Our Energy Sources
PROs & CONs

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John F. Robbins CEM / CSDP

Design, Analysis, Consulting & Education to Improve Energy & Ecological Performance Since 1983
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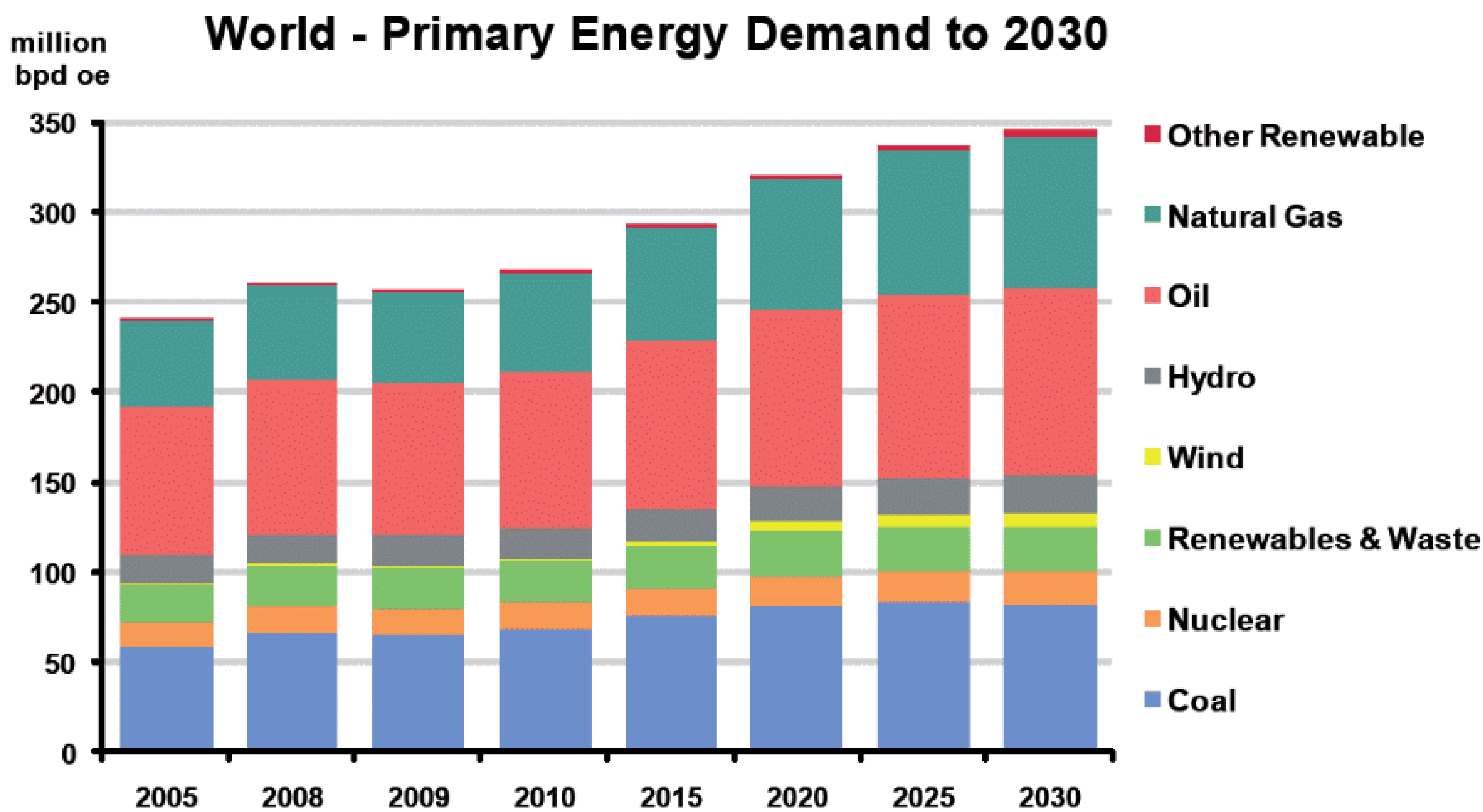
- Member, Association of Energy Engineers (AEE) (*www.aeecenter.org*)
  CEM - Certified Energy Manager since 1990
  Current Board Member & Website Manager, SW Ohio Chapter (*www.aeecincy.org*)

- Developer and instructor since 2009 of technical energy seminars & continuing education programs sponsored by Halfmoon Seminars and Impact Management Services

- Adult-Ed Developer & Instructor 2005-2011, "Energy At Home" & "Solar Energy At Home", Great Oaks Institute, SW Ohio

- Leader, SW Ohio Alternate Energy Association (AEA) 1995-2005

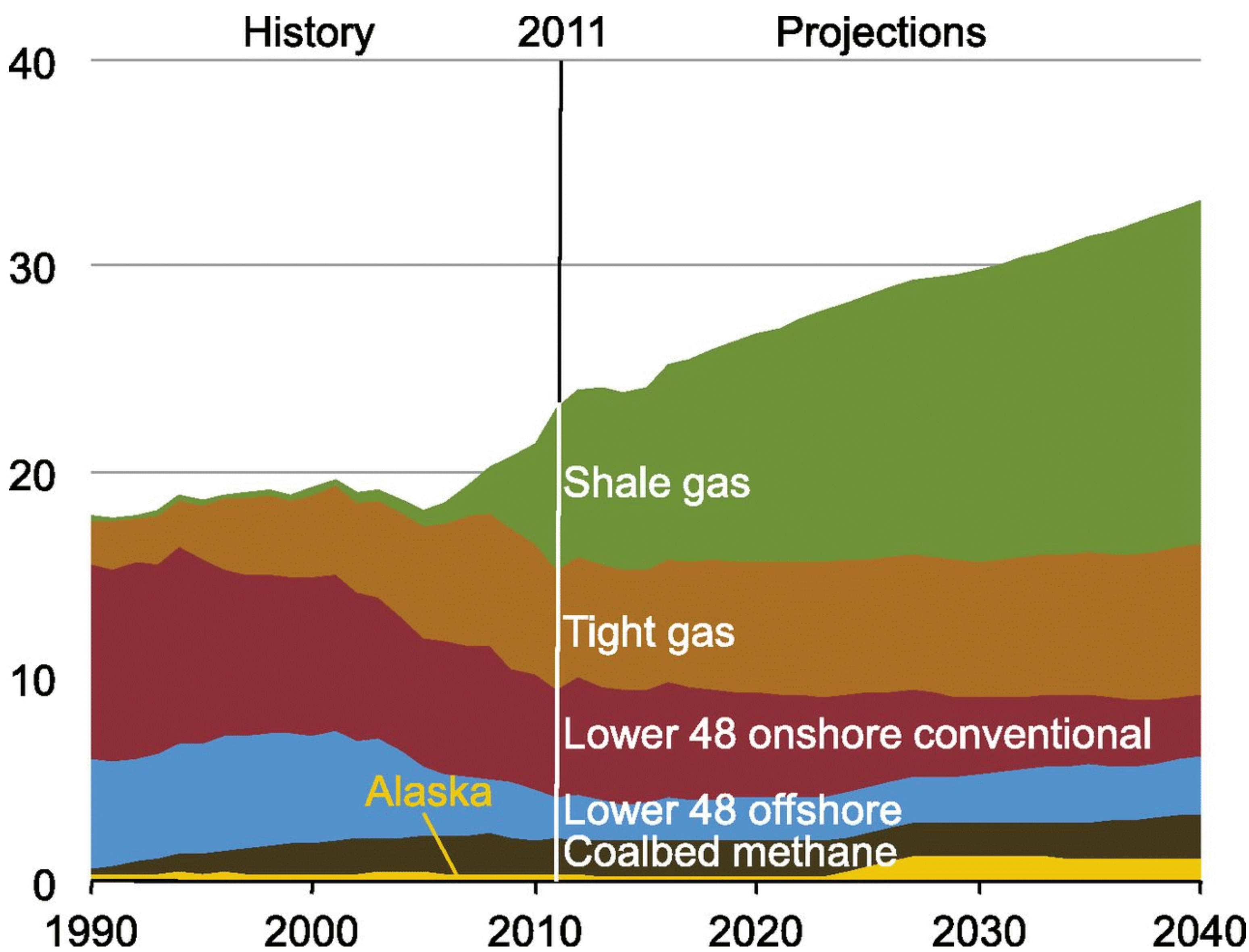
- 1998 Ohio Governor's Award for Excellence in Energy Efficiency - Education Category



KBC Energy Economics' Annual Long-Term Oil & Energy Outlook Report, 2012

Oil and natural gas from deep shale formations are transforming the United States economy and its energy outlook. Back in 2005, the US Energy Information Administration published projections of United States natural gas supply that stressed the need to develop an import infrastructure (1): by 2025, imports would account for almost one-third of United States consumption. When we compare those forecasts with the current ones to 2040, it is inevitable to feel that a disruptive technology has emerged since.

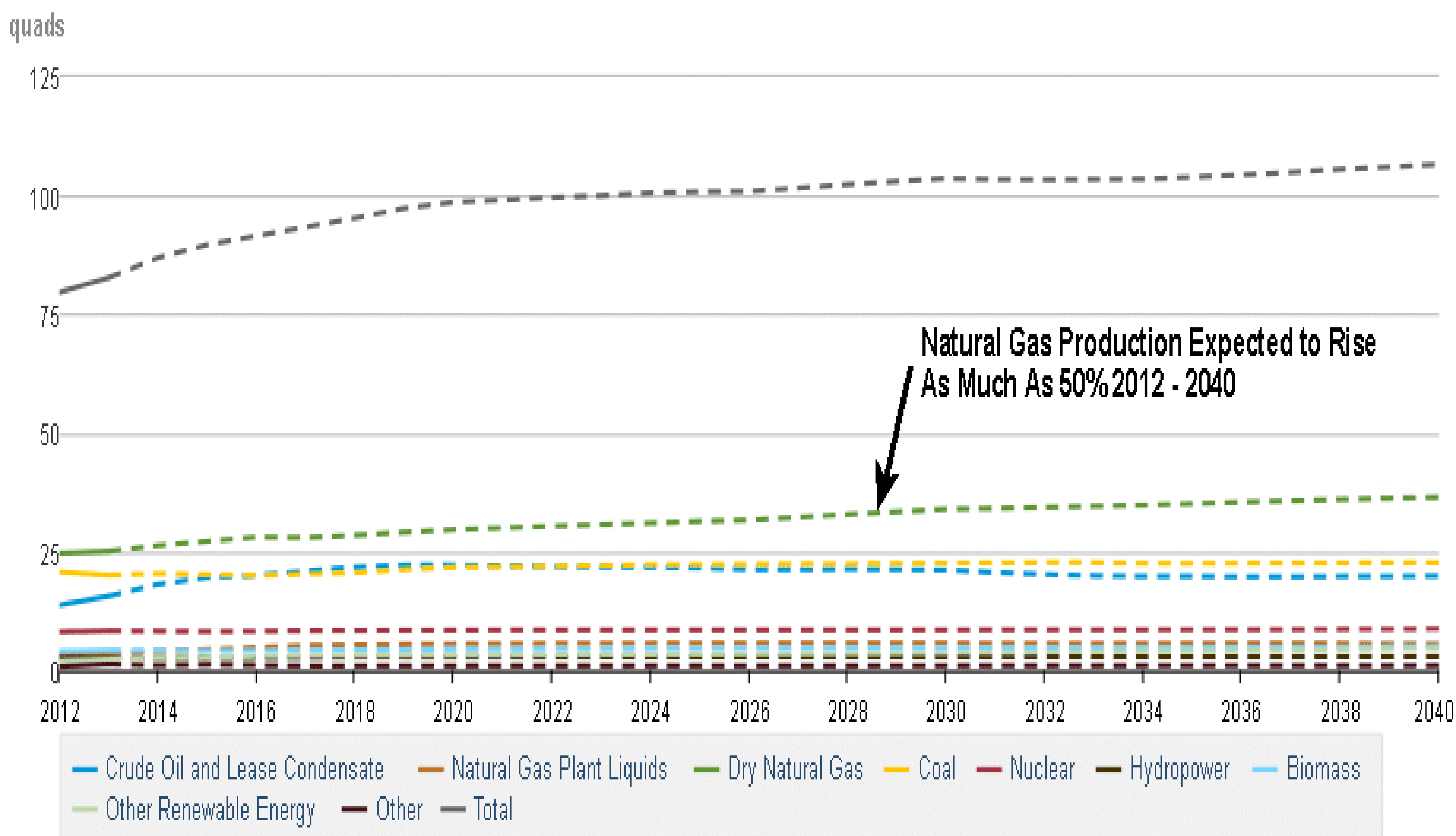
Natural gas consumption is expected to increase significantly over the next three decades, with strong demand growth from the electricity generation and industrial sectors. However, the United States will probably become a net exporter of gas before 2020, increasing domestic production by 44% over the projection period.



