Institute for 21st Century Energy Index of U.S. Energy Security Risk: Assessing America's Vulnerability in a Global Energy Market

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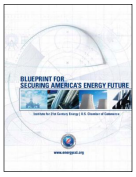
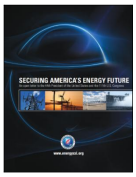
Institute for 21st Century Energy

- Mission: Unify policymakers, regulators, business leaders, and the American public behind a common sense energy strategy to help keep America secure, prosperous, and clean.
- Approach: Build support for meaningful energy action at the local, state, national, and int'l levels through policy development, education, and advocacy.
- Developing an Agenda for Energy Security
  - *Securing America's Energy Future Open Letter*
  - *Blueprint for Securing America's Energy Future*
  - *Transition Plan for Securing America's Energy Future*
- Important progress in defining goals & actions
  - 13 energy pillars
  - 80+ policy actions
  - Timeline for action





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Energy Security: Four Decades of "It's a Problem"

Presidential Statements on Energy Over the Years

Richard Nixon: "Project Independence 1980 is a series of plans and goals set to insure that by the end of this decade, Americans will not have to rely on any source of energy beyond our own." *(25-Nov-1973)*

Gerald Ford: "I am recommending a plan to make us invulnerable to cutoffs of foreign oil. It will require sacrifices, but it--and this is most important--it will work." *(15-Jan-1975)*

Jimmy Carter: "Our decision about energy will test the character of the American people and the ability of the President and the Congress to govern. This difficult effort will be the 'moral equivalent of war.'" *(18-Apr-1977)*

Ronald Reagan: "Overall, the outlook for this country's energy supplies is not nearly as grim as some have painted it, although our problems are not all behind us... Given our continued vulnerability to energy supply disruptions, certain emergency preparations ... remain principally a Government responsibility. *(17-Jul-1981)*

George H.W. Bush: "Our imports of foreign oil have been climbing steadily since 1985 and now stand at 42 percent of our total consumption. Too many of those oil imports come from sources in troubled parts of the world." *(20-Feb-1991)*

Bill Clinton: "... we must do more to free working families from the grip of rising energy costs, especially the price we pay at the pump ...we still have more to do to strengthen our security over the long term. That's the most important thing." *(01-Jul-2000)*

George W. Bush: "Keeping America competitive requires affordable energy. And here we have a serious problem: America is addicted to oil, which is often imported from unstable parts of the world." *(31-Jan-2006)*

Barack Obama: "Given our energy needs, in order to sustain economic growth and produce jobs, and keep our businesses competitive, we are going to need to harness traditional sources of fuel even as we ramp up production of new sources of renewable, homegrown energy." *(31-Mar-2010)*

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What Do We Mean by "Energy Security"?

- Modern life not possible without energy, but reliance on energy poses risks
  - Oil supply disruptions, gasoline price spikes, power blackouts, natural gas shortages & environmental concerns have made energy a pressing national economic and security priority
- Energy security is not necessarily energy independence
  - Energy independence not realistically achievable & may not even be desirable in today's globalized economy
- Many factors interact to affect energy security—it's not just about oil!
  - Reliability & diversity of production and supply
  - Diversity of energy sources & fuels
  - Geopolitical & physical vulnerabilities
  - Price & price volatility
  - Reliability of delivery & transmission systems
  - Consumption patterns & energy efficiency
  - Emissions from energy
  - Intellectual capital and advanced technology
  - & many more . . .

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Need for an Index of U.S. Energy Security

- How can we tell from if U.S. energy security is getting better or worse?
  - Where have we been?
  - Where are we now?
  - Where are we headed?
  - What actions would make a difference?
- "If you can't measure it, you can't manage it." (Peter Drucker)
  - Plenty of energy data, but . . . How to make sense of it?
- Most existing measures of energy security focus on oil
  - Inadequate to the task of capturing totality & complexity of energy security

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Need for an Index of U.S. Energy Security

- Energy security not an "either-or" proposition
  - Moves along a spectrum of possibilities ranging from very good to very bad
- Indexes are a common way to convey economic, social, environmental & other kinds of information and trends
  - Indexes take complex issues & reduce them to a number that everyone understands
    - Misery Index
    - VIX Index (S&P 500 "fear index")
    - Freedom House Freedom Index
    - Heritage Foundation Index of Economic Freedom
    - Yale University and Columbia University Environmental Performance Index
    - *National Journal* Vote Rankings
    - etc.
- An annual Index of U.S. Energy Security is long overdue
  - Permits us to answer with precision & regularity the fundamental question: Is our energy security getting better or worse, and why?

