NATIONAL AND STATE ENERGY USE AND CARBON EMISSIONS TRENDS

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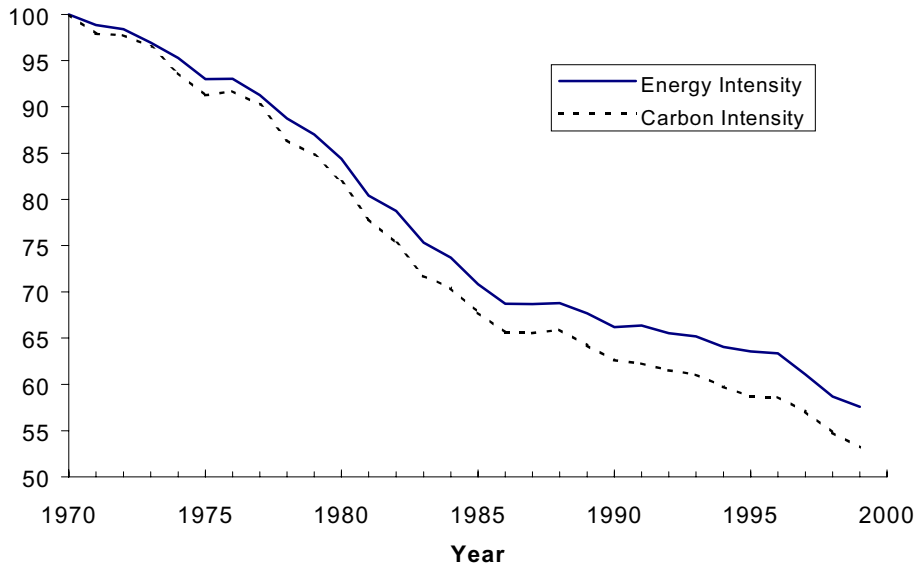
EXECUTIVE SUMMARY

U.S. energy intensity (primary energy per unit of gross domestic product [GDP]) fell 42 percent between 1970 and 1999 (see Figure ES-1). Carbon emissions intensity (carbon emissions per unit of GDP) fell 47 percent. Carbon intensity declined more than energy intensity because there was a slight decarbonization of overall energy supply during this time period.

Figure ES-1. Trends in U.S. Energy and Carbon Intensity
(Value in 1970 as 100)



Source: EIA 2000a

These large reductions in energy and carbon intensity provided a variety of economic, environmental, and national security benefits. Consumers and businesses cut their energy purchases, saved money, and became more productive. Shifting expenditures from energy purchases to other goods and services also led to a net increase in employment due to the relatively low labor intensity of the energy supply industries compared to other sectors of the economy. Declining energy intensity helped the United States restrain its oil import dependence, thereby benefitting the economy and national security. If we had not cut our use of oil during the past three decades, our loss of wealth from oil price shocks and monopolistic pricing would have been even greater. Finally, air pollution levels are much lower, and the task of meeting emissions standards is much easier, due to reductions in energy and carbon intensity over the past thirty years.

Three time periods stand out when examining these energy and carbon intensity trends: (1) 1973-86; (2) 1987-96; and (3) 1997-99. The first period started with the 1973 oil embargo and encompassed the two world oil price shocks. Energy intensity fell 29 percent between 1973 and 1986, 2.6 percent per year on average. Total energy use in 1986 was about the same as it had

been in 1973 while carbon emissions were actually about 2.5 percent less. About three-quarters of the decline in energy intensity is attributed to efficiency improvements and about one-quarter to structural change and fuel substitution.

The second period from 1987 through 1996 followed the 1986 "crash" in the world oil price and accompanying decline in the natural gas price. U.S. energy intensity fell just 8 percent and carbon intensity fell 10.5 percent during this ten-year period. With these moderate reductions in intensities, total primary energy use rose 22 percent and carbon emissions from burning fossil fuels grew 18 percent during 1986-96.

Starting in 1997, U.S. energy and carbon intensity began a new phase of steep decline. National energy intensity and carbon intensity fell nearly10 percent (3.2 percent per year on average) during this three-year period (EIA 2000b). Although oil prices moved up sharply starting in mid-1999, prices for all types of energy were generally falling during the period, making the recent decline in national energy and carbon intensity even more remarkable. The recent decline appears to be due to a combination of accelerating efficiency improvements and structural shifts especially in residential, commercial, and industrial sectors.

