Independent Statistics & Analysis
U.S. Energy Information Administration

U.S. Energy-Related Carbon Dioxide Emissions, 2012

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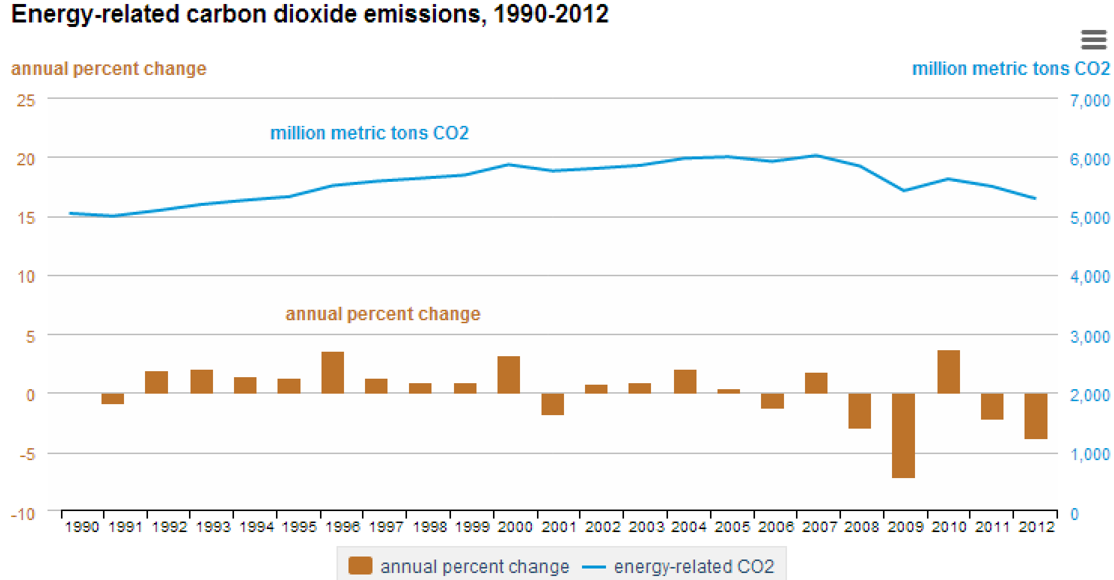
U.S. ENERGY-RELATED CARBON DIOXIDE EMISSIONS DECLINED 3.8 PERCENT IN 2012

- The 2012 downturn means that emissions are at their lowest level since 1994 and over 12 percent below the recent 2007 peak.
- After 1990, only the recession year of 2009 saw a larger percentage emissions decrease than 2012.
- Energy-related carbon dioxide emissions have declined in 5 out of the last 7 years.

Energy-related carbon dioxide emissions, 1990-2012



Source: U.S. Energy Information Administration, Monthly Energy Review (September 2013), Table 12.1.

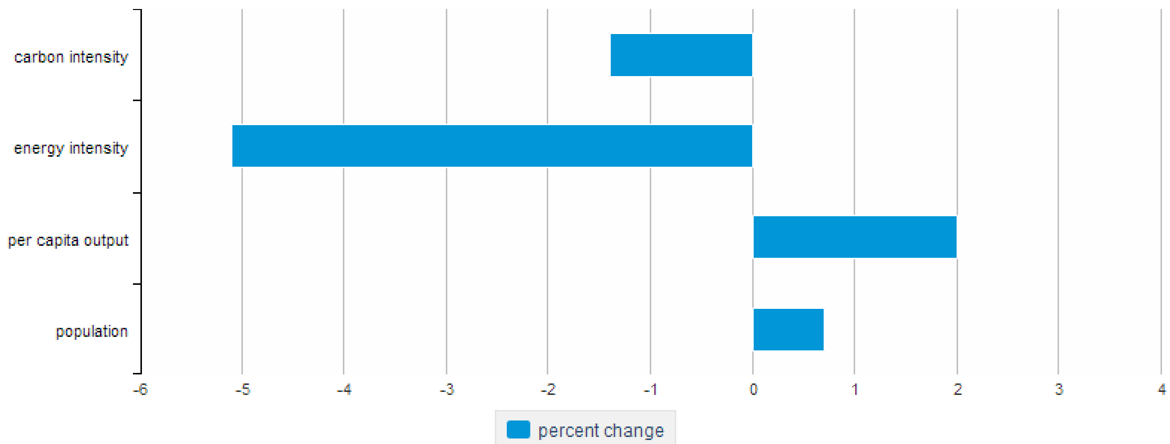
Note: All data in this analysis refers to the Monthly Energy Review of September, 2013 unless otherwise indicated. Because of slightly differing coverage and data vintage, absolute values and percent changes may differ slightly with other Energy Information Administration (EIA) publications.

