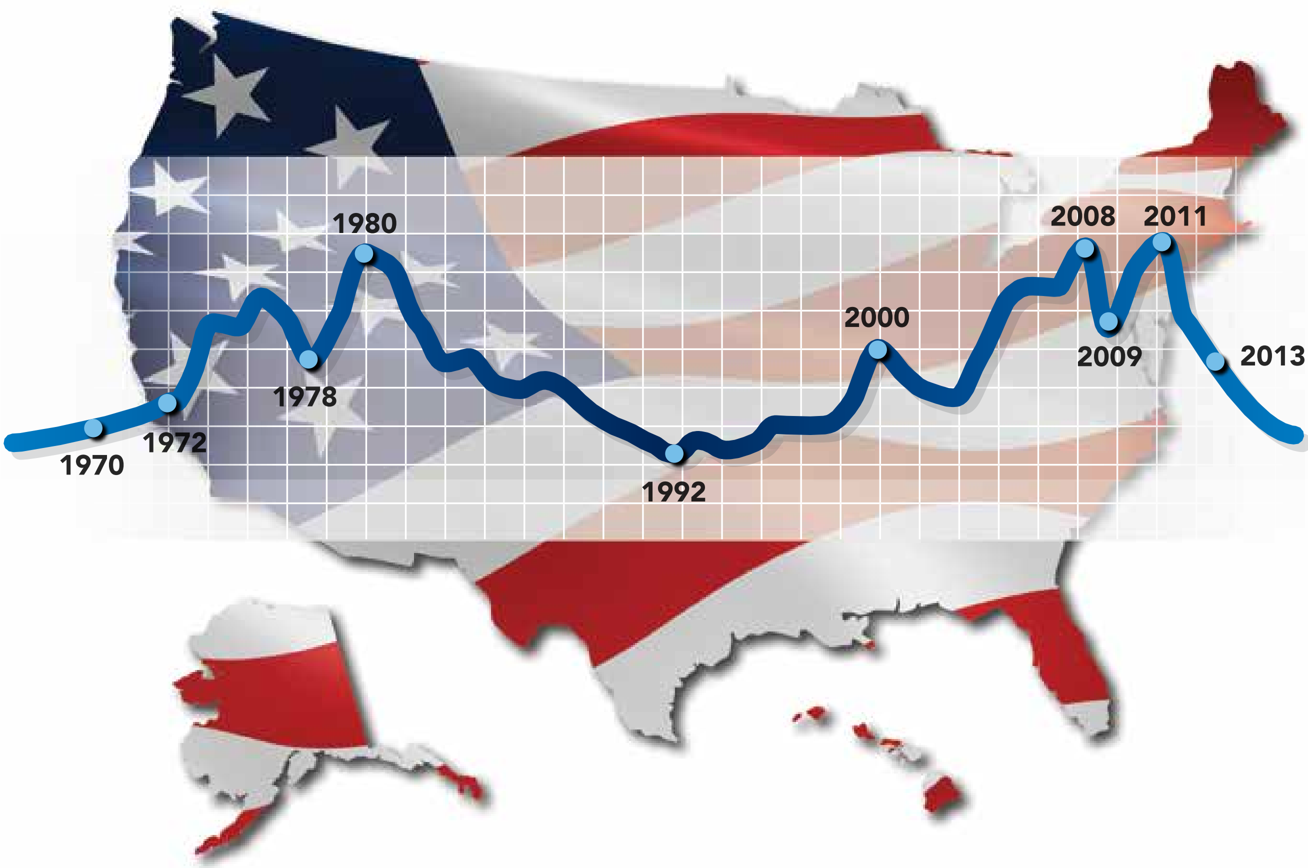
INDEX OF U.S. ENERGY SECURITY RISK®

2014 EDITION

ASSESSING AMERICA'S VULNERABILITIES IN A GLOBAL ENERGY MARKET



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OUR MISSION

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.

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Contents

Foreword

This 2014 Edition of the Institute for 21st Century Energy 's Index of U.S. Energy Security Risk (U.S. Index) shows a decline in risk for the second straight year. This year's results could mark the beginning of a durable trend of U.S. improved energy security, though the continuation of this trend is not inevitable.

The data in this report demonstrates how the sharply rising trends in unconventional oil and natural gas production in the United States are beginning to take hold and ripple through key measures that have a big influence on U.S. energy security. It also contains warning signs about the impacts that the forced closure of base load coal and nuclear power plants could have on energy security in the future.

"There are good reasons to be optimistic about growing U.S. oil and natural gas production, but realizing America's full potential is not a foregone conclusion."

Using advanced technologies, industry is unlocking vast amounts of domestic energy resources, turning scarcity into abundance and boosting America's standing as a global energy powerhouse. We are also seeing growing energy production from Canada and may soon see more production from a reformed hydrocarbon sector in Mexico. These trends will bring tremendous economic and geopolitical advantages. Given these developments, it's no surprise that Canada, Mexico, and the U.S. occupy three of the top six places among the 25 large energy consuming countries in the Energy Institute's latest International Index of Energy Security Risk released earlier this year.

Compare what's happening in North America to what's happening in Ukraine. Its energy security is dead last in our ranking, and by a big margin. There are a number of reasons for Ukraine's perennially poor showing—including dependence on Russia for about 60% of its natural gas needs—but the recent crisis there is a reminder of how energy vulnerabilities can aggravate political vulnerabilities.

The "Shale Gale" blowing through America's Oil Patch—and areas outside the traditional Oil Patch—invites few comparisons. Surging domestic oil and gas production, along with the world's biggest coal resource, is revolutionizing America's energy sector, revitalizing our economy in ways unanticipated as little as five years ago, and blunting many energy security challenges beyond our borders.

Rising U.S. output couldn't come at a better time. Large emerging economies like China's are growing into large oil consumers, which means there is less spare oil production capacity globally. Potential political instability in many producing countries also is a mounting risk. About 75% of the world's oil and 60% of its natural gas is produced in countries Freedom House categorizes as "Not Free" or "Partly Free."

There are good reasons to be optimistic about growing U.S. oil and natural gas production, but realizing America's full potential is not a foregone conclusion. Indeed, America's energy fortunes have brightened in the face of an energy policy uncomfortable with, if not actively hostile to, America's energy abundance.

Consider that all of that additional production is coming from, and will continue to come from, non-federal onshore lands. In fact, the Energy Information Administration's (EIA) 2014 forecast shows lower oil production from federal offshore areas and Alaska than its 2008 forecast. The trends are similar for natural gas. What this means is that while the rest of the country will enjoy an oil and gas boom, federal lands will continue to experience an oil and gas bust because of federal policy that locks out four-fifths of them from exploration and production. Under these kinds of restrictions, energy-rich public lands won't contribute as much to U.S. energy security as they should.

Complicating matters is disagreement over the goal of U.S. policy—energy independence or energy security, which are two very different things. Confusion on this point still plagues U.S. policy.

Our pursuit of energy independence in practice has displayed many of the traits of energy autarky. This is evident in long-standing statutory limitations on crude oil and natural gas exports, and more recently in proposals to prevent export of refined oil products derived from Canadian oil transported via the proposed Keystone XL pipeline (something neither Venezuelan nor Russian oil, for example, would be subject to). An inward-looking energy policy that limits U.S. participation in international energy markets, however, does nothing to increase directly the quantity, diversity, or reliability of energy supplies. A less timid American policy faithful to free trade principles would aim to enhance the energy security of ourselves and our allies.

"Lifting export restrictions on crude oil not only would yield obvious trade benefits, it would stimulate greater domestic output and send a reassuring signal to global markets."

Take crude oil production. In the two years after 2011, domestic production increased 1.8 million barrels per day (MMbbl/d), an incredibly rapid rate of increase. In 2013, the United Sates produced almost 7.5 million barrels per day (MMbbl/d), 10% of the world output, a global share not exceeded since 1997. Moreover, we are producing more at home than we are importing for the first time in decades.

In the first five months of 2014, crude oil production bumped up another 730,000 bbl/d to 8.2 MMbbl/d. At this pace, there is no reason the United States, already the world's largest natural gas producer, can't also become the world's largest oil producer. U.S. oil production of 11 to 12 million barrels per day is certainly possible.

Imagine how much bigger the geostrategic impact of America's energy revolution could be without export barriers. Today, the U.S. is experiencing a growing mismatch in the kind of crude oil we're producing—light sweet—and the kind most of our refineries are designed to process—heavy sour. Lifting export restrictions on crude oil not only would yield obvious trade benefits, it also would stimulate greater domestic output and send a reassuring signal to global markets. But a 1970s era ban prevents the U.S. from playing a much bigger role in the international oil market on the demand side.

Greater U.S. participation in global markets on the supply side can help reduce price volatility and the use of energy as a geopolitical weapon. We are already beginning to see the positive effects of higher U.S. shale gas production in European markets and even in Ukraine, where the market dominance of Russia's Gazprom has weakened. An energy export policy that adheres to free trade principles can only increase our influence.

Nevertheless, the United States will never be a price maker on world markets, but as a reliable supplier to world markets, we can be a price smoother. In 2013, for example, the United States and Canada increased their output by more than 2 million barrels per day, more than enough to offset lower output from the rest of the world.

Under normal circumstances, the kind of drops we have seen recently in oil production from Iran, Libya, and the North Sea would create large price volatility, but U.S. and Canadian production increases kept markets calm. Lifting the ban on U.S. exports of crude oil as well as quickening the pace of approvals for liquefied natural gas exports could increase U.S. influence, reduce global energy security risks, and boost the economy. The consulting firm IHS Energy estimates that free trade in crude oil could reduce the nation's oil import bill by $67 billion per year and reduce the cost of a gallon of gasoline by 8 cents, potentially saving motorists $265 billion from 2016-2030.

A new feature in this year's U.S. Index report also looks at various alternate future scenarios prepared by EIA and sees how they might affect future energy security. It is clear from the results of this analysis that greater domestic oil and gas production confers the greatest energy security and economic benefits of the 20 future scenarios examined.

This new analysis also points to the economic damage that will result from the rush to shut in America's coal-fired and nuclear power generating capacity, which represent huge energy security assets.

Growing supplies of natural gas clearly are putting competitive pressure on coal. But the biggest threat comes from Washington, where the Environmental Protection Agency is unleashing a regulatory onslaught intended to banish coal from the realm. EPA's rule on new power plants alone will virtually guarantee that no new coal power stations will be built here, and its proposed rule on existing plants will cause electricity prices to rise across the country without impacting global greenhouse gas emissions in any meaningful way.

"Unless we embrace a policy based on energy abundance instead of energy scarcity, we risk missing out on the kind of strategic opportunity that comes along only rarely."

The rest of the world has no compunction about using coal. The International Energy Agency predicts that before 2020, coal will surpass oil as the world's largest source of energy. Most of that growth will come from energy-hungry Asia, an important outlet for U.S. coal exports.

Even green Europe, where natural gas costs about three times more than it does here, is rediscovering the advantages of lower-cost electricity generated from coal. Europe is learning the hard way that its exorbitant energy prices, largely a deliberate policy choice, are ruining the competitiveness of its energy-intensive industries.

More and more, we're seeing European companies shifting production to the U.S. And why not? Affordable and reliable fuel and electricity, supplied by a diverse mix of coal, nuclear, and increasingly natural gas, give American industry an enormous economic edge, and they're driving a manufacturing revival in areas of the country desperately in need of jobs and investment.

Preserving coal and nuclear power as part of a diverse electricity generating mix that includes natural gas and renewables is not only critical to supply reliability—as we saw during the polar vortex in the winter of 2013/2014 when coal plants scheduled for shuttering were brought back online to satisfy soaring demand—it is also good economics. Another analysis by IHS Energy pegged the value of a diverse generating sector at $93 billion per year.

The past five years have shown that we have the energy resources, technology, capital, workforce, and entrepreneurial spirit needed to usher in and sustain a new era of energy abundance. America's anachronistic disco-era energy policy, however, is increasingly at odds with the nation's new energy reality and with what the Index suggests will result in the best energy security outcomes. Unless we embrace a policy based on energy abundance instead of energy scarcity, we risk missing out on the kind of strategic opportunity that comes along only rarely.

The Energy Institute's Energy Works for US platform is an actionable path forward toward a forceful, forward-looking energy policy that will serve our nation's vital interests, both foreign and domestic. Energy Works for US is divided into nine energy planks that identify the most promising areas taking into account our changed energy, economic, and fiscal positions. Each energy plank includes a set of specific policy recommendations that, if put into practice, would accelerate our nation's ability to fully capture our energy potential and overcome those barriers that stand in the way, creating millions of jobs, billions in government revenue, and trillions of private sector investment.

The United States has a greater variety and quantity of energy resources than any other country in the world. When combined with new exploration, production and end-use technologies, there is no reason we cannot usher in a new and long-lasting era of energy security. Instead of erecting roadblocks to domestic energy development, government policy should be embracing a more secure energy future by creating an environment that welcomes investment, innovation, and job creation. Now is the time to adopt an agenda that will unleash the energy revolution and all of its benefits.

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

Acknowledgements

Developing and maintaining something as complex as the U.S. Index remains very challenging task that could not happen without the remarkable efforts of many people. In particular, our thanks go to Daniel E. Klein, President of Twenty-First Strategies of Santa Fe, New Mexico for designing and compiling much of the data used. Rice University Fellow Bo Kim also was instrumental in crunching the numbers for the various forecast scenarios examined in this report, something that may be an ongoing feature of future U.S. Index reports. The entire production team here at the U.S. Chamber of Commerce, led by Brian Miller, is due a big debt of thanks for designing clean graphics that make sense of complex issues and producing a publication under a tight deadline.

Our nine planks for a sound energy policy include:

1. Remove Barriers to Increased Domestic Oil and Natural Gas Exploration and Production and Fuel Manufacturing
2. Maintain Coal's Role as a Vital Part of a Diverse Energy Portfolio
3. Expand Nuclear Energy Use and Commit to a Nuclear Waste Solution
4. Enhance the Competitiveness of Renewable Sources of Energy
5. Promote 21st Century Energy Efficiency and Advanced Technologies
6. Modernize the Permitting Process for Our Nation's Energy Infrastructure
7. Protect Our Energy Infrastructure from Physical Disruptions and Cyber Attacks
8. Reform the Regulatory Process for Balance, Predictability, and Transparency
9. Ensure a Competitive Energy Workforce

Introduction

This year's edition of the Institute for 21st Century Energy's (Energy Institute) Index of U.S. Energy Security Risk (Index) marks the fifth in the annual series and provides an updated look at U.S. energy security incorporating the most recent historical data and reflecting the latest and updated forecasts. The Index employs 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 covers the period from 1970 to 2040.

The Energy Institute's Index includes four Sub-Indexes that identify the major areas of risk to U.S. energy security: geopolitical, economic, reliability, and environmental. Each of the 37 metrics is mapped to one or more of these four sub-indexes. These four Sub-Indexes are then combined into an overall Index, where the weighted average of the four sub-indexes constitutes the overall Index of U.S. Energy Security Risk.[2]

This 2014 edition reflects revisions to the historical data and the new forecast in the Energy Information Administration's Annual Energy Outlook 2014.

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 approaching or surpassing 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 (75.6) scores, is 84.3. When reviewing this year's results, the 1980 baseline score and the 30-year averages along with the historical high and low scores also provided can be used as reference points against which to assess current and future risk scores. Unless noted otherwise, all dollar figures are in real 2010 dollars.

The Index discussed in this report is focused exclusively on the United States and how its energy security risks have moved over time and where they might be headed in 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 compare to those faced by other countries should consult the International Index, which is available on the Energy Institute's website.

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.

Highlights

The total U.S. energy security risk fell a healthy 4.5 points in 2013, and while the trend in near term future risks looks better than projected last year, longer term risks out to 2040 are still expected to be well above the historical average, especially the closer one gets to 2040.

The decline in risk in 2013 is the second consecutive year of declining risk. Unlike the large recession-related drop in risk in 2009, where the improvement was for all the wrong reasons, the drops in risk observed in 2012 and most recently in 2013 were propelled by real improvements in the energy picture, many of them related in one way or another to greater unconventional oil and natural gas output.

This 2014 edition of the Index of U.S. Energy Security Risk (U.S. Index) includes the most recent energy data available, including projections in the Energy Information Administration's (EIA) Annual Energy Outlook 2014 (AEO 2014), to provide an up-to-date assessment of those energy supply and use metrics having the greatest impact on energy security over the past year. The U.S. Index is based on a combination of 37 different energy security metrics beginning in 1970 and ending in 2040. Highlights include the following.

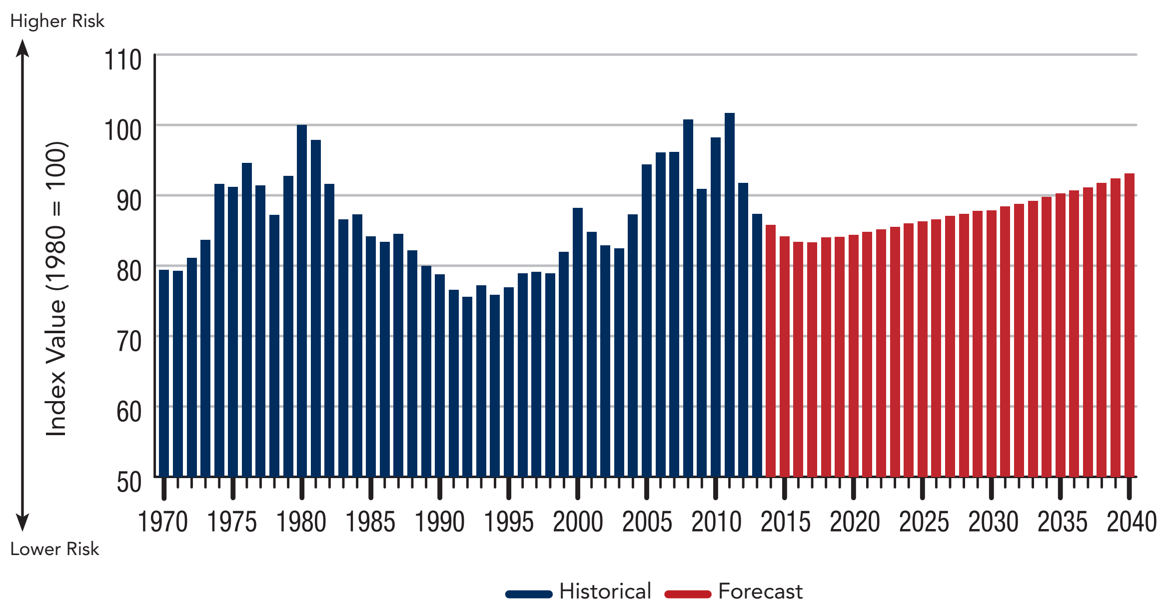
Total energy security risk in 2013 fell for the second year in a row, dropping 4.5 points (4.9%) from 2012 to

87.4,

the first time it's been below 90 since 2004.

Figure 1

U.S. Energy Security Risk Index, 1970-2040



Overview

Total energy security risk in 2013 fell for the second year in a row, dropping 4.5 points (4.9%) from 2012 to 87.4, the first time it's been below 90 since 2004. This decline follows a nearly 10 point drop in risk in 2012 from a record high risk of 101.7 points in set in 2011 (Figure 1).

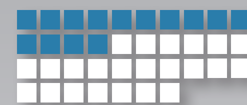
The 2013 score is just three points above the 30-year (1970-1999) average, and it is the 18th highest score since 1970 (Table 1). Like in 2012, greater domestic unconventional oil and natural gas production on private and state lands was the biggest single factor contributing to the improved U.S. energy security picture in 2013.

Of the 37 Index metrics, 14 showed a decrease in risk of 1% or more, 10 showed an increase in risk of 1% or more, and 11 showed essentially no change in risk in 2013. Not only was the number of number of metrics displaying rising risk scores comparatively small, they generally did not increase by all that much. Of those metrics that showed a decrease in risk, the average drop was 11.2%, with six recording improvements topping 10 percentage points.

Although decreasing risks were seen across about one-third of the energy security measures, most of the decrease in 2013 risk can be attributed to a half dozen oil and natural gas related measures. These included risk measures associated with oil and natural gas import supplies and expenditures as well as energy price volatility, factors that were primarily responsible for the 4.5-point drop in overall energy security risks in 2013. Only one showed a growing risk of 10% or more in 2013 (Table 2).

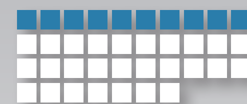
Of the 37 Index metrics,

14



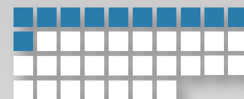
showed an increase in risk of 1% or more,

10



showed a decrease in risk of 1% or more, and

11



showed essentially no change in risk in 2013.

Table 1. U.S. Energy Security Risks from 1970 to 2013: Highest, Lowest and 30-Year (1970-1999) Average Index Scores

Indexes of U.S. Energy Security Risk	2013 Score	1980 Baseline Score	Highest Risk		Lowest Risk		30-Year Average (1970-1999)
			Year	Index Score	Year	Index Score	
Total Composite Index	87.4	100	2011	101.7	1992	75.6	84.3
Sub-Indexes:							
Geopolitical	88.0	100	2008	103.1	1998	73.1	83.6
Economic	86.4	100	2007	102.9	1998	61.5	73.8
Reliability	89.3	100	2011	114.2	1992	75.2	86.0
Environmental	85.8	100	1973	110.7	2012	84.2	99.4

As in 2012, the unconventional oil and natural gas boom in the United States increased supply security, reduced net imports, and put downward pressure on energy costs and expenditures, all of which to contributed to lower energy security risk. The growing impacts of increasing shale gas production have been noted in previous years of the U.S. Index. Crude oil production rose an impressive 954,000 barrels per day (bbl/d)—on top of the 835,000 bbl/d increase in 2012—to 7.4 million barrels per day (MMbbl/d) in 2013, a 15% jump. This represents the largest annual percentage increase since 1940. Natural gas output rose for the eight consecutive year in 2013 and achieved a record high of 24.3 trillion cubic feet (tcf). Between 40 and 45% of U.S. gas production in 2013 was from shale formations.

Rapidly domestic production of crude oil and natural gas on private and state reduced import exposure risks for these fuels. Because of increased production of crude oil, only about half of U.S. crude oil supplies in 2013 were imported, well below the record high level of 66.5% set in 2006. For natural gas, imports accounted for just below 6% of supply in 2013, well off the 17% peak in 2005. As a result, the risk metrics for petroleum and natural gas declined 18% and 16%, respectively, in 2013.

Declining imports of both oil and natural gas also have benefited the United States by lowering import expenditures. From $290 billion 2012, it is estimated that U.S. expenditures on imports of oil and natural gas slipped 21% ($61 billion) in 2013 to $229 billion, sending the risk index for this metric down 35 points. The index measuring these expenditures as a share of GDP, a gauge of the exposure of the United States to price shocks, also improved about 16 points, proportionally about the same as for total import expenditures. This the second large decline in these two metrics in as many years. As a result, the amount spent on imports of oil and natural gas, both nominally and as a share of GDP, has decreased by nearly one-third since 2011. The United States produces all the coal it needs, and in recent years has increased its export volumes, primarily to Asia but also to Europe and South America.

Crude oil price volatility and energy expenditure volatility moved much lower in 2013 for the second year running. Energy costs are a significant portion of our overall economy, and extreme price volatility can slow economic growth. Both the index for crude oil price volatility and expenditure volatility each improved by nearly 24% in 2013. This is a dramatic turnaround for both measures, which reached record highs in 2010 and 2011. Since then, crude oil volatility risks have been lowered by 55% and energy volatility expenditures by 60%. Rising domestic production of crude especially has been instrumental in contributing to lower price volatility because it had been more than enough to offset declines in supply of just about 900,000 bbl/d from the rest of the world stemming from political turmoil in from Libya, trade sanctions on Iran, and declining North Sea output. Without added U.S. supplies, it is likely that volatility would have been much greater over the past couple of years.

Table 2. Energy Security Metrics Changing >±10% in 2013

Declining Risk		Rising Risk	
Metric	% Change	Metric	% Change
Energy Expenditure Volatility	-23.8%	Federal Energy & Science R&D Expenditures	+12.6%
Crude Oil Price Volatility	-23.7%		
Oil & Natural Gas Import Expenditures per GDP	-22.4%		
Oil & Natural Gas Import Expenditures	-20.9%		
Security of U.S. Petroleum Imports	-17.8%		
Security of U.S. Natural Gas Imports	-15.9%		

Risks related to energy-related carbon dioxide emissions fell for the second consecutive year, falling to its lowest level since 1994. Slow but steady trends towards greater energy efficiency in all sectors, fuel switching from coal to cheap natural gas in the power sector, and still sluggish economic growth all contributed to the decline in total emissions.

Outlook to 2040

Based on EIA's latest AEO 2014, the U.S. Index is projected to average 87.4 points over the entire forecast period from 2014 to 2040, about a 5 point improvement over last year's Index projection based on the AEO 2013 forecast. Looking forward, risks are projected to continue to fall to 83.3 in 2017 and then rise steadily thereafter to 93.1 in 2040. This year's forecast averages more than 5.0 points lower because of the impact of greater U.S. oil and gas output in the short- to mid-term.

Event though the risk level in 2040 is expected to be higher, most metrics are expected to improve from 2014 to 2040. Of the 27 metrics for which forecast data are available, 15 are expected to improve, eight are expected to get deteriorate, and the rest are expected to remain about the same.

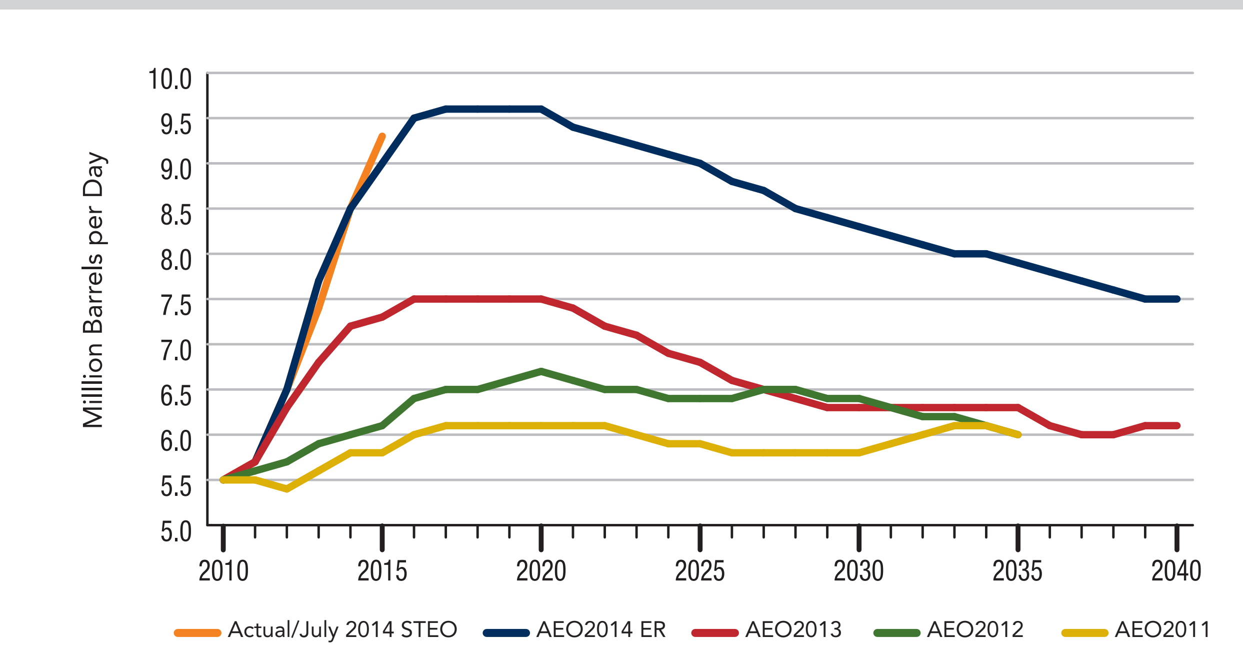
Based on EIA's latest AEO 2014, the U.S. Index is projected to average 87.4 points over the entire forecast period from 2014 to 2040, about a

5 point

improvement over last year's Index projection based on the AEO 2013 forecast.

