INDEX OF U.S. ENERGY SECURITY RISK®

ASSESSING AMERICA'S VULNERABILITIES IN A GLOBAL ENERGY MARKET

2012 Edition




Institute for 21st Century Energy • U.S. Chamber of Commerce

www.energyxxi.org

The mission of the U.S. Chamber of Commerce's Institute for 21st Century Energy is to unify policymakers, regulators, business leaders, and the American public behind a common sense energy strategy to help keep America secure, prosperous, and clean. Through policy development, education, and advocacy, the Institute is building support for meaningful action at the local, state, national, and international levels.

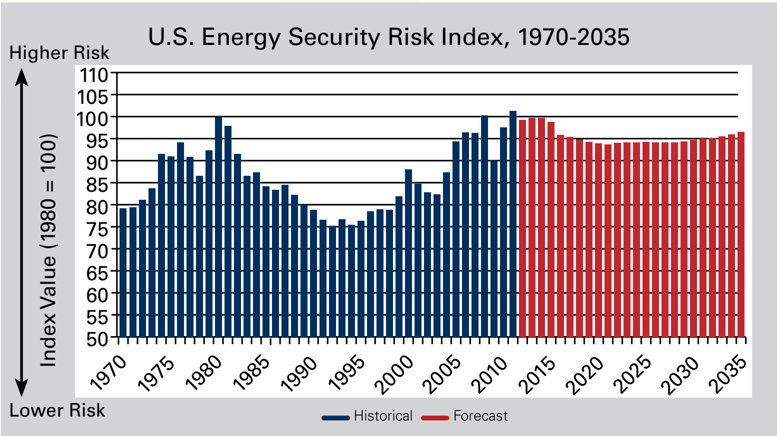
The U.S. Chamber of Commerce is the world's largest business federation representing the interests of more than 3 million businesses of all sizes, sectors, and regions, as well as state and local chambers and industry associations.

100 Years Standing Up for American Enterprise
U.S. CHAMBER OF COMMERCE

INDEX OF U.S. ENERGY SECURITY RISK®

ASSESSING AMERICA'S VULNERABILITIES IN A GLOBAL ENERGY MARKET

2012 Edition



Contents

Foreword

Since the second edition of the annual Index of U.S. Energy Security Risk was released last spring, pundits have rediscovered what we at the Energy Institute already knew: the United States has the potential to be an energy superpower. So swift have been the changes in the U.S. energy outlook that some are beginning to entertain seriously the previously unimaginable idea that U.S. energy independence actually may be within reach.

Despite that optimism, however, this year's Index shows stubbornly high risks for 2012 and into the future. A closer look at some of the individual metrics—such as those related to natural gas—is encouraging, but it is clear we must do better to achieve such a lofty goal.

While some aspects of the energy landscape look very promising, the current energy policy landscape is as inhospitable as it has been in a long time. It does not have to be this way. The U.S. is on the cusp of a domestic energy renaissance, but policy and regulatory uncertainty threatens to hold back U.S. energy exploration jeopardizing the investment and jobs that go with it. Consider the following:

Horizontal drilling and hydraulic fracturing in shale formations have combined to open up vast new areas to natural gas, gas liquids, and crude oil production. The "shale gale" in natural gas has already had a big and beneficial impact on our energy security and economy. The application of hydraulic fracturing to shale gas formations has created a glut of natural gas, changed the energy landscape and brought new jobs in formerly depressed areas of Pennsylvania, Ohio, and West Virginia—even New York has benefited with spillover jobs. These benefits can and should increase, but only if governments at every level act sensibly.

Similarly, new exploration, drilling, and production technologies will be critically important in finding and developing the large amounts of domestic crude oil located in unconventional oil sands and shales and in deep water on the Outer Continental Shelf. Rapidly increasing oil production in North Dakota's Bakkan Formation is largely responsible for reversing the Nation's decades-long decline in domestic oil production and has contributed to North Dakota having the lowest unemployment rate of any state in the country. This mini oil boom, however, is occurring almost exclusively on private and state lands. If we want to sustain the growth in domestic production, it will be necessary for the government to allow access to our vast resources on federal lands, offshore and onshore, including the Gulf of Mexico, Alaska, and the Outer Continental Shelf. And there is no excuse for the continued delay of a permit for the Keystone XL pipeline, which would bring to America about 700,000 barrels each day of secure oil from our most reliable and stable trading partner, Canada.

Coal remains another secure source of energy, and the United States has about a 250 year supply, but it is under almost constant attack. An unprecedented "avalanche" of regulations coming out of the Environmental Protection Agency will shutter a growing number of base-load coal plants across the country. Greenhouse gas regulations recently proposed by the Environmental Protection Agency also make it virtually impossible to construct efficient, new coal-fired power plants. Rapid coal plant closures threaten to raise electricity prices and jeopardize the reliability of the electric grid.

The slow pace of growth for nuclear power is due to a number of factors. A major source of uncertainty facing this integral and reliable source of energy remains the permanent storage of spent nuclear fuel. Unfortunately, a sensible policy to manage the country's waste safely and efficiently continues to elude policymakers, creating doubts about the long-term viability of this important and emissions-free resource. The permitting process remains lengthy and costly, and the increased costs of new plants poses a huge challenge for developers and utilities.

Moreover, the nation's aging energy infrastructure is increasingly inadequate to meet growing energy demand. Blackouts, brownouts, service interruptions, and rationing could become commonplace without new and upgraded capacity. An increasingly archaic and byzantine system of approving energy projects, however, makes it extremely difficult to build energy infrastructure in the United States anymore.

Renewable power continues to grow, but it still accounts for a small portion of total electricity generation, and renewable projects are subject to the same siting and permitting delays other projects face. Federal lands are home to large renewable resources, and the government also must do all it can to make these available in a timely and predictable manner.

In addition to promoting greater domestic supply, greater use of the energy that is wasted every day is one of the best sources of "new" energy. Over the years, improvements in energy efficiency have had a large and beneficial impact on U.S. energy security. Policymakers should promote greater energy efficiency to keep this momentum going to lower future risks.

How U.S. energy security looks in the years ahead will depend in great measure on how these issues are decided in the next few years. This Index shows where we must improve and what will and will not move the needle. Policymakers and regulators should take heed, as the numbers tell the story plainly and objectively.

Karen A. Harbert
President and CEO
Institute for 21st Century Energy
U.S. Chamber of Commerce

Highlights

The total U.S. energy security risk rose to a record high in 2011, and the trend for future risk looks worse than projected last year. Following the drop in risks measured in 2009 propelled in large part by the economic recession, 2011 marks the second year in a row of rising risk. The total risk score would have been higher still were it not for favorable trends in a few individual metrics, particularly those related to natural gas.

This 2012 edition of the Index incorporates the most current energy data, including the Energy Information Administration's (EIA) *Annual Energy Outlook* 2012 (*AEO 2012*), to provide an up-to-date assessment of the trends having the greatest impact on energy security over the past year. The Index is based on a combination of 37 different energy security metrics covering the years 1970 to 2035. Highlights include the following:

Total energy security risk reached a record high in 2011. The U.S. energy security risk score jumped 3.8 points (3.9%) in 2011 to a record high 101.3 points. This is 17.1 points above the 30-year average. Based on last year's forecast data, the total risk score in 2011 had been expected to dip slightly instead of rise. Higher than expected energy prices driven by a large price spike in crude oil prices and import expenditures and persistently high year-to-year price volatility were largely to blame. This is only the third year on record with a risk score of 100 or above (1980 and 2008 being the other two years).

As in 2010, increasing risks primarily were seen in measures related to higher energy prices, expenditures, and high volatility driven by sharply rising crude oil prices. Of the 37 Index metrics, 13 showed an increase in risk, 21 showed a decrease in risk, and three showed essentially no change in risk in 2011. While the number of metrics displaying rising

The Index of U.S. Energy Security Risk for the year 2011 is:

101.3

This is the highest score since 1970.

risk scores was comparatively small, they generally had the largest numerical change in risk scores. The change in metrics with declining risk scores tended to be more moderate with the exception of natural gas imports.

Shale gas continues to improve the energy security picture of the country by increasing the security of natural gas supplies and putting downward pressure on energy costs and expenditures. The continued increase in natural gas production from shale caused the score for natural gas imports to plunge 31.3 points (24.6%) in 2011. Although the overall U.S. risk rose in 2011, the improvement in this metric alone shaved 0.4 points off of the increase. Moreover, cheap natural gas, along with continued use of coal, helped keep the lid on retail electricity prices. Increasing shale gas supplies resulting from improvements in natural gas extraction technologies have essentially uncoupled the prices of crude oil and natural gas in the United States. Continued growth in shale gas production can give the United States a tremendous competitive advantage for years to come.

The rise in overall risk was moderated by reduced natural gas imports, improvements in carbon dioxide emissions and the power sector, and steady, if modest, improvements in most energy efficiency measures. Mild weather and fuel switching from coal to natural gas in the power sector were largely responsible for a decline in risks related to carbon dioxide emissions. The trend toward increased capacity diversity and margins in the power sector noted last year continued into 2011. Productivity per mile traveled in the transportation sector improved in 2011, as did industrial energy efficiency. Both reflect continuation of longer-term trends.

EIA forecasts suggest the Index will remain quite high for many years. Based on EIA's latest *AEO 2012* reference case projection, the Index is projected to average 95.5 points over the entire forecast period from 2012 to 2035, never dropping below 93.7. This average score is 1.8 points higher than the average projected score from last year based on the *AEO 2011*. The increased risk level is being driven primarily by projections of increasing crude oil prices and stubbornly high crude oil price volatility that in turn lead to higher energy prices and expenditures.

The forecasted U.S. energy security risk scores out to 2035 would be higher still but for greater shale oil and natural gas production and slower growth in carbon dioxide emissions. The *AEO 2012* increased the outlook for shale gas over the *AEO 2011* forecast, and this change alone trimmed more than half a point from the average risk score out to 2035. Lower projected growth of carbon dioxide emissions and slight improvements in the energy use across all sectors also helped to moderate the impacts of higher crude oil prices and volatility.

EIA projects that even as natural gas makes inroads into electricity markets, coal will remain a mainstay of the U.S. energy mix, accounting for approximately 40% or more of electricity generation. Regulatory pressure and price competition from natural gas will lift exports of coal, which are expected to increase even more than the amount anticipated just last year.

Geopolitical energy security risks rose by 5.3 points in 2011, breaching 100 for only the second time since 1980. Its score of 101.6 is 18.4 points above the above the 1970-1999 average of 83.2. Most of the increase in risks seen in the Geopolitical Sub-Index over the past decade or more is due to higher crude oil prices and price volatility and greater import expenditures. However, lower crude oil and natural gas import risks stemming from growing oil output from the Bakken shale formation in North Dakota and natural gas from the Barnett and Marcellus shale formations in Texas and Pennsylvania helped offset some of the rising risks from volatility in world oil markets. Metrics measuring security of global fossil fuel reserves and production were essentially unchanged from 2009.

Economic energy security risks rose by 8.6 points in 2011 to 102.1, a record high for this measure. The Economic Sub-Index risk score for 2011 is 28.3 points higher than the 30-year average of 73.8. It is only the third time since 1970 that this sub-index has gone to or above 100. Higher crude oil prices and volatility, greater import expenditures, and increasing household energy expenditures were the primary causes, and these factors are expected to help maintain an economic risk score greater than 96 through 2035.

Reliability energy security risks worsened for the third year running, climbing 1.1 points in 2011 to 112.7. This, too, is a record score, and since 2005, only one year—2008—had a Reliability Sub-Index score below 100. Very high crude oil price volatility is responsible for much of the increase. Reliability risks related to oil and natural gas imports and the power sector, however, continue to show some improvement. Even after assuming that crude oil energy price volatility will return to historical averages, forecast scores based on the *AEO 2012* suggests risk level above 98 will be the norm for this sub-index through 2026, and over 100 after that.

Environmental energy security risks in 2011 fell to 88.3, 2.9 points lower than the year before and 11.1 points below the historical (1970-1999) average. This is the second lowest score in the sub-index record. Most of the improvement was from a drop in carbon dioxide emissions linked to relatively slow economic growth, mild winter weather, gains in efficiency and fuel economy, and some fuel switching in the power sector. Estimated future risks based on EIA's *AEO 2012* indicate steady improvement, driven largely by gains in energy intensity, better vehicle fuel economy, and greater use of natural gas and renewables in electricity generation. U.S. carbon dioxide emissions from energy are still projected to rise, but only modestly. Projections suggest that by 2027 this Sub-Index could fall below 80 for the first time.

Index of U.S. Energy Security Risk®

2012 Edition

This 2012 edition of the Institute for 21st Century Energy's (Energy Institute) Index of U.S. Energy Security Risk (Index), the third in the series, provides an updated look at U.S. energy security since the 2011 edition was issued in August 2011. The Index incorporates 37 different measures of energy security risk that include: global fuels; fuel imports; energy expenditures; price and market volatility; energy use intensity; electric power sector; transportation sector; environmental; and basic science and energy research & development.[1] The Index looks back in time to 1970 and forward in time to 2035.

The Energy Institute's Index combines 37 metrics to create four Sub-Indexes that identify the major areas of risk to U.S. energy security: geopolitical, economic, reliability, and environmental. These four Sub-Indexes were then merged into an overall Index based on the following weightings:

- Geopolitical 30%
- Economic 30%
- Reliability 20%
- Environmental 20%

The weighted average of the four sub-indexes constitutes the overall Index of U.S. Energy Security Risk™.[2]

This 2012 edition reflects revisions to the historical data and the new forecast in the Energy Information Administration's (EIA) *Annual Energy Outlook (AEO) 2012* issued in June 2012.

The Index is designed to convey the notion of risk: a lower Index score indicates a lower risk to energy security and a higher score indicates a higher risk. When evaluating the results, it is important to recognize that the Index necessarily moves along an open-ended scale. To provide a relative sense of potential hazard, the Index score for 1980, a particularly bad year for U.S. (and global) energy security risks, was set at 100. Index scores that approach or surpass 100, therefore, suggest a very high degree of risk.

The average Index score for the 30-year period from 1970 to 1999, a period that includes times with relatively very high (100) and very low (75.2) scores, is 84.2. The 1980 baseline score, the historical high and low scores, and the 30-average scores found in table 1 for the total composite Index and the four sub-indexes can be used as historical reference points against which to assess current and future risk scores. It is also important to note that in this report, unless noted otherwise, all dollar figures are in real 2010 dollars.[3]

The Index is focused exclusively on the United States and how its energy security risks have trended over time and may trend into the future. The Energy Institute also has developed an International Index of Energy Security Risk that puts the risks to the U.S. in an international context and provides comparisons with other large energy producing countries. Readers interested in how U.S. risks stack up against

1 Each of the 37 metrics is presented and discussed in Appendix 2.

2 Appendix 1 contains more information on the methods used to develop the Index.

3 Real 2010 dollars are used in the report to give readers a better idea of prices and expenditures in vis-à-vis today's prices. To develop the metrics, however, real 2000 dollars were used to provide comparability with previous editions of the Index. Real 2000 dollars can be converted into 2010 dollars by multiplying the 2000 dollar value by 1.2521.

Table 1. U.S. Energy Security Risks from 1970 to 2011: Highest, Lowest and 30-Year (1970-1999) Average Index Scores

Indexes of U.S Energy Security Risk	2011 Score	1980 Baseline Score	Highest Risk		Lowest Risk		30-Year Average (1970-1999)
			Year	Index Score	Year	Index Score	
Total Composite Index	101.3	100	2011	101.3	1992	75.2	84.2
Sub-Indexes:							
Geopolitical	101.6	100	2008	103.1	1998	73.0	83.2
Economic	102.1	100	2008	102.1	1998	61.4	73.8
Reliability	112.7	100	2011	112.7	1992	75.2	86.1
Environmental	88.3	100	1973	110.7	2009	87.7	99.3

those faced by other countries should consult the International Index, which is available on the Energy Institute website, www.energyxxi.org.

Index of U.S. Energy Security Risk: 2011

Since falling nearly ten points in the recession year of 2009, U.S. energy security risks have risen for two years in a row. Following a 7.4 point rise in 2010, the overall index rose another 3.8 points in 2011 to a record high of 101.3. Before 2011, only the years 1980 and 2008 had scores in the triple digits. Since 2005, risk scores have been as high as, or higher than, they were during the "Arab oil embargo" and Iran revolution and hostage crisis of the mid 1970s to early 1980s.

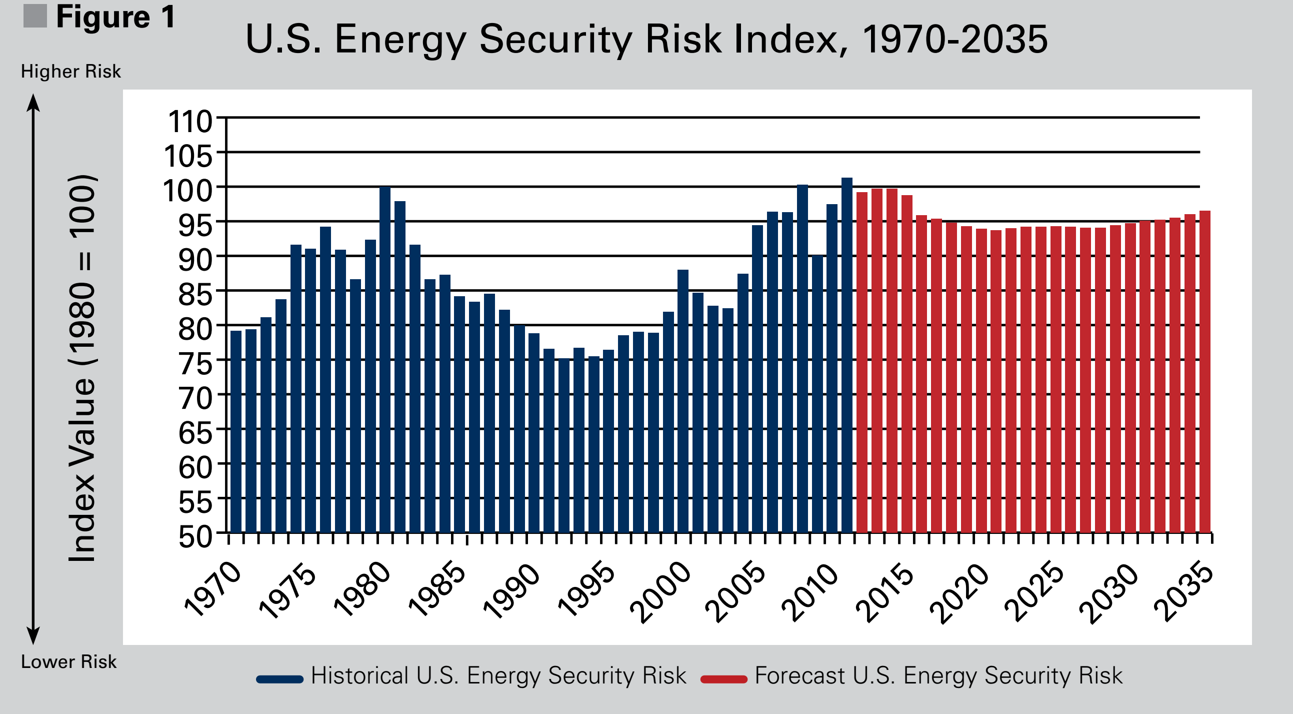
Of the 37 metrics used in the Index, 13 showed an increase in risk in 2011, 21 showed a decrease in risk, and three showed no change. Even though the number of metrics showing increased risk was comparatively small, these metrics generally showed the largest changes in risk scores. Leading the way were the indexes for crude oil prices and oil and natural gas import expenditures, which jumped 31.1 points and 28.0 points, respectively. Even though crude price volatility was little changed from 2010, it was still very high, a mere 0.1 points off the record high.

While those metrics showing declining risk were more numerous, with one exception the changes also were more modest. Most of the energy use metrics, which have been showing generally steady progress over the years, continued to show improvement in 2011, especially productivity per mile traveled in the transportation sector.

The metric measuring the security of natural gas imports showed the largest improvement of all the metrics in 2011. Its risk score fell 31.3 points in 2011, and since 2007, scores for this metric have plunged 91.3 points, a dramatic turnaround. From just 2% of production in 2000, shale gas accounted for just over one-third of overall natural gas production in 2011. Before the shale gas revolution, projections were indicating greater volumes of natural gas imports. EIA's most recent *AEO 2012* projection, however, shows the United States becoming a net exporter of natural gas imports instead of an importer.

After increasing more than 3% in 2010, emissions of carbon dioxide from energy fell 2.4% in 2011 to a level about where they were in the mid-1990s, leading to a 17.4 point drop in the risk index for total carbon dioxide emissions from energy.

■ Figure 1



Though there was some fuel switching, most of this decrease is related to improvements in the energy intensity of the economy and relatively mild weather in 2011, which lowered the demand for electricity and some fuels.

The electric power sector improved in two areas in 2011. The diversity of electricity generating capacity increased with the addition of renewable capacity, primarily wind, and capacity margins increased. As a result, the risk index scores for capacity diversity fell by 8.3 points while that for capacity margins fell by 13.0 points.

Index of U.S. Energy Security Risk: Outlook to 2035

Based on EIA's latest AEO 2012, the Index is projected to average 95.5 points over the entire forecast period from 2012 to 2035, never dropping below 93.7. This average score is 1.8 points higher than the average projected score from last year based on the AEO 2011. In the past, risk scores at these levels have been associated with geopolitical crises or energy shortage, such as the "Arab oil embargo" in the 1970s, the Iranian revolution and hostage crisis in 1979-80, policy-driven natural gas shortages in 2000, and the September 11, 2001 terrorist attacks and the wars in Afghanistan and Iraq. That such high levels of energy security risk are anticipated to be the norm for the foreseeable future should be a cause of concern.

Comparing this year's edition to last year's edition of the Index, much of the difference in the outlook for risk going forward has to do with evolving expectations about economic, technological, market, and regulatory conditions in EIA's AEO 2011 and AEO 2012 forecasts.

The increased risk level is being driven primarily by higher projections of crude oil prices that in turn lead to higher energy prices and expenditures. From 2012 to 2035, EIA sees crude oil prices rising from about \$99 to \$133 per barrel (in real 2010 dollars). Compared to the AEO 2011 projection, crude oil prices over the course of the period average about $16 per barrel higher than in the *AEO 2011*. While crude oil price projections generally follow a fairly smooth path (in this case upward), history suggests that crude oil prices are likely to display greater volatility.

Because so little oil is used in power generation, crude oil prices have very little impact on retail electricity prices, yet the average forecast for these this year also is higher, by about 7.6% (0.7¢). New pollution rules targeting use, together with expanded requirements for generally more expensive renewables, are the primary causes of the difference.

The forecast U.S. energy security risk scores out to 2035 would be higher still but for projections of increased domestic oil and natural gas shale production and a slower carbon dioxide emissions growth. The *AEO 2012* increased the outlook for shale gas over the *AEO 2011* forecast, and this change alone trimmed about 0.6 points from the average risk score out to 2035. The outlook for shale gas is even better in the *AEO 2012* than the *AEO 2011*. Estimates based on last year's projection show a small risk in this metric lingering out to 2035. This year's projection, however, forecasts shale gas production growing by 4.1% annually instead of 3.8%.[4] By 2022, the U.S. becomes a net exporter of natural gas, and this risk metric is scored at zero, or no risk.

Tight oil production also is expected to expand, with EIA forecasting an increase in output of tight oil from formations such as the Bakken, Eagle Ford, and Three Forks—4.8% each year to 2035, enough to propel total domestic crude oil production 2% each year. The forecast of output from offshore areas, however, barely changes, and output from Alaska declines by a 3.2% year and in 2035 is less than half current output.

Greater production and use of natural gas also contributed to lower estimates of future carbon dioxide emissions from energy. EIA now expects that total energy-related emissions will grow much slower than thought just last year—0.1% per year versus 0.4% per year—and will remain below their 2001 level throughout the entire forecast period.

> *The forecast U.S. energy security risk scores out to 2035 would be higher still but for projections of increased domestic oil and natural gas shale production and a slower carbon dioxide emissions growth.*

In addition, long-term trends towards greater energy efficiency across most sectors also had an impact on lowering the trajectory of future emissions. These efficiency trends also should lessen energy expenditures as a share of GDP, increasing the resiliency of the economy and lowering the impact of higher energy costs.

EIA projects that even as natural gas makes inroads into electricity markets, secure domestic coal will remain a mainstay of the U.S. energy mix. By 2035, coal power stations are expected to provide 40% of the nation's electricity, down from the 46% share estimated for the same year in the *AEO 2011*. Exports of coal also are expected to increase even more than anticipated last year. The *AEO 2012* forecast suggests that coal exports could be more than 180% greater than projected in the *AEO 2011*. Growing U.S. coal exports will continue improve the security of worldwide coal supplies.

While these projected trends provide an indication of where U.S. energy security might be headed, there is no objective way to determine technology changes, geopolitical crises, new resource discoveries, political elections, or any of a number of things that can and do occur whether we are prepared for them or not. If the energy future unfolds as EIA forecasts—though

4 Total domestic natural gas production increases 1% over EIA's forecast period.

experience tells us that it almost certainly will not—the Index of U.S. energy security is not expected to drop below 93.7 through 2035 and average 11.3 points above the 30-year average. At this high level of risk, the impact of the next inevitable if unpredictable energy crisis has the potential to be extremely disruptive to our economy and security. Lowering risks cannot guarantee that energy crises will not emerge, but it can limit U.S. exposure when they do.

Sub-Index of U.S. Geopolitical Energy Security Risk

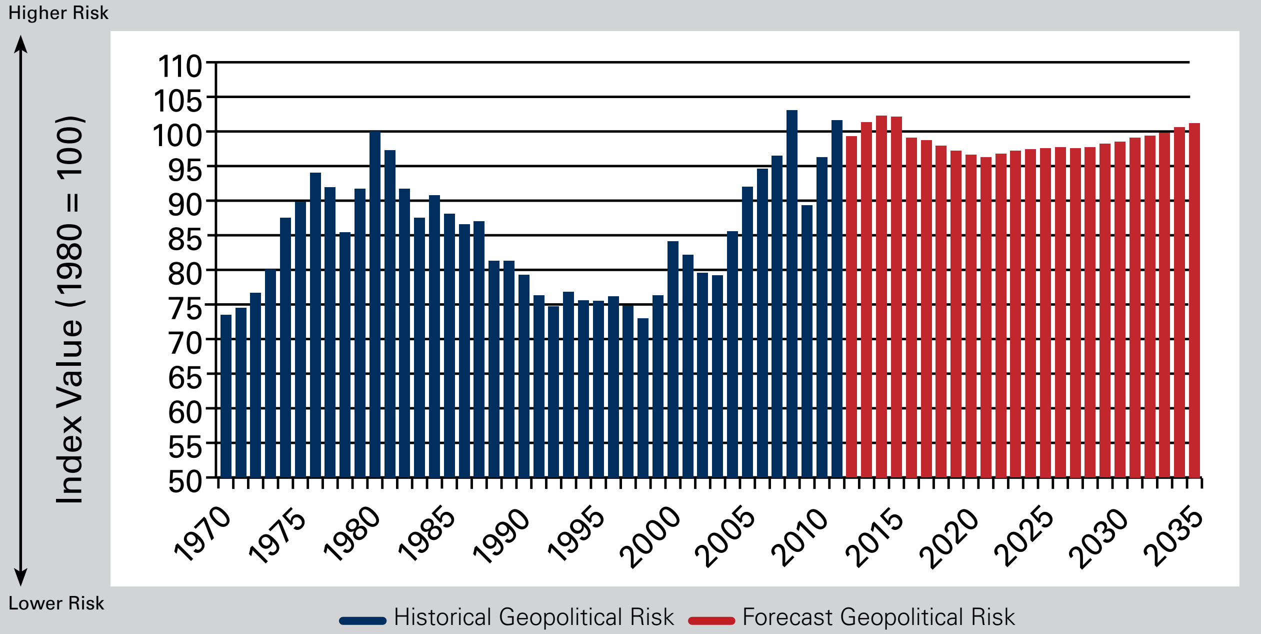
The Geopolitical Sub-Index measures the security of global oil, gas, and coal supplies and other factors that affect the ability of the U.S. economy to withstand supply disruptions from whatever causes. Geopolitical energy security risks in 2011 breeched 100 for the second time since 1980, climbing 5.3 points to 101.6 (Figure 2). This is 18.4 points above the above the 30-year average of 83.2.

Most of the increase in risks seen in the Geopolitical Sub-Index over the past decade or more is because of higher crude oil prices and price volatility, which led to greater import expenditures. Supply and demand fundamentals were largely responsible for moving oil prices higher. Despite the sluggish economies of many developed countries, demand in the large emerging economies like China, India, Brazil and others kept upward pressure on global prices. Moreover, tension in the Middle East related to terrorism, the "Arab Spring," and Iran's pursuit of nuclear weapons all contributed to nervousness in the market that pushed prices higher than they might have been otherwise.

Greater domestic oil and natural gas production, however, helped to offset a portion of these rising

Figure 2

U.S. Energy Security Risk: Geopolitical Sub-Index, 1970-2035



risks by lower the risks associated with oil and natural gas imports. Growing oil output from the Bakken, Eagle Ford and other shale formations and natural gas from the Barnett and Marcellus shale formations have helped reverse the declining production of these two energy resources, causing a drop in import levels.

Because we live in a global energy marketplace, the Geopolitical Sub-Index also incorporates measures of the reliability and concentration of oil, natural gas, and coal supplies worldwide. For reliability, we use measures of civil and political liberties developed by Freedom House, reasoning that political volatility can lead to supply volatility and that politically free countries are more likely to be politically stable and less likely to join cartels.[5]

To measure supply diversity, a concept from competition law and antitrust analysis—the Herfindahl-Hirschman Index (HHI), which measures market concentration—was adopted. Greater diversity of supply leads to enhanced competition and reduced volatility, both of which help lessen security risks. Even if a set of oil producing countries fares poorly on a measure of freedom, our energy security still is enhanced when supplies are more evenly spread among them. When energy supplies are concentrated among a handful of countries, there are not only increased risks of supply interruptions, but also greater exposure to potential producer cartels.

Oil accounts for about 35% of world primary energy use, and its status as a globally traded commodity and its primacy as a transportation fuel confers on it a strategic importance other fuels do not share. Its reserves and production largely are concentrated in small number of countries, primarily in the Middle East. Many large oil-producing countries also are politically unstable. The geopolitical disposition of oil supplies creates increased risks of supply interruptions. These risks are exacerbated by the oil producer cartels. The 12 members of the Organization of Petroleum Exporting Countries (OPEC) hold over two-thirds of the world's reserves.

Oil accounts for about 35% of world primary energy use, and its status as a globally traded commodity and its primacy as a transportation fuel confers on it a strategic importance other fuels do not share.

In contrast, in 2011 North America held about 14% of world reserves. This may seem a small amount compared to OPEC reserves, but in 2000, North American reserves were just 5% of the world total. The difference is attributable to the addition of about 175 billion barrels of proved reserves from Canada's oil sands in 2003.

While the security of world oil reserves has been getting better progressively because of these developments, the security of world production has been getting worse since the early 2000s. Two factors have been at play. The first is that production in higher-risk countries has been growing, and the second is that production in lower-risk countries like Norway has been shrinking.

Projections suggest that unconventional oil reserves in countries outside of OPEC will gain in importance as a source of supply over the coming decades. U.S. unconventional oil resources are potentially enormous, perhaps as high as 2 trillion barrels, and exploration and development can lead to great increases in domestic and secure reserves.

Exploration and development of these resources would have a beneficial impact on the security of global crude oil supplies. It was noted above how increased oil production from the Bakken, Eagle

5 Recent political upheaval in the Middle Eastern countries whose Freedom House rankings are very poor bears out the relationship between political freedoms and political stability.

Ford, and other shale formations has contributed to increased domestic production, which in 2011 was over 700 thousand barrels per day more than in 2008. Most of this added production, however, has come from state and private lands, and production from others areas, most notably Alaska, is declining. Many of our largest resources are on federal lands, and many of these lands have been placed off limits to exploration and production. The degree to which access to these resources is allowed could have a large impact on the country's future energy security.

U.S. unconventional oil resources are potentially enormous, perhaps as high as 2 trillion barrels, and exploration and development can lead to great increases in domestic and secure reserves.

Natural gas also is highly concentrated geographically, with reserves currently dominated by the Russian Federation, Iran, and Qatar, which together account for over half of global reserves. U.S. reserves rank fifth in size, 4% of the world total.

Not so long ago, rising levels of natural gas imports led many observers to conclude that the U.S. was going down the same path with natural gas it had trod with crude oil. Since 2007, that has no longer been the case. Indeed, the downward trend in projected natural gas imports is an important and positive development that was not foreseen just a few years ago.

This is seen in the metric for security of natural gas imports, which combines two different components: (1) the share of U.S. natural gas supply met by imports; and (2) a freedom and diversity adjusted measure of foreign natural gas supplies. The resulting index indicates the degree to which changes in import levels expose the U.S. to potentially unreliable or concentrated supplies of natural gas.

The historical trend for this metric was until 2008 clearly in the direction of rising risks and was driven by growing imports of natural gas. Recently, however, the combined use of horizontal drilling and hydraulic fracturing has allowing producers to tap profitably into domestic shale formations holding very large quantities of natural gas. As a result, since 2007, the risk score for this metric has plummeted 91.3 points, from 186.9 to 95.6.

