

Measuring Energy Security Risk

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Twenty-First Strategies

*Geopolitics, Country Risk Assessment and
Commodity Pricing Workshop*
U.S. Energy Information Administration

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Topics

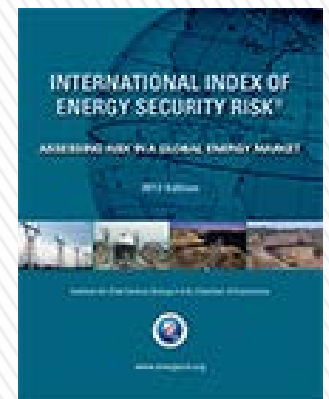
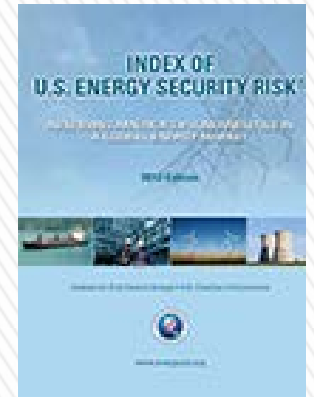
- » **Measuring Energy Security Risk**
- » **Developing the U.S. Index of Energy Security Risk**
- » **Developing an International Index**
- » **Findings**
- » **Insights and Issues**



Institute for 21st Century Energy



- » An affiliate of the U.S. Chamber of Commerce
- » **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.
- » <http://www.energyxxi.org/energy-security-risk-index>



Energy Security: Four Decades of “It’s a Problem”



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)

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)

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)

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)

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)

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)

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)

Obama: “So we have a choice to make. We can remain one of the world’s leading importers of foreign oil, or we can make the investments that would allow us to become the world’s leading exporter of renewable energy. We can let climate change continue to go unchecked, or we can help stop it. We can let the jobs of tomorrow be created abroad, or we can create those jobs right here in America and lay the foundation for lasting prosperity.” (19-Mar-2009)



What do we even mean by “Energy Security”?

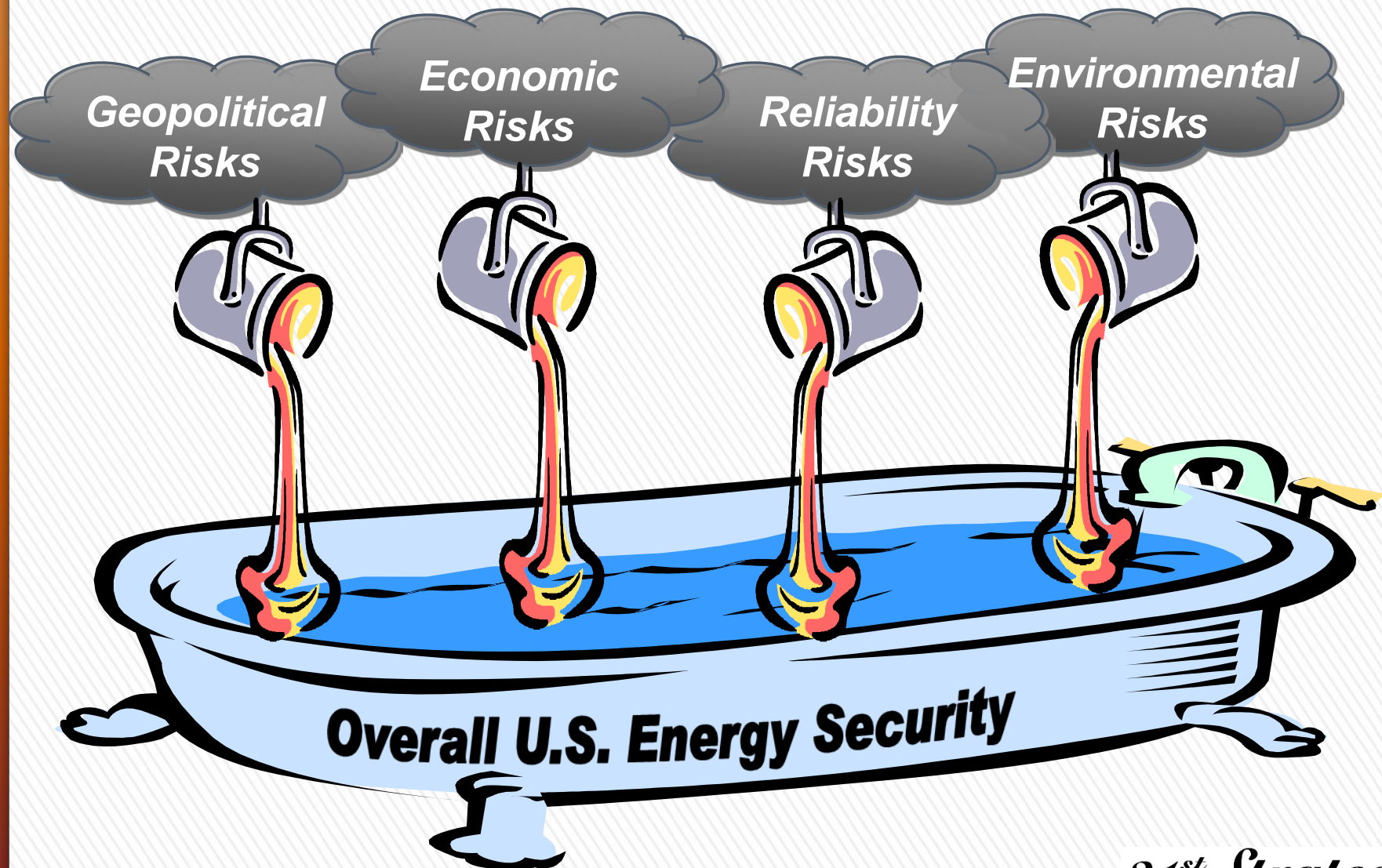
Is it

- » How much oil we import?
- » Who controls the energy supplies?
- » How much do we pay?
- » What countries get the money?
- » How sustainable over the long-term?
- » How reliable are the supplies?
- » How vulnerable to war, weather, disruption, etc.?
- » How well-suited to a low-carbon future?
- » Whether we have a trained and educated labor force?

.....Yes

- » All of them.
- » ... and much more

“Energy Security” requires a reliable supply of clean & affordable energy, consistent with domestic and international objectives and sustainability.



Need for an Index of U.S. Energy Security Risk

- » How can we tell if U.S. energy security is getting better or worse?
 - > “If you can’t measure it, you can’t manage it.” (*Peter Drucker*)

- » Measuring helps us know “How are we doing?”
 - > Where have we been?
 - > Where are we now?
 - > Where are we headed?
 - > What actions would make a difference?

- » Most existing measures of energy security focus on oil & imports
 - > Far too narrow in scope
 - > Inadequate to capture totality and complexity of energy security

Building the Index: Complexity Demands Multiple Metrics

» 37 metrics drive the 1970-2040 assessment

> Grouped into nine categories:

- | | |
|--------------------------------|-----------------------------|
| 1. Global Fuels | 6. Electric Power Sector |
| 2. Fuel Import | 7. Transportation Sector |
| 3. Energy Expenditure | 8. Environmental |
| 4. Price and Market Volatility | 9. Research and Development |
| 5. Energy Use intensity | |