Figure 2

EIA Forecasts of U.S. Crude Oil Production: 2010–2030



The rising risk trend late in the forecast period is being driven primarily by a projected 39% increase in the price of crude oil by 2040 (to $126 per barrel) that in turn will lead to higher (43%) total import expenditures. While large, the increases in these two metrics are actually quite a bit less than what EIA was projecting just last year. For example, EIA now forecasts that each year from 2014 to 2040 a barrel of crude oil will cost on average $21, or 17%, less than it did in last year's forecast. Although oil and gas import expenditures are expected to increase out to 2040, import expenditures as a share of GDP are expected to decline through 2040 owing to flattening oil demand and a sharp decline in natural gas imports as the U.S. shifts from being a net importer to a net exporter of natural gas by 2018.

The growth in U.S. oil and gas production is proceeding much more rapidly than expected even last year. We noted in last year's edition how the trend in real world crude oil output was a better match for EIA's AEO 2013 "High Oil and Gas" case rather than its "Reference" case (Figure 2) because of surging production from tight oil from low-permeability shale and chalk formations such as the Bakken formation in North Dakota, and the Eagle Ford, and Three Forks formations in Texas. One year later, EIA's AEO 2014 "Reference" case resembles more the previous year's "High Oil and Gas" case. EIA now projects that from 2014 to 2040, the U.S. will produce an average of 8.6 MMbbl/d. Over the entire period, EIA now projects that the United States will pump about 1.9 MMbbl/d—a total of about 18.5 billion barrels—more crude oil than it projected in 2013. It is possible that, like its 2013 Reference forecast, EIA's 2014 reference forecast likely will underestimate reality. Natural gas output also is exceeding previous forecasts. Combined with flat petroleum demand, this increased output is expected to lower even further oil and gas import risks.

Unprecedented levels of regulation covering fossil fuel-fired power plants and changing market dynamics are expected to increase electric power sector risks by decreasing generation diversity. The generation diversity metric captures the flexibility of the power sector's ability to dispatch electricity from a diverse range of sources. Since there are inherent differences in availability among different generating technologies, the generating capacities are weighted by an availability factor. Risks related to electricity generation capacity diversity are forecast to rise by one-third, reaching 118.1 points in 2040, a level higher than at any time in the past and much higher than the historical average of 94. Federal environmental regulations targeting coal plants and to a lesser extent greater competition between natural gas and coal in the power sector are primarily responsible for the loss of generation diversity. This is potentially very worrisome from a number of different perspectives.

Integration of a diverse fuels and generation technologies in the power sector provide economic benefits. A recent study by IHS Energy concluded that the current diversified generation portfolio "lowers the cost of generating electricity by more than $93 billion per year, and halves the potential variability of monthly power bills compared to a less diverse supply." It added that "the diverse mix of fuels and technologies available today produces lower and less volatile power prices compared to a less diverse case with no meaningful contributions from coal and nuclear power and a smaller contribution from hydroelectric power."[3]

Along with nuclear power plants, coal-fired plants provide base-load power and are critical to the smooth functioning of the electric grid, but over the short term (out to 2017), electricity capacity margins are expected to decline because of the coal plant closures of nearly 50 gigawatts in capacity related to EPA rules on mercury. Capacity margin risk over this period is expected to jump from an index score of 94.3 in 2013 to 112.7 in 2017. Forecast data beyond 2017 are not available. Nevertheless, should this short-term trend be extended, the lack of adequate capacity margins in the future could pose serious reliability risks. Indeed, utility companies and independent organizations like the North American Electric Reliability Corporation (NERC), with primary responsibility for the reliability of the electric grid, noted that these and other unbalanced rules could cause disruptions to the stability and reliability of the grid. In fact, in its 2011 reliability report,[4] NERC concluded that environmental regulations are the single greatest risk to the reliability of the grid over the next five years.

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3 IHS Energy. 2014. The Value of US Power Supply Diversity. Available at: http://www.ihs.com/info/0714/power-diversity-special-report.aspx.

4 NERC. 2011. 2011 Long Term Reliability Assessment. Available at: http://www.nerc.com/files/2011LTRA_Final.pdf.

Exports of coal also are expected to increase even more than anticipated last year. The AEO 2014 forecast also suggests that in 2040 net coal exports, at 160 million short tons, could be 30% greater than projected just last year in the AEO 2013. Growing U.S. coal exports will continue improve the security of worldwide coal supplies. It is important, however, that regulators ensure that port facilities are expanded to enable higher coal exports.

The long-term trend towards greater energy efficiency across most sectors continues to moderate future U.S. energy risks. Metrics measuring energy and petroleum intensity, sectoral energy efficiency, import expenditures as a share of GDP, transportation energy use and fuels, and energy-related carbon dioxide emissions all show considerable improvement from 2013 to 2040. The rate of change in these energy intensity and efficiency metrics out to 2040 has not changed appreciably from those reported in earlier editions of the U.S. Index.

Much greater efficiency in the transportation sector combined with fewer vehicle miles being traveled were the main factors contributing to a 48% reduction in petroleum intensity. These trends represent extensions of trends that have existed for many years. Petroleum demand in the transportation sector peaked in 2007, the year before the deep recession, and has not recovered. By 2040, demand for petroleum in the transportation sector is forecast to be 12.2 MMbbl/d, just above the level in 1997. Together with greater domestic crude oil production, these trends will continue to dampen demand for foreign crude oil.

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 declined in 2013 to 88 points. This is the second consecutive year of lower risk since the record high score of 101.5 points was recorded for this sub-index in 2011 (Figure 3). Despite the improvement, this is 44 points above the above the 30-year average score of 83.6. Lower crude oil and natural gas import and lower total import expenditure risks stemming from growing unconventional domestic oil and natural gas production and less volatility in the price of crude oil were the main factors contributing to lower geopolitical risks in 2013.

EIA's 2014 forecast suggests that geopolitical risks will rise, driven by increasing crude oil prices and volatility despite the strong trends in increasing production of U.S. crude oil and natural gas. Increasing unconventional crude oil gas production in North America, however, is expected to shift the geopolitical center of gravity of oil production towards North America, moderating the risks associated with the large concentration of crude oil supplies in the Middle East. Nevertheless, increasing demand in large emerging economies like China, India, Brazil and others will keep upward pressure on global prices. Moreover, political turmoil like that being experienced in the Middle East today may lead to market instability and price volatility.

Allowing free trade of U.S. crude oil could reap geopolitical and economic benefits. Crude oil exports have been banned since shortly after the Arab oil embargo. However, the mismatch in the type of crude oil being pumped in increasing quantities in the United States—light sweet—and the type of crude oil most of our refineries are geared to process—heavy sour—is creating market dislocations that could jeopardize increasing production. Exports could alleviate these conditions and trigger even further domestic production. The consulting firm IHS Energy estimates that lifting the export ban could: boost U.S. production to 11.2 MMbbl/d; add $750 billion in investment; create nearly 1 million new jobs; and reduce the nation's oil import bill by $67 billion per year. Moreover, the report points out that "by boosting global supplies, the elimination of the ban will result in lower global oil prices" that could save motorists 8¢ per a gallon of gasoline for a savings of $265 billion over the 2016-2030 period.[5] The recent decision by the Department of Commerce allowing exports of stabilized condensates is a step in the right direction, but lifting the entire ban would yield tremendous benefits.

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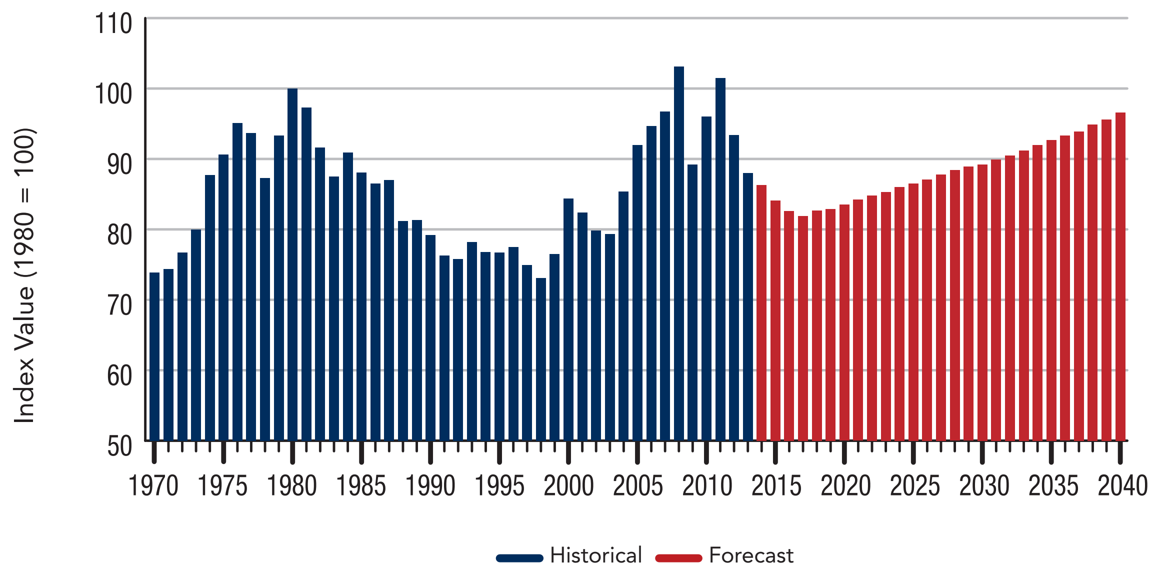
5 IHS Energy. 2014. US Crude Oil Export Decision: Assessing the Impact of the Export Ban and Free Trade on the US Economy. Available at: http://www.ihs.com/info/0514/crude-oil.aspx.

■ Figure 3

U.S. Energy Security Risk: Geopolitical Sub-Index, 1970-2040



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

Energy costs are a significant portion of our overall economy. In 2013, roughly $1.25 trillion were spent for end-use energy in the residential, commercial, industrial, and transportation sectors, amounting to roughly 10.5% of GDP. 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, the competitiveness of U.S. industries, and U.S. balance of trade.

Economic energy security risks risk fell nearly 7% in 2013 to 86.4, the lowest level since 2009 but still above the 30-year average of 73.8. The biggest improvements were noted in the metrics covering energy expenditure crude oil volatility and oil and gas import expenditures (Figure 4).

In 2013, the risk index for energy expenditure volatility and crude oil price volatility moved proportionally more than any other metric in the U.S. Index, each dropping 24%. Price spikes and market chaos peaked in 2010/11. Since then, the risk scores for these two metrics have fallen by more than half, a remarkable decline over such a short period. In absolute terms, energy expenditure volatility slipped from $14.67 per $1,000 of GDP in 2011 to $5.85 in 2013. Comparatively flat oil, natural gas, and retail electricity prices contributed to energy price stability.

With a large part of our energy use still consisting of fuel imports, volatility in the markets can lead to sudden and large shifts in international trade. Greater expenditures on imported fuels represent lost economic investment opportunities closer to home, and this risk is captured in metrics measuring how much the U.S. spends on imported oil and natural gas, both in total and as a share of GDP. Both of these measures got significantly better in 2013, the former by 21% (to 130.5 points) and the latter by about 22% (to 55 points). Historically, however, the scores for these two metrics remain well above their 30-year averages of 47.8 for total import expenditures and 42.3 for import expenditures as a share of GDP.

Further declines in economic risks are expected through about 2020, after which they will rise steadily, increasing to 93.7 points in the late 2040 largely due to high crude oil prices and import expenditures. If the domestic boom in unconventional oil output can be maintained or even increased for a longer period than projected currently, expenditure risks could be moderated to a great extent over the forecast period.

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

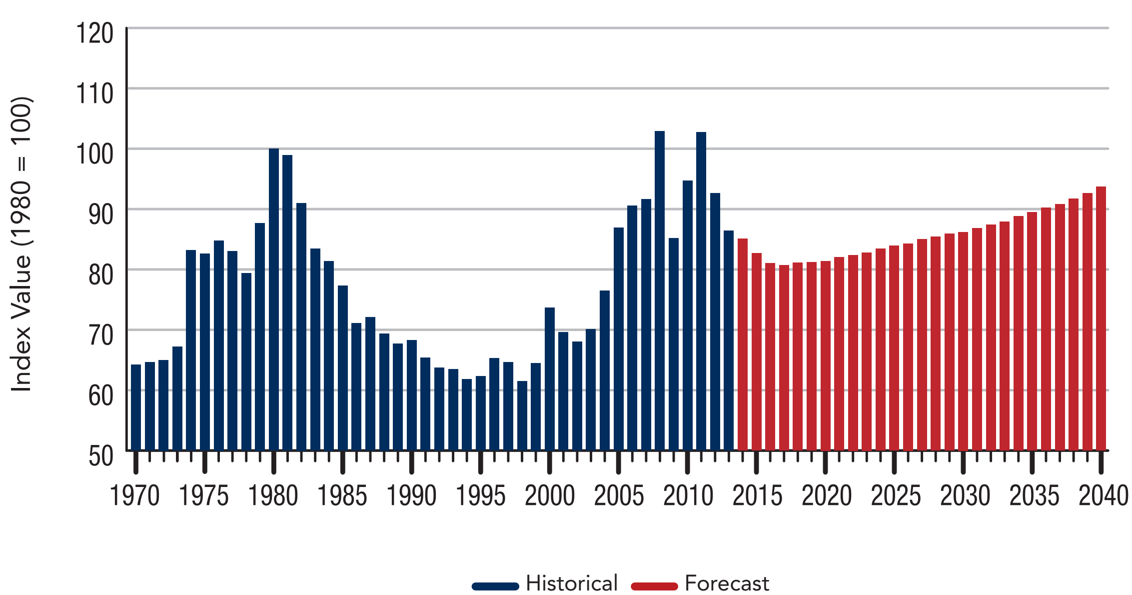
The metrics that make up the Reliability Sub-Index measure such things as global fossil fuel production and imports, crude oil price and volatility, oil refining and stock levels, the power sector, and energy research and development.

Reliability energy security risks fell 6.6 points (7%) to 89.3 points, only about 3 points off its 1970-1999 baseline average score of 86 (Figure 5). The reduction in risk observed in 2013 was due chiefly to large drops in crude oil volatility and energy expenditure volatility, discussed above. Large and growing supplies of unconventional oil and gas in the United States continue to enhance the reliability of supplies both in the United States and globally, with oil import risks tumbling 18% and natural gas import risks 16% in 2013. Reliability risks related to the power sector, world oil refining capacity utilization, and domestic petroleum stocks, however, remained little changed from 2012. Only the metric for government support for energy research and development showed a significant shift in 2013, seeing its risk score rise nearly 13%.

Reliability risks related the power sector remained basically unchanged in 2011, with only the risk index for generation capacity dropping appreciably (by nearly 8%). Measures for capacity diversity and transmission line mileage per peak demand showed little change in 2013. Compared to its historical average, the risk index for capacity margins was 27 points higher

Figure 4

U.S. Energy Security Risk: Economic Sub-Index, 1970-2040



than its 1970-1999 baseline average because capacity has not kept up with peak summer demand. Capacity diversity and transmission system risks, critical aspects of grid reliability, were not appreciably different from their historical averages.

Forecast scores based on the AEO 2014 suggest steadily rising risks out to 2040, reaching 104. Rising crude oil prices and potentially price volatility are factors going forward. Of equal significance are the growing risks related to lower generating capacity diversity and generating capacity margins (discussed above), both of which are being driven by shrinking shares of base load coal and nuclear generating capacity in the generating mix. Between 2013 and 2040, risks connected to capacity diversity are expected to rise by one-third and those associated with capacity margins by 20%. EPA regulations covering mercury and hazardous air pollutants, which will close 60 gigawatts of coal-fired generating capacity by 2020, are one the driving forces behind the anticipated rise in capacity diversity risk. Though EIA's AEO 2014 does not include proposed EPA rules on greenhouse gases for existing power plants, unveiled in June 2014, it is almost a certainty that once implemented, these rules also will drive capacity diversity risks higher.

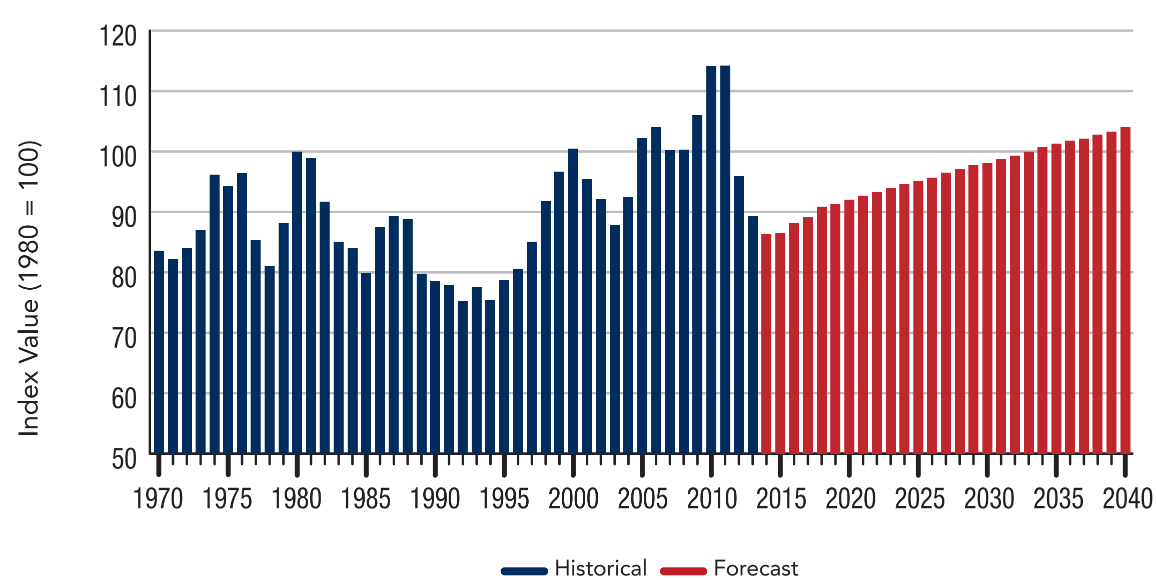
Sub-Index of U.S. Environmental Energy Security Risk

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.

With a score of 85.8, environmental energy security risks were little changed (-2%) in 2013. (Figure 6). This is the second lowest score for this sub-index in the entire record going back to 1970, and it is nearly 14 points below the historical average. No metric in this sub-index moved more than 5% in 2013. Of the 20 metrics in the sub-index, nine saw risks rise in 2013 by 1% or more, three declined by 1% or more, and eight remained essentially unchanged.

Figure 5

U.S. Energy Security Risk: Reliability Sub-Index, 1970-2040



Of the four sub-indexes, the Environment is the only one showing steadily declining risk out to 2040. By 2027, the risk score for this sub-index could fall below 80 for the first time, and by 2040 reach 76. Large improvements in the metrics measuring energy and petroleum intensity (nearly 50% for each) and energy efficiency in all sectors—residential (-18%), commercial (-12%), industrial (-29%), and transportation (-31%)—are responsible for the decline in environmental risks going forward. Each of these metrics shows constant future improvement, and by 2040, their scores are at the lowest level recorded by the index. Largely as a result of these trends, emissions of carbon dioxide are expected to rise less than 4% by 2040, while per capita emissions and emissions intensity fall sharply.

Energy Security Risks Under Alternate Future Scenarios

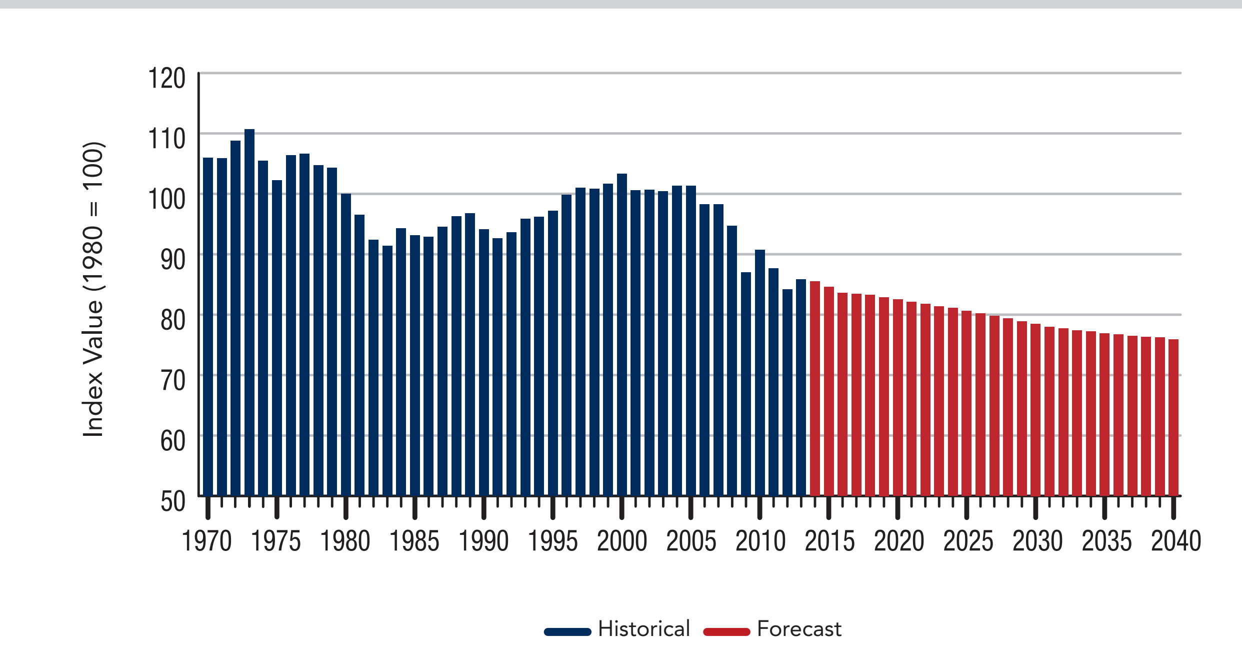
As part of its Annual Energy Outlook, EIA provides, in addition to it Reference case, a number of alternative cases that provide very different looks at what the future might hold. These can and do include quite different assumptions about many critical factors, including domestic oil and natural gas production, technology readiness and adoption, regulation and policy, fuel costs, energy demand, energy efficiency, and others. For its AEO 2014, EIA ran and made forecast data available for over 25 different side cases.[6]

As a special feature this year, a representative group of 20 of these alternate cases were selected and assessed as to their impact on future energy security risk as measured through the Energy Institute's U.S. Index. The cases are ranked in Table 3 and described Table 4. In addition, the table contains the cumulative difference in GDP from 2014 to 2040 for each case as a way to gauge the cost of the change in risk.

6 EIA. 2014. Annual Energy Outlook 2014 with Projections to 2040. DOE/EIA-0383(2014). Available at: http://www.eia.gov/forecasts/aeo/pdf/0383%282014%29.pdf. Descriptions of each case are found in Appendix E.

Figure 6

U.S. Energy Security Risk: Environmental Sub-Index, 1970-2040



A few things stand out immediately. The first is that the Low Oil Price case and the High Oil & Gas Resource case result in the most impressive drop in energy security risk in 2040, 11.7 points for the former and 11.1 points for the latter. The economic benefits of these cases, however, are much different. Whereas under the Low Oil Price case, about a half trillion dollars are added to the U.S. economy over the forecast period, under the High Oil & Gas Resource case nearly $4.3 trillion are added. Put another way, for every point of risk reduction in 2040, the economy gained $43 billion under the Low Oil Price case and $386 billion under the High Oil & Gas Resource case.

The difference is because in the Low Oil Price case, most of the benefits of increased oil production are captured outside of the United States. In the High Oil & Gas Resource case, in contrast, production of domestic shale gas, tight gas, and tight oil is much higher, new tight oil resources are added reflecting

Table 3. Energy Security Risk Scores in 2040 Under Different EIA AEO 2014 Side Cases

EIA AEO 2014 Case	2013-2040 Change in:	
	U.S. Energy Security Risk Score	Cumulative GDP (Billion 2010$)
Low Oil Price	-11.7	+508
High Oil & Gas Resource	-11.1	+4,286
$25 CO_2 Case	-7.7	-3,549
Extended Policies	-3.9	-39
$10 CO_2 Case	-3.4	-1,850
Low Electricity Demand	-3.4	+1,225
Low Vehicle Miles Traveled	-3.1	-103
High Technology	-2.4	+1,034
No Sunset	-1.1	+165
Low Renewable Technology Cost	-0.8	+58
High Cost Coal	-0.6	-934
High Nuclear	-0.6	+194
Accelerated Nuclear & Coal Retirements	+0.2	-1,568
No GHG Concern	+0.2	+32
Low Cost Coal	+0.2	+384
Accelerated Nuclear Retirements	+0.9	-383
Accelerated Coal Retirements	+0.9	-1,232
High Vehicle Miles Traveled	+1.0	+13
Low Oil & Gas Resource	+1.8	-2,043
High Oil Price	+8.6	+648

new or expanded plays, technology improves rapidly, and higher offshore resources are discovered, among other factors. All of these have contributed not only to significantly improved U.S. energy security but also to a huge boost in GDP and employment, with approximately 920,000 additional non-farm jobs in 2040 compared to the Reference case.

The only other case that results in a lowering of risk of five points of more is the $25 CO_2 case (7.7 points). In this case, the cost to the economy of each point reduction in risk is $460 billion compared to a increase in GDP of $386 per point in the High Oil & Gas Resource case (the price per point reduction in energy security risk in 2040 is higher still under the $10 GHG case). As an energy security strategy, a $25 per ton carbon fee would be extremely costly, reducing GDP by a cumulative $3.5 trillion from 2014 to 2040.

"Lastly, forecast data from the EIA cases that include accelerating the premature closure of coal-fired and nuclear power plants indicate strongly that these types of policies will not improve in the long run either energy security or the economy. "

At the other end of the table are the High Oil Price and the Low Oil & Gas Resource cases. While the High Oil Price case shows the biggest increases in risk in 2040 of the 20 cases examined, it also shows modestly more growth in GDP compared to the Reference case. This is due to the fact that high prices generate increased domestic drilling activity, the value of which is reflected in the GDP figures.

The Low Oil & Gas Resource case, the mirror image of the High Oil & Gas Resource case, results in a small (1.8 point) increase in energy security risk, but it also (after the $25 CO_2) case results in the second largest loss of cumulative GDP—$2 trillion. This case assumes recovery of shale gas, tight gas, and tight oil is about 50% less than expected and clearly showing the value of pursuing expanded unconventional oil and gas production in the United States. Besides the hit to GDP, this case produces nearly 400,000 fewer jobs in 2040 than in the Reference case and lower disposable income.

Both the Low Electricity and High Technology cases incorporate advanced technologies and demonstrate how they can help lower future risks and create economic growth. While the decrease in risk resulting from these two cases are fairly modest, they nonetheless result in significantly greater economic growth comparable on a risk index point basis to the High Oil & Gas Resource case. However, neither of these cases produces anywhere near a comparable drop in energy security risk in 2040.

Lastly, forecast data from the EIA cases that include accelerating the premature closure of coal-fired and nuclear power plants indicate strongly that these types of policies will not improve in the long run either energy security or the economy. The Accelerated Coal Retirement, Accelerated Nuclear Retirement, and the Accelerated Nuclear & Coal Retirements cases all show no appreciable improvements in energy security, but all show big costs to the economy. In the most costly scenario, the Accelerated Nuclear & Coal Retirements case, energy security risks rise marginally in 2040 while GDP suffers cumulative losses of almost $1.6 trillion from 2014 to 2040. Compared to its Reference case, EIA estimates that this scenario would lead to 500,000 fewer non-farm jobs in 2040.