While national energy and carbon emissions intensity trends are overarching, it is important to recognize that there is substantial variation among states. Some states have significantly lower energy and carbon emissions intensity levels than other states and have experienced higher rates of decline in energy and carbon intensity. The states with lower intensities and steeper reductions in intensities are experiencing lower energy service costs and other economic benefits. The top states are also cutting pollutant emissions associated with energy use and contributing to enhanced national security more than other states. In this study, we calculate overall scores for each state and the District of Columbia based on their energy and carbon intensities in 1997 and the change in intensities during 1970-97.

Table ES-1 shows the absolute levels of energy use and carbon emissions along with energy and carbon intensity values for all states as of 1997. The absolute levels of energy use and carbon emissions are closely related to state population and therefore are not factored into the overall scores and state rankings. The states with the lowest energy intensity per capita (Hawaii, New York, Rhode Island, California, and Connecticut) are about 35-40 percent less energy-intensive than the national average, while the most energy-intensive states (Alaska, Louisiana, Wyoming, Texas, and North Dakota) consume 3-5 times more energy per capita than the least energy-intensive states. Low energy-intensive states are concentrated in the Northeast and Western regions.

Carbon emissions and intensity results are similar to the energy intensity results. But states in regions with a significant amount of hydropower and nuclear energy (e.g., the Pacific North-

Table ES-1. State Energy and Carbon Intensity Levels in 1997

State	Primary Energy Use		Energy Use per Capita		Energy Use per GSP		Carbon Emissions		Carbon Emissions per Capita		Carbon Emissions per GSP	
	(Trillion Btu)	rank	(MBtu)	rank	(kBtu/$)	rank	(MTons)	rank	(Tons)	rank	(kg/$)	rank
Alabama	1,978	35	458	45	19.55	44	29.63	34	6.86	41	0.29	41
Alaska	697	17	1145	51	29.01	50	10.52	16	17.28	51	0.44	48
Arizona	1,152	26	253	8	9.69	14	15.71	22	3.45	8	0.13	12
Arkansas	1,030	20	408	37	17.95	39	14.43	20	5.72	29	0.25	37
California	7,728	50	240	4	7.62	6	97.59	50	3.03	4	0.10	5
Colorado	1,133	24	291	12	9.16	12	20.47	28	5.26	25	0.17	20
Connecticut	796	18	243	5	6.03	2	11.71	18	3.58	10	0.09	3
Delaware	267	6	364	28	8.62	9	4.67	7	6.36	36	0.15	15
Dist of Columbia	177	2	334	21	3.44	1	2.66	2	5.03	20	0.05	1
Florida	3,615	44	246	6	9.68	13	59.07	45	4.02	13	0.16	18
Georgia	2,588	41	346	23	11.50	20	40.94	41	5.47	27	0.18	26
Hawaii	240	4	201	1	6.42	4	3.87	6	3.25	6	0.10	7
Idaho	498	11	411	38	17.40	38	4.80	8	3.96	12	0.17	21
Illinois	3,900	45	325	17	10.10	15	60.79	46	5.06	21	0.16	17
Indiana	2,684	42	457	44	16.91	37	52.91	42	9.01	45	0.33	45
Iowa	1,136	25	398	36	14.39	32	19.93	27	6.98	42	0.25	38
Kansas	1,033	21	395	35	14.68	35	17.23	24	6.59	38	0.24	36
Kentucky	1,810	33	463	46	18.43	40	36.14	38	9.25	46	0.37	46
Louisiana	4,093	47	941	50	33.54	51	61.72	47	14.18	49	0.51	51
Maine	553	12	444	42	18.70	42	5.10	9	4.10	14	0.17	23
Maryland	1,360	27	267	10	9.01	11	21.37	29	4.20	15	0.14	14
Massachusetts	1,534	30	251	7	7.07	5	22.95	30	3.75	11	0.11	8
Michigan	3,259	43	333	20	12.18	25	53.22	43	5.44	26	0.20	28
Minnesota	1,686	31	360	27	11.50	21	24.60	32	5.25	24	0.17	22
Mississippi	1,124	22	411	39	19.64	45	16.03	23	5.87	31	0.28	40
Missouri	1,749	32	323	15	11.72	23	31.87	35	5.89	33	0.21	32
Montana	378	9	430	41	20.08	46	5.61	10	6.38	37	0.30	42
Nebraska	617	14	373	30	12.88	30	9.75	14	5.89	32	0.20	31
Nevada	584	13	349	24	10.37	17	9.76	15	5.83	30	0.17	24
New Hampshire	304	7	259	9	8.13	7	3.63	5	3.09	5	0.10	6
New Jersey	2,585	40	321	14	8.96	10	38.95	40	4.84	18	0.13	13
New Mexico	647	15	376	31	14.58	34	11.44	17	6.64	39	0.26	39
New York	4,093	48	226	2	6.40	3	53.86	44	2.97	3	0.08	2
North Carolina	2,425	39	326	18	11.29	19	37.89	39	5.10	22	0.18	25
North Dakota	356	8	555	47	22.97	48	6.96	11	10.86	48	0.45	49
Ohio	4,144	49	370	29	13.18	31	76.13	49	6.79	40	0.24	35
Oklahoma	1,405	28	424	40	18.68	41	24.30	31	7.33	43	0.32	44
Oregon	1,133	23	349	25	11.74	24	9.26	13	2.86	2	0.10	4
Pennsylvania	3,901	46	325	16	11.69	22	62.83	48	5.23	23	0.19	27
Rhode Island	235	3	238	3	8.62	8	3.29	4	3.34	7	0.12	11
South Carolina	1,474	29	389	34	16.11	36	18.40	25	4.85	19	0.20	29
South Dakota	242	5	331	19	12.21	26	3.21	3	4.39	16	0.16	19
Tennessee	2,084	36	388	33	14.45	33	32.54	37	6.05	34	0.23	33
Texas	11,396	51	589	48	19.30	43	186.86	51	9.65	47	0.32	43
Utah	691	16	335	22	12.71	28	12.92	19	6.25	35	0.24	34
Vermont	167	1	284	11	11.19	18	1.64	1	2.79	1	0.11	9
Virginia	2,126	37	316	13	10.25	16	32.12	36	4.77	17	0.15	16
Washington	2,164	38	386	32	12.80	29	19.63	26	3.50	9	0.12	10
West Virginia	809	19	446	43	21.57	47	15.43	21	8.50	44	0.41	47
Wisconsin	1,835	34	353	26	12.70	27	29.31	33	5.64	28	0.20	30
Wyoming	428	10	892	49	24.86	49	8.05	12	16.78	50	0.47	50
U.S.	94,045		351		11.82		1453.74		5.43		0.18	