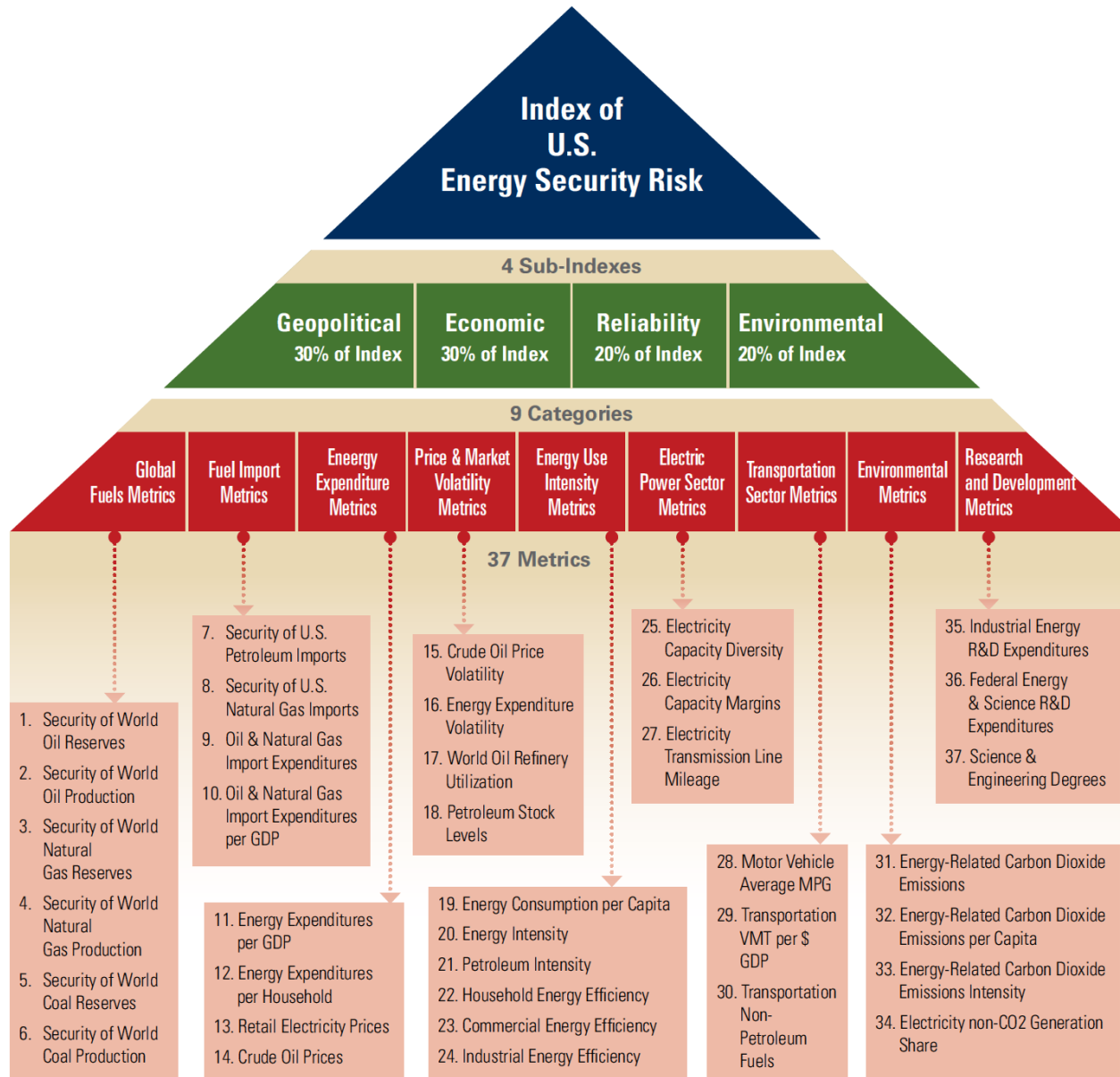
> Metric units transformed into comparable indexes with 1980 = 100.

» These 37 metrics used to create four Sub-Indexes measuring risk in areas of particular concern

- | | |
|-----------------------|------------------------|
| 1. Geopolitical (30%) | 3. Reliability (20%) |
| 2. Economic (30%) | 4. Environmental (20%) |

» When weighted and aggregated, these Sub-Indexes sum to an overall Index of U.S. Energy Security Risk.

Building the U.S. Index



What Makes for a Good Metric?

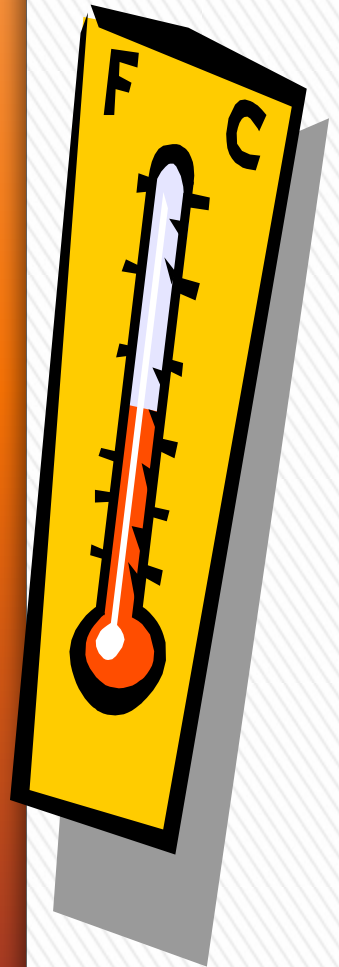
- » An ideal metric will reflect:
 - > **Sensibility** – Relates to common-sense expectations
 - > **Credibility** – Data sources are well-recognized
 - > **Transparency** – Derivation & manipulations are clear
 - > **Completeness** – Historical data, preferably back to 1970
 - > **Forward-looking** – Extends out to 2040; dovetails cleanly with forecasts
 - > **Updatability** – Both recent data and new forecast outlooks
- » 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



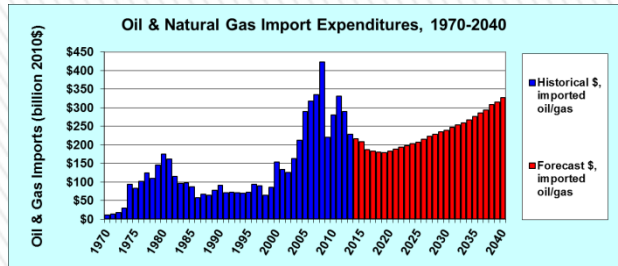
- » Compromises are sometimes needed between what's theoretically ideal and what's realistically achievable

For Risk, Which Way is Up?

- » For most metrics, upward trends indicate worsening conditions. For a few, up is good.
- » 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 scarier.
 - > Most of the metrics (3/4ths) 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.



Allocating Metrics to Energy Security Sub-Indexes



- » Each Sub-Index totals 100 points (1980 Base Year)
- » 100 points spread among the 37 metrics
- » Points * metric's risk value, summed over 37 metrics, gives Sub-Index value for each year, 1970-2040

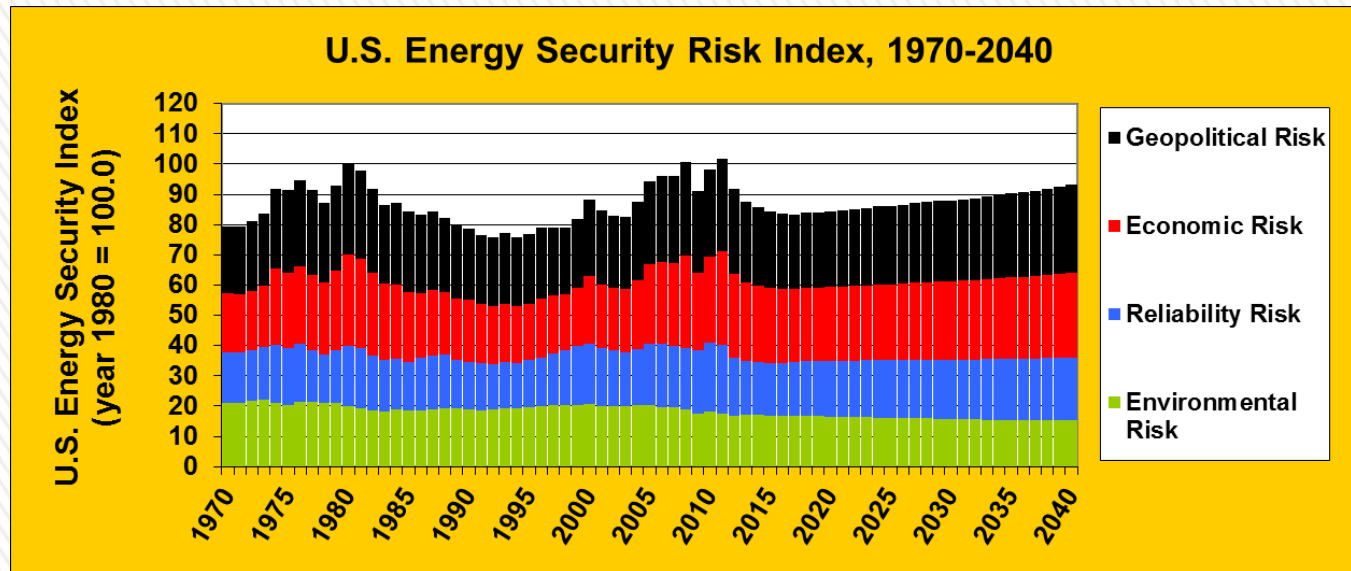
#	Metric	Units of Measurement	Input Weightings			
			Geopolitical	Economic	Reliability	Environmental
Global Fuels Metrics						
1	Security of World Oil Reserves	reserves index, freedom & diversity-weighted	9			
2	Security of World Oil Production	production index, freedom & diversity-weighted	7	5	6	
3	Security of World Natural Gas Reserves	reserves index, freedom & diversity-weighted	6			2
4	Security of World Natural Gas Production	production index, freedom & diversity-weighted	5	2	3	2
5	Security of World Coal Reserves	reserves index, freedom & diversity-weighted	4			
6	Security of World Coal Production	production index, freedom & diversity-weighted	2	1	1	
Research and Development Metrics						
35	Industrial Energy R&D Expenditures	Energy R&D \$/\$1000 GDP		1	2	2
36	Federal Energy & Science R&D Expenditures	R&D \$/\$1000 GDP (2010\$)		1	2	2
37	Science & Engineering Degrees	# degrees/\$billion GDP (2010\$)		1	2	2
Total Weightings			100	100	100	100