THE DECLINE IN ENERGY-RELATED CARBON DIOXIDE EMISSIONS OCCURRED WHILE THE U.S. ECONOMY GREW IN 2012

A large drop in energy intensity (energy measured in Btu per dollar of gross domestic product [GDP]) assisted the 2012 decline in energy-related carbon dioxide emissions despite economic growth.

- Although GDP increased by 2.8 percent in 2012[1], energy consumption fell by 2.4 percent (2.4 quadrillion Btu) in that same year—the result was a 5.1 percent decline in energy use per dollar of GDP and this meant emissions were about 282 million metric tons CO_2 ($MMTCO_2$) lower.
- The decline in carbon intensity reduced emissions by about 75 $MMTCO_2$.
- With population growth of about 0.7 percent, per capita output rose by about 2 percent in 2012. The emissions decline was the largest in a year with positive growth in per capita output and the only year to show a decline where per capita output increased 2 percent or more. However, emissions would have increased by about 143 $MMTCO_2$ if the energy and carbon intensities had not decreased at the rates they did.

Percent changes in emissions drivers that led to a decline in energy-related carbon dioxide in 2012



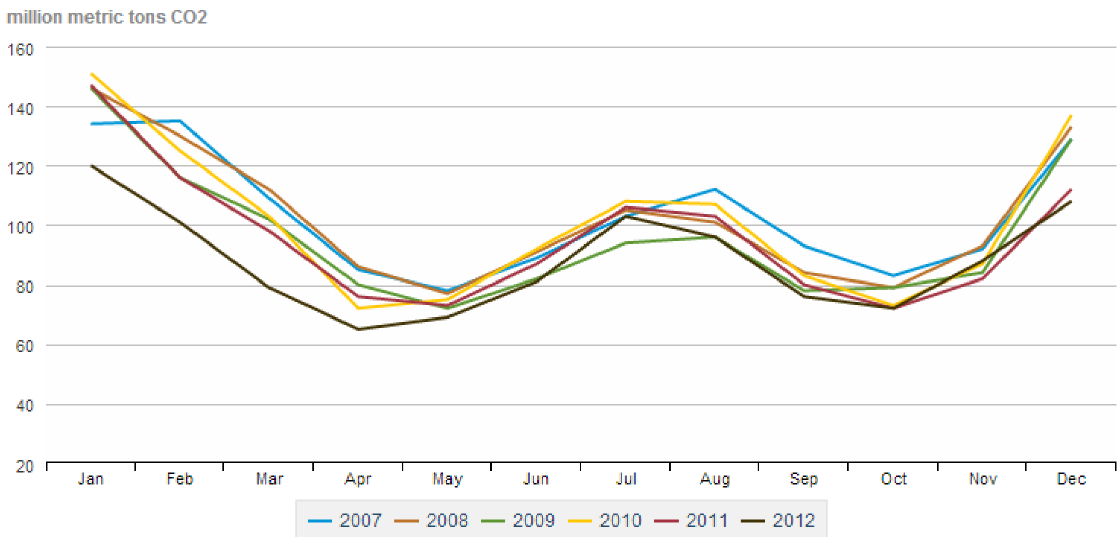
Source: U.S. Energy Information Administration, Monthly Energy Review (September 2013), Tables 12.1 and 1.1. Population growth for 2012, Census Bureau as of October 17, 2013. GDP, Bureau of Economic Analysis , as of July 31, 2013.

