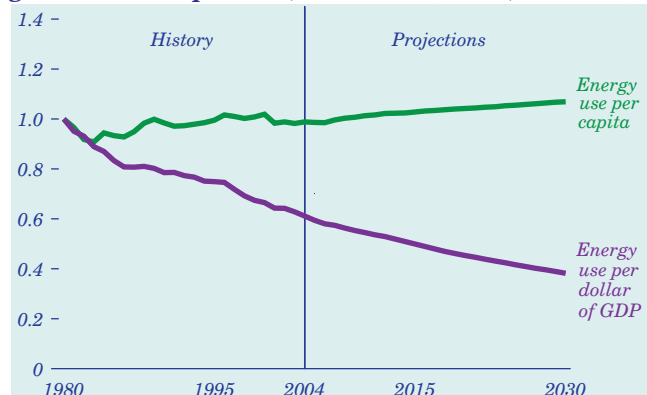


Average Energy Use per Person Increases Through 2030

Figure 31. Energy use per capita and per dollar of gross domestic product, 1980-2030 (index, 1980 = 1)



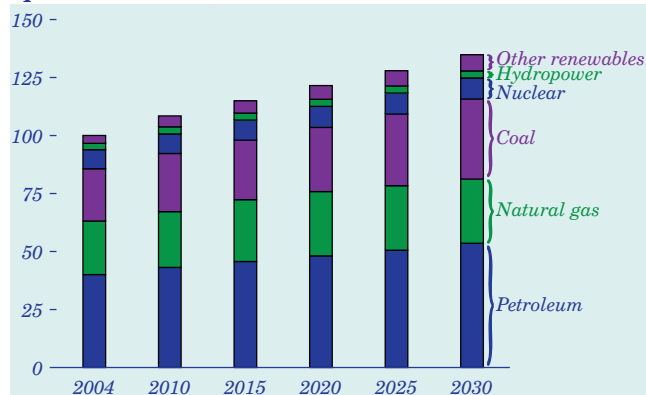
Population growth is a key determinant of total energy consumption, closely linked to rising demand for housing, services, and travel. Energy consumption per capita, controlling for population growth, shows the combined effect of other factors, such as economic growth and technology improvement. In the *AEO-2006* reference case, energy consumption per capita grows faster than it has in recent history (Figure 31), as a result of continued growth in disposable income.

In dollar terms, the economy as a whole is becoming less dependent on energy, the Nation’s growing reliance on imported fuel notwithstanding. Projected energy intensity, as measured by energy use per 2000 dollar of GDP, declines at an average annual rate of 1.8 percent in the reference case. Efficiency gains and faster growth in less energy-intensive industries account for much of the decline, more than offsetting the expected growth in demand for energy services in buildings, transportation, and electricity generation. Energy intensity declines more rapidly in the near term, as consumers and businesses react to high energy prices. As energy prices moderate over the longer term, energy intensity declines at a slower rate. A similar pattern occurred from 1986 to 1992, when energy prices were generally falling.

AEO2006 does not assume policy-induced conservation measures beyond those in existing legislation and regulation, nor does it assume behavioral changes that could result in greater energy conservation, beyond those experienced in the past.

Coal and Petroleum Lead Increases in Primary Energy Use

Figure 32. Primary energy use by fuel, 2004-2030 (quadrillion Btu)



Total primary energy consumption, including energy for electricity generation, grows by 1.1 percent per year from 2004 to 2030 (Figure 32). Fossil fuels account for 88 percent of the growth, with coal use increasing by 53 percent, petroleum by 34 percent, and natural gas by 20 percent over that period. The increase in coal consumption occurs primarily in the electric power sector, with strong growth in electricity demand and favorable economics prompting increases in coal-fired baseload capacity. More than one-half of the increase in coal consumption is expected after 2020, when higher natural gas prices make coal the fuel choice for most new power plants. Growth in natural gas consumption for power generation is restrained by its high price relative to coal. Industry and buildings account for 71 percent of the increase in natural gas consumption from 2004 to 2030.

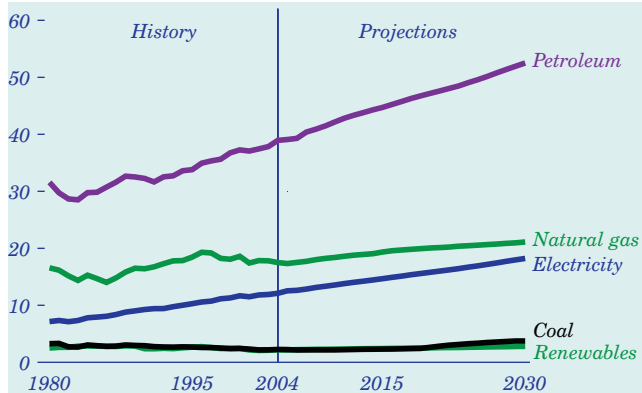
Transportation accounts for 87 percent of the increase in petroleum consumption, dominated by growth in fuel use for light-duty vehicles. Fuel use by freight trucks, second in energy use among travel modes, grows by 1.9 percent per year on average, the fastest annual rate among the major forms of transport. Petroleum use in the buildings sectors, mostly for space heating, declines slightly in the projection.

AEO2006 projects rapid growth in energy production from nonhydroelectric renewable sources, partly as a result of State mandates for renewable electricity generation and renewable energy production tax credits. An increase in power generation from nuclear energy is also projected, as tax credits spur construction of new nuclear plants between 2014 and 2018.

Energy Demand

Petroleum and Electricity Lead Growth in Energy Consumption

Figure 33. Delivered energy use by fuel, 1980-2030 (quadrillion Btu)



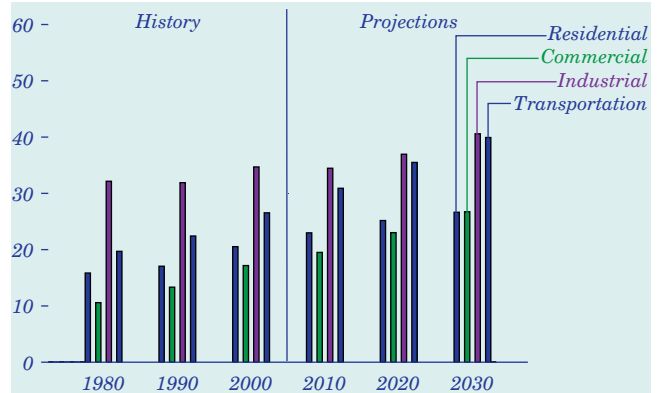
Delivered energy use (excluding losses in electricity generation) grows by 1.1 percent per year on average from 2004 through 2030. Petroleum use, which makes up more than one-half of total delivered energy use, grows at about the same rate (Figure 33). The fastest growth in petroleum use is projected for transportation energy use. Although high fuel prices tend to restrain travel by passenger and commercial vehicles, economic growth and more travel per capita increase demand for gasoline and diesel fuel, assuming no changes in consumer behavior.