Weighting the 4 Sub-Indexes to Derive the Index of U.S. Energy Security Risk

Geopolitical	Economic	Reliability	Environmental
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Weighted Contribution

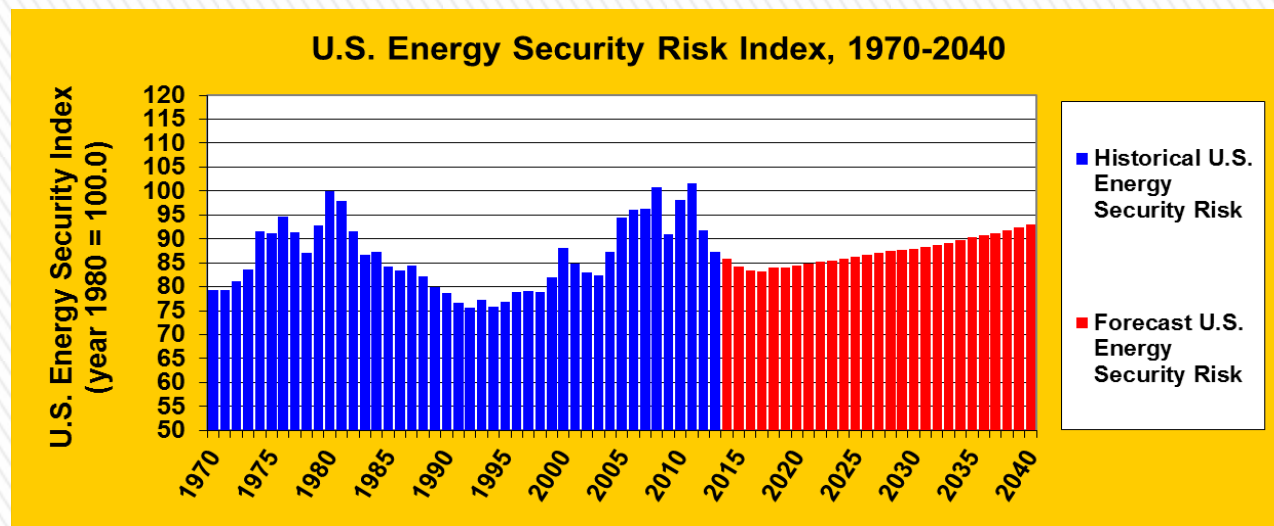
Weighting for Overall U.S. Index	30%	30%	20%	20%	100%
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So ... How are We doing?

» Historical Data show ups and downs of U.S. Energy Security:

- > Oil shocks of the 1970s and early 1980s
- > Relative calm, mid-1980s-late 1990s
- > Growing problems in the last decade, rivaling those of the oil shocks



» Progress seen in recent years

- > Global and U.S. recession has provided temporary relief:
- > Policies and shale technologies are making a big difference
- > But risks remain, especially from oil and geopolitical factors
- > **A compelling need to avert “Business as Usual” outcome**

Going Internationally, beyond the U.S. ESRI

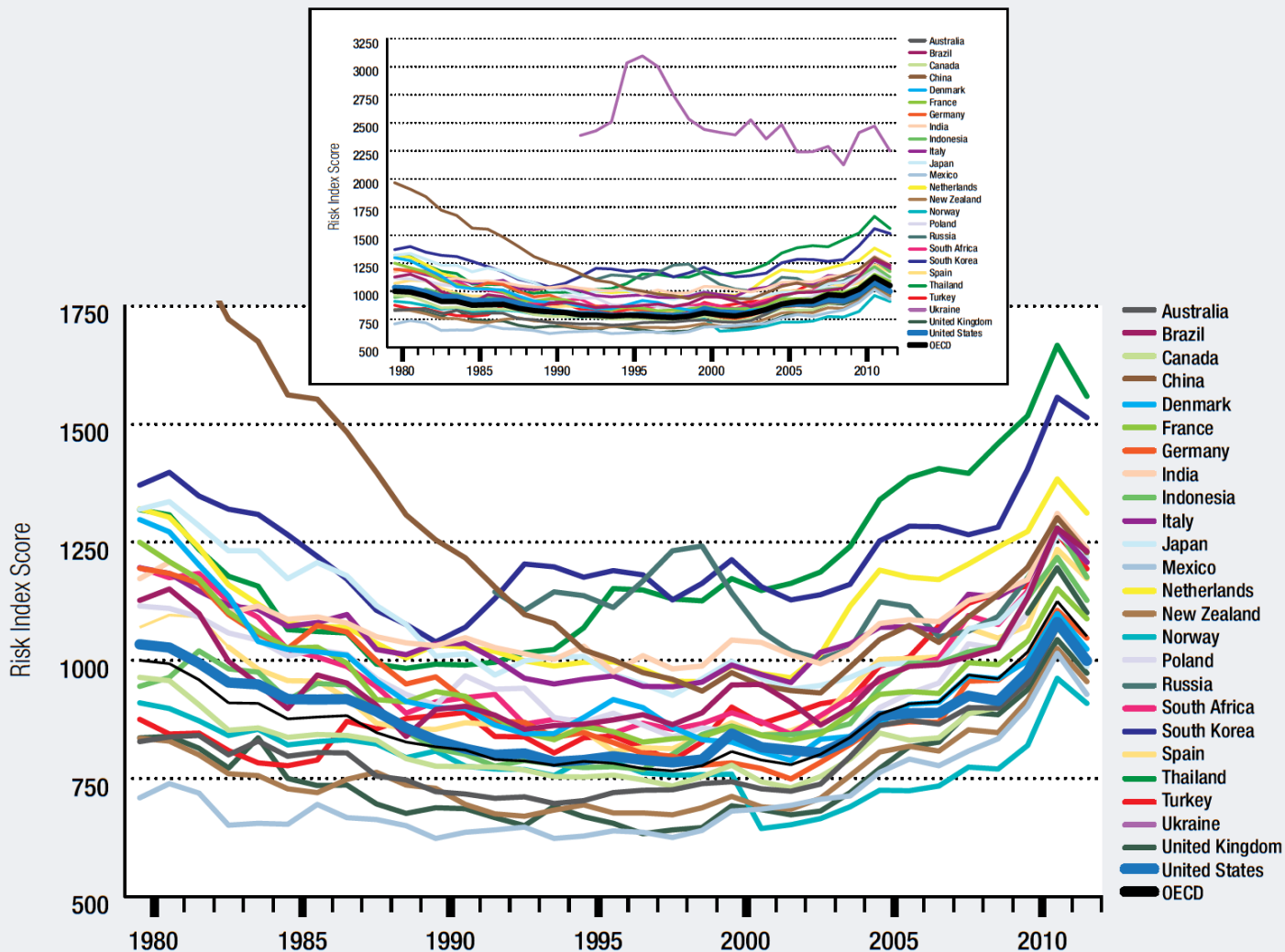
- » Energy security is both local and global
 - > Several U.S. ESRI metrics are int'l, with global values
 - > Int'l events affect several other metrics
- » Over time, a shrinking U.S. share in world energy markets
 - > Smaller share of world energy production
 - > Smaller share of world energy consumption, driven by faster growth elsewhere and energy efficiency here
 - > Increasingly, global market conditions are less influenced by U.S. activity
- » Communicating energy security risks internationally helps U.S. as well
 - > Energy efficiency anywhere create benefits everywhere
 - > Ditto with shale gas & renewables