By Luis Cueto-Felguerosoa & Ruben Juanes for the National Academy of Sciences, 2016

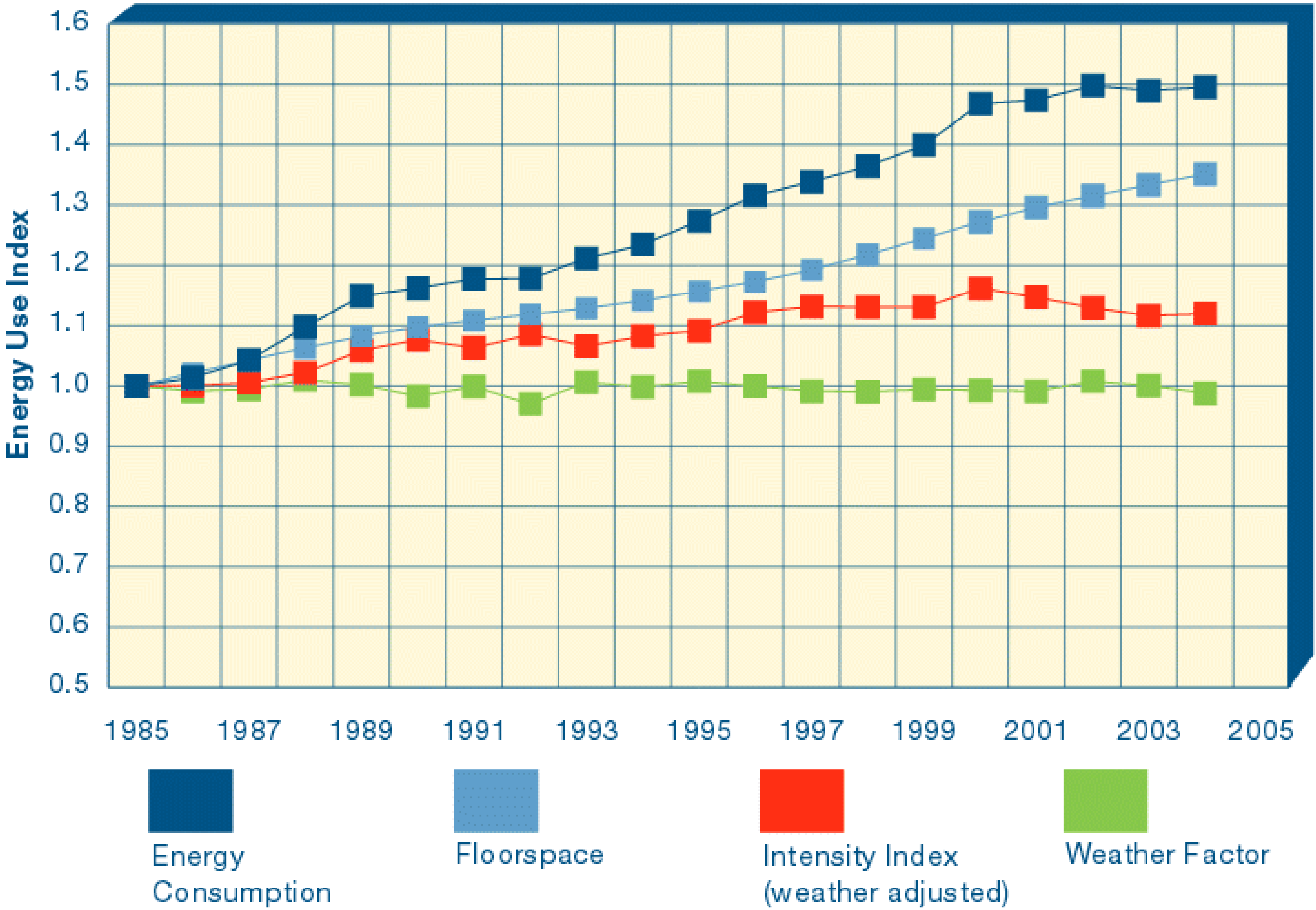
Total Energy: Production

Case: Reference case

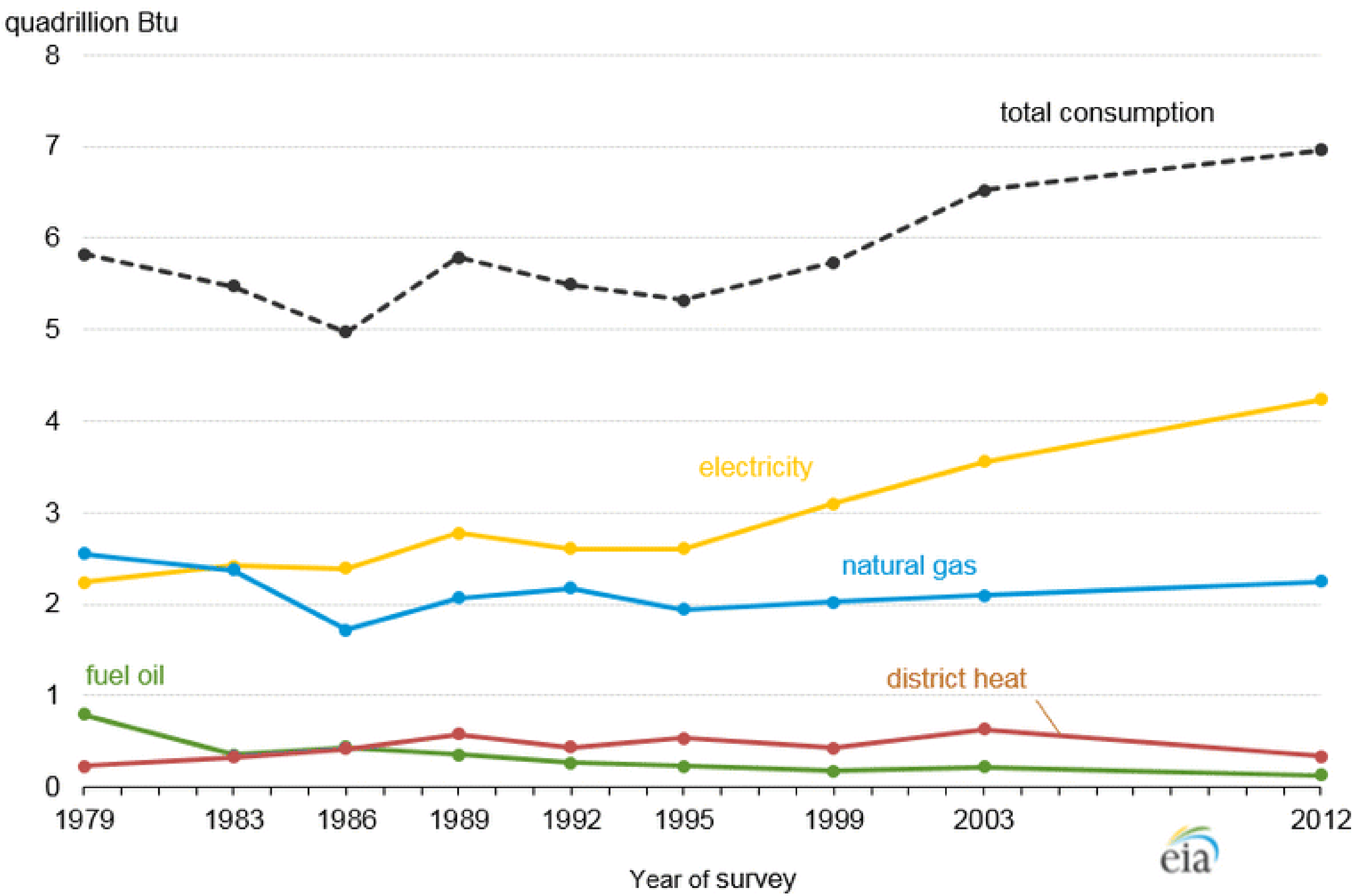


Source: U.S. Energy Information Administration Annual Energy Outlook 2015

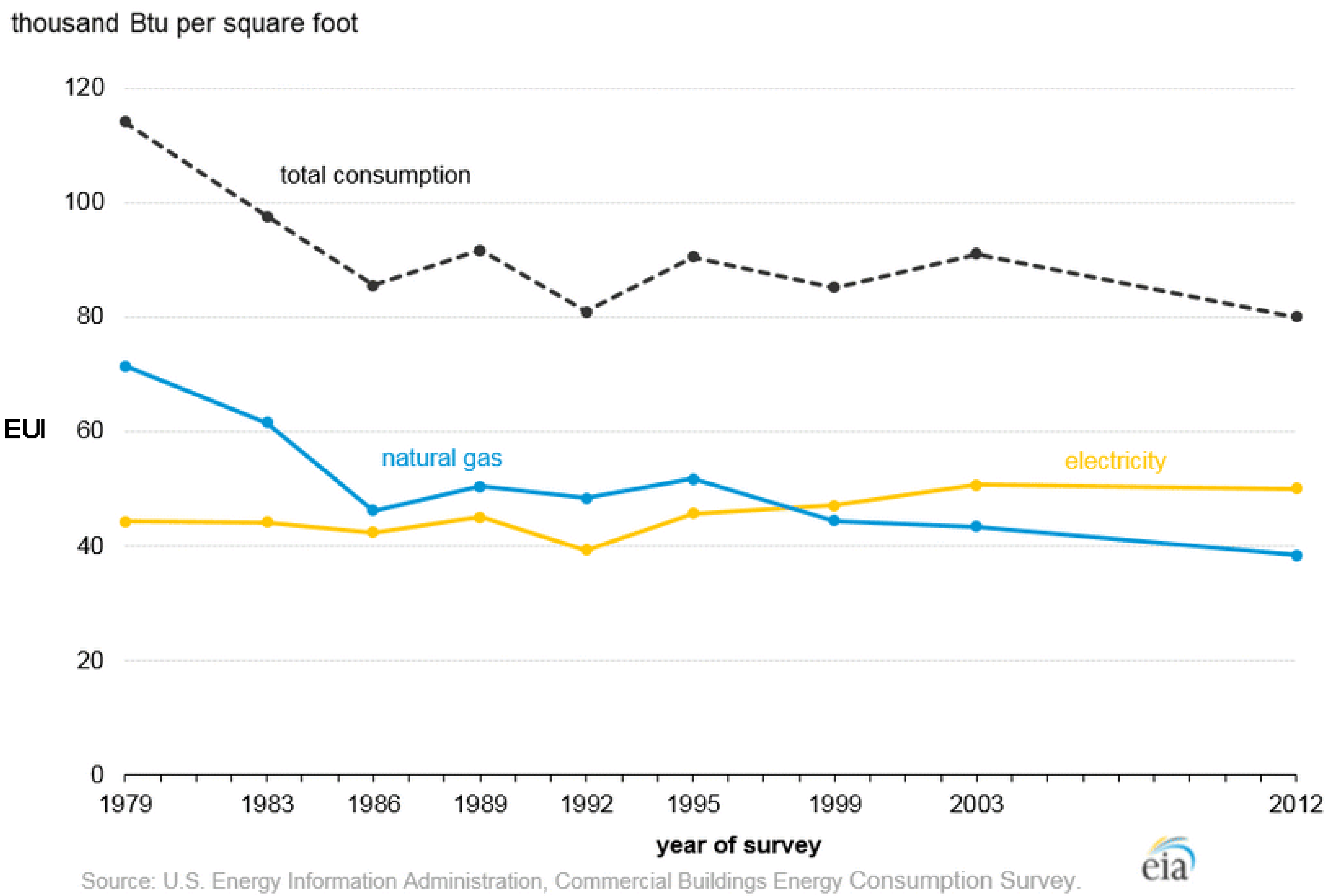
Commercial Energy Use Intensity and Factors
2005, US DOE