Past trends in electricity consumption are expected to continue, with future increases resulting from strong growth in commercial floorspace, continued penetration of electric appliances in the residential sector, and increases in industrial output. Natural gas use grows more slowly than overall delivered energy demand, in contrast to its more rapid growth during the 1990s. As a result, natural gas meets 21 percent of total end-use energy requirements in 2030, compared with 24 percent in 2004.

End-use demand for energy from marketed renewables, such as wood, grows by 1.0 percent per year. Biomass used in the industrial sector, mostly as a byproduct fuel in the pulp and paper industry, is the largest source of renewable fuel for end use. Demand for purchased wood for home heating remains steady in the projections, with potential growth constrained by its limited availability and inconvenience. Energy from nonmarketed renewables, such as solar and geothermal heat pumps, more than doubles over the projection period but is less than 1 percent of delivered residential energy use throughout the period.

U.S. Primary Energy Use Climbs to 134 Quadrillion Btu in 2030

Figure 34. Primary energy consumption by sector, 1980-2030 (quadrillion Btu)



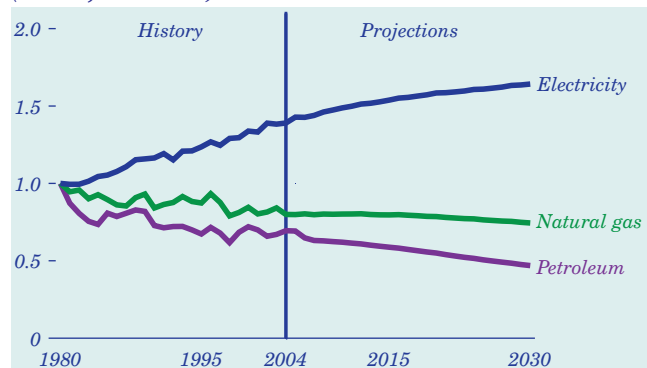
Primary energy use (including electricity generation losses) increases by one-third over the next 26 years (Figure 34). The projected growth rate of energy consumption in the *AEO2006* reference case approximately matches the average from 1981 to 2004. Demand for energy in the early 1980s fell in the face of recession, high energy prices, and changing regulations; but beginning in the mid-1980s, declining real energy prices and economic expansion contributed to a marked increase in energy consumption. The long-term upward trend in energy consumption is projected to continue in the reference case, with growth slowed somewhat by rising energy prices.

The most rapid growth in sectoral energy use is in the commercial sector, where services continue to expand more rapidly than the economy as a whole. The growth rate for residential energy use is about half that for the commercial sector, with demographic trends being a dominant factor. Transportation energy use grows at a slightly slower rate than it has since 1980, despite high fuel prices. Increases in travel by personal and commercial vehicles are only partially offset by vehicle efficiency gains. Primary energy use in the industrial sector grows more slowly than in the other sectors, with efficiency gains, higher real energy prices, and shifts to less energy-intensive industries moderating the expected growth.

Alternative cases have been developed to explore the key uncertainties in the forecast, including two economic growth cases and two world oil price cases. Detailed projections and comparisons with the reference case are provided in Appendixes B, C, and D.

Demographic Shifts Lead to Changes in Residential Energy Use per Capita

Figure 35. Delivered residential energy consumption per capita by fuel, 1980-2030 (index, 1980 = 1)



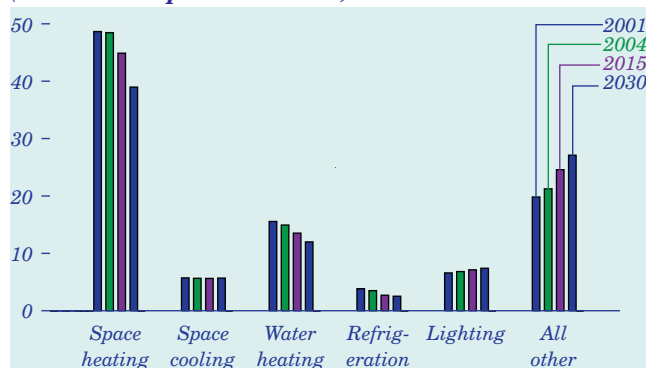
Residential electricity use per person has increased significantly since 1980 (Figure 35). With the U.S. population migrating south and west, electricity use for air conditioning has become more important than natural gas and petroleum for space heating. The South and West Census regions, which accounted for 52 percent of the U.S. population in 1980, increased to 59 percent in 2004 and continue increasing to nearly 65 percent in 2030.

The type and size of houses, household energy uses, and the fuels chosen vary by region. In the Northeast, 37 percent of households (compared with 27 percent nationally) live in multifamily units, which generally are smaller and use less energy per household than other types of housing. Fuel use for space heating is relatively more important in this region than in other regions. The Northeast, which accounted for 21 percent of the U.S. population in 1980, decreased to 19 percent in 2004 and falls to 16 percent in 2030. This is one of the factors that contributes to a decline in heating oil use per capita in the U.S. residential sector.

Natural gas use per capita has remained relatively constant in the residential sector since 1990. In 2004, 56 percent of all households and 63 percent of new single-family households used natural gas for home heating. Natural gas consumption per household declines as a growing share of the population lives in warmer climates; but per capita consumption of natural gas does not change significantly, because the average size of new houses increases.

Energy Use per Household for Space and Water Heating Is Expected To Fall

Figure 36. Delivered residential energy consumption by end use, 2001, 2004, 2015, and 2030 (million Btu per household)



The size, type, and location of housing affect not only the type and amount of energy consumed per household but also which services are used more intensively. Larger houses require more energy to heat, cool, and illuminate, and as housing size continues to grow, energy use per household for these services can be expected to grow, all else being equal. Energy consumption for space heating, water heating, and refrigeration per household decreases over time, while energy use for lighting and all other applications grows, despite continuing increases in their energy efficiency (Figure 36).

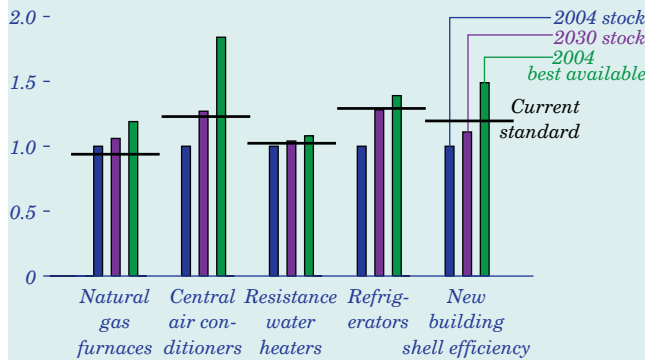
In 2004, houses required 101 million Btu of delivered energy on average to provide all services. Energy use for space heating, the largest single energy-consuming service, declines by about 9 million Btu per household (20 percent) from 2004 to 2030 as a result of increasing energy efficiency and a 5-percent decrease in the average number of heating degree-days per year. Energy use for space cooling per household increases slightly, based on an 8-percent increase in cooling degree-days and the expectation that central air conditioning will be installed in more existing homes over time.