Greater production of shale gas also promises much lower future risks for this metric than would have been the case looking at projections of just a few years ago, when shale gas production was in its infancy. For example, EIA's *AEO 2006* forecast that by 2030, imported natural gas—much of it in the form of liquefied natural gas—would account for 21% of U.S. supply. In its *AEO 2012*, EIA forecasts that by 2022 the U.S. will become a net exporter of natural gas. Our ability to realize these gains in security will depend on the ability of companies to explore and develop these shale gas resources and build the infrastructure necessary to move these new supplies.

Like crude oil and natural gas, coal reserves are highly concentrated geographically. In 2008, the last year for which data are available, the 10 countries with the largest coal reserves held 879 billion short tons, about 93% of the world total.

The United States had 261 billion short tons the largest recoverable reserves of any country in the world—more than one-quarter of global supplies. The U.S. has very secure coal supplies, with enough reserves to last well over centuries. Federal regulations targeting coal and lower natural gas prices are expected to reduce domestic demand for coal. Many U.S. companies, therefore, are increasing their exports. The *AEO 2012* forecast suggests that coal exports in 2035 could be more than 180% greater than projected in the *AEO 2011*. Growing U.S. coal exports will continue improve the security of worldwide coal supplies.

Sub-Index of U.S. Economic Energy Security Risk

The Economic Sub-Index includes metrics measuring trends in the costs associated with energy, the intensity and efficiency of energy use, and international supply risks. Energy price volatility and high energy prices can have large impacts on the economy and the competitiveness of U.S. industries. Since so much of U.S. petroleum consumption is supplied through imports—even with the recent increase in domestic output—the U.S. balance of trade is affected by hundreds of billions of dollars each year spent on those imports.

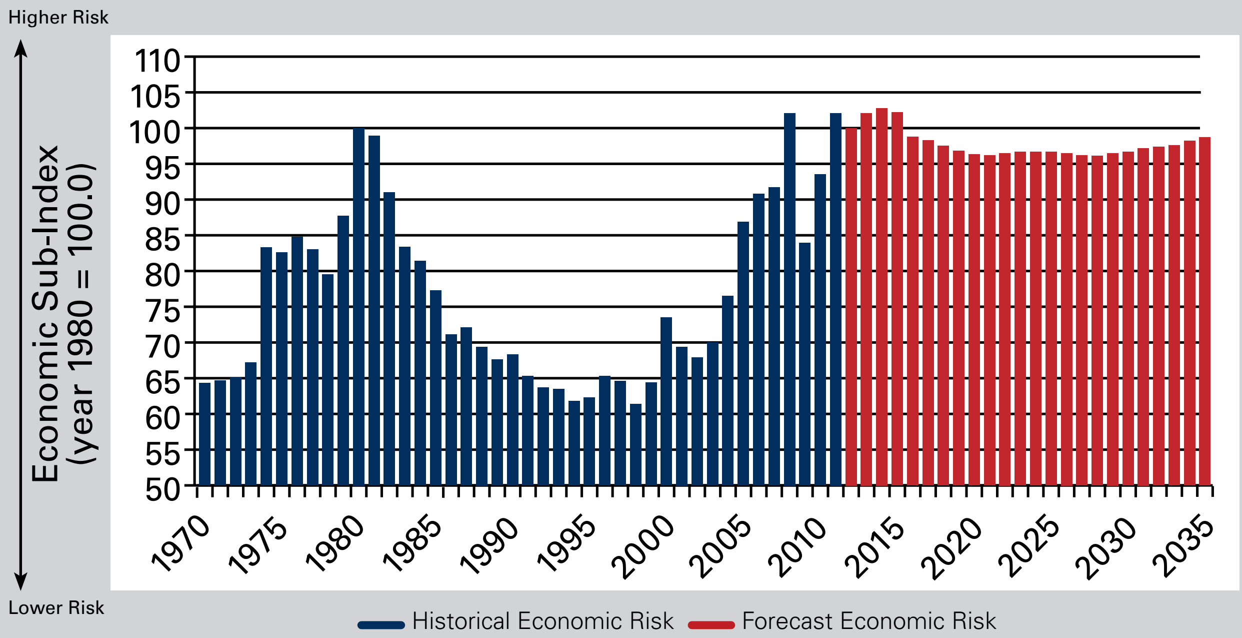
As shown in Figure 3, economic energy security risks rose to a record high in 2011, jumping 8.6 points to 102.1. The 2011 score is almost 28.3 points higher than the 30-year average of 73.8. It is only the third time since 1970 that this sub-index has gone to or above 100. Higher crude oil prices and volatility, import expenditures, and household energy expenditures were the primary cause, and these factors will help maintain economic risks at a high level, with scores consistently above 96, through 2035.

Steady improvement in the energy intensity of the U.S. economy since 1970—related both to greater energy efficiency and to long-term structural changes away from manufacturing and toward services—has lessened the economic impact of energy price swings.

The biggest movers, and those with the biggest impact on the economy, were the indexes for crude oil prices and import expenditures, which jumped 31.1 points and 28.0 points, respectively. The rise in the crude oil price index reflects a real rise (in 2010 dollars) in the year-to-year price of a barrel of crude

Figure 3

U.S. Energy Security Risk: Economic Sub-Index, 1970-2035



oil of $24.35[6] to an average of about $100.84.[7] In real terms, this was the highest price for crude oil in the record, exceeding even the price in 2008, and was the primary cause in the sharp rise in import expenditures.

Everyone can see the impact of rising oil prices, but price volatility also poses risks. In 2011 crude oil price volatility—measured as the three-year rolling average of annual changes in the world price of crude oil—was $24.80[8] per barrel, just one cent off it historical high set the year before.

Some amount of price volatility is an inevitable consequence of a market-based economy. Since companies invest based on expectations about prices, high price volatility creates uncertainty and risk, and risk premiums rise to compensate. When energy markets are volatile, which frequently has been the case with petroleum and natural gas, the year-to-year changes in the total costs can themselves pose a significant jolt to the economy. And with a large part of our energy use consisting of fuel imports, volatility in the markets amounts to sudden and large shifts in international trade.

Greater expenditures on imported fuels represent lost economic investment opportunities, and this risk is captured in metrics measuring how much the U.S. spends on imported oil and natural gas, in total and as a share of GDP. Both of these measures worsened in 2011 for the second year in a row, but they are still well below the highest risk records for these two metrics in 2008. Nevertheless, they are quite high.

In 2011, the U.S. spent in $333 billion[9] (in 2010 dollars) on oil and gas imports (mostly oil), a figure only exceeded in 2007 and 2008. While in the recent past increases in import expenditure were mostly the result on declining domestic output, higher domestic output in 2011 means the higher expenditures reflect primarily higher prices.

Like crude oil price and volatility, energy expenditures per household, an indication of the importance of energy costs to family budgets, also climbed to record level in 2011. Further, the cost of energy as a share of GDP increased again in 2011, indicating that energy costs are rising more rapidly than incomes. While EIA's AEO 2012 projects that energy costs will consume less and less GDP in the future, the trend since the late 1990s/early 2000s has been moving toward higher costs as a share of GDP.

Greater expenditures on imported fuels represent lost economic investment opportunities, and this risk is captured in metrics measuring how much the U.S. spends on imported oil and natural gas, in total and as a share of GDP.

Longer term trends producing greater economic value with less energy in general and oil in particular continued in 2011, otherwise the Economic Sub-Index score would be greater than it is. Steady improvement in the energy intensity of the U.S. economy since 1970—related both to greater energy efficiency and to long-term structural changes away from manufacturing and toward services—has lessened the economic impact of energy price swings. In fact, with one exception, all of the energy intensity and efficiency risk metrics show record or near record lows. The one exception, energy use per household, has not changed all that much since the mid 1980s, reflecting the competing trends of larger yet more energy efficient houses with more electronic devices.

Lower retail electricity prices in 2011 also moderated economic risks. Plentiful and inexpensive supplies of both coal and natural gas have helped send electricity prices lower for the third year in a row.

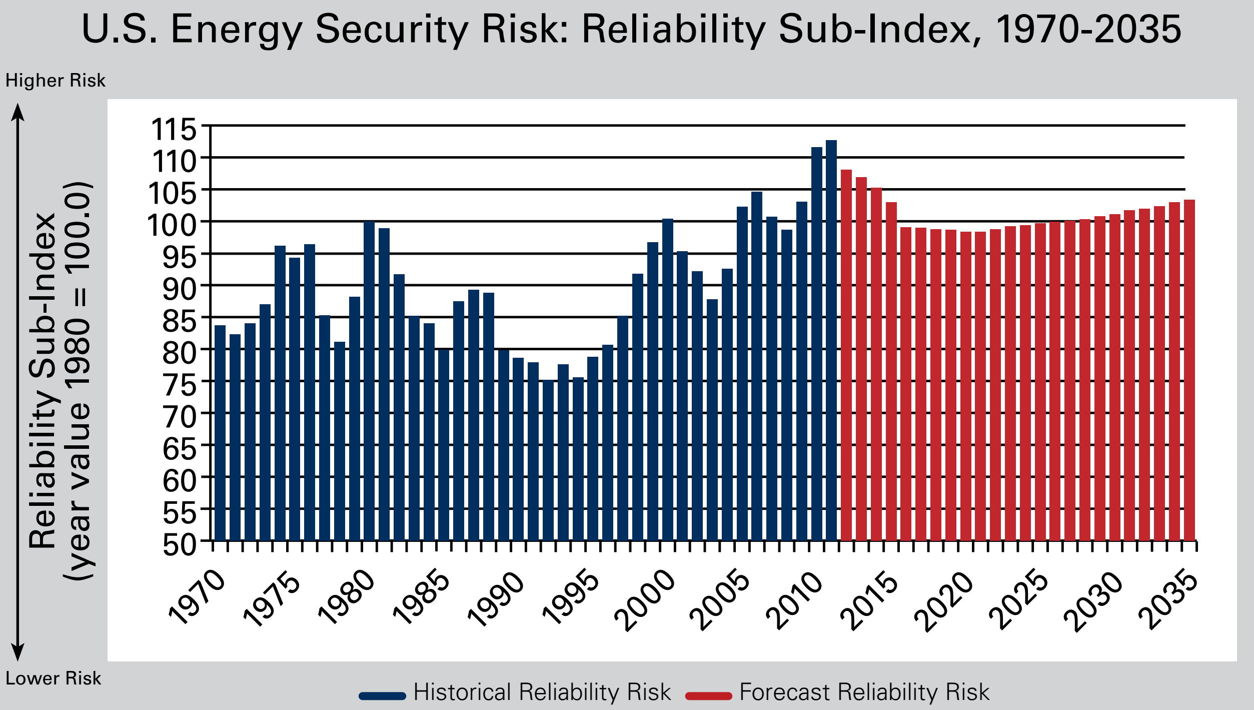
6 $19.45 in 2000 dollars.

7 $80.54 in 2000 dollars.

8 $19.81 in 2000 dollars.

9 $266 million in 2000 dollars.

Figure 4



EIA projects increasing prices for crude oil out to 2035 that will have ripple effects throughout the economy. In particular, higher crude oil prices will lead to greater expenditures on imports of oil and rising household energy expenditures. Although crude oil price volatility is not embedded to EIA's forecasts, history suggests that it could be quite high. These factors are expected to help maintain the economic risk score greater than 96 through 2035.

Sub-Index of U.S. Reliability Energy Security Risk

The metrics that make up the Reliability Sub-Index measure such things as global fossil fuel production and imports, crude oil price and volatility, oil refining and stock levels, the power sector, and R&D.

As the chart in figure 4 shows, the 2011 score for this sub-index increased for the third year running, climbing 1.1 points in 2011 to 112.7, a record high score. Since 2005, only one year—2008—has had a Reliability Sub-Index score below 100.

Record high crude oil price volatility is responsible for much of the increase. A measure of the gyrations in the price of crude oil, this metric presents a much higher risk profile now than in previous years. It was noted earlier that volatility in 2011 was $24.80, its second highest level ever.

Much of the volatility in crude oil prices in 2011 was related to unrest in the Middle East initiated during the Arab Spring. The political and in some cases military upheavals in Libya, Egypt, Syria, and other countries, continuing concern about Iran's efforts to develop a nuclear weapons program, and the risk of terrorist attacks all have conspired to keep oil market unsettled and price volatility high.

While these events have raised prices substantially, they have not seriously disrupted oil supplies to date—but they could. Greater oil production from the United States, Canada, and other politically stable countries, therefore, could provide a critical hedge against price volatility.

The reliability score would have been worse had it not been for the tremendous improvement in the security of natural gas imports also noted earlier in this report. While this metric is not weighed very heavily in this sub-index, its 31.3-point drop in 2011 was so large that it had a definite moderating influence. The metric measuring the security of crude oil imports also fell, but not by nearly as much as the comparable metric for natural gas. The large reserves of natural gas and unconventional crude oil in the United States, if tapped, could not only enhance the reliability of supplies of these fuels to the U.S., it could lower the reliability–related risks of these fuels internationally.

Reliability risks related the power sector also showed some improvement. Capacity margins, the unused available capability at peak load as a percentage of total peak capability, rose from 23.5% to 26.6%. As a result, the risk indexes for these two metrics improved by 8.3 and 13.0 points, respectively.

Transmission capacity is a critical aspect of the reliability of the grid. While the risk score for electricity transmission lines, derived from a measure of circuit-miles per summer peak demand, is only just slightly lower in 2011, it continues a four-year trend of declining risk because of the addition of new line-miles. Nevertheless, the pace of improvement could be hastened if new transmission infrastructure could be sited and permitted with more alacrity.

World oil refining capacity utilization and domestic petroleum stock levels were little changed from 2010. Refinery utilization in 2011 was 81.2%, and there were about 943 days of crude oil and refined petroleum stocks on hand.

The reliability score would have been worse had it not been for the tremendous improvement in the security of natural gas imports also noted earlier in this report. While this metric is not weighed very heavily in this sub-index, its 31.3-point drop in 2011 was so large that it had a definite moderating influence.

Looking to the future, the index assumes crude oil price volatility will not stay as high as it was in 2011, but will over time return to historical averages. Even with this assumption, forecast scores for the Reliability Sub-Index based on the *AEO 2012* suggests risk levels above 98 will be the norm for this sub-index through 2026, and over 100 after that.

Sub-Index of U.S. Environmental Energy Security Risk

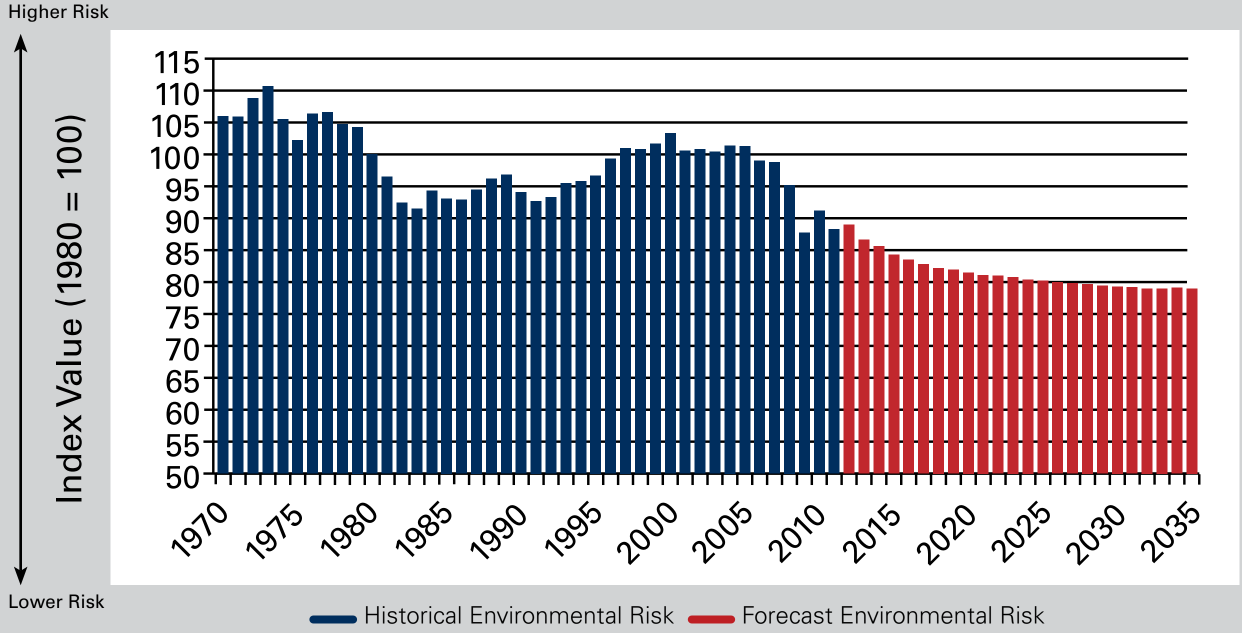
The Environmental Sub-Index—using metrics of energy intensity and efficiency, transportation, power, carbon dioxide emissions, and research and development (R&D)—is the only one of the four sub-indexes to show an improvement in 2011. At 88.3, this measure of overall environmental risk came in 2.9 points lower than the year before and 11.0 points below its 30-year average (Figure 5). This is the second lowest score for this sub-index in the record.

The single biggest factor in the improvement in this sub-index was the drop in energy-related carbon dioxide emissions in 2011. Total emissions are the product of four variables: (1) gross domestic product (GDP) per capita; (2) population; (3) energy intensity; and (4) the carbon intensity of energy supply.[10]

10 The calculation would be expressed as: Population × GDP per Capita × Energy Intensity × Carbon Intensity = Carbon Dioxide Emissions. This calculation, known as the Kaya Identity, was developed by the Japanese energy economist Yoichi Kaya.

Figure 5

U.S. Energy Security Risk: Environmental Sub-Index, 1970-2035



Typically, in the United States GDP and population growth cause emissions to rise whereas improving energy intensity causes emissions to fall. Changes in the carbon intensity of the energy supplies vary from year to year, but usually causes emissions to fall. How these factors balance each other determines whether total emissions rise or fall in any given year.

If there is any one factor responsible for the drop in emissions in 2011, it was that GDP growth contributed very little to the plus side of the emissions ledger, as economic growth was very sluggish. Mild winter weather (which reduced energy demand for space heating), gains in efficiency and fuel economy, and a small amount of fuel switching in the power sector also helped send emissions lower in 2011.

EIA also has lowered its outlook for energy-related carbon dioxide emissions. In its AEO 2012, EIA's emissions forecast averages roughly 370 million metric tons per year less than in its AEO 2011. Cumulatively, this amounts to 8.9 gigatons in overall emission reduction from 2012 to 2035, the equivalent of about a year-and-a-half of emissions at their current level. There are a number of reasons for EIA's lower estimate, such as greater use of natural gas and renewables in power production, regulations targeting coal-fired power plants, improved energy intensity, and better automobile efficiency.

Indeed, EIA has been lowering its projections of future carbon dioxide emissions consistently over the past seven years or so. In the *AEO 2005*, for example, carbon dioxide emissions were projected to total over 8 gigatons in 2025. Now, the *AEO 2012* forecasts only 5.6 gigatons in 2025, more than 2 gigatons less than projected in 2005.

Most energy use trends used in this sub-index are declining steadily if not spectacularly, and this helps account for its reasonably good outlook. Scores for most energy intensity and efficiency measures (except for household energy efficiency, noted earlier) were close to if not below their best score in the record, and each is expected to improve even more out to 2035. Changes in R&D spending, however, did not impact the sub-index substantially.

Estimations of future sub-index risk based on EIA's *AEO 2012* suggest that continued improvement in energy intensity of the economy, greater fuel economy in the transportation sector, and growing use of natural gas and renewables in electricity generation future could lower future risk even further, and by 2027 the risk score for this sub-index could fall below 80 for the first time.

Appendix 1: Methodology Used to Develop the Index of U.S. Energy Security Risk

The Energy Institute's ultimate goal in developing the Index of U.S. Energy Security Risk was to use available data and forecasts to develop the metrics that collectively describe the geopolitical, economic, reliability, and environmental risks that in turn combine to measure the risk to overall U.S. energy security in a single Index.

Boiling down something as multifaceted as U.S. energy security into a single number posed a significant challenge. The Index was built from a foundation of just over three dozen individual metrics measuring energy security in a variety of aspects. The Index uses historical and forecast data covering the period 1970, before the time when energy security first became a large concern with the American public, to 2035 using "business-as-usual" forecasts from the Energy Information Administration (EIA).

The process used to develop the Index is described below, and it is represented schematically in figure A1-1.

Selecting and Developing the Metrics

Before selecting the measures, the first task was to establish some criteria that would ensure the data used possessed several important characteristics. The data for each metric had to be:

- **Sensible**—The data had to relate to common-sense expectations.
- **Credible**—The data source had to be well-recognized and authoritative.
- **Accessible**—The data had to be readily and publicly available.
- **Transparent**—Data derivations and manipulations had to be clear.
- **Complete**—The data record had to extend back in history for a reasonable amount of time, preferably back to 1970.
- **Prospective**—The historical data had to dovetail cleanly with forecast data that extends 25 years into the future, where these are available.
- **Updatable**—The historical data had to be revised each year, with a new historical year added and new forecast outlooks prepared.

In many cases, data from government agencies—primarily the EIA, Department of Commerce, and Department of Transportation—were tapped, but this was not always possible, especially for certain types of data extending back to the 1970s and 1980s. Where historical data from government sources were not available, other widely used and respected sources were employed.

The metrics selected were organized around nine broad types of metrics that represent and balance some key and often competing aspects of energy security. These are found in table A1-1.

Using these categories as guides, 37 individual metrics were selected and developed covering a wide range of energy supplies, energy end-uses, operations, and environmental emissions. Anywhere from three to six metrics were selected for each metric category.

The Energy Institute's Index of U.S. Energy Security Risk and the various metrics that support it are designed to convey the notion of risk, in which a lower Index number equates to a lower risk to energy security and a higher Index number relates to a higher risk. This notion of risk is conceptually different from the notion of outcome. Periods of high risk do not necessarily lead to bad outcomes just as periods of low risk do not necessarily lead to good outcomes.

Figure A1-1. Building the Index of U.S. Energy Security Risk

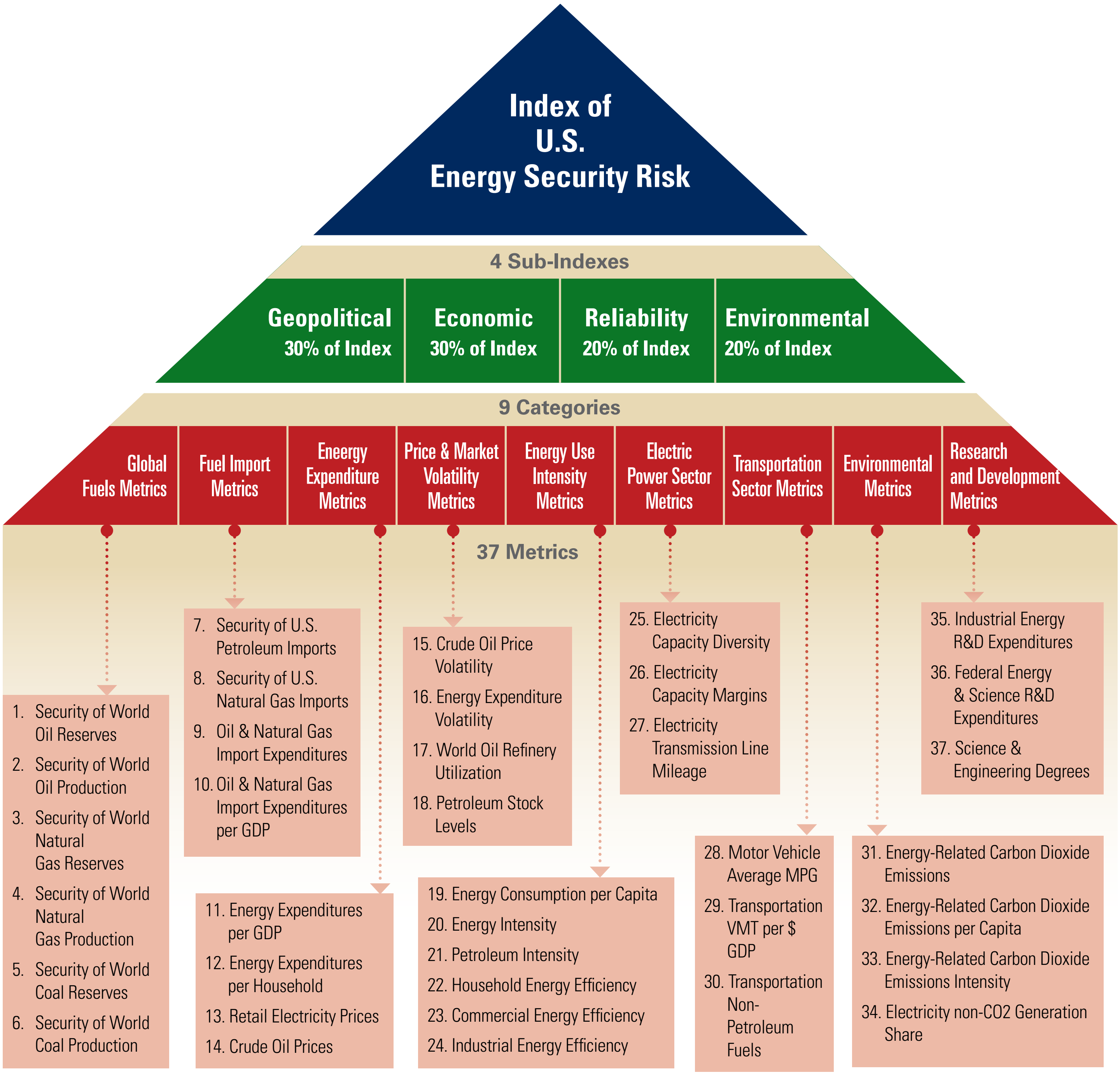


Table A1-1. Categories of Energy Security Metrics

	Metric Category	General Description of the Metrics
1.	**Global Fuels**	Measure the reliability and diversity of global reserves and supplies of oil, natural gas, and coal. Higher reliability and diversity mean a lower risk to energy security.
2.	**Fuel Imports**	Measure the exposure of the U.S. economy to unreliable and concentrated supplies of oil and natural gas and import costs (not necessarily related to the amount of imports). Higher reliability and diversity and lower costs mean a lower risk to energy security.
3.	**Energy Expenditures**	Measure the magnitude of energy costs to the U.S. economy and the exposure of consumers to price shocks. Lower costs and exposure mean a lower risk to energy security.
4.	**Price & Market Volatility**	Measure the susceptibility of the U.S. economy and consumers to large swings in energy prices. Lower volatility means a lower risk to energy security.
5.	**Energy Use Intensity**	Measure energy use in relation to economic output and energy efficiency. Lower energy use by industry to produce goods and services and by commercial and residential consumers mean a lower risk to energy security.
6.	**Electric Power Sector**	Measure the diversity and reliability of electricity generating capacity. Higher diversity and reliability mean a lower risk to energy security.
7.	**Transportation Sector**	Measure efficiency of the vehicle fleet and diversity of fuels. Higher efficiency and diversity mean a lower risk to energy security.
8.	**Environmental**	Measure the exposure of the U.S. economy to national and international greenhouse gas emission reduction mandates. Lower emissions of carbon dioxide from energy mean a lower risk to energy security.
9.	**Research & Development**	Measure the prospects for new advanced energy technologies and development of intellectual capital. Higher R&D investments and technical graduates mean a lower risk to energy security.

More often than was preferred, the available historical data measured what actually happened, not what might have happened. In other words, much of the available data measure history, not risk.

In choosing which metrics to use, it was necessary to strike a balance between the desired "ideal" measure and the available measure. Where data for the preferred metric existed, they were used, but in many cases, proxies for the risks that could not be measured directly had to be developed.

Several of the metrics use similar data in different ways and many of these related metrics rise and fall at the same times in the historic record, a situation that could introduce a bias in the Index. However, it is important to note that seemingly related metrics can often diverge at some point in the historical record or future. Furthermore, a procedure for weighting each metric avoided giving undue influence in the overall Index to metrics that on the surface appear similar.

Because the metrics are measured in many different units, it was necessary to transform them into comparable "building blocks" that could be assembled into the composite Geopolitical, Economic, Reliability, and Environmental Sub-Indexes and, ultimately, a single comprehensive Index of U.S. Energy Security Risk. To achieve this, the 1970 to 2035 time series for each metric was normalized into an index by setting the value for the year 1980 at 100 and setting the values for all other years in proportional relation to 1980 value, either higher or lower so that the trend lines remains the same. This normalizing procedure simply places all the metrics into a common unit that it preserves the trend as well as the relative movement up or down of each metric over time.

Setting each individual metric so that 1980 equals 100 also means that the Geopolitical, Economic, Reliability, and Environmental Sub-Indexes as well as the overall Index built from them will have a 1980 value of 100. The year 1980 was selected because an initial analysis of the metrics suggested that it reflected the worst year overall for U.S. energy security since 1970.[1]

With some metrics, additional transformations were needed beyond this normalization procedure. The Index is designed so that a lower value represents an improvement in energy security while a higher value represents deterioration in energy security. This makes sense because for most of the metrics used, a declining trend is better for U.S. energy security than a rising trend. There are, however, some metrics where a rising trend signals a declining risk. When creating the normalized index for these metrics, various techniques were used to invert or "flip" the metric so that its index value moves in the opposite direction of its measured value, that is, increases became decreases and vice versa.[2] Additionally, some of the metrics required further transformations to reflect non-linearities in the scale.[3]

EIA's *Annual Energy Outlook 2011 (AEO 2011)* was the primary source for metric forecasts out to 2035. *AEO 2011* projections, however, are not available for all of our metrics. In these cases, a neutral assumption was adopted and the last year of available data was extended over the forecast period.[4]

All of these data transformations are discussed in detail in the documentation material available on the Energy Institute's web site.

Using the Metrics to Create Four Sub-Indexes of Energy Security Risk

Within our broad definition of energy security, four areas of concern were identified: (1) geopolitical; (2) economic; (3) reliability; and (4) environmental. While there are no "bright lines" delineating these categories, they nonetheless provided a reasonable framework around which to develop Sub-Indexes that when combined create the overall Index of U.S. Energy Security Risk.

- **Geopolitical:** Petroleum is a globally-traded commodity with a supply that is concentrated in a relative handful of countries. Natural gas also is increasingly becoming a globally-traded commodity, and it too is fairly well concentrated, with about 70% of proven reserves located in the Middle East, Russia, and other former Soviet Union states. Trade in coal is more regional, but as China, India, and other large economies expand, it also may become a more international commodity. For both oil and gas, several of the top reserve-owning countries have uncertain political stability and are at best reluctant business partners with the United States.

1 This does not mean that 1980 necessarily represents the worst year for each individual metric or even for the Geopolitical, Economic, Reliability, and Environmental Sub-Indexes. Some metrics display higher (worse) values in years other than 1980, but in the composite Index for the United State, these are offset by lowers values for other metrics leading to an overall score of 100, the highest in the record for the composite Index.

2 For example, while a decline in energy use per unit of economic output would decrease energy security risks, a decline in energy R&D expenditures would increase risks.

3 For example, in cases where movement of a metric above or below a specific range of values does not change the risk in any meaningful way.

4 Similarly, on those few occasions where data for the metric did not extend all the way back to 1970, the last year of available data was "back cast" to 1970.

Dependence upon these fuel sources—for both the United States and the rest of the world—poses political and military risks. Because international disputes can quickly turn into energy problems, and vice versa, energy necessarily occupies a consequential role in U.S. foreign policy.

- **Economic:** With a large part of U.S. national income being spent on energy, price volatility and high prices can have large negative national impacts that crimp family budgets and idle factories. Over the longer-term, high energy prices can diminish our national wealth and provoke energy-intensive industries to migrate to other countries. Since much of U.S. petroleum consumption is supplied by imports, the Nation's trade balance is affected by hundreds of billions of dollars each year spent on imported oil.

- **Reliability:** Disruptions to energy supplies—whether natural or man-made, accidental or deliberate—entail high costs. Long-distance supply chains, including tankers and pipelines, are vulnerable to accidents and sabotage. Oil and gas fields located in weather-sensitive areas can be knocked out of service. Inadequate and outdated electrical grids can overload and fail. Lack of adequate electricity generation or refinery capacity can cause shortages and outages. These reliability considerations, in turn, have economic and even geopolitical consequences.

- **Environmental:** Fossil fuels—coal, oil, and gas—dominate the U.S. energy system. Combusting these fuels releases carbon dioxide, and these emissions comprise about four-fifths of total gross U.S. greenhouse gas emissions. Climate change poses risks related both to the actual impacts of climate change and to the economic and energy market impacts of taking actions to reduce GHG emissions. These risks and uncertainties are appropriately included as part of an assessment of energy security.

In determining the metrics that should be selected to build the Geopolitical, Economic, Reliability, and Environmental Sub-Indexes, the relevance of each metric to each of the four Sub-Indexes had to be established as well as the weight each metric should be accorded. In general, the aim was to develop a set of weightings that reflected not only each metric's intrinsic characteristics, but also provided a balance across sectors and within groups of metrics.

The weightings were applied as fixed values that remain unchanged over the 1970 to 2035 period. Both analysis and expert judgment were relied on in setting the appropriate weights. Those metrics considered of greater importance within a Sub-Index were given a greater weighting than those considered of lesser importance. It is also important to note that the importance of an individual metrics can differ across different Sub-Index categories, so when the same metric is used in two or more Sub-Indexes, its weighting might be different in one Sub-Index compared to another.

To arrive at the Sub-Indexes, the weightings were applied to each metric within each of the four areas to calculate essentially a weighted average of all the metrics selected for that group. The resulting weighted average is the energy security Sub-Index number.

As with the individual metric indexes, a lower Sub-Index number indicates a lower risk to U.S. energy security, a higher number a greater risk. Since each of the individual metrics has been normalized to a scale where its value for the year 1980 equals 100, all four Sub-Indexes also have a value for the year 1980 equaling 100.