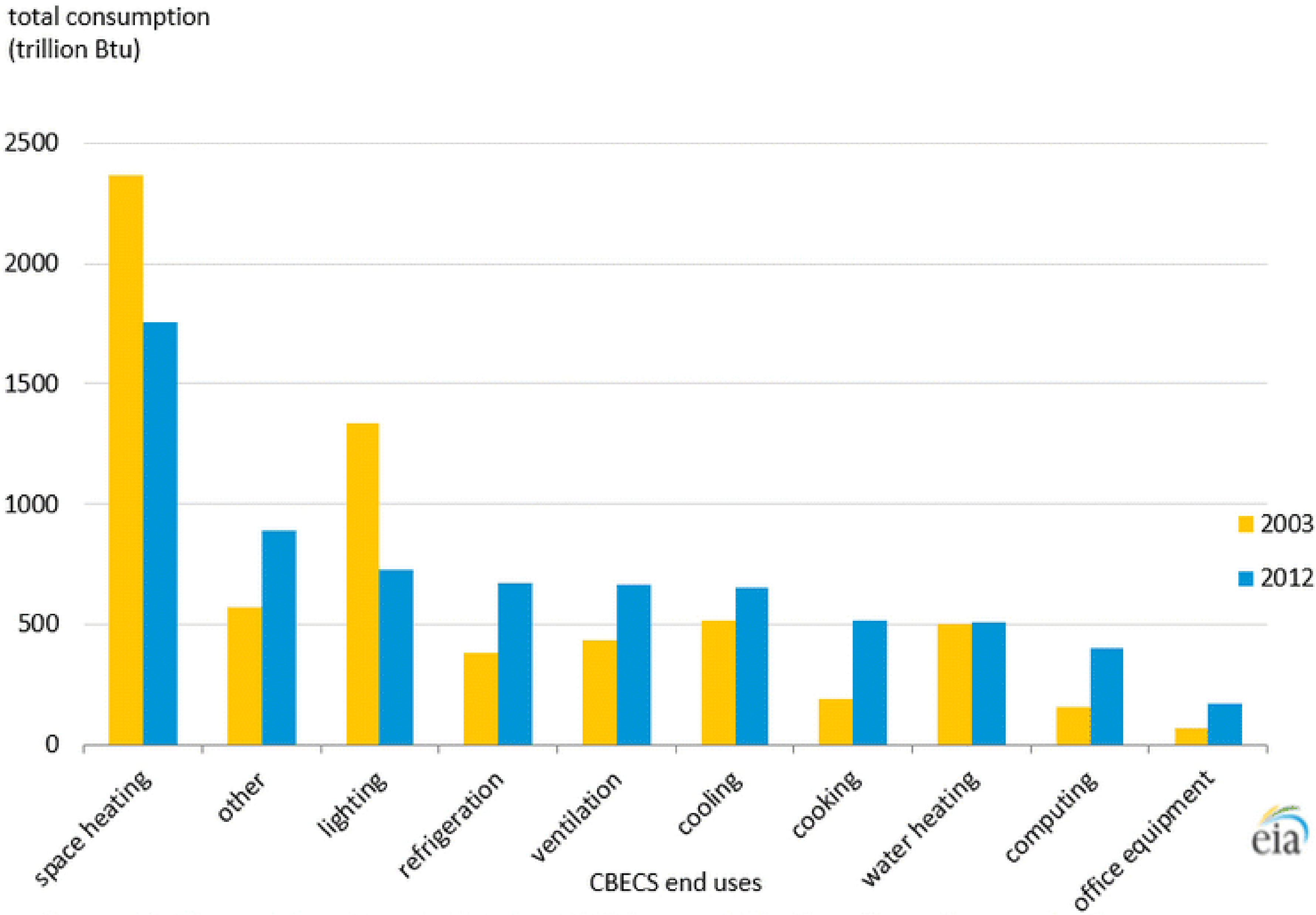
Electricity usage is the fastest growing part of energy consumption in U.S. commercial buildings



Source: U.S. Energy Information Administration, Commercial Buildings Energy Consumption Survey.

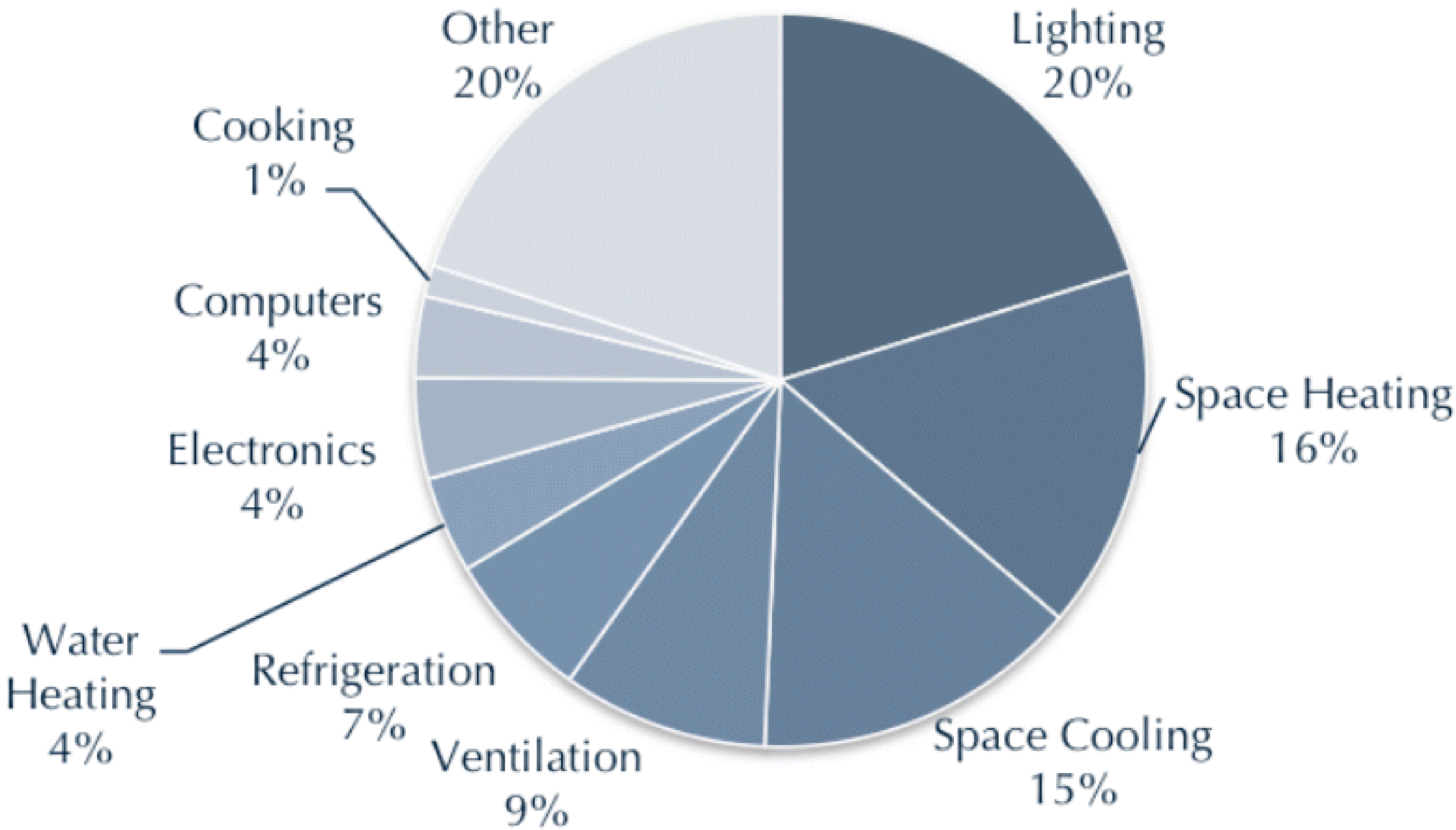

thousand Btu per square foot
120
100
80
60
40
20
0
EUI
total consumption
natural gas
electricity
1979
1983
1986
1989
1992
1995
1999
2003
2012
year of survey
Source: U.S. Energy Information Administration, Commercial Buildings Energy Consumption Survey.
eia

The only major recent reductions in commercial building energy use are for heating and lighting. Most other areas of energy use have increased usage. Water heating stayed about the same.

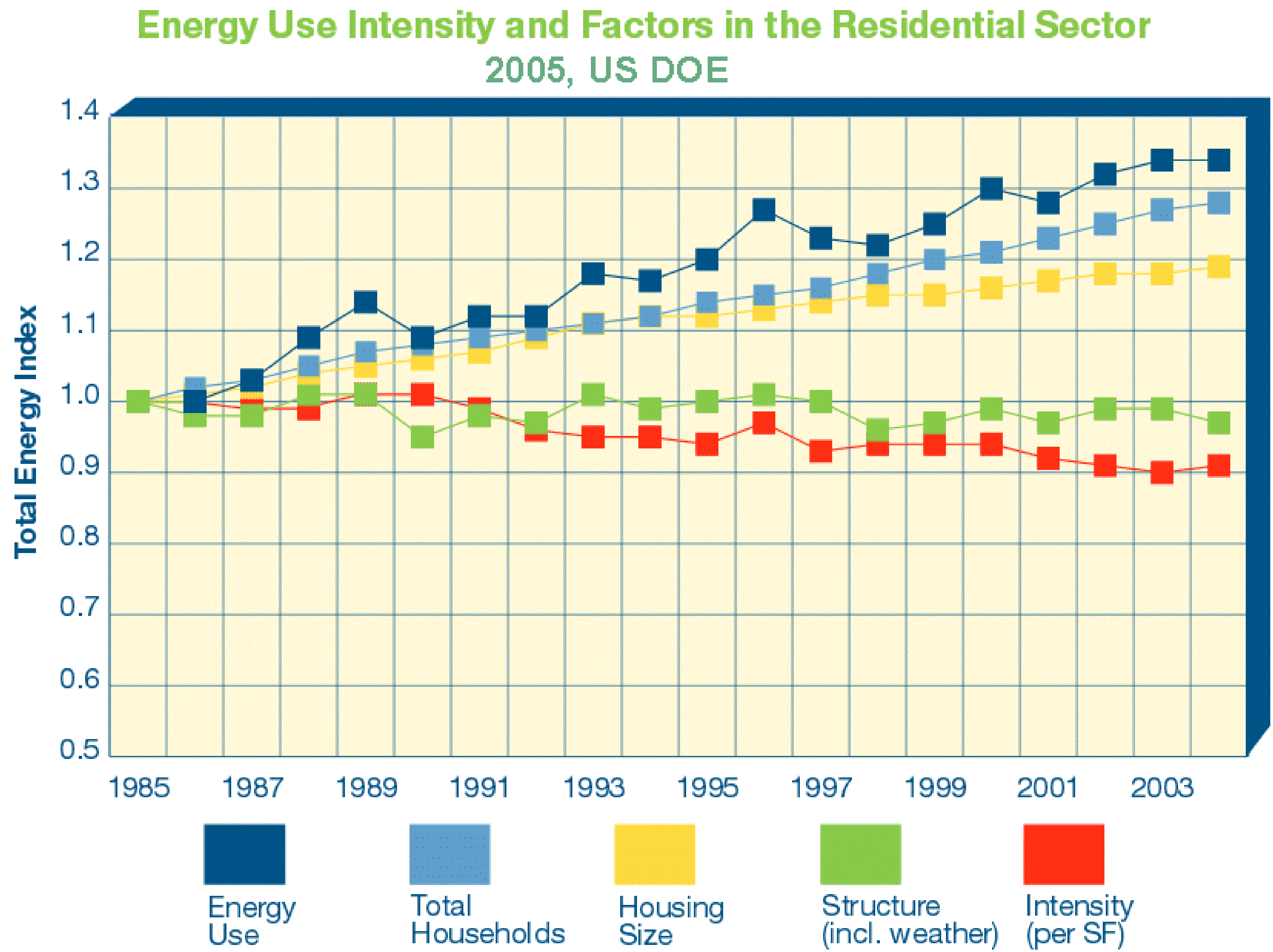


Source: U.S. Energy Information Administration, 2012 Commercial Buildings Energy Consumption Survey.

Commercial Buildings Primary Energy End Use Splits (2010)

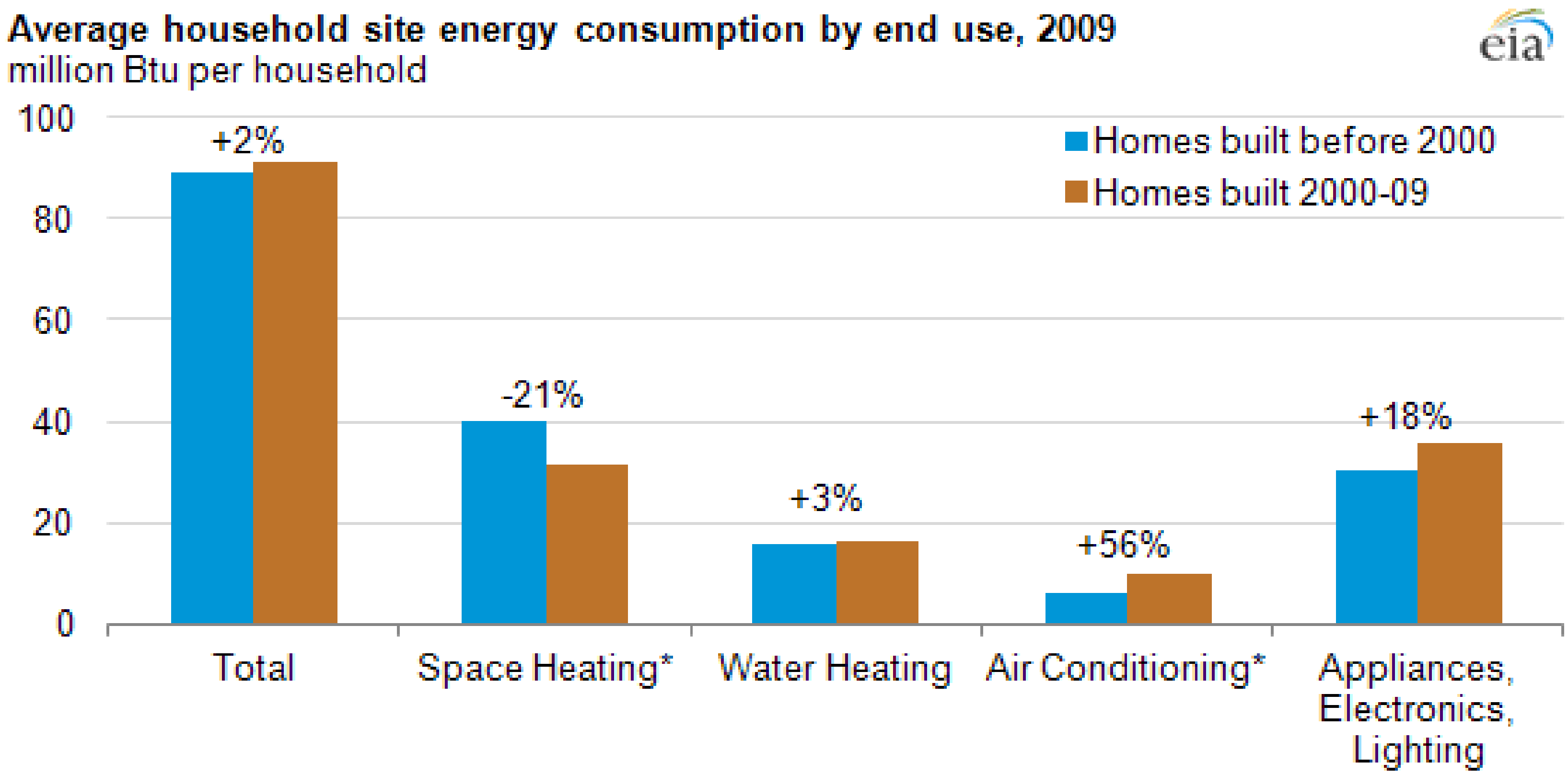


Source: DOE, *2011 Buildings Energy Data Book, Section 3.1.4, March 2012.* http://buildingsdatabook.eren.doe.gov/.