The “all other” category shows the fastest growth on a per household basis, as higher incomes and new uses lead to additional purchases of electronics and other miscellaneous devices. In 2004, 21 percent of the energy used in the average home was for small appliances. Their share of energy use per household grows to 29 percent in 2030, as more large-screen television sets, computers, and related equipment are purchased.

Residential Sector Energy Demand

Increases in Energy Efficiency Are Projected To Continue

Figure 37. Efficiency indicators for selected residential appliances, 2004 and 2030 (index, 2004 stock efficiency = 1)



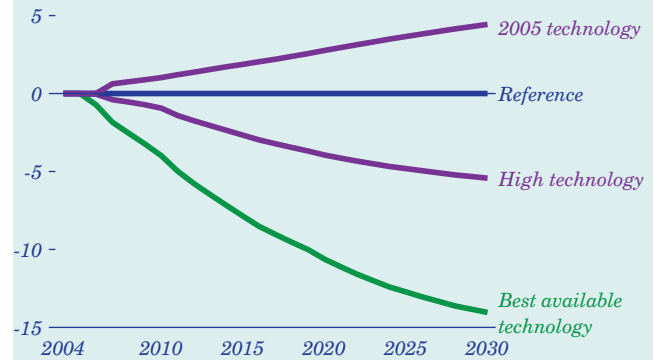
The energy efficiency of new household appliances plays a large role in determining the type and amount of energy used in the residential sector. As a result of stock turnover and purchases of more efficient equipment, the amount of energy used by residential consumers on a per household basis has fallen over time, and many technologies exist today that can further reduce residential energy consumption if they are purchased and used by more consumers (Figure 37).

The most efficient technologies can provide significant long-run savings in energy bills, but their higher purchase costs (and in some cases unsuitability for retrofit applications) may restrict their market penetration. For example, condensing technology for natural gas furnaces, which reclaims heat from exhaust gases, can raise efficiency by more than 20 percent over units that just meet the current standard. In contrast, there is little room for efficiency improvements in electric resistance water heaters, because the technology is approaching its thermal limit.

In 2004, 8 percent of all new single-family homes were certified as ENERGY STAR compliant, implying at least a 30-percent energy savings for heating and cooling relative to comparable homes built to current code. Four States—Texas, California, Arizona, and Nevada—account for two-thirds of all ENERGY STAR home completions, concentrating energy savings in areas with relatively moderate climates. ENERGY STAR completions, as a percent of total completions, are expected to increase over time as builders become more familiar with the required building practices and the cost of the more efficient components used decreases.

Advanced Technologies Could Reduce Residential Energy Use

Figure 38. Variation from reference case delivered residential energy use in three alternative cases, 2004-2030 (million Btu per household)

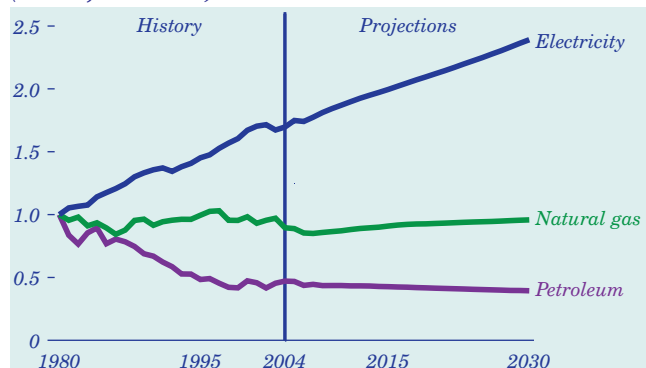


The reference case includes the effects of several policies aimed at increasing residential end-use efficiency, including minimum efficiency standards and voluntary energy savings programs designed to promote energy efficiency through innovations in manufacturing, building, and mortgage financing. In the 2005 technology case, which assumes no increase in the efficiency of equipment or building shells beyond that available in 2005, energy use per household in 2030 would be 5 percent higher than projected in the reference case (Figure 38). In the best available technology case, which assumes that the most energy-efficient technology is always chosen regardless of cost, energy use per household in 2030 would be 15 percent lower than in the reference case and 19 percent lower than in the 2005 technology case. In the high technology case, which assumes earlier availability of the most energy-efficient technologies, with lower costs and higher efficiencies, but does not constrain consumer choices, energy use per household would be 6 percent lower than projected in the reference case but higher than in the best available case.

In the high technology case, the consumer discount rates used to determine the purchased efficiency of all residential appliances do not vary from those used in the reference case; that is, consumers value efficiency equally across the two cases. Energy-efficient equipment, such as central air conditioners with efficiency ratings 50 percent higher than the current standard, can significantly reduce electricity use for space cooling. Likewise, home builders can construct homes that use 50 percent less energy for heating and cooling relative to current code in most regions of the country.

Economic, Population Growth Shape Trends in Commercial Energy Use

Figure 39. Delivered commercial energy consumption per capita by fuel, 1980-2030 (index, 1980 = 1)



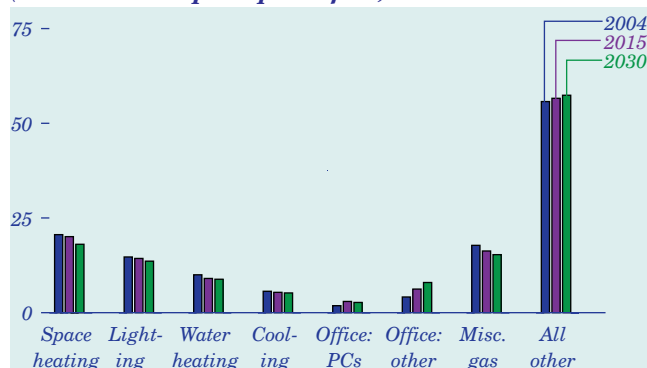
Recent trends in commercial fuel use are expected to continue, with growth in overall consumption similar to its pace in recent history (Figure 39). Commercial delivered energy use (excluding primary energy losses in electricity generation) grows at about the same rate as commercial floorspace, by 1.6 percent per year from 2004 through 2030.

Commercial floorspace growth and, in turn, commercial energy use are driven by trends in economic and population growth. Growth in disposable income leads to increased demand for services ranging from hotels and restaurants to stores, theaters, galleries, and arenas. These establishments continue to grow more electricity-based, as well as depending on electricity-based support services such as electronic processing centers and Internet providers to complete business transactions.