A MILD HEATING SEASON HELPED DAMPEN ENERGY DEMAND AND RELATED EMISSIONS IN 2012

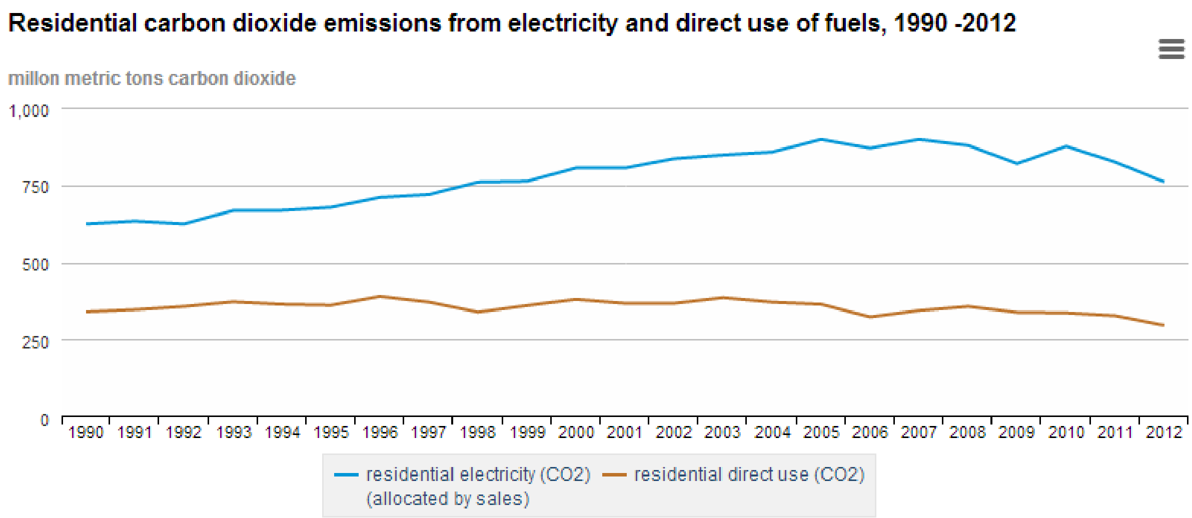
Half of the overall energy decline was from the residential sector (1,213 trillion Btu or 5.7 percent), where a very warm first quarter of the year lowered energy demand and emissions.

- By the end of March, cumulative heating degree days (HDD) were about 19% below the 10-year normal and 22 percent below 2011.
- As indicated in the figure below, the lower demand for heating fuel was reflected in the decreased residential emissions during the early part of the year and, with the exception of 2009 (a relatively cool summer), they stayed below the recent years for most of the months.

Residential sector monthly energy-related carbon dioxide emissions, 2007-2012



eia **Source: U.S. Energy Information Administration, Monthly Energy Review (September 2013), Table 12.2.**



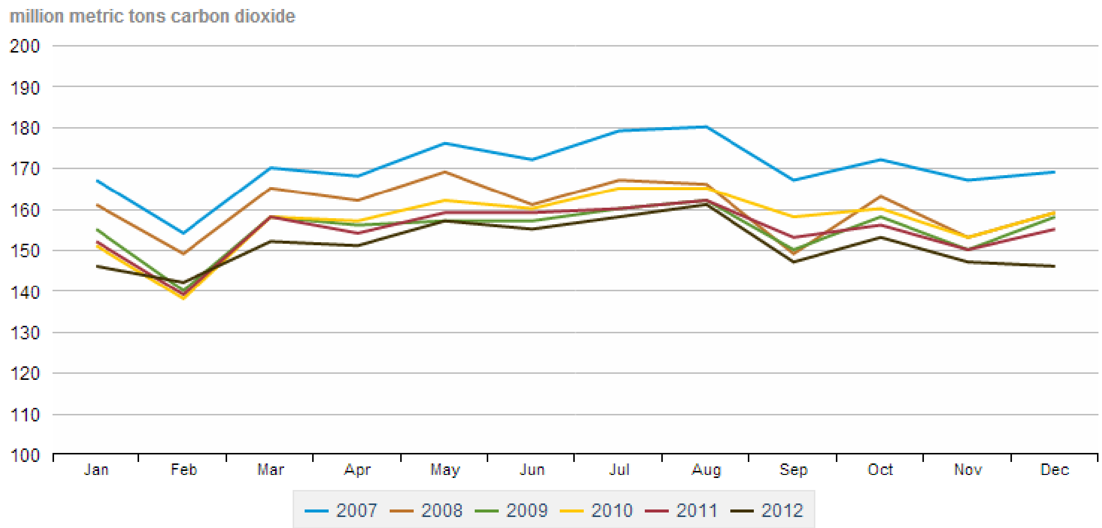
Sources: U.S. Energy Information Administration, Monthly Energy Review, Table 12.2 (September 2013).

THE TRANSPORTATION SECTOR ALSO CONTRIBUTED TO LOWER ENERGY-RELATED CARBON DIOXIDE EMISSIONS IN 2012

After the residential sector, the next biggest decline in energy consumption was in the transportation sector (513 trillion Btu) or 22 percent of the total energy decline.

- Vehicle miles traveled in 2012 were flat compared to 2011 (8,072 million miles per day in both years), while more energy-efficient vehicles are continuing to enter the market.
- As indicated below, transportation sector emissions in 2012 remained well below the comparable level for 2007 in each month over the year, and only February, with an extra day, was above any of the five previous years.