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Goal of Index

- **Create a means to track energy security over time**
  - Update annually with new data & forecasts
    - Use recently collected and published data to help explain whether our energy security is trending better or worse.
  - Assess future effects of different policy scenarios
    - Use model output to assess the potential impact of new or alternative policies on U.S. energy security.
  - Identify factors that have greatest impact
    - Use various analytical and statistical techniques to measure those aspects of energy security that have had, or are likely to have, the greatest impact on energy security risks and thus provide insights on where policies should be focused.

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Building the Index: Complexity Demands Multiple Metrics

- 37 metrics covering 1970 to 2030 drive the assessment
  - Sorted into nine categories:
    1. Global Fuels
    2. Fuel Import
    3. Energy Expenditure
    4. Price & Market Volatility
    5. Energy Use intensity
    6. Electric Power Sector
    7. Transportation Sector
    8. Environmental
    9. Research & Development
  - Metric units of measure transformed into comparable indexes with 1980 = 100.
- These 37 metrics used to create four Sub-Indexes measuring risk in areas of particular concern
  1. Geopolitical (30%)
  2. Economic (30%)
  3. Reliability (20%)
  4. Environmental (20%)
- When weighted & aggregated, these Sub-Indexes create overall Index of U.S. Energy Security.
- Index designed to convey the notion of risk
  - A lower Index number corresponds to a lower level of risk, a higher number a higher level of risk

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What Makes for a Good Metric?

- An ideal metric will reflect:
  - *Sensibility* – Relates to common-sense expectations
  - *Credibility* – Data sources are well-recognized
  - *Transparency* – Derivation & manipulations are clear
  - *Completeness* – Historical data, preferably back to 1970
  - *Forward-looking* – Preferably extends out to 2030; dovetails cleanly with forecasts
  - *Updatability* – Each year, historical data extended, and new forecast outlooks prepared
- But reality sometimes falls short of the ideal
  - Historical data missing, esp. in the 1970s
  - Forecasts weak, and sometimes impossible
  - Dovetailing of historical and forecast data series
- Compromises are sometimes needed between what's theoretically ideal and what's realistically achievable

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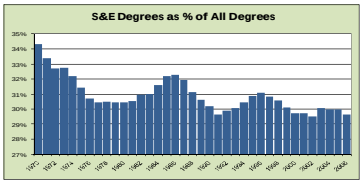
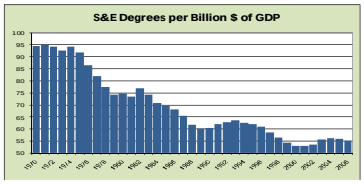
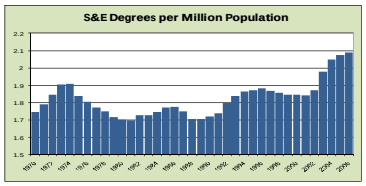
Picking a Metric to Tell the Story

- *"There are three kinds of lies: lies, damned lies, and statistics."* (Mark Twain)
- But there are often many legitimate ways to tell the story
- Goal here is to seek objective measures that comport with our sense of reality
- Use of many metrics makes the findings less sensitive to flaws or distortions in any single metric







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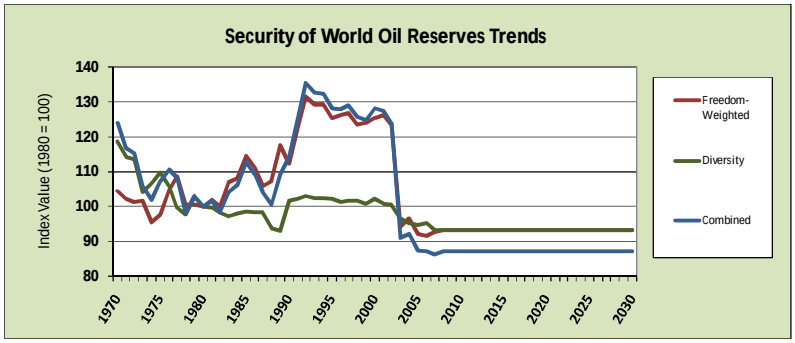
New Ways to Look at Energy Issues