Using the Four Sub-Indexes to Create an Index of U.S. Energy Security

The final step was to merge the four Sub-Indexes into an overall annual Index of U.S. Energy Security Risk for each year from 1970 to 2035. To do this, the input share of each of the four Sub-Indexes to the final overall Index was weighted and apportioned as follows:

- Geopolitical 30%
- Economic 30%
- Reliability 20%
- Environmental 20%

These values were used to arrive at a weighted average of the four Sub-Indexes.[5] The resulting number represents the overall Index of U.S. Energy Security Risk.

As with the weightings applied to the individual metrics in the Sub-Indexes, these weightings are unchanged over the entire 65-year period the Index covers. The weightings used to create the Energy Institute's Index are intended to give substantial weight to each of the four Sub-Indexes but to give slightly more weight to the geopolitical and economic risks that, for good reason, tend to dominate much of the public debate on energy security.

Like the individual metric indexes and the four Sub-Indexes, the year 1980 is set at 100. Although at 100, 1980 represents the worst year in historical record, this level is not a cap—the scale is open-ended. Whether future values approach or exceed this high point will be determined in large part by developments in U.S. policy, international politics, energy markets, technology, and many other factors.

5 To arrive at the Index, each Sub-Index was multiplied by its percentage weighting, and the products of these calculations were added together.

Appendix 2: Metrics and Data Tables

Appendix 2 presents and describes the individual metrics used to define, quantify, and construct the Sub-Indexes and Index of U.S. Energy Security Risk. Nine types of metrics were selected covering a wide range of energy supplies, energy end-uses, operations, and environmental emissions covering the years 1970 to 2035. The nine types of metrics categories are as follows:

1. Global Fuels
2. Fuel Imports
3. Energy Expenditures
4. Price & Market Volatility
5. Energy Use Intensity
6. Electric Power Sector
7. Transportation Sector
8. Environmental
9. Research & Development

The following information is provided for each metric:

• **Definition:** Describes what is being measured and the units of measurement.

• **Importance:** Describes the potential impact and risks associated with each metric.

• **Category of Metric:** Identifies the metric as one of nine broad types of metrics.

• **Historical and Forecast Values:** Provides two charts: one that shows the metric in its units of measurement and another that shows the metric as a normalized index in which 1980 equals 100. Historical values are in blue and forecast values are in red. Lighter shades of blue or red indicate assumed data or combined forecast/assumed data.

• **Observations:** Provides a brief overview of major trends, policies, and events that contributed to the observe trends in the metric.

• **Weighting and Average Historical Contribution of Metric to Energy Security Indexes:** Provides a table with: (1) the weight each metric was assigned in creating each of the four Sub-Indexes and its average weight for the total U.S. Index and (2) the average historical contribution of each metric to the resulting Sub-Index value. These weights are given as percentages. The weight assigned to each metric is an input measure, and it remains the same for each year over the entire period (both historical and forecast). The average historical contribution (1970-2011) of each metric to the Sub-Index and Index values is an output measure. It can and does change from year-to-year as the metric moves up or down in relation to other metrics.

• **Primary Data Sources:** Lists government and other sources used to compile the metric.

• **Data Issues:** Describes briefly how the metric data were manipulated, where necessary, to arrive at the annual metric values and metric indexes and how gaps and discontinuities in the data were resolved.

Additionally, the annual data for each metric as well as the four Sub-Indexes and Index are provided in two sets of tables that follow the metric summaries. The first set lists the values for each of the metrics in the units in which it was measured. The second set of tables lists the values for each of the metrics as an index, with the value for the year 1980 pegged at 100 and the values for all other years set in relation to 1980 value, either higher or lower.

Data references used to develop the metrics are listed at the end of this appendix.

Acronyms

AEO	*Annual Energy Outlook*
AER	*Annual Energy Review*
API	American Petroleum Institute
ARRA	American Recovery and Reinvestment Act
BEA	Bureau of Economic Analysis
BP	British Petroleum
Btu	British thermal unit
CBECS	Commercial Buildings Energy Consumption Survey
CO2	carbon dioxide
EIA	Energy information Administration
EISA 2007	Energy Independence and Security Act of 2007
EPAct 2005	Energy Policy Act of 2005
FRB	Federal Reserve Board
FSU	Former Soviet Union
GDP	gross domestic product
HHI	Herfindahl-Hirschman Index
IEA	International Energy Agency
IEO	*International Energy Outlook*
IP Index	Industrial Production Index
IPEDS	Integrated Postsecondary Education Data System Completions Survey
kWh	kilowatt hour
MER	*Monthly Energy Review*
mpg	miles per gallon
NERC	North American Electric Reliability Council
NSF	National Science Foundation
O&G Journal	*Oil & Gas Journal*
SPR	Strategic Petroleum Reserve
UAE	United Arab Emirates
UK	United Kingdom
USSR	Union of Soviet Socialist Republics
VMT	vehicle-miles traveled

Metric #1

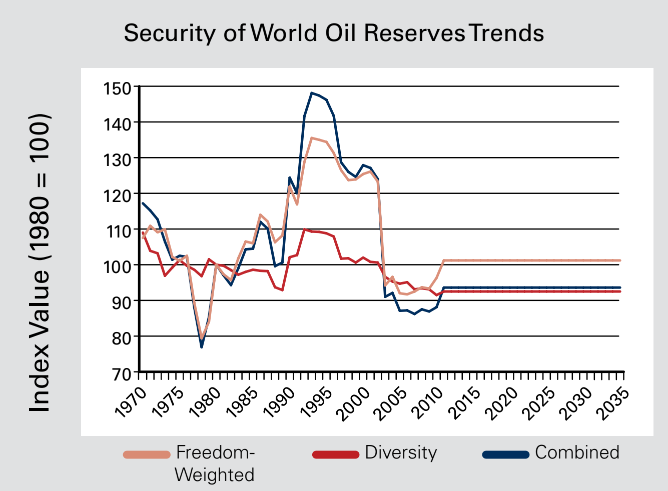
Security of World Oil Reserves

Definition: Global proved oil reserves in billions of barrels weighted by (1) each country's Freedom House freedom ranking and (2) a diversity index applied to global oil reserves.

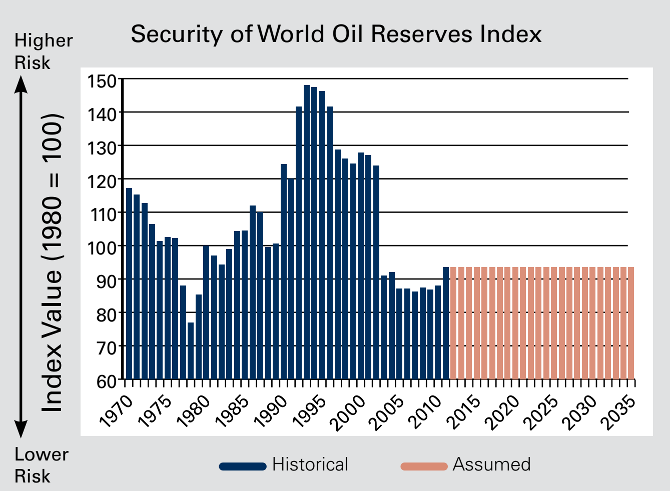
Importance: Indicates risk attached to the average barrel of global crude oil reserves. As a measure of reserves and not production, it largely reflects longer-term concerns.

Category of Metric: Global Fuels

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- Changes over time reflect both the effects of changes in oil reserve estimates among countries having different Freedom rankings, as well as changes in the Freedom rankings over time for different countries.
- From 1970 to 2008, global oil reserves more than doubled. Also during this time, the world saw many changes in global freedom, for better and for worse.
- Most growth in oil reserves until early 2000s was concentrated in a handful of countries, particularly Iran, Iraq, Saudi Arabia, UAE, and Venezuela. Over much of this period, the freedom rankings in those countries tended to worsen. The combination of the two led to a worsening of the global average.
- In the earlier years, much of the change in diversity is tied to changes in Saudi Arabia reserves, both in absolute terms as well as relative to global supplies. In 2003, Canada's massive deposits of oil sands were included in the global reserves, producing a dramatic improvement in the global average for freedom of reserves.
- Looking ahead, we have no methodology for projecting future reserves or freedom rankings. Growth in reserves in the freer countries, and/or improvements in freedom rankings anywhere, would lessen the future risks.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	9	N/A	N/A	N/A	2.7
Average Contribution	11.5	N/A	N/A	N/A	3.4

Primary Data Sources:

Historical: EIA International Statistics from 1980; *O&G Journal* for pre-1980; Freedom House.

Forecast: Not available.

Data Issues:

General: Freedom House's Freedom Index was used as a proxy for reliability of a supplier; the Herfindahl-Hirschman Index (HHI) was used as a measure of diversity. The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.

Historical: Mix of two historical datasets that match up closely.

Forecast: Metric was assumed to remain constant at its most recent measured value.

Metric #2

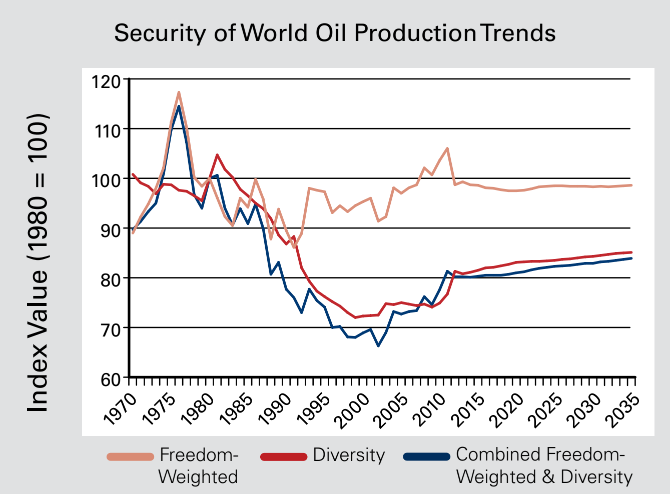
Security of World Oil Production

Definition: Global oil production weighted by (1) each country's Freedom House freedom ranking and (2) a diversity index applied to global oil production.

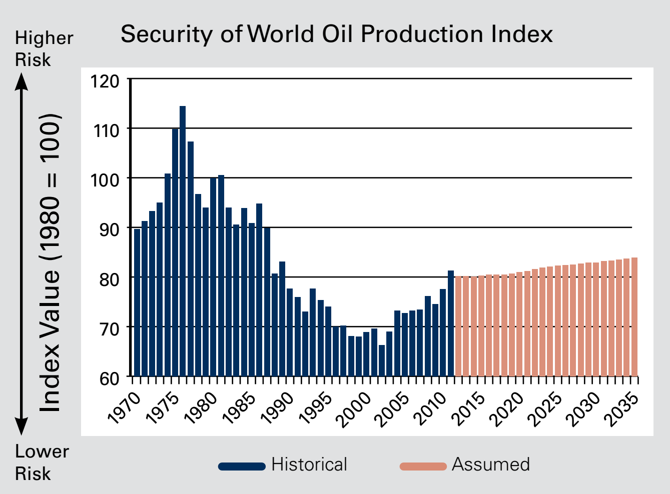
Importance: Indicates the level of risk attached to the average barrel of crude oil produced globally.

Category of Metric: Global Fuels

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- Changes over time reflect changes in oil production among countries, different Freedom House rankings, as well as changes in the Freedom rankings over time for different countries.
- The biggest change has been in the diversity trend, which has improved markedly since the 1970s. Part of this improvement is tied to the decline in the U.S. share of world production over the years, from over 20% in 1970 to less than 8% today. However, this increase in diversity was accompanied by a worsening in the freedom-weighted global oil production.
- The ups and downs in the freedom-weighted production trend reflect a variety of events around the world, including declining production in Iran after the fall of the Shah in 1978, increasing production in the U.S. from the Alaskan North Slope and the UK and Norway in the 1970s and 1980s, and declining production in the Former USSR after its breakup in 1989.
- Since the early 2000s, risks have begun a modest increase. Oil production in the UK, Norway, and Mexico has been declining in recent years, with increases in Iran, Iraq, Russia, and Saudi Arabia.
- Looking ahead, the projection methodology suggests a continuing but modest worsening of risks associated with the security of world oil. Growth in production in the freer countries and improvements in freedom rankings anywhere would lessen the future risks.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	7.0	5.0	6.0	N/A	4.8
Average Contribution	6.9	5.5	5.6	N/A	4.7

Primary Data Sources: Historical: EIA International Statistics, Freedom House.
Forecast: EIA *IEO 2010* for world oil production.

Data Issues: General: Freedom House's Freedom Index was used as a proxy for reliability of a supplier; the HHI was used as a measure of diversity. The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.
Historical: Mix of two historical datasets that match up fairly closely.
Forecast: Freedom metric assumed to remain constant at most recent measured value; diversity calculated from *IEO 2010*. Metric combined to come up with forecast.

Metric #3

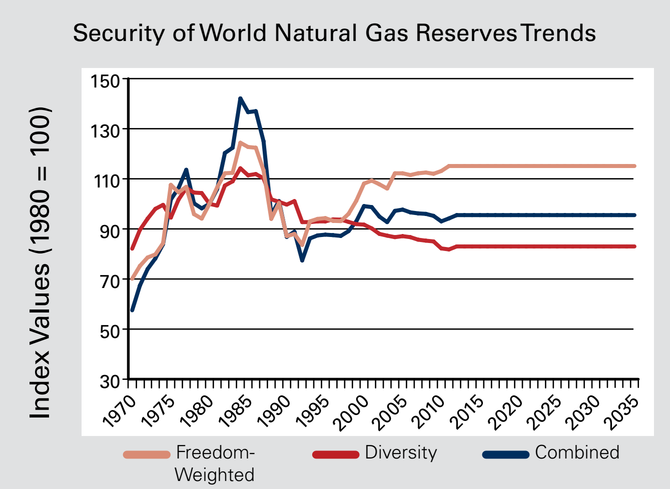
Security of World Natural Gas Reserves

Definition: Global proved natural gas reserves weighted by (1) each country's Freedom House freedom ranking and (2) a diversity index applied to global gas reserves.

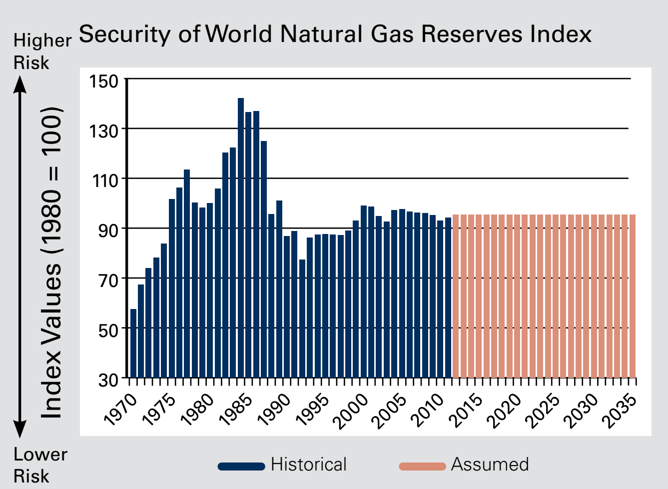
Importance: Indicates the risk attached to the average cubic foot of natural gas reserves globally. As a measure of reserves and not production, it largely reflects longer-term concerns.

Category of Metric: Global Fuels

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- Changes in the values over time reflect both the effects of changes in natural gas reserves among countries having different Freedom rankings, as well as changes in the Freedom rankings over time for different countries.
- Much of the changes observed in the above graphs result from the rapid growth in global gas reserves, which increased five-fold between 1970 and 2008. Much of this growth has been in countries such as Russia, Iran, Saudi Arabia, and Qatar, where the Freedom House rankings have fluctuated, but are generally worse than average. Part of this growth is related to actual discoveries, and part is related to improvements in global data reporting.
- The trend in diversity shows a couple of major shifts. Up until the mid 1980s, much of the change in diversity is tied to changes in Russian reserves estimates (and for earlier years, the Former Soviet Union), both in absolute terms as well as relative to global supplies.
- Looking ahead, there is no methodology for projecting future reserves or how Freedom House's rankings will change. Growth in reserves in the freer countries, and/or improvements in Freedom House rankings anywhere, would lessen future risks. In particular, in recent years the developments in shale gas and the subsequent increased estimates of the shale reserves are expected to have a significant impact on this metric in future years.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	6.0	N/A	N/A	2.0	2.2
Average Contribution	6.9	N/A	N/A	2.0	2.5

Primary Data Sources: Historical: EIA International Statistics from 1980; *O&G Journal* for pre-1980; Freedom House.
Forecast: Not available.

Data Issues: General: Freedom House's Freedom Index was used as a proxy for reliability of a supplier; HHI was used as a measure of diversity. The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.
Historical: Mix of two historical datasets that match up fairly closely.
Forecast: Metric was assumed to remain constant at its most recent measured value. Methodology for future production could be developed.

Metric #4

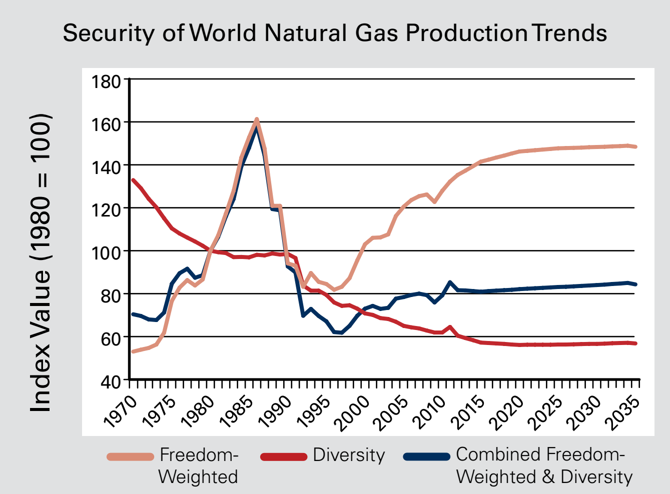
Security of World Natural Gas Production

Definition: Global natural gas production weighted by (1) each country's Freedom House freedom ranking and (2) a diversity index applied to global natural gas production.

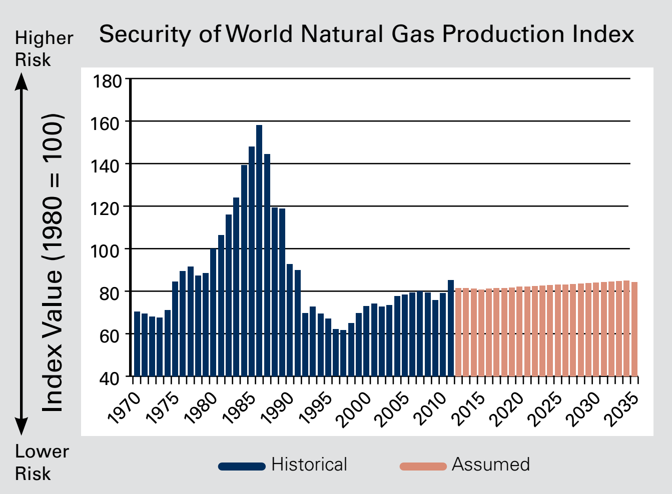
Importance: Indicates the level of risk attached to the average cubic foot of natural gas produced globally.

Category of Metric: Global Fuels

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- Natural gas production more than tripled since 1970. As world markets grew, U.S production fell as a percentage of global production, which improved diversity but worsened the average-weighted measure of supplies.
- From 1970 to the mid-1980s, there is a sharp trend toward less freedom in production, as the largest growth in production was seen in the USSR, which at the time was ranked as "not free."
- In the late 1980s and the 1990s, conditions improved, with greater gas production in the U.S. and the North Sea and improving freedoms in Russia and other FSU countries.
- In the last few years, the index has been worsening, largely due to adverse trends in freedom in Russia and other major gas-producing countries.
- The net effect of these trends was to increase global supply security risks through the mid-1980s. Beginning in the late 1980s, the energy security index shows a substantial overall improvement due to improving freedom among producing countries, expansion of production in many regions, and the subsequent breakup of the Former Soviet Union.
- The Index's projections suggest a continuing worsening in the security trends, but a slight improvement in diversity as the United State and other countries ramp up gas production. These two trends roughly offset each other. Growth in production in the freer countries (especially from shale), and/or improvements in Freedom House rankings anywhere would lessen future risks.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	5.0	2.0	3.0	2.0	3.1
Average Contribution	5.2	2.3	2.9	1.8	3.2

Primary Data Sources: Historical: EIA International Statistics from 1980; BP data for pre-1980; Freedom House.
Forecast: EIA IEO 2010 for world natural gas production.

Data Issues: General: Freedom House's Freedom Index was used as a proxy for reliability of a supplier; HHI was used as a measure of diversity. The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.
Historical: Mix of two historical datasets that match up fairly closely.
Forecast: Metric was assumed to remain constant at its most recent measured value.

Metric #5

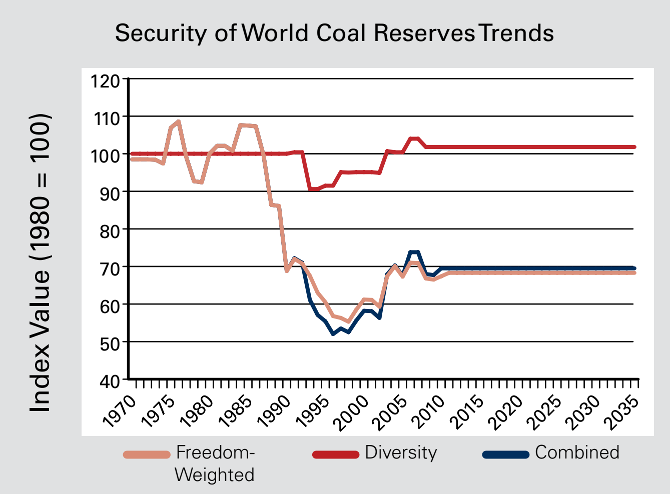
Security of World Coal Reserves

Definition: Global proven coal reserves weighted by (1) each country's Freedom House freedom ranking and (2) a diversity index applied to global coal reserves.

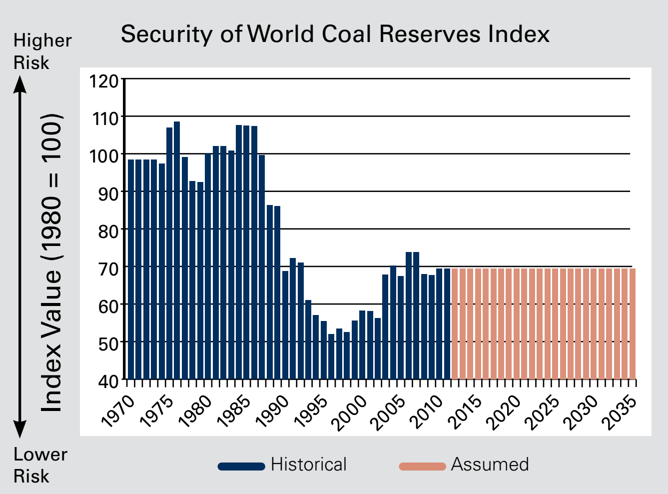
Importance: Indicates the risk attached to the average ton of coal reserves globally. As a measure of reserves, it largely reflects longer-term concerns.

Category of Metric: Global Fuels

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- Estimates of coal reserves generally do not exhibit the kinds of rapid shifts seen in oil and natural gas reserve estimates. The location of coal deposits is generally well-known and reserves tend to be large relative to production. Consequently, there is relatively little change in overall reserves and few shifts in diversity among countries.
- The changes in the values seen here tend to reflect more the changes in the Freedom House rankings of the major coal reserve-holding countries. Political developments in South Africa and Eastern Europe in the late 1980s, and in the Former Soviet Union in the 1990s, account for most of the changes observed here.
- Additionally, for the Former Soviet Union, what had been measured as one country was now split among several, resulting in a greater degree of global diversity.
- Looking ahead, there is methodology for projecting future reserves or freedom rankings. Growth in reserves in the freer countries and improvements in freedom rankings anywhere would lessen future risks.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	4.0	N/A	N/A	N/A	1.2
Average Contribution	3.8	N/A	N/A	N/A	1.1

Primary Data Sources:

Historical: Historical: EIA International Statistics; Freedom House.

Forecast: Not available.

Data Issues:

General: Freedom House's Freedom Index was used as a proxy for reliability of a supplier; HHI was used as a measure of diversity. The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.

Historical: Incomplete time series for historical coal reserves. Assumed that from 1970 to 1989, reserves remained constant at 1990 measured value.

Forecast: No data on future reserves or future Freedom rankings. Metric was assumed to remain constant at its most recent measured value. Methodology for future production could be developed.

Metric #6

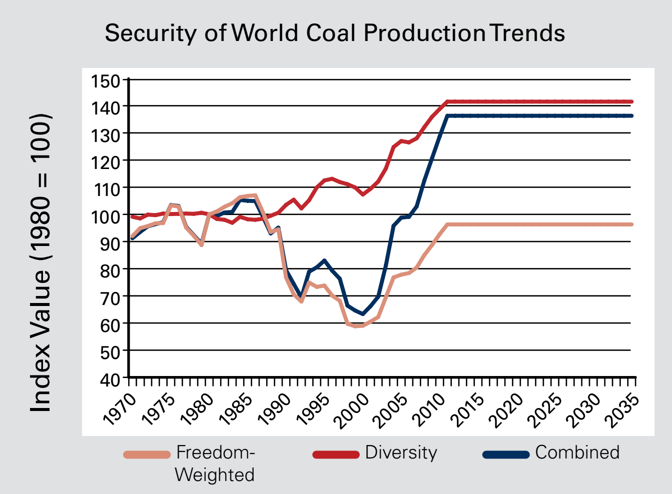
Security of World Coal Production

Definition: Global coal production weighted by (1) each country's Freedom House freedom ranking and (2) a diversity index applied to global coal production.

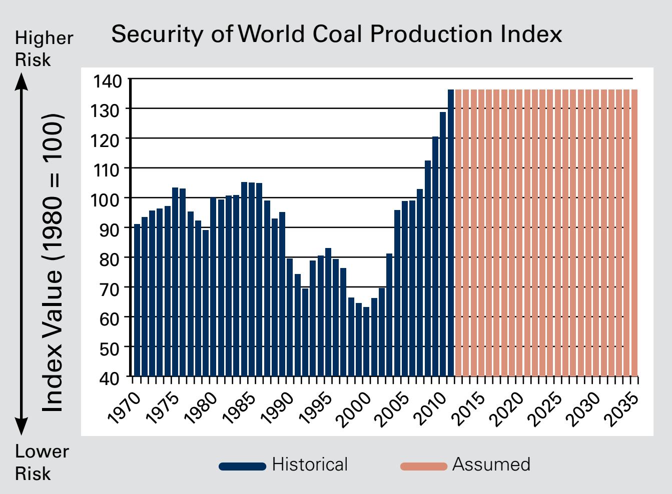
Importance: Indicates the level of risk attached to the average ton of coal production globally.

Category of Metric: Global Fuels

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- Globally, most of the growth in coal production has taken place in the U.S., China, India, Australia, and Indonesia. Changes in the values over time reflect both the effects of changes in coal production among countries having different Freedom rankings, as well as changes in the Freedom rankings over time for different countries.
- Most of the changes in the metric stem from changes in the freedom component. Most significantly, the events leading up to and following the breakup of the Former Soviet Union, as well as the political developments in South Africa and Eastern Europe beginning in the late 1980s, brought a significantly greater degree of freedom to a large part of the global reserves.
- More recently, changes in the metric are dominated by the rapid growth in Chinese coal production, where China's production now accounts for over 40% of global coal production.
- Looking ahead, there is no methodology for projecting future reserves or freedom rankings. Growth in production in the freer countries and improvements in freedom rankings anywhere would lessen future risks.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	2.0	1.0	1.0	N/A	1.1
Average Contribution	2.2	1.2	1.0	N/A	1.2

Primary Data Sources:

Historical: EIA International Statistics from 1980; IEA for pre-1980; Freedom House.
Forecast: Not available.

Data Issues:

General: Freedom House's Freedom Index was used as a proxy for reliability of a supplier; HHI was used as a measure of diversity. The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.
Historical: Mix of two historical datasets that match up fairly closely.
Forecast: No data on future Freedom rankings. Metric was assumed to remain constant at its most recent measured value.

Metric #7

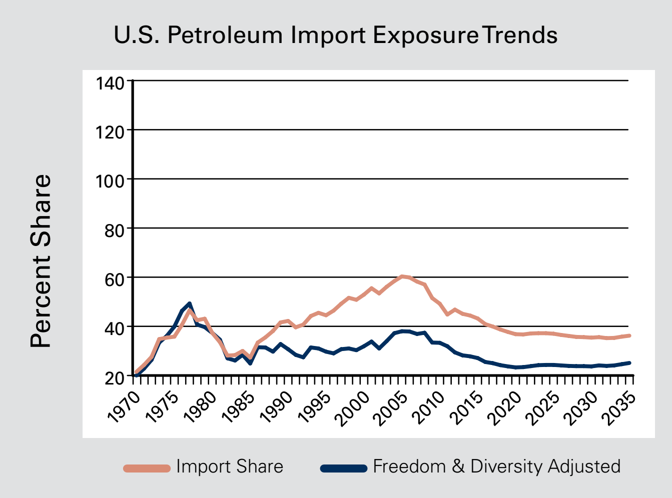
Security of U.S. Petroleum Imports

Definition: Net petroleum imports as a percentage of total U.S. petroleum supply adjusted to reflect (1) each country's Freedom House freedom ranking and (2) a diversity index applied to non-U.S. oil producing countries.

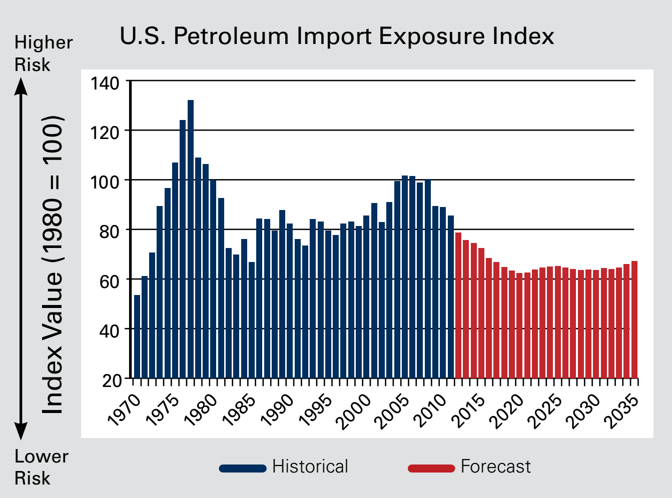
Importance: Indicates the degree to which changes in import levels expose the U.S. to potentially unreliable and/or concentrated supplies of crude and refined petroleum.

Category of Metric: Fuel Imports

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- At the beginning of the 1970s, imports were barely 20% of U.S. supply. This rapidly grew to more than 40%, before oil price shocks, supply disruptions, economic recessions, and fuel economy standards caused oil imports to decline as a share of demand.
- From the mid-1980s until recently, however, imported oil's share started growing, hitting 60% of total supply in 2005.
- Looking forward, EIA's projections in *AEO 2012* indicate a gradual reduction in the share of imports in U.S. petroleum supplies.
- A somewhat different picture emerges when the freedom and diversity weightings are applied. Even though imports accounted for a smaller portion of oil usage in the late 1970s than they do today (or are forecast to do in the future), the import risk at that time was much larger because the freedom and diversity of those supplies was much more adverse at that time. Conversely, the risk of high levels of U.S. oil imports today is tempered by increased domestic output and the relative increases in diversity and freedom seen in world markets.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	8.0	N/A	9.0	N/A	4.2
Average Contribution	8.2	N/A	8.8	N/A	4.3

Primary Data Sources:

Historical: EIA *AER,* Table 5.1; EIA International Statistics; Freedom House.
Forecast: EIA *AEO 2011*, Tables 11; EIA *IEO 2010* for world oil production.

Data Issues:

General: Freedom House's Freedom Index was used as a proxy for reliability of a supplier; HHI was used as a measure of diversity. The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.
Historical: None.
Forecast: No data on future Freedom rankings. Freedom ranking assumed to remain constant at most recent measured value and applied to projected imports.

Metric #8

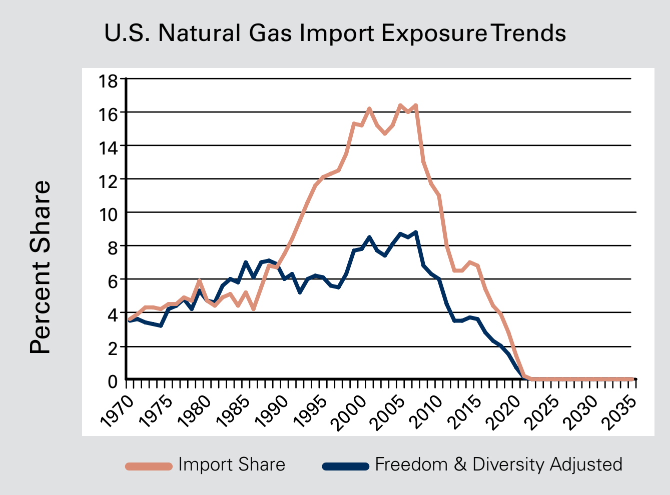
Security of U.S. Natural Gas Imports

Definition: Net natural gas imports as a percentage of total U.S. natural gas supply risk-adjusted to reflect (1) each country's Freedom House freedom ranking and (2) a diversity index applied to non-U.S. natural gas producing countries.