Sources: Census Bureau 1991, Census Bureau 1999, Census Bureau 2000, EIA 1999a, EIA 2000a, EIA 2000e

Note: Energy and carbon intensity calculated using 1996 dollars

west) tend to have a higher ranking on carbon intensity than energy intensity. The five least carbon-intensive states per capita (Vermont, Oregon, New York, California, and New Hampshire) are about 45 percent less carbon intensive than the national average, while the five most carbon-intensive states (Alaska, Wyoming, Louisiana, North Dakota, and Texas) emit 3-6 times more carbon per capita than the least carbon-intensive states.

Table ES-2 shows the change in energy and carbon intensity during 1970-97. The best states (Hawaii, New Mexico, Arizona, California, and Utah) cut their energy use per capita about 10-20 percent, compared to a 5 percent increase on average nationwide. The worst states, including Alaska, North Dakota, Maine, South Carolina, and Kentucky, saw their energy use per capita rise 30-90 percent during this period.

Table ES-3 and Figure ES-2 present the overall scores. The top three states with similar total scores are New York, Hawaii, and California. Other states making the "top ten list" are New Hampshire, Connecticut, Massachusetts, Arizona, Rhode Island, Maryland, and Vermont. The top states are concentrated in the Northeast and West. The worst states, apart from Alaska, are North Dakota, Louisiana, Wyoming, and Kentucky. The worst states are relatively dispersed geographically, including states from the Southeast, Midwest, and northern Rocky Mountain regions.

There are a number of reasons why some states have performed much better than other states with respect to both absolute level of energy and carbon intensity and decline in intensity over the past thirty years. The overall score tends to increase as average energy price increases, and this correlation is relatively strong. Two other factors—degree of urbanization and presence of energy-intensive industries—appear to influence the overall score but with weaker correlation. One factor that does not appear to affect the overall score is climate.