Security of World Oil Reserves Trends

- Measures global proved oil reserves in billions of barrels:
  1. Weighted by each country's Freedom House freedom ranking (proxy for reliability) and
  2. a diversity index applied to global oil reserves.
- 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.



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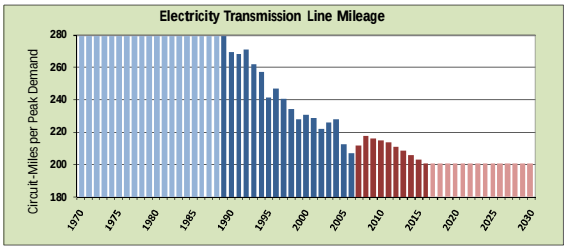
Expectations of Future Data Improvement

- Use 1970-2030 time range for all metrics
- Where data are missing:
  - Develop a proxy, if possible
  - Or, adopt a neutral assumption



- Philosophy of not letting the perfect be the enemy of the good
  - Expectations of improvement over time
  - Transparency & documentation invites collaboration

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For Risk, Which Way is Up?

- For most metrics, upward trends indicate worsening conditions
  - For a few, upward trend indicates improving conditions.
- For compiling risks across metrics, essential that directions have consistent meaning.
- Here, we have adopted the convention that we are measuring *security risks*, and that bigger is not better.
  - Most of the metrics (about 3/4s) naturally lean toward up being bad, down being good.
  - As "risk" seems open-ended, hard to think about lower numbers indicating ever-increasing risk, but bounded at zero.
- A few metrics need transformation into comparable measures of security risks.

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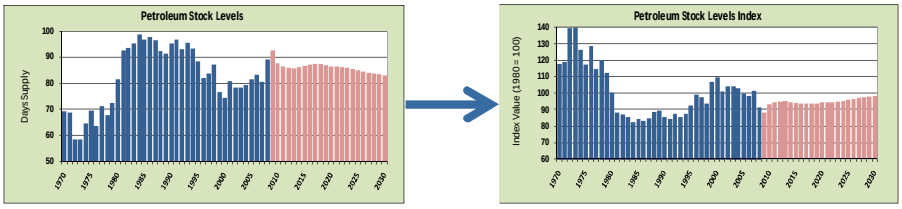
Transforming Metrics into Indexes

- Generally, if the metric pointed in the same way as the risk, the risk was expressed as a simple ratio, with year 1980 = 100.0
- Often, if the metric went the opposite way of the risk, the risk was expressed by inverting the metric



- Sometimes, other manipulations were called for:
  - Squaring the ratio (to magnify changes in narrow ranges)
  - Measuring only the increment above a base level
  - Calculating HHI to derive market share index

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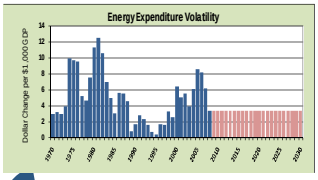
Allocating Metrics to Energy Security Sub-Indexes



- 37 metrics distributed among Sub-Indexes based on relevance
- Each metric assigned a weight (all input weightings for each Sub-Index total 100)
- Weighting × metric's risk value, summed over 37 metrics, gives Sub-Index value for each year, 1970-2030