Energy Use Intensity and Factors in the Residential Sector
2005, US DOE
Total Energy Index
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
Energy Use
Total Households
Housing Size
Structure (incl. weather)
Intensity (per SF)

February 12, 2013

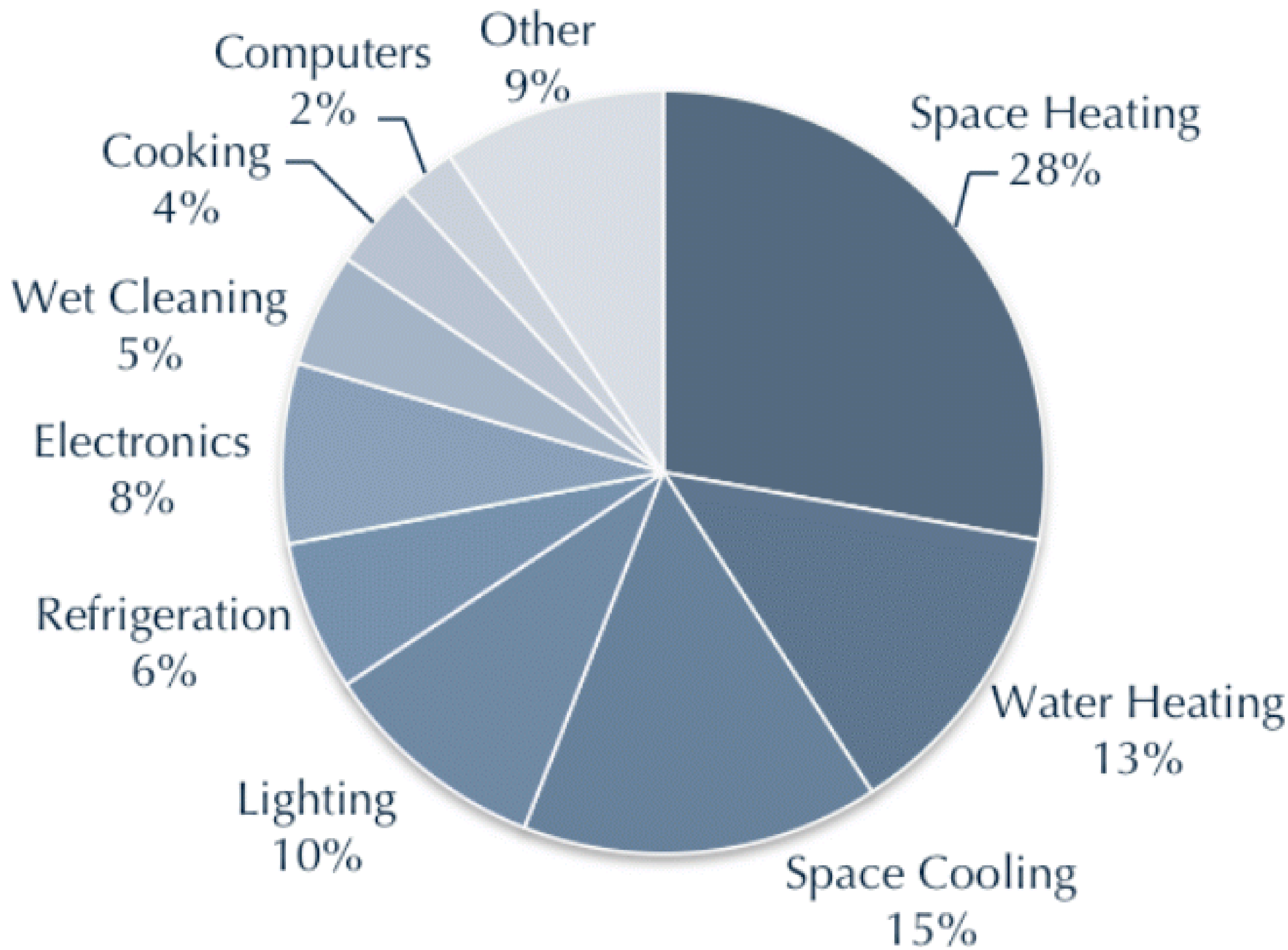
Newer U.S. homes are 30% larger but consume about as much energy as older homes



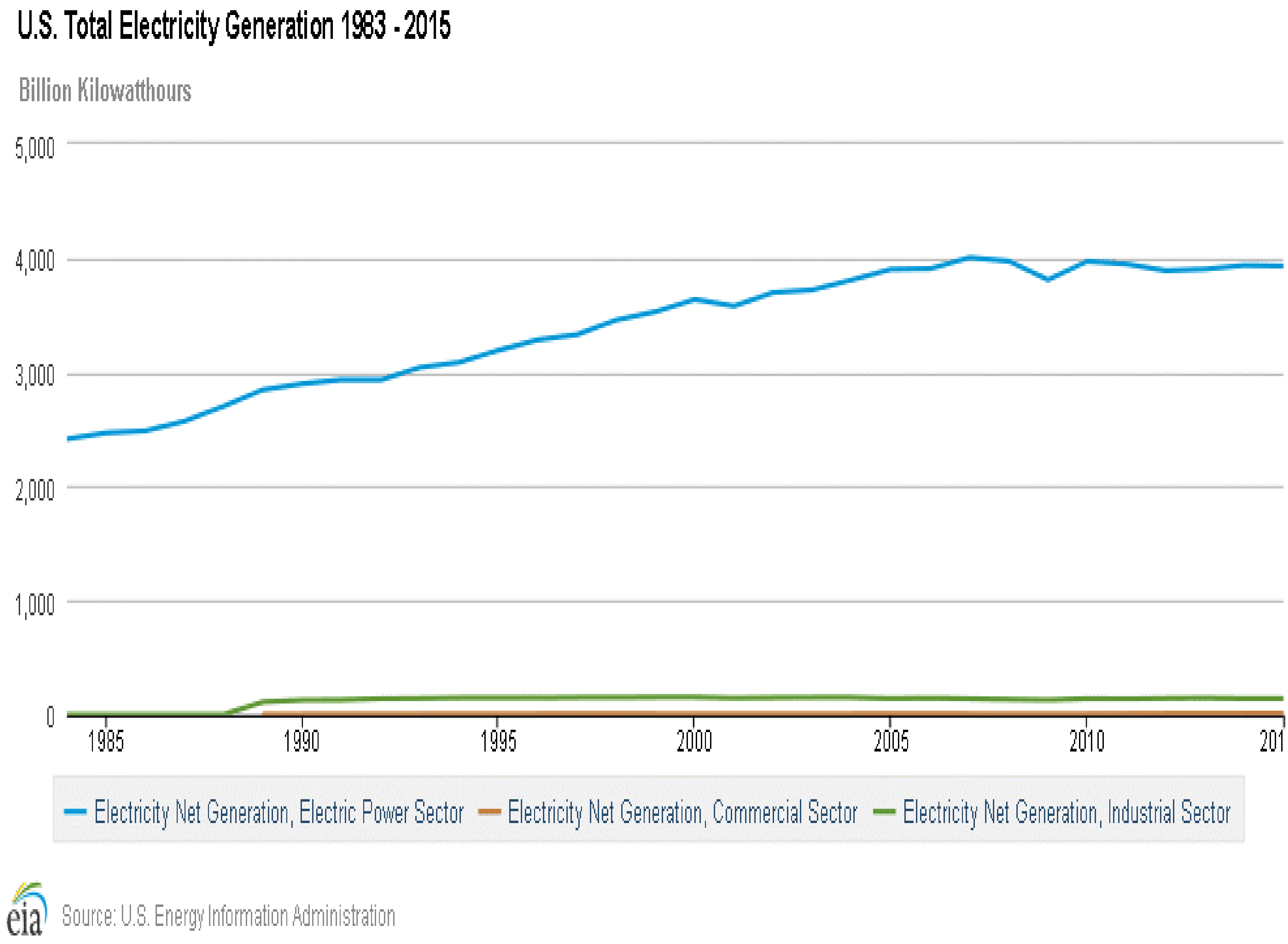
Source: U.S. Energy Information Administration, Residential Energy Consumption Survey

John F. Robbins Jul 2014

Residential Buildings Primary Energy End Use Splits (2010)



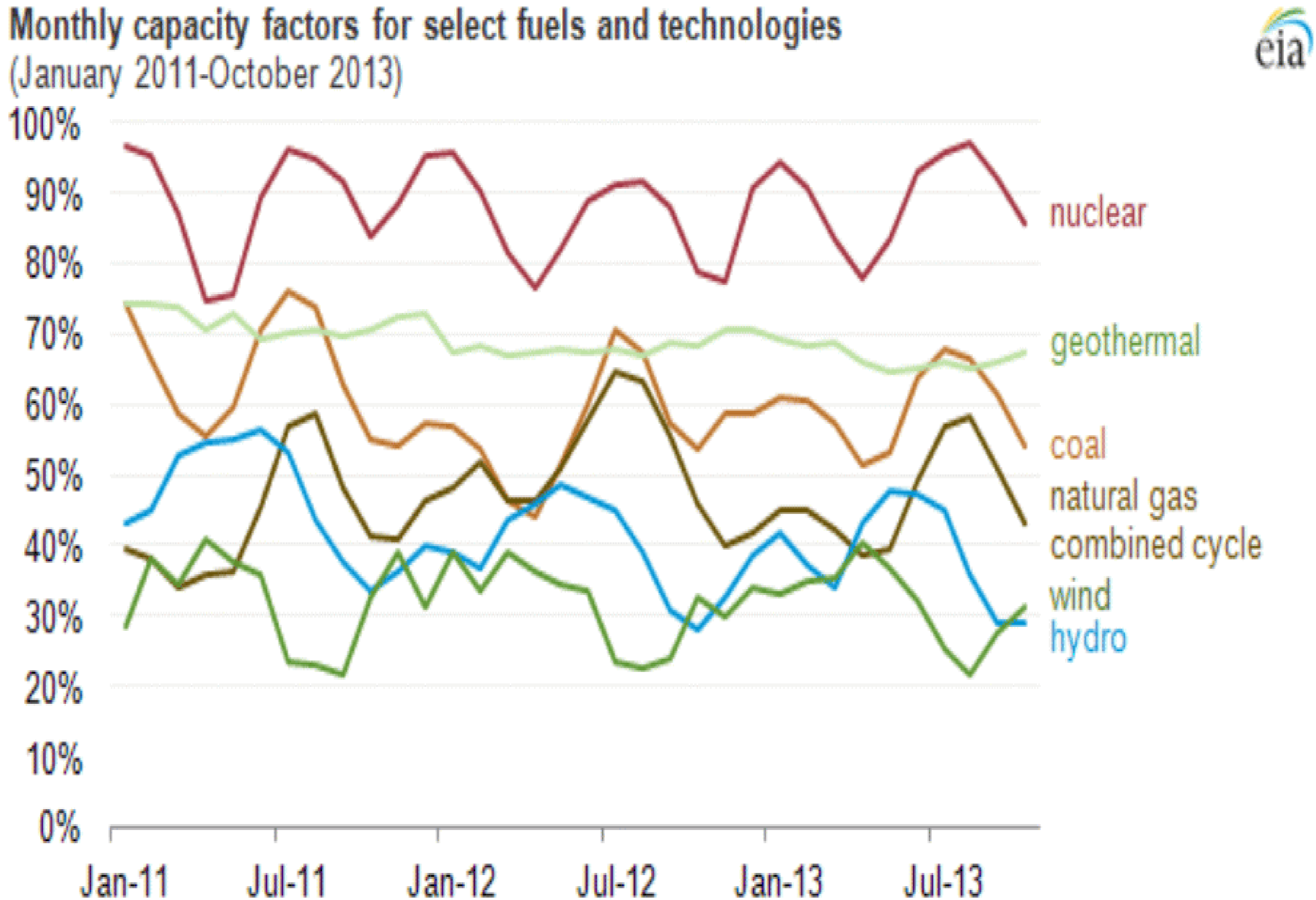
Source: DOE, *2011 Buildings Energy Data Book, Section 2.1.5, March 2012.* http://buildingsdatabook.eren.doe.gov/.