International Index of Energy Security Risk

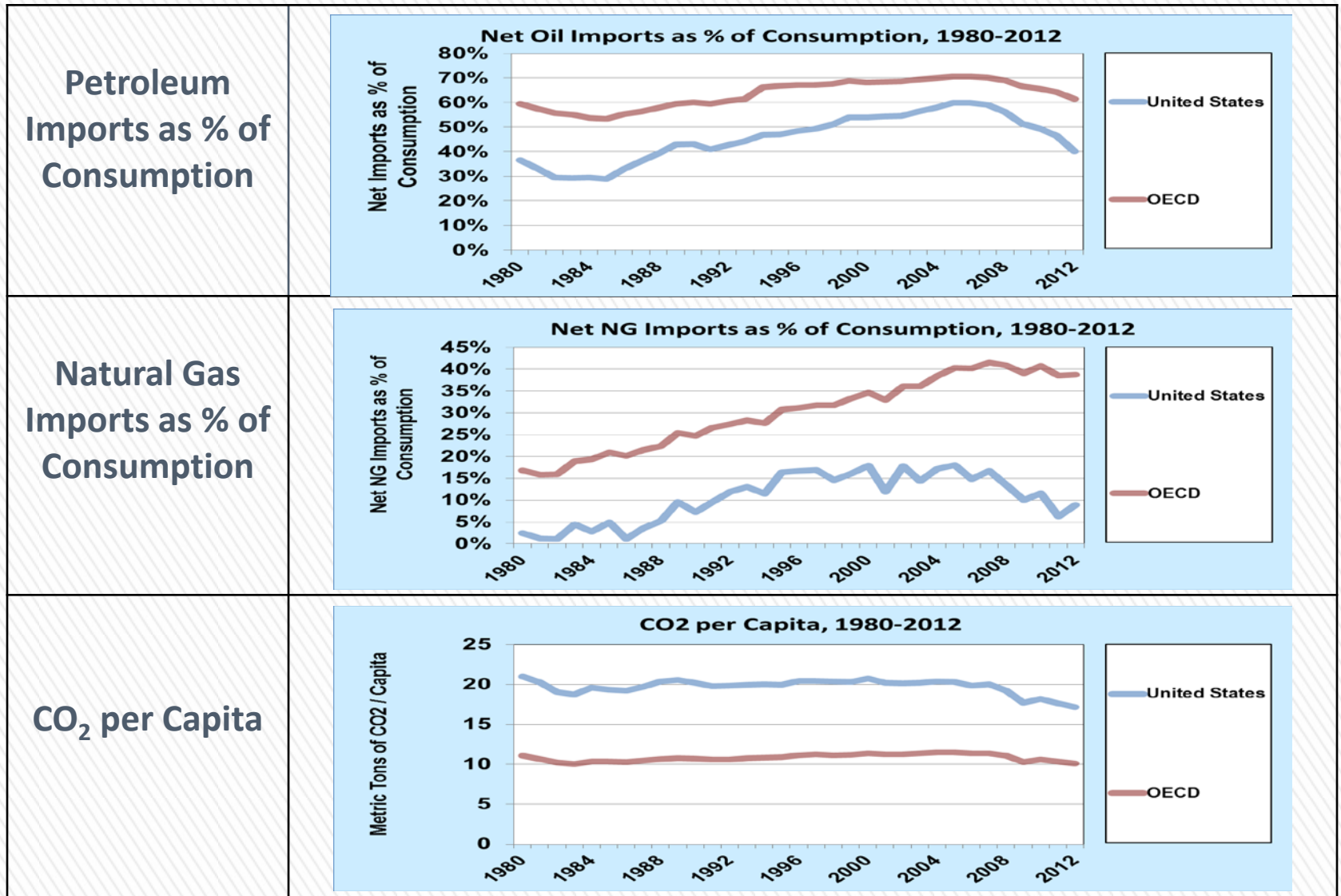
- » Extends U.S. Index methods to other countries
 - > Works within limitations of data availability
- » Uses 29 metrics covering imports, expenditures, efficiency, energy-use sectors, etc.
- » Establishes OECD baseline for comparison (1980=1,000)
- » Uses historical data from 1980 to 2013
- » Focuses on 25 large energy consuming economies accounting for 80% of global energy demand
- » Unlike U.S. Index, no forecast component (yet)

International Index Risk Scores

Figure H-1. Energy Security Risk Index Scores for Large Energy User Group: 1980-2012



Charting relative to OECD trends (1980=100) shows countries' absolute & relative trends



International Index Country Rankings

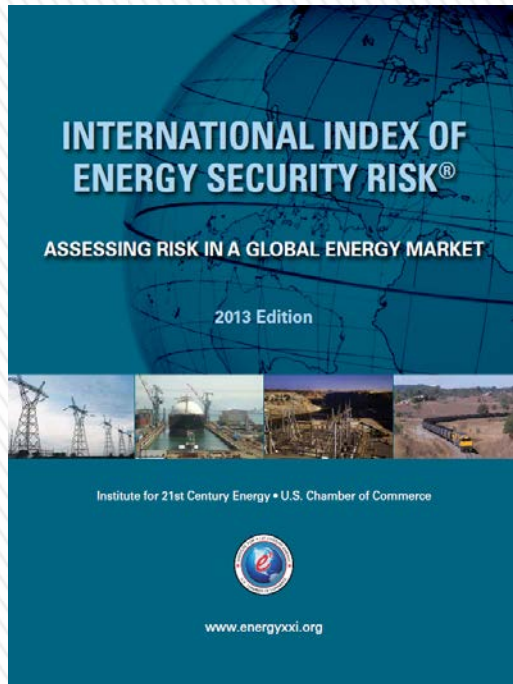


Table H-1. Energy Security Risk Scores and Rankings for 25 Large Energy Using Countries: 2012

Country	Risk Score	Large Energy User Group Rank
Norway	909	1
Mexico	928	2
New Zealand	955	3
United Kingdom	973	4
Canada	987	5
United States	999	6
Australia	1,000	7
Denmark	1,024	8
Germany	1,047	9
OECD	1,051	
France	1,088	10
Poland	1,101	11
Indonesia	1,127	12
Spain	1,173	13
Russia	1,176	14
Turkey	1,194	15
South Africa	1,207	16
Italy	1,208	17
Japan	1,219	18
China	1,228	19
Brazil	1,231	20
India	1,237	21
Netherlands	1,312	22
South Korea	1,514	23
Thailand	1,559	24
Ukraine	2,250	25