#	Metric	Units of Measurement	Input Weightings: Geopolitical	Economic	Reliability	Environmental
Global Fuels Metrics						
1	Security of World Oil Reserves	reserves, freedom & diversity-weighted	4	2	2	
2	Security of World Oil Production	production, freedom & diversity-weighted	7	4	7	
3	Security of World Natural Gas Reserves	reserves, freedom & diversity-weighted	4	2	4	3
4	Security of World Natural Gas Production	production, freedom & diversity-weighted	4	2	3	4
5	Security of World Coal Reserves	reserves, freedom & diversity-weighted	3			4
6	Security of World Coal Production	production, freedom & diversity-weighted	2			3
Research and Development Metrics						
35	Industrial Energy R&D Expenditures	Energy R&D $/$1000 GDP		1		1
36	Federal Energy & Science R&D Expenditures	R&D $/$1000 GDP	1	1	1	1
37	Science & Engineering Degrees	# degrees/$billion GDP	1	1	3	2
	Total Weightings		100	100	100	100

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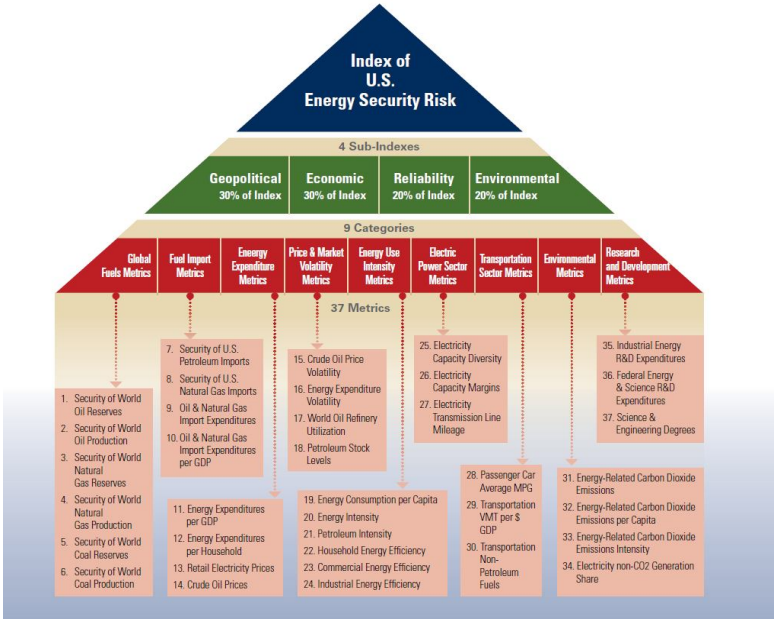
Building the U.S. Energy Security Index



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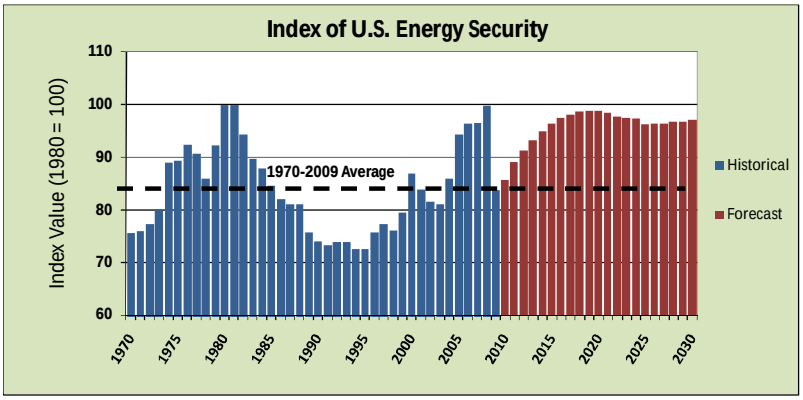
U.S. Energy Security Over the Years

- Higher Index values and spikes generally coincide with times of fuel shortages, high & volatile prices, & international tensions
- Four clear spikes in Index—two in 1970s & two in 2000s
- In 2009, Index was 83.7, an improvement of 16 points from the previous year
  - Lower Index score by-product of a severe financial crisis
- EIA BAU forecast suggests Index will approach the highs seen in 1980-81 & 2008 and remain over 95 through 2030.



