%	42%	5%	4%	9%	8%	0%	100%

Note(s): 1) See Table 6.1.1 for generic quad definition. 2) The total 1998 Commercial buildings sector primary energy consumption was 15.40 quads. Excludes buildings-related energy consumption in the industrial sector.

Source(s): EIA, AEO 2000, Dec.1999, Table A2, p. 119-121 for energy consumption and Table A18, p. 141 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		
	1998	2000	2010	2020
Petroleum	0.70	0.00	0.00	0.00
Natural Gas	1.35	8.20	7.05	7.79
Coal	13.52	21.02	14.73	12.04
Nuclear	0.00	0.00	0.00	0.00
Renewable Energy (2)	0.00	0.00	0.00	0.00
Total	15.58	29.22	21.78	19.84

Note(s): 1) This table provides estimates of the carbon emissions resulting from consumption of a primary quad at electric utilities. Projected (2000-2020) new marginal capacity emissions will result from natural gas- and coal-fired power plants (petroleum consumption increases until 2000 and then declines). 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 2000, Dec. 1999, Tables A2 and A19, p. 119-121 and 142.

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								
	1998			2000			2010			2020		
	Resid.	Comm.	Bldgs.	Resid.	Comm.	Bldgs.	Resid.	Comm.	Bldgs.	Resid.	Comm.	Bldgs.
Electricity (2)	10.22	11.60	10.84	14.35	19.12	16.31	15.43	17.35	16.32	14.48	17.33	15.61
Petroleum	1.33	0.84	1.11	0.85	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00
Natural Gas	3.55	2.93	3.27	4.81	2.96	4.08	3.49	2.35	2.98	3.06	2.38	2.80
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	0.08	0.15	0.11	0.08	0.17	0.12	0.00	0.13	0.05	0.00	0.12	0.04
Total	15.18	15.52	15.33	20.09	22.24	20.54	18.91	19.82	19.35	17.54	19.84	18.44

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 (petroleum consumption increases until 2000 and then declines). 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 2000, Dec. 1999, Table A2, p. 119-121 and Table A18, p. 141 for energy consumption and Table A19, p. 142 for carbon emissions.

7.1.1 Weatherization Population Facts

- Roughly 25% of Federally eligible households move in and out of poverty each year.
- The average income of Federally eligible households in FY 1997 was $12,500, 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 1997, the energy burden on Federally eligible households was more than four times the burden on Federally ineligible households (14.1% versus 3.3%).
- DOE Weatherization saves an average of 13-34% on home energy bills (depending on main heating fuel). This equates to $1.80 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 1997, Sept. 1999, Table A-2a, p. 50 for Federally eligible average income Federally eligible and Federally ineligible burdens; ORNL, Progress Report of the National Weatherization Assistance Program, Sept. 1997 and DOE, Weatherization Works, Progress Report of the National Weatherization Assistance Program, Feb. 1998 for DOE weatherization savings; and BTS for remaining data.

7.1.2 Weatherization Program Facts

- In FY 1996, DOE contributed 36% to all Federal weatherization funding, LIHEAP 43%, and others 21%.
- 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 can spend up to 85% of its funding for direct fuel subsidies and weatherization, of which up to 15% can be spent on weatherization. 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): BTS, Weatherization Program, Nov. 1996 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

- DOE regulations for 1999 require that states spend no more than an average of $2,032 per household and that at least 40% of this total must be spent on materials; however, this materials requirement can be waived if advanced energy audits are performed.
- 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)
- During Program Year 1990-1996, DOE Weatherization saved an average of 22% on home energy space heating bills with a range of 13-34%, a benefit-cost ratio of 1.8 and a societal benefit-cost ratio of 2.4. On average, weatherized residences that use natural gas save $193 per year. (1)

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

Source(s): BTS, Weatherization Program Notice 99-1, Nov. 23, 1998 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 PY 1989; and ORNL, Progress Report of the National Weatherization Assistance Program, Sept. 1997 and DOE, Weatherization Works, Progress Report of the National Weatherization Assistance Program, Feb. 1998 for DOE weatherization savings for DOE weatherization savings.

7.1.4 Residential Energy Burdens, by Weatherization Eligibility and Year

	1987	1990			FY 1997 (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%	6.8%	3.8%	2.8%
Federally Eligible	**13.0%**	**14.4%**	**N.A.**	**10.1%**	**14.1%**	**9.0%**	**9.0%**
Federally Ineligible	4.0%	3.5%	N.A.	N.A.	3.3%	2.8%	2.3%
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 1993, adjusted to reflect FY 1997 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, FY1997, Sept. 1999, Tables A-2a, A-2b, and A-2c, p. 50-51.