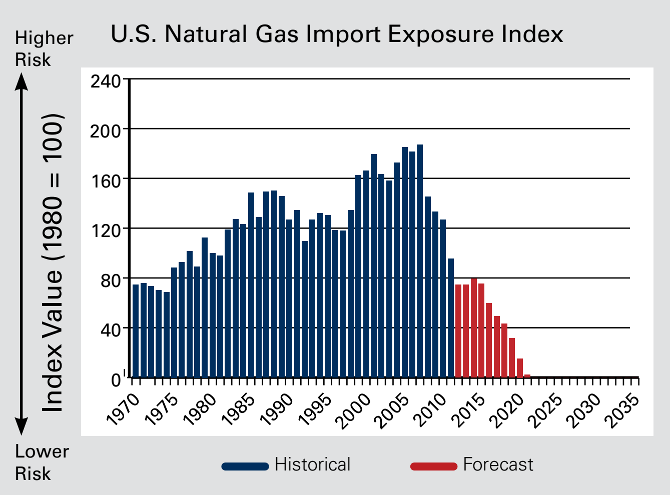
Importance: Indicates the degree to which changes in import levels expose the U.S. to potentially unreliable and/or concentrated supplies of natural gas.

Category of Metric: Fuel Imports

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- The historical data show a strong increasing trend in natural gas import shares. In 1970, the U.S. met more than 95% of its natural gas demand with domestic resources. Since then, and continuing into this decade, natural gas imports climbed sharply, recently reaching about 16% of total U.S. supply.
- This growth in imports was accompanied by deterioration in the freedom index for global gas production, driven largely by growth from Russia and other FSU countries.
- Prior to the 1990s, the non-U.S. portion of global gas was dominated by FSU production. With the breakup of the FSU, coupled with growing production in other regions, there was a marked improvement in both supply freedom and supply diversity.
- Looking forward, EIA's projections in *AEO 2012* indicate a substantial reduction in U.S. gas imports. This is a significant change from the projections of just a few years ago. Decreasing projections of economic growth, increasing domestic supplies, and other factors are combining to reduce our expectations of future natural gas import volumes.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	3.0	N/A	2.0	N/A	1.3
Average Contribution	4.5	N/A	2.8	N/A	1.9

Primary Data Sources:

Historical: EIA *AER,* Table 6.1; Freedom House.
Forecast: EIA *AEO 2011,* Table 13; EIA *IEO 2010* for world natural gas production.

Data Issues:

General: Freedom House's Freedom Index was used as a proxy for reliability of a supplier; HHI was used as a measure of diversity. The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.
Historical: None.
Forecast: No data on future Freedom rankings. Freedom ranking assumed to remain constant at most recent measured value and applied to projected imports.

Metric #9

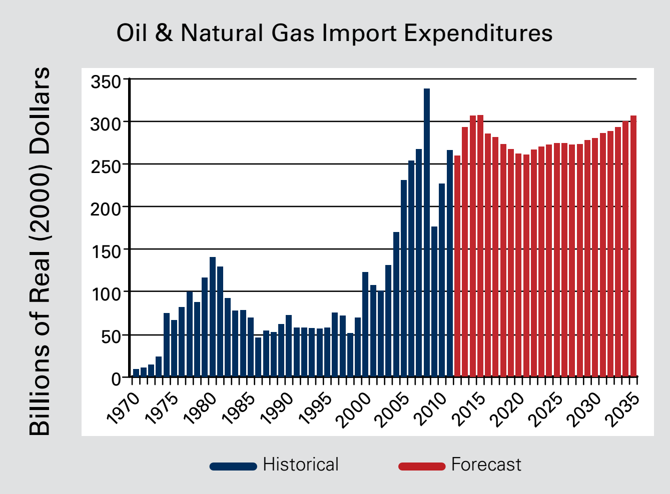
Oil & Natural Gas Import Expenditures

Definition: Value of net imports of crude oil, petroleum products, and natural gas in billions of real (2000) dollars.

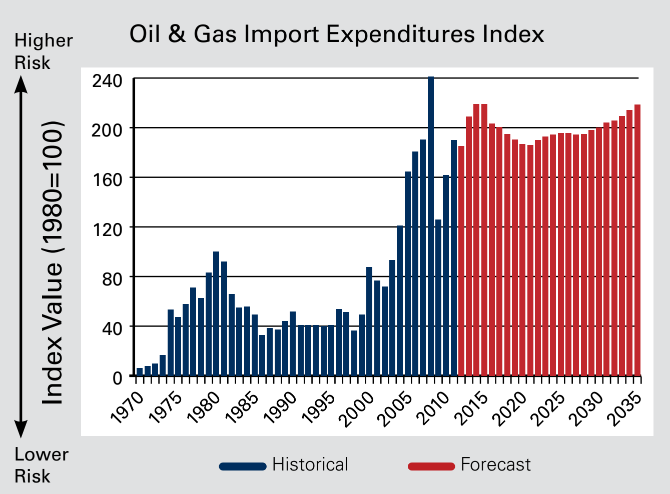
Importance: Indicates lost domestic economic investment and opportunity and the relative magnitude of revenues received by foreign suppliers.

Category of Metric: Fuel Imports

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- The historical data dramatically show the effects of the oil shocks of the 1970s, as well as the recent run-up in oil prices. In the early 1970s, import costs were less than $10 billion per year measured in real (2000) dollars. By the end of that decade, we were spending over $100 billion per year on oil and natural gas imports.
- Lower fuel prices and reduced imports held U.S. import costs in check throughout much of the 1980s and 1990s. Since 2000, however, sharply increasing imports coupled with sharply higher prices, led to import costs exploding to over $200 billion per year.
- Looking forward, EIA's projections in *AEO 2012* indicate a brief easing in import costs through 2020. However, EIA's projections indicate that by 2035 import costs will reach more than $300 billion per year (in 2000 dollars).

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	6.0	6.0	N/A	N/A	3.6
Average Contribution	5.3	5.8	N/A	N/A	3.1

Primary Data Sources:

Historical: EIA *AER,* Table 3.9.

Forecast: EIA *AEO 2011,* Table 11 & Supplemental Table 116.

Data Issues:

General: Cost data converted to 2000 dollars. The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.

Metric #10

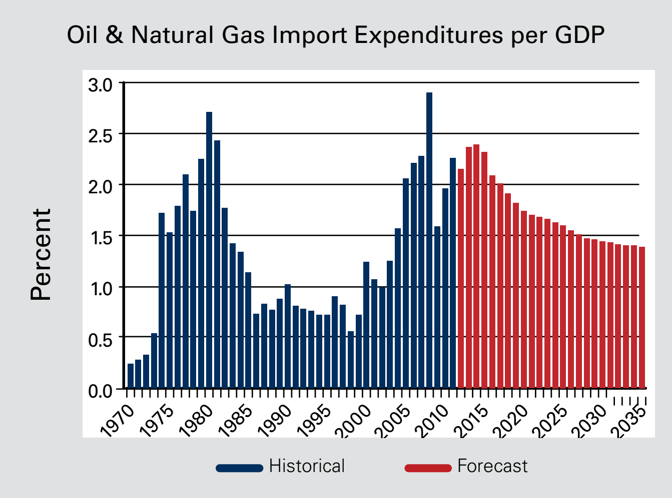
Oil & Natural Gas Import Expenditures per GDP

Definition: Value of net imports of crude oil, petroleum products, and natural gas as a percentage of GDP.

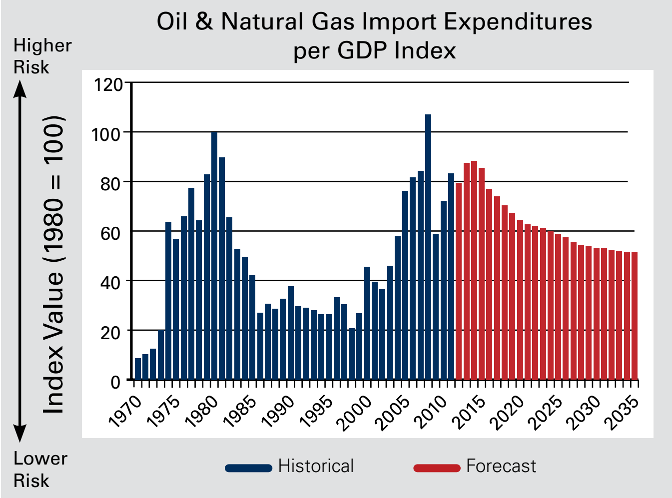
Importance: Indicates the susceptibility of the U.S. economy to imported oil and gas price shocks.

Category of Metric: Fuel Imports

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- Expressed as a percentage of GDP, historical data show the dramatic effects of the oil shocks of the 1970s as well as the recent run-up in oil prices. Because the economy was much smaller in the 1970s than it is today, the dollar cost of those oil shocks was a relatively bigger share of total GDP, even though the U.S. imported much less oil then than we do today.
- The second large rise in risk occurred in the late 2000s. This peak reflects record real oil prices coupled with significantly larger import volumes, which pushed the oil and natural gas import expenditure risk index to its highest point in about 30 years.
- Looking forward, EIA's projections in *AEO 2012* indicate that costs for oil and natural gas imports again will rise within a few years. However, since the U.S. economy is also projected to grow, the percentage of GDP directed toward these fuel imports gradually declines.
- Still, over the entire period from 2012 to 2035, the level of import expenditures as a share of GDP generally is forecast to remain fairly high at 1.5 % or above through 2027—more than double the rate that prevailed from the mid-1980s to 2000—indicating a continuing reliance on imports, especially of oil.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	N/A	9.0	N/A	N/A	2.7
Average Contribution	N/A	5.7	N/A	N/A	1.5

Primary Data Sources:

Historical: EIA *AER,* Table 3.9; DOC BEA for GDP.

Forecast: EIA *AEO 2011,* Tables 11 & 20.

Data Issues:

General: The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.

Metric #11

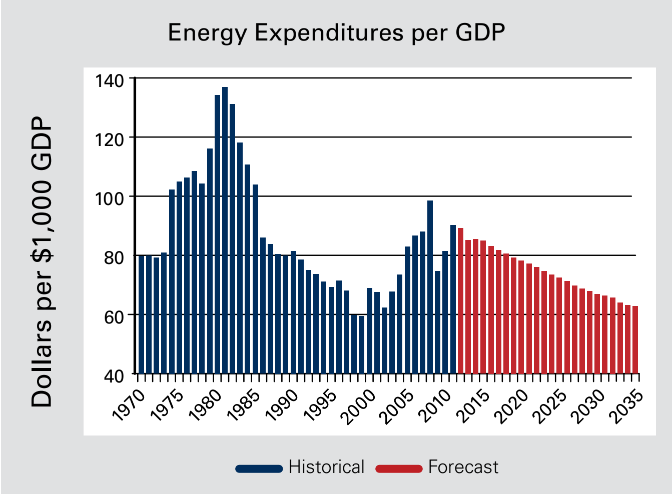
Energy Expenditures per GDP

Definition: Total real (2000) dollar cost of energy consumed per $1,000 of GDP per year.

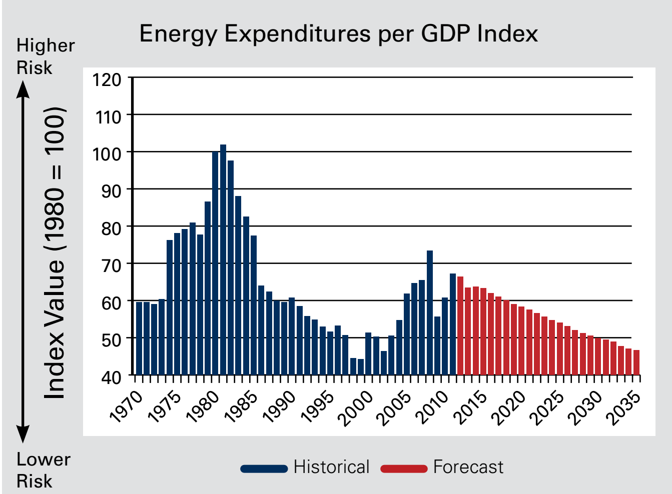
Importance: Indicates the magnitude of energy costs in the U.S. economy and its susceptibility to energy price shocks and exposure to price changes.

Category of Metric: Energy Expenditures

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- While the trends in energy consumption per capita or energy intensity generally show only modest year-to-year changes, expenditure data show a much more volatile picture.
- The price increases in the 1970s and early 1980s led to a sharp rise in energy costs per dollar of GDP. This eased in the mid-1980s and remained at moderate levels until after 2000.
- In recent years, energy costs have risen sharply, peaking in 2008. However, despite the high absolute prices for energy, a greater level of energy efficiency and a larger GDP combined to make the 2008 peak significantly below the 1980s peak.
- Looking forward, EIA's projections in *AEO 2012* indicate energy prices and expenditures gradually declining. By 2005, expenditures are expected to be as low as they were in the mid-1990s.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	5.0	7.0	N/A	N/A	3.6
Average Contribution	3.8	5.9	N/A	N/A	2.7

Primary Data Sources:

Historical: EIA *AER,* Table 3.5; DOC BEA for GDP.

Forecast: EIA *AEO 2011*, Tables 2, 3 & 20.

Data Issues:

General: The time series was normalized to an indexed value where the year 1980 is set at 100.

Historical: Incomplete data pre-1973; proxies developed.

Projection: None.

Metric #12

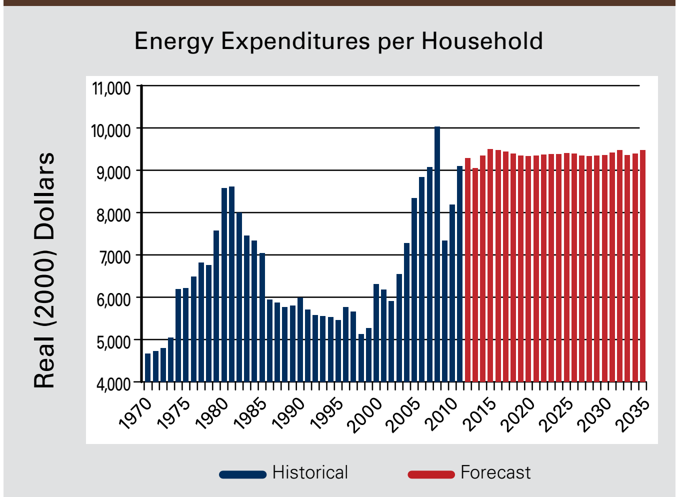
Energy Expenditures per Household

Definition: Total real (2000) dollar cost of the energy consumed per household per year.

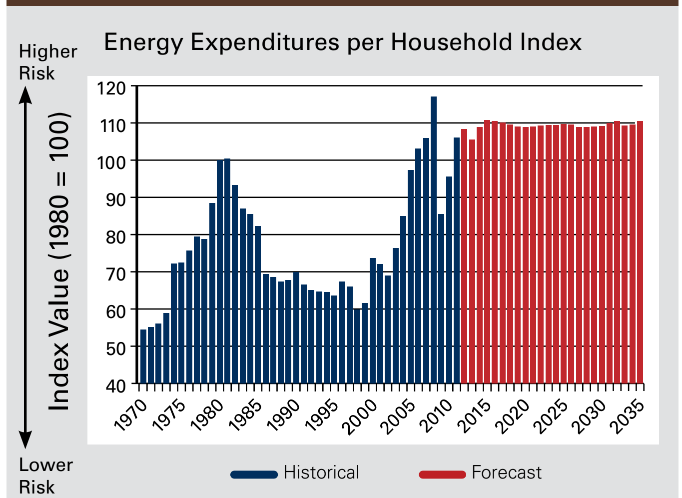
Importance: Indicates the importance of energy in household budgets and the susceptibility of U.S. households to energy price shocks.

Category of Metric: Energy Expenditures

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- While the trends in energy consumption per capita and energy intensity generally show only modest year-to-year changes, expenditure data show a much more volatile picture.
- Price increases in the 1970s led to a doubling of per-household energy costs. Similarly, the recent price spikes led to nearly a doubling in per-household energy expenditures, even after starting from a higher base.
- Looking forward, EIA's projections in *AEO 2012* indicate steady and continuing increases in per-household energy expenditures. This projection is driven partly by continuing and increasing high prices, particularly for petroleum products.
- Over the *AEO* projection period of 2012-2035, the total energy expenditures are projected to rise at over 1.1% per year in real terms, faster than projected growth in the number of households.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	N/A	9.0	N/A	N/A	2.7
Average Contribution	N/A	9.1	N/A	N/A	2.4

Primary Data Sources:

Historical: EIA *AER,* Table 3.5; DOC BEA for GDP; Census Bureau *Housing Vacancy Survey.*

Forecast: EIA *AEO 2011,* Tables 3 & 4.

Data Issues:

General: The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.

Historical: Number of housing units, the category the Census Bureau uses, used as a proxy for number of households, the category EIA uses.

Forecast: None.

Metric #13

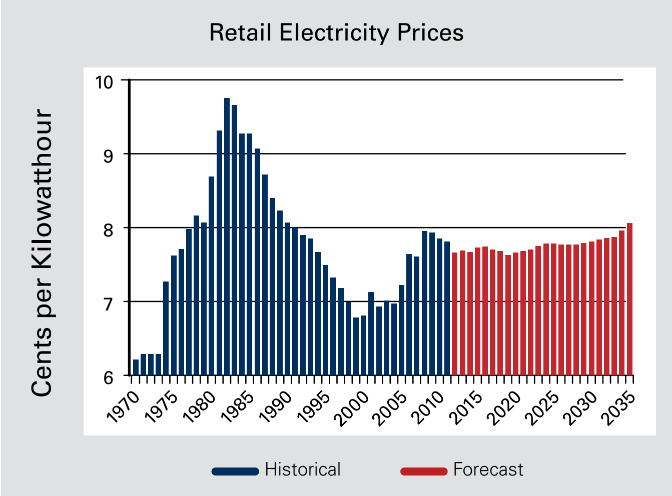
Retail Electricity Prices

Definition: Average electricity costs in the U.S. in cents per kWh in real (2000) dollars.

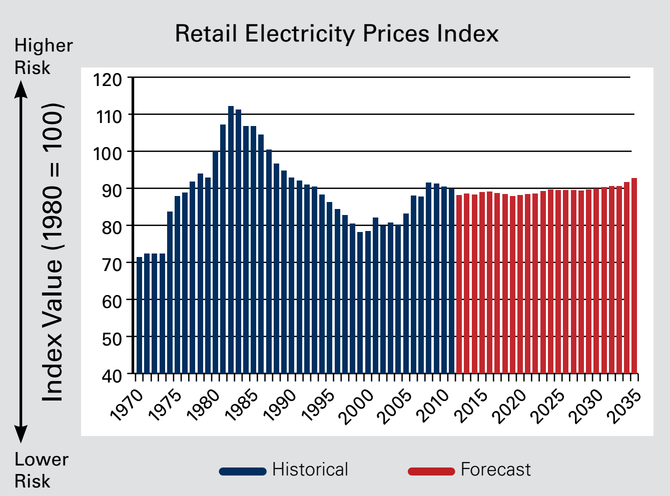
Importance: Indicates the availability of low-cost, reliable forms of power generation.

Category of Metric: Energy Expenditures

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:
- During the 1970s, rapidly increasing fuel prices, construction costs for new capacity, and financing costs led to a sharp increase in electricity rates.
- From the mid-1980s until 2000, prices fell at a steady rate as a result of lower fossil fuel prices, improvements in natural gas supplies, combined cycle generating technologies, and reduced levels of capital-intensive capacity construction.
- In this decade, the increases in natural gas and coal prices, plus sharply higher costs for new construction, have contributed to an increasing price trend for power generation.
- The economic recession beginning in 2008 led to sharply lower fuel prices, reversing the recent upward trend.
- Looking forward, EIA's projections in *AEO 2012* indicate that retail electricity prices will increase because of new regulations targeting coal and expanded use of renewables.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	N/A	10.0	N/A	N/A	3.0
Average Contribution	N/A	11.7	N/A	N/A	3.1

Primary Data Sources:

Historical: EIA *AER,* Table 8.10.

Forecast: EIA *AEO 2011,* Table 8.

Data Issues:

General: Price data converted to 2000 dollars. The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed. Retail prices include taxes, which are transfer prices rather than economic costs.

Metric #14

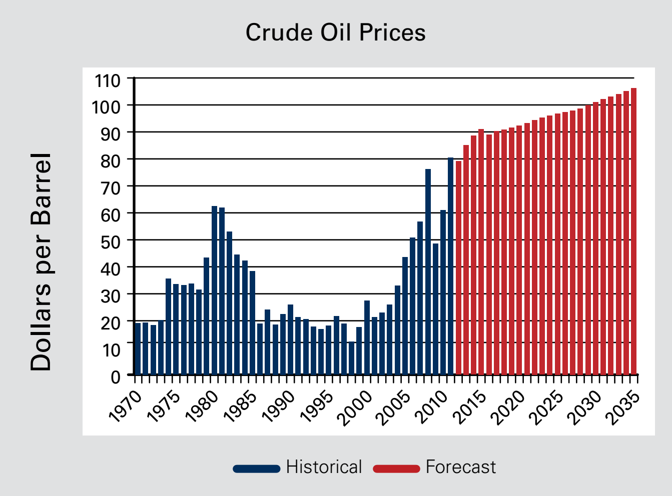
Crude Oil Prices

Definition: Cost per barrel of crude oil landed in the U.S. in real (2000) dollars.

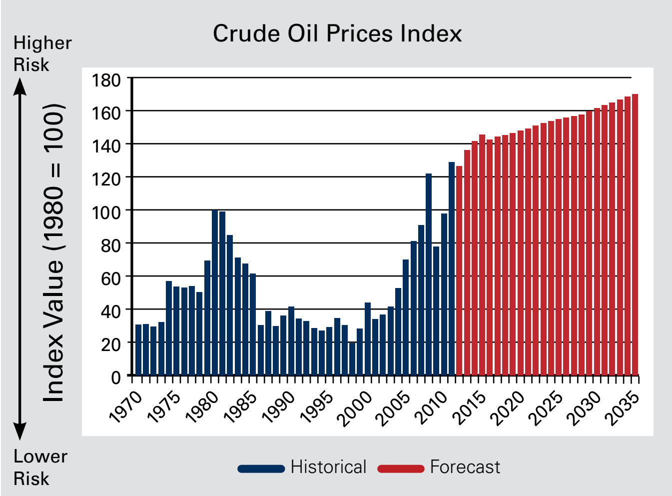
Importance: Indicates the susceptibility of the U.S. economy to high prices for petroleum, which supplies a significant portion of U.S. energy demand.

Category of Metric: Energy Expenditures

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- The oil price shocks of the 1970s and early 1980s are clearly seen in the historical data for this metric. Because high inflation rates were also experienced over much of this period, real prices jumped at a slightly less dramatic pace.
- From the early 1980s until just a few years ago, oil prices remained at relatively low levels.
- Beginning earlier this decade, imported oil prices began a steady and rapid climb, peaking in 2008. Greater demand from China, India, and other large emerging economies and turmoil in the Middle East contributed to the rise. Currently, the global recession and the response to earlier high prices have dampened global oil demand and prices.
- Looking forward, EIA's projections in *AEO 2012* indicate that crude oil prices will continue to climb, reaching over $100.00 per barrel by 2030 (in constant 2000s).

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	13.0	13.0	6.0	N/A	9.0
Average Contribution	8.2	9.1	3.6	N/A	5.6

Primary Data Sources:

Historical: EIA *AER*, Table 5.19 & 5.21.

Forecast: EIA *AEO 2011*, Table 1.

Data Issues:

General: Cost data converted to 2000 dollars. The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.

Historical: EIA data on imported crude costs do not go back further than 1973. Estimates for 1970 to1972 were based upon crude oil refiner acquisition costs.

Forecast: None.

Metric #15

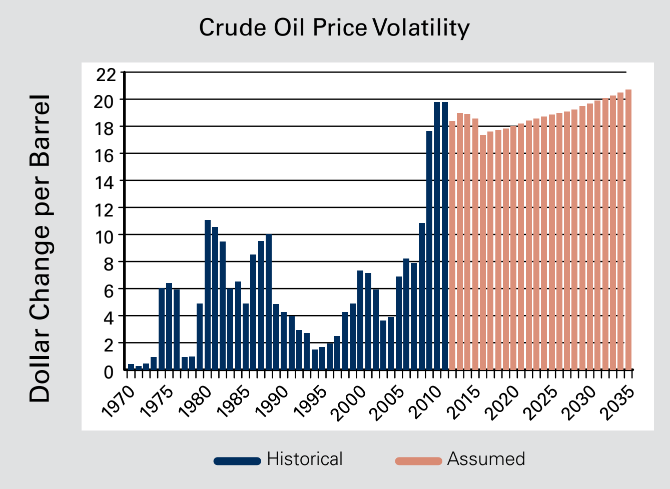
Crude Oil Price Volatility

Definition: Annual change in real (2000) crude oil prices averaged over a three-year period.

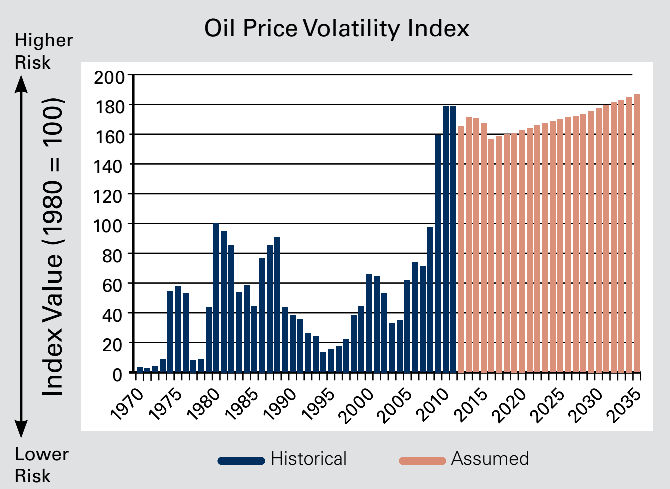
Importance: Indicates the susceptibility of the U.S. economy to large swings in the price of petroleum, which supplies a significant portion U.S. energy demand.

Category of Metric: Price Volatility

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- The historical trend vividly shows the high volatility seen in the oil market in recent decades. The two oil price shocks in the 1970s and early-1980s show up as periods of high volatility, as does the oil price plummet of the mid-1980s.
- More recently, the oil market turmoil—both up and down—has raised volatility to record levels. Upside price volatility created economic pain, raised shipping costs, disrupted transportation economics, and created massive windfalls for oil-exporting countries.
- But downside price volatility has not been without problems and dislocations either, as oil exploration and drilling plans are deferred and renewable energy projects become less attractive.
- Looking over the forecast period from 2012 to 2035, there are no comparable data indicating price volatility. Forecasting models generally assume a market in balance, and typically do not show volatility. But as these data show, long periods of price stability are not the norm.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	5.0	3.0	10.0	N/A	4.4
Average Contribution	3.3	2.2	6.2	N/A	2.8

Primary Data Sources:

Historical: EIA *AER*, Table 5.21 & 5.18.

Forecast: Not available.

Data Issues:

General: The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.

Historical: Proxy data used to develop pre-1970 data inputs for a 1970 estimate.

Forecast: Metric was assumed to remain constant at its 1970-2009 average after a five-year transition period. The 1970-2009 dollar average was arrived at using average volatility measured as a percent.

Metric #16

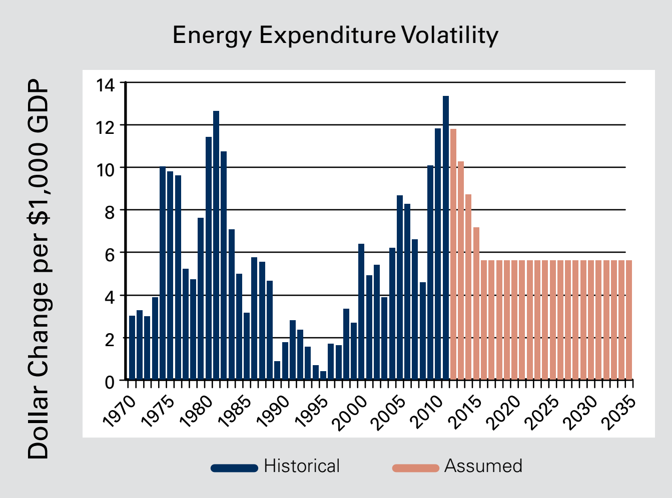
Energy Expenditure Volatility

Definition: Average annual change in real (2000) U.S energy expenditures per $1,000 of GDP.

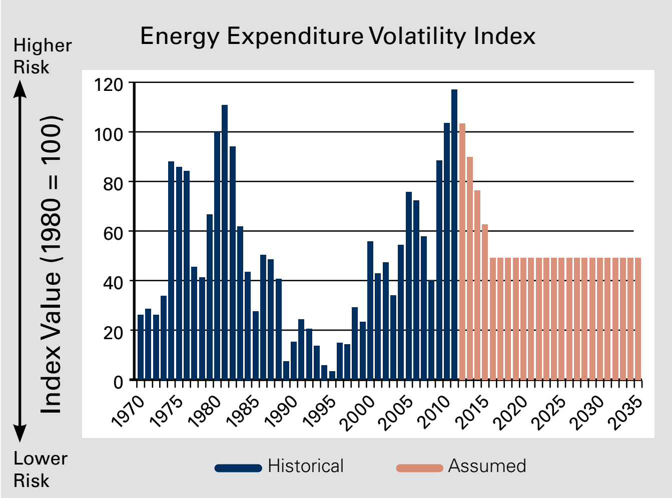
Importance: Indicates the susceptibility of the U.S. economy to large swings in expenditures for all forms of energy.

Category of Metric: Price Volatility

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- The historical trend shows the dramatic changes in energy costs and high volatility in energy expenditures in recent decades. The two oil price shocks in the 1970s and early 1980s can be seen in the Index as periods of high volatility. Similar volatility is seen in oil markets in the 2000s.
- During these volatile periods, the annual changes in energy costs approached one % of total GDP, equal to many tens of billions of dollars.
- The changes seen in the 1970s and early-1980s are actually slightly larger than the volatility observed in the 2000s, mainly because GDP was much larger, and partly because U.S. petroleum and other energy use today is proportionately smaller than it used to be.
- Looking forward from 2012-2035, there are no comparable data indicating volatility of energy expenditures. Forecasting models such as that used in EIA's *AEO 2012* project energy expenditures, but generally assume a market in balance, and typically do not show year-to-year volatility. But as with crude oil prices, these data show that long periods of stability are not the norm.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	N/A	5.0	14.0	N/A	4.3
Average Contribution	N/A	3.2	7.6	N/A	2.4

Primary Data Sources:

Historical: EIA *AER,* Table 3.6 & 3.1; EIA MER Table 1.3 & 1.6; DOC BEA for GDP.

Forecast: Not available.

Data Issues:

General: The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.

Historical: Additional data sources were needed to estimate values for 1970 because these data were not available and for 2007 and 2008 because that data is not yet available.

Forecast: Metric was assumed to remain constant at its 1970-2009 average after a five-year transition period.

Metric #17

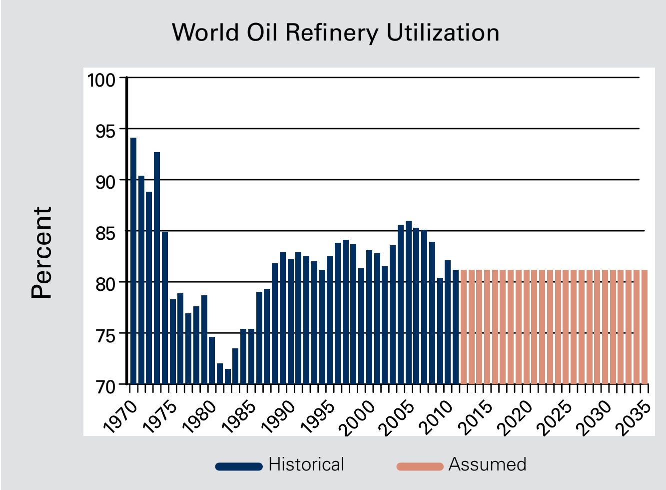
World Oil Refinery Utilization

Definition: Average % utilization of global petroleum refinery capacity.

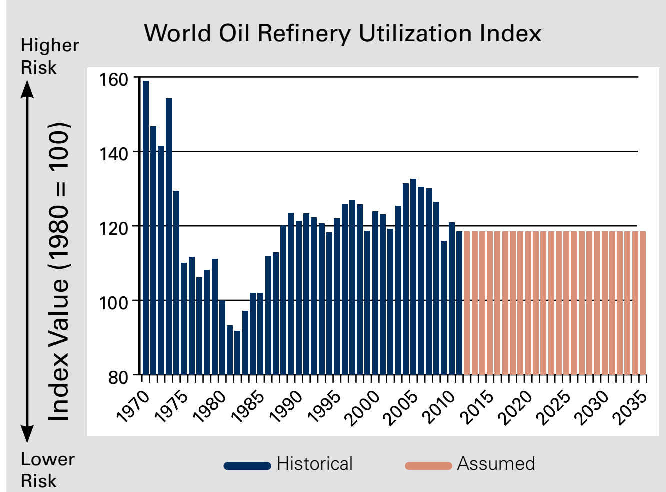
Importance: Indicates the likelihood of higher prices at high capacity utilization, and higher risk of supply limitations during refinery outages or disruptions.

Category of Metric: Price Volatility

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- The 1970s began as a time of very high capacity utilization, and this lack of excess capacity greatly increased our vulnerability during the Arab Oil Embargo.
- Following the oil price shocks of the 1970s, rapid growth in refinery capacity and a moderating of oil consumption led to a sharp drop in capacity utilization rates through much of the 1980s.
- Utilization rates have gradually increased over the years, and in recent years the refinery utilization rates have reached levels not seen since the 1970s.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	3.0	N/A	6.0	N/A	2.1
Average Contribution	4.2	N/A	8.0	N/A	2.9

Primary Data Sources:

Historical: *BP Statistical Review* from 1980; API data pre-1980.