U.S. Total Electricity Generation 1983 - 2015
Billion Kilowatthours
5,000
4,000
3,000
2,000
1,000
0
1985
1990
1995
2000
2005
2010
2015
Electricity Net Generation, Electric Power Sector
Electricity Net Generation, Commercial Sector
Electricity Net Generation, Industrial Sector
Source: U.S. Energy Information Administration

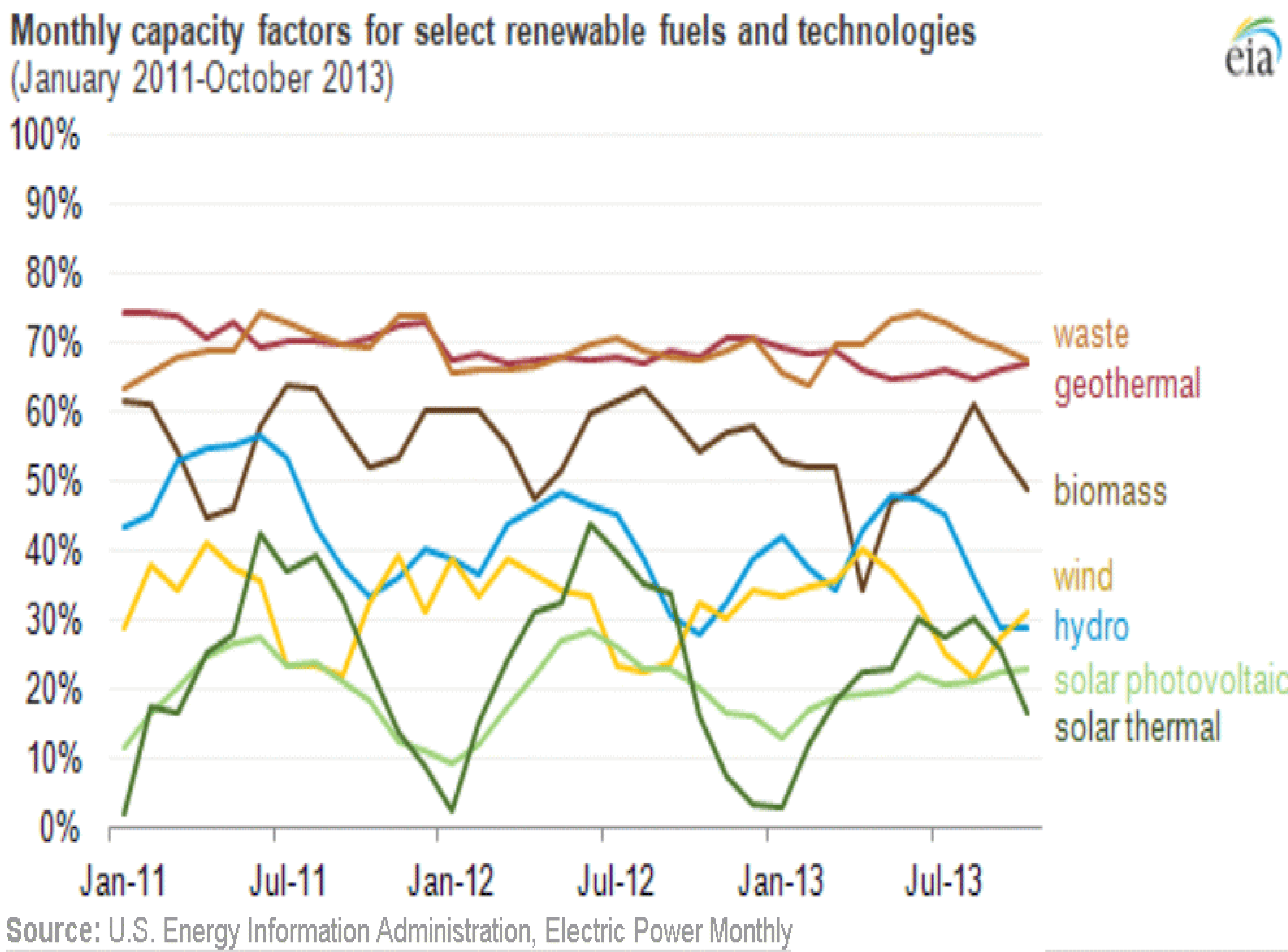
Conventional Electricity Fuel Mixes Vs Average CO2 Emissions Per kWh												
	Lbs CO2 per kWh	Coal	Natural Gas	Other Gases	Petrol	Nuclear	Solar & Wind	Hydro	Geo-thermal	Wood	Other Biomass	All Else
CA	0.47	1%	60%	1%		9%	6%	13%	6%	2%	1%	1%
IL	1.03	41%	6%			49%	4%					
IN	2.01	81%	13%	2%	1%		3%					
KY	2.11	92%	3%		2%			3%				
MO	1.81	13%	71%			13%				3%		
OH	1.85	66%	17%	1%	1%	13%	1%					1%
TN	1.16	46%	10%			32%		11%		1%		
VT	0.002					76%	2%	17%		5%		
VA	1.03	20%	35%		1%	41%		1%			1%	1%
WV	2.02	96%					2%	2%				
USA	1.19	37%	30%		1%	19%	3%	7%		1%		2%
Source: US EIA (for 2012)												
Germany	1.12	45%	11%		1%	15%	24%					4%
Source: AG Energiebilanzen (for 2013)												

What is a capacity factor?

Capacity factors describe how intensively a fleet of generators is run. A capacity factor near 100% means a fleet is operating nearly all of the time. It is the ratio of a fleet's actual generation to its maximum potential generation.



Source: U.S. Energy Information Administration, Electric Power Monthly, Tables 6.7a and 6.7b



Monthly capacity factors for select renewable fuels and technologies
(January 2011-October 2013)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Jan-11
Jul-11
Jan-12
Jul-12
Jan-13
Jul-13
waste
geothermal
biomass
wind
hydro
solar photovoltaic
solar thermal
Source: U.S. Energy Information Administration, Electric Power Monthly

Capacity Factors for Utility Scale Generators Not Primarily Using Fossil Fuels

Period	Nuclear	Conventional Hydropower	Wind	Solar Photovoltaic	Solar Thermal	Landfill Gas and Muncipal Solid Waste	Other Biomass Including Wood	Geothermal
Annual Factors								
2014	91.7%	37.3%	34.0%	25.9%	19.8%	68.9%	58.9%	74.0%
2015	92.2%	35.9%	32.5%	28.6%	22.7%	67.6%	52.9%	71.7%
Year 2015								
January	101.3%	41.5%	31.7%	19.7%	5.1%	67.2%	55.3%	73.3%
February	95.8%	42.5%	34.5%	26.2%	15.9%	62.0%	58.4%	73.8%
March	88.0%	41.8%	31.7%	30.5%	24.2%	58.9%	50.5%	74.5%
April	84.2%	39.2%	37.8%	34.3%	32.5%	65.3%	41.7%	70.2%
May	89.7%	34.0%	35.2%	34.0%	31.1%	67.1%	48.0%	74.3%
June	96.4%	35.0%	28.3%	34.4%	34.5%	69.4%	54.3%	71.9%
July	97.2%	35.5%	27.7%	33.9%	35.1%	70.6%	59.9%	72.3%
August	98.6%	33.0%	26.0%	33.7%	32.8%	72.8%	61.3%	71.7%
Sept	93.5%	28.3%	28.3%	29.2%	27.5%	67.6%	52.0%	65.5%
October	82.5%	28.0%	31.9%	25.5%	16.7%	68.3%	46.3%	69.4%
November	84.8%	33.4%	39.0%	23.5%	17.1%	69.7%	51.0%	71.9%
December	94.8%	38.6%	37.5%	19.2%	9.6%	71.9%	56.0%	72.0%
Year 2016								
January	98.8%	42.4%	34.2%	17.9%	6.9%	69.2%	52.3%	72.8%

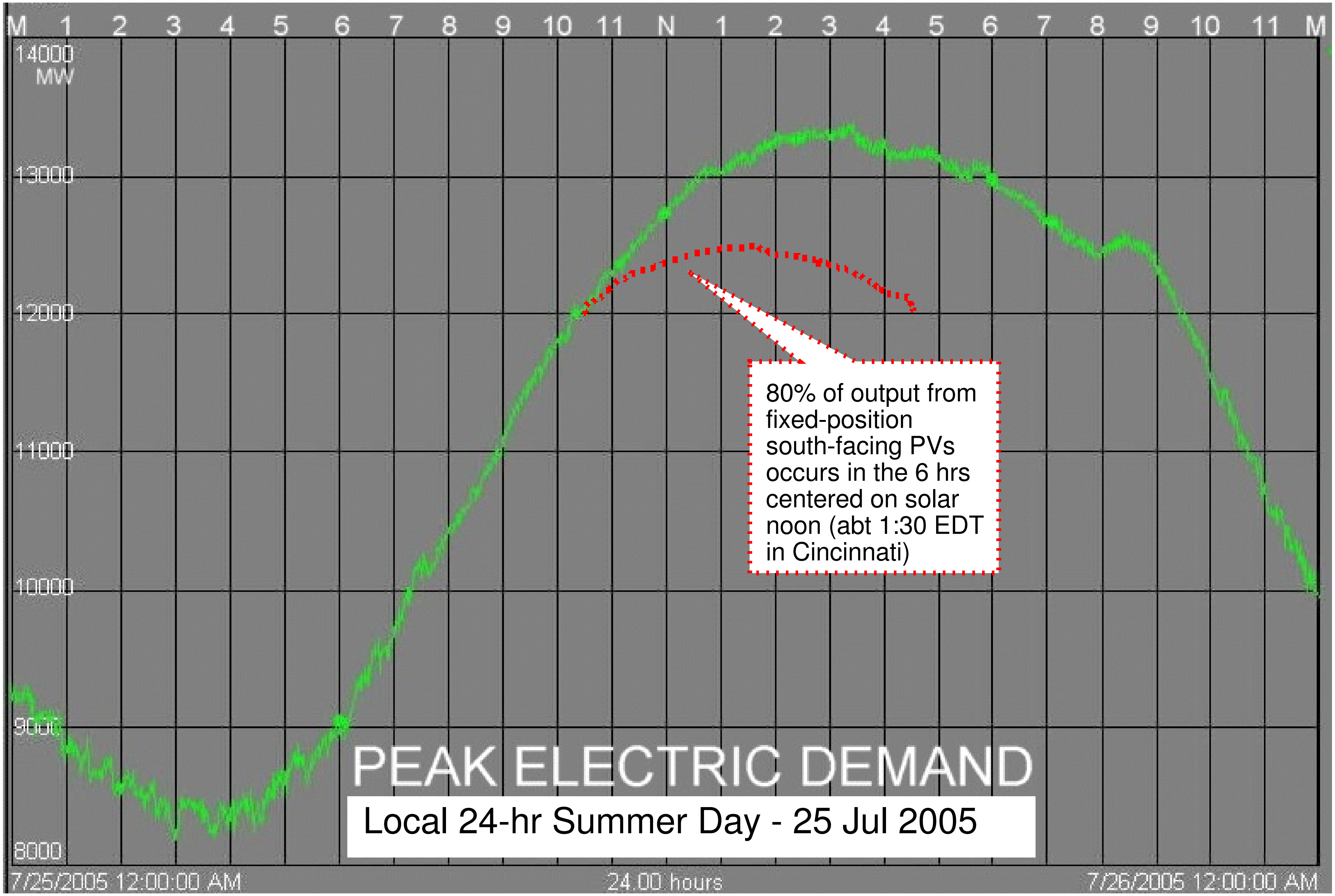
According to an NREL study of PVs in USA

"The Impacts of Commercial Electric Utility Rate Structure Elements on the Economics of Photovoltaic Systems" - Tech.Rept. NREL/TP-6A2-46782, June 2010

www.nrel.gov/docs/fy10osti/46782.pdf

"On average, peak PV production and peak demand occurs three hours apart for all months. On a clear day, PV systems can provide between 44% and 69% of rated capacity three hours from solar peak in December and June."