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U.S. Energy Security Peaks & Valleys

U.S. Energy Security Risks from 1970 to 2009: High, Low & Average Index Scores

Indexes of U.S Energy Security	Highest Risk		Lowest Risk		Historical Average
	Year	Index Score	Year	Index Score	
Total Composite Index	1980	100.0	1994	72.6	84.2
Sub-Indexes:					
Geopolitical	2008	101.1	1995	69.5	82.4
Economic	2008	105.7	1970	62.5	78.5
Reliability	1981	103.9	1995	69.5	84.3
Environmental	1973	104.4	1991	85.0	95.1

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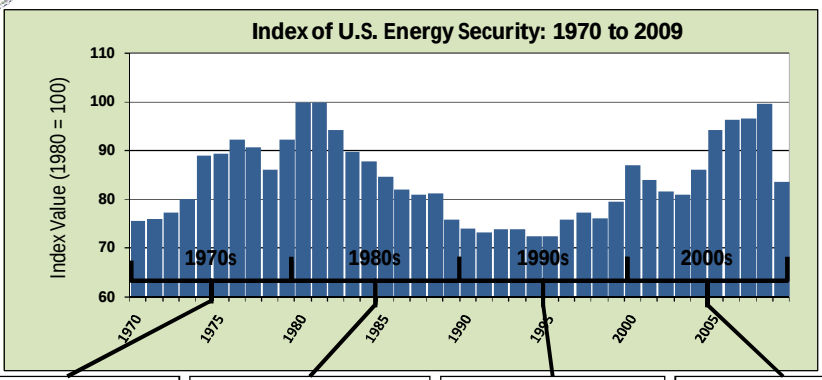
Key Events & Trends Affecting U.S. Energy Security



- Arab oil "embargo" (1973) and Iran Revolution (1979)
- International oil production security (freedom & diversity) worsens
- Security of U.S. oil imports worsens
- O&G import, energy, and electricity costs rise sharply
- Oil and energy prices extremely volatile
- Energy intensity poor but improving
- Oil dominates energy economy
- Government & industry R&D spending starts to rise sharply

- Iranian hostage crisis ends
- International oil production security improves
- Lower oil prices cause import, energy & electricity expenditures to decline
- Oil prices volatile on the downside
- Energy price volatility declines
- U.S. oil production generally increases
- Oil stock levels increase & flatten
- Power sector diversity increases as oil is replaced by coal and nuclear
- Passenger car mpg improves
- R&D spending declines
- Soviet Union breaks apart increasing supply diversity

- Persian Gulf War (1991)
- International oil reserves security worsens
- International coal reserves security increases
- U.S. oil production declines
- Oil & energy expenditures and volatility decline
- Energy efficiency continues to improve but at a slower rate than in previous decade
- Electricity capacity margins worsen
- VMT begins to diverge from long-term correlation with GDP
- R&D spending declines

- 9/11 terrorist attacks (2001) and Operation Iraqi Freedom (2003)
- International oil reserves security improves dramatically with Canadian oil sands
- O&G import, oil & energy expenditures worsen; NG spikes
- Global demand pushes oil prices to record highs, prices very volatile
- Energy intensity improvements accelerate
- Overbuild of NG capacity in power sector
- R&D spending increases

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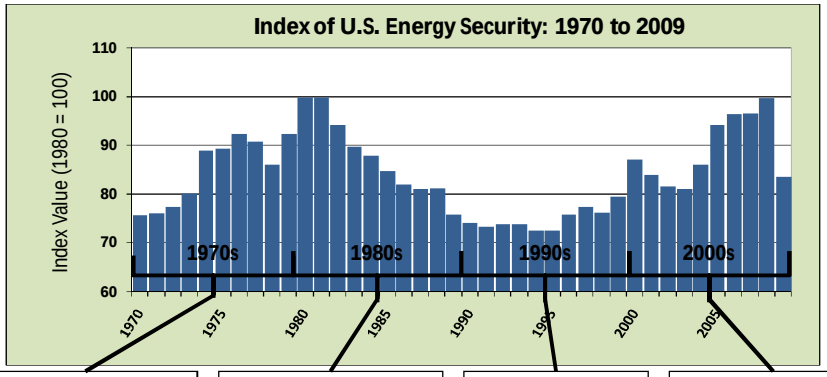
U.S. Energy Policy Over the Years



- Economic Stabilization Act of 1970
- Emergency Petroleum Allocation Act of 1973
- Trans-Alaska Pipeline Authorization Act of 1973
- Energy Supply & Environmental Coordination Act of 1974
- Energy Policy & Conservation Act of 1975 (included CAFE & SPR)
- Natural Gas Policy Act of 1978
- Power Plant & Industrial Fuels Use Act of 1978
- Commercial reprocessing of nuclear fuel ceases.