Forecast: Not available.

Data Issues:

General: The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.

Historical: Minor differences observed in comparing historical data trends seen in the BP and API datasets. Possible improvements could be realized in quantifying risks as utilization approaches full capacity.

Forecast: Metric was assumed to remain constant at its most recent measured value.

Metric #18

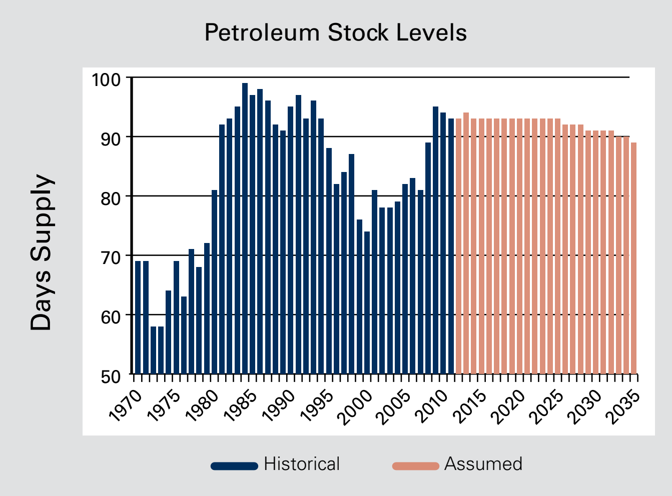
Petroleum Stock Levels

Definition: Average days supply of petroleum stocks, including strategic petroleum reserve (SPR), non-SPR crude, and petroleum products.

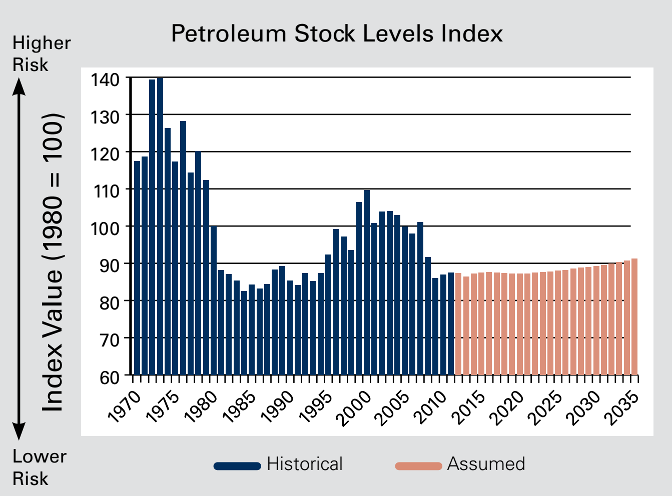
Importance: Indicates vulnerability of the U.S. to a supply disruption based on the quantity of oil stocks that are available domestically to be drawn down.

Category of Metric: Price Volatility

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- The historical trend shows the relatively low level of petroleum stocks that persisted through much of the 1970s.
- During the 1980s and into the 1990s, stocks levels were collectively at a higher level, largely as a result of the SPR build-up and partly due to an increase in non-SPR crude stocks.
- During the 1990s, SPR levels held roughly steady while non-SPR stocks declined, resulting in a downward trend in days supply, and thus greater energy security risk.
- Since 2000, stock levels have again improved, primarily as a result of further increases in the SPR.
- Looking forward over the forecast period, we do not have a good methodology for projecting stock levels long-term. By holding the physical stock levels constant, the days supply estimate gradually declines as the petroleum consumption gradually increases.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	2.0	N/A	6.0	N/A	1.8
Average Contribution	2.3	N/A	6.7	N/A	2.1

Primary Data Sources:

Historical: EIA *AER,* Tables 5.13a-d & 5.16.

Forecast: EIA *AEO 2011,* Table 11.

Data Issues:

General: For this metric, a higher value indicates lower risk. Therefore, the values were inverted and the time series normalized to an indexed value where the year 1980 is set at 100.

Historical: None.

Forecast: Uses *AEO 2011* projections of consumption and assumes petroleum stocks remain constant at most recent measured value.

Metric #19

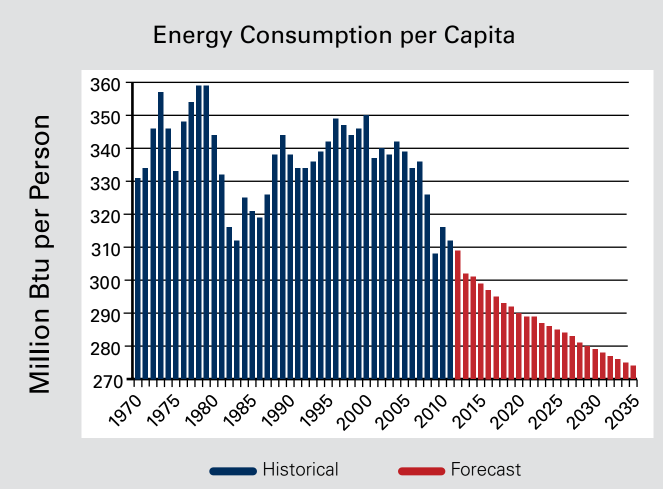
Energy Consumption per Capita

Definition: Million Btu consumed per person per year.

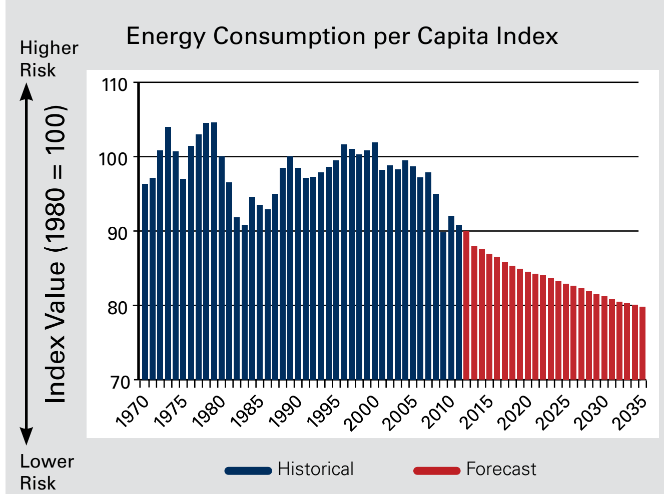
Importance: Indicates changes in both energy intensity and in per-capita GDP.

Category of Metric: Energy Use Intensity

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- The historical data show rising per-capita energy consumption during the 1960s and early 1970s. This period was marked by rapid growth in electricity use, automobile ownership, and the economy that outpaced energy intensity gains, leading to a rise in per capita energy use.
- Oil shocks and rising prices in the 1970s led to a decline in per-capita consumption.
- During much of the 1980s and 1990s, relatively low energy prices began to undo some of the earlier improvements, but the per-capita levels never again reached the peaks seen in the late 1970s.
- More recently, the high fuel prices, especially for petroleum and natural gas, have dampened overall energy consumption.
- EIA's projections indicate a continuing gradual reduction. This projection is driven partly by continuing high prices, and partly by policy changes relating to CAFE standards and other energy efficiency requirements. But the overall decline is modest: By 2035, per capita energy use is projected to be 83% of the 1970 level.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	N/A	3.0	N/A	8.0	2.5
Average Contribution	N/A	3.8	N/A	7.9	2.8

Primary Data Sources:

Historical: EIA *AER*, Table 2.1; U.S. Statistical Abstract 2009, Table 2.

Forecast: EIA *AEO 2011*, Tables 2 & 20.

Data Issues:

General: The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.

Metric #20

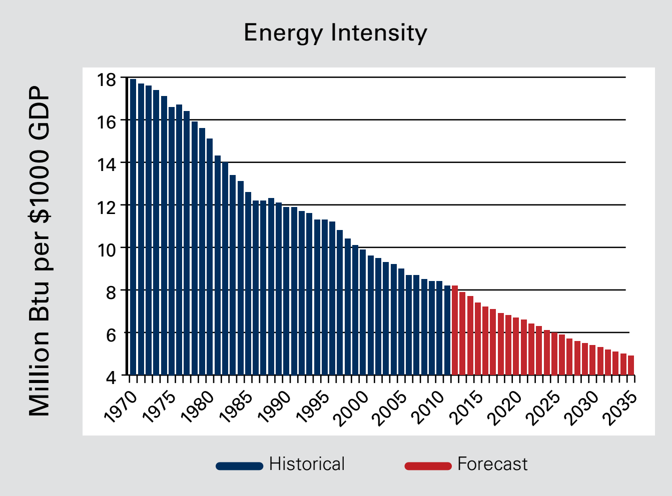
Energy Intensity

Definition: Million Btu of primary energy used in the economy per $1,000 of real (2000) GDP.

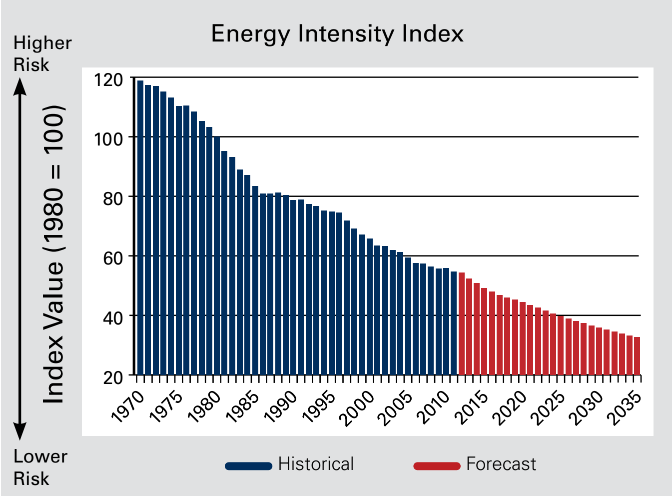
Importance: Indicates the importance of energy as a component of economic growth.

Category of Metric: Energy Use Intensity

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- Long-term trends show considerable improvement in U.S. energy intensity. Whereas in 1970 it took about 18,000 Btu to produce one dollar of real (2000) GDP, it now takes less than half of that.
- The historical data show a relatively rapid pace of energy intensity improvement during the 1970s and early 1980s, responding to oil price shocks, automobile mileage standards, and other policies and measures.
- Beginning in the mid-1980s, the pace of improvement slowed, possibly due in part to the lower fuel prices that prevailed.
- In recent years, higher energy costs have quickened the pace of improvement to levels near those attained in the 1970s. The long-term trend towards a more service-orientated economy also has contributed to the improvement in intensity.
- Looking forward, EIA's projections in *AEO 2012* indicate a gradual continuation in the reduction of energy intensity. Over 2012-2035, EIA projects an annual rate of improvement of 2.2%. In EIA's projections, the energy intensity in the year 2035 is well less than one-third the intensity seen in 1970. In other words, each million Btu consumed in 2035 will power more than three times as much GDP as in 1970.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	N/A	4.0	N/A	10.0	3.2
Average Contribution	N/A	4.3	N/A	8.3	3.0

Primary Data Sources:

Historical: EIA *AER*, Table 2.1; DOC BEA for GDP.

Forecast: EIA *AEO 2011*, Tables 2 & 20.

Data Issues:

General: GDP data converted to 2000 dollars. The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.

Metric #21

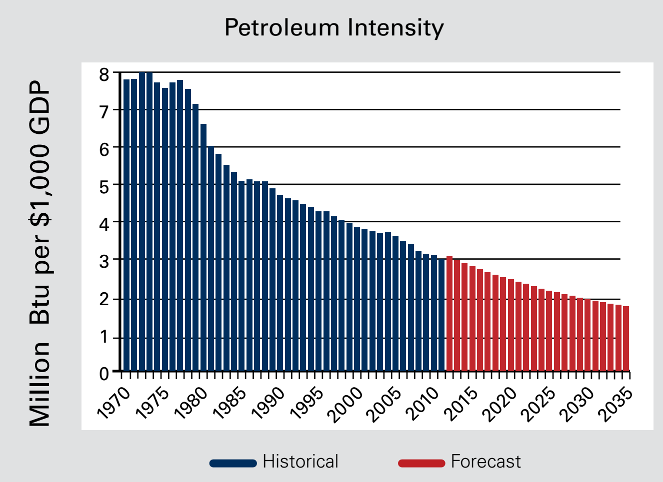
Petroleum Intensity

Definition: Million Btu of petroleum consumed per $1,000 GDP in real (2000) dollars.

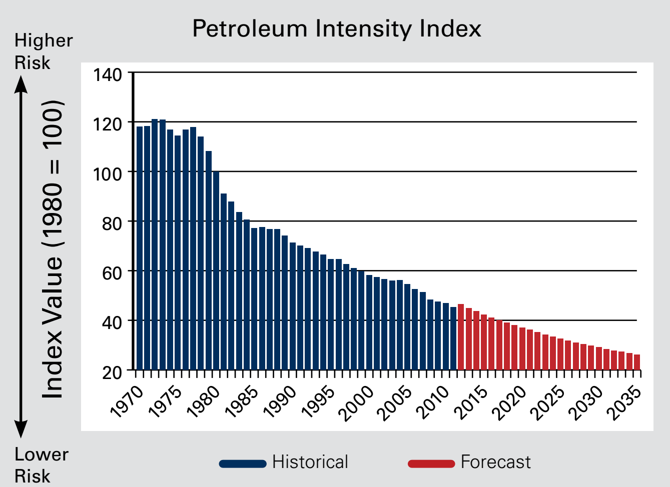
Importance: Indicates the importance of petroleum as a component of economic growth.

Category of Metric: Energy Use Intensity

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- The historical data show a much higher level of petroleum consumption per dollar of GDP during the 1970s. The oil shocks and rising prices during that period were followed by sharp reductions in petroleum consumption in subsequent years. From 1973 to 1983, U.S. petroleum use intensity fell by over 30%, for an average annual improvement exceeding 3.5%.
- Since the mid-1980s, U.S. petroleum use intensity has continued to improve, but at a much slower pace, averaging less than 2% annually.
- Looking forward, EIA's forecasts in *AEO 2012* indicate a continuing and gradual reduction in petroleum use intensity. From 2012-2035, EIA projects an improvement of 2.5% annually, such that by 2035 U.S. petroleum use intensity will be less than one-fourth of the level that prevailed in the early 1970s.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	8.0	3.0	N/A	6.0	4.5
Average Contribution	7.3	3.1	N/A	4.7	4.1

Primary Data Sources:

Historical: EIA *AER,* Table 2.1(b-f); DOC BEA for GDP.

Forecast: EIA *AEO 2011,* Tables 2 & 20.

Data Issues:

General: GDP data converted to 2000 dollars. The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.

Metric #22

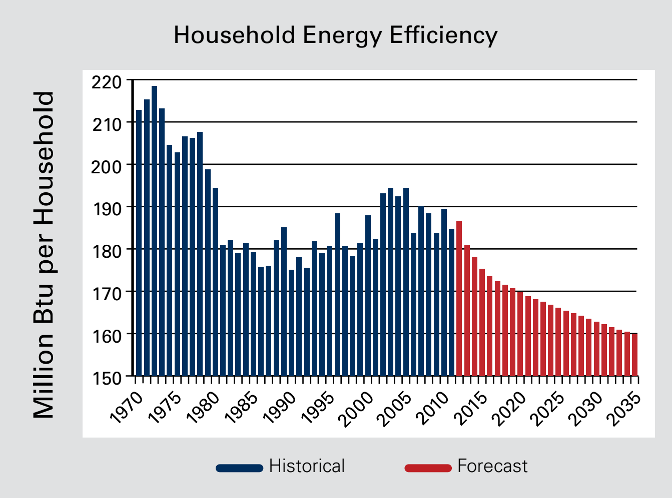
Household Energy Efficiency

Definition: Million Btu of total energy consumed per household.

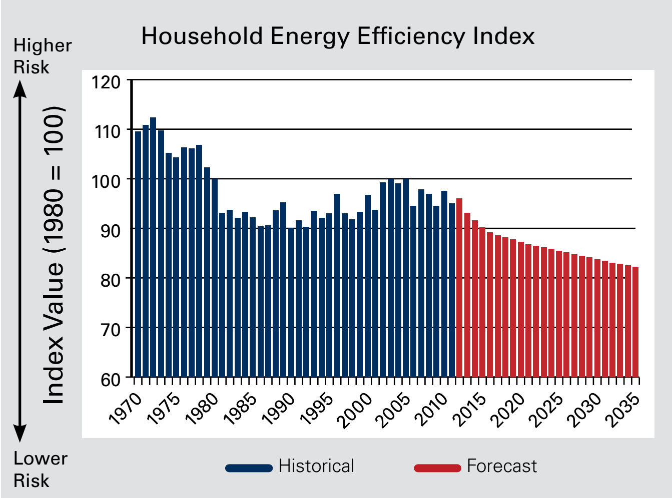
Importance: Indicates the degree to which the typical household uses energy efficiently.

Category of Metric: Energy Use Intensity

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- The long-term trend shows the effects of several interacting trends. The historical data show a relatively rapid pace of improvement in energy use per household during the 1970s and early 1980s, responding to energy price shocks and other policies and measures.
- For most of the 1980s and 1990s, per-household consumption was steady, even rising slightly over time. Efficiencies were still improving, but larger houses, more appliances, and home computers required additional energy.
- Looking forward, EIA's projections in *AEO 2012* indicate a gradual return to lower levels of per-household energy use. Under EIA's projections, per-household energy use in 2035 is lower than at any other time in the record.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	N/A	3.0	N/A	4.0	1.7
Average Contribution	N/A	3.8	N/A	4.0	1.9

Primary Data Sources:

Historical: EIA *AER,* Table 2.1b; Census Bureau *Housing Vacancy Survey.*

Forecast: EIA *AEO 2011,* Tables 2 & 4.

Data Issues:

General: The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.

Historical: Adequate square footage data were unavailable for the entire historical period; number of housing units was used as a proxy. Categories of housing units were used to come up with an approximation of households, which is what EIA uses in its forecasts.

Forecast: *AEO 2011* projections are based on number of households, not the number of housing units used for historical data.

Metric #23

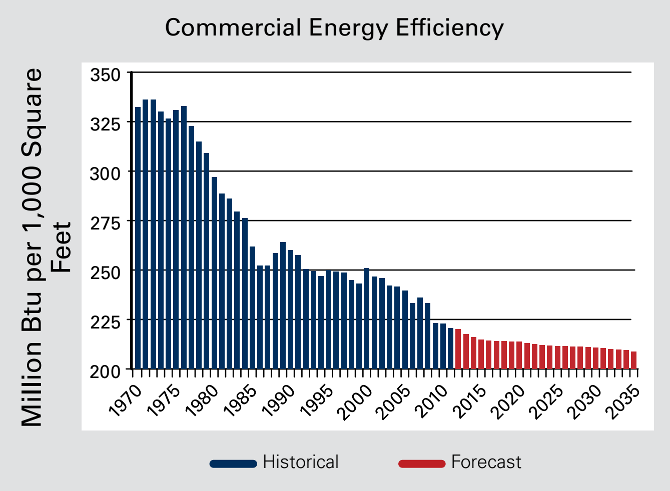
Commercial Energy Efficiency

Definition: Million Btu of total commercial energy consumed per 1,000 square feet of commercial floor space.

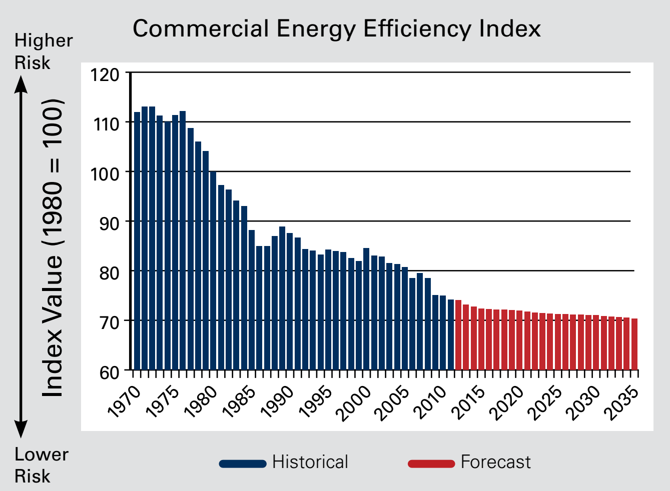
Importance: Indicates the degree to which commercial enterprises use energy efficiently.

Category of Metric: Energy Use Intensity

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- The long-term trend shows an improvement in energy intensity. From the mid- 1970s through the mid-1980s, the improvements were most pronounced, driven largely by higher energy costs.
- Beginning in the mid-1980s, the pace of improvement slowed as energy prices dropped. Consumption per square foot of natural gas and fuel oil declined over time while consumption of electricity rose modestly.
- In addition to the overall improvements reflected in individual technologies, the data also indicate shifts from natural gas to electricity and greater use of electricity consuming technologies such as computers.
- Looking forward, EIA's projections in *AEO 2012* indicate only a very small continuation in the reduction of energy intensity. Commercial floorspace is projected to increase at about 1.0% annually. While direct use of fossil fuels grows at a slower rate than floorspace, the consumption of electricity shows a faster rate of growth. The combined effect is that energy efficiency in the commercial sector is projected to improve by only about 0.3% annually from 2012-2035.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	N/A	3.0	N/A	4.0	1.7
Average Contribution	N/A	3.5	N/A	3.7	1.8

Primary Data Sources:

Historical: EIA *AER,* Table 2.1c & 2.10.
Forecast: EIA *AEO 2011*, Tables 2 & 5.

Data Issues:

General: The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.

Historical: The commercial floor space survey changed scope in 1995, requiring adjustments to be made to earlier years. No data source for floor space is available pre-1979. Data for 1970 to 1978 was estimated based on the relationship of floor space to GDP.

Forecast: None.

Metric #24

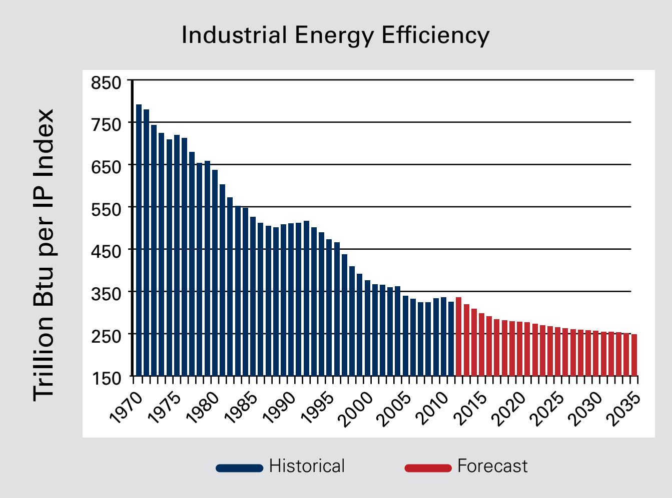
Industrial Energy Efficiency

Definition: Trillion Btu of total Industrial energy consumed per unit of industrial production as measured by the Federal Reserve Bank's Industrial Production (IP) Index.

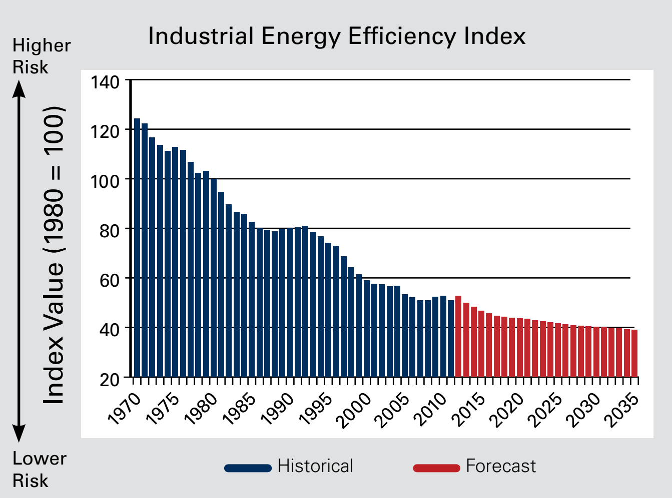
Importance: Indicates the degree to which the typical commercial enterprise uses energy efficiently.

Category of Metric: Energy Use Intensity

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- The long-term trend shows a dramatic improvement in overall industrial energy efficiency. Between 1970 and 2007, the efficiency of the U.S. industrial sector improved by more than half.
- This historical improvement reflects both improvement in the efficiencies of most industries and processes, but also the broader shifts in our economy towards services and less energy-intensive goods.
- Looking forward, EIA's projections in *AEO 2012* indicate a continuing if gradual improvement in industrial energy efficiency.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	N/A	3.0	N/A	4.0	1.7
Average Contribution	N/A	3.1	N/A	3.3	1.6

Primary Data Sources:

Historical: EIA *AER*, Table 2.1d; Federal Reserve Board for Industrial Production Index.

Forecast: EIA *AEO 2011*, Tables 2 & 6.

Data Issues:

General: The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.

Minor definitional differences for "industrial sector" as used by FRB in its IP Index and by in EIA in its historical and forecast data.

Metric #25

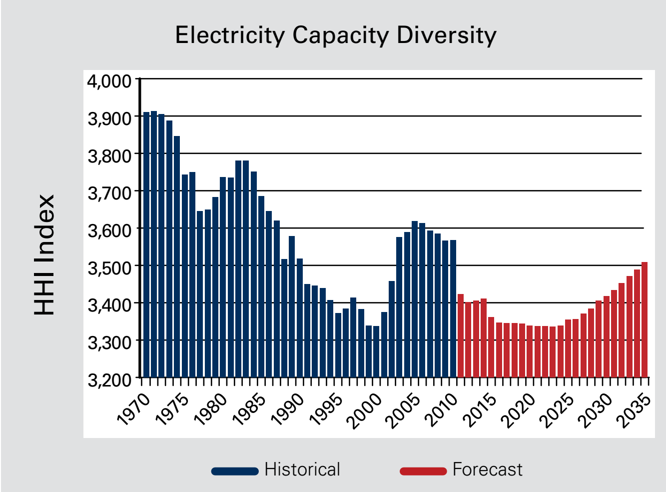
Electricity Capacity Diversity

Definition: Market share concentration index (HHI) of the primary categories of electric power generating capacity, adjusted for availability.

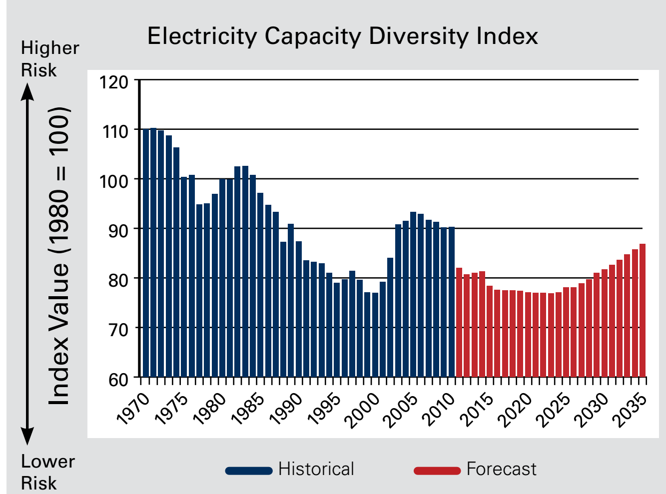
Importance: Indicates the flexibility of the power sector and its ability to dispatch electricity from a diverse range of sources.

Category of Metric: Electric Power Sector

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- Except for a short period in the 1980s, from 1970 to 1990, there was a generally improving trend in capacity diversity. Most of this is attributable to an increasing share of nuclear capacity and to improving availability factors. The decreasing capacity diversity that occurred in the early 1980s reflects the closing of oil-fired generating capacity in response to the oil crises of the 1970s.
- During the 1990s, capacity became more diverse, primarily as a result of increasing nuclear capacity availability and the construction of natural gas combined-cycle units.
- However, since the late 1990s, the diversity in potential generation has declined (i.e., it has a higher HHI), as nuclear capacity gains became fewer and a large over-building of natural gas combined cycle units occurred. Today, although generation from coal-fired plants is much greater than that from natural gas-fired plants, natural gas capacity, and hence potential generation, is greater than coal capacity. Therefore, the recent addition of natural gas capacity decreased the diversity of potential generation.
- Looking forward, EIA's projections in *AEO 2012* suggest an improvement in electricity capacity diversity through the mid-2020s, and a worsening out to 2035.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	N/A	N/A	7.0	3.0	2.0
Average Contribution	N/A	N/A	7.2	2.8	2.1

Primary Data Sources:

Historical: EIA *AER,* Table 8.11a & 8.2a from 1989; EIA-860 data for pre-1989.

Forecast: EIA *AEO 2011*, Table 9 & Supplemental Table 101.

Data Issues:

General: Used the HHI Index value in excess of 2,000 (the theoretical minimum for five categories) and normalized the time series to an indexed value where the year 1980 is set at 100. No further data transformations were needed. Uncertainties on availability factors for intermittent and dispatchable capacity types.

Metric #26

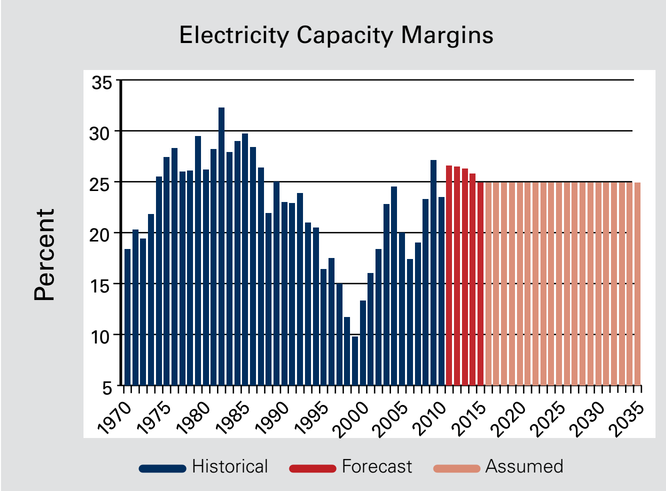
Electricity Capacity Margins

Definition: Unused available capability in the U.S. electric power system at peak load as a percentage of total peak capability.

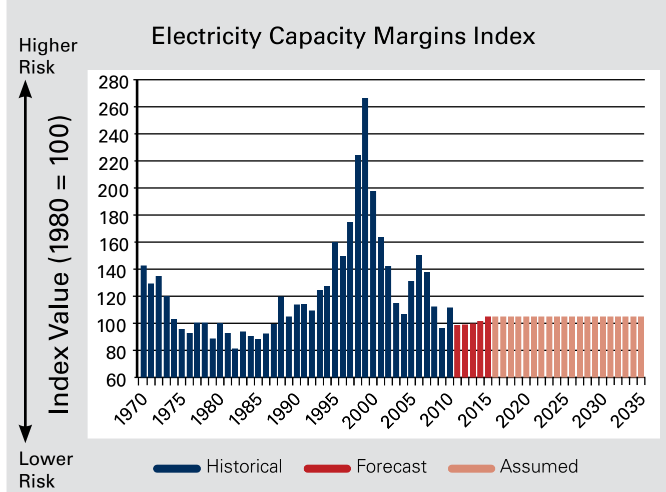
Importance: Indicates the ability of the power sector to respond to the disruption or temporary loss of some production capacity without an uneconomic overhang of excess capacity.

Category of Metric: Electric Power Sector

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- The historical data show the ups and downs the electric power sector has experienced over time. Construction of electricity generating capacity is generally a long-term process, typically requiring several years and often longer for assets such as coal and nuclear. With long lead times, demand changes from business cycles, changes in fuel markets, and regulatory uncertainty, the industry has moved from periods of relative excess capacity to periods of near under capacity and back again.
- Looking forward, the data show a slight near-term improvement, reflecting increases in demand response and supply-side resources, as well as a reduction in peak demands resulting from the economic recession.
- This adequacy is not assured over time, however, and NERC's assessment is that more resources will be needed in the coming years to maintain reliability.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	N/A	1.0	7.0	N/A	1.7
Average Contribution	N/A	1.6	9.6	N/A	2.4

Primary Data Sources:

Historical: EIA *AER,* Table 8.12 from 1990; EIA archive data pre-1990.

Forecast: EIA Form EIA-411 data.

Data Issues:

General: For this metric, a higher value indicates lower risk. Therefore, the values were inverted and the time series was normalized to an indexed value where the year 1980 is set at 100.

Historical: Pre-1990 data developed from different data sets.

Projections: Future trends based on planning projections and do not include as-yet firm plans. Metric was assumed to remain constant at its most recent measured value.

Metric #27

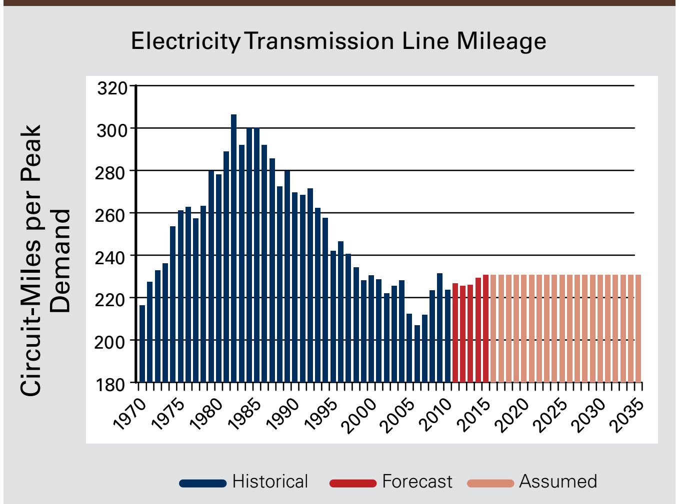
Electric Power Transmission Line Mileage

Definition: Circuit-miles of transmission lines per gigawatt of peak summer demand.