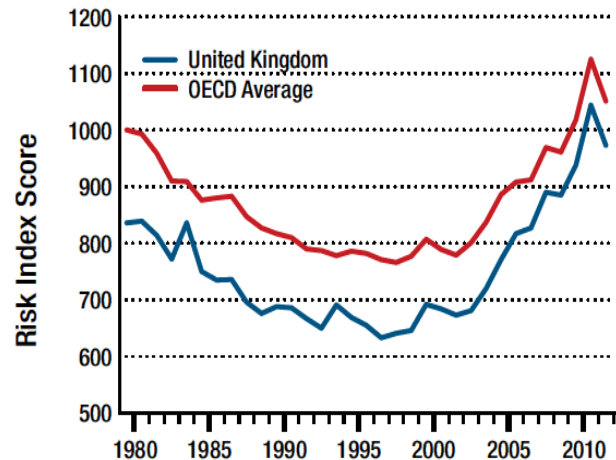
Changes in Country Rankings over Time

Table H-2. Energy Security Rankings for Large Energy User Group: 1980-2012

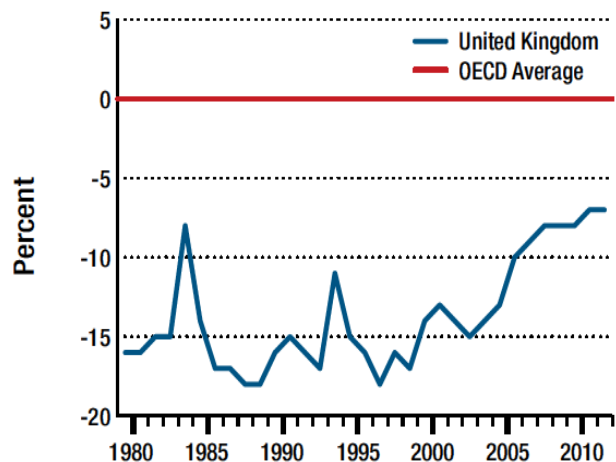
	1980	1985	1990	1995	2000	2005	2010	2011	2012
Australia	2	5	3	4	4	6	5	5	7
Brazil	12	8	11	13	16	14	14	18	20
Canada	8	7	5	5	6	5	6	6	5
China	23	23	23	20	17	18	21	20	19
Denmark	18	14	12	16	8	8	8	8	8
France	17	16	15	12	11	11	10	10	10
Germany	14	15	16	10	7	7	9	9	9
India	13	20	19	21	21	20	19	21	21
Indonesia	7	9	7	6	12	12	13	12	12
Italy	15	18	21	17	19	19	18	17	17
Japan	20	21	18	19	20	16	15	14	18
Mexico	1	1	1	1	1	2	2	2	2
Netherlands	21	19	20	18	18	22	22	22	22
New Zealand	3	2	4	3	3	4	3	3	3
Norway	6	6	6	8	5	1	1	1	1
Poland	11	12	13	14	10	10	12	11	11
Russia	24	24	24	23	22	21	20	19	14
South Africa	16	13	14	15	14	13	16	16	16
South Korea	22	22	22	24	24	23	23	23	23
Spain	10	11	9	11	13	17	11	13	13
Thailand	19	17	17	22	23	24	24	24	24
Turkey	5	4	10	9	15	15	17	15	15
Ukraine	25	25	25	25	25	25	25	25	25
United Kingdom	4	3	2	2	2	3	4	4	4
United States	9	10	8	7	9	9	7	7	6

Lessons: UK

United Kingdom vs. OECD: Risk Index Scores



United Kingdom: Risk Variance from OECD

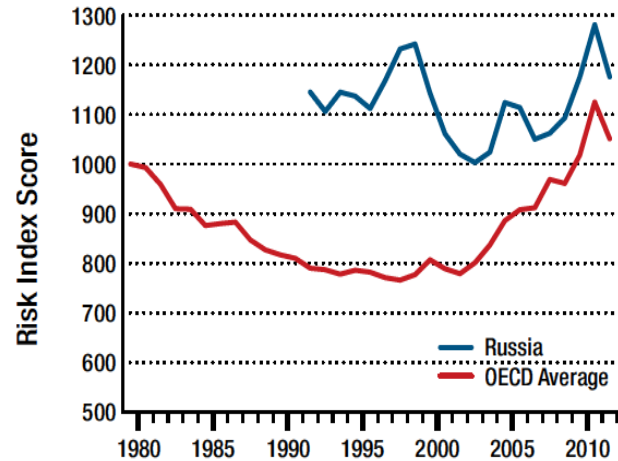


In general, resource-rich countries with efficient economies rank best

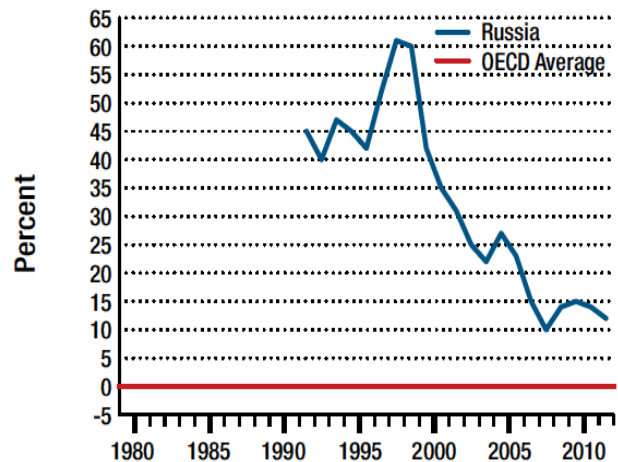
- » UK Ranked #4
 - > Resource-rich
 - > Efficient economy
- » **But**—UK risks rising driven largely by
 - > Growing natural gas & coal imports
- » Very high electricity prices
- » Can UK shale gas development lower costs & risks?

Lessons: Russia

Russian Federation vs. OECD: Risk Index Scores



Russian Federation: Risk Variance from OECD

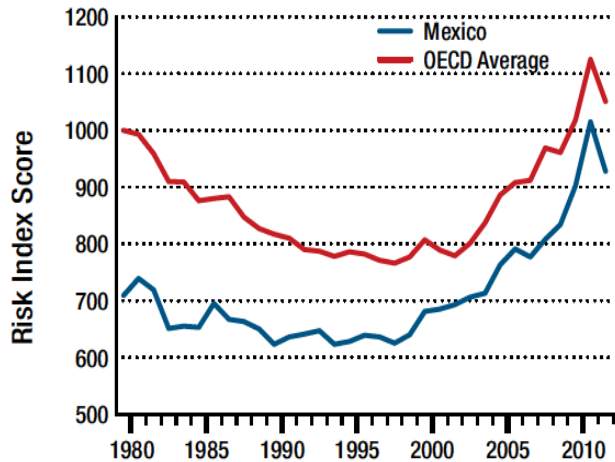


Conversely, resource-rich countries with inefficient economies do not score as well

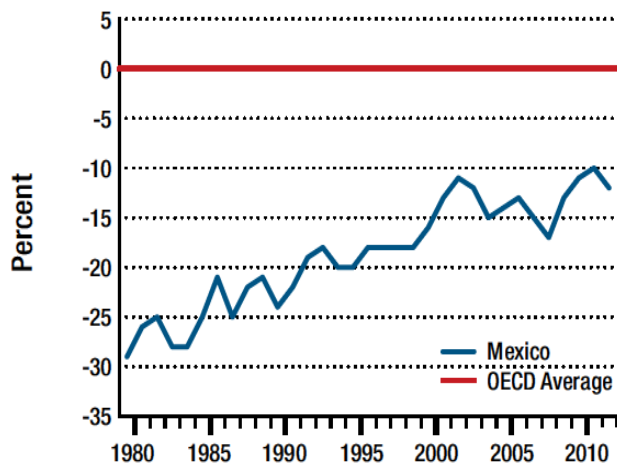
- » Russia: Ranked #14
- » Huge reserves of oil, gas & coal
- » **But**—worst energy intensity of 25 countries
- » **Also**—Russia using resource clout to influence gas markets in Europe

Lessons: Mexico

Mexico vs. OECD: Risk Index Scores



Mexico: Risk Variance from OECD

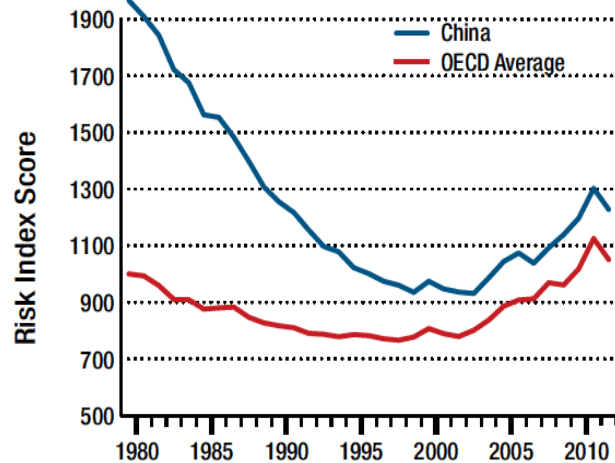


Resources are not enough without proper investment environment

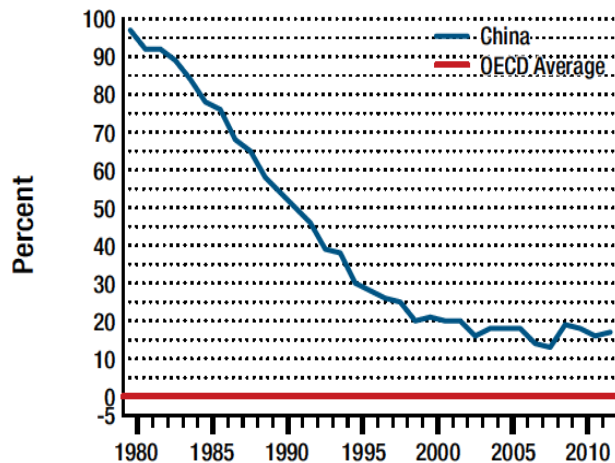
- » Mexico ranked #1 or #2 for entire period
- » **But**—Mexico rapidly losing comparative advantages
 - > Gas & coal import, energy intensity & transportation risks rising
- » Oil production declining
 - > Need proper investment environment to maintain output
 - > Constitutional reform of hydrocarbon sector should help Mexico maintain its high ranking