- Crude Oil Windfall Profit Tax Act of 1980
- Oil prices completely decontrolled (1981)
- OCS access restricted by Congress (1982)
- Nuclear Waste Policy Act of 1982
- Omnibus Trade & Competitiveness Act of 1988 (repealed Windfall Profits Tax)
- Natural Gas Wellhead Decontrol Act of 1989

- Energy Policy Act of 1992

- Energy Policy Act of 2005
- Energy Independence & Security Act of 2007
- Executive Order & Congress lift OCS restrictions (2008)
- American Reinvestment & Recovery Act of 2009

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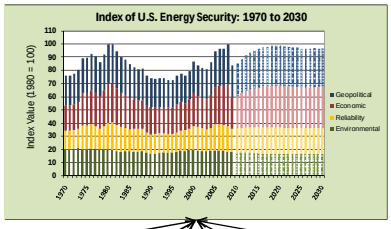
Interactive Tool: http://www.energyxxi.org/energysecuritytool/

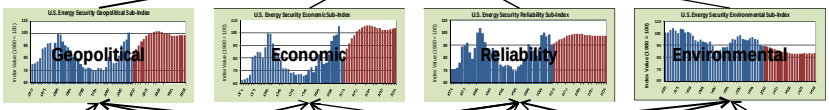
Key Conclusions

- Energy Institute's Index of U.S. Energy Security offers way to accurately & dispassionately assess U.S. energy security
  - Allows policymakers, economists, energy professional & public to understand how our energy security has evolved & where it might be headed & why
- Policy matters
  - Clear link between Nation's energy security & policy choices
    - free markets and greater domestic production in the 1980s led to declining risks—markets work
  - Beware the law of unintended consequences
    - encouraging oil for power production in the 1960s and gas in the 1990s were in hindsight mistakes
- Events beyond our control can impact energy security
  - While unpredictable & largely unavoidable, sound policies can improve our resilience when the next crisis arrives
- Increased risks are on the horizon
  - 2009 decrease in risks reflection of economic downturn
  - Need a comprehensive approach to energy to prevent future risks

Building the U.S. Energy Security Index



30% 30% 20% 20%



37 Energy Security Metrics

Global Fuels Metrics
1. Security of World Oil Reserves
2. Security of World Oil Production
3. Security of World Natural Gas Reserves
4. Security of World Natural Gas Production
5. Security of World Coal Reserves
6. Security of World Coal Production

Fuel Import Metrics
7. Security of U.S. Petroleum Imports
8. Security of U.S. Natural Gas Imports
9. Oil & Natural Gas Import Expenditures
10. Oil & Natural Gas Import Expenditures per GDP

Energy Expenditure Metrics
11. Energy Expenditures per GDP
12. Energy Expenditures per Household
13. Retail Electricity Prices
14. Crude Oil Prices

Price & Market Volatility Metrics
15. Crude Oil Price Volatility
16. Energy Expenditure Volatility
17. World Oil Refinery Utilization
18. Petroleum Stock Levels

Energy Use Intensity Metrics
19. Energy Consumption per Capita
20. Energy Intensity
21. Petroleum Intensity
22. Household Energy Efficiency
23. Commercial Energy Efficiency
24. Industrial Energy Efficiency

Electric Power Sector Metrics
25. Electricity Capacity Diversity
26. Electricity Capacity Margins
27. Electricity Transmission Line Mileage

Transportation Sector Metrics
28. Passenger Car Average MPG
29. Transportation VMT per $ GDP
30. Transportation Non-Petroleum Fuels

Environmental Metrics
31. Energy-Related Carbon Dioxide Emissions
32. Energy-Related Carbon Dioxide Emissions per Capita
33. Energy-Related Carbon Dioxide Emissions Intensity
34. Electricity non-CO2 Generation Share

Research and Development Metrics
35. Industrial Energy R&D Expenditures
36. Federal Energy & Science R&D Expenditures
37. Science & Engineering Degrees

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