Increases in cooling demand contribute to the growth in commercial electricity use per capita, as the commercial sector expands to serve expected population growth in the South and West. Slower population growth in the Northeast, where heating oil is used more extensively, contributes to a decline in per capita petroleum use. Population effects on projected commercial energy use are not limited to regional trends. The share of the population over age 65 increases from 12 to 20 percent between 2004 and 2030, increasing the need for healthcare and assisted living facilities and for electricity to power medical and monitoring equipment in those facilities.

Efficiency Gains Moderate Increases in Commercial Energy Intensity

Figure 40. Delivered commercial energy intensity by end use, 2004, 2015, and 2030 (thousand Btu per square foot)



The determinants of commercial energy demand include both structural and demographic components. The Nation's continued move to a service economy implies growth in commercial services that use energy intensively, such as health care; however, new construction must meet building codes and efficiency standards, offsetting potential increases in energy intensity (consumption per square foot of commercial floorspace).

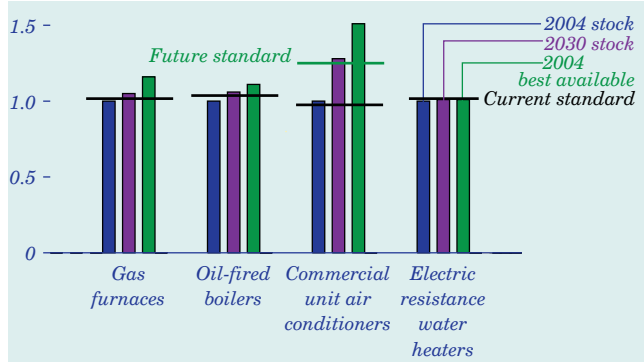
Energy intensity for the major commercial end uses declines as more energy-efficient equipment is adopted (Figure 40). Minimum efficiency standards, including those in EPACT2005, contribute to projected efficiency improvements in commercial space heating, space cooling, water heating, and lighting, moderating the growth in commercial energy demand. An increase in building shell efficiency also contributes to the trend. In addition, the prospect of high fossil fuel prices factors into expected efficiency increases for space and water heating equipment.

Increases in energy intensity are expected only for end uses that have not yet saturated the commercial market, including electricity use for office equipment, as well as new telecommunications technologies and medical imaging equipment in the "all other" end-use category. The "all other" category also includes ventilation, refrigeration, minor fuel consumption, municipal water services, service station equipment, elevators, vending machines, and a myriad of other uses.

Commercial Sector Energy Demand

Current Technologies Provide Potential Energy Savings

Figure 41. Efficiency indicators for selected commercial equipment, 2004 and 2030 (index, 2004 stock efficiency = 1)

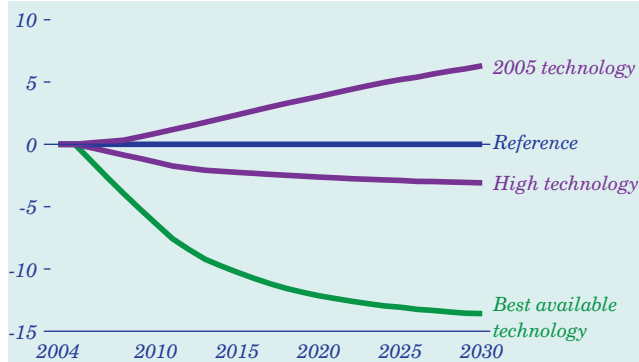


The stock efficiency of energy-using equipment in the commercial sector increases in the *AEO2006* reference case (Figure 41). As equipment is replaced and new buildings are built, technology advances are expected to reduce commercial energy intensity in most end-use services, although the long equipment service lives for many technologies moderate the pace of efficiency improvement in the forecast. For much of the equipment covered by the EPACT1992, the existing Federal efficiency standards are higher than the average efficiency of the 2004 stock, ensuring some increase in the stock average efficiency as new equipment is added. EPACT2005 includes efficiency standards for a variety of commercial technologies, such as air-cooled air conditioners, guaranteeing further increases in stock efficiency. Future updates to the Federal standards could have significant effects on commercial energy consumption, but they are not included in the reference case.

Currently available technologies have the potential to reduce commercial energy consumption significantly. Improved heat exchangers for oil-fired boilers can raise efficiency by 8 percent over the current standard; and the use of multiple compressors and enhanced heat exchanger surfaces can increase the efficiency of unit air conditioners by more than 50 percent over the current standard and more than 20 percent over the new standard. When a business is considering an equipment purchase, however, the additional capital investment required for the most efficient technologies often carries more weight than do future energy savings, limiting the adoption of more efficient technologies.

Advanced Technologies Could Reduce Commercial Energy Use

Figure 42. Variation from reference case delivered commercial energy intensity in three alternative cases, 2004-2030 (thousand Btu per square foot)



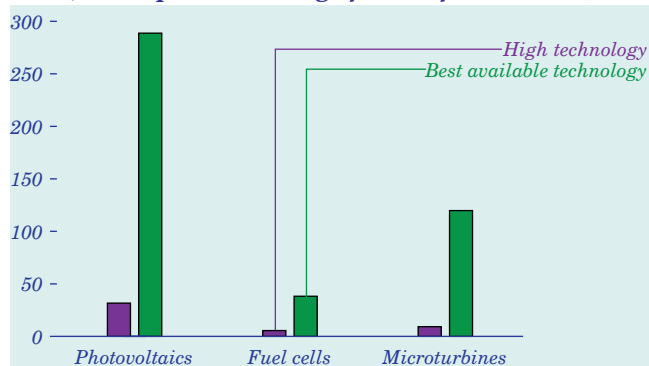
The *AEO2006* reference case incorporates efficiency improvements for commercial equipment and building shells, resulting in little change in projected commercial energy intensity (delivered energy use per square foot of floorspace) over the projection period, despite increased demand for services. The 2005 technology case assumes that future equipment and building shells will be no more efficient than those available in 2005. The high technology case assumes earlier availability, lower costs, and higher efficiencies for more advanced equipment than in the reference case and more rapid improvement in building shells. The best available technology case assumes that only the most efficient technologies will be chosen, regardless of cost, and that building shells will improve at a faster rate than assumed in the high technology case.

In the 2005 technology case, energy use per square foot in 2030 is 6 percent higher than in the reference case (Figure 42), as a result of an 0.3-percent average annual increase in commercial delivered energy intensity. The high technology case projects a 3-percent energy savings per square foot in 2030 relative to the reference case. In the best available technology case, commercial delivered energy intensity in 2030 is 12 percent lower than in the reference case.