While energy security is a desirable goal in and of itself, this brief analysis of these 20 different EIA cases shows how energy security improvements are achieved cannot be overlooked. Clearly, policies that lower risk and improve the economy are superior to those that do not. Energy policy should strive therefore, to improve security and the economy. As the results of these cases show, a policy approach that encourages greater domestic production of unconventional and offshore oil and natural gas, promotes development of advanced and cost-effective technologies, and does not prematurely shutter coal-fired and nuclear power plants and other valuable energy assets offers a much better chance of tacking our energy security problems and strengthening America's economy than alternative approaches.

Table 4. Summary of Side Cases

EIA AEO 2014 Case	EIA Description
Reference	Real GDP grows at an average annual rate of 2.4% from 2012 to 2040. Crude oil prices rise to about $141/barrel (2012 dollars) in 2040.
Low Oil Price	Low prices result from a combination of low demand for petroleum and other liquids in the non-Organization for Economic Cooperative Development (non-OECD) nations and higher global supply. Lower demand is measured by lower economic growth relative to the Reference case. On the supply side, the Organization of the Petroleum Exporting Countries (OPEC) increases its market share to 51%, and the costs of other liquids production technologies are lower than in the Reference case. Light, sweet crude oil prices fall to $70/barrel in 2017 and rise slowly to $75/barrel in 2040.
High Oil & Gas Resource	Estimated ultimate recovery per shale gas, tight gas, and tight oil well is 50% higher and well spacing is 50% lower (or the number of wells left to be drilled is 100% higher) than in the Reference case. In addition, tight oil resources are added to reflect new plays or the expansion of known tight oil plays and the estimated ultimate recovery for tight and shale wells increases 1%/year to reflect additional technological improvement. Also includes kerogen development, tight oil resources in Alaska, and 50% higher undiscovered resources in the offshore lower 48 states, Alaska, and shale gas in Canada than in the Reference case.
$25 CO_2 Case	Applies a price for CO2 emissions throughout the economy, starting at $25/metric ton in 2015 and rising by 5%/year through 2040.
$10 CO_2 Case	Applies a price for CO2 emissions throughout the economy, starting at $10/metric ton in 2015 and rising by 5%/year through 2040.
Low Electricity Demand	This case was developed to explore the effects on the electric power sector if growth in sales to the grid remained relatively low. Begins with the Best Available Demand Technology case, which lowers demand in the building sectors, and also assumes greater improvement in industrial motor efficiency.
Low Vehicle Miles Traveled	Assumes lower licensing rates and travel demand for specific age and gender cohorts. Vehicle miles traveled per licensed driver is 5% lower than in the Reference case for the full projection. Licensing rates stay constant at 2011 levels or decline from 2011 to 2040, specific to gender, age, and census division categories.
No Sunset	Begins with the Reference case and assumes extension of all existing tax credits and policies that contain sunset provisions, except those requiring additional funding (e.g., loan guarantee programs) and those that involve extensive regulatory analysis, such as CAFE improvements and periodic updates of efficiency standards. Also includes extension of the $1.01/gallon ethanol subsidy and $1.00/gallon biodiesel subsidy to the end of the projection period.
Low Renewable Technology Cost	Capital costs for new nonhydro renewable generating technologies are 20% lower than Reference case levels through 2040, and biomass feedstocks are 20% less expensive for a given resource quantity. Capital costs for new ethanol, biodiesel, pyrolysis, and other BTL production technologies are 20% lower than Reference case levels through 2040, and the industrial sector assumes a higher rate of recovery for biomass by products from industrial processes.
High Cost Coal	Regional productivity growth rates for coal mining are approximately 2.3 percentage points per year lower than in the Reference case, and coal miner wages, mine equipment costs, and coal transportation rates are higher than in the Reference case, ranging between 24% and 31% above the Reference case in 2040. The price change for non-U.S. export supplies is assumed to be roughly 10% less than the price change projected for U.S. coal exports.

Table 4. Summary of Side Cases	
EIA AEO 2014 Case	EIA Description
Accelerated Nuclear & Coal Retirements	Combines the assumptions in the Accelerated Nuclear Retirements and Accelerated Coal Retirements cases.
No GHG Concern	No GHG emissions reduction policy is enacted, and market investment decisions are not altered in anticipation of such a policy.
Accelerated Nuclear Retirements	Assumes that all nuclear plants are limited to a 60-year life, uprates are limited to the 0.7 GW that have been reported to EIA, and no new additions beyond those planned in the Reference case. Nonfuel operating costs for existing nuclear plants are assumed to increase by 3%/year after 2013.
Accelerated Coal Retirements	Begins with the AEO2014 High Coal Cost case assumptions and also assumes that nonfuel operating costs for existing coal plants increase by 3%/year after 2013.
Low Oil & Gas Resource	Estimated ultimate recovery per shale gas, tight gas, and tight oil well is 50% lower than in the Reference case. All other resource assumptions remain the same as in the Reference case.
High Oil Price	High prices result from a combination of higher demand for liquid fuels in non-OECD nations and lower global supply. Higher demand is measured by higher economic growth relative to the Reference case. OPEC market share averages 37% throughout the projection. Non-OPEC petroleum production expands more slowly in the short to middle term relative to the Reference case. Crude oil prices rise to $204/barrel (2012 dollars) in 2040.

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 2040 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 extend to 2040 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.

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

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.

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 2040 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 2014 (AEO 2014) was the primary source for metric forecasts out to 2040. AEO 2014 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.

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.

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. 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 2040 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 2040. 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 70-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 2040. 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 (1970-2013) 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.

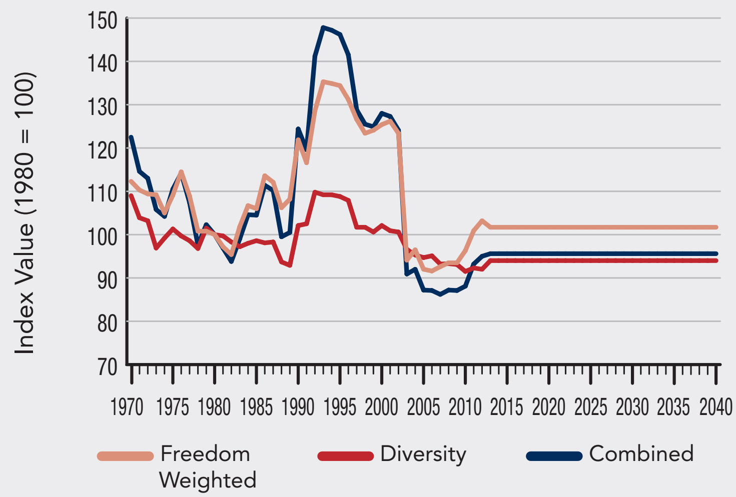
Importance

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.

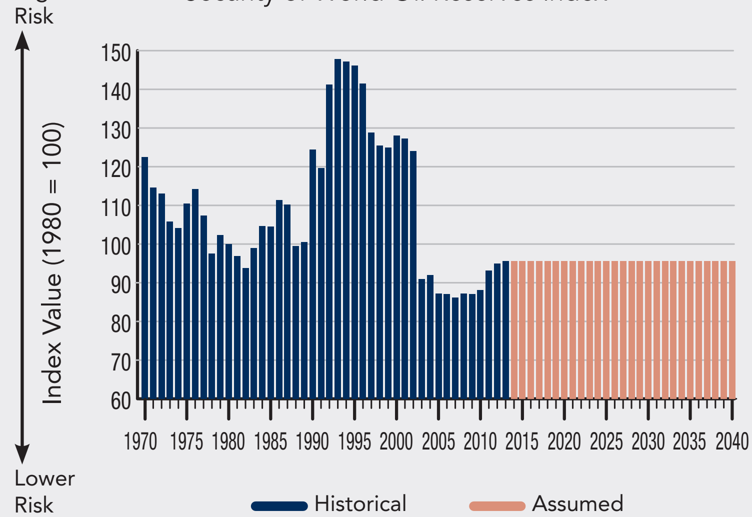
Category of Metric

Global Fuels

Historical and Forecast Values (1970-2040):
Security of World Oil Reserves Trends



Index (1970-2040):
Security of World Oil Reserves Index



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

	GEOPOLITICAL	ECONOMIC	RELIABILITY	ENVIRONMENTAL	TOTAL INDEX
Weight	9.0	N/A	N/A	N/A	2.7
Average Contribution	11.5	N/A	N/A	N/A	3.4

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.

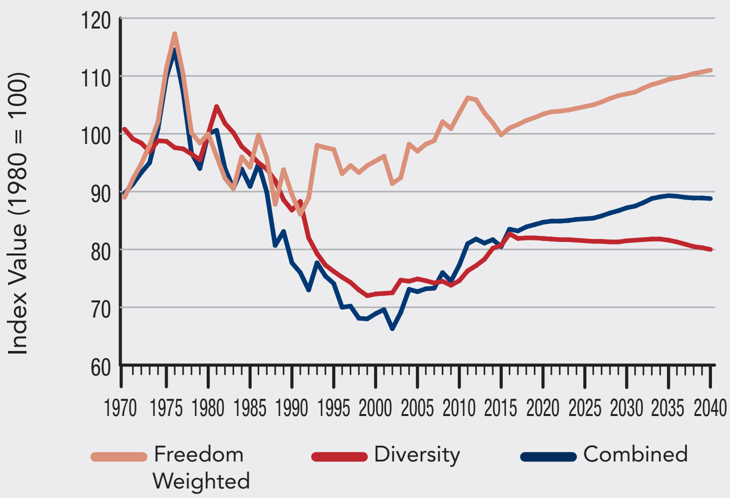
Importance

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

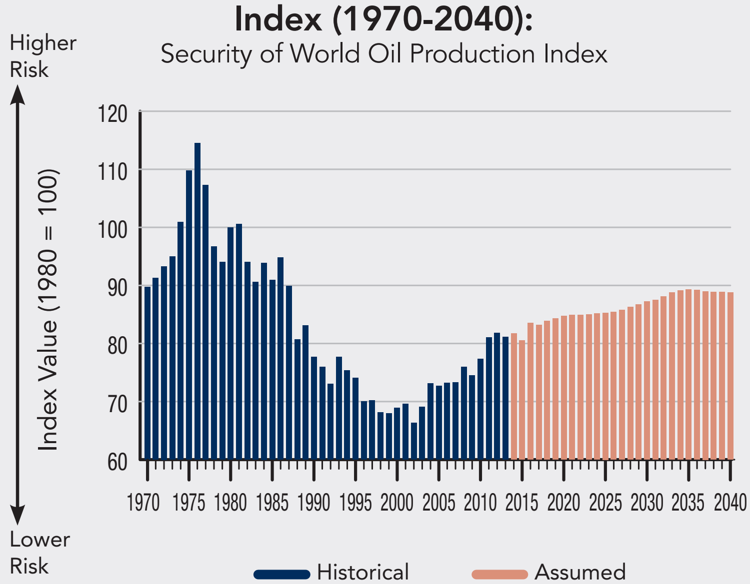
Category of Metric

Global Fuels

Historical and Forecast Values (1970-2040):
Security of World Oil Production Trends



Index (1970-2040):
Security of World Oil Production Index



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	6.8	5.4	5.6	N/A	4.6

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.

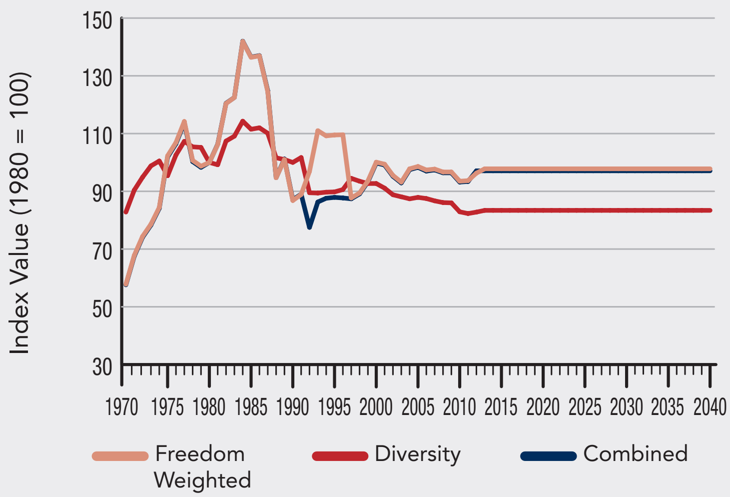
Importance

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.

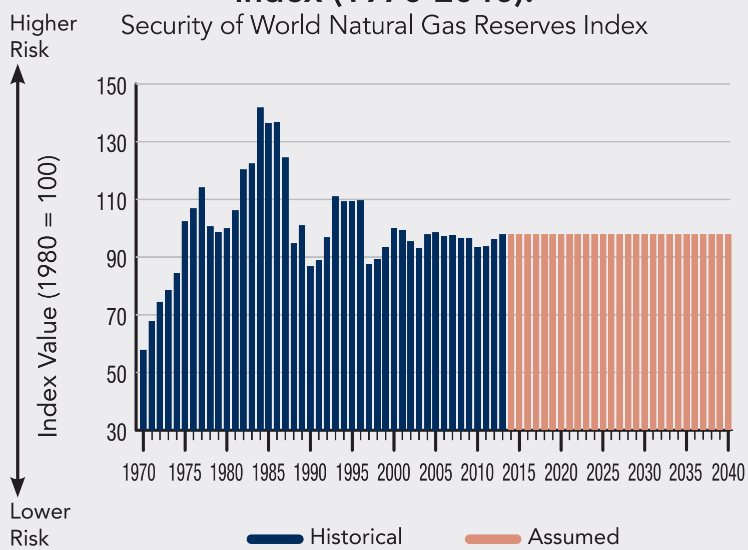
Category of Metric

Global Fuels

Historical and Forecast Values (1970-2040):
Security of World Natural Gas Reserves Trends



Index (1970-2040):
Security of World Natural Gas Reserves Index



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	7.0	N/A	N/A	2.0	3.5

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.

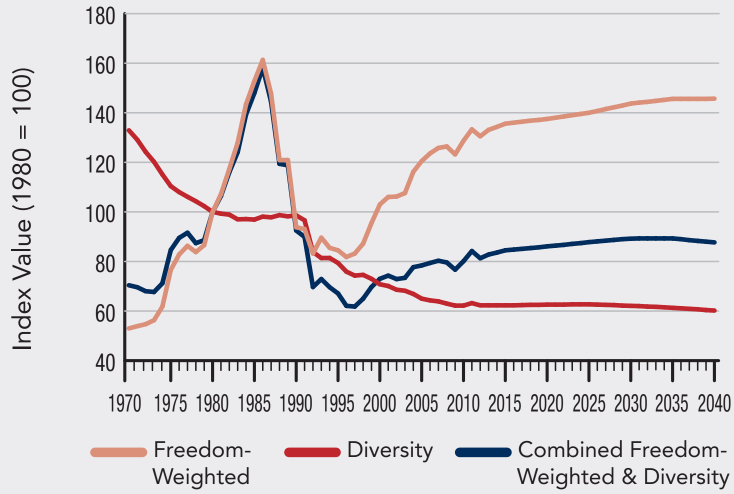
Importance

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

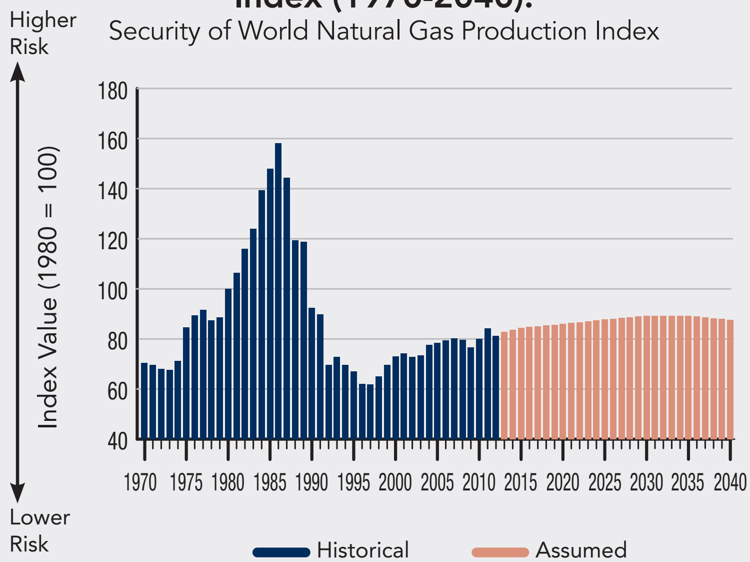
Category of Metric

Global Fuels

Historical and Forecast Values (1970-2040):
Security of World Natural Gas Production Trends



Index (1970-2040):
Security of World Natural Gas Production Index



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	5.1	2.3	2.9	1.8	3.2

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.

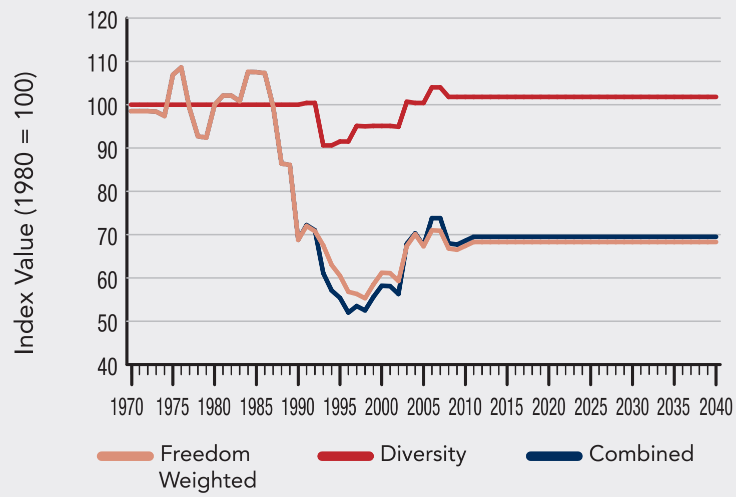
Importance

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

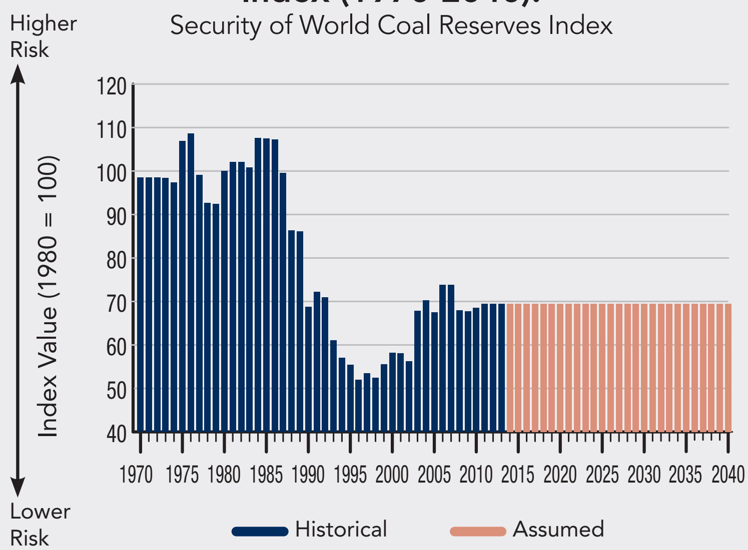
Category of Metric

Global Fuels

Historical and Forecast Values (1970-2040):
Security of World Coal Reserves Trends



Index (1970-2040):
Security of World Coal Reserves Index



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	3.7	N/A	N/A	N/A	1.1

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.

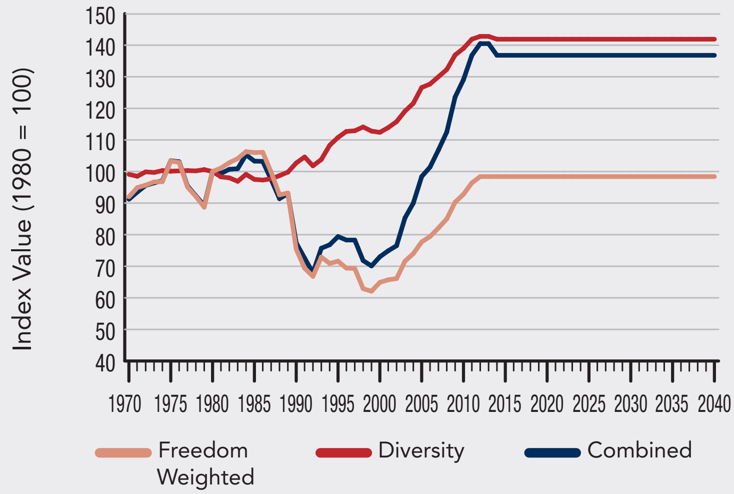
Importance

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

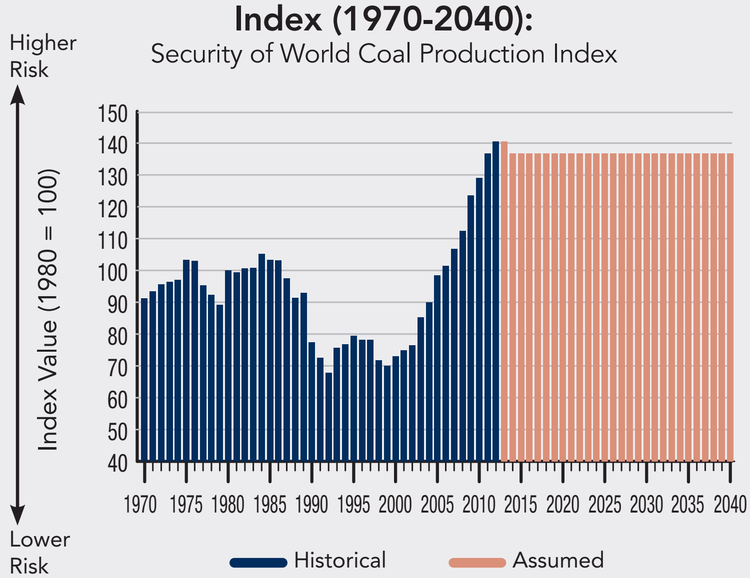
Category of Metric

Global Fuels

Historical and Forecast Values (1970-2040):
Security of World Coal Production Trends



Index (1970-2040):
Security of World Coal Production Index



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	1.1	N/A	1.2

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.

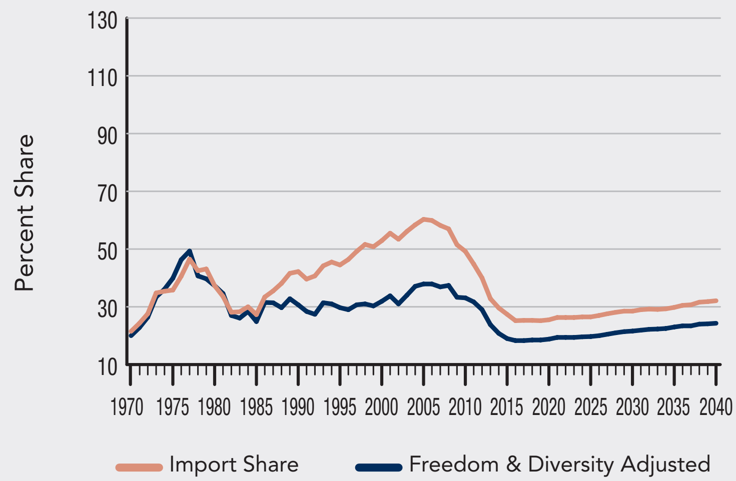
Importance

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.

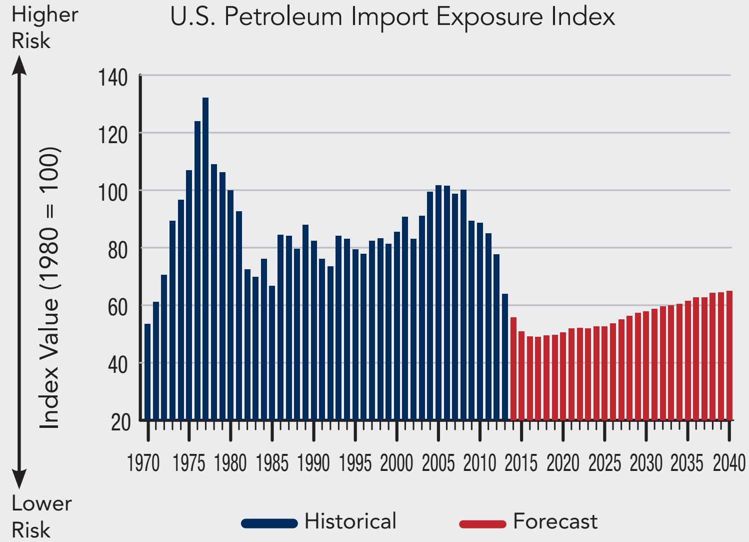
Category of Metric

Fuel Imports

Historical and Forecast Values (1970-2040):
U.S. Petroleum Import Exposure Trends



Index (1970-2040):
U.S. Petroleum Import Exposure Index



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	8.1	N/A	8.7	N/A	4.2

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.

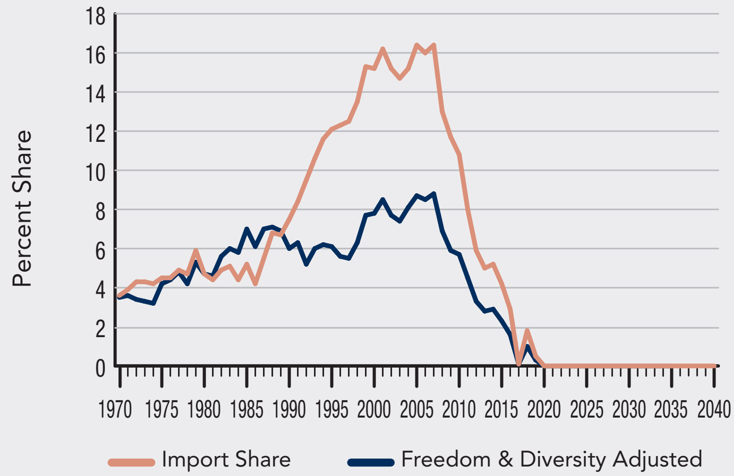
Importance

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

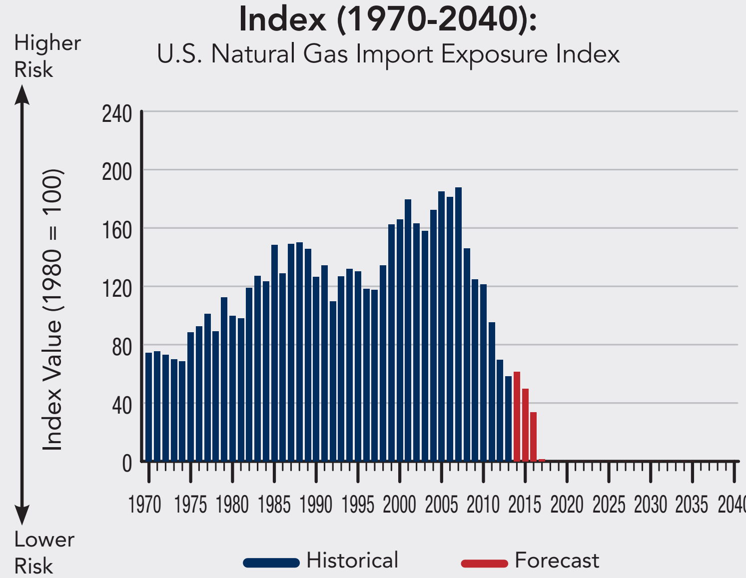
Category of Metric

Fuel Imports

Historical and Forecast Values (1970-2040):
U.S. Natural Gas Import Exposure Trends



Index (1970-2040):
U.S. Natural Gas Import Exposure Index



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	4.3	N/A	2.7	N/A	1.9

METRIC #9

Oil & Natural Gas Import Expenditures

Definition

Value of net imports of crude oil, petroleum products, and natural gas in billions of real (2010) dollars.