Report also found that percent of PV rated capacity likely available during a utility's peak demand period (called *Average Capacity Value*) for all studied PV Systems & locations averaged 21% for all months, 30% - 40% Jun - Sep



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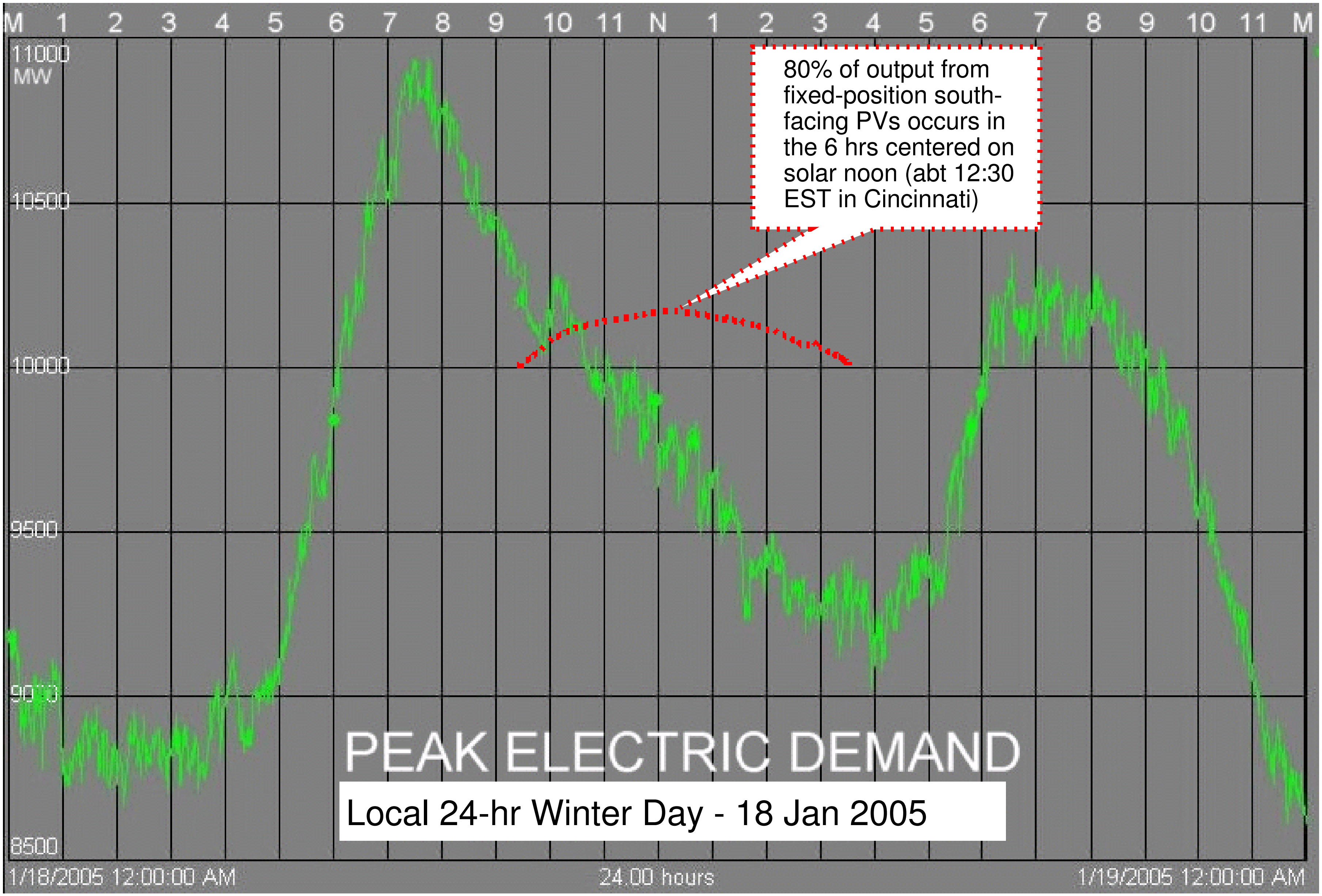

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Emissions From Conventional Energy

Air pollution produced to generate and/or use conventional energies includes particulates, carbon dioxide (CO_2), sulfur dioxide (SO_2), nitrogen oxides (NOX) & mercury

CO_2 EMISSION averages per common energies in the Ohio Valley region:

Energy Type	CO_2 Emissions
Midwest USA Electricity	1.9 - 2.1 lbs per kWh
Heating Oil	26.4 lbs per gallon
Liquid Propane	12.5 lbs per gallon
Natural Gas	12.1 lbs per CCF

AVERAGE CO_2 EMISSIONS PER MILLION BTUs FOR LOCAL HTG & CLG

557 - 615 lbs for electric resistance heating (COP=1)
250 - 290 lbs for electric heatpump heating w/ resistance b/u (COP 2.4 -2.0)
211 - 243 lbs for heating with oil at 90% - 78% AFUE
190 - 210 lbs for electric cooling at SEER 10
146 - 162 lbs for electric cooling at SEER 13
142 - 175 lbs for heating with LP at 96% - 78% AFUE
134 - 168 lbs for electric heating with geothermal (COP 4.4 - 3.5)
127 - 140 lbs for electric cooling at SEER 15
122 - 151 lbs for heating with ngas (96% - 78% Efficiency)

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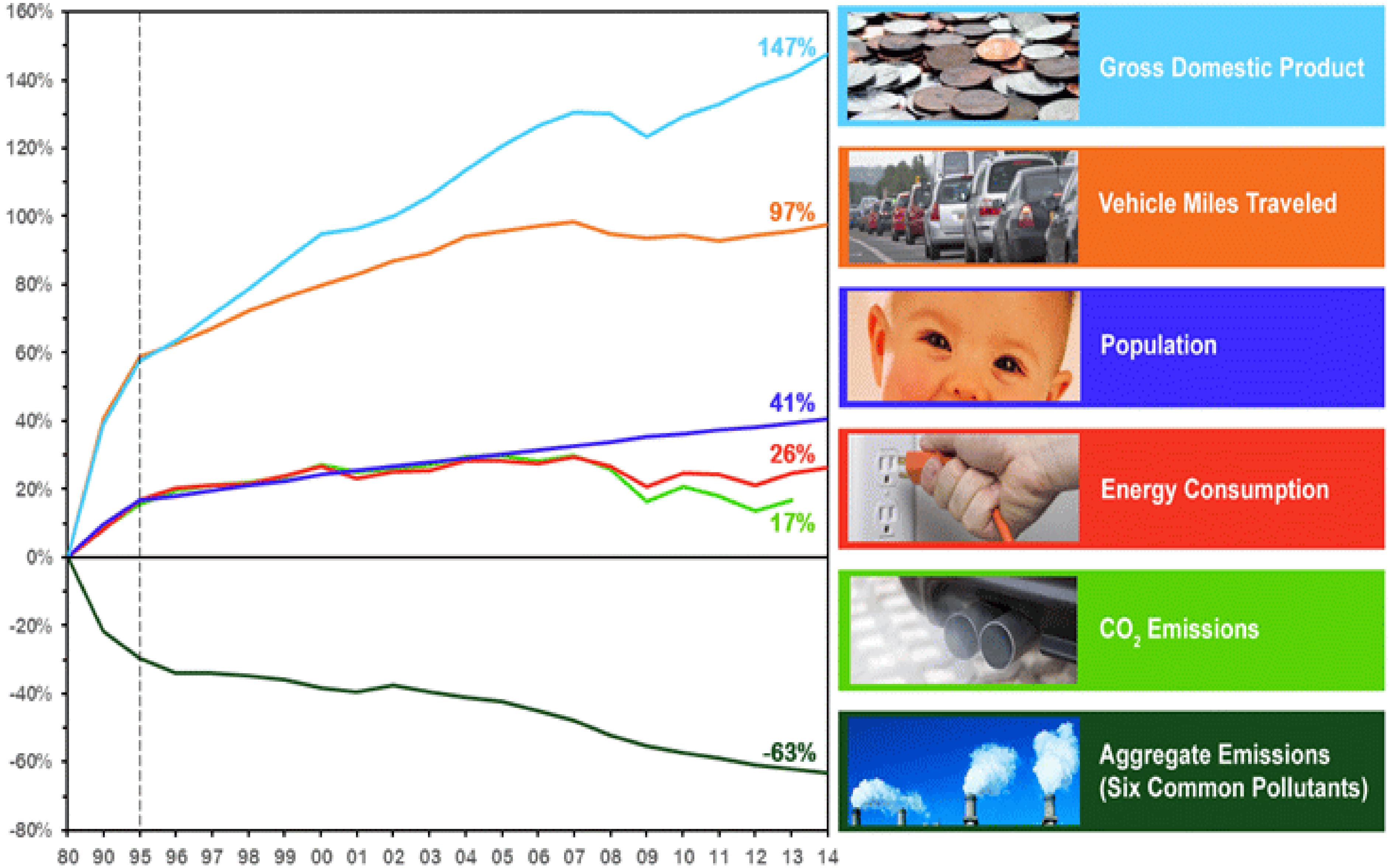
Comparison of Growth Areas and Emissions, 1980-2014



www3.epa.gov/airtrends/aqtrends.html

CO_2 Emissions from Conventional Electricity

Fuel	Lbs CO_2 per kWh
Coal	
Bituminous	2.08
Sub-bituminous	2.16
Lignite	2.18
Natural gas	1.22
Distillate Oil (No. 2)	1.68
Residual Oil (No. 6)	1.81

Last updated: April 17, 2014

Source: US Energy Information Administration (EIA)

Ohio CO2 Emissions from Fossil Fuel Combustion - Million Metric Tons											(2204.6 lbs/metric ton)			
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	
Ohio Total	263	254	259	266	262	268	262	268	262	238	248	237	217	
Commercial	11.5	11.1	11.1	11.5	11.5	10.9	9.4	10.3	11.1	10.8	10.5	10.6	9.6	**4.4%**
Industrial	38.9	39.0	37.3	38.0	37.0	35.8	37.1	38.8	38.7	32.9	36.3	35.3	37.1	**17.1%**
Residential	22.0	19.5	20.5	22.0	20.7	20.5	17.2	18.9	19.2	18.4	17.6	17.6	15.3	**7.0%**
Transportation	68.9	68.7	69.3	69.9	71.7	71.3	72.1	72.9	69.0	64.6	65.9	65.4	63.2	**29.1%**
Electric Power	121.7	115.3	121.3	125.1	121.0	129.3	125.7	127.4	124.3	111.0	117.8	108.0	92.1	**42.4%**
Source: US EIA publication "State Energy Consumption, Price, and Expenditure Estimates (SEDS)," Spring 2014														
www.eia.doe.gov/emeu/states/ seds.html														
Population (millions)	11.36	11.39	11.41	11.43	11.45	11.46	11.48	11.50	11.52	11.53	11.54	11.54	11.54	
Source: US Census Bureau														
CO2 Per Ohioan	139.4	134.5	137.4	140.7	137.8	141.1	137.6	140.9	137.2	124.6	129.9	123.9	113.3	
(Lbs per person per day)														

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Indiana CO2 Emissions from Fossil Fuel Combustion - Million Metric Ton (2204.6 lbs/metric ton)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
Indiana Total	234	224	228	233	234	233	231	231	227	206	216	208	194	
Commercial	6.3	5.6	5.9	6.7	6.4	5.4	4.7	5.1	6.2	5.8	5.5	5.4	4.7	**2.4%**
Industrial	52.8	54.4	54.1	54.7	56.9	53.6	53.3	52.7	49.9	43.9	47.7	45.9	44.3	**22.8%**
Residential	10.6	9.4	10.2	11.1	9.7	9.5	8.0	9.0	9.7	8.9	8.7	8.3	7.1	**3.6%**
Transportation	46.6	42.6	45.9	47.5	45.2	45.4	46.5	45.5	42.3	40.8	43.0	43.0	41.8	**21.6%**
Electric Power	117.3	112.3	111.7	113.4	115.9	118.8	118.7	118.8	119.1	106.0	111.1	105.8	96.2	**49.6%**

Source: US EIA publication "State Energy Consumption, Price, and Expenditure Estimates (SEDS)," Spring 2014

www.eia.doe.gov/emeu/states/ seds.html

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Population (millions)	6.09	6.13	6.16	6.20	6.23	6.28	6.33	6.38	6.42	6.46	6.49		6.48

Source: US Census Bureau

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
CO2 Per Indianan	230.9	221.2	223.4	227.6	226.2	223.9	220.6	218.8	213.1	192.2	201.0		180.3
(Lbs per person per day)													