There is evidence that the top states in this ranking have done more to promote energy efficiency improvements than low-ranking states. Utility energy efficiency programs in the top ten states in this ranking produced electricity savings equal to 2.9 percent of electricity sales in 1998, compared to program-induced savings of just 1.3 percent of sales in the remaining 40 states. The top states also tend to have stronger building energy codes than the low-ranking states. And the two large states scoring the best in this overall ranking—New York and California—have implemented a wide range of energy efficiency initiatives over the past 25 years.

While recent trends in energy intensity are encouraging, energy use and carbon emissions are still growing, albeit slowly. U.S. carbon emissions from burning fossil fuels increased about 40 million metric tons (MMT) between 1996 and 1999. U.S. carbon emissions in 2000 are likely to be about 175-180 MMT greater than they were in 1990, representing a 13 percent increase over this ten-year period. If carbon emissions continue to rise 1 percent per year, they will reach

Table ES-2. Change in Energy and Carbon Intensity, 1970 - 1997

State	Energy Use per Capita		Energy Use per GSP		Carbon Emissions per Capita		Carbon Emissions per GSP	
	(%)	rank	(%)	rank	(%)	rank	(%)	rank
Alabama	12.8	31	-41.2	25	-10.4	16	-53.3	13
Alaska	90.4	51	20.1	51	75.5	50	10.7	50
Arizona	-13.7	3	-48.1	10	-15.8	10	-49.4	17
Arkansas	10.8	29	-43.5	19	6.2	35	-45.8	27
California	-13.3	4	-47.0	13	-25.0	4	-54.1	10
Colorado	-5.1	11	-51.2	8	0.6	29	-48.2	20
Connecticut	2.2	24	-51.3	7	-10.4	15	-57.3	6
Delaware	-7.3	8	-57.5	1	-10.3	17	-58.9	3
Dist of Columbia	22.7	40	-53.4	4	0.7	30	-61.8	2
Florida	5.7	25	-37.8	31	0.6	28	-40.8	33
Georgia	23.8	43	-40.8	26	17.8	43	-43.7	30
Hawaii	-21.3	1	-48.8	9	-29.4	1	-54.1	11
Idaho	-1.1	18	-38.0	30	-15.9	9	-47.2	23
Illinois	-2.6	16	-40.4	27	-16.6	8	-49.0	19
Indiana	6.5	26	-34.5	38	7.2	37	-34.1	42
Iowa	32.2	46	-24.8	47	34.8	46	-23.4	45
Kansas	1.1	20	-42.4	23	8.8	38	-38.0	39
Kentucky	33.1	47	-21.4	48	41.2	49	-16.7	48
Louisiana	26.9	44	-28.2	45	26.8	44	-28.3	44
Maine	45.8	49	-17.4	49	-5.4	20	-46.4	26
Maryland	-2.4	17	-47.3	12	-17.6	7	-55.5	8
Massachusetts	-2.7	15	-52.7	5	-13.7	12	-58.0	4
Michigan	8.4	27	-28.3	44	-5.7	19	-37.6	40
Minnesota	23.5	42	-34.8	36	3.1	32	-45.6	28
Mississippi	22.5	39	-36.8	34	13.6	40	-41.5	32
Missouri	14.8	35	-32.5	41	17.5	42	-30.9	43
Montana	-7.2	9	-34.4	39	17.1	41	-17.2	47
Nebraska	13.6	33	-37.3	32	11.0	39	-38.7	37
Nevada	-10.4	6	-42.7	22	-3.9	23	-38.5	38
New Hampshire	2.1	23	-54.2	3	-28.9	2	-68.1	1
New Jersey	13.4	32	-41.6	24	-1.3	26	-49.2	18
New Mexico	-16.8	2	-54.5	2	-2.9	24	-46.9	24
New York	-4.8	12	-45.5	15	-25.9	3	-57.6	5
North Carolina	23.4	41	-36.1	35	3.3	33	-46.5	25
North Dakota	79.4	50	-2.0	50	140.6	51	31.5	51
Ohio	-0.1	19	-38.9	28	-7.7	18	-43.5	31
Oklahoma	15.7	37	-25.6	46	35.3	47	-13.0	49
Oregon	-3.2	13	-47.9	11	-12.6	13	-53.0	14
Pennsylvania	-6.9	10	-44.8	16	-24.4	6	-55.2	9
Rhode Island	1.4	21	-42.8	21	-13.9	11	-51.4	15
South Carolina	34.8	48	-29.1	43	-0.1	27	-47.4	22
South Dakota	30.7	45	-37.2	33	34.6	45	-35.3	41
Tennessee	9.9	28	-44.2	17	-1.4	25	-49.9	16
Texas	-2.8	14	-46.7	14	2.5	31	-43.9	29
Utah	-10.4	5	-51.8	6	-3.9	22	-48.2	21
Vermont	11.5	30	-34.8	37	-24.6	5	-55.9	7
Virginia	14.5	34	-43.8	18	-5.1	21	-53.4	12
Washington	1.7	22	-43.2	20	6.5	36	-40.5	35
West Virginia	-9.5	7	-38.7	29	-12.2	14	-40.6	34
Wisconsin	20.9	38	-31.3	42	6.0	34	-39.8	36
Wyoming	15.5	36	-33.3	40	35.6	48	-21.7	46
US Average	5.3		-39.9		-3.8		-45.1	