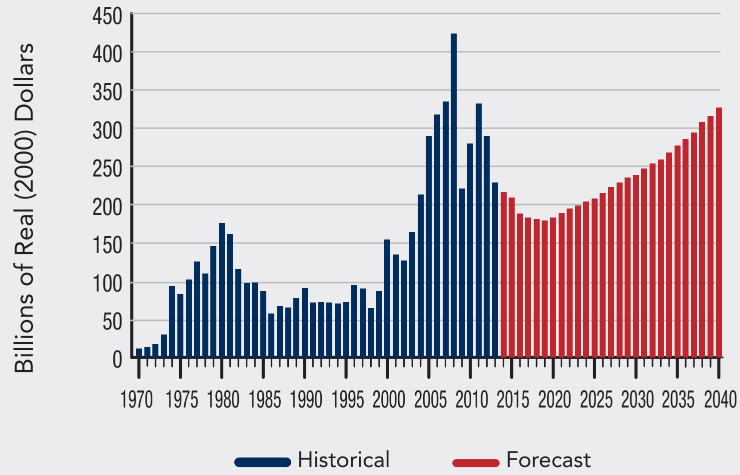
Importance

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

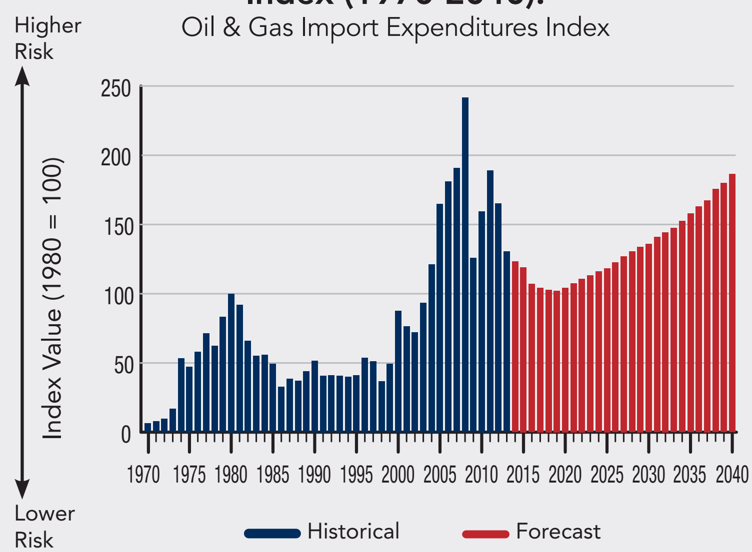
Category of Metric

Fuel Imports

Historical and Forecast Values (1970-2040):
Oil & Natural Gas Import Expenditures



Index (1970-2040):
Oil & Gas Import Expenditures Index



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	5.5	6.0	N/A	N/A	3.2

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.

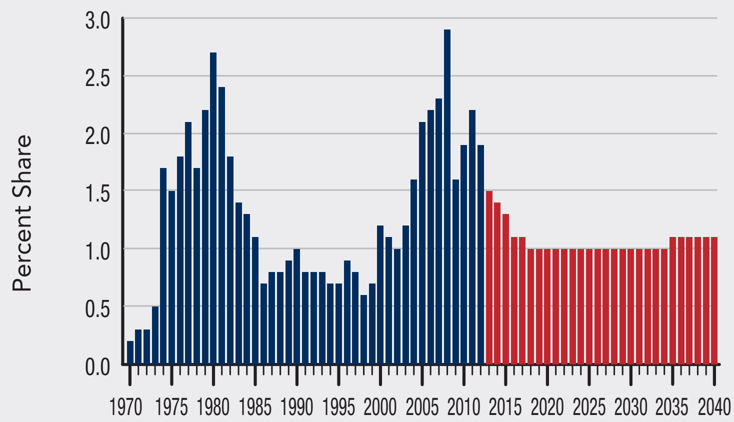
Importance

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

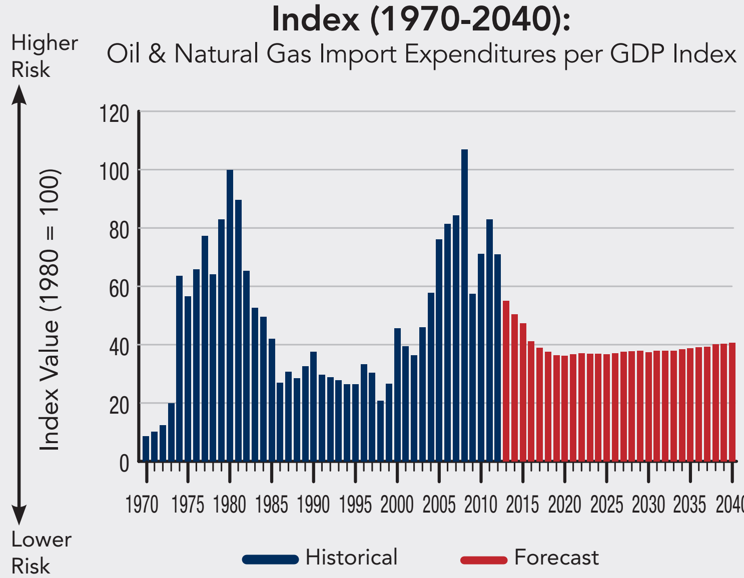
Category of Metric

Fuel Imports

Historical and Forecast Values (1970-2040):
Oil & Natural Gas Import Expenditures per GDP



Index (1970-2040):
Oil & Natural Gas Import Expenditures per GDP Index



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	5.8	N/A	N/A	1.5

METRIC #11

Energy Expenditures per GDP

Definition

Total real (2010) dollar cost of energy consumed per $1,000 of GDP per year.

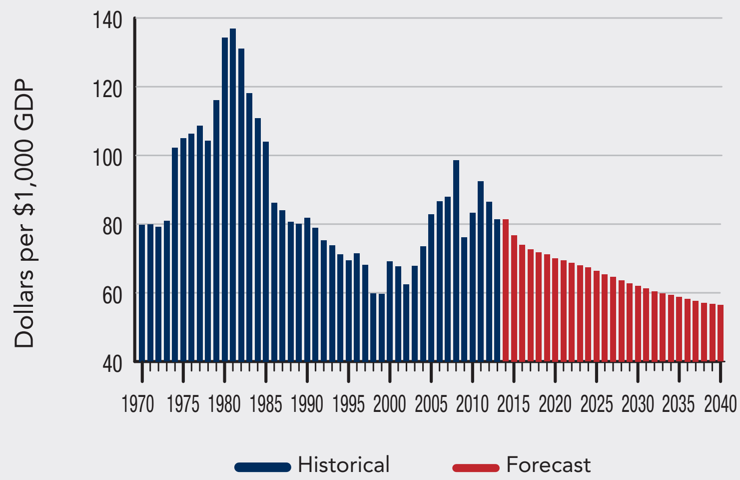
Importance

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

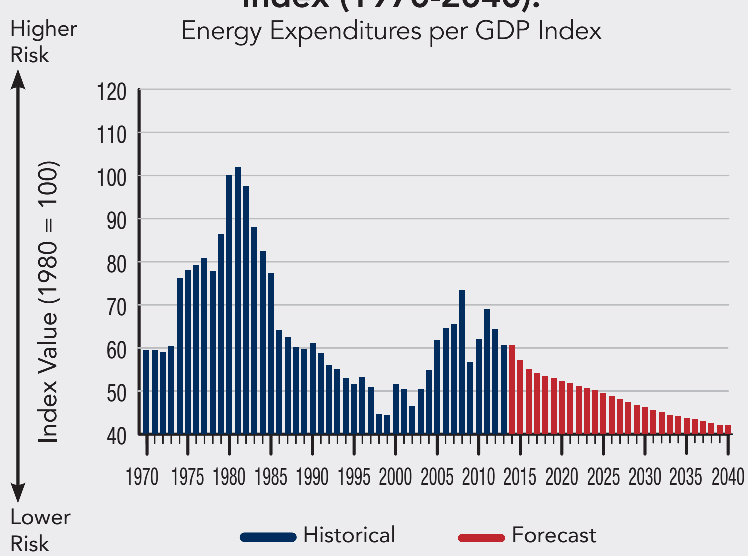
Category of Metric

Energy Expenditures

Historical and Forecast Values (1970-2040):
Energy Expenditures per GDP



Index (1970-2040):
Energy Expenditures per GDP Index



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

METRIC #12

Energy Expenditures per Household

Definition

Total real (2010) dollar cost of the energy consumed per household per year.

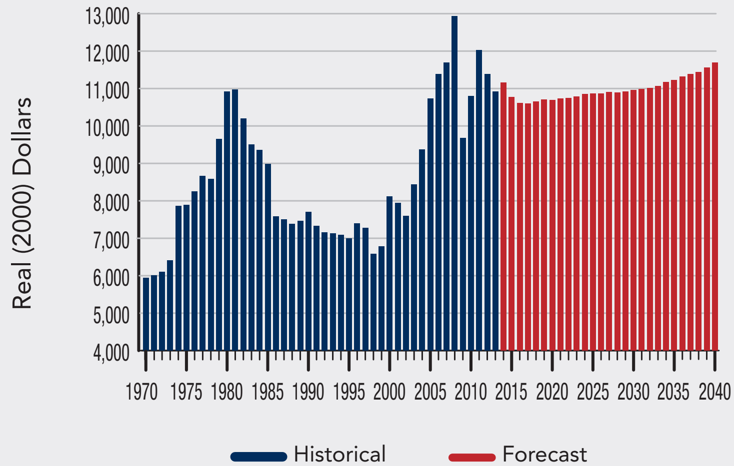
Importance

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 (1970-2040):
Energy Expenditures per Household



Index (1970-2040):
Energy Expenditures per Household Index

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	9.2	N/A	N/A	2.5

METRIC #13

Retail Electricity Prices

Definition

Average electricity costs in the U.S. in cents per kWh in real (2010) dollars.

Importance

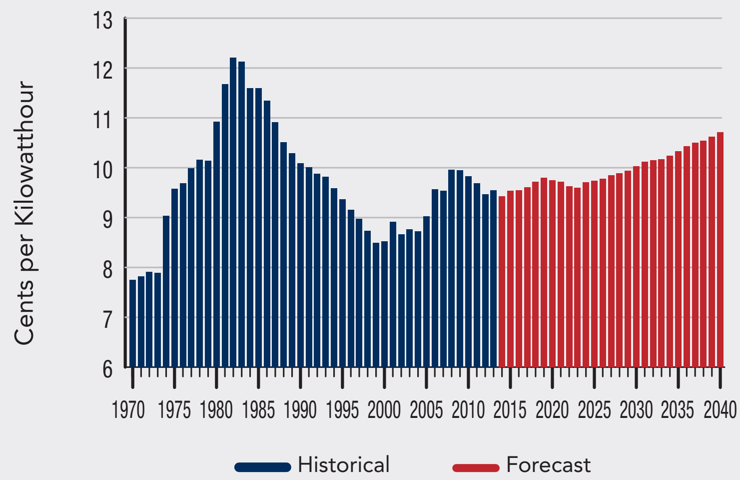
Indicates the availability of low-cost, reliable forms of power generation.

Category of Metric

Energy Expenditures

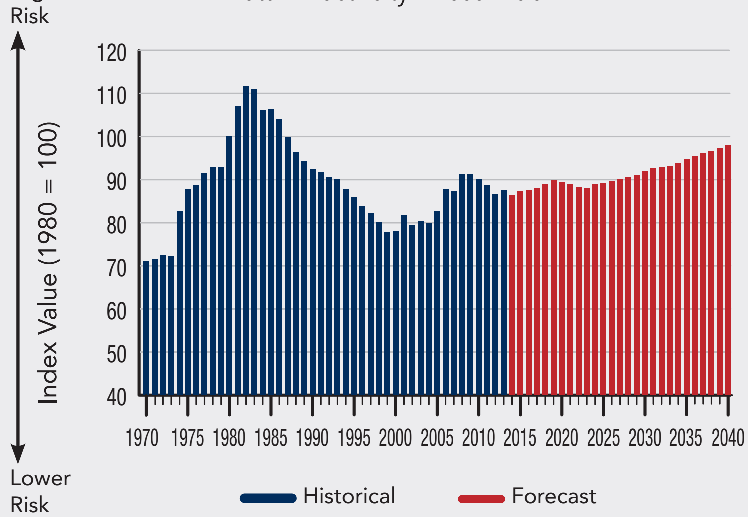
Historical and Forecast Values (1970-2040):

Retail Electricity Prices



Index (1970-2040):

Retail Electricity Prices Index



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	11.5	N/A	N/A	3.1

METRIC #14

Crude Oil Prices

Definition

Cost per barrel of crude oil landed in the U.S. in real (2010) dollars.

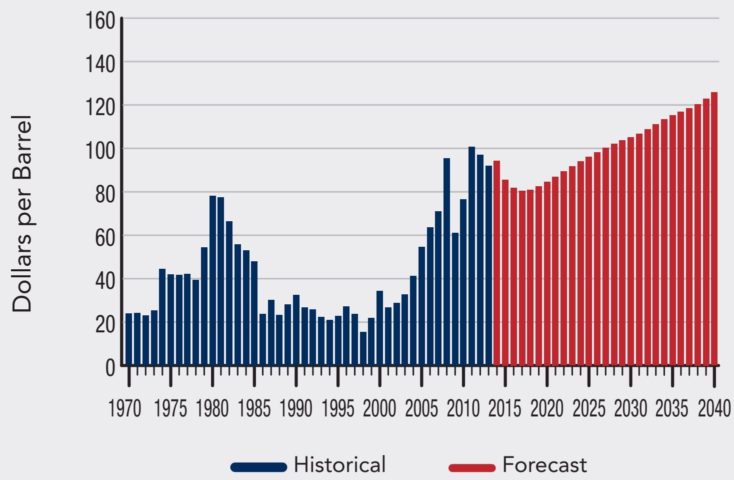
Importance

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

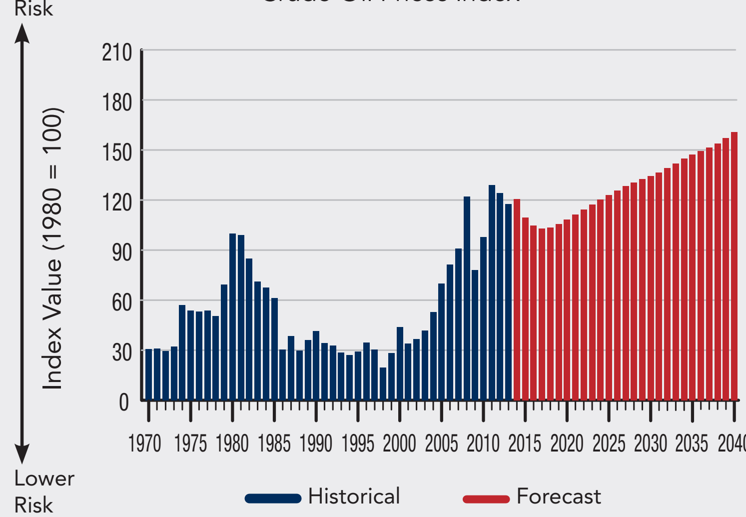
Category of Metric

Energy Expenditures

Historical and Forecast Values (1970-2040):
Crude Oil Prices



Index (1970-2040):
Crude Oil Prices Index



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	8.6	9.6	3.8	N/A	5.9

METRIC #15

Crude Oil Price Volatility

Definition

Annual change in real (2010) crude oil prices averaged over a three-year period.

Importance

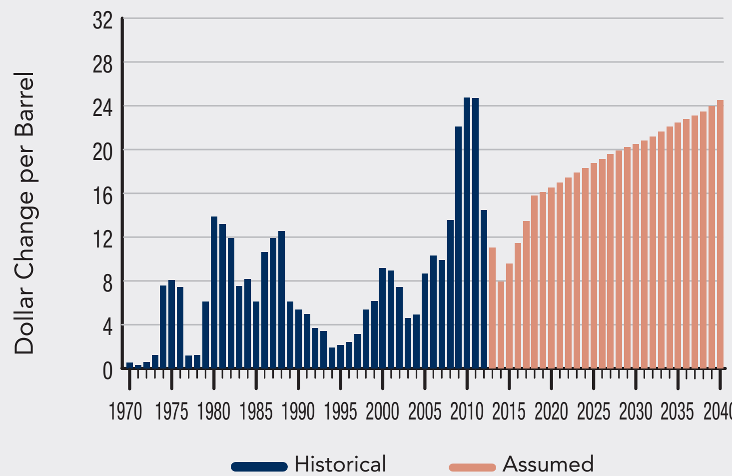
Indicates the susceptibility of the U.S. economy to large swings in the price of petroleum, which supplies a significant portion U.S. energy demand.

Category of Metric

Price Volatility

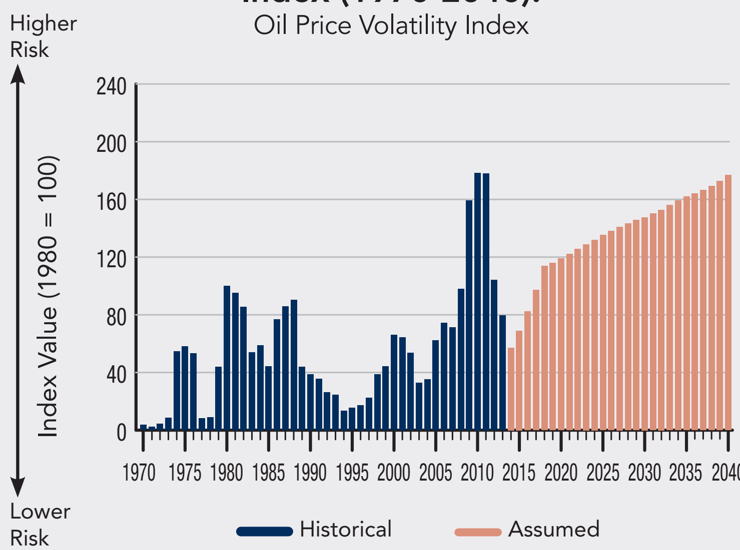
Historical and Forecast Values (1970-2040):

Crude Oil Price Volatility



Index (1970-2040):

Oil Price Volatility Index



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	6.3	N/A	2.9

METRIC #16

Energy Expenditure Volatility

Definition

Average annual change in real (2010) U.S. energy expenditures per $1,000 of GDP.

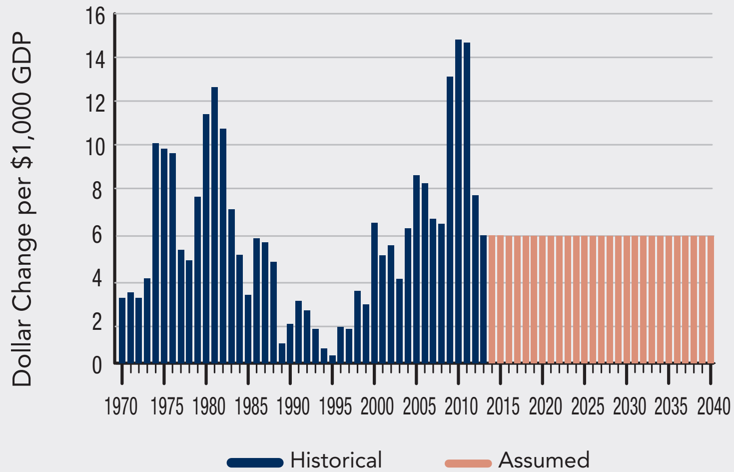
Importance

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

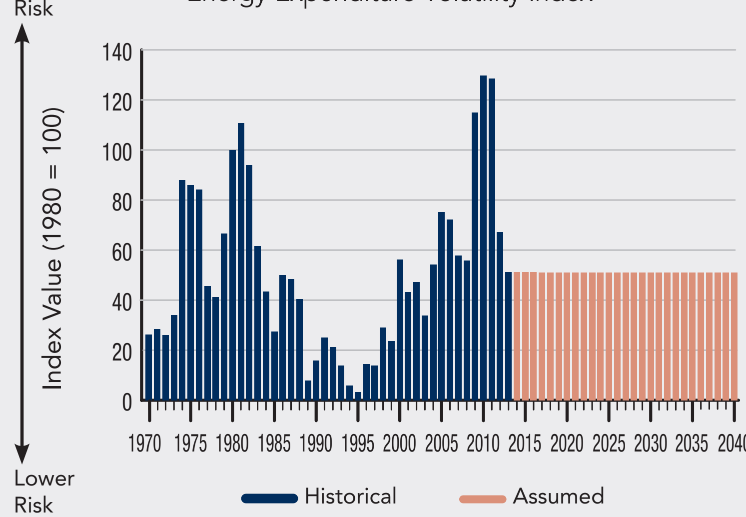
Category of Metric

Price Volatility

Historical and Forecast Values (1970-2040):
Energy Expenditure Volatility



Index (1970-2040):
Energy Expenditure Volatility Index



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	3.3	8.0	N/A	2.6

METRIC #17

World Oil Refinery Utilization

Definition

Average percentage utilization of global petroleum refinery capacity.

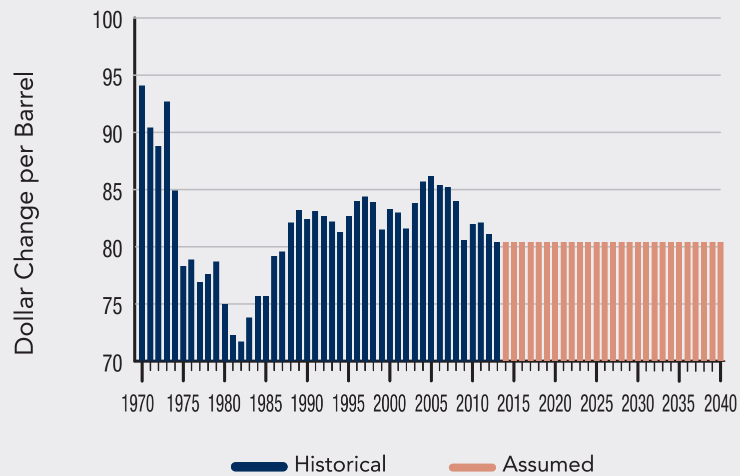
Importance

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

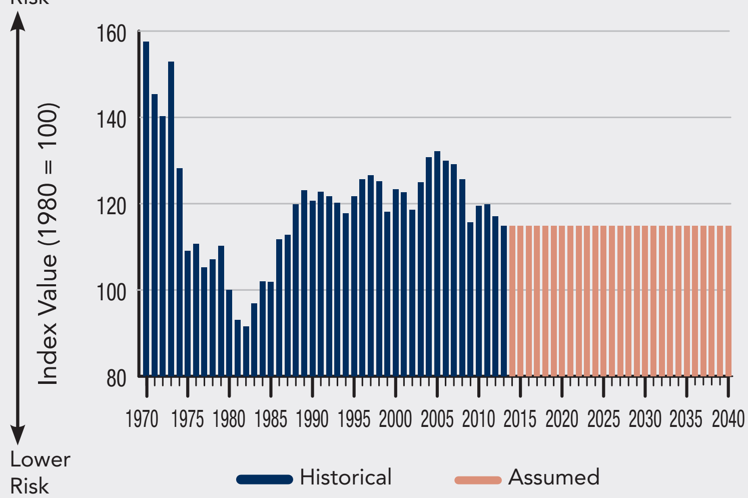
Category of Metric

Price Volatility

Historical and Forecast Values (1970-2040):
World Oil Refinery Utilization



Index (1970-2040):
World Oil Refinery Utilization Index



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	7.9	N/A	2.9

METRIC #18

Petroleum Stock Levels

Definition

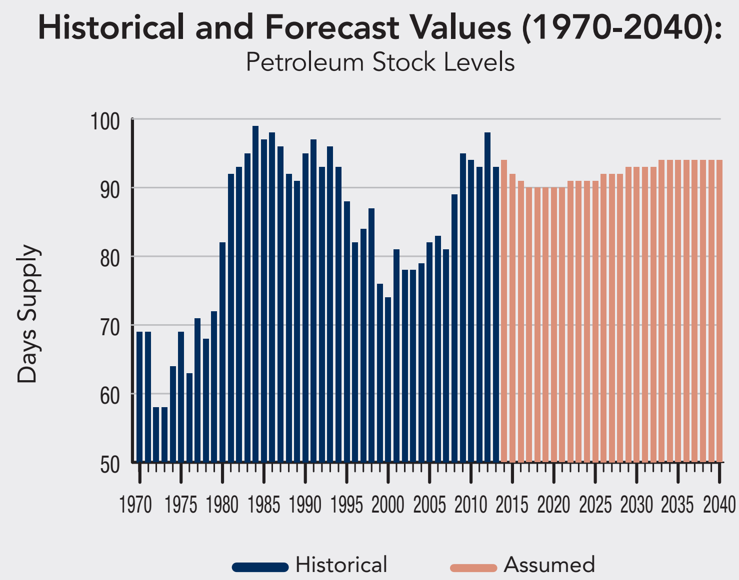
Average days supply of petroleum stocks, including strategic petroleum reserve (SPR), non-SPR crude, and petroleum products.

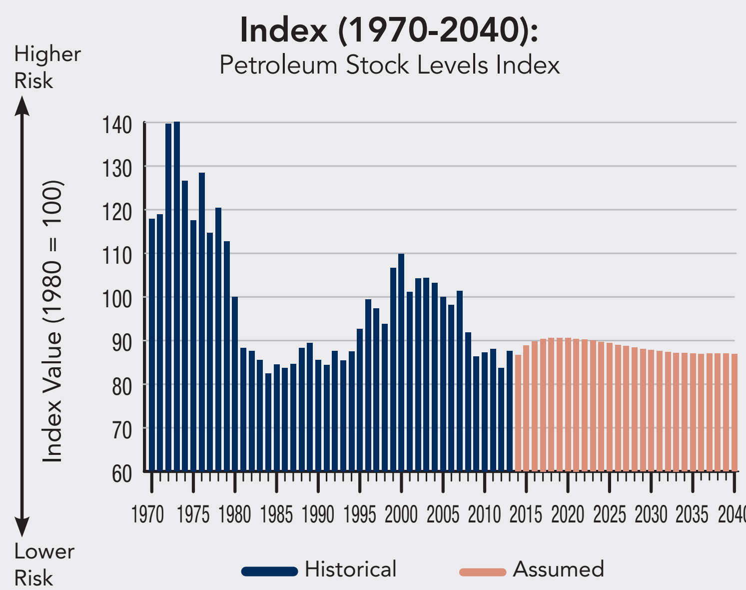
Importance

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





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	6.6	N/A	2.1

METRIC #19

Energy Consumption per Capita

Definition

Million Btu consumed per person per year.

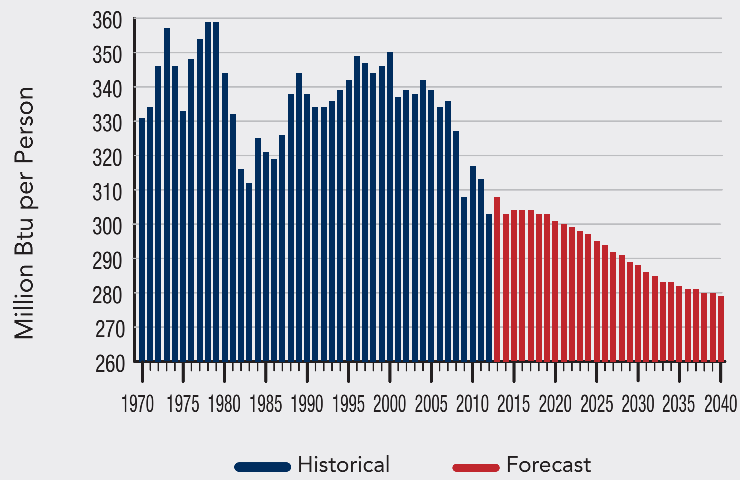
Importance

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

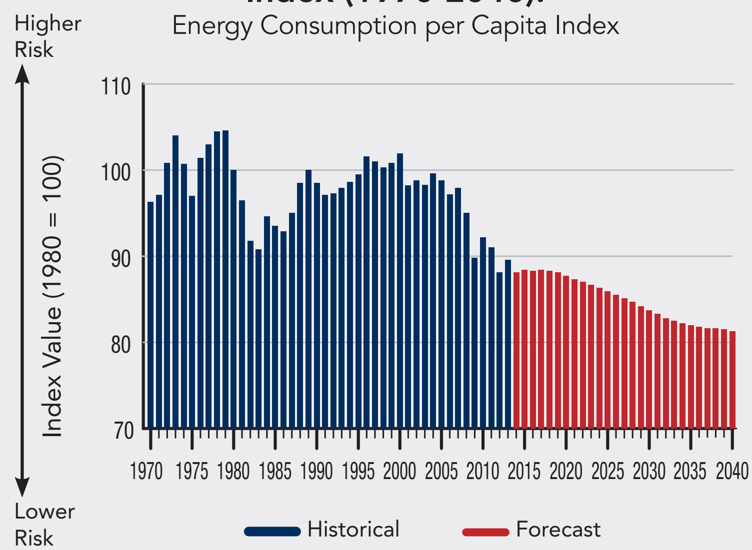
Category of Metric

Energy Use Intensity

Historical and Forecast Values (1970-2040):
Energy Consumption per Capita



Index (1970-2040):
Energy Consumption per Capita Index



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	8.0	2.8

METRIC #20

Energy Intensity

Definition

Million Btu of primary energy used in the economy per $1,000 of real (2010) GDP.