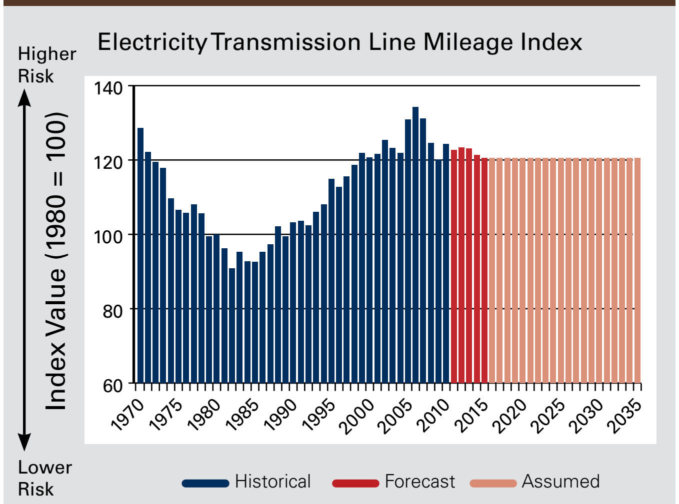
Importance: Indicates the integration of the transmission system and its ability to meet increasing demand reliably.

Category of Metric: Electric Power Sector

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- The historical data show declines in transmission infrastructure and growing risks associated with underinvestment in infrastructure. In 1989, there were about 280 circuit-miles for each GW of peak capacity. As of 2006, this had declined to only 207 circuit-miles for each GW of peak capacity, a decline of about 25%.
- Further troubling is that this decline has occurred at the same time when growth in wholesale power markets and demand for renewable energy resources would benefit from growing transmission capacity.
- Looking forward, the data show a slight near-term improvement, reflecting in part the drop in demand in the current recession. But continued underinvestment in transmission, as seen in the NERC projections, is seen as a further inability of transmission to keep up with peak power demand.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	N/A	1.0	8.0	3.0	2.5
Average Contribution	N/A	1.5	9.9	3.4	3.2

Primary Data Sources:

Historical: EIA *AER,* Table 8.12; North American Electric Reliability Council for circuit-miles.

Forecast: NERC data.

Data Issues:

General: For this metric, a higher value indicates lower risk. Therefore, the values were inverted and the time series normalized to an indexed value where the year 1980 is set at 100.

Historical: Data before 1989 were not available. Assumed that from 1970 to 1988, the metric remained constant at 1989 measured value.

Forecast: Future trends are based on planning projections and do not include as-yet firm plans. Metric was assumed to remain constant at its most recent measured value.

Metric #28

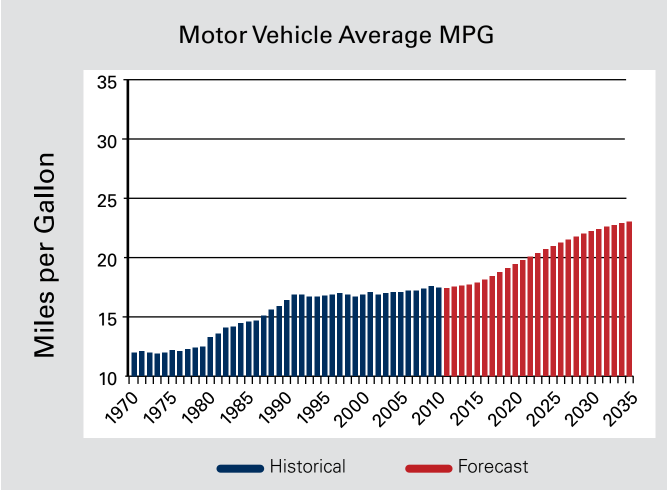
Motor Vehicle Average MPG

Definition: Average miles per gallon of passenger car fleet.

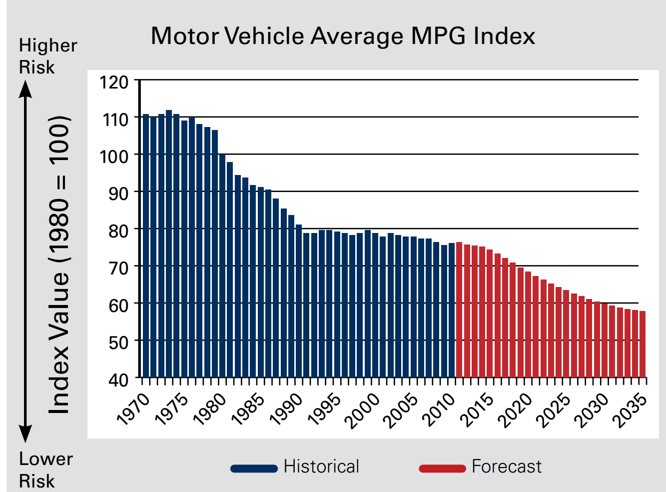
Importance: Indicates the degree to which the typical light vehicle uses energy efficiently (gasoline consumption accounts for about 17% of total U.S. energy demand).

Category of Metric: Transportation Sector

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- The historical data show the steady increase in average mpg following the oil price shocks of the 1970s and the subsequent implementation of corporate average fuel economy (CAFE) standards for cars and light trucks. From a fleet average of about 12 in the early 1970s, motor vehicle average MPG rose to more than 16 by 1990.
- For the period from about 1990 to 2010, average MPG showed only modest improvement (0.390 per year).
- Average vehicle MPG is projected to increase about 1.2% per year as a consequence of higher fuel prices and statutory mandates in EISA enacted in 2007.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	3.0	4.0	N/A	12.0	4.5
Average Contribution	3.1	4.6	N/A	10.8	4.6

Primary Data Sources:

Historical: EIA *AER,* Table 2.8.

Forecast: EIA *AEO 2011*, Supplemental Table 161.

Data Issues:

General: For this metric, a higher value indicates lower risk. Therefore, the values were inverted and the time series normalized to an indexed value where the year 1980 is set at 100.

Metric #29

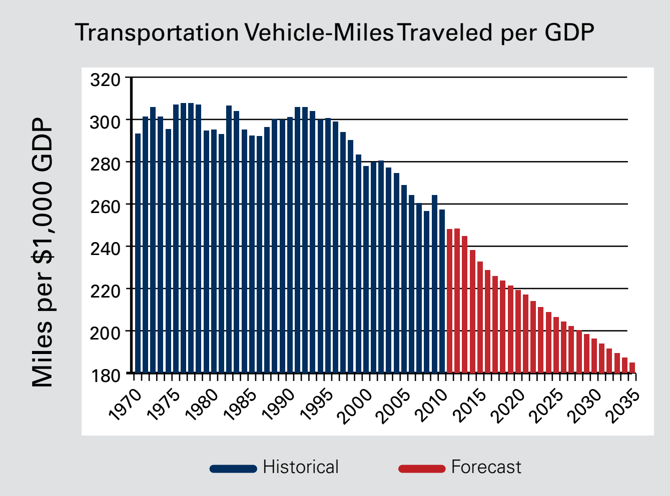
Vehicle-Miles Traveled per GDP

Definition: Vehicle-miles traveled (VMT) per $1,000 of GDP in real (2000) dollars.

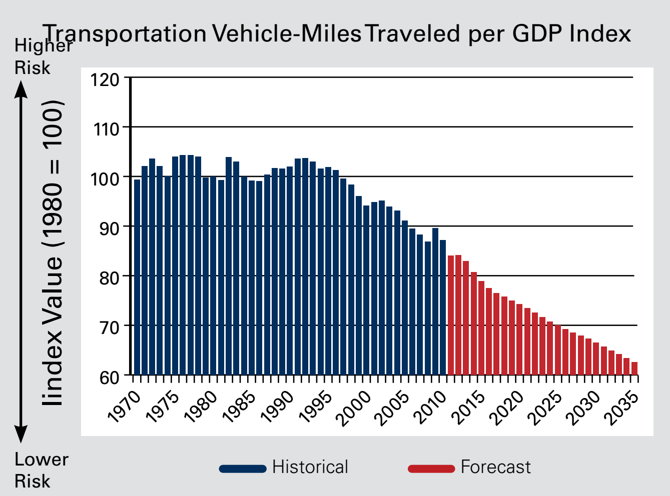
Importance: Indicates the importance of travel as a component of the economy.

Category of Metric: Transportation Sector

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- The historical data show that for many years, VMT generally increased in lockstep with the overall economy. From 1970 through the late 1990s, VMT intensity was rather flat, indicating that growth in VMT moved in sync with expansions and contractions of the economy.
- A closer look at the most recent years indicates a break from this overall trend, and VMT as a share of the economy began to slow. From the mid-1990s through 2008, the VMT intensity improved (declined) by about 1.5 % per year. While higher fuel prices have undoubtedly played a role in this decline, other causal factors are also likely involved, including telecommuting.
- EIA now forecasts a continuing improvement in VMT intensity, declining about 1.3% per year over the forecast period.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	2.0	2.0	N/A	8.0	2.8
Average Contribution	2.3	2.6	N/A	8.0	3.2

Primary Data Sources:

Historical: DOT/FHA for VMT; DOC BEA for GDP.

Forecast: EIA *AEO 2011,* Tables 2 & 7.

Data Issues:

General: GDP data converted to 2000 dollars. The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.

Metric #30

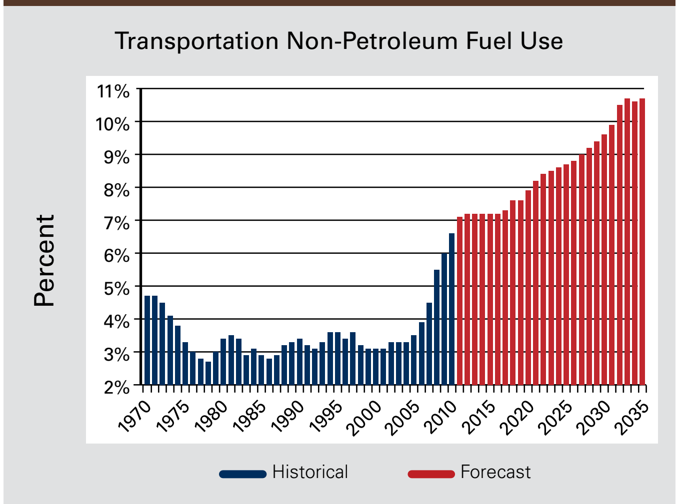
Transportation Non-Petroleum Fuel Use

Definition: Non-petroleum fuels as a percentage of total U.S. transportation energy consumption.

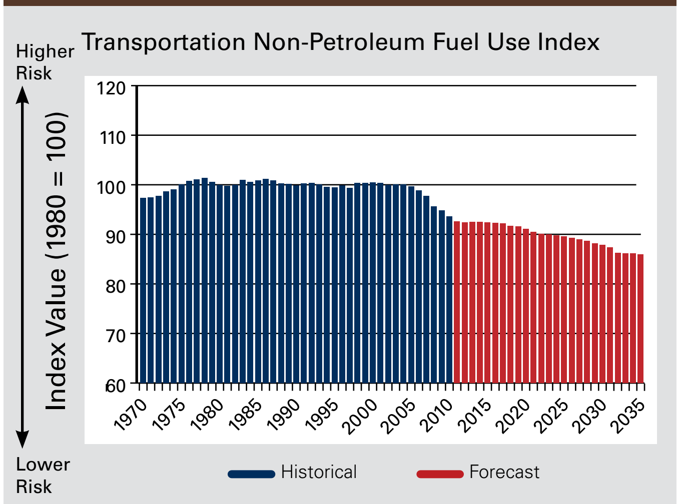
Importance: Indicates the diversity and flexibility of the fuel mix for transportation.

Category of Metric: Transportation Sector

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- Over most of the historical data shown, non-petroleum fuels accounted for only about 2% to 4% of the energy used in the U.S. transportation sector. Most of this small amount was natural gas used in pipeline operations.
- But in recent years, this low market share has begun to rise, and is expected to continue rising. Most of the recent and expected future increase is from biomass production of ethanol resulting from renewable fuel mandates legislated in EPAct 2005 and EISA 2007.
- Over the longer term, greater use of electricity, natural gas, and biofuels is expected to increase the portion of non-petroleum energy sources in the transportation sector by about 1.8% per year.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	3.0	N/A	4.0	4.0	2.5
Average Contribution	3.5	N/A	4.4	4.0	2.9

Primary Data Sources:

Historical: EIA *AER,* Table 2.1e.

Forecast: EIA *AEO 2011,* Table 2.

Data Issues:

General: For this metric, a higher value indicates lower risk. Therefore, the values were inverted and the time series normalized to an indexed value where the year 1980 is set at 100.

Metric #31

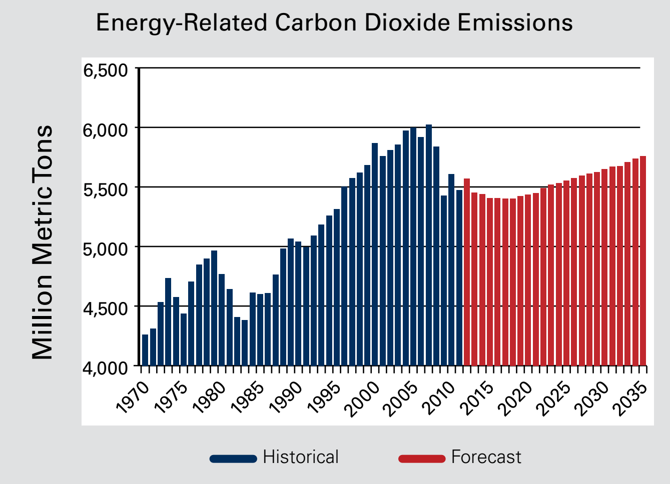
Energy-Related Carbon Dioxide Emissions

Definition: Total U.S. energy-related CO_2 emissions in million metric tons.

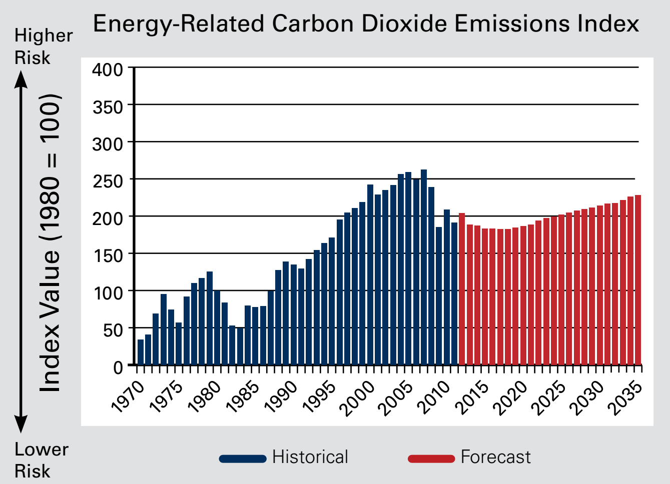
Importance: Indicates the exposure of the U.S. economy to domestic and international emissions reduction mandates.

Category of Metric: Environmental

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- The historical data generally show a rising level of CO_2 emissions, consistent with economic growth, population growth, and rising energy consumption.
- There are a couple of periods, notably the mid-1970s and early 1980s, when CO_2 emissions dipped, largely in response to oil price shocks and economic slowdowns.
- Over the past few years, CO_2 emissions have been essentially flat, with high fuel prices, economic slowdowns, and energy and environmental policies all playing a role.
- Looking forward, EIA's projections now indicate a very slow rate of increase in energy-related CO_2 emissions. In the *AEO 2012*, energy-related CO_2 emissions grow by 0.1% per year from 2012 to 2035, as compared with 0.8% per year from 1980 to 2007. By 2035, EIA projects energy-related CO_2 emissions to be only about 4% higher than in 2005.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	2.0	N/A	N/A	7.0	2.0
Average Contribution	3.5	N/A	N/A	10.5	3.4

Primary Data Sources:

Historical: EIA *Emissions Inventory Report*; EIA spreadsheet for pre-1990 emissions.

Forecast: EIA *AEO 2011*, Table 18.

Data Issues:

General: The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.

Metric #32

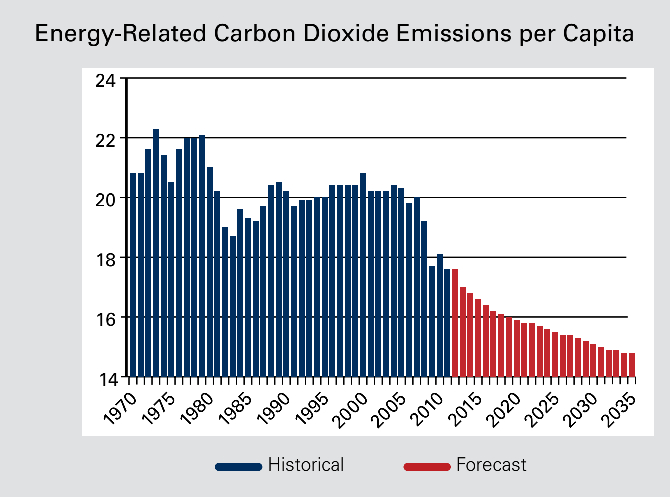
Energy-Related Carbon Dioxide Emissions per Capita

Definition: Million metric tons of CO_2 emissions from energy per capita.

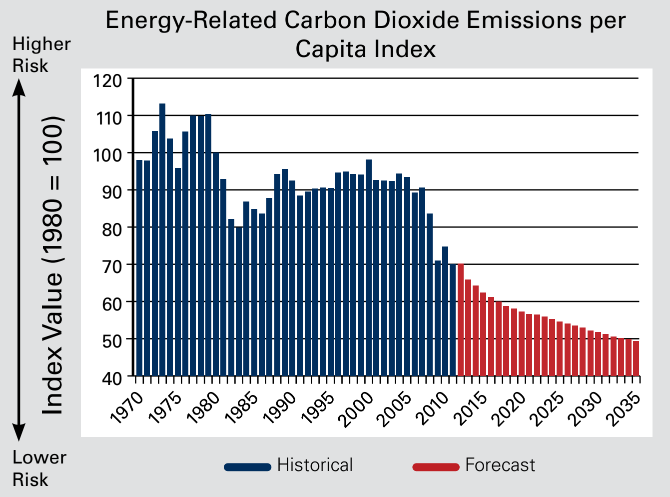
Importance: Indicates the joint effect of the amount of energy used per capita in the U.S. and the carbon intensity of that energy use.

Category of Metric: Environmental

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- During the 1950s and 1960s, per capita energy-related CO_2 emissions increased from about 15 to about 20 metrics tons per year.
- Per capita emissions peaked in 1973 at 22.1 metric tons per capita. That year ended with the first oil shock of the 1970s. Per-capita emissions fell for a couple of years, and then began rising again until the second oil shock took place around 1979-1980.
- Following a few years of falling per-capita emissions in the early 1980s, the trend again turned upward and has remained at about 20 tons per capita through the mid-2000s.
- Recently, higher fuel prices (especially for petroleum) and a weaker economic outlook point toward a gradual reduction in per capita emissions, leveling off at about 17 metric tons in the 2020 decade.
- Looking forward, EIA's projections show the U.S. economy becoming less carbon-intensive. By 2035, emissions per capita are forecast to decline 27% from the 2005 level, as increased demand for energy services is offset in part by shifts toward less energy-intensive industries, efficiency improvements, and increased use of renewables and other lower-carbon fuels.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	2.0	N/A	N/A	5.0	1.6
Average Contribution	2.2	N/A	N/A	4.7	1.7

Primary Data Sources:

Historical: EIA *Emissions Inventory Report*; EIA spreadsheet for pre-1990 emissions; *Statistical Abstract* for population

Forecast: EIA *AEO 2011*, Tables 18 & 20.

Data Issues:

General: To emphasize the relatively small changes in this metric, the values were squared and the time series normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.

Metric #33

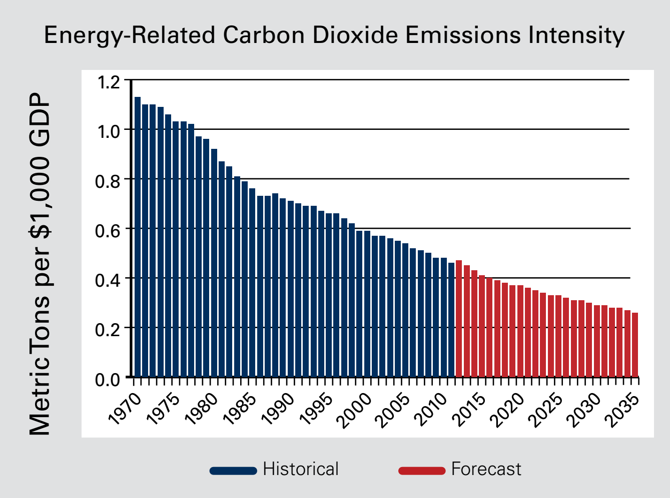
Energy-Related Carbon Dioxide Emissions Intensity

Definition: Metric tons of CO_2 from energy per $1,000 of GDP in real (2000) dollars.

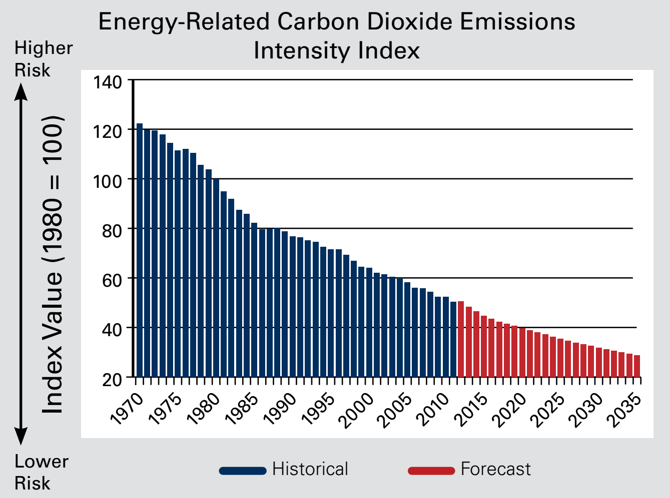
Importance: Indicates the importance of carbon-based fuels as a component of the economy.

Category of Metric: Environmental

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- Historically, there has been a steady and substantial downward trend in the CO_2 intensity of the U.S. economy. In the 1970s through the mid-1980s, CO_2 intensity fell rapidly as a result of our response to the oil price shocks, vehicle efficiency standards, and industrial energy efficiency.
- Since the mid-1980s, the improvements in CO_2 intensity continued to improve, but as a slower rate. Transportation improvements were fewer, but gains were still realized through efficiency in others sectors and an on-going shift in the economy from manufacturing to services. By the year 2005, the economy's CO_2 intensity was only about one-half of what it was in 1970.
- Looking ahead, EIA projects a continuing improvement in the CO_2 intensity of the U.S economy, roughly 2.4% per year on average. As a result, the economy-wide CO_2 intensity in the year 2035 is projected to be less than one-quarter the level seen in the 1970s.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	2.0	N/A	N/A	5.0	1.6
Average Contribution	1.9	N/A	N/A	4.1	1.5

Primary Data Sources:

Historical: EIA *Emissions Inventory Report*; EIA spreadsheet for pre-1990 emissions; DOC BEA for GDP.
Forecast: EIA *AEO 2011*, Tables 2 & 18.

Data Issues:

General: GDP data converted to 2000 dollars. The time series was normalized to an indexed value where the year 1980 is set at 100. No further data transformations were needed.

Metric #34

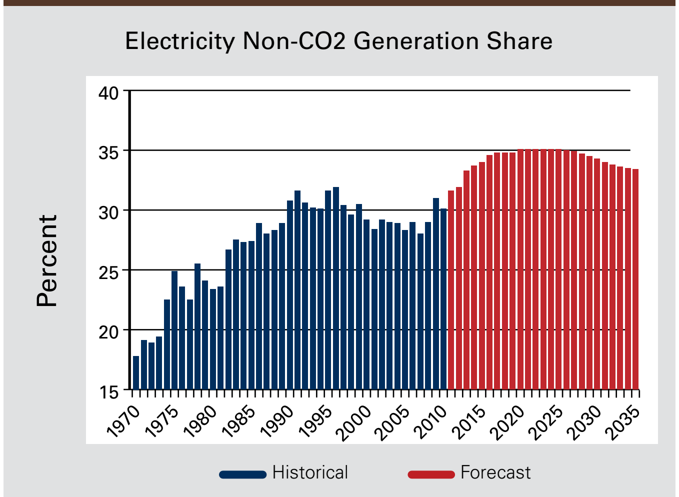
Electricity Non-CO_2 Generation Share

Definition: percentage of total electric power generation contributed by renewables, hydroelectric, nuclear, and fossil-fired plants operating with carbon capture and storage (CCS) technology.

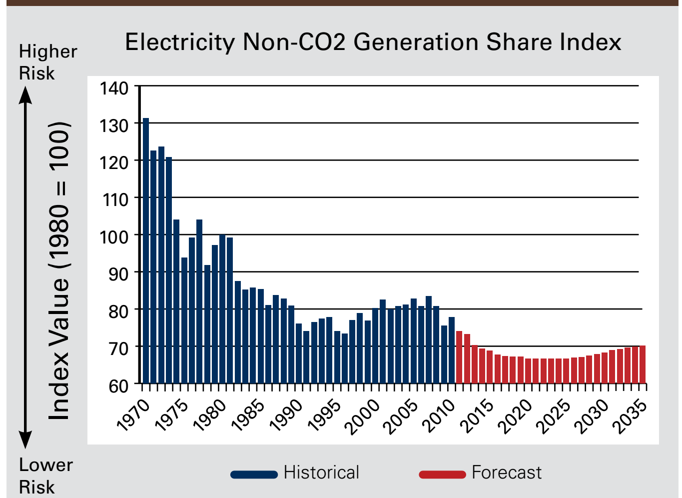
Importance: Indicates the degree to which the power sector is diversifying and employing non-CO_2 emitting generation.

Category of Metric: Environmental

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- During the 1970s and 1980s, the share of non-CO_2 generation nearly doubled, from about 17% in 1970 to about 32% in 1990. This increase was due primarily to the expansion of nuclear power capacity.
- After 1990, however, there were few additions to nuclear and renewable capacity, and growth in generation from these sources stemmed mainly from improving operating capacity factors at existing nuclear plants. However, with overall growth in demand being met disproportionately by coal and natural gas-fired plants, the non-CO_2 generation share began slipping.
- Looking forward, EIA's projections in *AEO 2012* indicate a reversal of recent trends, with the share of non-CO_2 emitting capacity climbing to and remaining above 30% of total generation. Most of this increase is due primarily to growth in renewables and secondarily to further increases in nuclear capacity.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	N/A	N/A	5.0	7.0	2.4
Average Contribution	N/A	N/A	4.9	6.2	2.4

Primary Data Sources:

Historical: EIA *AER*, Table 8.2a.

Forecast: EIA *AEO 2011*, Tables 8 & Supplemental Table on CCS.

Data Issues:

General: The time series was normalized to an indexed value where the year 1980 is set at 100. No additional data transformations were needed.

Historical: None.

Forecast: Published *AEO* tables currently do not include projections for the capacity of or generation from CCS-enabled power plants. However, they are part of the NEMS model that EIA uses, and EIA can provide those outputs upon request.

Metric #35

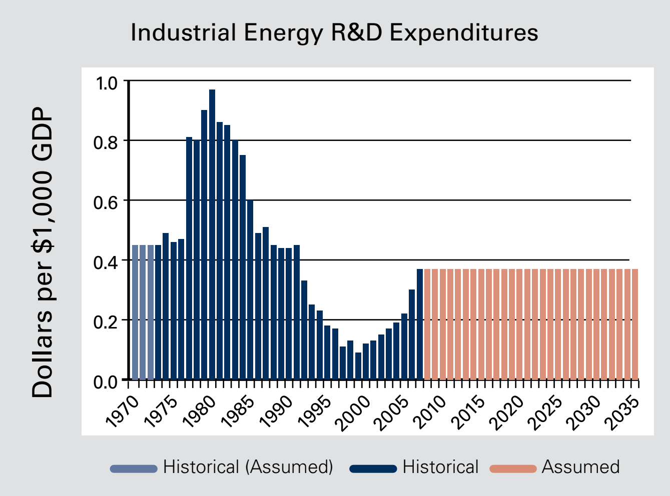
Industrial Energy R&D Expenditures

Definition: Dollars of industrial energy-related R&D (non-Federal) per $1,000 of GDP.

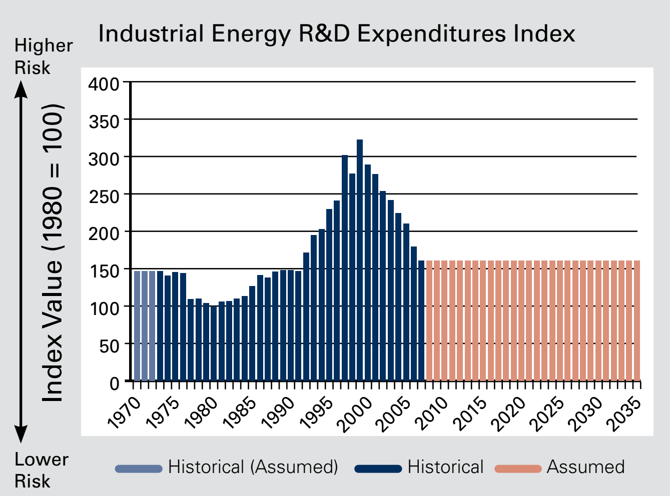
Importance: Indicates private industry engagement in improving performance and enabling new technological breakthroughs.

Category of Metric: Research & Development

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- The historical trend shows a dramatic swing. Beginning in the late 1970s, industry R&D on energy increased substantially, more than doubling earlier levels.
- But by the mid-1980s and continuing since then, the pattern has generally been one of decreasing investment. In recent years, the relative investment has only been 10% to 20% of the amounts seen in 1980.
- More recently, industrial R&D expenditures have begun to turn higher, though it still remains far below earlier levels.
- Over the forecast period through 2035, a constant level of industrial spending on energy R&D is assumed. With recent interest in energy policy, and market experience of the past few years, this assumption may turn out to be conservative.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	N/A	1.0	2.0	2.0	1.1
Average Contribution	N/A	2.3	3.9	3.5	2.2

Primary Data Sources:

Historical: NSF, Industrial Research & Development Information System; DOC BEA for GDP.

Forecast: Not available.

Data Issues:

General: For this metric, a higher value indicates lower risk. Therefore, the values were inverted and the time series normalized to an indexed value where the year 1980 is set at 100.

Historical: Incomplete data pre-1973. Assumed that for 1970-1972, the metric remained constant at value measured for 1973.

Forecast: Metric was assumed to remain constant at its most recent measured value.

Metric #36

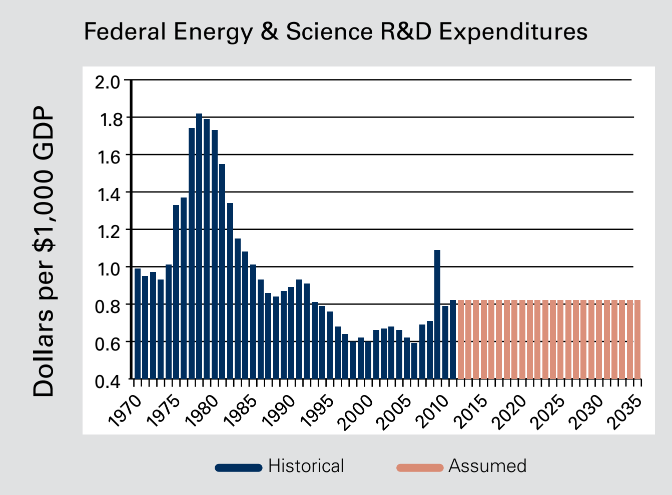
Federal Energy & Science R&D Expenditures

Definition: Dollars of federal energy and science R&D, per $1,000 of GDP

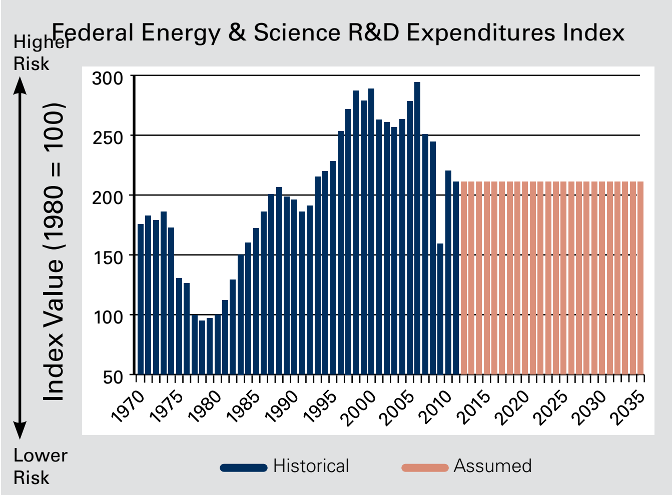
Importance: Indicates prospects for new scientific and technological breakthroughs through federally-supported public-private research.

Category of Metric: Research & Development

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- Following the oil price shocks beginning in the mid-1970s, federal support for energy and science R&D increased substantially, nearly doubling from earlier levels.
- Since peaking in the early 1980s, however, the pattern has generally been one of decreasing investment, such that by the year 2000, the relative investment was only about one-third of the amounts seen in 1980.
- Since around 2000, energy and science R&D funding has begun to increase again, though it is still far below its level in earlier years.
- Over the forecast period through 2035, a constant level of spending on federal energy and science R&D is assumed. With recent interest in energy policy, this assumption may turn out to be conservative.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	N/A	1.0	2.0	2.0	1.1
Average Contribution	N/A	2.6	4.4	4.0	2.5

Primary Data Sources:

Historical: NSF data on federal R&D; DOC BEA data for GDP.