Lessons: China

China vs. OECD: Risk Index Scores



China: Risk Variance from OECD

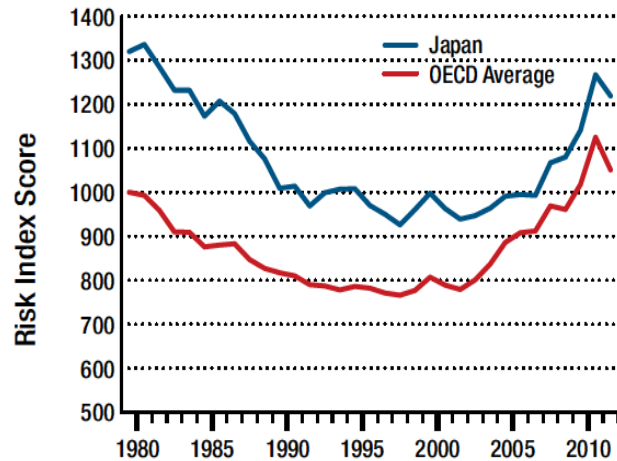


Strong economic growth in emerging economies has exposed underlying weaknesses in energy security

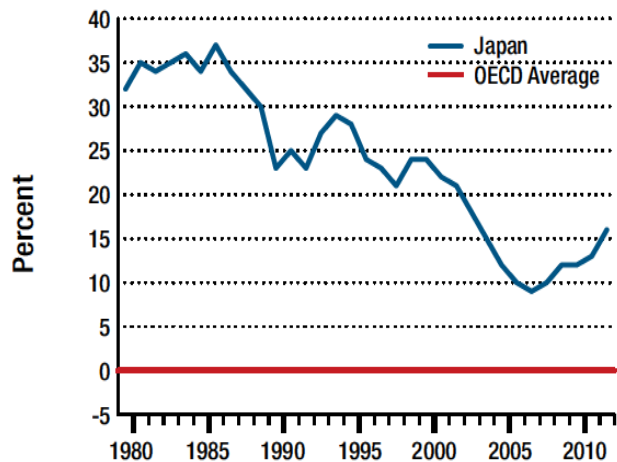
- » China: #19 in 2010
- » Improvements vis-a-vis OECD stalled beginning in 2000
- » Energy intensity and per capita energy use metrics getting worse
 - > Industrialization
 - > Expanding middle class
 - > Greater auto ownership
- » Improving energy security becoming a strategic priority

Lessons: Japan

Japan vs. OECD: Risk Index Scores



Japan: Risk Variance from OECD

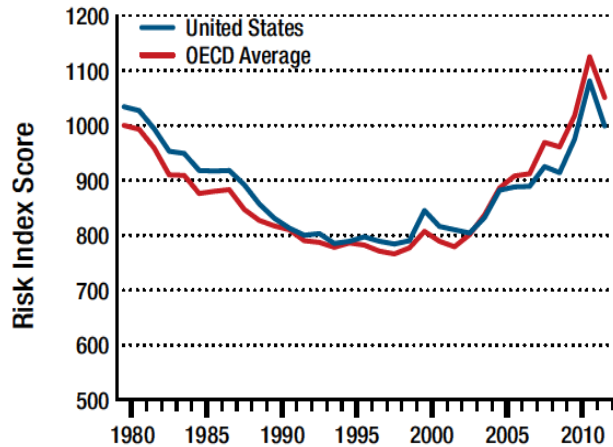


Fukushima

- » Japan: Ranked slipped from #14 in 2011 to #18 in 2012
- » Impact of policy reaction to Fukushima in 2011
- » **But**—Risks today lower than in 1980
- » Japan's among the best scores for:
 - > Energy intensity
 - > Energy use per capita
- » **Also**— What will Japan do about its large nuclear fleet?
 - > Will Germany follow through on its nuclear shutdown?

Lessons: United States

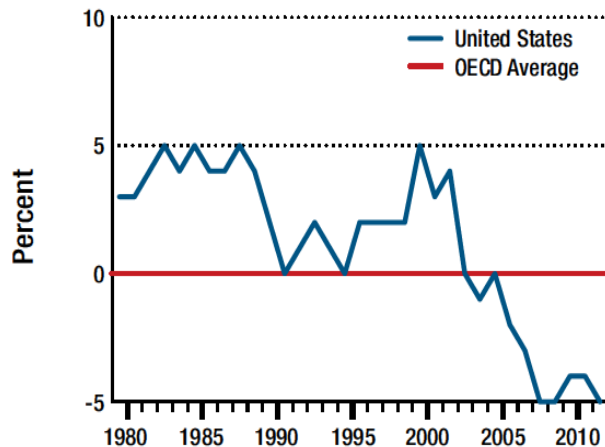
United States vs. OECD: Risk Index Scores



New technology can be a disruptive & positive force

- » U.S.: Ranked #6, up three places since 2005
- » Risks running consistently below OECD average after 2006
- » Reflects impact of shale technology and other developments
- » Benefits of low-cost gas ripple thru other metrics
- » Will “Shale Gale” blow overseas?

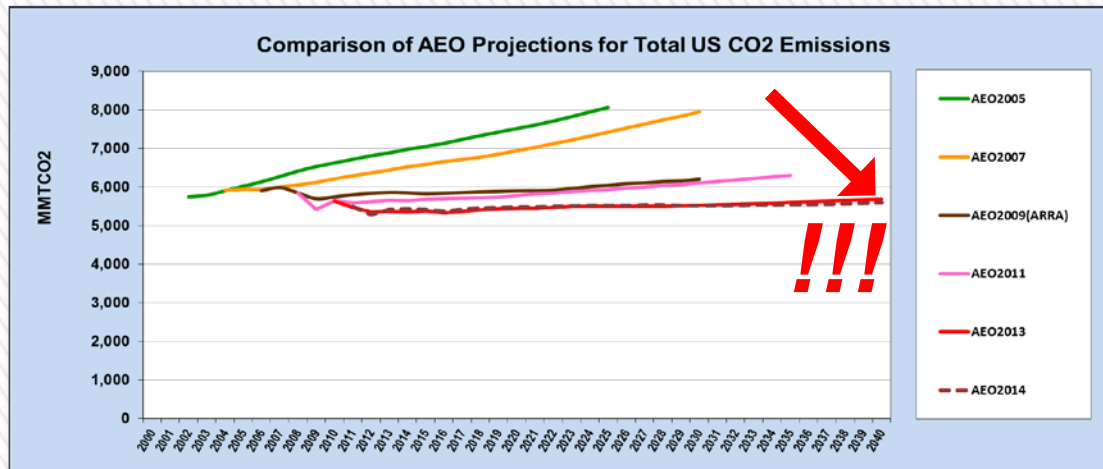
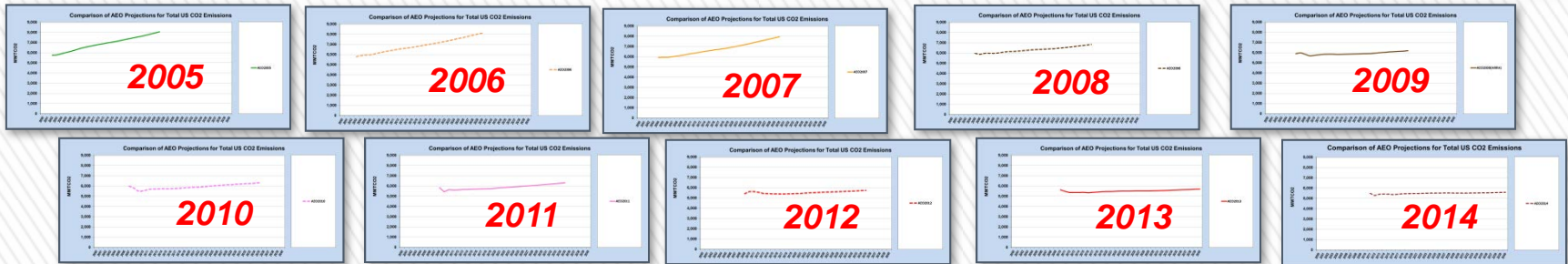
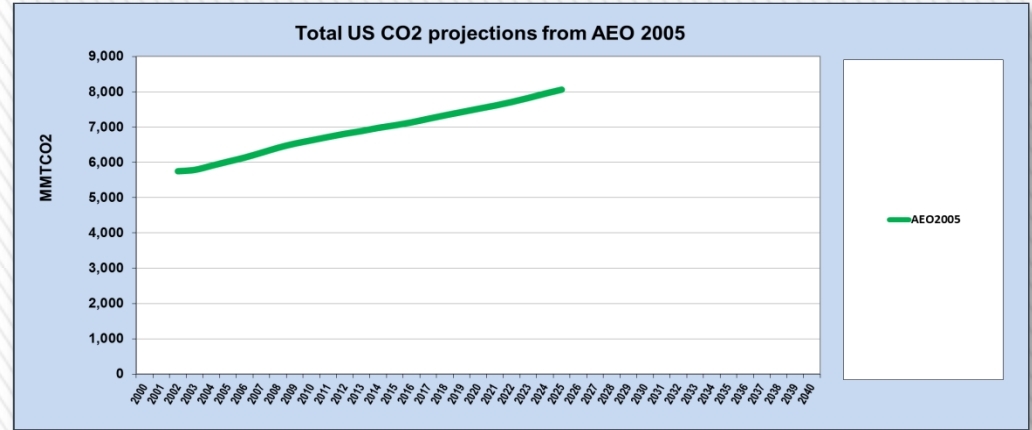
United States: Risk Variance from OECD