Transportation sector monthly energy-related carbon dioxide emissions, 2007 - 2012



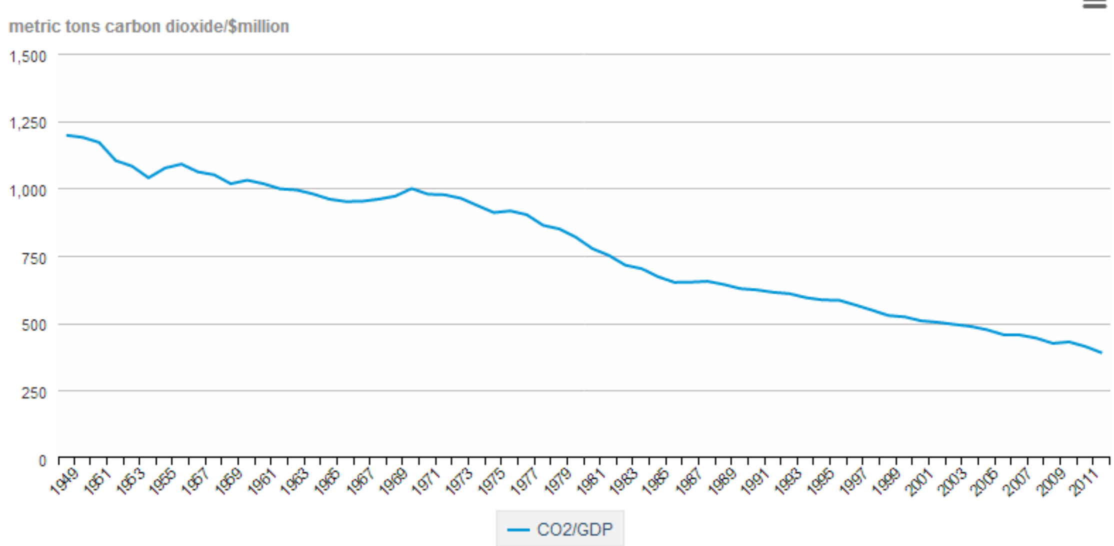
Source: U.S. Energy Information Administration, Monthly Energy Review (September 2013), Table 12.5.

THE OVERALL CARBON INTENSITY OF THE U.S. ECONOMY DECLINED IN 2012

The combined reduction in energy use per dollar of GDP and the carbon intensity of the energy supply meant that the overall carbon intensity of the economy (carbon dioxide per GDP) declined 6.5 percent in 2012

- The largest drop in the overall carbon intensity of the economy since records were kept beginning in 1949. Only two other years, 1952 and 1981 had declines greater than 5 percent
- There was decreased consumption of heating fuels because of a warm first quarter in 2012.
- Natural gas competed favorably with coal, and electric power producers consumed (dispatched) the lower-priced natural gas in place of coal, which has higher carbon content than natural gas.

Carbon intensity of the U.S. economy, 1949-2012



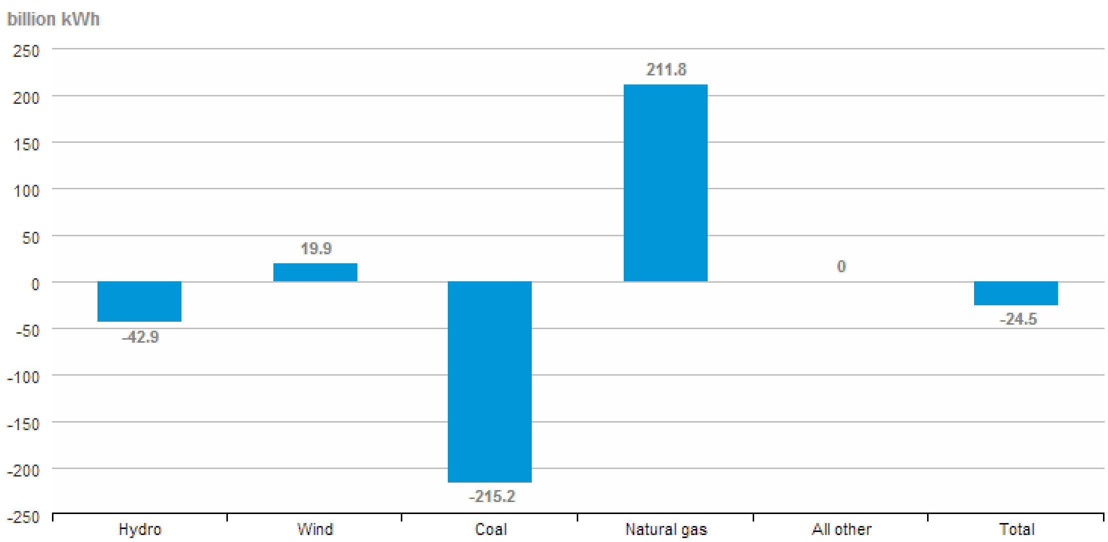
Sources: 1949 - 2011, Annual Energy Review (2011) , September 2012, Table 11.1, 2012. Monthly Energy Review Table 12.1 . GDP, Bureau of Economic Analysis , as of July 31, 2013.