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KY CO2 Emissions from Fossil Fuel Combustion - Million Metric Tons											(2204.6 lbs/metric ton)			
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
Kentucky Total	145	148	149	145	152	154	157	157	154	145	151	148	138	
Commercial	3.2	3.0	3.1	3.0	3.1	3.0	2.5	2.5	2.6	2.4	2.4	2.3	2.1	**1.5%**
Industrial	19.1	22.2	21.5	20.7	23.4	23.1	24.5	23.4	22.6	20.9	19.4	18.6	17.6	**12.7%**
Residential	4.6	3.9	4.0	4.3	4.0	3.9	3.3	3.5	3.7	3.6	3.7	3.5	2.8	**2.0%**
Transportation	31.5	32.0	33.0	31.7	34.5	33.5	33.5	35.0	32.2	32.7	33.3	32.7	31.3	**22.7%**
Electric Power	86.2	87.2	87.0	85.1	87.1	90.2	93.0	92.2	92.9	85.0	91.9	91.3	84.4	**61.1%**
Source: US EIA publication "State Energy Consumption, Price, and Expenditure Estimates (SEDS)," Spring 2014														
www.eia.doe.gov/emeu/states/ seds.html														
Population (millions)	4.04	4.07	4.10	4.13	4.16	4.19	4.26	4.26	4.29	4.32	4.35	4.37	4.38	
Source: US Census Bureau														
CO2 Per Kentuckian	215.5	219.9	218.8	211.5	219.8	221.4	222.3	222.2	216.3	202.2	209.3	205.3	190.0	
(Lbs per person per day)														

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2 choices for most energy users:

1) Reduce conventional energy use

2) Switch to less polluting conventional energies

	Typical Emissions *				
	Particulates	SO_2	NO_x	Mercury	CO_2
Coal	High	High	High	High	High
Ngas	Low	Low	Low	Low	Med
Petrol	Low	Med	Med	Low	High
Propane	Low	Low	Med	Low	Med
Wood & Waste	High				Low
	* With modern equipment & technology				

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Think More About Your Energy Choices:

	Pros	Cons
Coal	Abundant domestic supply & availability Relatively low long-term energy cost Acceptable for high load factor	Nonrenewable natural resource Upfront high investment cost Powerplant & waste siting restraints Much pollution or required pollution controls at powerplants Very high CO2 emissions Powerplant noise Heavy landscape impacts from extraction Water pollution typical from extraction Much in coal-mining is dangerous to workers Ash landfill failures are dangerous
Natural Gas	Abundant domestic supply & availability Less pollution and CO2 Relatively low upfront investment costs Relatively low long-term energy cost Acceptable for high load factor	Nonrenewable natural resource Powerplant noise Pipeline leak potential Explosive & toxic Environmental risks from fracking & deep-ocean wells Water pollution risks from frack-fluids
Petroleum	Abundant domestic supply & availability More mobile than other fossil fuels Acceptable for high load factor	Nonrenewable natural resource Abundant pollution and/or required pollution controls Very high CO2 emissions Explosive & toxic Pipeline & container leak potentials Environmental risks from fracking & deep-ocean wells Water pollution risks from leaks & frack-fluids

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Think More About Your Energy Choices:

	Pros	Cons
Uranium	Low conventional pollution and CO2 Acceptable for high load factor	Nonrenewable natural resource High terrorism potentials Mining is potentially hazardous Highly toxic long-life radioactivity Powerplant failures can be deadly High-level waste requires longterm secure storage Power plants require major upfront investments Least user-friendly of all energy options
Propane	Domestic availability Less pollution and CO2 More mobile than other fossil fuels	Nonrenewable natural resource Trucks & trains required for mobility Relatively high energy cost Pipeline & container leak potentials Explosive & toxic Environmental risks from fracking & deep-ocean wells Water pollution risks from leaks & frack-fluids
Wood, Biomass & Waste	Relatively low-cost Domestic availability Low CO2 Renewable natural & man-made resources	Fuel supplies more intermittent or geographically restricted Particulate pollution or required pollution controls

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Think More About Your Energy Choices:

	Pros	Cons
Solar	Renewable No fuel cost No noise No pollution or CO_2 Inexhaustible & abundant source energy User-friendly Directly integratable with built environment Direct heat gain possible with no conversion	Higher upfront investment costs Siting & orientation constraints Part-time intermittent supply Requires storage or conventional energy for continuous supply Difficult for high load factor
Wind	Renewable No fuel cost No pollution or CO_2 Inexhaustible & abundant source energy	Higher upfront investment costs Siting & orientation constraints & restrictions Part-time intermittent supply Requires storage or conventional energy for continuous supply Generator noise Sun-related blade flicker & strobe effects
Efficiency	Renewable No fuel cost No noise No pollution or CO_2 Highly available domestically Directly integratable with built environment User-friendly	Upfront investment costs
Conservation	Renewable No fuel cost No noise No pollution or CO_2 Highly available domestically Lowest cost of all energy choices Most user-friendly of all options	Requires user choices to reduce or avoid energy usage

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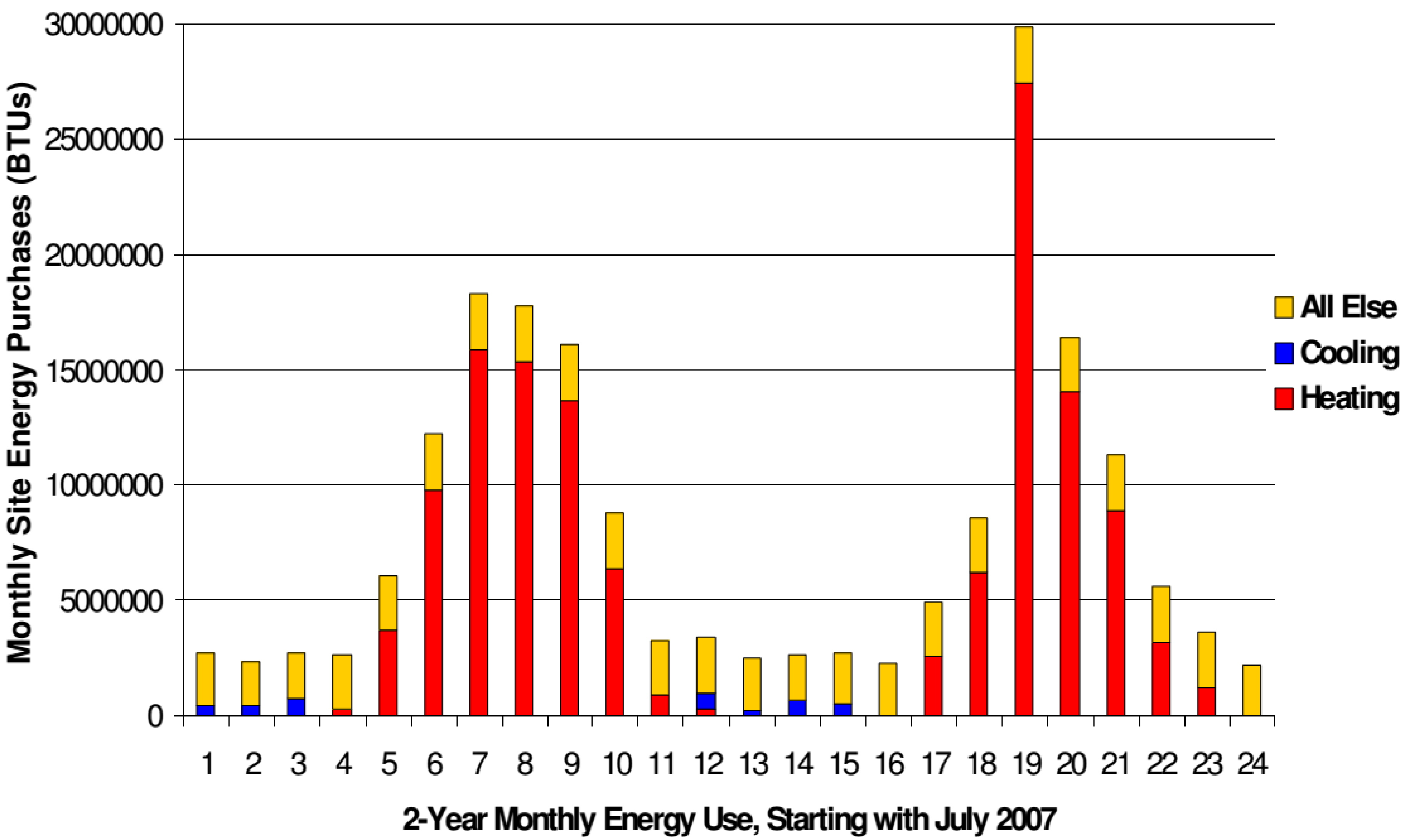
from SOLARIZING YOUR PRESENT HOME by J. Carter

Energy Breakdown - Older, Partially Improved 3-Story Urban Home
2025sf, 2 Adult Occupants Full-Time, 1 Part-Time Occupant



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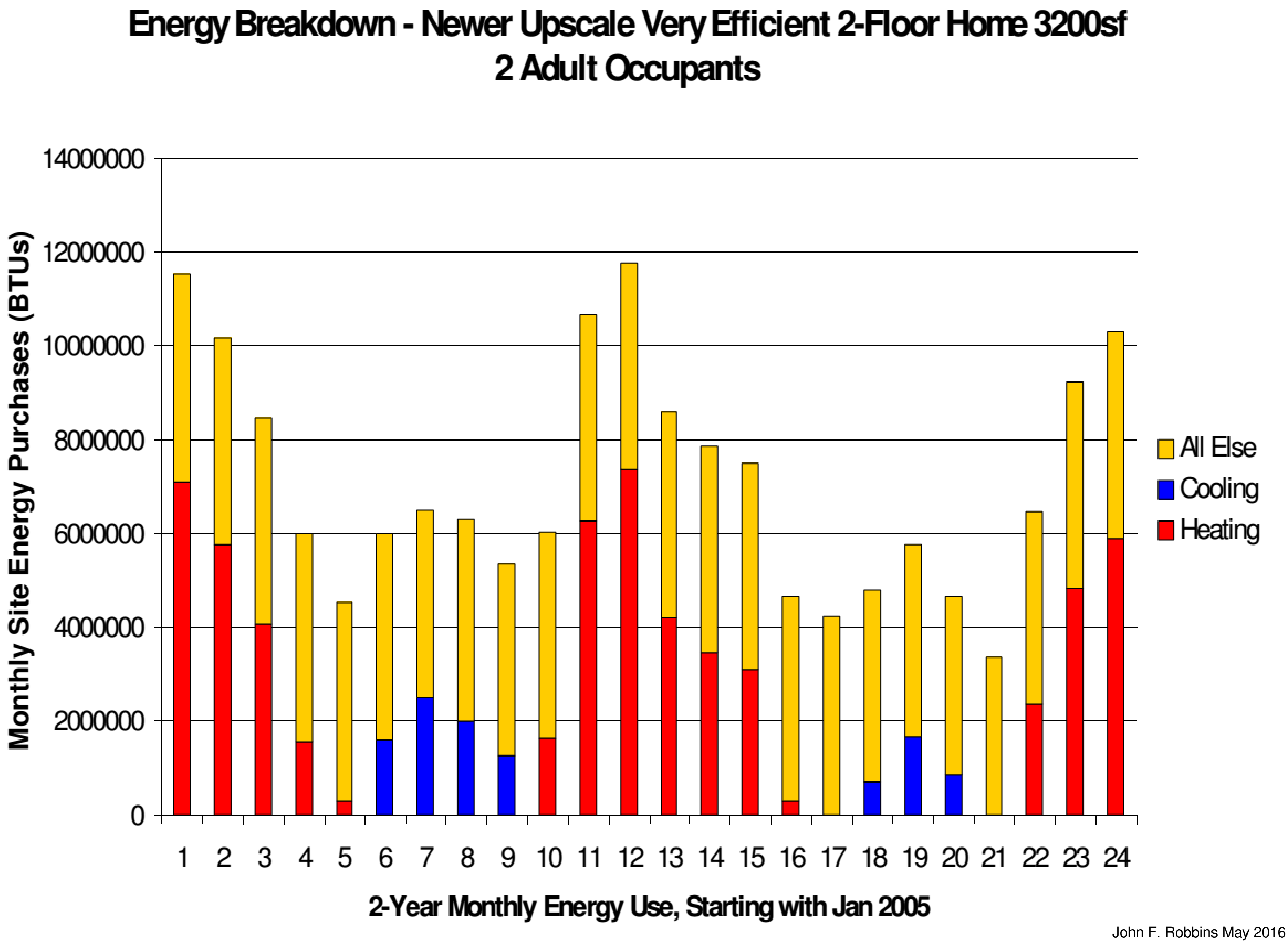
Energy Breakdown - Newer Upscale Very Efficient 2-Floor Home 3200sf
2 Adult Occupants
Monthly Site Energy Purchases (BTUs)
14000000
12000000
10000000
8000000
6000000
4000000
2000000
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
2-Year Monthly Energy Use, Starting with Jan 2005
All Else
Cooling
Heating
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Solar Heating Percent Depends on Home's Thermal Efficiency

2000	House conditioned floor area
10	% of floor area for south window or collector
0.55	Solar heat gain coefficient (SHGC)
0.80	Solar access %
0.90	Solar Collector & Delivery Efficiency