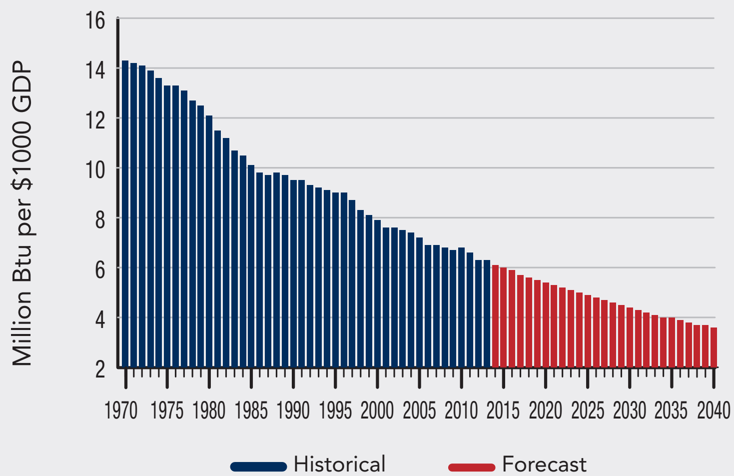
Importance

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

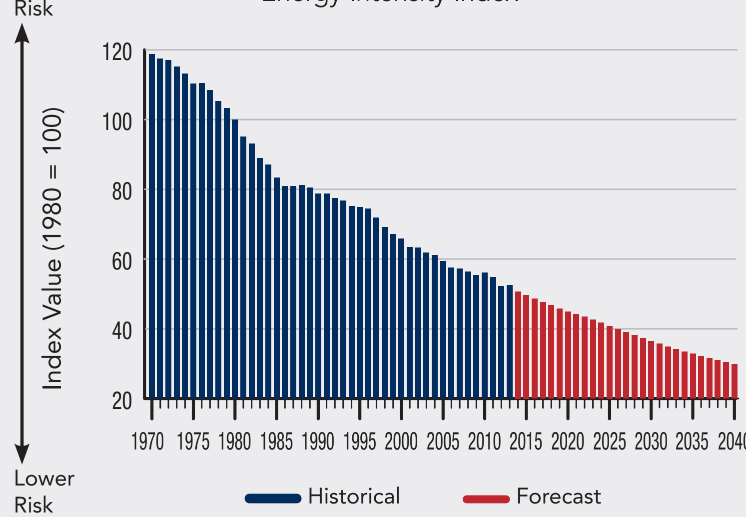
Category of Metric

Energy Use Intensity

Historical and Forecast Values (1970-2040):
Energy Intensity



Index (1970-2040):
Energy Intensity Index



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	4.2	N/A	8.2	3.0

METRIC #21

Petroleum Intensity

Definition

Million Btu of petroleum consumed per $1,000 GDP in real (2010) dollars.

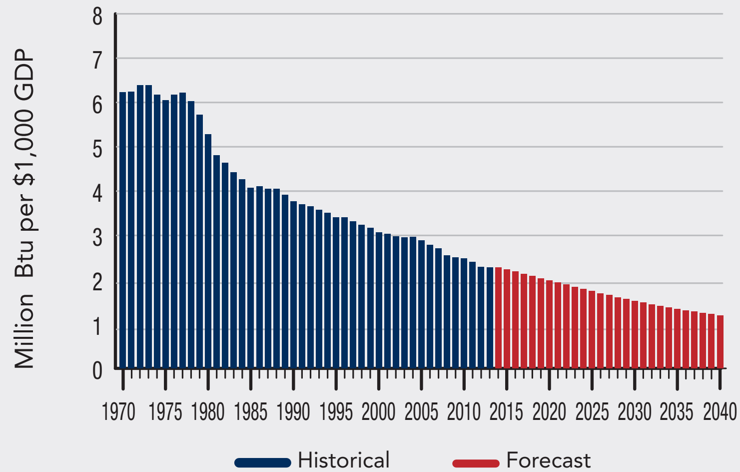
Importance

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

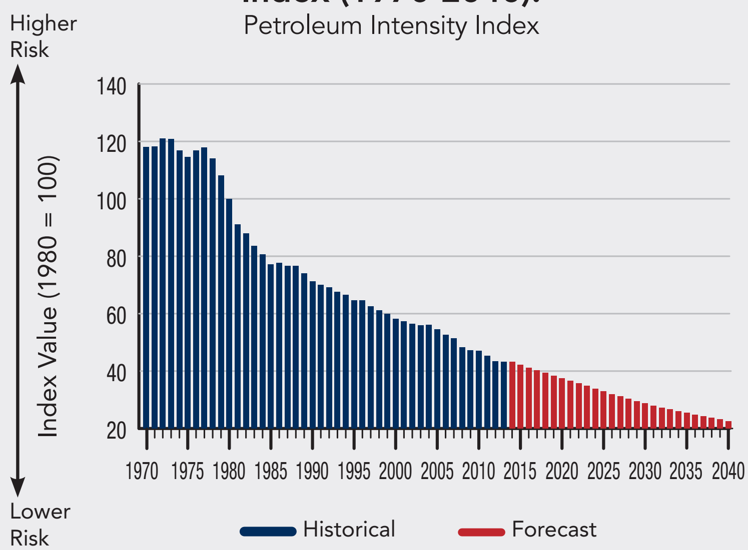
Category of Metric

Energy Use Intensity

Historical and Forecast Values (1970-2040):
Petroleum Intensity



Index (1970-2040):
Petroleum Intensity Index



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	7.1	3.0	N/A	4.7	4.0

METRIC #22

Household Energy Efficiency

Definition

Million Btu of total energy consumed per household.

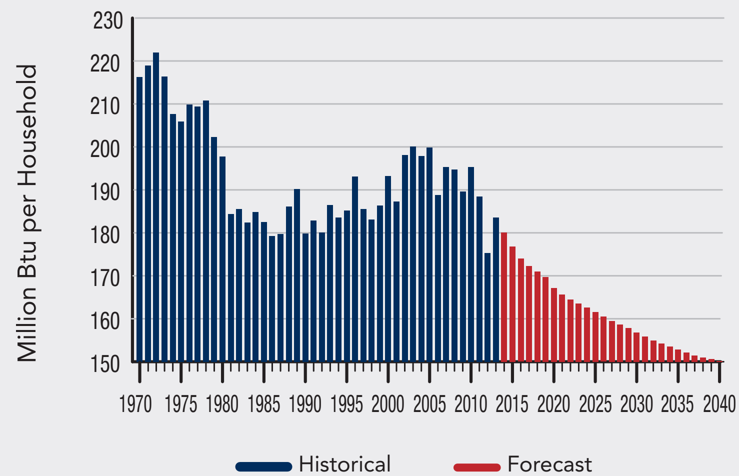
Importance

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

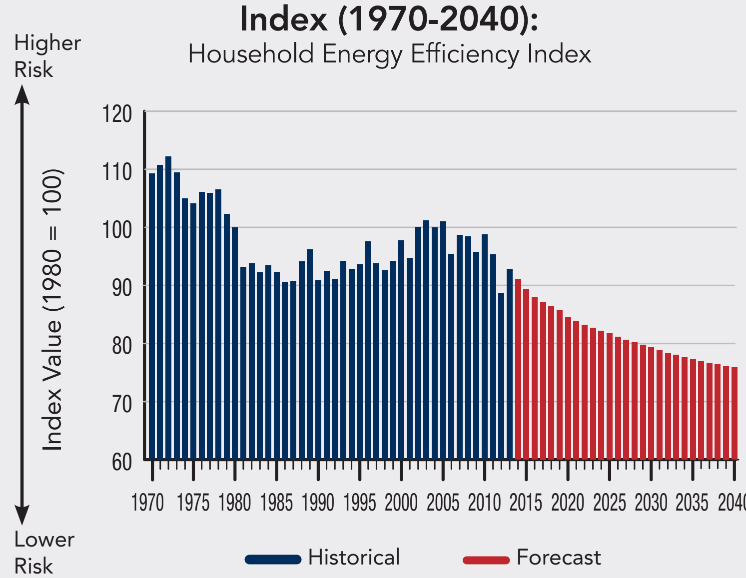
Category of Metric

Energy Use Intensity

Historical and Forecast Values (1970-2040):
Household Energy Efficiency



Index (1970-2040):
Household Energy Efficiency Index



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

METRIC #23

Commercial Energy Efficiency

Definition

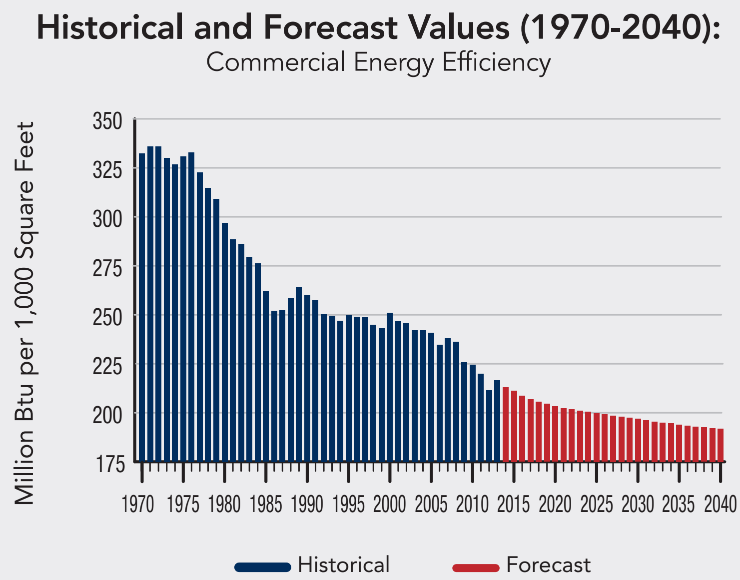
Million Btu of total commercial energy consumed per 1,000 square feet of commercial floor space.

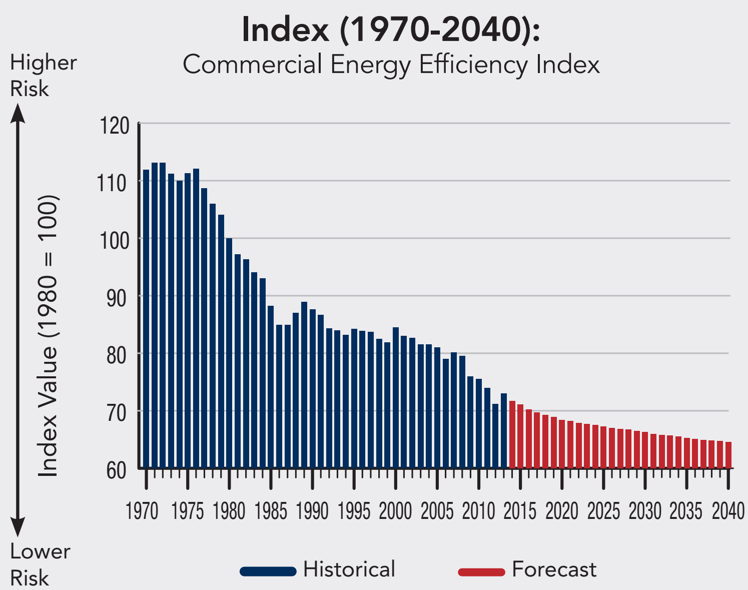
Importance

Indicates the degree to which commercial enterprises use energy efficiently.

Category of Metric

Energy Use Intensity





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

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.

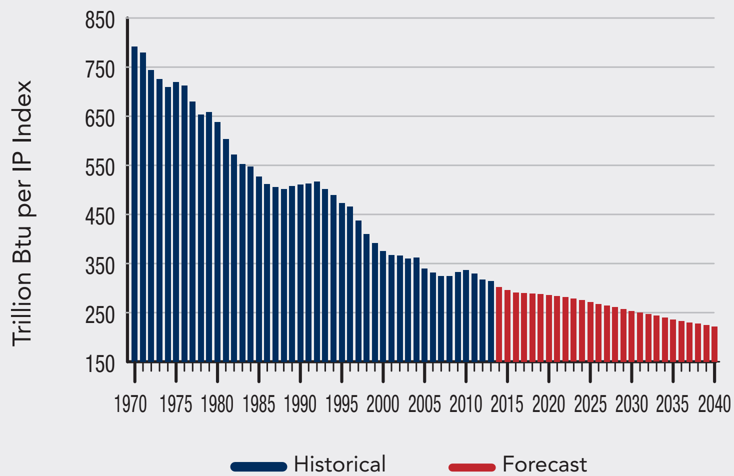
Importance

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

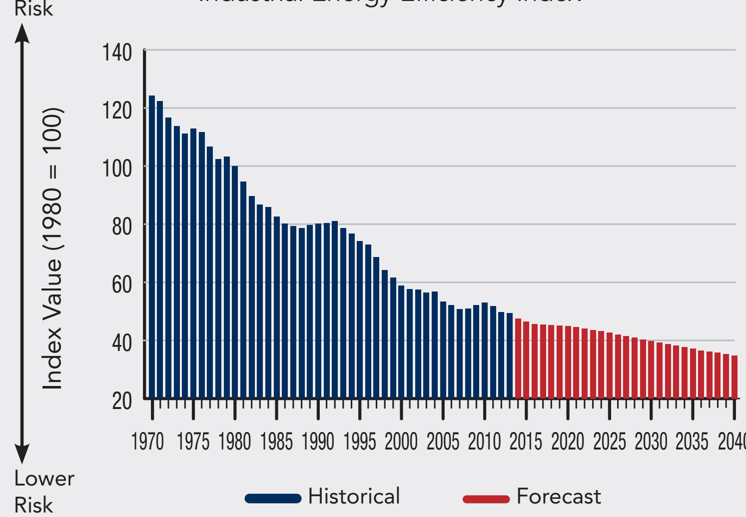
Category of Metric

Energy Use Intensity

Historical and Forecast Values (1970-2040):
Industrial Energy Efficiency



Index (1970-2040):
Industrial Energy Efficiency Index



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	3.2	1.5

METRIC #25

Electricity Capacity Diversity

Definition

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

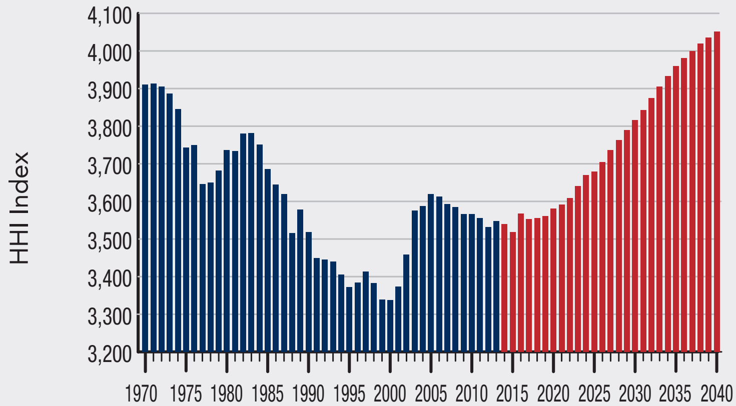
Importance

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

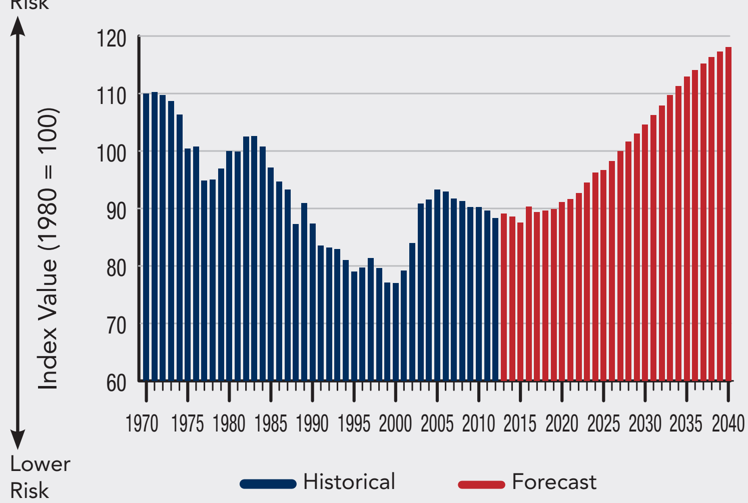
Category of Metric

Electric Power Sector

Historical and Forecast Values (1970-2040):
Electricity Capacity Diversity



Index (1970-2040):
Electricity Capacity Diversity Index



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	7.0	2.8	2.1

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.

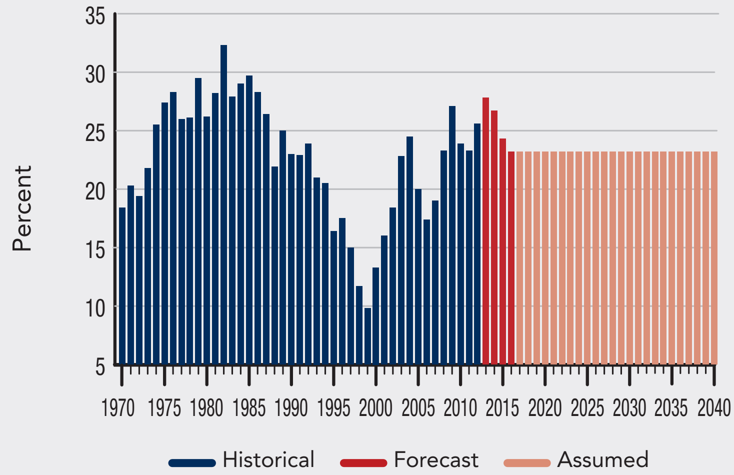
Importance

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.

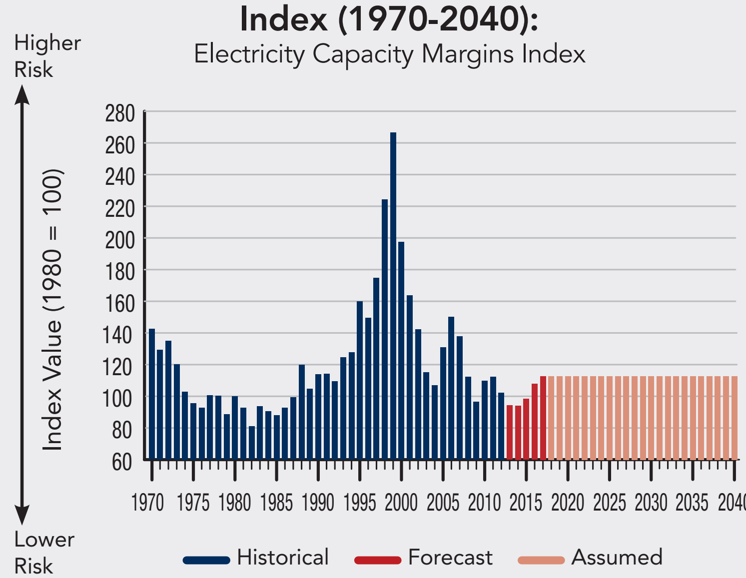
Category of Metric

Electric Power Sector

Historical and Forecast Values (1970-2040):
Electricity Capacity Margins



Index (1970-2040):
Electricity Capacity Margins Index



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	9.5	N/A	2.4

METRIC #27

Electric Power Transmission Line Mileage

Definition

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

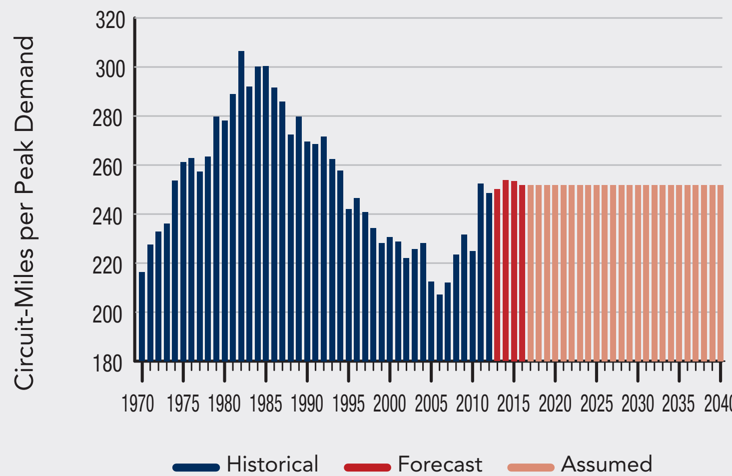
Importance

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

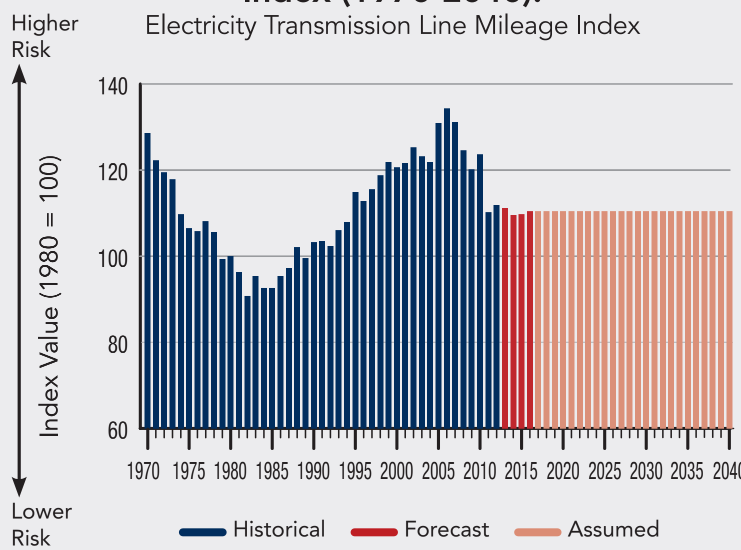
Category of Metric

Electric Power Sector

Historical and Forecast Values (1970-2040):
Electricity Transmission Line Mileage



Index (1970-2040):
Electricity Transmission Line Mileage Index



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	1.4	9.9	3.4	3.2

METRIC #28

Motor Vehicle Average MPG

Definition

Average miles per gallon of passenger car fleet.

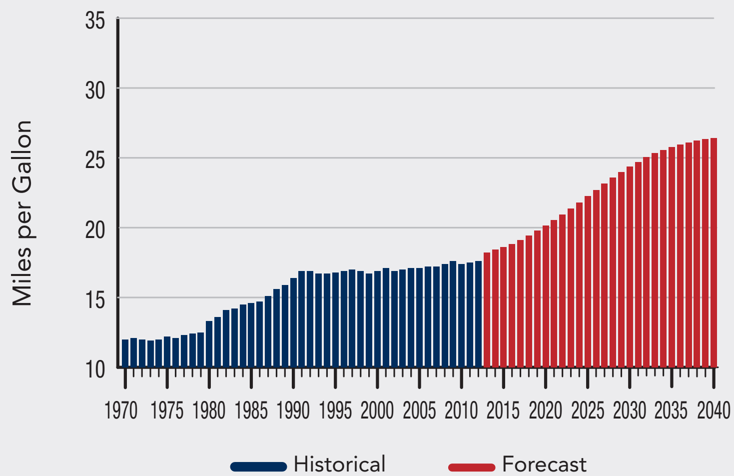
Importance

Indicates the degree to which the typical light vehicle uses energy efficiently (gasoline consumption accounts for about 16% of total U.S. energy demand).

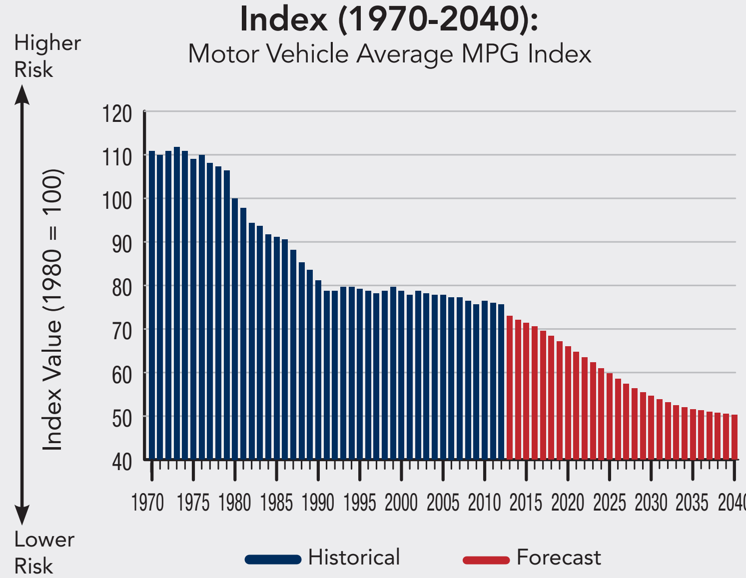
Category of Metric

Transportation Sector

Historical and Forecast Values (1970-2040):
Motor Vehicle Average MPG



Index (1970-2040):
Motor Vehicle Average MPG Index



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

METRIC #29

Vehicle-Miles Traveled per GDP

Definition

Vehicle-miles traveled (VMT) per $1,000 of GDP in real (2010) dollars.