More optimistic assumptions result in additional projected energy savings from both renewable and conventional fuel-using technologies. In 2030, commercial solar PV systems generate more than three times as much electricity in the best technology case as in the reference case.

Advanced Technologies Could Slow Electricity Sales Growth for Buildings

Figure 43. Buildings sector electricity generation from advanced technologies in two alternative cases, 2030 (percent change from reference case)

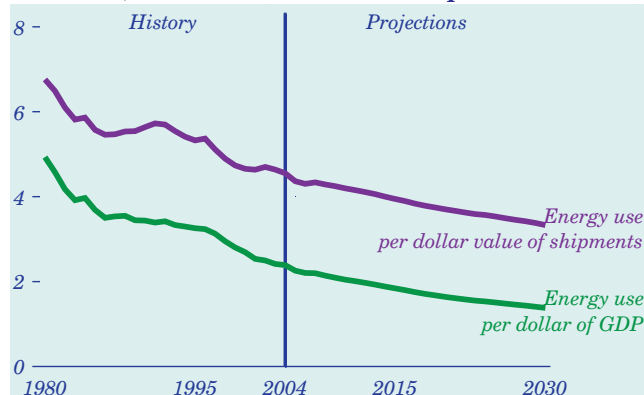


Alternative technology cases for the residential and commercial sectors include varied assumptions for the availability and market penetration of advanced distributed generation technologies (solar PV systems, fuel cells, and microturbines). In the high technology case, buildings generate 1.2 billion kilowatthours (10 percent) more electricity in 2030 than in the reference case (Figure 43), most of which offsets residential and commercial electricity purchases. In the best available technology case, electricity generation in buildings in 2030 is 10.9 billion kilowatthours (90 percent) higher than in the reference case, with solar systems responsible for 96 percent of the increase relative to the reference case. The optimistic assumptions of the best technology case affect solar PV systems more than fuel cells and microturbines, because there are no fuel expenses for solar systems. In the 2005 technology case, assuming no further technological progress or cost reductions after 2005, electricity generation in buildings in 2030 is 2.8 billion kilowatthours (23 percent) lower than in the reference case.

Some of the heat produced by fossil-fuel-fired generating systems may be used to satisfy heating requirements, increasing system efficiency and enhancing the attractiveness of the advanced technologies. On the other hand, the additional natural gas use for fuel cells and microturbines in the high technology and best technology cases offsets some of the reductions in energy costs that result from improvements in building shells and end-use equipment. In addition, the prospect of high natural gas prices may slow or limit their adoption.

Economic Growth, Structural Change Shape Industrial Energy Intensity

Figure 44. Industrial energy intensity by two measures, 1980-2030 (thousand Btu per 2000 dollar)



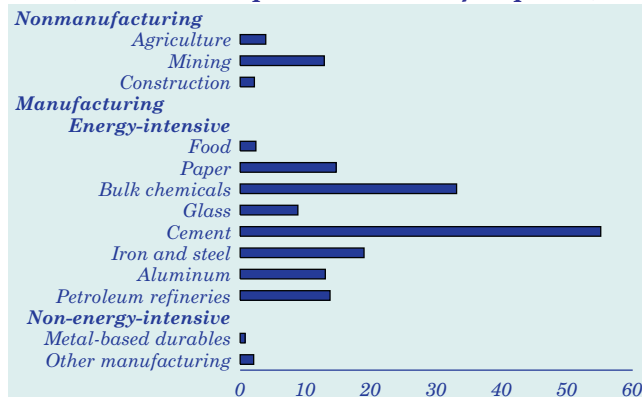
For the U.S. industrial sector, delivered energy consumption in 2004 was approximately the same as in 1980, although GDP more than doubled and the value of shipments in the industrial sector was 50 percent higher. Thus, aggregate industrial energy intensity, measured as industrial delivered energy per dollar of GDP, declined by 3.0 percent per year, and industrial delivered energy per dollar of industrial value of shipments declined by 1.6 percent per year from 1980 to 2004 (Figure 44). Factors contributing to the decline in industrial energy intensity included a greater focus on energy efficiency after the energy price shocks of the 1970s and 1980s and a reduction in the share of manufacturing activity accounted for by the most energy-intensive industries. As the economy evolved, a larger portion of the nation's output was provided by the services sector and a smaller portion by the industrial sector.

In the *AEO2006* reference case, these trends continue at a slower pace through 2030. Industrial energy use per dollar of GDP declines by 2.1 percent per year on average from 2004 through 2030, and energy use per dollar of industrial value of shipments declines by 1.2 percent per year. The rates of decline in industrial energy intensity are less rapid than those from 1980 to 2004, in part because the nonmanufacturing portion of industrial value of shipments (agriculture, mining, and construction) grows more slowly than the manufacturing portion, which includes the more energy-intensive manufacturing sectors.

Industrial Sector Energy Demand

Most Energy-Intensive Industries Are in the Manufacturing Sector

Figure 45. Energy intensity in the industrial sector, 2004 (thousand Btu per 2000 dollar of shipment)

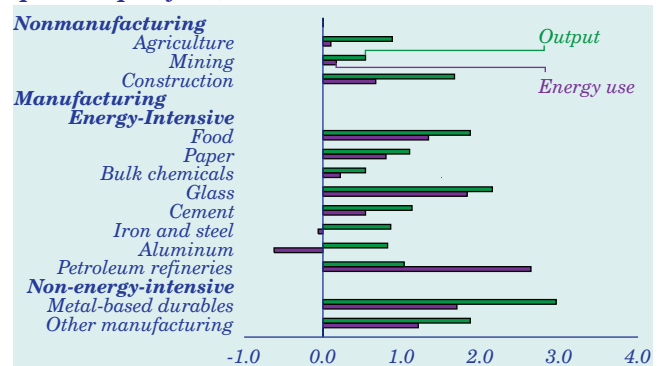


In the industrial sector, the manufacturing subsector is more energy-intensive than the nonmanufacturing subsector (Figure 45), using about 50 percent more energy per dollar of output in 2004 [85]. From 1985 to 2004, energy intensity declined more rapidly for nonmanufacturing industries than for manufacturing, primarily because most of the historical reduction in energy intensity for the manufacturing subsector had already occurred by 1985 in response to the high energy prices of the late 1970s and early 1980s. In the nonmanufacturing subsector, much of the decline in energy intensity from 1985 to 2004 resulted from a compositional shift: the relatively low-intensity construction industry grew more rapidly, particularly in the late 1990s and early 2000s, than the relatively high-intensity mining sector.