7.1.5 FY 1997 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	8.5%	4.1%	3.1%	7.0%	4.0%	2.9%	6.7%	4.1%	3.0%	4.7%	2.9%	2.0%
Federally Eligible	**18.8%**	**11.1%**	**10.3%**	**14.2%**	**9.2%**	**9.1%**	**13.7%**	**9.9%**	**9.9%**	**9.7%**	**6.1%**	**6.3%**
Federally Ineligible	3.6%	3.1%	2.5%	3.5%	3.0%	2.5%	3.7%	3.0%	2.4%	2.5%	2.1%	1.7%

Note(s): 1) Data are derived from RECS 1993, adjusted to reflect FY 1997 HDD, CDD, and fuel prices. See Table 7.1.4 for totals and Table 7.1.11 for definitions.

Source(s): HHS, LIHEAP Home Energy Notebook, FY1997, Sept. 1999, Tables A-2a, A-2b, and A-2c, p. 50-52.

7.1.6 Households, by Weatherization Eligibility and Year (million)

	Total Households	Weatherization Recipient (1)	Federally Eligible (2)	Federally Ineligible	Below 125% Poverty Line
1977	74.8	0.03	N.A.	N.A.	N.A.
1980	79.6	0.18	N.A.	N.A.	N.A.
1985	87.9	0.30	N.A.	N.A.	N.A.
1987	90.5	0.31	N.A.	N.A.	18.2
1990	94.2	0.25	27.9	66.1	18.2
1991	95.3	0.23	N.A.	N.A.	N.A.
1992	96.4	0.22	N.A.	N.A.	N.A.
1993	96.6	0.21	30.7	65.9	19.4
1994	98.7	0.25	N.A.	N.A.	N.A.
1995	100.0	0.23	N.A.	N.A.	N.A.
1996	101.0	0.16	N.A.	N.A.	N.A.
1997	101.5	0.17	34.1	67.4	19.7
1998	102.8	0.17	N.A.	N.A.	N.A.
1999	104.2	0.17	N.A.	N.A.	N.A.
Total 1977-1999	N/A	4.93	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/BTS 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 2000, Dec. 1999, Table A4, p. 124-125 for 1998-1999 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, Apr. 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 ($1998)

	Per Household Member	Members/ Hhold	Per Square Foot	Square Feet/ Hhold
Total U.S. Households	522	2.6	0.81	1663
Federally Eligible	**432**	**2.7**	**0.91**	**1259**
Federally Ineligible	571	2.5	0.78	1868
Below 125% Poverty Line	398	2.8	0.95	1164

Source(s): Data taken from EIA, 1997 Residential Energy Consumption Survey; and EIA, Annual Energy Review 1998, July 1999, Appendix E, p. 337 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 1995, Aug. 1997, 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 1995, Aug. 1997, p. 55 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	1100/70	0	61/360	8339	92	7.43
Dishwasher	(3) 0.332	0	(4) 365	8456	121	9.74
Freezer					678	54.59
Microwave Oven	1500	3	72	8688	135	10.87
Refrigerator-Freezer					938	75.51
Lighting						
18-W Compact Fluorescent	18	0	1189	7571	21	1.72
60-W Incandescent Lamp	60	0	672	8088	40	3.24
100-W Incandescent Lamp	100	0	672	8088	67	5.41
Torchiere Lamp-Halogen	300	0	1460	7300	438	35.26
Bedroom and Bathroom						
Hair Dryer	710	0	50	8710	36	2.86
Waterbed Heater	350	0	3051	5709	1070	86.14
Laundry Room						
Clothes Dryer			(4) 359		1000	80.50
Clothes Washer	(3) 0.276	0	(4) 392	8564	108	8.69
Home Electronics						
Cable Box	20	12	1456	7304	114	9.18
Computer (CPU & Monitor)	182/30	0	1337/632	6791	262	21.09
Portable Stereo	7	2	526	5606	17	1.37
Compact Stereo	15	12	964	7796	110	8.86
Rack Stereo	53	12	1664	7096	150	12.08
Color Television	83	5	2810	5950	(5) 261	21.01
VCR	14	6	2424	6336	71	5.72
Heating and Cooling						
Dehumidifier	600	0	1620	7140	972	78.25
Furnace Fan	295	0	1350	7410	398	32.04
Window Fan	30	0	270	8490	8	0.65
Water Heating						
Water Heater-Family of 4	4500	N.A.	(6) 16		4966	399.80
Water Heater-Family of 2	4500	N.A.	(6) 16		2483	199.90
Miscellaneous						
Clock/Radio	2	2	131	8629	15	1.21
Lawn Mower	1500	0	20	8740	30	2.42
Pool Pump	1000	0	792	7968	792	63.76
Well Pump	725	0	115	8645	83	6.71

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 additional unit. 6) Usage is gallons/person-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; and GAMA, Consumer's Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment, April 2000 for water heater power draw.