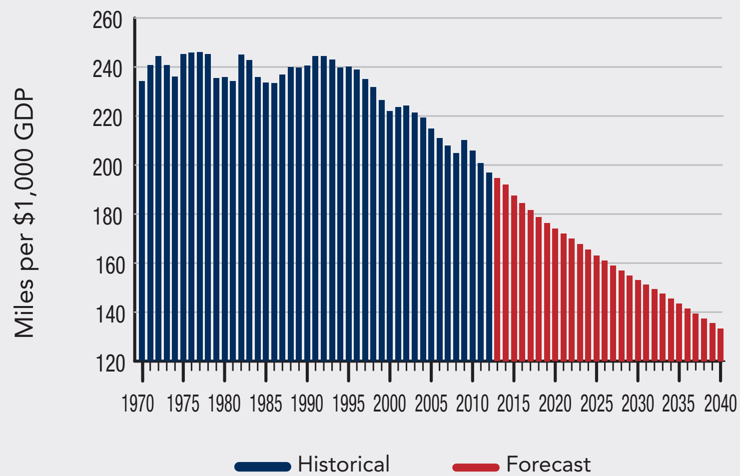
Importance

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

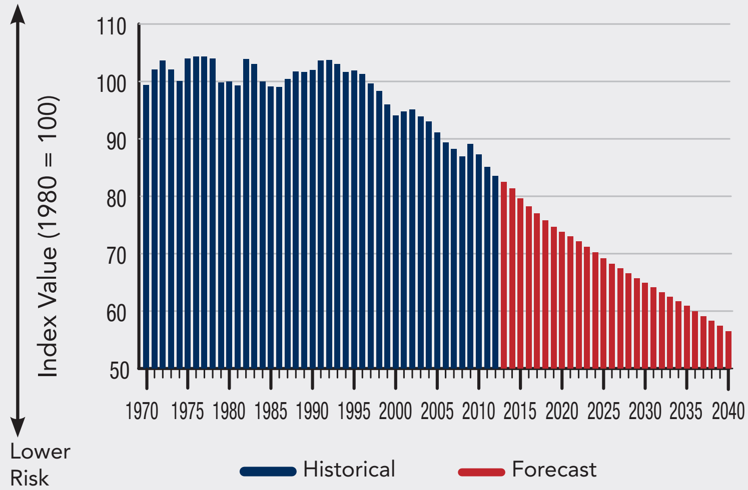
Category of Metric

Transportation Sector

Historical and Forecast Values (1970-2040):
Transportation Vehicle-Miles Traveled per GDP



Index (1970-2040):
Transportation Vehicle-Miles Traveled per GDP Index



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	2.5	N/A	8.0	3.2

METRIC #30

Transportation Non-Petroleum Fuel Use

Definition

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

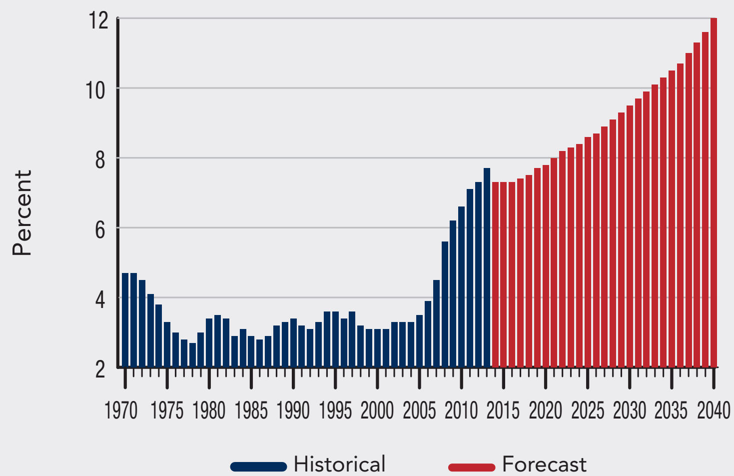
Importance

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

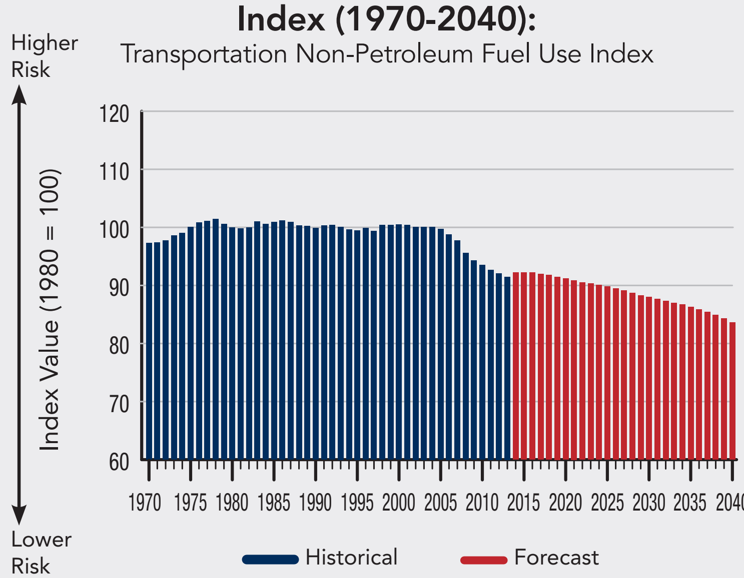
Category of Metric

Transportation Sector

Historical and Forecast Values (1970-2040):
Transportation Non-Petroleum Fuel Use



Index (1970-2040):
Transportation Non-Petroleum Fuel Use Index



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

METRIC #31

Energy-Related Carbon Dioxide Emissions

Definition

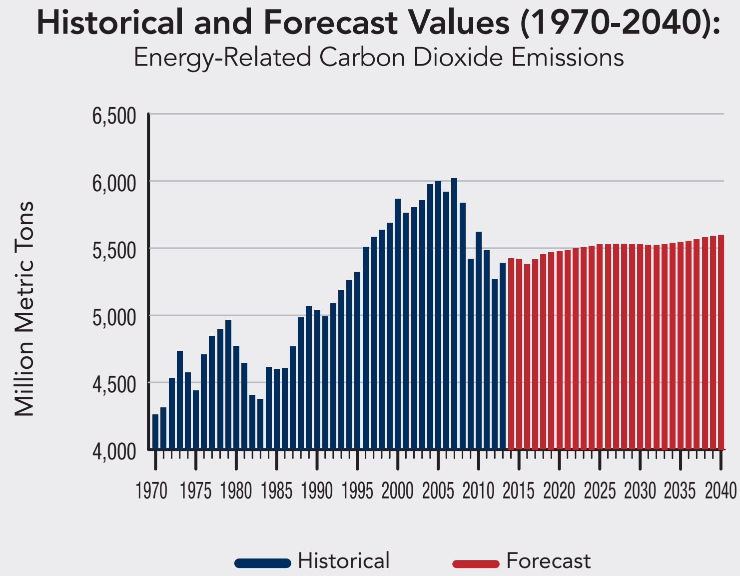
Total U.S. energy-related CO_2 emissions in million metric tons.

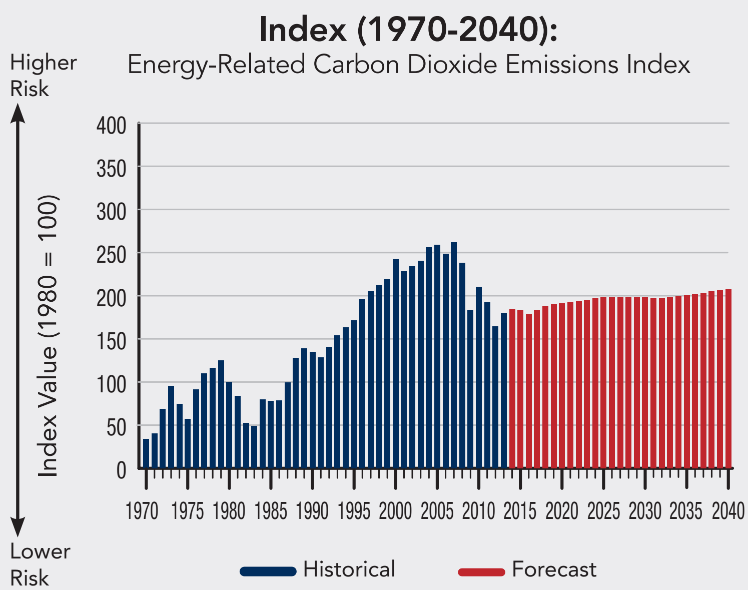
Importance

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

Category of Metric

Environmental





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	10.6	3.4

METRIC #32

Energy-Related Carbon Dioxide Emissions per Capita

Definition

Million metric tons of CO_2 emissions from energy per capita.

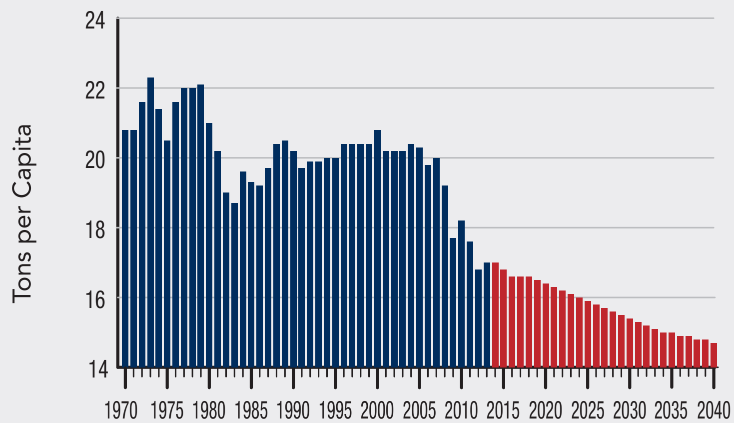
Importance

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

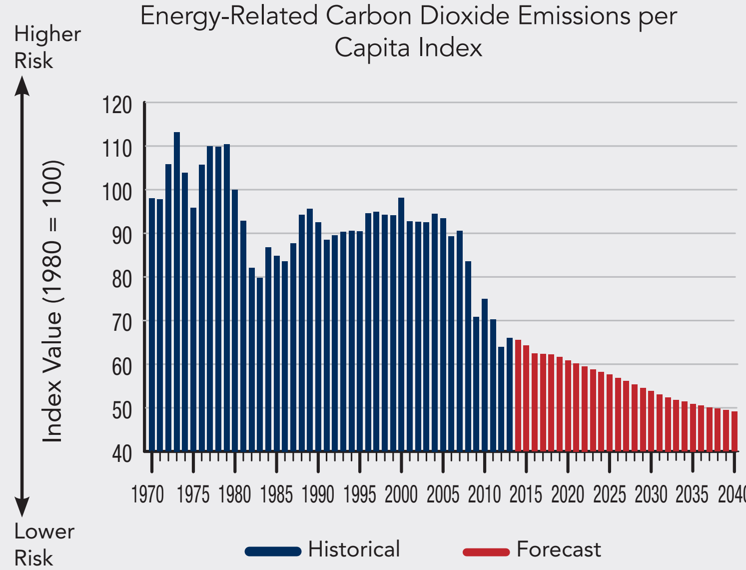
Category of Metric

Environmental

Historical and Forecast Values (1970-2040):
Energy-Related Carbon Dioxide Emissions per Capita



Index (1970-2040):
Energy-Related Carbon Dioxide Emissions per Capita Index



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	2.1	N/A	N/A	4.7	1.7

METRIC #33

Energy-Related Carbon Dioxide Emissions Intensity

Definition

Metric tons of CO_2 from energy per $1,000 of GDP in real (2010) dollars.

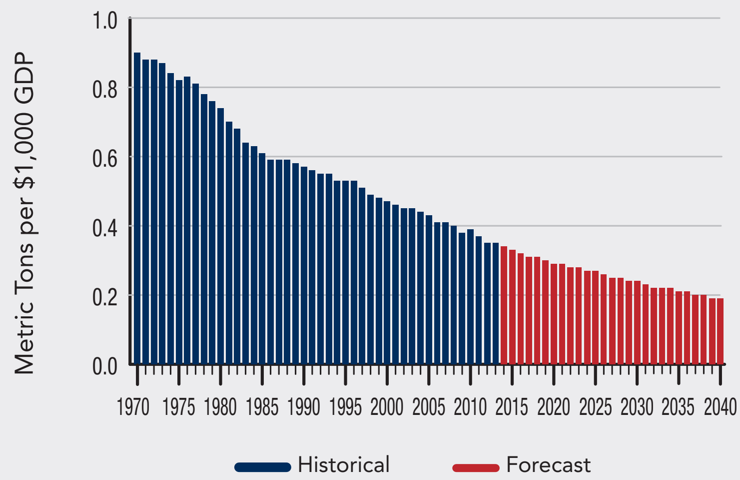
Importance

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

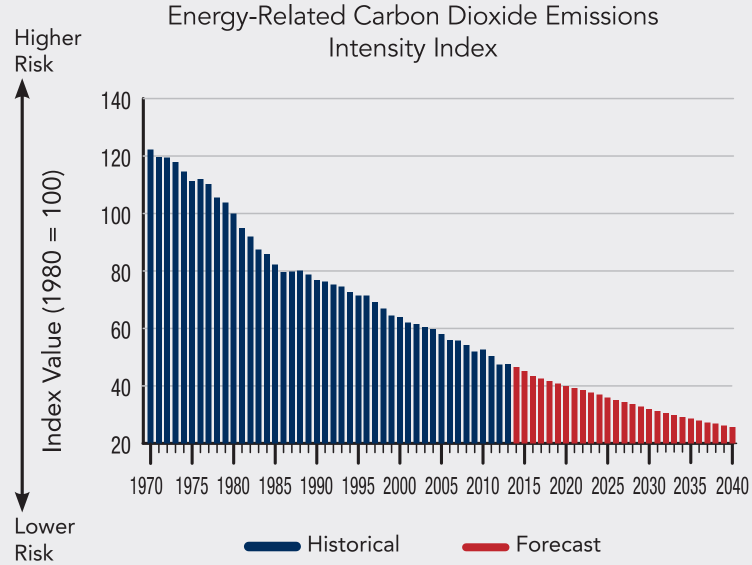
Category of Metric

Environmental

Historical and Forecast Values (1970-2040):
Energy-Related Carbon Dioxide Emissions Intensity



Index (1970-2040):
Energy-Related Carbon Dioxide Emissions Intensity Index



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

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.

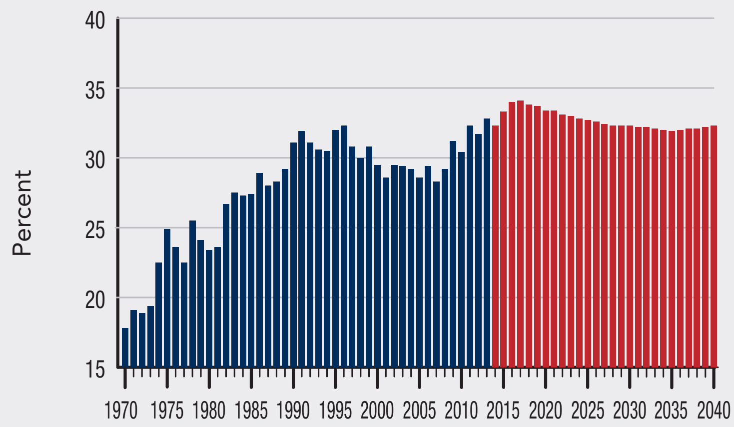
Importance

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

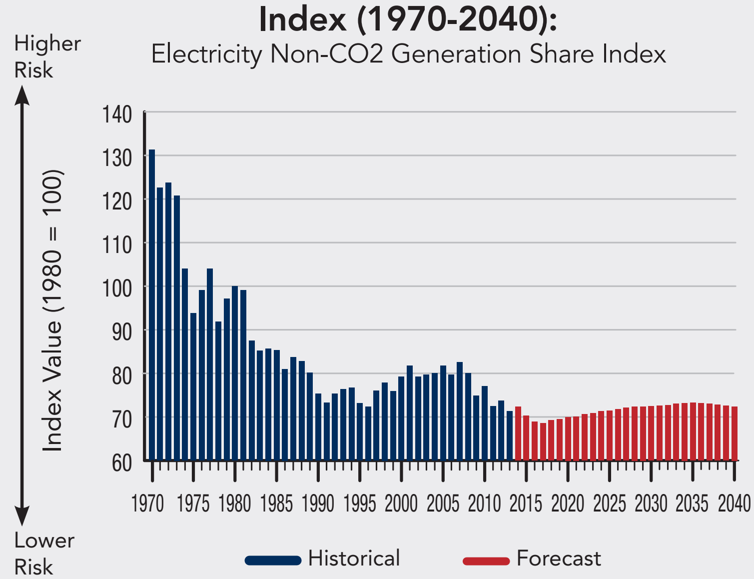
Category of Metric

Environmental

Historical and Forecast Values (1970-2040):
Electricity Non-CO2 Generation Share



Index (1970-2040):
Electricity Non-CO2 Generation Share Index



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	4.8	6.2	2.4

METRIC #35

Industrial Energy R&D Expenditures

Definition

Dollars of industrial energy-related R&D (non-Federal) per $1,000 of GDP in real (2010) dollars.

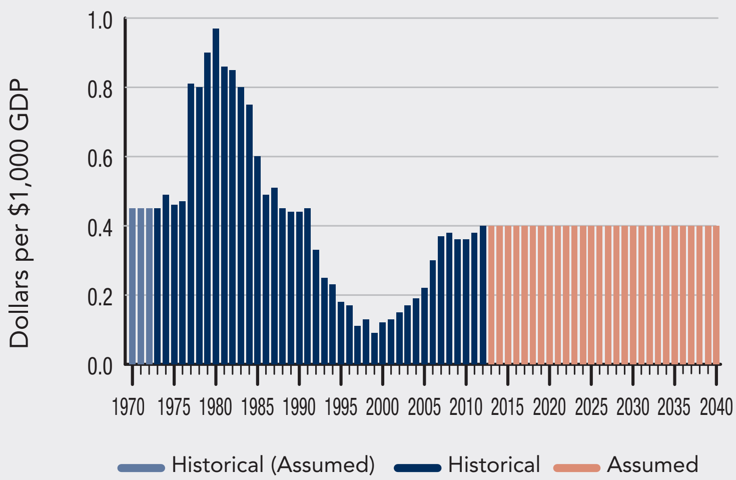
Importance

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

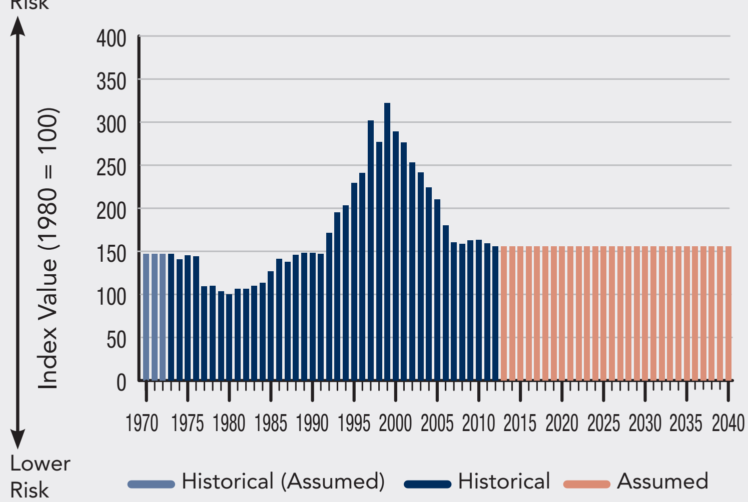
Category of Metric

Research & Development

Historical and Forecast Values (1970-2040):
Industrial Energy R&D Expenditures



Index (1970-2040):
Industrial Energy R&D Expenditures Index



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	2.2	3.8	3.5	2.2

METRIC #36

Federal Energy & Science R&D Expenditures

Definition

Dollars of federal energy and science R&D per $1,000 of GDP in real (2010) dollars.

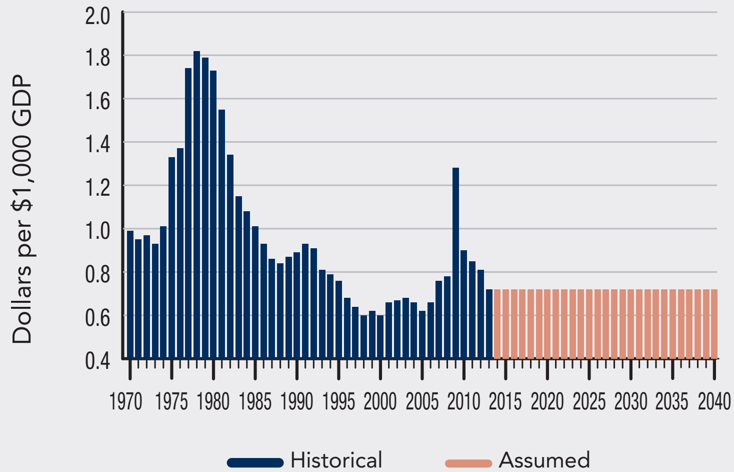
Importance

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

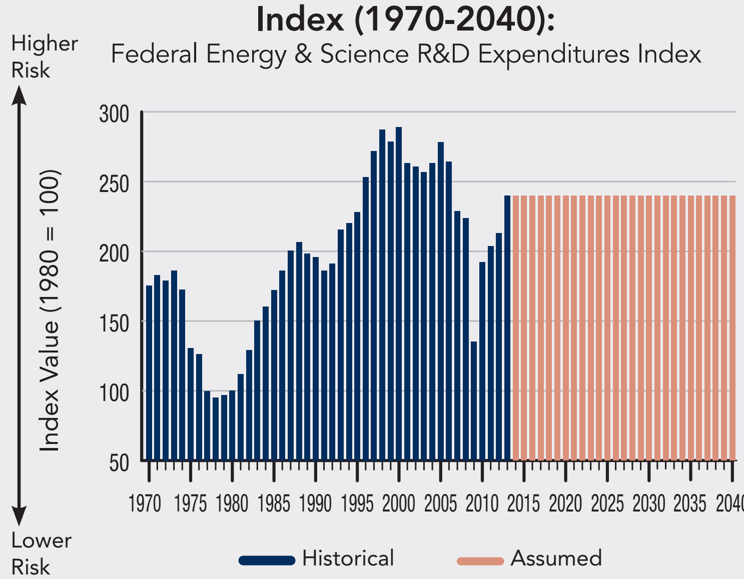
Category of Metric

Research & Development

Historical and Forecast Values (1970-2040):
Federal Energy & Science R&D Expenditures



Index (1970-2040):
Federal Energy & Science R&D Expenditures Index



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

METRIC #37

Science & Engineering Degrees

Definition

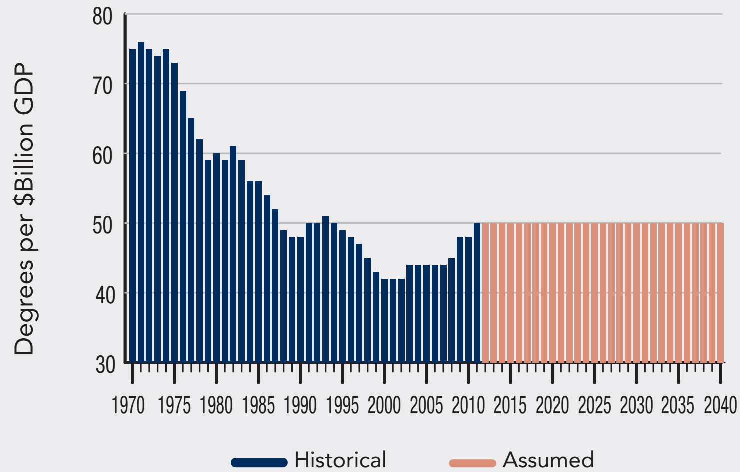
Number of science and engineering degrees, per billion dollars of GDP in real (2010) dollars.

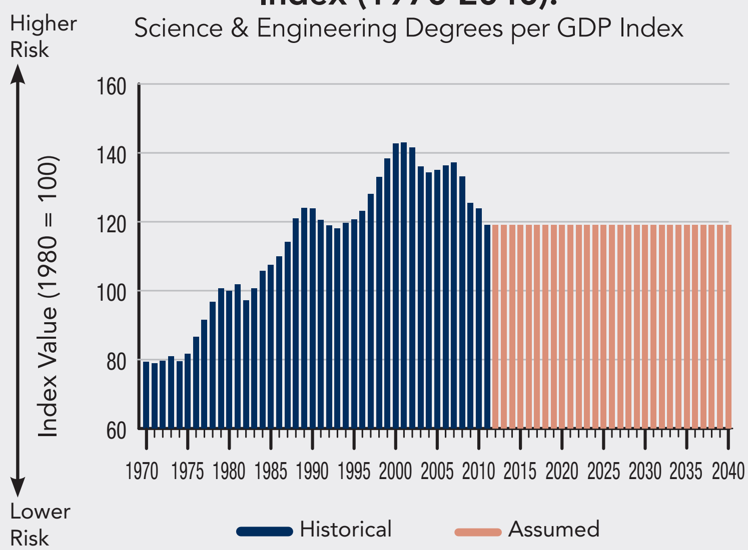
Importance

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





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	2.5	2.3	1.5

Summary Table 1: Energy Security Metrics (Values)

1970-1976

#	Metric	Units of Measurement	1970	1971	1972	1973	1974	1975	1976
Global Fuels Metrics									
1	Security of World Oil Reserves	reserves, freedom & diversity-weighted	122.5	114.6	113.0	105.8	104.2	110.5	114.2
2	Security of World Oil Production	production, freedom & diversity-weighted	89.7	91.3	93.3	95.0	100.9	109.8	114.5
3	Security of World Natural Gas Reserves	reserves, freedom & diversity-weighted	57.8	67.8	74.4	78.6	84.4	102.3	106.9
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
5	Security of World Coal Reserves	reserves, freedom & diversity-weighted	98.5	98.5	98.5	98.4	97.4	106.9	108.6
6	Security of World Coal Production	production, freedom & diversity-weighted	91.2	93.5	95.6	96.4	97.1	103.4	103.1
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
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
9	Oil & Natural Gas Import Expenditures	billions of 2010$	$11.2	$13.5	$17.3	$29.5	$93.5	$83.0	$101.8
10	Oil & Natural Gas Import Expenditures per GDP	percent	0.2%	0.3%	0.3%	0.5%	1.7%	1.5%	1.8%
Energy Expenditure Metrics									
11	Energy Expenditures per GDP	$ per $1,000 GDP (2010$)	$79.80	$79.89	$79.21	$80.94	$102.27	$104.93	$106.27
12	Energy Expenditures per Household	2010$/Household	$5,938	$6,008	$6,099	$6,410	$7,860	$7,894	$8,253
13	Retail Electricity Prices	cents/kWh (2010$)	7.8¢	7.8¢	7.9¢	7.9¢	9.0¢	9.6¢	9.7¢
14	Crude Oil Price	2010$/bbl	$23.95	$24.16	$23.02	$25.29	$44.56	$41.96	$41.62
Price & Market Volatility Metrics									
15	Crude Oil Price Volatility	$ change in year-to-year price	$0.53	$0.31	$0.59	$1.20	$7.55	$8.04	$7.40
16	Energy Expenditure Volatility	average yearly price change/$1,000 GDP (2010$)	$2.99	$3.25	$2.98	$3.88	$10.06	$9.83	$9.62
17	World Oil Refinery Utilization	percent utilization	94.1%	90.4%	88.8%	92.7%	84.9%	78.3%	78.9%
18	Petroleum Stock Levels	average days supply	69	69	58	58	64	69	63
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
20	Energy Intensity	million Btu/$1,000 GDP (2010$)	14.3	14.2	14.1	13.9	13.6	13.3	13.3
21	Petroleum Intensity	million Btu/real $1,000 GDP (2010$)	6.23	6.24	6.39	6.39	6.17	6.05	6.17
22	Household Energy Efficiency	million Btu/household	216.3	218.9	221.9	216.4	207.7	206.0	209.9
23	Commercial Energy Efficiency	million Btu/1,000 sq.ft.	332.4	336.0	336.0	330.2	326.6	330.7	332.9
24	Industrial Energy Efficiency	trillion Btu/IP Index	792	780	744	725	709	720	713
Electric Power Sector Metrics									
25	Electricity Capacity Diversity	HHI Index	3,910	3,913	3,905	3,887	3,846	3,743	3,750
26	Electricity Capacity Margins	percent	18.4%	20.3%	19.4%	21.8%	25.5%	27.4%	28.3%
27	Electricity Transmission Line Mileage	circuit-miles/peak GW	216	228	233	236	254	261	263
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
29	Transportation VMT per $ GDP	vehicle miles traveled/$1,000 GDP (2010$)	234	241	244	241	236	245	246
30	Transportation Non-Petroleum Fuels	percent	4.7%	4.7%	4.5%	4.1%	3.8%	3.3%	3.0%
Environmental Metrics									
31	Energy-Related CO2 Emissions	MMTCO2	4,261	4,312	4,532	4,735	4,575	4,439	4,707
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
33	Energy-Related CO2 Emissions Intensity	metric tons CO2/$1,000 GDP (2010$)	0.90	0.88	0.88	0.87	0.84	0.82	0.83
34	Electricity Non-CO2 Generation Share	percent of total generation	17.8%	19.1%	18.9%	19.4%	22.5%	24.9%	23.6%
Research and Development Metrics									
35	Industrial Energy R&D Expenditures	energy R&D $/$1,000 GDP (2010$)	$0.45	$0.45	$0.45	$0.45	$0.49	$0.46	$0.47
36	Federal Energy & Science R&D Expenditures	R&D $/$1,000 GDP (2010$)	$0.99	$0.95	$0.97	$0.93	$1.01	$1.33	$1.37
37	Science & Engineering Degrees	# degrees/$billion GDP (2010$)	75.2	75.6	74.9	73.8	75.1	73.1	68.9

Summary Table 1: Energy Security Metrics (Values)