SUBSTITUTION OF NATURAL GAS FOR COAL IN POWER GENERATION HELPED LOWER EMISSIONS IN 2012

Because the generation of electricity, which is widely used in all sectors except transportation, is an important source of emissions, declines in the carbon intensity of electricity generation lowers emissions throughout the economy.

- The increase in natural gas-fired generation, while coal-fired generation decreased, substantially reduced the carbon intensity of electricity generation in 2012.
- While there was an increase in wind generation, hydropower generation declined from 2011 by over twice the increase in wind generation.
- Despite the overall decline in renewables, the carbon intensity of power generation still fell by 3.5 percent, due largely to the increase in the share of natural gas generation relative to coal generation.

Annual change in generation by fuel type in 2012

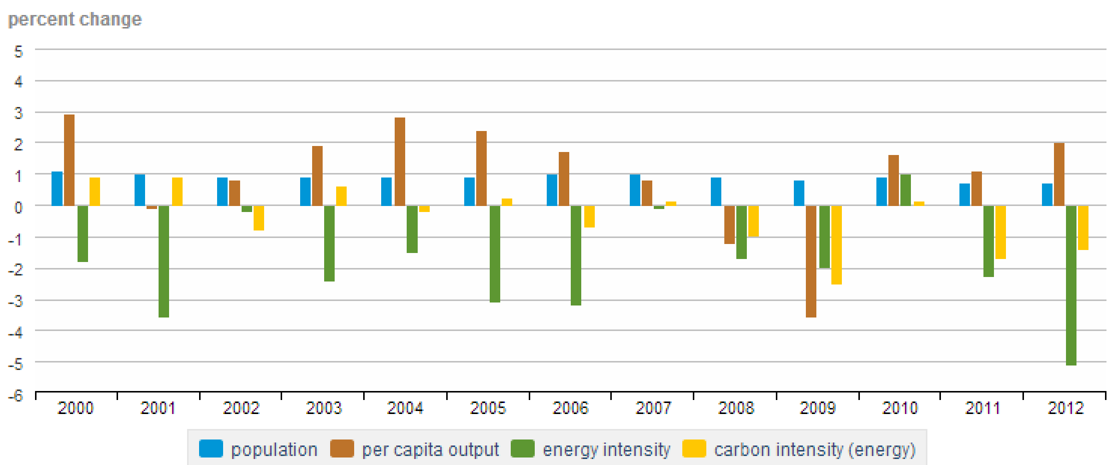


Source: U.S. Energy Information Administration, Monthly Energy Review (September 2013), Table 7.2b.

SINCE 2007 SEVERAL KEY DRIVERS THAT INFLUENCE EMISSIONS GROWTH HAVE CHANGED[1]

- Per capita output declined in 2008 and 2009.
- The carbon intensity of the energy supply declined by 1 percent or more in four of the last five years, while in prior years since 2000 it either rose or declined only slightly. Increased use of natural gas for electricity generation in high-efficiency combined cycle plants and increases in renewable energy generation, especially wind, have contributed to this decline.

Percent changes in key emission drivers from 2000 to 2012



**Sources: U.S. Energy Information Administration, Monthly Energy Review (September 2013), Table 12.1.
U.S. Energy Information Administration, Annual Energy Review (September 2012), Table D1. Census Bureau for 2011 and 2012 .
GDP, Bureau of Economic Analysis, as of July 31, 2013.**