Forecast: Not available.

Data Issues:

General: For this metric, a higher value indicates lower risk. Therefore, the values were inverted and the time series normalized to an indexed value where the year 1980 is set at 100.

Historical: None.

Forecast: Metric was assumed to remain constant at its most recent measured value. Budget documents might provide basis for near-term projections.

Metric #37

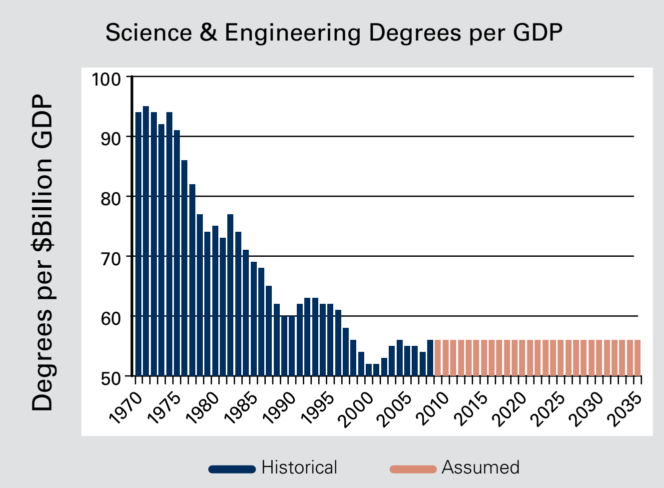
Science & Engineering Degrees

Definition: Number of science and engineering degrees, per billion dollars of real (2000) GDP

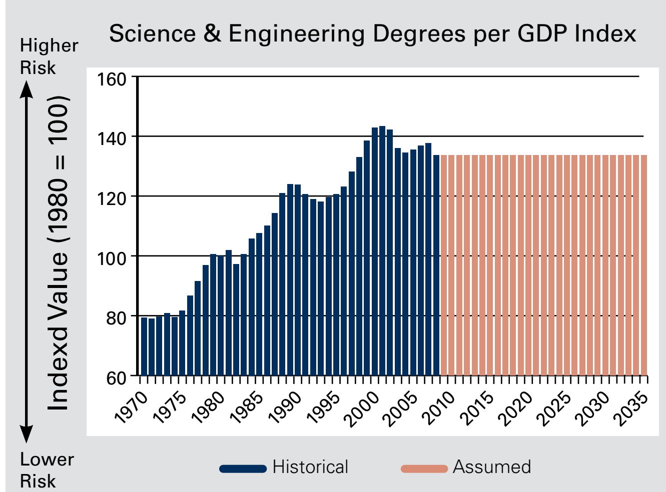
Importance: Indicates the degree to which human capital in high-tech science, technology, engineering, and mathematics fields will be available to the economy.

Category of Metric: Research & Development

Historical and Forecast Values (1970-2035):



Index (1970-2035):



Observations:

- The historical data show a steadily worsening trend relative to the economy. Over the 1970 to 2006 period, while the total number of college degrees more than doubled and rose relative to overall population, the share of science and engineering degrees fell as a share of all degrees. From over 34% in 1970, science and engineering degrees account for less than 30% of all college degrees today.
- Relative to the more rapid growth in GDP over the period, the degrees awarded have not kept pace.
- The U.S. share of Ph.D.s has been in steady decline since peaking in the early 1970s, when more than half of the world's graduate degrees in science and engineering were issued by U.S. universities.
- Over the forecast period through 2035, a constant level of science and engineering degrees, per billion dollars of GDP is assumed. Potentially, college admissions datasets could be developed to project degrees awarded over the next few years.

Weighting and Average Historical Contribution of Metric to Energy Security Indexes (Percent):

	Geopolitical	Economic	Reliability	Environmental	Total Index
Weight	N/A	1.0	2.0	2.0	1.1
Average Contribution	N/A	1.5	2.6	2.3	1.5

Primary Data Sources:

Historical: NSF data from Integrated Postsecondary Education Data System Completions Survey (IPEDS); DOC BEA data for GDP.

Forecast: Not available.

Data Issues:

General: For this metric, a higher value indicates lower risk. Therefore, the values were inverted and the time series normalized to an indexed value where the year 1980 is set at 100.

Historical: None.

Forecast: Metric was assumed to remain constant at its most recent measured value. College admissions datasets might provide basis for near-term projections.

Summary Table 1: Energy Security Metrics (Values)

1970-1981

Metric	Units of Measurement	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Global Fuels Metrics													
1 Security of World Oil Reserves	reserves, freedom & diversity-weighted	117.2	115.2	112.7	106.5	101.4	102.5	102.2	88.1	76.9	85.3	100.0	97.0
2 Security of World Oil Production	production, freedom & diversity-weighted	89.7	91.3	93.3	95.0	100.9	109.8	114.5	107.3	96.7	94.0	100.0	100.6
3 Security of World Natural Gas Reserves	reserves, freedom & diversity-weighted	57.5	67.4	74.0	78.2	83.9	101.7	106.3	113.6	100.2	98.2	100.0	105.9
4 Security of World Natural Gas Production	production, freedom & diversity-weighted	70.4	69.6	68.0	67.7	71.2	84.6	89.5	91.6	87.4	88.6	100.0	106.4
5 Security of World Coal Reserves	reserves, freedom & diversity-weighted	98.5	98.5	98.5	98.4	97.4	106.9	108.6	99.1	92.7	92.4	100.0	102.1
6 Security of World Coal Production	production, freedom & diversity-weighted	91.2	93.5	95.6	96.4	97.1	103.4	103.1	95.4	92.3	89.2	100.0	99.4
Fuel Import Metrics													
7 Security of U.S. Petroleum Imports	oil imports, freedom & diversity-weighted	20.0	22.8	26.4	33.4	36.1	39.9	46.3	49.3	40.7	39.7	37.3	34.6
8 Security of U.S. Natural Gas Imports	gas imports, freedom & diversity-weighted	3.5	3.6	3.4	3.3	3.2	4.2	4.4	4.8	4.2	5.3	4.7	4.6
9 Oil & Natural Gas Import Expenditures	billions of 2000$	$8.9	$10.8	$13.8	$23.6	$74.7	$66.3	$81.4	$99.9	$87.6	$116.5	$140.3	$129.0
10 Oil & Natural Gas Import Expenditures per GDP	percent of GDP	0.2%	0.3%	0.3%	0.5%	1.7%	1.5%	1.8%	2.1%	1.7%	2.2%	2.7%	2.4%
Energy Expenditure Metrics													
11 Energy Expenditures per GDP	$ per $1,000 GDP	$79.80	$79.89	$79.21	$80.90	$102.24	$104.89	$106.23	$108.55	$104.26	$116.09	$134.23	$136.81
12 Energy Expenditures per Household	2000$/Household	$4,670	$4,725	$4,799	$5,047	$6,187	$6,211	$6,491	$6,815	$6,753	$7,576	$8,575	$8,612
13 Retail Electricity Prices	cents/kWh (2000$)	6.2¢	6.3¢	6.3¢	6.3¢	7.3¢	7.6¢	7.7¢	8.0¢	8.2¢	8.1¢	8.7¢	9.3¢
14 Crude Oil Price	2000$/bbl	$19.14	$19.31	$18.41	$20.21	$35.62	$33.54	$33.27	$33.72	$31.49	$43.45	$62.51	$61.90
Price & Market Volatility Metrics													
15 Crude Oil Price Volatility	change in year-to-year price	$0.41	$0.29	$0.47	$0.96	$6.04	$6.43	$5.92	$0.93	$0.98	$4.88	$11.08	$10.54
16 Energy Expenditure Volatility	average yearly price change/$1,000 GDP	$2.99	$3.25	$2.98	$3.87	$10.04	$9.81	$9.62	$5.20	$4.71	$7.61	$11.42	$12.65
17 World Oil Refinery Utilization	percent utilization	94.1%	90.4%	88.8%	92.7%	84.9%	78.3%	78.9%	76.9%	77.6%	78.7%	74.6%	72.0%
18 Petroleum Stock Levels	average days supply	69	69	58	58	64	69	63	71	68	72	81	92
Energy Use Intensity Metrics													
19 Energy Consumption per Capita	million Btu/Person	330.8	333.6	346.3	357.2	345.9	333.2	348.5	354.0	359.2	359.3	343.6	331.7
20 Energy Intensity	million Btu/$1,000 GDP	17.9	17.7	17.6	17.4	17.1	16.6	16.7	16.4	15.9	15.6	15.1	14.3
21 Petroleum Intensity	million Btu/real $1000 GDP	7.80	7.81	8.00	7.99	7.72	7.57	7.72	7.79	7.54	7.15	6.61	6.02
22 Household Energy Efficiency	million Btu/household	212.8	215.4	218.5	213.2	204.6	202.8	206.6	206.3	207.6	198.8	194.4	181.0
23 Commercial Energy Efficiency	MMBtu/1,000 sq.ft.	332.4	336.0	336.0	330.2	326.6	330.7	332.9	322.8	314.8	309.2	297.0	288.6
24 Industrial Energy Efficiency	trillion Btu/IP Index	792	780	744	725	709	720	712	680	653	658	637	603
Electric Power Sector Metrics													
25 Electricity Capacity Diversity	HHI Index	3,910	3,913	3,905	3,887	3,846	3,743	3,750	3,646	3,650	3,682	3,736	3,734
26 Electricity Capacity Margins	percent	18.4%	20.3%	19.4%	21.8%	25.5%	27.4%	28.3%	26.0%	26.1%	29.5%	26.2%	28.2%
27 Electricity Transmission Line Mileage	circuit-miles/peak GW	216	228	233	236	254	261	263	257	263	280	278	289
Transportation Sector Metrics													
28 Motor Vehicle Average MPG	miles per gallon	12.0	12.1	12.0	11.9	12.0	12.2	12.1	12.3	12.4	12.5	13.3	13.6
29 Transportation VMT per $ GDP	vehicle miles traveled/$1,000 GDP (2000$)	293	301	306	301	295	307	308	308	307	295	295	293
30 Transportation Non-Petroleum Fuels	percent	4.7%	4.7%	4.5%	4.1%	3.8%	3.3%	3.0%	2.8%	2.7%	3.0%	3.4%	3.5%
Environmental Metrics													
31 Energy-Related CO2 Emissions	MMTCO2	4,261	4,312	4,532	4,733	4,574	4,437	4,705	4,846	4,896	4,964	4,770	4,642
32 Energy-Related CO2 Emissions per Capita	metric tons CO2/Person	20.8	20.8	21.6	22.3	21.4	20.5	21.6	22.0	22.0	22.1	21.0	20.2
33 Energy-Related CO2 Emissions Intensity	metric tons CO2/$1,000 GDP	1.13	1.10	1.10	1.09	1.06	1.03	1.03	1.02	0.97	0.96	0.92	0.87
34 Electricity Non-CO2 Generation Share	percent of total generation	17.8%	19.1%	18.9%	19.4%	22.5%	24.9%	23.6%	22.5%	25.5%	24.1%	23.4%	23.6%
Research and Development Metrics													
35 Industrial Energy R&D Expenditures	energy R&D $/$1,000 GDP	$0.45	$0.45	$0.45	$0.45	$0.49	$0.46	$0.47	$0.81	$0.80	$0.90	$0.97	$0.86
36 Federal Energy & Science R&D Expenditures	R&D $/$1,000 GDP	$0.99	$0.95	$0.97	$0.93	$1.01	$1.33	$1.37	$1.74	$1.82	$1.79	$1.73	$1.55
37 Science & Engineering Degrees	number of degrees/$billion GDP	94.0	94.6	93.7	92.3	93.9	91.4	86.2	81.6	77.2	74.2	74.7	73.4

Summary Table 1: Energy Security Metrics (Values)

1982-2002

1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
94.3	99.0	104.3	104.5	112.0	110.1	99.6	100.6	124.4	120.0	141.6	148.1	147.4	146.2	141.7	128.7	126.0	124.6	127.9	127.1	124.0
94.0	90.6	93.9	90.9	94.8	89.9	80.7	83.1	77.7	76.0	73.0	77.7	75.4	74.1	70.0	70.2	68.1	68.0	68.9	69.6	66.3
120.3	122.4	142.1	136.6	137.0	125.0	95.7	101.1	86.8	88.9	77.4	86.2	87.4	87.7	87.5	87.2	89.1	93.0	99.1	98.7	94.9
116.0	124.1	139.3	148.0	158.2	144.4	119.4	118.8	92.7	89.9	69.7	72.9	69.6	67.1	62.1	61.8	65.0	69.7	73.0	74.3	72.9
102.1	100.8	107.6	107.5	107.3	99.6	86.4	86.1	68.8	72.2	71.0	61.1	57.1	55.4	52.0	53.5	52.5	55.6	58.2	58.1	56.3
100.7	100.9	105.3	105.0	104.9	99.1	93.0	95.1	79.5	74.4	69.4	78.9	80.5	83.0	79.3	76.3	66.4	64.6	63.3	66.2	69.7
27.0	26.1	28.4	24.9	31.5	31.4	29.7	32.8	30.7	28.4	27.4	31.4	31.0	29.7	29.0	30.7	31.0	30.3	31.9	33.8	31.0
5.6	6.0	5.8	7.0	6.1	7.0	7.1	6.9	6.0	6.3	5.2	6.0	6.2	6.1	5.6	5.5	6.3	7.7	7.8	8.5	7.7
$92.2	$77.5	$78.1	$69.1	$45.9	$53.8	$52.1	$61.7	$72.5	$57.3	$57.6	$57.2	$56.3	$57.7	$75.4	$71.9	$51.3	$69.1	$123.0	$107.5	$100.9
1.8%	1.4%	1.3%	1.1%	0.7%	0.8%	0.8%	0.9%	1.0%	0.8%	0.8%	0.8%	0.7%	0.7%	0.9%	0.8%	0.6%	0.7%	1.2%	1.1%	1.0%
$131.05	$118.06	$110.67	$103.89	$85.96	$83.70	$80.46	$79.81	$81.45	$78.51	$74.96	$73.64	$71.14	$69.32	$71.43	$68.01	$59.76	$59.49	$68.93	$67.52	$62.23
$7,998	$7,456	$7,336	$7,046	$5,942	$5,875	$5,770	$5,807	$5,994	$5,702	$5,571	$5,552	$5,532	$5,454	$5,769	$5,664	$5,128	$5,271	$6,313	$6,176	$5,913
9.8¢	9.7¢	9.3¢	9.3¢	9.1¢	8.7¢	8.4¢	8.2¢	8.1¢	8.0¢	7.9¢	7.9¢	7.7¢	7.5¢	7.3¢	7.2¢	7.0¢	6.8¢	6.8¢	7.1¢	6.9¢
$53.08	$44.52	$42.33	$38.40	$19.00	$24.16	$18.63	$22.54	$25.94	$21.37	$20.56	$17.81	$16.85	$18.24	$21.67	$18.99	$12.27	$17.60	$27.53	$21.34	$23.01
$9.49	$6.00	$6.52	$4.90	$8.51	$9.50	$10.03	$4.87	$4.28	$3.96	$2.93	$2.71	$1.51	$1.70	$1.93	$2.50	$4.27	$4.91	$7.32	$7.15	$5.93
$10.74	$7.06	$4.97	$3.15	$5.75	$5.55	$4.64	$0.85	$1.75	$2.78	$2.34	$1.55	$0.67	$0.39	$1.69	$1.62	$3.33	$2.66	$6.38	$4.90	$5.41
71.5%	73.5%	75.4%	75.4%	79.0%	79.3%	81.8%	82.9%	82.2%	82.9%	82.5%	82.0%	81.2%	82.5%	83.8%	84.1%	83.7%	81.3%	83.1%	82.8%	81.5%
93	95	99	97	98	96	92	91	95	97	93	96	93	88	82	84	87	76	74	81	78
315.5	312.1	325.0	321.1	319.2	326.3	338.3	343.5	338.5	333.8	334.4	336.3	338.6	341.9	349.0	347.0	344.4	346.4	350.2	337.4	339.5
14.0	13.4	13.1	12.6	12.2	12.2	12.3	12.1	11.9	11.9	11.7	11.6	11.3	11.3	11.2	10.8	10.4	10.1	9.9	9.6	9.5
5.81	5.52	5.33	5.09	5.13	5.07	5.07	4.89	4.71	4.62	4.56	4.47	4.39	4.27	4.27	4.14	4.04	3.96	3.84	3.80	3.73
182.1	179.1	181.4	179.2	175.8	176.1	182.0	185.1	175.1	178.1	175.6	181.8	179.1	180.8	188.4	180.8	178.4	181.3	188.0	182.3	193.1
286.1	279.6	276.2	261.9	252.1	252.3	258.5	264.0	260.1	257.4	250.4	249.5	247.0	249.9	249.1	248.7	244.9	243.2	251.0	246.6	245.9
572	553	547	527	512	505	502	508	511	512	517	501	489	473	465	438	410	392	376	367	366
3,780	3,781	3,751	3,686	3,645	3,620	3,516	3,578	3,518	3,449	3,445	3,440	3,406	3,372	3,384	3,414	3,383	3,339	3,337	3,374	3,458
32.3%	27.9%	29.0%	29.7%	28.4%	26.4%	21.9%	25.0%	23.0%	22.9%	23.9%	21.0%	20.5%	16.4%	17.5%	15.0%	11.7%	9.8%	13.3%	16.0%	18.4%
307	292	300	300	292	286	273	280	270	269	272	262	258	242	247	241	234	228	231	229	222
14.1	14.2	14.5	14.6	14.7	15.1	15.6	15.9	16.4	16.9	16.9	16.7	16.7	16.8	16.9	17.0	16.9	16.7	16.9	17.1	16.9
306	304	295	292	292	296	300	300	301	306	306	304	300	301	299	294	290	283	278	280	281
3.4%	2.9%	3.1%	2.9%	2.8%	2.9%	3.2%	3.3%	3.4%	3.2%	3.1%	3.3%	3.6%	3.6%	3.4%	3.6%	3.2%	3.1%	3.1%	3.1%	3.3%
4,406	4,383	4,613	4,600	4,608	4,764	4,982	5,067	5,039	4,996	5,093	5,185	5,258	5,314	5,501	5,575	5,622	5,682	5,867	5,759	5,809
19.0	18.7	19.6	19.3	19.2	19.7	20.4	20.5	20.2	19.7	19.9	19.9	20.0	20.0	20.4	20.4	20.4	20.4	20.8	20.2	20.2
0.85	0.81	0.79	0.76	0.73	0.73	0.74	0.72	0.71	0.70	0.69	0.69	0.67	0.66	0.66	0.64	0.62	0.59	0.59	0.57	0.57
26.7%	27.5%	27.3%	27.4%	28.9%	28.0%	28.3%	28.9%	30.8%	31.6%	30.6%	30.2%	30.1%	31.6%	31.9%	30.4%	29.6%	30.5%	29.2%	28.4%	29.2%
$0.85	$0.80	$0.75	$0.60	$0.49	$0.51	$0.45	$0.44	$0.44	$0.45	$0.33	$0.25	$0.23	$0.18	$0.17	$0.11	$0.13	$0.09	$0.12	$0.13	$0.15
$1.34	$1.15	$1.08	$1.01	$0.93	$0.86	$0.84	$0.87	$0.89	$0.93	$0.91	$0.81	$0.79	$0.76	$0.68	$0.64	$0.60	$0.62	$0.60	$0.66	$0.67
76.8	74.3	70.6	69.5	67.9	65.4	61.8	60.2	60.3	61.9	62.8	63.3	62.4	61.9	60.7	58.3	56.1	53.9	52.3	52.1	52.5

Summary Table 1: Energy Security Metrics (Values)

2003-2014

Metric	Units of Measurement	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Global Fuels Metrics													
1 Security of World Oil Reserves	reserves, freedom & diversity-weighted	91.0	92.1	87.1	87.2	86.2	87.5	86.9	88.1	93.6	93.6	93.6	93.6
2 Security of World Oil Production	production, freedom & diversity-weighted	69.0	73.2	72.7	73.2	73.4	76.2	74.6	77.6	81.3	80.2	80.2	80.1
3 Security of World Natural Gas Reserves	reserves, freedom & diversity-weighted	92.7	97.2	97.7	96.6	96.2	96.0	95.2	93.0	94.2	95.5	95.5	95.5
4 Security of World Natural Gas Production	production, freedom & diversity-weighted	73.4	77.7	78.4	79.4	80.0	79.3	75.9	79.2	85.3	81.6	81.5	81.2
5 Security of World Coal Reserves	reserves, freedom & diversity-weighted	67.9	70.3	67.5	73.8	73.8	68.0	67.7	69.5	69.5	69.5	69.5	69.5
6 Security of World Coal Production	production, freedom & diversity-weighted	81.2	95.8	98.8	99.1	102.9	112.4	120.6	128.7	136.3	136.3	136.3	136.3
Fuel Import Metrics													
7 Security of U.S. Petroleum Imports	oil imports, freedom & diversity-weighted	34.0	37.2	38.0	37.9	36.9	37.4	33.4	33.3	31.9	29.4	28.2	27.8
8 Security of U.S. Natural Gas Imports	gas imports, freedom & diversity-weighted	7.4	8.1	8.7	8.5	8.8	6.8	6.3	6.0	4.5	3.5	3.5	3.7
9 Oil & Natural Gas Import Expenditures	billions of 2000$	$130.8	$170.1	$231.0	$253.6	$267.1	$338.3	$176.5	$227.1	$266.3	$259.8	$293.3	$307.1
10 Oil & Natural Gas Import Expenditures per GDP	percent of GDP	1.2%	1.6%	2.1%	2.2%	2.3%	2.9%	1.6%	2.0%	2.3%	2.1%	2.4%	2.4%
Energy Expenditure Metrics													
11 Energy Expenditures per GDP	$ per $1,000 GDP	$67.73	$73.48	$82.93	$86.68	$87.98	$98.57	$74.62	$81.45	$90.22	$89.14	$85.19	$85.55
12 Energy Expenditures per Household	2000$/Household	$6,550	$7,277	$8,342	$8,840	$9,080	$10,031	$7,332	$8,192	$9,102	$9,288	$9,045	$9,341
13 Retail Electricity Prices	cents/kWh (2000$)	7.0¢	7.0¢	7.2¢	7.6¢	7.6¢	8.0¢	7.9¢	7.9¢	7.8¢	7.7¢	7.7¢	7.7¢
14 Crude Oil Price	2000$/bbl	$26.09	$33.04	$43.69	$50.76	$56.72	$76.19	$48.66	$61.09	$80.54	$79.13	$85.17	$88.57
Price & Market Volatility Metrics													
15 Crude Oil Price Volatility	change in year-to-year price	$3.65	$3.90	$6.90	$8.22	$7.89	$10.83	$17.66	$19.81	$19.81	$18.37	$18.98	$18.91
16 Energy Expenditure Volatility	average yearly price change/$1,000 GDP	$3.88	$6.21	$8.66	$8.26	$6.61	$4.58	$10.09	$11.82	$13.35	$11.81	$10.26	$8.71
17 World Oil Refinery Utilization	percent utilization	83.6%	85.6%	86.0%	85.3%	85.1%	83.9%	80.4%	82.1%	81.2%	81.2%	81.2%	81.2%
18 Petroleum Stock Levels	average days supply	78	79	82	83	81	89	95	94	93	93	94	93
Energy Use Intensity Metrics													
19 Energy Consumption per Capita	million Btu/Person	337.6	341.9	339.2	333.8	336.3	326.4	308.4	316.0	312.0	309.0	302.0	300.9
20 Energy Intensity	million Btu/$1,000 GDP	9.3	9.2	9.0	8.7	8.7	8.5	8.4	8.4	8.2	8.2	7.9	7.7
21 Petroleum Intensity	million Btu/real $1000 GDP	3.70	3.71	3.61	3.48	3.40	3.20	3.14	3.10	2.99	3.07	2.96	2.88
22 Household Energy Efficiency	million Btu/household	194.5	192.4	194.4	183.8	190.1	188.4	183.8	189.5	184.8	186.6	181.0	178.1
23 Commercial Energy Efficiency	MMBtu/1,000 sq.ft.	242.0	241.6	239.6	233.2	236.0	233.2	223.0	222.8	220.5	220.0	217.5	216.0
24 Industrial Energy Efficiency	trillion Btu/IP Index	360	362	340	332	324	324	334	336	325	336	319	309
Electric Power Sector Metrics													
25 Electricity Capacity Diversity	HHI Index	3,576	3,588	3,619	3,613	3,593	3,585	3,566	3,567	3,423	3,401	3,406 0	3,411
26 Electricity Capacity Margins	percent	22.8%	24.5%	20.0%	17.4%	19.0%	23.3%	27.1%	23.5%	26.6%	26.5%	26.3%	25.8%
27 Electricity Transmission Line Mileage	circuit-miles/peak GW	226	228	212	207	212	223	232	224	227	226	226	229
Transportation Sector Metrics													
28 Motor Vehicle Average MPG	miles per gallon	17.0	17.1	17.1	17.2	17.2	17.4	17.6	17.5	17.4	17.6	17.6	17.7
29 Transportation VMT per $ GDP	vehicle miles traveled/$1,000 GDP (2000$)	277	275	269	264	260	256	264	257	248	248	245	238
30 Transportation Non-Petroleum Fuels	percent	3.3%	3.3%	3.5%	3.9%	4.5%	5.5%	6.0%	6.6%	7.1%	7.2%	7.2%	7.2%
Environmental Metrics													
31 Energy-Related CO2 Emissions	MMTCO2	5,857	5,975	5,996	5,918	6,022	5,838	5,426	5,607	5,473	5,570	5,453	5,438
32 Energy-Related CO2 Emissions per Capita	metric tons CO2/Person	20.2	20.4	20.3	19.8	20.0	19.2	17.7	18.1	17.6	17.6	17.0	16.8
33 Energy-Related CO2 Emissions Intensity	metric tons CO2/$1,000 GDP	0.56	0.55	0.54	0.52	0.51	0.50	0.48	0.48	0.46	0.47	0.45	0.43
34 Electricity Non-CO2 Generation Share	percent of total generation	29.0%	28.9%	28.3%	29.0%	28.0%	29.0%	31.0%	30.1%	31.6%	31.9%	33.3%	33.7%
Research and Development Metrics													
35 Industrial Energy R&D Expenditures	energy R&D $/$1,000 GDP	$0.17	$0.19	$0.22	$0.30	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37
36 Federal Energy & Science R&D Expenditures	R&D $/$1,000 GDP	$0.68	$0.66	$0.62	$0.59	$0.69	$0.71	$1.09	$0.79	$0.82	$0.82	$0.82	$0.82
37 Science & Engineering Degrees	number of degrees/$billion GDP	54.9	55.6	55.2	54.6	54.2	55.9	55.9	55.9	55.9	55.9	55.9	55.9

Summary Table 1: Energy Security Metrics (Values)

2015-2035

2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6
80.3	80.5	80.5	80.5	80.7	81.0	81.2	81.6	81.9	82.1	82.3	82.4	82.5	82.7	82.9	82.9	83.2	83.3	83.5	83.7	83.9
95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5
80.9	81.2	81.4	81.6	81.8	82.1	82.3	82.5	82.7	82.9	83.1	83.2	83.4	83.6	83.8	84.0	84.2	84.5	84.7	85.0	84.3
69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5
136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3
27.1	25.5	25.0	24.2	23.7	23.3	23.4	23.8	24.2	24.3	24.3	24.1	23.9	23.8	23.8	23.7	24.1	23.9	24.1	24.6	25.1
3.6	2.8	2.3	2.0	1.5	0.7	0.1	-0.5	-1.1	-1.4	-1.7	-1.8	-1.8	-1.7	-1.8	-1.9	-1.9	-2.0	-2.2	-2.5	-2.8
$307.5	$285.3	$281.4	$273.6	$267.2	$261.9	$261.1	$266.6	$270.6	$272.6	$274.7	$274.7	$272.9	$273.4	$277.7	$280.5	$286.3	$288.7	$293.4	$300.3	$306.7
2.3%	2.1%	2.0%	1.9%	1.8%	1.7%	1.7%	1.7%	1.7%	1.6%	1.6%	1.6%	1.5%	1.5%	1.5%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%
$84.94	$83.16	$81.83	$80.61	$79.25	$78.25	$77.26	$75.95	$74.70	$73.45	$72.45	$71.25	$69.76	$68.69	$67.83	$66.92	$66.38	$65.77	$63.97	$63.14	$62.73
$9,496	$9,472	$9,445	$9,391	$9,343	$9,335	$9,343	$9,364	$9,381	$9,379	$9,400	$9,392	$9,343	$9,335	$9,346	$9,358	$9,421	$9,472	$9,360	$9,390	$9,477
7.7¢	7.7¢	7.7¢	7.7¢	7.6¢	7.7¢	7.7¢	7.7¢	7.7¢	7.8¢	7.8¢	7.8¢	7.8¢	7.8¢	7.8¢	7.8¢	7.8¢	7.9¢	7.9¢	8.0¢	8.1¢
$91.03	$89.08	$90.35	$90.85	$91.56	$92.44	$93.30	$94.45	$95.26	$96.05	$96.81	$97.40	$97.95	$98.65	$99.91	$101.04	$102.21	$103.13	$104.11	$105.24	$106.18
$18.59	$17.36	$17.61	$17.71	$17.85	$18.02	$18.19	$18.41	$18.57	$18.72	$18.87	$18.99	$19.09	$19.23	$19.48	$19.70	$19.92	$20.10	$20.29	$20.51	$20.70
$7.16	$5.61	$5.61	$5.61	$5.61	$5.61	$5.61	$5.61	$5.61	$5.61	$5.61	$5.61	$5.61	$5.61	$5.61	$5.61	$5.61	$5.61	$5.61	$5.61	$5.61
81.2%	81.2%	81.2%	81.2%	81.2%	81.2%	81.2%	81.2%	81.2%	81.2%	81.2%	81.2%	81.2%	81.2%	81.2%	81.2%	81.2%	81.2%	81.2%	81.2%	81.2%
93	93	93	93	93	93	93	93	93	93	93	92	92	92	91	91	91	91	90	90	89
298.7	297.1	294.8	293.0	291.7	290.4	289.1	288.7	287.4	285.9	284.8	283.7	282.6	281.4	280.0	278.9	277.7	276.6	275.9	275.1	274.1
7.4	7.2	7.1	6.9	6.8	6.7	6.6	6.4	6.3	6.1	6.0	5.9	5.7	5.6	5.5	5.4	5.3	5.2	5.1	5.0	4.9
2.80	2.72	2.64	2.58	2.51	2.45	2.39	2.33	2.26	2.20	2.15	2.10	2.05	2.01	1.96	1.92	1.88	1.84	1.80	1.77	1.73
175.3	173.5	172.4	171.5	170.7	169.8	168.8	168.1	167.5	166.8	166.1	165.4	164.8	164.2	163.5	162.8	162.2	161.5	160.9	160.5	159.9
214.8	214.3	214.1	214.1	213.9	213.7	213.0	212.5	212.1	211.7	211.5	211.4	211.3	211.2	211.0	210.7	210.4	210.0	209.7	209.4	208.8
298	291	284	282	280	278	276	274	270	268	265	263	261	259	258	256	255	255	253	251	249
3,362	3,347	3,345	3,345	3,343	3,339	3,338	3,337	3,335	3,339	3,355	3,357	3,370	3,384	3,406	3,418	3,434	3,452	3,471	3,489	3,508
24.9%	24.9%	24.9%	24.9%	24.9%	24.9%	24.9%	24.9%	24.9%	24.9%	24.9%	24.9%	24.9%	24.9%	24.9%	24.9%	24.9%	24.9%	24.9%	24.9%	24.9%
231	231	231	231	231	231	231	231	231	231	231	231	231	231	231	231	231	231	231	231	231
17.9	18.2	18.5	18.8	19.1	19.5	19.8	20.1	20.4	20.7	21.0	21.3	21.5	21.8	22.0	22.2	22.4	22.6	22.8	22.9	23.0
233	229	226	224	221	219	217	214	211	209	206	204	202	200	198	196	194	192	189	187	185
7.2%	7.2%	7.3%	7.6%	7.6%	7.9%	8.2%	8.4%	8.5%	8.6%	8.7%	8.8%	9.0%	9.2%	9.4%	9.6%	9.9%	10.5%	10.7%	10.6%	10.7%
5,407	5,408	5,402	5,402	5,421	5,434	5,450	5,492	5,519	5,534	5,552	5,576	5,596	5,613	5,626	5,647	5,669	5,676	5,706	5,739	5,758
16.6	16.4	16.2	16.1	16.0	15.9	15.8	15.8	15.7	15.6	15.5	15.4	15.4	15.3	15.2	15.1	15.0	14.9	14.9	14.8	14.8
0.41	0.40	0.39	0.38	0.37	0.37	0.36	0.35	0.34	0.33	0.33	0.32	0.31	0.31	0.30	0.29	0.29	0.28	0.28	0.27	0.26
34.0%	34.6%	34.8%	34.8%	34.8%	35.1%	35.1%	35.1%	35.1%	35.1%	35.1%	35.0%	34.9%	34.7%	34.5%	34.3%	34.0%	33.8%	33.6%	33.5%	33.4%
$0.37	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37	$0.37
$0.82	$0.82	$0.82	$0.82	$0.82	$0.82	$0.82	$0.82	$0.82	$0.82	$0.82	$0.82	$0.82	$0.82	$0.82	$0.82	$0.82	$0.82	$0.82	$0.82	$0.82
55.9	55.9	55.9	55.9	55.9	55.9	55.9	55.9	55.9	55.9	55.9	55.9	55.9	55.9	55.9	55.9	55.9	55.9	55.9	55.9	55.9