Sources: Census Bureau 1991, Census Bureau 1999, Census Bureau 2000, EIA 1999a, EIA 2000a, EIA 2000e

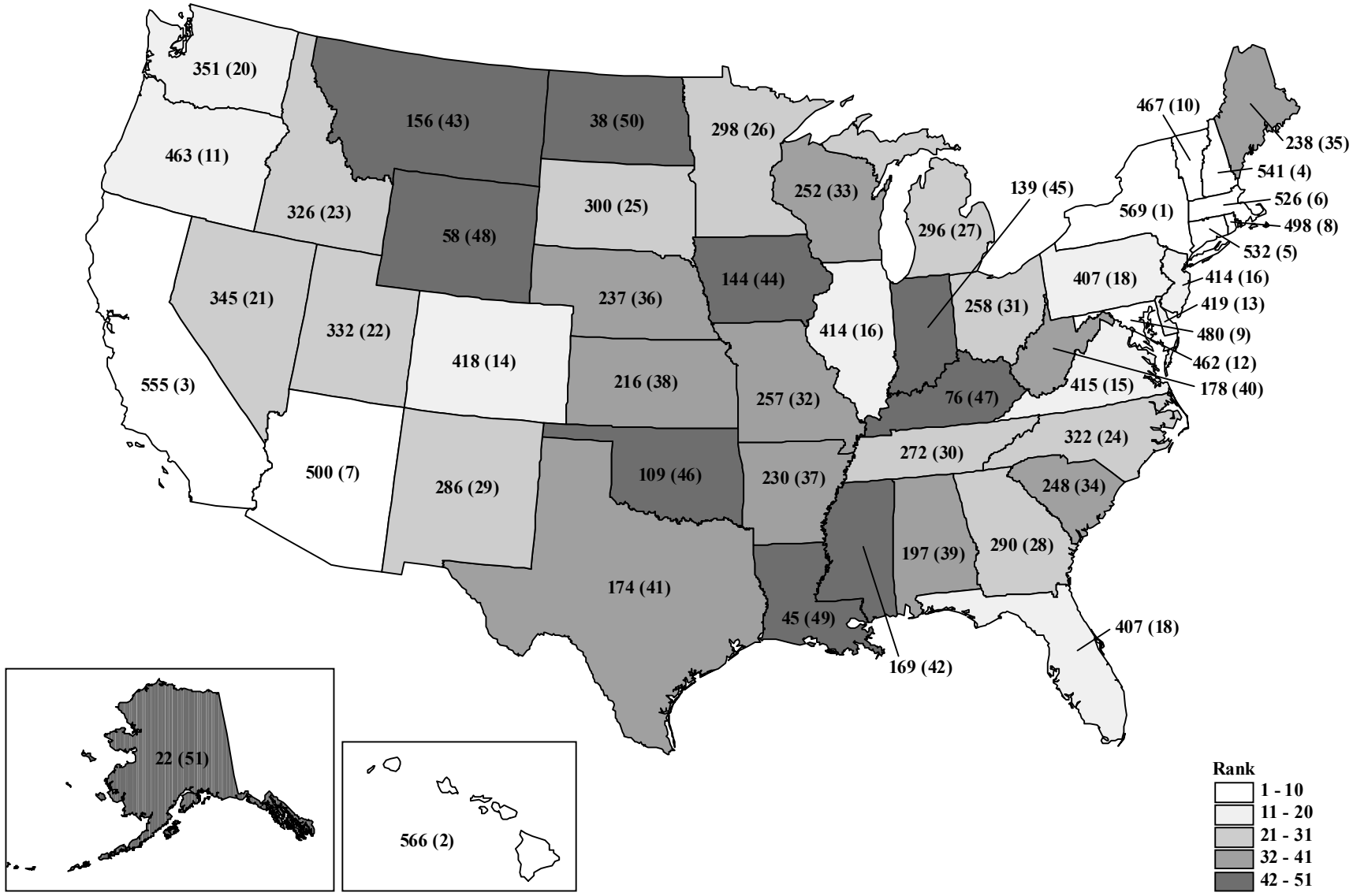
Note: Energy and carbon intensity calculated using 1996 dollars