Greater Cincinnati		OCT	NOV	DEC	JAN	FEB	MAR	ARP	OCT-APR		
HtgDegDays65		319	614	944	1100	899	686	350			
Solar kBTU/sf		30.2	26.5	25.6	21.9	20.7	35.2	32.0			
Solar BTU		2,391,840	2,098,800	2,027,520	1,734,480	1,639,440	2,787,840	2,534,400			
House Heat Loss Htg BTU/sf-hdd									Heating BTU/year	Max Solar Htg Potential w/ Moderate Storage sBTU/year	
USA Best	1	638,000	1,228,000	1,888,000	2,200,000	1,798,000	1,372,000	700,000	9,824,000	9,199,920	94%
My Best	2	1,276,000	2,456,000	3,776,000	4,400,000	3,596,000	2,744,000	1,400,000	19,648,000	12,920,240	66%
	3	1,914,000	3,684,000	5,664,000	6,600,000	5,394,000	4,116,000	2,100,000	29,472,000	14,302,080	49%
	4	2,552,000	4,912,000	7,552,000	8,800,000	7,192,000	5,488,000	2,800,000	39,296,000	15,214,320	39%
	5	3,190,000	6,140,000	9,440,000	11,000,000	8,990,000	6,860,000	3,500,000	49,120,000	15,214,320	31%
Normal Least	6	3,828,000	7,368,000	11,328,000	13,200,000	10,788,000	8,232,000	4,200,000	58,944,000	15,214,320	26%
	7	4,466,000	8,596,000	13,216,000	15,400,000	12,586,000	9,604,000	4,900,000	68,768,000	15,214,320	22%
	8	5,104,000	9,824,000	15,104,000	17,600,000	14,384,000	10,976,000	5,600,000	78,592,000	15,214,320	19%
Average	9	5,742,000	11,052,000	16,992,000	19,800,000	16,182,000	12,348,000	6,300,000	88,416,000	15,214,320	17%
	10	6,380,000	12,280,000	18,880,000	22,000,000	17,980,000	13,720,000	7,000,000	98,240,000	15,214,320	15%
	11	7,018,000	13,508,000	20,768,000	24,200,000	19,778,000	15,092,000	7,700,000	108,064,000	15,214,320	14%
	12	7,656,000	14,736,000	22,656,000	26,400,000	21,576,000	16,464,000	8,400,000	117,888,000	15,214,320	13%
	13	8,294,000	15,964,000	24,544,000	28,600,000	23,374,000	17,836,000	9,100,000	127,712,000	15,214,320	12%
	14	8,932,000	17,192,000	26,432,000	30,800,000	25,172,000	19,208,000	9,800,000	137,536,000	15,214,320	11%
Normal Most	15	9,570,000	18,420,000	28,320,000	33,000,000	26,970,000	20,580,000	10,500,000	147,360,000	15,214,320	10%
	16	10,208,000	19,648,000	30,208,000	35,200,000	28,768,000	21,952,000	11,200,000	157,184,000	15,214,320	10%
	17	10,846,000	20,876,000	32,096,000	37,400,000	30,566,000	23,324,000	11,900,000	167,008,000	15,214,320	9%
	18	11,484,000	22,104,000	33,984,000	39,600,000	32,364,000	24,696,000	12,600,000	176,832,000	15,214,320	9%
	19	12,122,000	23,332,000	35,872,000	41,800,000	34,162,000	26,068,000	13,300,000	186,656,000	15,214,320	8%
	20	12,760,000	24,560,000	37,760,000	44,000,000	35,960,000	27,440,000	14,000,000	196,480,000	15,214,320	8%

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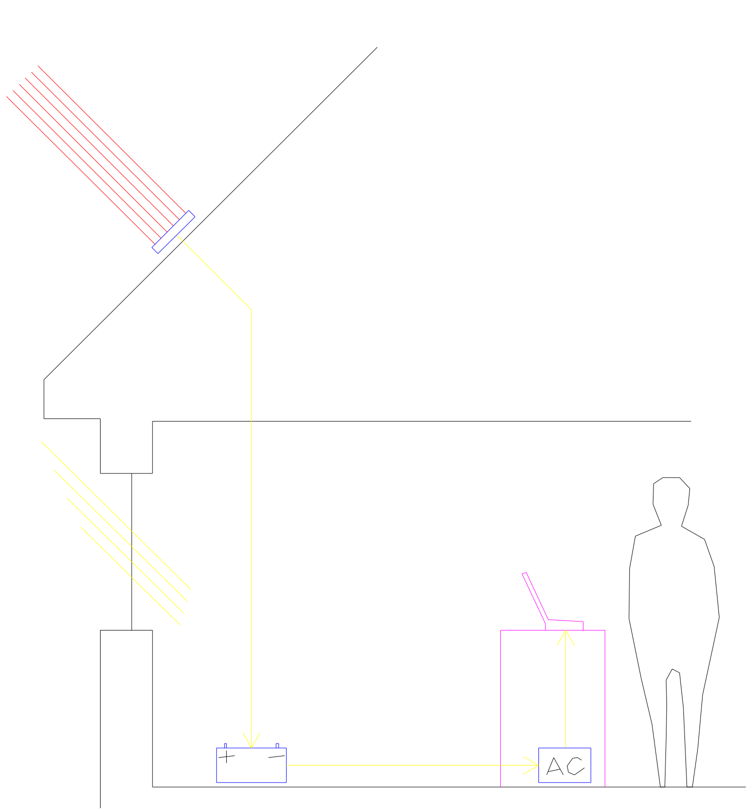
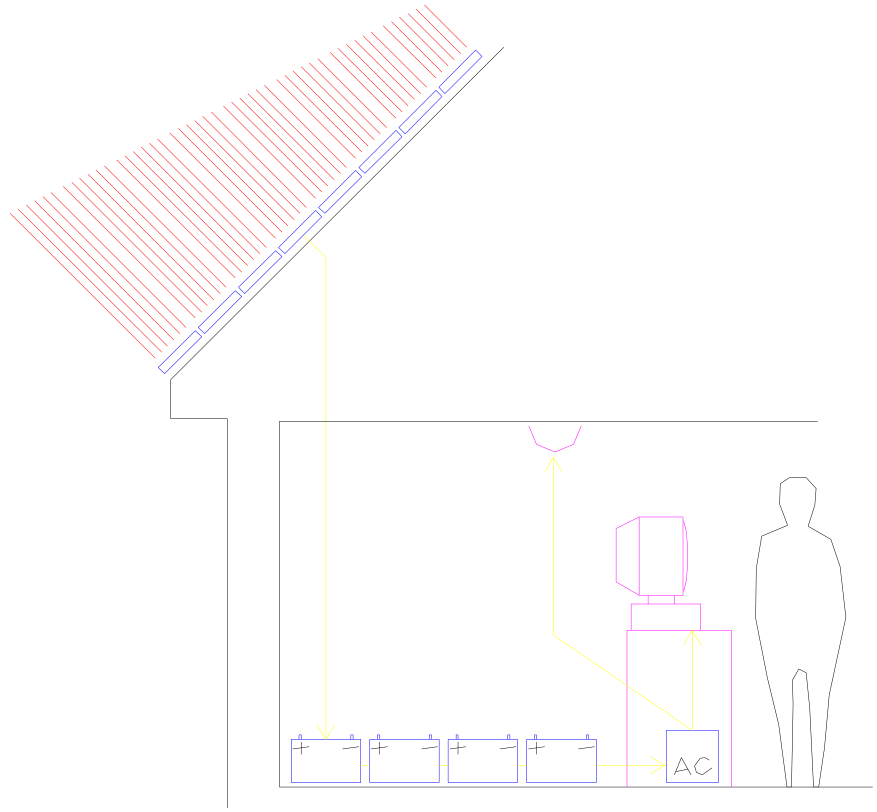
BALANCE POWER FLOWS BY DESIGN

SEASONALLY PREDICTABLE SUNLIGHT
SEASONALLY PREDICTABLE POWER DEMAND
SOLAR & RENEWABLE POWER SUPPLY & POTENTIAL



LESS POWER SUPPLY NEEDED FOR
LOWER POWER CONSUMPTION



MORE POWER SUPPLY NEEDED FOR
GREATER POWER CONSUMPTION

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Table CE1.1 Summary Household [Site] Energy Consumption in the U.S., 2009 - EIA

Housing Unit Characteristics and Energy Usage Indicators	Total Housing Units (millions)	Percent Of Total	Average Household Members	Average Floor Area (SF)	Average Floor Area (SF) Per Member	Average Consumption Per Member (million Btu)	Average Consumption Per Square Foot (thousand Btu)	Average Consumption Per Household (million Btu)
Total U.S.....................................	113.6		2.6	1969	767	34.9	45.5	89.6
Year of Construction								
Before 1940.............................	14.4	13%	2.4	2134	882	45.5	51.6	110.1
1940 to 1949...........................	5.2	5%	2.7	1860	700	36.4	52.0	96.7
1950 to 1959...........................	13.5	12%	2.5	1850	726	38.1	52.5	97.1
1960 to 1969...........................	13.3	12%	2.5	1751	713	35.8	50.2	87.9
1970 to 1979...........................	18.3	16%	2.5	1684	665	31.2	46.9	79.0
1980 to 1989...........................	17.0	15%	2.5	1770	706	30.7	43.5	77.0
1990 to 1999...........................	16.4	14%	2.7	2201	827	33.0	39.9	87.8
2000 to 2009...........................	15.6	14%	2.8	2466	873	32.4	37.1	91.5
15% less than average new - EnergyStar Minimum Level						**27.5**	**31.5**	
30% less than average new - EnergyStar Typical Maximum Expectation						**22.7**	**26.0**	
50% less than average new						**16.2**	**18.6**	

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Table CE1.1 Summary Household [Site] Energy Consumption in the U.S., 2009 - EIA

Housing Unit Characteristics and Energy Usage Indicators	Total Housing Units (millions)	Percent Of Total	Average Household Members	Average Floor Area (SF)	Average Floor Area (SF) Per Member	Average Consumption Per Member (million Btu)	Average Consumption Per Square Foot (thousand Btu)	Average Consumption Per Household (million Btu)
Total U.S.....................................	113.6		2.6	1969	767	34.9	45.5	89.6
Household Size								
1 Person.................................	31.3	28%	1.0	1449	1449	65.8	45.4	65.8
2 Persons................................	35.8	32%	2.0	2095	1048	45.4	43.3	90.7
3 Persons................................	18.1	16%	3.0	2054	685	32.8	47.9	98.4
4 Persons................................	15.7	14%	4.0	2318	580	26.6	45.9	106.4
5 Persons................................	7.7	7%	5.0	2330	466	22.2	47.6	110.9
6 or More Persons....................	5.0	4%	6.7	2397	357	16.9	47.4	113.6

Ohio Valley Household Energy Surveys 2001-2012

Download @ www.johnfrobbins.com/home_energy_surveys.htm

Annual EUI (kBTU/sf)	Best:	14.0	-	16.7
	Avg:	35.6	-	53.6
	Worst:	76.5	-	240.6
Annual PEUI (mmBTU/person)	Best:	7.7	-	15.7
	Avg:	31.7	-	42.3
	Worst:	67.4	-	106.9

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Who Is Usually Responsible… For Which Opportunities?

Developer	Designer	Builder	Owner Occupant	Renting Occupant	
					Siting & Design
X	X	X	X	X	Orientation to optimize solar energy & natural ventilation
X			X	X	Location to minimize energy for regular driving
X	X		X	X	Passive solar design, natural ventilation, solar water heating
			X	X	Smallest appropriate size & space per persons & processes
	X				Lowest ratio of exterior surface areas per floor area
X	X		X		Least complicated structure & support systems
	X		X		Owner/occupant participation in planning & design
X	X	X	X	X	Commitment to low energy use & pollution
X	X		X		Estimation of energy use & pollution during design & planning
					Building Components
	X	X			Airtightness, high R-value & moisture tolerance
X	X	X	X	X	Specs driven to achieve energy performance targets
	X		X		Low or known & acceptable maintenance requirements
	X	X			Lower embodied energy during manufacturing & delivery
	X	X	X	X	Less toxic materials & substances, esp. inside the home
	X	X			Less waste requirements
					Construction & Installations
	X	X	X		Contractors & installers informed about energy & pollution goals
	X	X	X		Inspections of energy details during construction
	X	X	X		Contractors & installers educated and assisted as needed
		X			Reduced waste during construction
					Efficient Operations & Upkeep
			X	X	Minimized energy usage, especially electricity
			X	X	Daylighting, energy-efficient electric lamps & appliances
	X	X	X	X	Regular assessment of energy use relative to design targets
			X	X	Least pollution & waste by house operations
			X	X	Low transportation energy needs
			X	X	Regular maintenance & systems checks
			X	X	Least energy, pollution & watering for yard maintenance

As much as 1/4 to 1/3 of low energy achievement is upto occupants & users

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How best to achieve less energy usage via widespread efficiency & conservation:

1) More participation

choosing to reduce their energy usage
and knowing how low to aim

2) Better energy programs

encouraging and rewarding for actual reductions
achieving aggragate reductions at powerplant scale

3) Consistent energy policies

teaching and aiming for longer-term focus
discouraging high usage and rewarding low usage

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Cartoon-like image from an old REAL GOODS catalog

End of this course

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