Summary Table 2: Energy Security Indexes (1980 = 100)

1970-1982

Metric	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Index of U.S. Energy Security Risk	79.2	79.4	81.1	83.7	91.6	91.0	94.2	90.9	86.6	92.3	100.0	97.9	91.6
Sub-Indexes													
Geopolitical	73.5	74.5	76.7	80.1	87.5	89.8	94.0	91.9	85.4	91.7	100.0	97.3	91.7
Economic	64.3	64.7	65.1	67.2	83.3	82.6	84.8	83.0	79.5	87.7	100.0	98.9	91.0
Reliability	83.7	82.3	84.0	87.0	96.2	94.3	96.4	85.3	81.1	88.2	100.0	98.9	91.7
Environmental	106.0	105.9	108.8	110.7	105.5	102.2	106.4	106.6	104.7	104.3	100.0	96.5	92.4
Global Fuels Metrics													
1 Security of World Oil Reserves	117.2	115.2	112.7	106.5	101.4	102.5	102.2	88.1	76.9	85.3	100.0	97.0	94.3
2 Security of World Oil Production	89.7	91.3	93.3	95.0	100.9	109.8	114.5	107.3	96.7	94.0	100.0	100.6	94.0
3 Security of World Natural Gas Reserves	57.5	67.4	74.0	78.2	83.9	101.7	106.3	113.6	100.2	98.2	100.0	105.9	120.3
4 Security of World Natural Gas Production	70.4	69.6	68.0	67.7	71.2	84.6	89.5	91.6	87.4	88.6	100.0	106.4	116.0
5 Security of World Coal Reserves	98.5	98.5	98.5	98.4	97.4	106.9	108.6	99.1	92.7	92.4	100.0	102.1	102.1
6 Security of World Coal Production	91.2	93.5	95.6	96.4	97.1	103.4	103.1	95.4	92.3	89.2	100.0	99.4	100.7
Fuel Import Metrics													
7 Security of U.S. Petroleum Imports	53.5	61.2	70.6	89.4	96.7	106.9	124.0	132.2	109.0	106.3	100.0	92.7	72.4
8 Security of U.S. Natural Gas Imports	74.5	75.6	73.2	70.2	68.5	88.4	92.6	101.3	89.2	112.5	100.0	98.0	118.9
9 Oil & Natural Gas Import Expenditures	6.4	7.7	9.8	16.8	53.3	47.3	58.0	71.2	62.5	83.1	100.0	92.0	65.8
10 Oil & Natural Gas Import Expenditures per GDP	8.7	10.2	12.4	20.0	63.6	56.6	65.9	77.4	64.2	82.9	100.0	89.7	65.4
Energy Expenditure Metrics													
11 Energy Expenditures per GDP	59.5	59.5	59.0	60.3	76.2	78.1	79.1	80.9	77.7	86.5	100.0	101.9	97.6
12 Energy Expenditures per Household	54.5	55.1	56.0	58.9	72.2	72.4	75.7	79.5	78.8	88.4	100.0	100.4	93.3
13 Retail Electricity Prices	71.4	72.4	72.4	72.4	83.7	87.8	88.8	91.8	93.9	92.9	100.0	107.1	112.2
14 Crude Oil Price	30.6	30.9	29.4	32.3	57.0	53.7	53.2	53.9	50.4	69.5	100.0	99.0	84.9
Price & Market Volatility Metrics													
15 Crude Oil Price Volatility	3.7	2.6	4.3	8.6	54.5	58.0	53.4	8.4	8.9	44.0	100.0	95.1	85.7
16 Energy Expenditure Volatility	26.2	28.5	26.1	33.9	88.0	85.9	84.2	45.5	41.2	66.6	100.0	110.8	94.0
17 World Oil Refinery Utilization	158.9	146.7	141.5	154.2	129.4	110.0	111.7	106.1	108.1	111.1	100.0	93.2	91.7
18 Petroleum Stock Levels	117.5	118.6	139.3	139.7	126.3	117.3	128.2	114.4	120.1	112.4	100.0	88.1	87.1
Energy Use Intensity Metrics													
19 Energy Consumption per Capita	96.3	97.1	100.8	104.0	100.7	97.0	101.4	103.0	104.5	104.6	100.0	96.5	91.8
20 Energy Intensity	118.8	117.4	117.0	115.1	113.1	110.3	110.5	108.4	105.3	103.3	100.0	95.1	93.1
21 Petroleum Intensity	118.0	118.2	121.0	120.9	116.8	114.5	116.8	117.8	114.1	108.2	100.0	91.0	87.9
22 Household Energy Efficiency	109.5	110.8	112.4	109.7	105.2	104.3	106.3	106.1	106.8	102.3	100.0	93.1	93.7
23 Commercial Energy Efficiency	111.9	113.1	113.1	111.2	110.0	111.3	112.1	108.7	106.0	104.1	100.0	97.2	96.3
24 Industrial Energy Efficiency	124.2	122.3	116.7	113.7	111.2	112.9	111.7	106.7	102.4	103.2	100.0	94.6	89.7
Electric Power Sector Metrics													
25 Electricity Capacity Diversity	110.0	110.2	109.7	108.7	106.3	100.4	100.8	94.8	95.0	96.9	100.0	99.9	102.5
26 Electricity Capacity Margins	142.7	129.2	135.0	120.1	102.9	95.7	92.6	100.6	100.4	88.6	100.0	92.7	81.1
27 Electricity Transmission Line Mileage	128.6	122.2	119.5	117.8	109.7	106.5	105.8	108.1	105.6	99.4	100.0	96.2	90.8
Transportation Sector Metrics													
28 Motor Vehicle Average MPG	110.8	109.9	110.8	111.8	110.8	109.0	109.9	108.1	107.3	106.4	100.0	97.8	94.3
29 Transportation VMT per $ GDP	99.4	102.1	103.6	102.1	100.1	104.0	104.3	104.3	104.0	99.8	100.0	99.3	103.9
30 Transportation Non-Petroleum Fuels	97.3	97.4	97.7	98.6	99.0	100.1	100.8	101.1	101.4	100.6	100.0	99.8	100.0
Environmental Metrics													
31 Energy-Related CO2 Emissions	33.9	40.5	69.1	95.2	74.5	56.8	91.6	109.9	116.4	125.2	100.0	83.4	52.7
32 Energy-Related CO2 Emissions per Capita	98.0	97.8	105.8	113.2	103.8	95.8	105.7	109.9	109.8	110.4	100.0	92.9	82.1
33 Energy-Related CO2 Emissions Intensity	122.2	119.6	119.4	117.8	114.5	111.3	112.0	110.3	105.6	103.8	100.0	94.9	91.9
34 Electricity non-CO2 Generation Share	131.3	122.6	123.6	120.8	104.0	93.8	99.1	104.0	91.8	97.1	100.0	99.1	87.5
Research and Development Metrics													
35 Industrial Energy R&D Expenditures	147.0	147.0	147.0	147.0	140.9	145.1	143.9	109.2	110.0	103.8	100.0	106.2	106.7
36 Federal Energy & Science R&D Expenditures	175.5	182.8	179.1	186.1	172.5	130.5	126.2	99.6	95.1	97.0	100.0	112.0	129.1
37 Science & Engineering Degrees	79.4	78.9	79.7	80.9	79.5	81.7	86.6	91.5	96.8	100.6	100.0	101.8	97.2

Summary Table 2: Energy Security Indexes (1980 = 100)

1983-2002

1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
86.6	87.3	84.2	83.4	84.5	82.2	80.0	78.8	76.6	75.2	76.7	75.5	76.4	78.5	79.0	78.9	81.9	88.0	84.7	82.8
87.5	90.8	88.1	86.6	87.0	81.3	81.3	79.3	76.3	74.7	76.8	75.6	75.5	76.2	74.8	73.0	76.3	84.1	82.2	79.6
83.4	81.4	77.3	71.1	72.1	69.4	67.6	68.3	65.3	63.7	63.5	61.8	62.3	65.3	64.6	61.4	64.4	73.5	69.4	67.9
85.2	84.0	79.9	87.5	89.3	88.8	79.8	78.6	77.9	75.2	77.6	75.6	78.8	80.7	85.2	91.8	96.7	100.4	95.3	92.2
91.5	94.3	93.1	92.9	94.5	96.2	96.8	94.1	92.7	93.3	95.5	95.8	96.7	99.3	101.0	100.8	101.7	103.3	100.6	100.8
99.0	104.3	104.5	112.0	110.1	99.6	100.6	124.4	120.0	141.6	148.1	147.4	146.2	141.7	128.7	126.0	124.6	127.9	127.1	124.0
90.6	93.9	90.9	94.8	89.9	80.7	83.1	77.7	76.0	73.0	77.7	75.4	74.1	70.0	70.2	68.1	68.0	68.9	69.6	66.3
122.4	142.1	136.6	137.0	125.0	95.7	101.1	86.8	88.9	77.4	86.2	87.4	87.7	87.5	87.2	89.1	93.0	99.1	98.7	94.9
124.1	139.3	148.0	158.2	144.4	119.4	118.8	92.7	89.9	69.7	72.9	69.6	67.1	62.1	61.8	65.0	69.7	73.0	74.3	72.9
100.8	107.6	107.5	107.3	99.6	86.4	86.1	68.8	72.2	71.0	61.1	57.1	55.4	52.0	53.5	52.5	55.6	58.2	58.1	56.3
100.9	105.3	105.0	104.9	99.1	93.0	95.1	79.5	74.4	69.4	78.9	80.5	83.0	79.3	76.3	66.4	64.6	63.3	66.2	69.7
69.9	76.2	66.8	84.4	84.1	79.6	87.9	82.3	76.1	73.5	84.1	83.1	79.5	77.8	82.3	83.2	81.3	85.5	90.7	83.0
127.2	123.3	148.6	129.0	149.2	150.2	145.6	126.6	134.3	109.6	126.9	132.0	130.3	118.4	117.8	134.5	162.5	166.0	179.5	163.5
55.2	55.7	49.3	32.7	38.4	37.1	44.0	51.7	40.8	41.0	40.8	40.1	41.1	53.8	51.3	36.6	49.3	87.7	76.6	72.0
52.6	49.5	42.0	26.9	30.7	28.5	32.6	37.6	29.7	28.9	27.9	26.4	26.4	33.3	30.4	20.8	26.7	45.6	39.4	36.4
88.0	82.5	77.4	64.0	62.4	59.9	59.5	60.7	58.5	55.8	54.9	53.0	51.6	53.2	50.7	44.5	44.3	51.4	50.3	46.4
86.9	85.5	82.2	69.3	68.5	67.3	67.7	69.9	66.5	65.0	64.7	64.5	63.6	67.3	66.0	59.8	61.5	73.6	72.0	69.0
111.2	106.7	106.7	104.4	100.4	96.7	94.7	92.9	92.1	90.9	90.4	88.3	86.2	84.3	82.7	80.4	78.1	78.4	82.0	79.8
71.2	67.7	61.4	30.4	38.7	29.8	36.1	41.5	34.2	32.9	28.5	27.0	29.2	34.7	30.4	19.6	28.2	44.0	34.1	36.8
54.1	58.9	44.2	76.7	85.7	90.5	43.9	38.6	35.7	26.4	24.4	13.6	15.4	17.4	22.6	38.6	44.3	66.1	64.5	53.5
61.9	43.6	27.6	50.3	48.6	40.6	7.5	15.3	24.3	20.5	13.6	5.9	3.4	14.8	14.2	29.2	23.3	55.9	42.9	47.4
97.1	102.0	102.0	111.9	112.9	120.1	123.4	121.3	123.3	122.2	120.7	118.2	122.0	125.9	127.0	125.8	118.6	123.9	123.1	119.1
85.3	82.5	84.3	83.2	84.4	88.3	89.2	85.3	84.1	87.3	85.2	87.3	92.3	99.1	97.2	93.5	106.4	109.6	100.8	103.9
90.8	94.6	93.5	92.9	95.0	98.5	100.0	98.5	97.1	97.3	97.9	98.6	99.5	101.6	101.0	100.3	100.8	101.9	98.2	98.8
88.9	87.1	83.4	80.9	80.9	81.2	80.4	78.7	78.8	77.4	76.7	75.1	74.9	74.5	71.8	69.1	67.1	65.8	63.4	63.2
83.6	80.6	77.1	77.6	76.7	76.7	74.1	71.3	70.0	69.1	67.6	66.5	64.6	64.6	62.6	61.1	59.9	58.2	57.4	56.5
92.1	93.3	92.2	90.4	90.6	93.6	95.2	90.1	91.6	90.3	93.5	92.1	93.0	96.9	93.0	91.8	93.3	96.7	93.7	99.3
94.1	93.0	88.2	84.9	84.9	87.0	88.9	87.6	86.7	84.3	84.0	83.2	84.2	83.9	83.7	82.5	81.9	84.5	83.0	82.8
86.7	85.8	82.6	80.2	79.3	78.7	79.7	80.1	80.3	81.0	78.6	76.7	74.2	73.0	68.7	64.2	61.5	58.9	57.6	57.4
102.6	100.8	97.1	94.7	93.3	87.3	90.9	87.4	83.5	83.2	82.9	81.0	79.0	79.7	81.4	79.6	77.1	77.0	79.2	84.0
93.7	90.4	88.1	92.4	99.2	119.7	104.8	113.7	114.3	109.5	124.5	127.6	159.8	149.6	174.7	224.3	266.4	197.5	163.7	142.3
95.3	92.7	92.6	95.3	97.3	102.1	99.5	103.2	103.6	102.4	106.0	108.0	114.9	112.8	115.5	118.7	121.9	120.6	121.6	125.3
93.7	91.7	91.1	90.5	88.1	85.3	83.6	81.1	78.7	78.7	79.6	79.6	79.2	78.7	78.2	78.7	79.6	78.7	77.8	78.7
103.0	100.0	99.1	99.0	100.4	101.7	101.6	102.0	103.6	103.7	103.0	101.6	101.9	101.3	99.6	98.3	96.0	94.1	94.8	95.1
101.0	100.6	100.9	101.2	100.9	100.3	100.2	99.9	100.3	100.4	100.1	99.6	99.5	99.9	99.4	100.4	100.4	100.5	100.4	100.0
49.7	79.6	77.9	79.0	99.2	127.5	138.6	134.9	129.3	141.9	153.9	163.4	170.7	195.0	204.5	210.6	218.4	242.5	228.5	234.9
79.8	86.8	84.8	83.6	87.7	94.2	95.6	92.5	88.5	89.5	90.3	90.6	90.4	94.6	94.9	94.2	94.1	98.1	92.6	92.5
87.4	85.9	82.2	79.6	79.7	80.1	78.7	76.8	76.3	75.2	74.5	72.6	71.5	71.4	69.3	66.9	64.5	64.0	62.1	61.5
85.2	85.7	85.3	81.0	83.7	82.8	80.9	76.1	74.1	76.4	77.4	77.8	74.1	73.4	77.0	78.9	76.8	80.2	82.5	80.0
109.7	113.3	126.8	141.1	137.9	145.9	148.1	148.1	146.8	171.6	195.1	203.2	229.6	240.9	302.0	277.2	322.3	289.2	276.4	253.4
150.3	160.2	172.1	186.0	200.6	206.4	198.4	195.9	186.0	191.0	215.4	220.0	228.1	253.3	271.9	287.3	278.7	289.0	263.1	260.7
100.6	105.8	107.5	110.0	114.2	120.9	124.0	123.8	120.6	119.0	118.1	119.6	120.6	123.1	128.1	133.0	138.5	142.8	143.3	142.2

Summary Table 2: Energy Security Indexes (1980 = 100)

2003-2015

Metric	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Index of U.S. Energy Security Risk	82.4	87.4	94.4	96.4	96.3	100.3	90.1	97.5	101.3	99.2	99.7	99.7	98.8
Sub-Indexes													
Geopolitical	79.2	85.6	92.0	94.6	96.5	103.1	89.3	96.3	101.6	99.3	101.3	102.3	102.1
Economic	70.0	76.5	86.9	90.8	91.7	102.1	83.9	93.5	102.1	100.0	102.1	102.8	102.2
Reliability	87.8	92.6	102.3	104.6	100.7	98.7	103.1	111.6	112.7	108.1	106.9	105.3	103.0
Environmental	100.4	101.4	101.3	99.0	98.8	95.2	87.7	91.2	88.3	89.0	86.6	85.6	84.3
Global Fuels Metrics													
1 Security of World Oil Reserves	91.0	92.1	87.1	87.2	86.2	87.5	86.9	88.1	93.6	93.6	93.6	93.6	93.6
2 Security of World Oil Production	69.0	73.2	72.7	73.2	73.4	76.2	74.6	77.6	81.3	80.2	80.2	80.1	80.3
3 Security of World Natural Gas Reserves	92.7	97.2	97.7	96.6	96.2	96.0	95.2	93.0	94.2	95.5	95.5	95.5	95.5
4 Security of World Natural Gas Production	73.4	77.7	78.4	79.4	80.0	79.3	75.9	79.2	85.3	81.6	81.5	81.2	80.9
5 Security of World Coal Reserves	67.9	70.3	67.5	73.8	73.8	68.0	67.7	69.5	69.5	69.5	69.5	69.5	69.5
6 Security of World Coal Production	81.2	95.8	98.8	99.1	102.9	112.4	120.6	128.7	136.3	136.3	136.3	136.3	136.3
Fuel Import Metrics													
7 Security of U.S. Petroleum Imports	91.0	99.6	101.8	101.6	98.9	100.3	89.5	89.1	85.5	78.8	75.7	74.5	72.5
8 Security of U.S. Natural Gas Imports	158.0	172.6	185.1	181.5	186.9	145.4	133.2	126.9	95.6	74.6	74.5	79.3	75.4
9 Oil & Natural Gas Import Expenditures	93.3	121.3	164.7	180.8	190.4	241.2	125.8	161.9	189.9	185.2	209.1	218.9	219.2
10 Oil & Natural Gas Import Expenditures per GDP	46.0	57.8	76.2	81.5	84.2	107.0	58.8	72.2	83.3	79.3	87.5	88.3	85.5
Energy Expenditure Metrics													
11 Energy Expenditures per GDP	50.5	54.7	61.8	64.6	65.5	73.4	55.6	60.7	67.2	66.4	63.5	63.7	63.3
12 Energy Expenditures per Household	76.4	84.9	97.3	103.1	105.9	117.0	85.5	95.5	106.1	108.3	105.5	108.9	110.7
13 Retail Electricity Prices	80.7	80.2	83.1	88.0	87.7	91.5	91.3	90.4	89.9	88.1	88.5	88.2	89.0
14 Crude Oil Price	41.7	52.9	69.9	81.2	90.7	121.9	77.8	97.7	128.8	126.6	136.3	141.7	145.6
Price & Market Volatility Metrics													
15 Crude Oil Price Volatility	32.9	35.2	62.2	74.2	71.2	97.7	159.3	178.8	178.7	165.7	171.2	170.6	167.7
16 Energy Expenditure Volatility	34.0	54.4	75.8	72.4	57.9	40.1	88.4	103.5	117.0	103.4	89.8	76.3	62.7
17 World Oil Refinery Utilization	125.4	131.4	132.6	130.5	130.0	126.4	116.0	120.9	118.5	118.5	118.5	118.5	118.5
18 Petroleum Stock Levels	104.0	102.9	99.8	97.9	101.1	91.6	86.0	87.0	87.5	87.3	86.4	87.2	87.5
Energy Use Intensity Metrics													
19 Energy Consumption per Capita	98.3	99.5	98.7	97.2	97.9	95.0	89.8	92.0	90.8	90.0	87.9	87.6	86.9
20 Energy Intensity	61.9	61.2	59.4	57.5	57.4	56.4	55.7	55.8	54.6	54.3	52.4	50.8	49.2
21 Petroleum Intensity	56.0	56.2	54.6	52.6	51.4	48.4	47.6	46.9	45.2	46.5	44.8	43.7	42.3
22 Household Energy Efficiency	100.0	99.0	100.0	94.5	97.8	96.9	94.5	97.5	95.0	96.0	93.1	91.6	90.2
23 Commercial Energy Efficiency	81.5	81.3	80.7	78.5	79.5	78.5	75.1	75.0	74.2	74.1	73.2	72.7	72.3
24 Industrial Energy Efficiency	56.5	56.8	53.3	52.1	50.9	50.9	52.4	52.7	51.0	52.7	50.0	48.4	46.7
Electric Power Sector Metrics													
25 Electricity Capacity Diversity	90.8	91.5	93.3	92.9	91.7	91.3	90.2	90.3	82.0	80.7	81.0	81.3	78.4
26 Electricity Capacity Margins	115.0	106.8	131.0	150.2	137.8	112.3	96.5	111.5	98.5	98.9	99.7	101.7	105.0
27 Electricity Transmission Line Mileage	123.2	121.9	130.9	134.3	131.2	124.5	120.1	124.3	122.7	123.3	123.1	121.3	120.5
Transportation Sector Metrics													
28 Motor Vehicle Average MPG	78.2	77.8	77.8	77.3	77.3	76.4	75.6	76.1	76.4	75.7	75.4	75.1	74.3
29 Transportation VMT per $ GDP	93.9	93.1	91.1	89.5	88.3	86.9	89.6	87.2	84.0	84.1	82.9	80.7	78.9
30 Transportation Non-Petroleum Fuels	100.1	100.1	99.7	98.8	97.7	95.6	94.8	93.6	92.6	92.4	92.5	92.5	92.4
Environmental Metrics													
31 Energy-Related CO2 Emissions	241.2	256.4	259.3	249.1	262.6	238.7	185.1	208.7	191.3	203.8	188.7	186.8	182.8
32 Energy-Related CO2 Emissions per Capita	92.4	94.4	93.4	89.2	90.6	83.6	71.0	74.7	70.0	70.1	65.9	64.3	62.4
33 Energy-Related CO2 Emissions Intensity	60.5	59.7	58.1	55.9	55.8	54.3	52.3	52.4	50.3	50.6	48.4	46.5	44.7
34 Electricity non-CO2 Generation Share	80.8	81.1	82.8	80.7	83.5	80.8	75.5	77.8	74.1	73.3	70.3	69.4	68.8
Research and Development Metrics													
35 Industrial Energy R&D Expenditures	241.6	224.3	210.3	179.8	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6
36 Federal Energy & Science R&D Expenditures	256.6	263.3	278.3	294.2	250.8	244.7	159.5	220.3	211.2	211.2	211.2	211.2	211.2
37 Science & Engineering Degrees	136.0	134.4	135.4	136.8	137.7	133.6	133.6	133.6	133.6	133.6	133.6	133.6	133.6

Summary Table 2: Energy Security Indexes (1980 = 100)

2016-2035

2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
95.9	95.4	94.8	94.3	93.9	93.7	94.0	94.2	94.2	94.3	94.2	94.1	94.1	94.4	94.7	95.1	95.2	95.5	96.0	96.5
99.1	98.7	97.9	97.2	96.6	96.3	96.8	97.2	97.4	97.6	97.7	97.6	97.7	98.2	98.5	99.1	99.4	99.8	100.6	101.2
98.8	98.3	97.5	96.8	96.3	96.2	96.5	96.7	96.7	96.7	96.5	96.2	96.1	96.5	96.7	97.2	97.4	97.6	98.2	98.7
99.1	99.0	98.8	98.7	98.4	98.4	98.8	99.2	99.4	99.7	99.9	100.1	100.3	100.8	101.1	101.7	102.0	102.4	103.0	103.4
83.5	82.8	82.2	81.9	81.5	81.1	81.0	80.8	80.4	80.2	80.0	79.8	79.7	79.4	79.3	79.2	79.0	79.0	79.1	79.0
93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6
80.5	80.5	80.5	80.7	81.0	81.2	81.6	81.9	82.1	82.3	82.4	82.5	82.7	82.9	82.9	83.2	83.3	83.5	83.7	83.9
95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5	95.5
81.2	81.4	81.6	81.8	82.1	82.3	82.5	82.7	82.9	83.1	83.2	83.4	83.6	83.8	84.0	84.2	84.5	84.7	85.0	84.3
69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5
136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3	136.3
68.4	66.9	64.9	63.5	62.4	62.7	63.9	64.7	65.1	65.2	64.6	64.0	63.7	63.8	63.6	64.5	64.1	64.6	66.1	67.2
59.8	49.2	43.2	31.7	15.3	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
203.4	200.6	195.0	190.5	186.7	186.1	190.1	192.9	194.4	195.8	195.8	194.6	194.9	198.0	200.0	204.1	205.8	209.2	214.1	218.7
77.0	74.0	70.4	67.2	64.4	62.7	62.1	61.2	60.0	58.9	57.4	55.5	54.3	53.9	53.1	53.0	52.2	51.7	51.6	51.4
62.0	61.0	60.1	59.0	58.3	57.6	56.6	55.6	54.7	54.0	53.1	52.0	51.2	50.5	49.9	49.5	49.0	47.7	47.0	46.7
110.5	110.1	109.5	109.0	108.9	109.0	109.2	109.4	109.4	109.6	109.5	108.9	108.9	109.0	109.1	109.9	110.5	109.2	109.5	110.5
89.1	88.7	88.4	87.8	88.1	88.4	88.6	89.2	89.6	89.5	89.5	89.5	89.4	89.6	89.9	90.3	90.5	90.6	91.6	92.7
142.5	144.5	145.3	146.5	147.9	149.3	151.1	152.4	153.7	154.9	155.8	156.7	157.8	159.8	161.7	163.5	165.0	166.6	168.4	169.9
156.7	158.9	159.8	161.0	162.6	164.1	166.1	167.5	168.9	170.2	171.3	172.3	173.5	175.7	177.7	179.7	181.4	183.1	185.1	186.7
49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2	49.2
118.5	118.5	118.5	118.5	118.5	118.5	118.5	118.5	118.5	118.5	118.5	118.5	118.5	118.5	118.5	118.5	118.5	118.5	118.5	118.5
87.6	87.5	87.3	87.2	87.2	87.2	87.5	87.6	87.7	88.0	88.2	88.5	88.8	89.0	89.2	89.5	89.9	90.3	90.7	91.2
86.5	85.8	85.3	84.9	84.5	84.2	84.0	83.6	83.2	82.9	82.6	82.3	81.9	81.5	81.2	80.8	80.5	80.3	80.1	79.8
47.9	46.8	46.0	45.2	44.4	43.5	42.6	41.6	40.6	39.8	38.9	38.1	37.4	36.6	35.9	35.2	34.6	33.9	33.2	32.6
41.1	40.0	39.0	38.0	37.1	36.2	35.2	34.2	33.4	32.6	31.8	31.0	30.4	29.7	29.1	28.4	27.8	27.3	26.7	26.2
89.2	88.6	88.2	87.8	87.3	86.8	86.5	86.1	85.8	85.4	85.1	84.7	84.4	84.1	83.7	83.4	83.0	82.8	82.5	82.2
72.2	72.1	72.1	72.0	71.9	71.7	71.5	71.4	71.3	71.2	71.2	71.1	71.1	71.0	71.0	70.8	70.7	70.6	70.5	70.3
45.6	44.6	44.2	43.9	43.7	43.4	42.9	42.4	42.0	41.6	41.2	40.9	40.6	40.5	40.2	40.0	39.9	39.7	39.3	39.1
77.6	77.5	77.5	77.4	77.1	77.0	77.0	76.9	77.1	78.1	78.1	78.9	79.7	81.0	81.7	82.6	83.6	84.7	85.7	86.9
105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0
120.5	120.5	120.5	120.5	120.5	120.5	120.5	120.5	120.5	120.5	120.5	120.5	120.5	120.5	120.5	120.5	120.5	120.5	120.5	120.5
73.3	72.1	70.8	69.5	68.4	67.2	66.3	65.2	64.2	63.4	62.5	61.8	61.0	60.4	59.8	59.3	58.8	58.4	58.1	57.8
77.5	76.5	75.8	75.0	74.3	73.5	72.5	71.6	70.7	70.0	69.2	68.5	67.9	67.3	66.5	65.7	64.9	64.2	63.4	62.6
92.3	92.2	91.7	91.6	91.1	90.5	90.1	90.0	89.8	89.6	89.3	89.0	88.7	88.2	87.9	87.4	86.3	86.1	86.2	85.9
182.9	182.1	182.1	184.5	186.3	188.3	193.8	197.3	199.2	201.6	204.7	207.3	209.5	211.1	213.9	216.7	217.6	221.6	225.8	228.3
61.2	59.9	58.8	58.1	57.3	56.6	56.4	55.9	55.2	54.6	54.1	53.5	52.9	52.2	51.7	51.2	50.5	50.2	49.9	49.4
43.4	42.2	41.4	40.6	39.7	38.9	38.1	37.2	36.3	35.4	34.6	33.9	33.2	32.5	31.8	31.2	30.5	29.9	29.3	28.7
67.7	67.3	67.2	67.2	66.7	66.7	66.6	66.7	66.7	66.6	66.9	67.1	67.5	67.8	68.3	68.9	69.2	69.6	69.9	70.1
160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6
211.2	211.2	211.2	211.2	211.2	211.2	211.2	211.2	211.2	211.2	211.2	211.2	211.2	211.2	211.2	211.2	211.2	211.2	211.2	211.2
133.6	133.6	133.6	133.6	133.6	133.6	133.6	133.6	133.6	133.6	133.6	133.6	133.6	133.6	133.6	133.6	133.6	133.6	133.6	133.6

Primary Data Sources

The Energy Institute relied primarily on government data from the Energy Information Administration (EIA), Department of Commerce, and Department of Transportation to develop its Index of U.S. Energy Security. Where historical data from government sources were not available (largely data before 1990 or so), other widely-used and respected sources were employed. EIA's *Annual Energy Outlook 2012 (AEO 2012)* was the primary source for metric forecasts out to 2035.

The following provides a list of the main sources of the data used to compile the metrics. Detailed information on these sources also is available on the Energy Institute's *Index of U.S. Energy Security* website at http://www.energyxxi.org/energysecurityindex.

American Petroleum Institute: For pre-1980 refinery utilization data.

British Petroleum. *BP Statistical Review of World Energy*. Available at: http://www.bp.com/sectionbodycopy.do?categoryId=7500&contentId=7068481. For pre-1980 international natural gas production and post-1980 refinery utilization data.

Department of Commerce:

- Bureau of the Census, *Statistical Abstract*. Available at: http://www.census.gov/compendia/statab/. For historical population data.

- Bureau of the Census, Housing Housing Vacancies and Homeownership (CPS/HVS) - Historical Tables, Table 7. Annual Estimates of the Housing Inventory: 1965 to Present. Available at: https://www.census.gov/hhes/www/housing/hvs/historic/. For historical household data.

- Bureau of Economic Analysis, National Economic Accounts: Current-Dollar and "Real" Gross Domestic Product. Available at: http://www.bea.gov/national/xls/gdplev.xls. For historical nominal and real GDP data.

- Bureau of the Census, *Statistical Abstract*, Energy & Utilities, Electric Power Industry - Capability, Peak Load, and Capacity Margin http://www.census.gov/compendia/statab/cats/energy_utilities.html. For pre-1989 summer peak load aggregates.

Department of Transportation: Federal Highway Administration, *Highway Statistics*. Available at: http://www.fhwa.dot.gov/policyinformation/statistics.cfm. For historical vehicle miles traveled data.

Energy Information Administration:

- *Annual Energy Outlook 2012.* Available at: http://www.eia.doe.gov/forecasts/aeo. For forecast import, expenditure, cost, electricity price, generating capacity, production, consumption, stock, miles per gallon, and energy-related carbon dioxide emissions data.

- *Annual Energy Review.* Available at: http://www.eia.doe.gov/emeu/aer/contents.html. For historical import, expenditure, cost, electricity price, generating capacity, production, consumption, stock, miles per gallon, and energy-related carbon dioxide emissions data

- *Emissions of Greenhouse Gases in the United States.* Available at: http://www.eia.gov/environment/emissions/ghg_report/. For historical energy-related carbon dioxide emissions data.

- *International Energy Outlook.* Available at: http://www.eia.doe.gov/oiaf/ieo/index.html. For forecast world oil and natural gas production data.

- International Energy Statistics. Available at: http://www.eia.doe.gov/countries/data.cfm. For historical international reserves and production data.

- *Monthly Energy Review.* Available at: http://www.eia.doe.gov/totalenergy/data/monthly/index.cfm. For historical energy expenditure data and preliminary energy data.

Federal Reserve Board: Industrial Production Index. Available at: http://www.federalreserve.gov/datadownload/Choose.aspx?rel=G.17. For historical industrial production data.

Freedom House: *Freedom in the World: Comparative and Historical Data.* Available at: http://www.freedomhouse.org/report-types/freedom-world. For historical international political rights and civil liberties data. Freedom House's annual index of political rights and civil liberties was used as a proxy for reliability of international trading partners.

International Energy Agency: For pre-1980 international coal production data.

Oil & Gas Journal: For pre-1980 international crude oil reserves and natural gas reserves data.

National Science Foundation: Division of Science Resources Statistics, Science and Engineering Statistics. Available at: http://www.nsf.gov/statistics/. For historical industrial R&D expenditure, federal science and energy R&D expenditure, and science and engineering degree data.

North American Electric Reliability Council: For historical transmission line mileage data.

Notes:

Institute for 21st Century Energy
U.S. Chamber of Commerce
1615 H Street, NW
Washington, DC 20062
Phone: 202-463-5558 | Fax: 202-887-3457
energyinstitute@uschamber.com
www.energyxxi.org

100 Years Standing Up for American Enterprise

U.S. CHAMBER OF COMMERCE

Printed on Recycled Paper