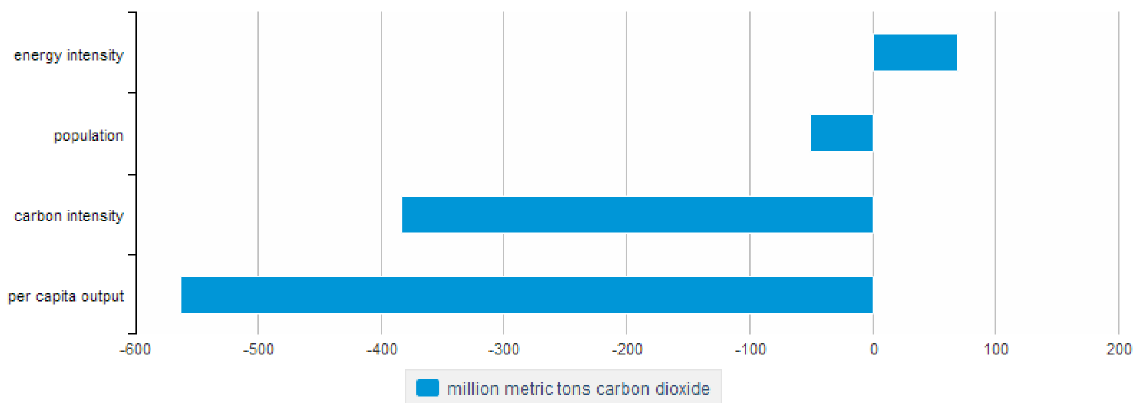
[1]These drivers are known collectively as the Kaya Identity. See "Terms used in this analysis," for a further explanation of the Kaya Identity.

CUMULATIVE CHANGES IN KEY DRIVERS HAVE REDUCED ENERGY-RELATED CARBON DIOXIDE EMISSIONS 12.2 PERCENT FROM 2007 TO 2012

U.S. energy-related carbon dioxide emissions have declined in all but one year since 2007. However, if the trends in drivers from the previous decade remained the same, emissions would have been over 900 $MMTCO_2$ higher.

- From 1997 to 2007 per capita output grew at an average rate of 2.0 % but from 2007 to 2012 per capita output was flat and as a result emissions were about 563 $MMTCO_2$ lower.
- The next largest contributor to the decline was carbon intensity that declined only 0.1 percent from 1997 to 2007, but declined 1.3 percent annually from 2007 to 2012 and reduced emissions by about 384 $MMTCO_2$.
- Slightly lower population growth contributed about 51 $MMTCO_2$ to the decline, however that was offset by a lower rate of decline in energy intensity that added approximately 69 $MMTCO_2$ from 2007 to 2012.

Changes in emissions attributed to key drivers from 2007 to 2012 as compared to the trend for the prior decade



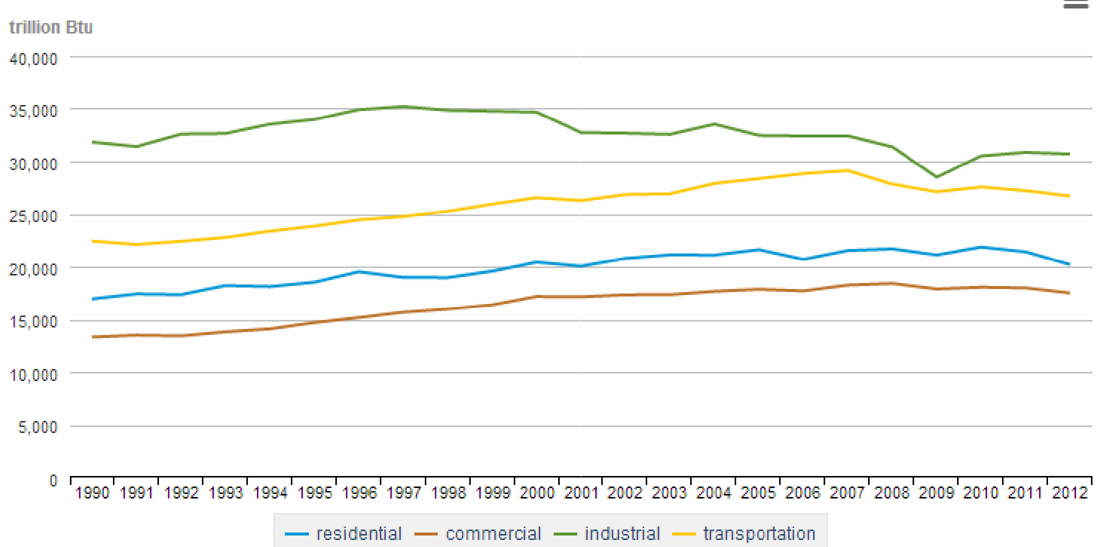
Source: U.S. Energy Information Administration, Monthly Energy Review (September 2013), Tables 12.1 and 1.1.
Population growth, Census Bureau as of October 17, 2013.
GDP, Bureau of Economic Analysis, as of July 31, 2013.