1977-1983

#	Metric	Units of Measurement	1977	1978	1979	1980	1981	1982	1983
Global Fuels Metrics									
1	Security of World Oil Reserves	reserves, freedom & diversity-weighted	107.4	97.6	102.3	100.0	96.9	93.8	99.0
2	Security of World Oil Production	production, freedom & diversity-weighted	107.3	96.7	94.0	100.0	100.6	94.0	90.6
3	Security of World Natural Gas Reserves	reserves, freedom & diversity-weighted	114.2	100.7	98.7	100.0	106.2	120.4	122.5
4	Security of World Natural Gas Production	production, freedom & diversity-weighted	91.6	87.4	88.6	100.0	106.4	116.0	124.1
5	Security of World Coal Reserves	reserves, freedom & diversity-weighted	99.1	92.7	92.4	100.0	102.1	102.1	100.8
6	Security of World Coal Production	production, freedom & diversity-weighted	95.4	92.3	89.2	100.0	99.4	100.7	100.9
Fuel Import Metrics									
7	Security of U.S. Petroleum Imports	oil imports, freedom & diversity-weighted	49.3	40.7	39.7	37.3	34.6	27.0	26.1
8	Security of U.S. Natural Gas Imports	gas imports, freedom & diversity-weighted	4.8	4.2	5.3	4.7	4.6	5.6	6.0
9	Oil & Natural Gas Import Expenditures	billions of 2010$	$125.0	$109.6	$145.8	$175.5	$161.4	$115.4	$96.9
10	Oil & Natural Gas Import Expenditures per GDP	percent	2.1%	1.7%	2.2%	2.7%	2.4%	1.8%	1.4%
Energy Expenditure Metrics									
11	Energy Expenditures per GDP	$ per $1,000 GDP (2010$)	$108.60	$104.31	$116.13	$134.26	$136.85	$131.10	$118.15
12	Energy Expenditures per Household	2010$/Household	$8,661	$8,580	$9,649	$10,917	$10,975	$10,194	$9,504
13	Retail Electricity Prices	cents/kWh (2010$)	10.0¢	10.2¢	10.1¢	10.9¢	11.7¢	12.2¢	12.1¢
14	Crude Oil Price	2010$/bbl	$42.18	$39.39	$54.36	$78.20	$77.44	$66.40	$55.70
Price & Market Volatility Metrics									
15	Crude Oil Price Volatility	$ change in year-to-year price	$1.16	$1.23	$6.11	$13.87	$13.19	$11.88	$7.50
16	Energy Expenditure Volatility	average yearly price change/$1,000 GDP (2010$)	$5.20	$4.71	$7.61	$11.41	$12.64	$10.73	$7.05
17	World Oil Refinery Utilization	percent utilization	76.9%	77.6%	78.7%	75.0%	72.3%	71.7%	73.8%
18	Petroleum Stock Levels	average days supply	71	68	72	82	92	93	95
Energy Use Intensity Metrics									
19	Energy Consumption per Capita	million Btu/Person	354.0	359.2	359.3	343.6	331.7	315.5	312.1
20	Energy Intensity	million Btu/$1,000 GDP (2010$)	13.1	12.7	12.5	12.1	11.5	11.2	10.7
21	Petroleum Intensity	million Btu/real $1,000 GDP (2010$)	6.22	6.03	5.72	5.28	4.81	4.64	4.42
22	Household Energy Efficiency	million Btu/household	209.4	210.7	202.3	197.8	184.3	185.5	182.4
23	Commercial Energy Efficiency	million Btu/1,000 sq.ft.	322.8	314.8	309.2	297.0	288.6	286.1	279.6
24	Industrial Energy Efficiency	trillion Btu/IP Index	680	653	658	638	603	572	553
Electric Power Sector Metrics									
25	Electricity Capacity Diversity	HHI Index	3,646	3,650	3,682	3,736	3,734	3,780	3,781
26	Electricity Capacity Margins	percent	26.0%	26.1%	29.5%	26.2%	28.2%	32.3%	27.9%
27	Electricity Transmission Line Mileage	circuit-miles/peak GW	257	263	280	278	289	307	292
Transportation Sector Metrics									
28	Motor Vehicle Average MPG	miles per gallon	12.3	12.4	12.5	13.3	13.6	14.1	14.2
29	Transportation VMT per $ GDP	vehicle miles traveled/$1,000 GDP (2010$)	246	245	235	236	234	245	243
30	Transportation Non-Petroleum Fuels	percent	2.8%	2.7%	3.0%	3.4%	3.5%	3.4%	2.9%
Environmental Metrics									
31	Energy-Related CO2 Emissions	MMTCO2	4,847	4,897	4,966	4,771	4,646	4,405	4,377
32	Energy-Related CO2 Emissions per Capita	metric tons CO2/Person	22.0	22.0	22.1	21.0	20.2	19.0	18.7
33	Energy-Related CO2 Emissions Intensity	metric tons CO2/$1,000 GDP (2010$)	0.81	0.78	0.76	0.74	0.70	0.68	0.64
34	Electricity Non-CO2 Generation Share	percent of total generation	22.5%	25.5%	24.1%	23.4%	23.6%	26.7%	27.5%
Research and Development Metrics									
35	Industrial Energy R&D Expenditures	energy R&D $/$1,000 GDP (2010$)	$0.81	$0.80	$0.90	$0.97	$0.86	$0.85	$0.80
36	Federal Energy & Science R&D Expenditures	R&D $/$1,000 GDP (2010$)	$1.74	$1.82	$1.79	$1.73	$1.55	$1.34	$1.15
37	Science & Engineering Degrees	# degrees/$billion GDP (2010$)	65.3	61.7	59.3	59.7	58.6	61.4	59.4

Summary Table 1: Energy Security Metrics (Values)

1984-2001

1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
104.6	104.5	111.4	110.2	99.5	100.5	124.4	119.6	141.2	147.8	147.2	146.2	141.5	128.8	125.5	124.9	128.0	127.3
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
141.9	136.4	136.9	124.5	94.7	101.0	86.8	88.9	96.9	111.0	109.2	109.5	109.6	87.7	89.4	93.6	100.1	99.4
139.3	148.0	158.2	144.4	119.4	118.8	92.5	89.9	69.7	72.9	69.6	67.1	62.1	61.8	65.0	69.7	73.0	74.3
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
105.3	103.3	103.2	97.5	91.4	93.0	77.4	72.6	67.9	75.7	76.8	79.4	78.3	78.3	71.8	70.1	73.0	74.9
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
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
$97.7	$86.5	$57.4	$67.4	$65.2	$77.2	$90.7	$71.6	$72.0	$71.5	$70.4	$72.2	$94.4	$89.9	$64.2	$86.5	$153.9	$134.5
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%
$110.76	$103.98	$86.16	$83.99	$80.73	$80.12	$81.86	$78.86	$75.21	$73.85	$71.27	$69.42	$71.50	$68.18	$59.86	$59.74	$69.12	$67.70
$9,352	$8,983	$7,581	$7,502	$7,385	$7,468	$7,705	$7,330	$7,150	$7,127	$7,091	$6,991	$7,400	$7,273	$6,583	$6,777	$8,116	$7,940
11.6¢	11.6¢	11.3¢	10.9¢	10.5¢	10.3¢	10.1¢	10.0¢	9.9¢	9.8¢	9.6¢	9.4¢	9.2¢	9.0¢	8.7¢	8.5¢	8.5¢	8.9¢
$52.96	$48.03	$23.77	$30.22	$23.31	$28.20	$32.46	$26.73	$25.72	$22.29	$21.08	$22.82	$27.11	$23.75	$15.36	$22.02	$34.44	$26.69
$8.16	$6.12	$10.64	$11.88	$12.54	$6.09	$5.35	$4.96	$3.66	$3.39	$1.88	$2.13	$2.41	$3.13	$5.35	$6.14	$9.16	$8.94
$4.96	$3.13	$5.71	$5.54	$4.63	$0.90	$1.80	$2.85	$2.42	$1.58	$0.67	$0.36	$1.66	$1.58	$3.31	$2.70	$6.43	$4.94
75.7%	75.7%	79.2%	79.6%	82.1%	83.2%	82.4%	83.1%	82.7%	82.2%	81.3%	82.7%	84.0%	84.4%	83.9%	81.5%	83.3%	83.0%
99	97	98	96	92	91	95	97	93	96	93	88	82	84	87	76	74	81
325.0	321.1	319.2	326.3	338.3	343.5	338.5	333.8	334.4	336.4	338.6	341.9	349.0	347.0	344.4	346.4	350.2	337.5
10.5	10.1	9.8	9.7	9.8	9.7	9.5	9.5	9.3	9.2	9.1	9.0	9.0	8.7	8.3	8.1	7.9	7.6
4.26	4.07	4.10	4.05	4.05	3.91	3.77	3.70	3.65	3.57	3.51	3.41	3.41	3.31	3.23	3.17	3.07	3.03
184.8	182.5	179.2	179.7	186.2	190.2	179.8	182.9	180.1	186.4	183.5	185.2	193.1	185.6	183.1	186.4	193.2	187.3
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
547	527	512	506	502	508	511	512	517	502	489	473	466	438	410	392	376	367
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
29.0%	29.7%	28.3%	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%
300	300	292	286	273	280	270	269	272	262	258	242	247	241	234	228	231	229
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
236	234	233	237	240	240	241	244	245	243	240	240	239	235	232	226	222	224
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%
4,614	4,600	4,608	4,766	4,984	5,070	5,039	4,993	5,087	5,189	5,262	5,323	5,510	5,584	5,635	5,688	5,868	5,761
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
0.63	0.61	0.59	0.59	0.59	0.58	0.57	0.56	0.55	0.55	0.53	0.53	0.53	0.51	0.49	0.48	0.47	0.46
27.3%	27.4%	28.9%	28.0%	28.3%	29.2%	31.1%	31.9%	31.1%	30.6%	30.5%	32.0%	32.3%	30.8%	30.0%	30.8%	29.5%	28.6%
$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
$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
56.4	55.5	54.3	52.3	49.4	48.1	48.2	49.5	50.2	50.6	49.9	49.5	48.5	46.6	44.9	43.1	41.8	41.8

Summary Table 1: Energy Security Metrics (Values)

2002-2008

#	Metric	Units of Measurement	2002	2003	2004	2005	2006	2007	2008
Global Fuels Metrics									
1	Security of World Oil Reserves	reserves, freedom & diversity-weighted	124.1	90.9	92.0	87.2	87.1	86.2	87.2
2	Security of World Oil Production	production, freedom & diversity-weighted	66.3	69.1	73.1	72.7	73.2	73.3	76.0
3	Security of World Natural Gas Reserves	reserves, freedom & diversity-weighted	95.5	93.2	97.8	98.6	97.4	97.7	96.7
4	Security of World Natural Gas Production	production, freedom & diversity-weighted	72.9	73.4	77.7	78.4	79.4	80.3	79.6
5	Security of World Coal Reserves	reserves, freedom & diversity-weighted	56.3	67.9	70.3	67.5	73.8	73.8	68.0
6	Security of World Coal Production	production, freedom & diversity-weighted	76.5	85.3	90.0	98.4	101.4	106.8	112.5
Fuel Import Metrics									
7	Security of U.S. Petroleum Imports	oil imports, freedom & diversity-weighted	31.0	34.0	37.1	37.9	37.9	36.9	37.4
8	Security of U.S. Natural Gas Imports	gas imports, freedom & diversity-weighted	7.7	7.4	8.1	8.7	8.5	8.8	6.9
9	Oil & Natural Gas Import Expenditures	billions of 2010$	$126.3	$163.7	$212.9	$289.3	$317.6	$334.7	$423.8
10	Oil & Natural Gas Import Expenditures per GDP	percent	1.0%	1.2%	1.6%	2.1%	2.2%	2.3%	2.9%
Energy Expenditure Metrics									
11	Energy Expenditures per GDP	$ per $1,000 GDP (2010$)	$62.40	$67.78	$73.51	$82.86	$86.64	$87.96	$98.61
12	Energy Expenditures per Household	2010$/Household	$7,597	$8,430	$9,372	$10,736	$11,379	$11,692	$12,931
13	Retail Electricity Prices	cents/kWh (2010$)	8.7¢	8.8¢	8.7¢	9.0¢	9.6¢	9.5¢	10.0¢
14	Crude Oil Price	2010$/bbl	$28.78	$32.65	$41.36	$54.71	$63.55	$71.02	$95.40
Price & Market Volatility Metrics									
15	Crude Oil Price Volatility	$ change in year-to-year price	$7.42	$4.57	$4.89	$8.64	$10.30	$9.88	$13.56
16	Energy Expenditure Volatility	average yearly price change/$1,000 GDP (2010$)	$5.39	$3.86	$6.18	$8.60	$8.24	$6.60	$6.38
17	World Oil Refinery Utilization	percent utilization	81.6%	83.8%	85.7%	86.2%	85.4%	85.2%	84.0%
18	Petroleum Stock Levels	average days supply	78	78	79	82	83	81	89
Energy Use Intensity Metrics									
19	Energy Consumption per Capita	million Btu/Person	339.5	337.6	342.1	339.3	333.9	336.3	326.5
20	Energy Intensity	million Btu/$1,000 GDP (2010$)	7.6	7.5	7.4	7.2	6.9	6.9	6.8
21	Petroleum Intensity	million Btu/real $1,000 GDP (2010$)	2.98	2.95	2.96	2.88	2.78	2.71	2.55
22	Household Energy Efficiency	million Btu/household	198.1	200.1	197.9	199.8	188.8	195.3	194.7
23	Commercial Energy Efficiency	million Btu/1,000 sq.ft.	245.8	242.1	242.2	240.7	234.8	238.0	236.1
24	Industrial Energy Efficiency	trillion Btu/IP Index	366	360	362	340	332	324	325
Electric Power Sector Metrics									
25	Electricity Capacity Diversity	HHI Index	3,458	3,576	3,588	3,619	3,613	3,593	3,585
26	Electricity Capacity Margins	percent	18.4%	22.8%	24.5%	20.0%	17.4%	19.0%	23.3%
27	Electricity Transmission Line Mileage	circuit-miles/peak GW	222	226	228	212	207	212	223
Transportation Sector Metrics									
28	Motor Vehicle Average MPG	miles per gallon	16.9	17.0	17.1	17.1	17.2	17.2	17.4
29	Transportation VMT per $ GDP	vehicle miles traveled/$1,000 GDP (2010$)	224	221	219	215	211	208	205
30	Transportation Non-Petroleum Fuels	percent	3.3%	3.3%	3.3%	3.5%	3.9%	4.5%	5.6%
Environmental Metrics									
31	Energy-Related CO2 Emissions	MMTCO2	5,804	5,855	5,975	5,999	5,919	6,021	5,836
32	Energy-Related CO2 Emissions per Capita	metric tons CO2/Person	20.2	20.2	20.4	20.3	19.8	20.0	19.2
33	Energy-Related CO2 Emissions Intensity	metric tons CO2/$1,000 GDP (2010$)	0.45	0.45	0.44	0.43	0.41	0.41	0.40
34	Electricity Non-CO2 Generation Share	percent of total generation	29.5%	29.4%	29.2%	28.6%	29.4%	28.3%	29.2%
Research and Development Metrics									
35	Industrial Energy R&D Expenditures	energy R&D $/$1,000 GDP (2010$)	$0.15	$0.17	$0.19	$0.22	$0.30	$0.37	$0.38
36	Federal Energy & Science R&D Expenditures	R&D $/$1,000 GDP (2010$)	$0.67	$0.68	$0.66	$0.62	$0.66	$0.76	$0.78
37	Science & Engineering Degrees	# degrees/$billion GDP (2010$)	42.2	43.9	44.5	44.2	43.8	43.5	44.9

Summary Table 1: Energy Security Metrics (Values)

2009-2026

2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
87.1	88.1	93.2	95.0	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6
74.5	77.3	81.0	81.8	81.1	81.7	80.5	83.5	83.2	83.9	84.3	84.7	84.9	84.9	85.0	85.2	85.3	85.4
96.7	93.5	93.7	96.3	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8
76.7	80.1	84.2	81.3	82.8	83.6	84.5	84.8	85.1	85.4	85.7	86.1	86.4	86.7	87.1	87.4	87.8	88.1
67.7	68.6	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
123.6	129.1	136.8	140.5	140.5	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8
33.3	33.1	31.7	29.0	23.8	20.8	19.0	18.3	18.3	18.5	18.5	18.8	19.4	19.4	19.4	19.6	19.7	20.0
5.9	5.7	4.5	3.3	2.8	2.9	2.3	1.6	0.1	-1.4	-3.0	-4.0	-4.8	-5.2	-5.9	-6.6	-7.0	-7.6
$220.8	$279.9	$331.8	$289.7	$229.0	$216.1	$209.0	$187.8	$183.1	$180.6	$179.2	$182.9	$188.8	$194.5	$198.5	$203.5	$207.7	$214.9
1.6%	1.9%	2.2%	1.9%	1.5%	1.4%	1.3%	1.1%	1.1%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
$76.13	$83.35	$92.47	$86.43	$81.46	$81.34	$76.76	$74.01	$72.60	$71.85	$71.13	$70.10	$69.49	$68.72	$67.98	$67.36	$66.44	$65.37
$9,683	$10,803	$12,023	$11,388	$10,915	$11,162	$10,774	$10,608	$10,601	$10,657	$10,703	$10,687	$10,725	$10,745	$10,779	$10,845	$10,866	$10,860
10.0¢	9.8¢	9.7¢	9.5¢	9.6¢	9.4¢	9.5¢	9.6¢	9.6¢	9.7¢	9.8¢	9.8¢	9.7¢	9.6¢	9.6¢	9.7¢	9.7¢	9.8¢
$61.04	$76.50	$100.77	$97.15	$91.96	$94.26	$85.54	$81.92	$80.54	$80.98	$82.57	$84.72	$86.99	$89.42	$91.75	$93.96	$96.20	$98.19
$22.07	$24.74	$24.70	$14.45	$11.03	$7.94	$9.57	$11.43	$13.46	$15.78	$16.09	$16.51	$16.95	$17.42	$17.88	$18.31	$18.74	$19.13
$13.11	$14.81	$14.67	$7.68	$5.85	$5.85	$5.85	$5.84	$5.84	$5.83	$5.83	$5.83	$5.83	$5.83	$5.83	$5.83	$5.83	$5.83
80.6%	82.0%	82.1%	81.1%	80.4%	80.4%	80.4%	80.4%	80.4%	80.4%	80.4%	80.4%	80.4%	80.4%	80.4%	80.4%	80.4%	80.4%
95	94	93	98	93	94	92	91	90	90	90	90	90	91	91	91	91	92
308.4	316.9	312.8	302.7	307.9	302.5	303.6	303.5	303.9	303.5	302.5	301.2	300.1	298.9	297.8	296.6	295.3	293.7
6.7	6.8	6.6	6.3	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	4.8
2.50	2.48	2.40	2.29	2.28	2.28	2.23	2.18	2.13	2.08	2.03	1.98	1.94	1.89	1.84	1.79	1.74	1.69
189.6	195.4	188.5	175.3	183.6	180.1	176.9	174.0	172.3	171.0	169.7	167.1	165.7	164.5	163.5	162.6	161.6	160.5
225.8	224.4	219.9	211.4	216.7	213.1	211.3	208.6	207.0	205.7	204.5	203.3	202.4	201.7	201.1	200.4	199.9	199.1
332	337	330	317	315	302	296	291	290	289	288	286	284	281	278	275	272	268
3,566	3,566	3,556	3,532	3,547	3,539	3,519	3,567	3,553	3,555	3,561	3,581	3,591	3,609	3,641	3,670	3,679	3,705
27.1%	23.9%	23.3%	25.6%	27.8%	27.8%	26.7%	24.3%	23.2%	23.2%	23.2%	23.2%	23.2%	23.2%	23.2%	23.2%	23.2%	23.2%
232	225	252	248	250	254	254	252	252	252	252	252	252	252	252	252	252	252
17.6	17.4	17.5	17.6	18.2	18.4	18.6	18.8	19.1	19.4	19.8	20.2	20.5	20.9	21.4	21.8	22.3	22.7
210	206	201	197	195	192	188	185	182	179	176	174	172	170	168	165	163	161
6.2%	6.6%	7.1%	7.3%	7.7%	7.3%	7.3%	7.3%	7.4%	7.5%	7.7%	7.8%	8.0%	8.2%	8.3%	8.4%	8.6%	8.7%
5,418	5,620	5,484	5,268	5,390	5,426	5,418	5,382	5,418	5,452	5,469	5,476	5,487	5,498	5,506	5,519	5,526	5,527
17.7	18.2	17.6	16.8	17.0	17.0	16.8	16.6	16.6	16.6	16.5	16.4	16.3	16.2	16.1	16.0	15.9	15.8
0.38	0.39	0.37	0.35	0.35	0.34	0.33	0.32	0.31	0.31	0.30	0.29	0.29	0.28	0.28	0.27	0.27	0.26
31.2%	30.4%	32.3%	31.7%	32.8%	32.3%	33.3%	34.0%	34.1%	33.8%	33.7%	33.4%	33.4%	33.1%	33.0%	32.8%	32.7%	32.6%
$0.36	$0.36	$0.38	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40
$1.28	$0.90	$0.85	$0.81	$0.72	$0.72	$0.72	$0.72	$0.72	$0.72	$0.72	$0.72	$0.72	$0.72	$0.72	$0.72	$0.72	$0.72
47.6	48.2	50.1	50.1	50.1	50.1	50.1	50.1	50.1	50.1	50.1	50.1	50.1	50.1	50.1	50.1	50.1	50.1

Summary Table 1: Energy Security Metrics (Values)

2027-2033

#	Metric	Units of Measurement	2027	2028	2029	2030	2031	2032	2033
Global Fuels Metrics									
1	Security of World Oil Reserves	reserves, freedom & diversity-weighted	95.6	95.6	95.6	95.6	95.6	95.6	95.6
2	Security of World Oil Production	production, freedom & diversity-weighted	85.8	86.3	86.7	87.2	87.5	88.1	88.8
3	Security of World Natural Gas Reserves	reserves, freedom & diversity-weighted	97.8	97.8	97.8	97.8	97.8	97.8	97.8
4	Security of World Natural Gas Production	production, freedom & diversity-weighted	88.4	88.7	89.0	89.2	89.3	89.3	89.3
5	Security of World Coal Reserves	reserves, freedom & diversity-weighted	69.5	69.5	69.5	69.5	69.5	69.5	69.5
6	Security of World Coal Production	production, freedom & diversity-weighted	136.8	136.8	136.8	136.8	136.8	136.8	136.8
Fuel Import Metrics									
7	Security of U.S. Petroleum Imports	oil imports, freedom & diversity-weighted	20.5	21.0	21.4	21.6	21.9	22.2	22.3
8	Security of U.S. Natural Gas Imports	gas imports, freedom & diversity-weighted	-8.3	-9.0	-9.6	-9.9	-10.1	-10.4	-10.5
9	Oil & Natural Gas Import Expenditures	billions of 2010$	$222.8	$229.0	$235.0	$238.5	$247.3	$253.3	$258.8
10	Oil & Natural Gas Import Expenditures per GDP	percent	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
Energy Expenditure Metrics									
11	Energy Expenditures per GDP	$ per $1,000 GDP (2010$)	$64.65	$63.64	$62.79	$62.01	$61.26	$60.49	$59.77
12	Energy Expenditures per Household	2010$/Household	$10,902	$10,893	$10,917	$10,952	$10,989	$11,017	$11,060
13	Retail Electricity Prices	cents/kWh (2010$)	9.9¢	9.9¢	9.9¢	10.0¢	10.1¢	10.2¢	10.2¢
14	Crude Oil Price	2010$/bbl	$100.35	$102.02	$103.79	$105.06	$106.82	$108.78	$111.06
Price & Market Volatility Metrics									
15	Crude Oil Price Volatility	$ change in year-to-year price	$19.55	$19.88	$20.22	$20.47	$20.81	$21.19	$21.64
16	Energy Expenditure Volatility	average yearly price change/$1,000 GDP (2010$)	$5.83	$5.83	$5.83	$5.83	$5.83	$5.83	$5.83
17	World Oil Refinery Utilization	percent utilization	80.4%	80.4%	80.4%	80.4%	80.4%	80.4%	80.4%
18	Petroleum Stock Levels	average days supply	92	92	93	93	93	93	94
Energy Use Intensity Metrics									
19	Energy Consumption per Capita	million Btu/Person	292.3	290.9	289.2	287.6	286.1	284.6	283.5
20	Energy Intensity	million Btu/$1,000 GDP (2010$)	4.7	4.6	4.5	4.4	4.3	4.2	4.1
21	Petroleum Intensity	million Btu/real $1,000 GDP (2010$)	1.65	1.60	1.56	1.52	1.48	1.44	1.41
22	Household Energy Efficiency	million Btu/household	159.5	158.6	157.8	156.8	155.8	154.9	154.2
23	Commercial Energy Efficiency	million Btu/1,000 sq.ft.	198.5	198.1	197.6	196.9	196.1	195.4	195.0
24	Industrial Energy Efficiency	trillion Btu/IP Index	264	261	257	253	250	247	244
Electric Power Sector Metrics									
25	Electricity Capacity Diversity	HHI Index	3,737	3,763	3,789	3,816	3,843	3,874	3,905
26	Electricity Capacity Margins	percent	23.2%	23.2%	23.2%	23.2%	23.2%	23.2%	23.2%
27	Electricity Transmission Line Mileage	circuit-miles/peak GW	252	252	252	252	252	252	252
Transportation Sector Metrics									
28	Motor Vehicle Average MPG	miles per gallon	23.2	23.6	24.0	24.4	24.7	25.0	25.3
29	Transportation VMT per $ GDP	vehicle miles traveled/$1,000 GDP (2010$)	159	157	155	153	151	149	148
30	Transportation Non-Petroleum Fuels	percent	8.9%	9.1%	9.3%	9.5%	9.7%	9.9%	10.1%
Environmental Metrics									
31	Energy-Related CO2 Emissions	MMTCO2	5,531	5,531	5,528	5,527	5,524	5,524	5,530
32	Energy-Related CO2 Emissions per Capita	metric tons CO2/Person	15.7	15.6	15.5	15.4	15.3	15.2	15.1
33	Energy-Related CO2 Emissions Intensity	metric tons CO2/$1,000 GDP (2010$)	0.25	0.25	0.24	0.24	0.23	0.22	0.22
34	Electricity Non-CO2 Generation Share	percent of total generation	32.4%	32.3%	32.3%	32.3%	32.2%	32.2%	32.1%
Research and Development Metrics									
35	Industrial Energy R&D Expenditures	energy R&D $/$1,000 GDP (2010$)	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40
36	Federal Energy & Science R&D Expenditures	R&D $/$1,000 GDP (2010$)	$0.72	$0.72	$0.72	$0.72	$0.72	$0.72	$0.72
37	Science & Engineering Degrees	# degrees/$billion GDP (2010$)	50.1	50.1	50.1	50.1	50.1	50.1	50.1

Summary Table 1: Energy Security Metrics (Values)