Table ES-3. Overall Ranking of States based on Energy and Carbon Intensity

State	Final Rank	Overall Score	Rankings for Each Factor							
			Energy Use per Capita		Energy Use per GSP		Carbon Emissions per Capita		Carbon Emissions per GSP	
			1997	Change	1997	Change	1997	Change	1997	Change
New York	**1**	569	2	12	3	15	3	3	2	5
Hawaii	**2**	566	1	1	4	9	6	1	7	11
California	**3**	555	4	4	6	13	4	4	5	10
New Hampshire	**4**	541	9	23	7	3	5	2	6	1
Connecticut	**5**	532	5	24	2	7	10	15	3	6
Massachusetts	**6**	526	7	15	5	5	11	12	8	4
Arizona	**7**	500	8	3	14	10	8	10	12	17
Rhode Island	**8**	498	3	21	8	21	7	11	11	15
Maryland	**9**	480	10	17	11	12	15	7	14	8
Vermont	**10**	467	11	30	18	37	1	5	9	7
Oregon	**11**	463	25	13	24	11	2	13	4	14
Dist of Columbia	**12**	462	21	40	1	4	20	30	1	2
Delaware	**13**	419	28	8	9	1	36	17	15	3
Colorado	**14**	418	12	11	12	8	25	29	20	20
Virginia	**15**	415	13	34	16	18	17	21	16	12
Illinois	**16**	414	17	16	15	27	21	8	17	19
New Jersey	**16**	414	14	32	10	24	18	26	13	18
Florida	**18**	407	6	25	13	31	13	28	18	33
Pennsylvania	**18**	407	16	10	22	16	23	6	27	9
Washington	**20**	351	32	22	29	20	9	36	10	35
Nevada	**21**	345	24	6	17	22	30	23	24	38
Utah	**22**	332	22	5	28	6	35	22	34	21
Idaho	**23**	326	38	18	38	30	12	9	21	23
North Carolina	**24**	322	18	41	19	35	22	33	25	25
South Dakota	**25**	300	19	45	26	33	16	45	19	41
Minnesota	**26**	298	27	42	21	36	24	32	22	28
Michigan	**27**	296	20	27	25	44	26	19	28	40
Georgia	**28**	290	23	43	20	26	27	43	26	30
New Mexico	**29**	286	31	2	34	2	39	24	39	24
Tennessee	**30**	272	33	28	33	17	34	25	33	16
Ohio	**31**	258	29	19	31	28	40	18	35	31
Missouri	**32**	257	15	35	23	41	33	42	32	43
Wisconsin	**33**	252	26	38	27	42	28	34	30	36
South Carolina	**34**	248	34	48	36	43	19	27	29	22
Maine	**35**	238	42	49	42	49	14	20	23	26
Nebraska	**36**	237	30	33	30	32	32	39	31	37
Arkansas	**37**	230	37	29	39	19	29	35	37	27
Kansas	**38**	216	35	20	35	23	38	38	36	39
Alabama	**39**	197	45	31	44	25	41	16	41	13
West Virginia	**40**	178	43	7	47	29	44	14	47	34
Texas	**41**	174	48	14	43	14	47	31	43	29
Mississippi	**42**	169	39	39	45	34	31	40	40	32
Montana	**43**	156	41	9	46	39	37	41	42	47
Iowa	**44**	144	36	46	32	47	42	46	38	45
Indiana	**45**	139	44	26	37	38	45	37	45	42
Oklahoma	**46**	109	40	37	41	46	43	47	44	49
Kentucky	**47**	76	46	47	40	48	46	49	46	48
Wyoming	**48**	58	49	36	49	40	50	48	50	46
Louisiana	**49**	45	50	44	51	45	49	44	51	44
North Dakota	**50**	38	47	50	48	50	48	51	49	51
Alaska	**51**	22	51	51	50	51	51	50	48	50