CAUSES FOR THE DROP IN ENERGY INTENSITY SINCE 2007

The factors behind the almost 10-percent drop in energy intensity include:

- Weather – there was a 7-percent increase in CDDs and an 11.5-percent decrease in HDDs from 2007 to 2012. Because much more energy is needed for space heating than for air conditioning, the decrease in HDDs (and heating demand) outweighed the increase in CDDs (and air conditioning demand). This change in weather reduced energy consumption about 481 trillion Btu in 2012 as compared to 2007 for the residential and commercial sectors.
- Industrial output was 2.7 percent lower in 2012 than in 2007 and manufacturing output in particular was 5 percent below the 2007 value.
- Vehicle miles traveled were lower in 2012 than 2007 by 3.3 percent.
- Vehicle fleet efficiency improved 16 percent between 2007 and 2012, also contributing to lower energy intensity.[2]

Energy consumption by end-use sectors, 1990-2012



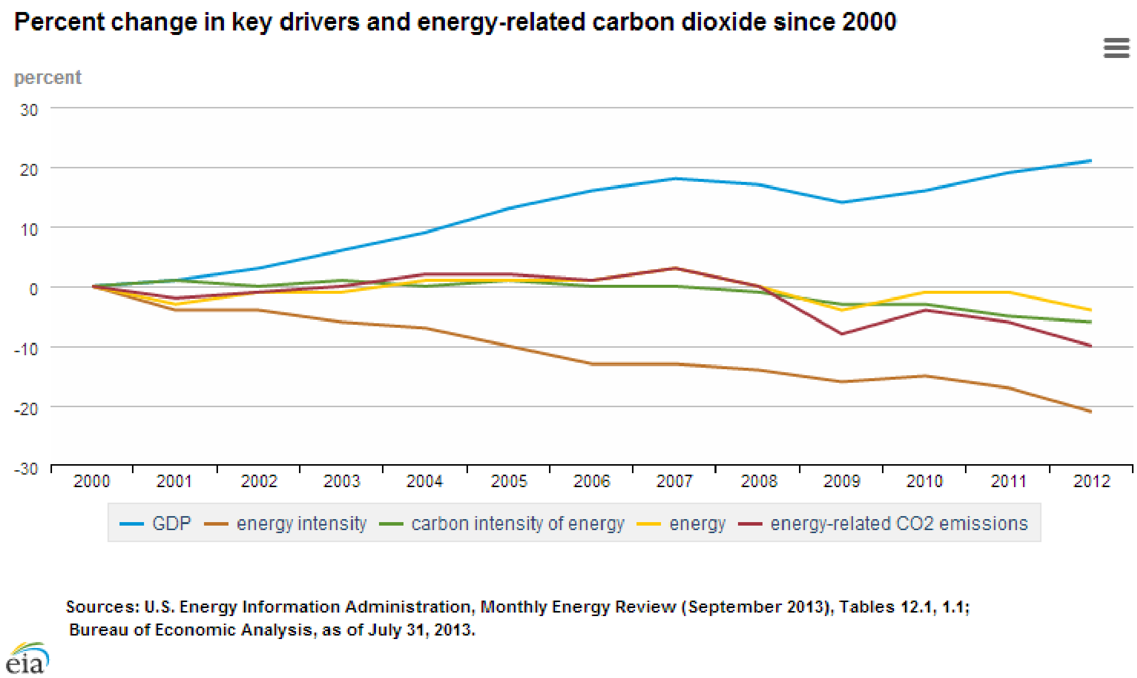
Source: U.S. Energy Information Administration, Monthly Energy Review (September 2013), Table 2.2 to 12.5.

[2]U.S. Environmental Protection Agency, Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2012, http://www.epa.gov/otaq/fetrends.htm

CAUSES FOR THE DROP IN CARBON INTENSITY OF ENERGY SINCE 2007

As indicated below, energy intensity has been consistently decreasing since 2000; however the carbon intensity of the total energy supply was relatively flat between 2000 and 2007, but fell 6 percent from 2007 to 2012.

- The carbon intensity of the electricity produced fell by 13 percent from 2007 to 2012. Emissions would have been about 314 $MMTCO_2$ higher if the carbon intensity of the electricity supply had not declined and this accounts for most of the reduction in the carbon intensity of the total energy supply shown below.
    - o Of this reduction about 198 $MMTCO_2$ is due mainly to the shift from coal to natural gas.
    - o The remainder (116 $MMTCO_2$) is largely the result of a 9-percent increase in non-carbon generation (renewable and nuclear).