Using EIA forecasts like a Flip Book Animation

Each year, EIA's *Annual Energy Outlook* updates EIA's projections of the future

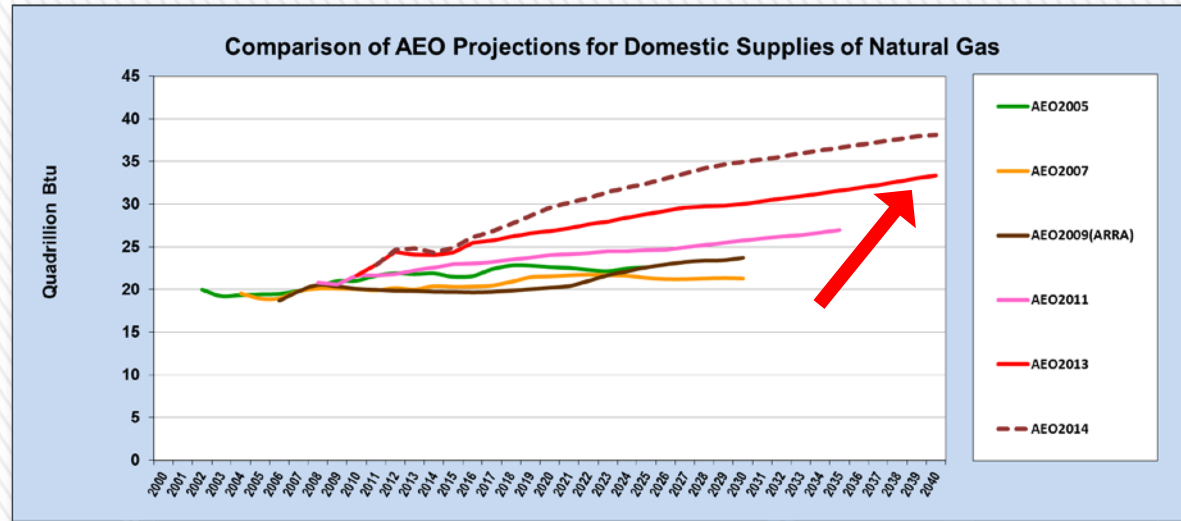
... but there's a good reason we don't call it the "*Once and Forever Energy Outlook*"



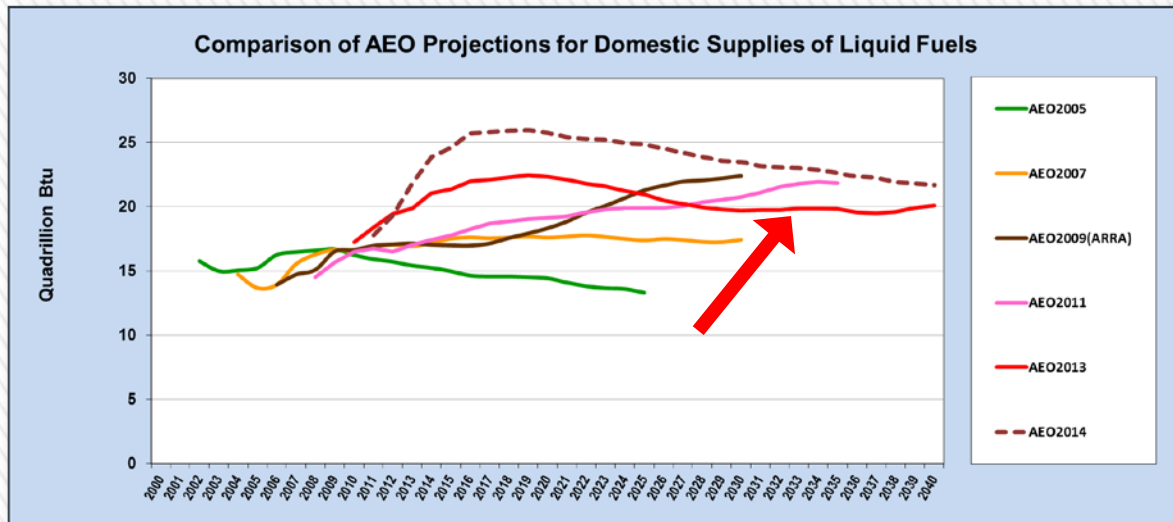
By comparing the changes in AEOs over time, we can tell a new kind of story: **What has changed our thinking over time?**

A dramatic change in future U.S. oil & gas production

Domestic natural gas supply is now trending markedly higher....



Developed from US Energy Information Administration, *Annual Energy Outlook*, multiple years.



... and domestic petroleum supplies are similarly surging

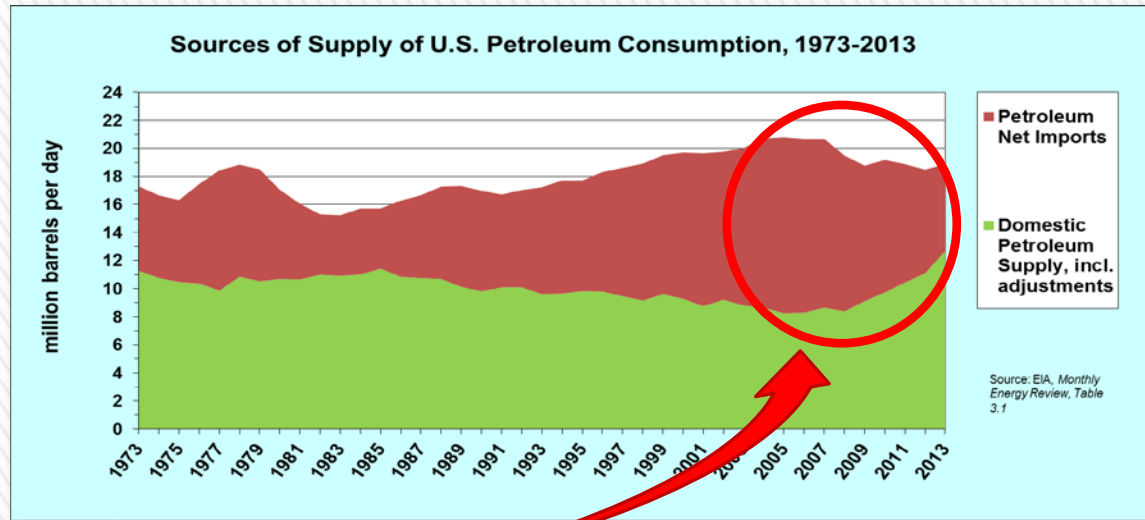
... with profound effects on U.S. and world markets.

Developed from US Energy Information Administration, *Annual Energy Outlook*, multiple years.