7.2.2 Residential Stock Natural Gas Appliance Usage

	Average Capacity (10^3 Btu/hr)		Annual Use	Annual Consumption (10^6 Btu/year)	Annual Cost ($) (1)
Range/Cooktop and Oven	10			2.3	15.07
Clothes Dryer		(2)	359	3.9	25.74
Water Heating					
Water Heater-Family of 4	40	(3)	16	27.1	179.00
Water Heater-Family of 2	40	(3)	16	13.6	89.50

Note(s): 1) $0.660/therm. 2) Cycles/yr. 3) Gallons/person-day

Source(s): A.D. Little, EIA-Technology Forecast Updates - Residential and Commercial Building Technologies - Reference Case, September 2, 1998, p. 30 for range/cooktop & oven and clothes dryer; LBNL, Energy Data Sourcebook for the U.S. Residential Sector, LBNL-40297, Sept. 1997, p. 62-67 for water heating; and GAMA, Consumer's Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment, April 2000, for water heater capacity.

7.3.1 1997 Average Household *Delivered* Energy End-Uses, 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	135.9	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 Average Household End-Use Carbon Splits, by Region (pounds of CO2)

	Northeast	Midwest	South	West	National
Space Heating	11,151	9,820	5,153	4,721	7,315
Space Cooling	666	1,310	3,548	1,867	2,350
Water Heating	3,588	3,286	3,509	3,158	3,426
Appliances (1)	8,100	10,025	11,223	8,678	9,774
Total	23,505	24,442	23,432	18,424	22,865

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 2000, Dec. 1999, Table A2, p. 119-121 for consumption data, and Table A19, p. 142 for carbon emissions data; and EIA, Emissions of Greenhouse Gases in the U.S. 1998, Oct. 1999, Table B1, p. 104 for petroleum carbon emission coefficients.

7.3.3 1997 Average Household Energy End-Use Expenditures, by Region ($1998)

	Northeast	Midwest	South	West	National
Space Heating	663	553	317	243	425
Space Cooling	75	82	203	129	141
Water Heating	235	181	205	171	198
Appliances (1)	724	621	637	569	635
Total	1698	1437	1362	1112	1400

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, July 1999, Appendix E, p. 337 for price inflators.

7.3.4 Materials Used in the Construction of a 2,085 Sq. Ft. New Single-Family Home, 1995

13,127 board-feet of lumber	12 interior doors
6,212 square feet of sheathing	7 closet doors
14 tons of concrete	2 garage doors
2,325 square feet of exterior siding material	1 fireplace
3,100 square feet of roofing material	3 toilets; 2 bathtubs; 1 shower stall
3,061 square feet of insulation	3 bathroom sinks
6,144 square feet of interior wall material	13 kitchen cabinets; 2 other cabinets
2,100 square feet of interior ceiling material	1 kitchen sink
120 linear feet of ducting	1 range; 1 refrigerator; 1 dishwasher; 1 garbage disposer; 1 range hood
15 windows	1 washer; 1 dryer
5 exterior doors (4 hinged, 1 sliding)	1 heating and cooling system
2,085 square feet of flooring material	

Source(s): NAHB, 1997 Housing Facts, Figures and Trends, 1997, p. 8.

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

Year Built		mid-1960s	Space Heating		
Occupants		3	Equipment	Central Warm-Air Furnace	
Floorspace			Fuel	Natural Gas	
Heated Floospace		1946	Age (6)	13	
Cooled Floorspace		1692	Space Cooling (7)	Yes	
Garage		2-Car	Water Heating		
Stories		1	Size (8)	48	
Foundation		Basement	Fuel	Natural Gas	
Total Rooms (2)		6	Age (6)	9	
Bedrooms		3	Refrigerator		
Other Rooms		3	Number	1	
Full Bathroom		2	Size (9)	19	
Half Bathroom		0	Age (6)	9	
Window			Freezer	No	
Area	(3)	224	Electric Clothes Dryer	Yes	
Number	(4)	14	Electric Clothes Washer	Yes	
Type		Single-Pane	Dishwasher	Yes	
Frame		Nonmetal	Range/Oven	Electric	
Insulation (5)			Microwave Oven	Yes	
Ceiling/Roof		Yes	Ceiling Fans	3	
Walls		Yes	Computer	No	(10)
Lighting		N.A.	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) of all 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 judgement.

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

7.4.3 Typical School Building (1)

		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 judgement.

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 judgement.

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 judgement.

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

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