From 2004 levels, energy intensity in the manufacturing subsector, based on value of shipments, declines in the reference case at an average annual rate of 1.2 percent through 2030, compared with an average decline of 1.0 percent per year in the nonmanufacturing subsector. The improvement in aggregate energy intensity for the manufacturing subsector is accelerated by a compositional shift. In 2004, the energy-intensive group of manufacturing industries accounted for 21 percent of industrial value of shipments and the non-energy-intensive group 54 percent. With more rapid output growth in the non-energy-intensive group from 2004 to 2030, the 2030 shares are 17 percent and 61 percent, respectively.

Energy-Intensive Industries Grow Less Rapidly Than Industrial Average

Figure 46. Average growth in industrial output and delivered energy consumption by sector, 2004-2030 (percent per year)



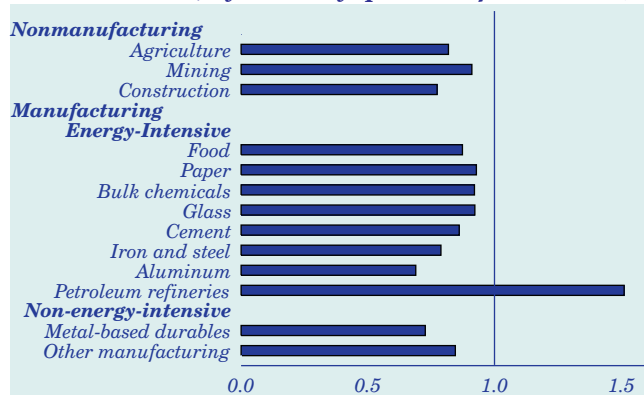
The shift in value of shipments from the industrial sector to the service sectors seen in recent decades continues in the *AEO2006* reference case. Total industrial sector value of shipments grows by 2.1 percent per year on average from 2004 through 2030, while GDP grows by 3.0 percent per year. Among the industrial subsectors, average annual growth rates range from 3.0 percent for metal-based durables to 0.5 percent for bulk chemicals (Figure 46).

The energy-intensive manufacturing subsector accounted for nearly two-thirds of industrial delivered energy consumption in 2004. From 2004 through 2030, the value of shipments for the energy-intensive subsector grows by an average of 1.3 percent per year, while the non-energy-intensive subsector grows at about twice that rate. The energy-intensive industries maintain their 2004 share of industrial energy consumption in 2030. With the growth of coal-to-liquids production in the refining sector, the bulk chemicals industry accounts for a smaller share of total industrial energy use in 2030 than it did in 2004; however, it remains the largest industrial energy consumer, accounting for nearly 25 percent of total industrial energy consumption in 2030. Together, the paper, bulk chemicals, and petroleum refining subsectors account for more than 50 percent of all the energy consumed in the industrial sector.

Nonfuel use of energy in the industrial sector is concentrated in the bulk chemicals and construction industries. More than 60 percent of the energy consumed in the bulk chemicals industry is in the form of feedstock, and asphalt accounts for more than 50 percent of the energy consumed in construction.

Energy Intensity Declines in Most Industrial Subsectors

Figure 47. Projected energy intensity in 2030 relative to 2004, by industry (percent of 2004 value)

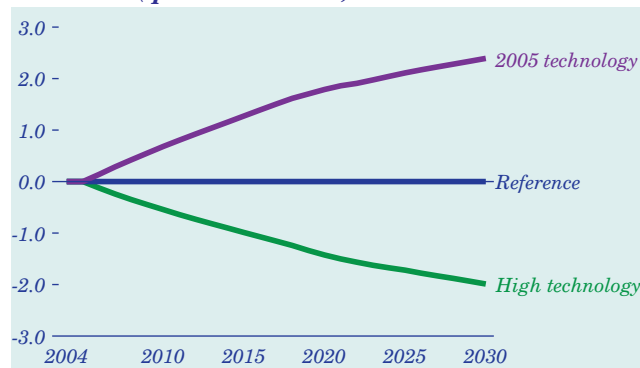


Within the industrial sector, the energy intensity of different industries (Figure 47) can change for a variety of reasons. For example, there may be a change in the types of activities or the methods used in a given subsector, or more energy-efficient new capacity may be installed to accommodate growth or replace worn-out machinery.

For each industry with a relatively rapid projected change in energy intensity from 2004 to 2030, there is a unique explanation. In the steel industry, most new capacity is expected to use electric arc furnace technology, which has a lower energy intensity than the older blast furnace/basic oxygen furnace technology. Thus, the average energy intensity for the iron and steel industry declines by 21 percent overall from 2004 to 2030. In the U.S. aluminum industry, no new primary smelting capacity is expected to be constructed, and secondary smelting, a less energy-intensive process of melting scrap, is expected to become the dominant technology. As a result, the energy intensity of the aluminum industry in 2030 is nearly one-third less than in 2004. In the metal-based durables industry, a robust growth projection, with output 114 percent greater in 2030 than in 2004, requires substantial amounts of new, more energy-efficient capital stock to meet demand for the industry's output. In the petroleum refining industry, coal consumption increases by 1.6 quadrillion Btu from 2004 to 2030, as CTL production grows. Consequently, its energy intensity increases over time.

Alternative Technology Cases Show Range of Industrial Efficiency Gains

Figure 48. Variation from reference case delivered industrial energy use in two alternative cases, 2004-2030 (quadrillion Btu)



The technology cases for the industrial sector represent alternative views of the evolution and adoption of energy-reducing technologies. In some sectors, energy-reducing technologies make significant contributions to lower energy intensity. For example, energy intensity in mining would increase if there were more widespread adoption of technologies to produce fuels from oil shale. In other subsectors, such as glass, technologies or techniques that tend to improve output quality have the ancillary effect of reducing energy consumption. Generally, the manufacturing sector has more potential than the nonmanufacturing sector for the adoption of energy-reducing technologies.

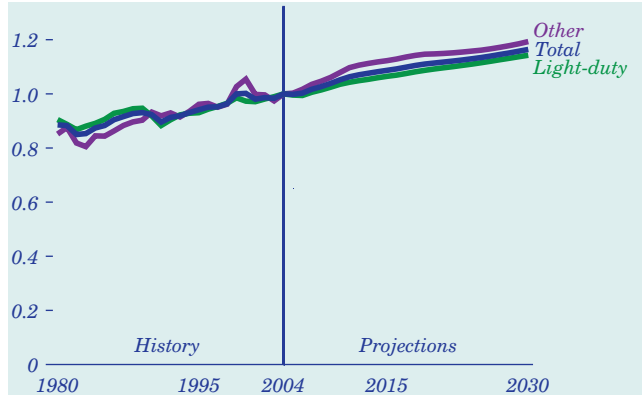
In the high technology case, increased biomass recovery and additions of CHP capacity offset process-related reductions in on-site energy consumption. Industrial cogeneration capacity increases more rapidly in the high technology case (3.4 percent per year) than in the reference case (3.1 percent per year) [86]. Still, total industrial delivered energy consumption in 2030 is 2 quadrillion Btu less than in the reference case for the same level of output, and industrial energy intensity improves by 1.4 percent per year on average, compared with 1.2 percent in the reference case (Figure 48).