2034-2040

2034	2035	2036	2037	2038	2039	2040
95.6	95.6	95.6	95.6	95.6	95.6	95.6
89.1	89.3	89.2	89.0	88.9	88.9	88.8
97.8	97.8	97.8	97.8	97.8	97.8	97.8
89.3	89.3	89.0	88.6	88.3	88.0	87.7
69.5	69.5	69.5	69.5	69.5	69.5	69.5
136.8	136.8	136.8	136.8	136.8	136.8	136.8
22.5	23.0	23.4	23.4	24.0	24.1	24.3
-10.6	-10.7	-10.7	-10.7	-10.7	-10.7	-10.5
$267.7	$277.0	$285.8	$293.9	$308.1	$315.8	$326.8
1.0%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%
$59.40	$58.76	$58.29	$57.69	$57.02	$56.72	$56.46
$11,170	$11,229	$11,319	$11,383	$11,435	$11,554	$11,687
10.2¢	10.3¢	10.4¢	10.5¢	10.5¢	10.6¢	10.7¢
$113.40	$115.24	$116.81	$118.42	$120.45	$122.93	$125.82
$22.09	$22.45	$22.76	$23.07	$23.47	$23.95	$24.51
$5.83	$5.83	$5.83	$5.83	$5.83	$5.83	$5.83
80.4%	80.4%	80.4%	80.4%	80.4%	80.4%	80.4%
94	94	94	94	94	94	94
282.6	281.7	281.0	280.5	280.3	279.9	279.4
4.0	4.0	3.9	3.8	3.7	3.7	3.6
1.37	1.34	1.31	1.28	1.25	1.22	1.19
153.6	152.8	152.1	151.5	151.0	150.6	150.2
194.6	194.0	193.4	192.9	192.6	192.2	191.8
240	236	233	230	228	225	222
3,933	3,960	3,981	4,000	4,019	4,036	4,051
23.2%	23.2%	23.2%	23.2%	23.2%	23.2%	23.2%
252	252	252	252	252	252	252
25.6	25.8	25.9	26.1	26.2	26.3	26.4
146	144	142	139	137	135	133
10.3%	10.5%	10.7%	11.0%	11.3%	11.6%	12.0%
5,538	5,546	5,554	5,564	5,580	5,591	5,599
15.0	15.0	14.9	14.9	14.8	14.8	14.7
0.22	0.21	0.21	0.20	0.20	0.19	0.19
32.0%	31.9%	32.0%	32.1%	32.1%	32.2%	32.3%
$0.40	$0.40	$0.40	$0.40	$0.40	$0.40	$0.40
$0.72	$0.72	$0.72	$0.72	$0.72	$0.72	$0.72
50.1	50.1	50.1	50.1	50.1	50.1	50.1

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

1970-1981

#	Metric	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
	Index of U.S. Energy Security Risk	79.4	79.3	81.1	83.7	91.6	91.2	94.6	91.4	87.2	92.8	100.0	97.9
	Sub-Indexes												
	Geopolitical	73.9	74.4	76.7	80.0	87.7	90.6	95.1	93.7	87.3	93.3	100.0	97.3
	Economic	64.2	64.6	65.0	67.2	83.2	82.6	84.8	83.0	79.4	87.7	100.0	98.9
	Reliability	83.6	82.2	84.0	87.0	96.2	94.3	96.4	85.3	81.1	88.1	100.0	98.9
	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
Global Fuels Metrics													
1	Security of World Oil Reserves	122.5	114.6	113.0	105.8	104.2	110.5	114.2	107.4	97.6	102.3	100.0	96.9
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
3	Security of World Natural Gas Reserves	57.8	67.8	74.4	78.6	84.4	102.3	106.9	114.2	100.7	98.7	100.0	106.2
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
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
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
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
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
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
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
Energy Expenditure Metrics													
11	Energy Expenditures per GDP	59.4	59.5	59.0	60.3	76.2	78.1	79.1	80.9	77.7	86.5	100.0	101.9
12	Energy Expenditures per Household	54.4	55.0	55.9	58.7	72.0	72.3	75.6	79.3	78.6	88.4	100.0	100.5
13	Retail Electricity Prices	71.0	71.6	72.5	72.3	82.8	87.8	88.7	91.5	93.0	92.9	100.0	107.0
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
Price & Market Volatility Metrics													
15	Crude Oil Price Volatility	3.8	2.2	4.3	8.7	54.5	58.0	53.4	8.4	8.9	44.0	100.0	95.1
16	Energy Expenditure Volatility	26.2	28.5	26.1	34.0	88.1	86.1	84.3	45.6	41.3	66.6	100.0	110.8
17	World Oil Refinery Utilization	157.5	145.4	140.3	152.9	128.2	109.1	110.7	105.2	107.1	110.2	100.0	93.0
18	Petroleum Stock Levels	117.9	118.9	139.7	140.1	126.6	117.6	128.5	114.7	120.4	112.7	100.0	88.3
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
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
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
22	Household Energy Efficiency	109.3	110.7	112.2	109.4	105.0	104.1	106.1	105.9	106.5	102.3	100.0	93.2
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
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
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
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
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
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
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
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
Environmental Metrics													
31	Energy-Related CO2 Emissions	33.8	40.4	69.0	95.3	74.5	56.9	91.6	109.8	116.3	125.2	100.0	83.7
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
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
34	Electricity non-CO2 Generation Share	131.3	122.6	123.7	120.8	104.0	93.8	99.1	104.0	91.8	97.1	100.0	99.1
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
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
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

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

1982-2000

1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
91.6	86.6	87.3	84.2	83.4	84.5	82.2	80.0	78.8	76.6	75.6	77.2	75.9	76.9	78.9	79.1	78.9	82.0	88.2
91.6	87.5	90.9	88.1	86.5	87.0	81.2	81.3	79.2	76.3	75.8	78.2	76.8	76.7	77.5	74.9	73.1	76.5	84.4
91.0	83.4	81.4	77.3	71.1	72.1	69.4	67.7	68.3	65.4	63.7	63.5	61.8	62.3	65.3	64.6	61.5	64.5	73.7
91.7	85.1	84.0	79.9	87.5	89.3	88.8	79.8	78.5	77.9	75.2	77.5	75.5	78.7	80.6	85.1	91.8	96.7	100.5
92.4	91.4	94.3	93.1	92.9	94.5	96.3	96.8	94.1	92.6	93.6	95.9	96.2	97.2	99.8	101.0	100.8	101.7	103.3
93.8	99.0	104.6	104.5	111.4	110.2	99.5	100.5	124.4	119.6	141.2	147.8	147.2	146.2	141.5	128.8	125.5	124.9	128.0
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
120.4	122.5	141.9	136.4	136.9	124.5	94.7	101.0	86.8	88.9	96.9	111.0	109.2	109.5	109.6	87.7	89.4	93.6	100.1
116.0	124.1	139.3	148.0	158.2	144.4	119.4	118.8	92.5	89.9	69.7	72.9	69.6	67.1	62.1	61.8	65.0	69.7	73.0
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
100.7	100.9	105.3	103.3	103.2	97.5	91.4	93.0	77.4	72.6	67.9	75.7	76.8	79.4	78.3	78.3	71.8	70.1	73.0
72.4	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
118.9	127.2	123.3	148.6	129.0	149.2	150.2	145.6	126.5	134.4	109.6	126.9	132.0	130.3	118.4	117.8	134.5	162.5	166.0
65.8	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
65.4	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
97.6	88.0	82.5	77.4	64.2	62.6	60.1	59.7	61.0	58.7	56.0	55.0	53.1	51.7	53.2	50.8	44.6	44.5	51.5
93.4	87.1	85.7	82.3	69.4	68.7	67.6	68.4	70.6	67.1	65.5	65.3	65.0	64.0	67.8	66.6	60.3	62.1	74.3
111.8	111.1	106.2	106.3	104.0	99.9	96.3	94.3	92.4	91.7	90.5	90.0	87.9	85.9	83.9	82.3	80.1	77.7	78.0
84.9	71.2	67.7	61.4	30.4	38.6	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
85.6	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
94.0	61.7	43.4	27.5	50.0	48.5	40.5	7.9	15.8	25.0	21.2	13.9	5.8	3.2	14.5	13.8	29.0	23.6	56.3
91.5	96.9	102.0	101.9	111.7	112.8	119.8	123.1	120.7	122.8	121.7	120.2	117.7	121.7	125.6	126.6	125.2	118.1	123.3
87.6	85.5	82.5	84.5	83.7	84.6	88.3	89.4	85.6	84.4	87.6	85.4	87.5	92.6	99.4	97.4	93.8	106.7	109.9
91.8	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
93.1	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
87.9	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
93.8	92.2	93.4	92.3	90.6	90.8	94.1	96.2	90.9	92.5	91.0	94.2	92.8	93.6	97.6	93.8	92.6	94.2	97.7
96.3	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
89.7	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
102.5	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
81.1	93.7	90.4	88.1	92.7	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
90.8	95.3	92.7	92.6	95.4	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
94.3	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
103.9	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
100.0	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
52.5	48.9	79.6	77.8	78.8	99.3	127.6	138.7	134.6	128.7	140.9	154.1	163.5	171.4	195.7	205.3	212.0	218.8	242.1
82.1	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
91.9	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	69.2	66.9	64.5	64.0
87.5	85.2	85.7	85.3	81.0	83.7	82.8	80.1	75.3	73.3	75.3	76.4	76.7	73.1	72.4	76.0	77.9	75.9	79.2
106.7	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
129.1	150.3	160.2	172.1	186.0	200.6	206.4	198.4	195.9	186.0	191.1	215.4	220.0	228.1	253.3	271.9	287.3	278.7	289.0
97.2	100.6	105.8	107.5	110.0	114.2	120.9	124.0	123.8	120.6	119.0	118.1	119.6	120.7	123.1	128.1	133.0	138.4	142.7

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

2001-2012

#	Metric	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
	Index of U.S. Energy Security Risk	84.8	82.9	82.5	87.3	94.4	96.1	96.2	100.8	90.9	98.2	101.7	91.8
	Sub-Indexes												
	Geopolitical	82.4	79.8	79.3	85.4	92.0	94.7	96.7	103.1	89.2	96.0	101.5	93.4
	Economic	69.6	68.0	70.1	76.5	86.9	90.6	91.6	102.9	85.2	94.7	102.7	92.6
	Reliability	95.4	92.1	87.8	92.4	102.2	104.0	100.2	100.3	106.0	114.1	114.2	95.9
	Environmental	100.6	100.7	100.4	101.3	101.3	98.3	98.3	94.7	87.0	90.7	87.7	84.2
Global Fuels Metrics													
1	Security of World Oil Reserves	127.3	124.1	90.9	92.0	87.2	87.1	86.2	87.2	87.1	88.1	93.2	95.0
2	Security of World Oil Production	69.6	66.3	69.1	73.1	72.7	73.2	73.3	76.0	74.5	77.3	81.0	81.8
3	Security of World Natural Gas Reserves	99.4	95.5	93.2	97.8	98.6	97.4	97.7	96.7	96.7	93.5	93.7	96.3
4	Security of World Natural Gas Production	74.3	72.9	73.4	77.7	78.4	79.4	80.3	79.6	76.7	80.1	84.2	81.3
5	Security of World Coal Reserves	58.1	56.3	67.9	70.3	67.5	73.8	73.8	68.0	67.7	68.6	69.5	69.5
6	Security of World Coal Production	74.9	76.5	85.3	90.0	98.4	101.4	106.8	112.5	123.6	129.1	136.8	140.5
Fuel Import Metrics													
7	Security of U.S. Petroleum Imports	90.7	83.0	91.0	99.5	101.7	101.5	98.8	100.1	89.3	88.7	85.0	77.7
8	Security of U.S. Natural Gas Imports	179.5	163.3	158.0	172.5	185.0	181.3	187.8	146.1	124.8	121.4	95.5	69.6
9	Oil & Natural Gas Import Expenditures	76.6	72.0	93.3	121.3	164.9	181.0	190.7	241.5	125.8	159.5	189.1	165.1
10	Oil & Natural Gas Import Expenditures per GDP	39.4	36.4	46.0	57.8	76.2	81.5	84.3	107.0	57.5	71.2	83.0	70.9
Energy Expenditure Metrics													
11	Energy Expenditures per GDP	50.4	46.5	50.5	54.8	61.7	64.5	65.5	73.4	56.7	62.1	68.9	64.4
12	Energy Expenditures per Household	72.7	69.6	77.2	85.8	98.3	104.2	107.1	118.4	88.7	99.0	110.1	104.3
13	Retail Electricity Prices	81.7	79.4	80.4	80.0	82.8	87.7	87.4	91.2	91.2	90.1	88.8	86.7
14	Crude Oil Price	34.1	36.8	41.8	52.9	70.0	81.3	90.8	122.0	78.1	97.8	128.9	124.2
Price & Market Volatility Metrics													
15	Crude Oil Price Volatility	64.5	53.5	32.9	35.3	62.3	74.3	71.3	97.8	159.2	178.4	178.1	104.2
16	Energy Expenditure Volatility	43.3	47.3	33.8	54.2	75.3	72.2	57.8	55.9	114.9	129.7	128.5	67.3
17	World Oil Refinery Utilization	122.6	118.6	124.9	130.8	132.1	129.9	129.1	125.6	115.7	119.5	119.8	117.1
18	Petroleum Stock Levels	101.1	104.2	104.3	103.2	100.0	98.2	101.4	91.9	86.3	87.3	88.1	83.7
Energy Use Intensity Metrics													
19	Energy Consumption per Capita	98.2	98.8	98.3	99.6	98.8	97.2	97.9	95.0	89.8	92.2	91.0	88.1
20	Energy Intensity	63.4	63.2	61.8	61.1	59.4	57.5	57.3	56.4	55.4	56.1	54.8	52.2
21	Petroleum Intensity	57.4	56.5	55.9	56.1	54.6	52.6	51.4	48.3	47.3	47.0	45.4	43.4
22	Household Energy Efficiency	94.7	100.1	101.2	100.0	101.0	95.4	98.7	98.4	95.8	98.8	95.3	88.6
23	Commercial Energy Efficiency	83.0	82.7	81.5	81.5	81.0	79.0	80.1	79.5	76.0	75.5	74.0	71.2
24	Industrial Energy Efficiency	57.6	57.4	56.5	56.8	53.3	52.1	50.8	50.9	52.1	52.9	51.7	49.7
Electric Power Sector Metrics													
25	Electricity Capacity Diversity	79.2	84.0	90.8	91.5	93.3	92.9	91.7	91.3	90.2	90.2	89.6	88.3
26	Electricity Capacity Margins	163.7	142.3	115.0	106.8	131.0	150.2	137.8	112.3	96.5	109.6	112.3	102.3
27	Electricity Transmission Line Mileage	121.6	125.3	123.2	121.9	130.9	134.3	131.2	124.5	120.1	123.6	110.2	111.9
Transportation Sector Metrics													
28	Motor Vehicle Average MPG	77.8	78.7	78.2	77.8	77.8	77.3	77.3	76.4	75.6	76.4	76.0	75.6
29	Transportation VMT per $ GDP	94.8	95.1	93.9	93.0	91.1	89.4	88.2	86.9	89.1	87.3	85.1	83.5
30	Transportation Non-Petroleum Fuels	100.4	100.1	100.1	100.1	99.7	98.8	97.7	95.6	94.3	93.5	92.7	92.1
Environmental Metrics													
31	Energy-Related CO2 Emissions	228.3	233.9	240.5	256.0	259.1	248.8	261.9	238.1	183.8	210.0	192.4	164.4
32	Energy-Related CO2 Emissions per Capita	92.7	92.6	92.5	94.5	93.4	89.3	90.6	83.6	70.8	74.9	70.3	63.9
33	Energy-Related CO2 Emissions Intensity	62.1	61.5	60.5	59.7	58.1	55.9	55.8	54.2	52.0	52.6	50.4	47.4
34	Electricity non-CO2 Generation Share	81.8	79.2	79.7	80.0	81.8	79.7	82.6	80.0	74.9	77.0	72.5	73.7
Research and Development Metrics													
35	Industrial Energy R&D Expenditures	276.4	253.4	241.6	224.3	210.3	179.8	160.6	158.6	162.9	163.4	159.4	155.8
36	Federal Energy & Science R&D Expenditures	263.1	260.7	256.6	263.3	278.3	264.2	228.8	223.7	135.2	192.3	203.6	213.1
37	Science & Engineering Degrees	143.0	141.6	136.1	134.3	135.1	136.4	137.2	133.1	125.5	123.9	119.1	119.1

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

2013-2031

2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
87.4	85.8	84.2	83.4	83.3	84.0	84.1	84.4	84.8	85.2	85.5	86.0	86.3	86.6	87.1	87.4	87.8	87.9	88.4
88.0	86.3	84.1	82.6	81.9	82.7	82.9	83.5	84.2	84.8	85.3	86.0	86.5	87.1	87.8	88.4	88.9	89.2	89.9
86.4	85.1	82.7	81.0	80.7	81.1	81.2	81.4	82.0	82.4	82.8	83.4	83.9	84.3	85.0	85.4	85.9	86.2	86.8
89.3	86.4	86.5	88.1	89.1	90.9	91.3	92.0	92.7	93.3	93.9	94.6	95.1	95.7	96.5	97.1	97.7	98.1	98.7
85.8	85.5	84.6	83.6	83.4	83.3	82.9	82.5	82.1	81.8	81.4	81.1	80.6	80.2	79.8	79.4	78.9	78.5	78.0
95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6
81.1	81.7	80.5	83.5	83.2	83.9	84.3	84.7	84.9	84.9	85.0	85.2	85.3	85.4	85.8	86.3	86.7	87.2	87.5
97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8
82.8	83.6	84.5	84.8	85.1	85.4	85.7	86.1	86.4	86.7	87.1	87.4	87.8	88.1	88.4	88.7	89.0	89.2	89.3
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
140.5	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8
63.9	55.7	50.9	49.1	49.0	49.5	49.6	50.5	52.0	52.1	52.0	52.6	52.7	53.7	55.0	56.3	57.4	57.8	58.8
58.5	61.4	49.8	33.9	1.4	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
130.5	123.2	119.1	107.0	104.3	102.9	102.1	104.3	107.6	110.8	113.1	116.0	118.4	122.5	127.0	130.5	133.9	135.9	140.9
55.0	50.5	47.3	41.2	39.0	37.6	36.4	36.3	36.7	37.0	36.9	36.9	36.8	37.1	37.6	37.8	37.9	37.5	38.0
60.7	60.6	57.2	55.1	54.1	53.5	53.0	52.2	51.8	51.2	50.6	50.2	49.5	48.7	48.2	47.4	46.8	46.2	45.6
100.0	102.2	98.7	97.2	97.1	97.6	98.0	97.9	98.2	98.4	98.7	99.3	99.5	99.5	99.9	99.8	100.0	100.3	100.7
87.5	86.4	87.4	87.5	88.1	89.0	89.8	89.4	89.0	88.3	88.0	89.0	89.2	89.6	90.2	90.6	91.1	91.9	92.7
117.6	120.5	109.4	104.8	103.0	103.6	105.6	108.3	111.3	114.4	117.3	120.2	123.0	125.6	128.3	130.5	132.7	134.3	136.6
79.5	57.2	69.0	82.4	97.1	113.8	116.0	119.0	122.2	125.6	128.9	132.0	135.2	138.0	141.0	143.3	145.8	147.6	150.1
51.3	51.3	51.2	51.2	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1
114.9	114.9	114.9	114.9	114.9	114.9	114.9	114.9	114.9	114.9	114.9	114.9	114.9	114.9	114.9	114.9	114.9	114.9	114.9
87.6	86.7	88.9	89.8	90.4	90.6	90.6	90.6	90.4	90.2	90.0	89.7	89.4	89.0	88.7	88.4	88.1	87.8	87.6
89.6	88.1	88.4	88.3	88.4	88.3	88.1	87.7	87.3	87.0	86.7	86.3	85.9	85.5	85.1	84.7	84.2	83.7	83.3
52.5	50.7	49.7	48.6	47.6	46.7	45.8	44.9	44.2	43.4	42.6	41.7	40.8	39.9	39.0	38.2	37.3	36.5	35.7
43.2	43.2	42.1	41.2	40.3	39.4	38.4	37.5	36.6	35.8	34.8	33.9	33.0	32.0	31.2	30.4	29.5	28.8	28.0
92.8	91.0	89.4	87.9	87.1	86.4	85.8	84.5	83.8	83.2	82.7	82.2	81.7	81.1	80.6	80.2	79.8	79.3	78.8
73.0	71.7	71.1	70.2	69.7	69.3	68.9	68.4	68.2	67.9	67.7	67.5	67.3	67.0	66.8	66.7	66.5	66.3	66.0
49.4	47.4	46.5	45.6	45.4	45.3	45.1	44.9	44.5	44.1	43.6	43.2	42.6	42.0	41.4	40.9	40.3	39.7	39.2
89.1	88.6	87.5	90.3	89.4	89.6	89.9	91.1	91.6	92.7	94.5	96.2	96.7	98.2	100.0	101.6	103.0	104.6	106.2
94.3	94.1	98.3	107.7	112.7	112.7	112.7	112.7	112.7	112.7	112.7	112.7	112.7	112.7	112.7	112.7	112.7	112.7	112.7
111.2	109.6	109.7	110.4	110.4	110.4	110.4	110.4	110.4	110.4	110.4	110.4	110.4	110.4	110.4	110.4	110.4	110.4	110.4
73.0	72.1	71.4	70.6	69.6	68.4	67.2	66.0	64.7	63.5	62.3	61.0	59.8	58.6	57.4	56.4	55.4	54.6	53.8
82.5	81.4	79.6	78.2	77.0	75.8	74.7	73.8	73.0	72.1	71.2	70.2	69.2	68.2	67.4	66.6	65.7	64.9	64.1
91.5	92.2	92.2	92.2	92.0	91.8	91.5	91.2	90.9	90.5	90.3	90.1	89.8	89.5	89.1	88.7	88.3	88.0	87.7
180.2	184.8	183.8	179.1	183.8	188.3	190.4	191.3	192.8	194.2	195.3	196.8	197.8	197.9	198.4	198.5	198.0	197.9	197.5
66.0	65.5	64.3	62.4	62.3	62.2	61.6	60.8	60.2	59.5	58.8	58.2	57.6	56.8	56.1	55.3	54.5	53.8	53.0
47.6	46.6	45.1	43.4	42.5	41.7	40.8	40.0	39.2	38.5	37.7	36.9	36.0	35.1	34.4	33.6	32.8	32.0	31.2
71.3	72.3	70.3	68.9	68.6	69.2	69.5	70.0	70.1	70.6	70.9	71.3	71.4	71.8	72.1	72.4	72.4	72.5	72.6
155.8	155.8	155.8	155.8	155.8	155.8	155.8	155.8	155.8	155.8	155.8	155.8	155.8	155.8	155.8	155.8	155.8	155.8	155.8
239.9	239.9	239.9	239.9	239.9	239.9	239.9	239.9	239.9	239.9	239.9	239.9	239.9	239.9	239.9	239.9	239.9	239.9	239.9
119.1	119.1	119.1	119.1	119.1	119.1	119.1	119.1	119.1	119.1	119.1	119.1	119.1	119.1	119.1	119.1	119.1	119.1	119.1

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

2032-2040

#	Metric	2032	2033	2034	2035	2036	2037	2038	2039	2040
	Index of U.S. Energy Security Risk	88.8	89.2	89.8	90.3	90.7	91.1	91.8	92.4	93.1
	Sub-Indexes									
	Geopolitical	90.5	91.2	92.0	92.7	93.3	93.9	94.9	95.6	96.6
	Economic	87.4	87.9	88.8	89.5	90.2	90.8	91.7	92.6	93.7
	Reliability	99.3	100.0	100.7	101.3	101.8	102.1	102.8	103.3	104.0
	Environmental	77.7	77.4	77.2	76.9	76.7	76.5	76.3	76.2	75.9
Global Fuels Metrics										
1	Security of World Oil Reserves	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6	95.6
2	Security of World Oil Production	88.1	88.8	89.1	89.3	89.2	89.0	88.9	88.9	88.8
3	Security of World Natural Gas Reserves	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8
4	Security of World Natural Gas Production	89.3	89.3	89.3	89.3	89.0	88.6	88.3	88.0	87.7
5	Security of World Coal Reserves	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5	69.5
6	Security of World Coal Production	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8	136.8
Fuel Import Metrics										
7	Security of U.S. Petroleum Imports	59.6	59.9	60.4	61.5	62.7	62.7	64.3	64.5	65.0
8	Security of U.S. Natural Gas Imports	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	Oil & Natural Gas Import Expenditures	144.4	147.5	152.5	157.9	162.9	167.5	175.6	180.0	186.3
10	Oil & Natural Gas Import Expenditures per GDP	38.0	38.0	38.4	38.8	39.1	39.3	40.2	40.3	40.7
Energy Expenditure Metrics										
11	Energy Expenditures per GDP	45.0	44.5	44.2	43.8	43.4	43.0	42.5	42.2	42.1
12	Energy Expenditures per Household	100.9	101.3	102.3	102.9	103.7	104.3	104.7	105.8	107.1
13	Retail Electricity Prices	93.0	93.2	93.8	94.7	95.5	96.2	96.5	97.3	98.1
14	Crude Oil Price	139.1	142.0	145.0	147.4	149.4	151.4	154.0	157.2	160.9
Price & Market Volatility Metrics										
15	Crude Oil Price Volatility	152.8	156.0	159.3	161.9	164.1	166.4	169.2	172.7	176.8
16	Energy Expenditure Volatility	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1
17	World Oil Refinery Utilization	114.9	114.9	114.9	114.9	114.9	114.9	114.9	114.9	114.9
18	Petroleum Stock Levels	87.4	87.2	87.1	87.0	86.9	87.0	87.0	87.0	86.9
Energy Use Intensity Metrics										
19	Energy Consumption per Capita	82.8	82.5	82.2	82.0	81.8	81.6	81.6	81.5	81.3
20	Energy Intensity	34.9	34.2	33.5	32.8	32.1	31.5	31.0	30.4	29.8
21	Petroleum Intensity	27.3	26.7	26.0	25.4	24.8	24.2	23.7	23.2	22.6
22	Household Energy Efficiency	78.3	78.0	77.6	77.3	76.9	76.6	76.4	76.1	75.9
23	Commercial Energy Efficiency	65.8	65.7	65.5	65.3	65.1	64.9	64.8	64.7	64.6
24	Industrial Energy Efficiency	38.7	38.2	37.6	37.1	36.5	36.1	35.7	35.3	34.8
Electric Power Sector Metrics										
25	Electricity Capacity Diversity	107.9	109.7	111.3	112.9	114.1	115.2	116.3	117.3	118.1
26	Electricity Capacity Margins	112.7	112.7	112.7	112.7	112.7	112.7	112.7	112.7	112.7
27	Electricity Transmission Line Mileage	110.4	110.4	110.4	110.4	110.4	110.4	110.4	110.4	110.4
Transportation Sector Metrics										
28	Motor Vehicle Average MPG	53.1	52.5	52.0	51.6	51.3	51.0	50.7	50.5	50.3
29	Transportation VMT per $ GDP	63.3	62.5	61.7	60.9	60.0	59.1	58.3	57.4	56.5
30	Transportation Non-Petroleum Fuels	87.3	87.0	86.7	86.3	85.9	85.4	84.9	84.3	83.6
Environmental Metrics										
31	Energy-Related CO2 Emissions	197.5	198.3	199.3	200.4	201.5	202.8	204.8	206.2	207.3
32	Energy-Related CO2 Emissions per Capita	52.4	51.8	51.4	50.9	50.5	50.1	49.8	49.5	49.1
33	Energy-Related CO2 Emissions Intensity	30.5	29.8	29.2	28.6	27.9	27.3	26.8	26.2	25.7
34	Electricity non-CO2 Generation Share	72.7	73.0	73.2	73.3	73.1	73.0	72.8	72.6	72.4
Research and Development Metrics										
35	Industrial Energy R&D Expenditures	155.8	155.8	155.8	155.8	155.8	155.8	155.8	155.8	155.8
36	Federal Energy & Science R&D Expenditures	239.9	239.9	239.9	239.9	239.9	239.9	239.9	239.9	239.9
37	Science & Engineering Degrees	119.1	119.1	119.1	119.1	119.1	119.1	119.1	119.1	119.1

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 2014 (AEO 2014)* was the primary source for metric forecasts out to 2040.

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/en/global/corporate/about-bp/energy-economics/statistical-review-of-world-energy.html. 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/housing/hvs/data/histtabs.html. 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 2013. Available at: http://www.eia.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.gov/totalenergy/data/annual/. For historical import, expenditure, cost, electricity price, generating capacity, production, consumption, stock, miles per gallon, and energy-related carbon dioxide emissions data

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

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

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

Federal Reserve Board:
Industrial Production Index. Available at: http://www.federalreserve.gov/releases/G17/download.htm. 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#.U_JVsqO5KiA. 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.

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