Note: Ranking for the 1997 values are given twice the weight as the rankings for the 70-90 change values

Figure ES-2: Overall Score and Rankings on Energy Consumption and Carbon



1,685 MMT by 2010, about 430 MMT more than the U.S. Kyoto Protocol target of roughly 1,255 MMT. Clearly much more needs to be done if this target is to be achieved.

There are many national policies that would help to maintain high rates of decline in national energy intensity and curtail growth in energy use and carbon emissions, including:

- New appliance efficiency standards, incentives, and labeling provisions;
- Building energy code requirements and incentives for very efficient new construction;
- Technical assistance and incentives for building retrofits;
- National public benefits trust fund to provide funding for state and utility energy efficiency programs;
- National renewable portfolio standard as part of electric utility restructuring;
- Stonger standards, incentives, and voluntary programs to increase the fuel economy of passenger vehicles and trucks;
- Renewable energy or greenhouse gas emissions standards for motor fuels;
- Expedited permitting, output-based emissions standards, accelerated depreciation, and favorable utility policies for combined heat and power systems;
- Voluntary agreements and incentives to reduce industrial energy use; and
- Tighter emissions standards on coal-fired power plants.

Adopting this set of policies could save consumers and businesses money, cut pollutant emissions, and reduce future oil import dependence.

States also can take initiatives to further reduce their energy intensity and carbon emissions. Twenty states have adopted state "public benefit funds" to maintain or expand funding for energy efficiency programs in conjunction with electric utility regulatory reform. Ten states have adopted renewable electricity standards to increase the amount of electric power generated from wind power, solar power, bioenergy, and other renewable-based energy sources. A few states such as Oregon, New Jersey, and Maryland have enacted specific policies aimed at cutting emissions of carbon dioxide (CO_2) and other greenhouse gases.

But most states have *not* adopted wide-ranging policies and programs to reduce energy and carbon emissions intensity. Many states still have relatively weak building codes and/or weak commitments to energy efficiency and renewable energy as part of their power sector reforms. Also, states by and large are doing relatively little to promote more fuel-efficient vehicles or energy savings in transportation more generally.

The policies that states could adopt to further reduce energy and carbon emissions intensity, complementing the national policies suggested above, include:

- Substantial public benefit funds to support energy efficiency programs as part of utility regulatory reform;

- Renewable portfolio standards as part of utility regulatory reform;
- Stimulation of retirement of older, inefficient and highly polluting coal-fired power plants, and replacement of these plants with renewable-based power and state-of-the-art gas-fired combined cycle power plants;
- Removal of barriers inhibiting greater use of cogeneration, such as eliminating onerous exit fees, high standby power charges, and overly burdensome permitting requirements;
- Stringent residential and commercial building energy codes, and funding for code education and enforcement;
- Financial incentives to encourage purchase of fuel-efficient vehicles and discourage purchase of gas guzzlers;
- "Smart growth"policies to discourage urban sprawl and cut growth in vehicle use;
- Financial incentives for innovative energy efficiency and renewable energy technologies such as fuel cells, hybrid vehicles, and solar photovoltaic systems;
- Technical and financial assistance to stimulate industrial process improvements; and
- Procurement of energy-efficient appliances, lighting products, vehicles, and "green power" by state agencies.

In summary, deep reductions in national energy and carbon intensity were achieved over the past thirty years, providing enormous economic, environmental, and national security benefits. Energy and carbon intensity reductions over the past three years were especially strong. Nonetheless, improving energy efficiency and increasing use of renewable energy sources is as important today as it has ever been, given the multiple challenges of: (1) growing oil imports and the vulnerability of our economy to oil price spikes; (2) mounting evidence of global warming and the need to cut greenhouse gas emissions; (3) persistent urban air pollution and nonattainment of air quality standards; and (4) growing concerns about power outages and electric system reliability during periods of high demand. By adopting comprehensive new policies to raise energy efficiency and lower energy and carbon intensity, the United States can make major strides towards addressing all of these challenges over the next thirty years.

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