In the 2005 technology case, industrial delivered energy use in 2030 is 2.4 quadrillion Btu higher than in the reference case. Although the energy efficiency of new equipment remains at its 2005 level in this case, average efficiency improves as old equipment is retired, and aggregate industrial energy intensity improves by 0.9 percent per year.

Transportation Sector Energy Demand

Transportation Energy Use Per Capita in 2030 Is 15 Percent Over 2004 Level

Figure 49. Transportation energy use per capita, 1980-2030 (index, 2004 = 1)



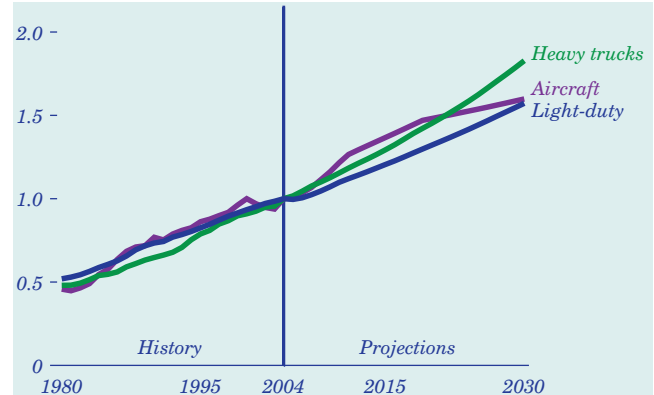
Total delivered energy consumption for transportation in the *AEO2006* reference case grows from 27.8 quadrillion Btu in 2004 to 39.7 quadrillion Btu in 2030, an increase of 43 percent. On a per-capita basis, however, the corresponding increase is only 15 percent (Figure 49). By mode, the most rapid increases are in demand for freight movement and air travel. Energy use for freight trucks increases by 61 percent from 2004 to 2030, followed by increases of 47 percent for aircraft and 42 percent for light-duty vehicles.

The increase in diesel fuel consumption by heavy freight trucks averages 1.9 percent annually from 2004 through 2030, primarily as a result of growth in industrial output that averages 2.1 percent per year. Economic growth is the primary reason for the increase in demand for air travel, which results in a 1.5-percent average annual increase in jet fuel use.

Demand for light-duty vehicle fuels increases from 16.2 quadrillion Btu in 2004 to 23.0 quadrillion Btu in 2030. Although the vast majority of light-duty fuel use continues to be gasoline, diesel fuel consumption grows from 1.6 percent of total light-duty vehicle fuel consumption in 2004 to 5.2 percent in 2030. Transportation demand for alternative fuels, mostly ethanol used in gasoline blending and liquefied petroleum gas (LPG), increases from 1.9 percent of total transportation energy use in 2004 to 5.9 percent in 2030.

Travel Demand Is Projected To Grow for All Modes of Transportation

Figure 50. Transportation travel demand by mode, 1980-2030 (index, 2004 = 1)



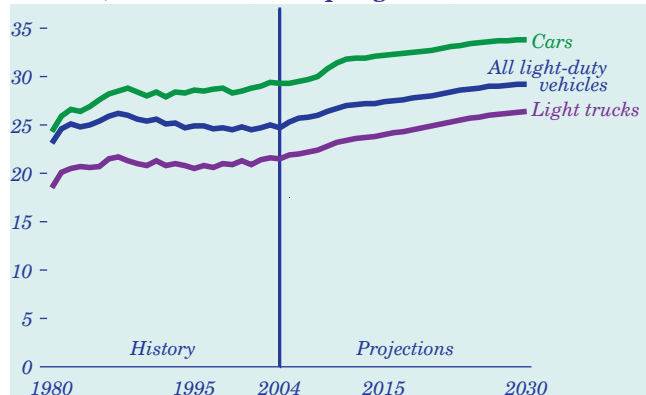
From 2004 to 2030, demand for transportation services increases for all modes of travel (Figure 50). Light-duty vehicle travel grows by 1.8 percent annually through 2030, significantly slower than the average of 2.9 percent per year over the past 3 decades. Approximately 50 percent of the growth in light-duty vehicle travel can be attributed to growth in the driving age population, which increases by 0.9 percent annually. Higher fuel prices through 2008 slow the growth in demand for light-duty vehicle travel, but as fuel prices stabilize and per capita disposable income rises, there is a more rapid increase in travel demand.

Historically, freight truck travel has grown by 3.0 percent annually. In the reference case, its growth averages 2.3 percent per year from 2004 through 2030. Although output grows in many manufacturing sectors, most of the future increase in demand for freight movement is tied to increased output from the electronics, food, plastics, furniture, and miscellaneous sectors.

Demand for air travel increases by 1.8 percent annually from 2004 through 2030, down from its historical annual growth rate of 3.3 percent. The airline industry is expected to recover from current financial conditions and experience a strong recovery period through 2011, when growth slows as congested conditions begin to affect the market. By 2019, severe constraints associated with available infrastructure make airport capacity expansion a requirement for increasing air travel.

New Technologies Promise Improved Fuel Economy for Light-Duty Vehicles

Figure 51. Average fuel economy of new light-duty vehicles, 1980-2030 (miles per gallon)

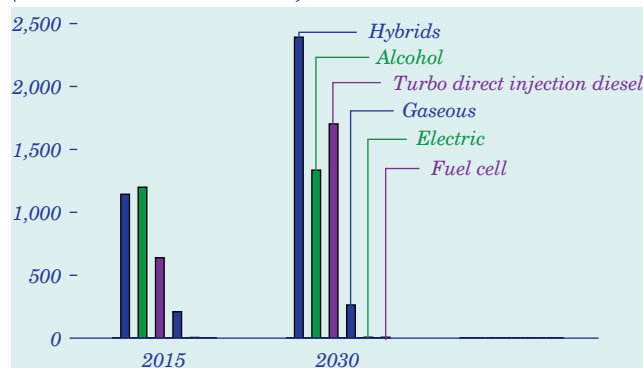


The average fuel economy of new light-duty vehicles, which peaked at 26.2 miles per gallon in 1987, declined to 24.9 miles per gallon in 2004 (Figure 51). The downward trend in light-duty vehicle fuel economy resulted from a rapid increase in sales of light trucks (sport utility vehicles, minivans, and pickups), which were required to meet a CAFE standard of 20.7 miles per gallon, compared with 27.5 miles per gallon for cars. In April 2003, NHTSA increased the CAFE standards for light trucks to 21 miles per gallon for model year 2005, 21.6 miles per gallon for model year 2006, and 22.2 miles per gallon for 2007, and more recently the agency has proposed a restructuring of light truck standards, with additional increases in fuel efficiency standards for model years 2008 through 2011. *AEO2006* assumes no changes in currently promulgated fuel efficiency standards for cars and light trucks.