IMPLICATIONS OF THE CARBON DIOXIDE EMISSIONS DECREASE IN 2012 FOR FUTURE EMISSIONS

It is difficult to draw conclusions from one year of data. Specific circumstances such as the very warm first quarter of 2012 and the large increase in natural gas-fired generation relative to coal contributed to the significant decline in emissions in 2012. Other factors, such as improvements in vehicle fuel efficiency and increased use of renewable generation, however, could play a continuing role in subsequent years.

For EIA projections on emissions and their key drivers see either the Short-Term Energy Outlook, updated monthly with projections through 2014 (2015 beginning in January of 2014) or the Annual Energy Outlook with annual projections through 2040. EIA's International Energy Outlook contains current projections of international energy consumption and emissions through 2040.

The analysis of energy-related carbon dioxide emissions presented here is based on the data in the Monthly Energy Review (MER). The MER reports monthly U.S. energy-related carbon dioxide emissions in Chapter 12 derived from our monthly energy data. For the full range of EIA's emissions products see the Environment page.

Terms used in this analysis:

British thermal unit (Btu): The quantity of heat required to raise the temperature of 1 pound of liquid water by 1 degree Fahrenheit at the temperature at which water has its greatest density (approximately 39 degrees Fahrenheit).

Carbon intensity (economy): The amount of carbon by weight emitted per unit of economic activity. It is most commonly applied to the economy as a whole, where output is measured as the gross domestic product (GDP). The carbon intensity of the economy is the product of the energy intensity of the economy and the carbon intensity of the energy supply. Note: this value is currently measured in the full weight of the carbon dioxide emitted (CO_2/GDP).

Carbon intensity (energy supply): The amount of carbon by weight emitted per unit of energy consumed. A common measure of carbon intensity is weight of carbon per Btu of energy. When there is only one fossil fuel under consideration, the carbon intensity and the emissions coefficient are identical. When there are several fuels, carbon intensity is based on their combined emissions coefficients weighted by their energy consumption levels. Note: this value is currently measured in the full weight of the carbon dioxide emitted (CO_2/energy or CO_2/Btu).

Cooling degree-days (CDD): A measure of how warm a location is over a period of time relative to a base temperature, most commonly specified as 65 degrees Fahrenheit. The measure is computed for each day by subtracting the base temperature (65 degrees) from the average of the day's high and low temperatures, with negative values set equal to zero. Each day's cooling degree days are summed to create a cooling degree day measure for a specified reference period. Cooling degree days are used in energy analysis as an indicator of air conditioning energy requirements or use.

Energy intensity: A measure relating the output of an activity to the energy input to that activity. It is most commonly applied to the economy as a whole, where output is measured as the gross domestic product (GDP) and energy is measured in Btu that allow for the summing of all energy forms (energy/GDP or Btu/GDP). On an economy-wide level, it is reflective of both energy efficiency as well as the structure of the economy. Economies in the process of industrializing tend to have higher energy intensities than economies that are in their post-industrial phase. The term energy intensity can also be used on a smaller scale to relate, for example, the amount of energy consumed in buildings to the amount of residential or commercial floor space.

Gross domestic product (GDP): The total value of goods and services produced by labor and property located in the United States. As long as the labor and property are located in the United States, the supplier (that is, the workers and, for property, the owners) may be either U.S. residents or residents of foreign countries.

Heating degree-days (HDD): A measure of how cold a location is over a period of time relative to a base temperature, most commonly specified as 65 degrees Fahrenheit. The measure is computed for each day by subtracting the average of the day's high and low temperatures from the base temperature (65 degrees), with negative values set equal to zero. Each day's heating degree days are summed to create a heating degree day measure for a specified reference period. Heating degree days are used in energy analysis as an indicator of space heating energy requirements or use.

Kaya Identity: An equation stating that total energy-related carbon dioxide emissions can be expressed as the product of four inputs: 1) population, 2) GDP (output) per capita, 3) energy use per unit of GDP, and 4) carbon emissions per unit of energy consumed. The change in the four inputs can approximate the change in energy-related carbon dioxide emissions.

Primary energy: Energy in the form that it is first accounted for in a statistical energy balance, before any transformation to secondary or tertiary forms of energy. For example, coal can be converted to synthetic gas, which can be converted to electricity; in this example, coal is primary energy, synthetic gas is secondary energy, and electricity is tertiary energy. In the context of this analysis it would mean energy consumed directly by a home, business or industrial operation as opposed to electricity generated elsewhere and supplied to the end-user.

For other definitions see the EIA glossary.