Reversing the historic trend, the average fuel economy of new light-duty vehicles increases in the reference case as a result of advances in fuel-saving technologies. Fuel economy for new light-duty vehicles is 29.2 miles per gallon in 2030. Although higher personal incomes are expected to increase demand for larger, more powerful vehicles, and the average horsepower for new cars is 27 percent above the 2004 average in 2030, advanced technologies and materials permit increases in performance and size of new vehicles without sacrificing improvements in fuel economy.

Advanced Technologies Are Projected To Exceed 25 Percent of Sales by 2030

Figure 52. Sales of advanced technology light-duty vehicles by fuel type, 2015 and 2030 (thousand vehicles sold)



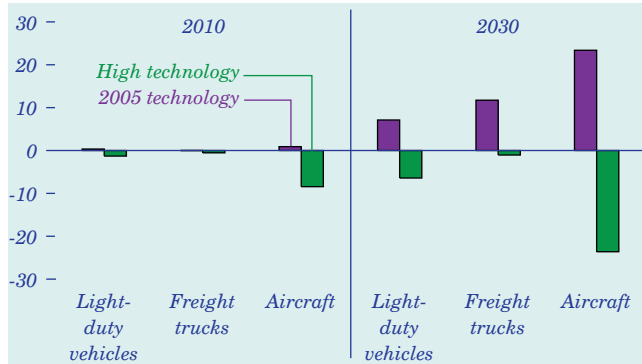
Sales of advanced technology vehicles, representing automotive technologies that use alternative fuels or require advanced engine technology, reach 5.7 million per year (Figure 52) and make up more than 25 percent of total light-duty vehicle sales in 2030. Hybrid electric vehicles (including those specifically designed to use electric motors and batteries in combination with a combustion engine to drive the vehicle and those incorporating only an integrated starter generator for fuel economy) are anticipated to sell well, with 1.1 million units sold in 2015, increasing to 2.4 million units in 2030. Sales of turbo direct injection diesel vehicles increase to 638,500 units in 2015 and 1.7 million units in 2030. Sales of alcohol flexible-fueled vehicles continue to increase, with 1.3 million sold in 2030.

About 40 percent of advanced technology sales are as a result of Federal and State mandates for fuel economy standards, emissions programs, or other energy regulations. Currently, manufacturers selling alcohol flexible-fueled vehicles receive fuel economy credits that count toward compliance with CAFE regulations. In the *AEO2006* reference case, the majority of gasoline hybrid, electric, and fuel cell vehicle sales result from compliance with low-emission vehicle programs in California, Connecticut, Maine, Massachusetts, New Jersey, New York, Rhode Island, Washington, and Vermont. *AEO2006* does not include the impacts of California Assembly Bill 1493, which effectively sets carbon emission standards for light-duty vehicles, because of uncertainty about the State's ability to enforce the standards.

Transportation Sector Energy Demand

Vehicle Technology Advances Reduce Transportation Energy Demand

Figure 53. Changes in projected transportation fuel use in two alternative cases, 2010 and 2030 (percent change from reference case)

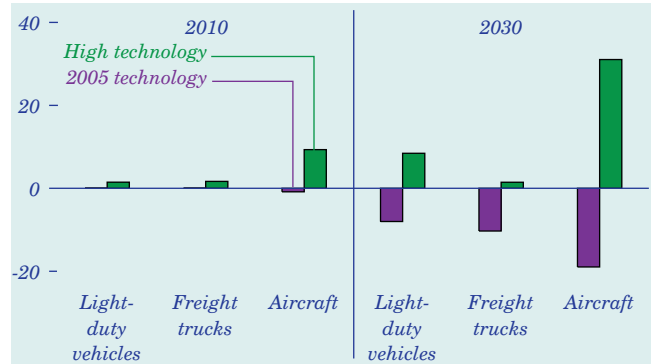


In the *AEO2006* reference case, delivered energy use in the transportation sector increases from 27.8 quadrillion Btu in 2004 to 39.7 quadrillion Btu in 2030. In the high technology case, the projection for 2030 is 2.8 quadrillion Btu (7.1 percent) lower, with about 54 percent (1.5 quadrillion Btu) of the difference attributed to efficiency improvements in light-duty vehicles (Figure 53) as a result of increased penetration of advanced technologies, including variable valve lift, electrically driven power steering pumps, and advanced electronic transmission controls. Similarly, projected fuel use by heavy freight trucks in 2030 is 0.1 quadrillion Btu (0.9 percent) lower in the high technology case than in the reference case, and advanced aircraft technologies reduce fuel use for air travel by 1.0 quadrillion Btu (23.7 percent) in 2030.

In the 2005 technology case, with new technology efficiencies fixed at 2005 levels, efficiency improvements can result only from stock turnover. As a result, total delivered energy demand for transportation in 2030 is 3.7 quadrillion Btu (9.2 percent) higher in 2030 in the 2005 technology case than in the reference case. Fuel use for air travel in 2030 is 1.0 quadrillion Btu (23.4 percent) higher in the 2005 technology case than in the reference case, and freight trucks use 0.9 quadrillion Btu (11.9 percent) more fuel in 2030 [87].

Technology Assumptions Include Improvements in Vehicle Efficiency

Figure 54. Changes in projected transportation fuel efficiency in two alternative cases, 2010 and 2030 (percent change from reference case)



The high technology case assumes lower costs and higher efficiencies for new transportation technologies. Advances in conventional technologies increase the average fuel economy of new light-duty vehicles in 2030 from 29.2 miles per gallon in the reference case to 32.1 miles per gallon in the high technology case. The average efficiency of the light-duty vehicle stock is 20.6 miles per gallon in 2010 and 24.4 miles per gallon in 2030 in the high technology case, compared with 20.4 miles per gallon in 2010 and 22.5 miles per gallon in 2030 in the reference case (Figure 54).

For freight trucks, average stock efficiency in the high technology case is 0.6 percent higher in 2010 and 1.1 percent higher in 2030 than the reference case projection of 6.8 miles per gallon. Advanced aircraft technologies increase aircraft efficiency by 9.3 percent in 2010 and 31.0 percent in 2030 relative to the reference case projections.

In the 2005 technology case, the average fuel economy of new light-duty vehicles is 26.2 miles per gallon in 2030, and the average for the entire light-duty vehicle stock is 20.7 miles per gallon in 2030. For freight trucks, the average stock efficiency in 2030 is 6.1 miles per gallon. Aircraft efficiency in 2030 averages 61.6 seat-miles per gallon in the 2005 technology case, compared with 76.0 seat-miles per gallon in the reference case.