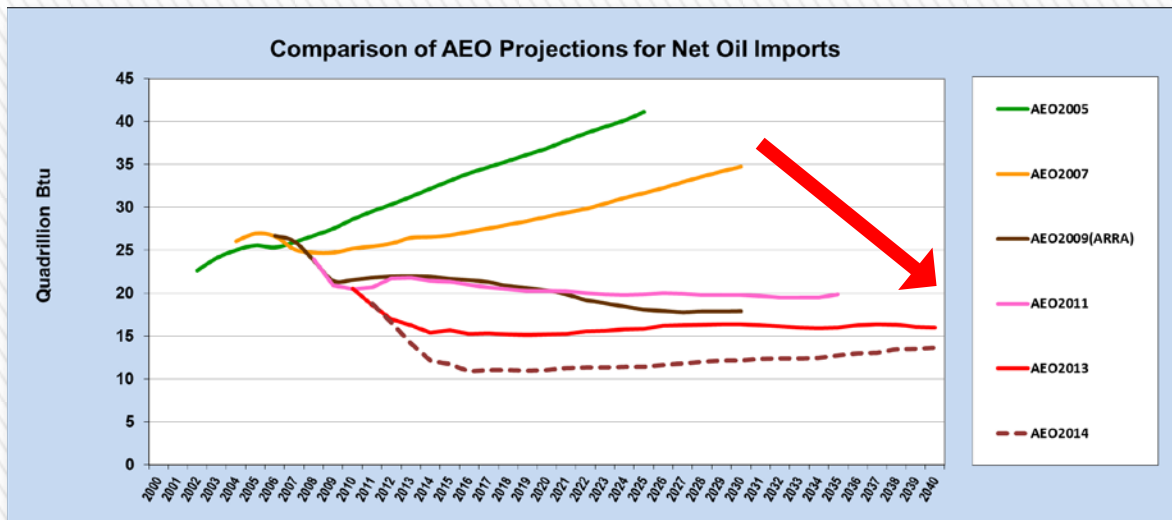
A dramatic change in the outlook for U.S. oil imports

Imports make up the difference between U.S. consumption and domestic production.

Recently, sharply increasing oil production, & a contraction in imports



Developed from US Energy Information Administration, *Monthly Energy Review*, Table 3.1.

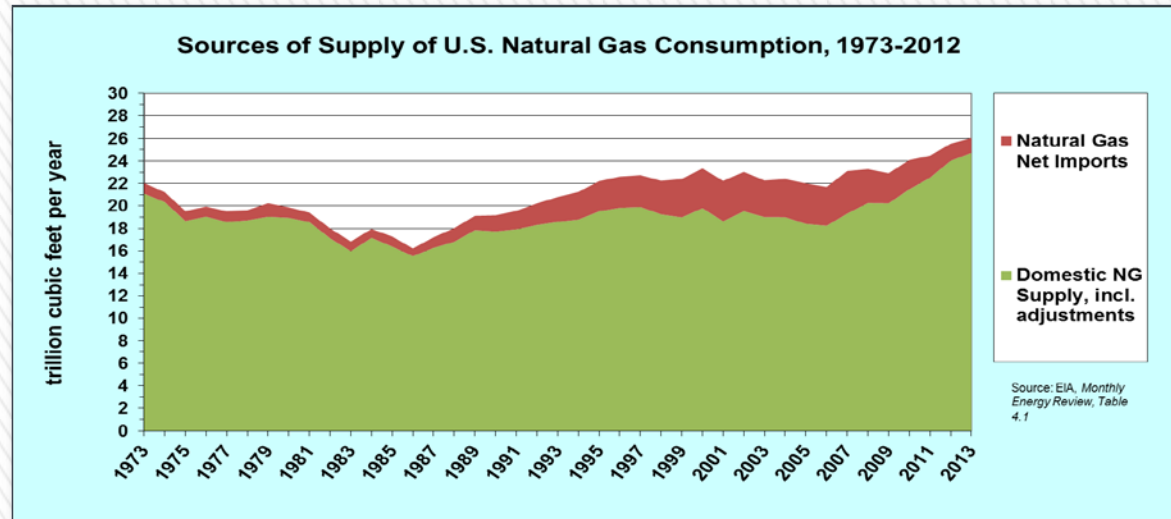


Developed from US Energy Information Administration, *Annual Energy Outlook*, multiple years.

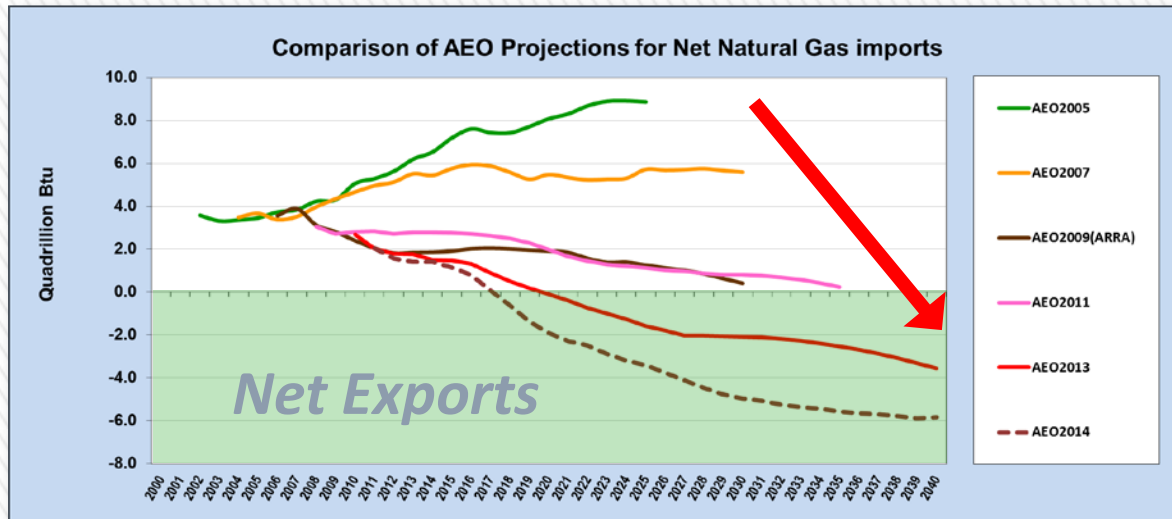
With domestic supply now trending higher, and consumption trending lower, expectations of future imports are shrinking rapidly.

Dramatic changes also in the U.S. NG import outlook

Imports make up the difference between U.S. consumption and domestic production.



Developed from US Energy Information Administration, *Monthly Energy Review*, Table 4.1.

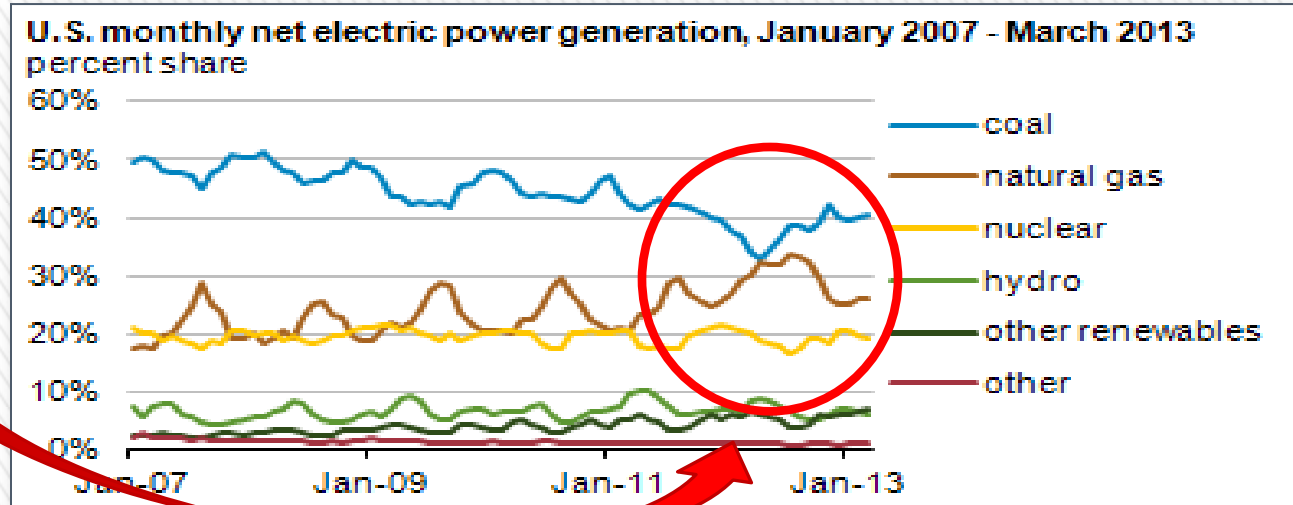


Developed from US Energy Information Administration, *Annual Energy Outlook*, multiple years.

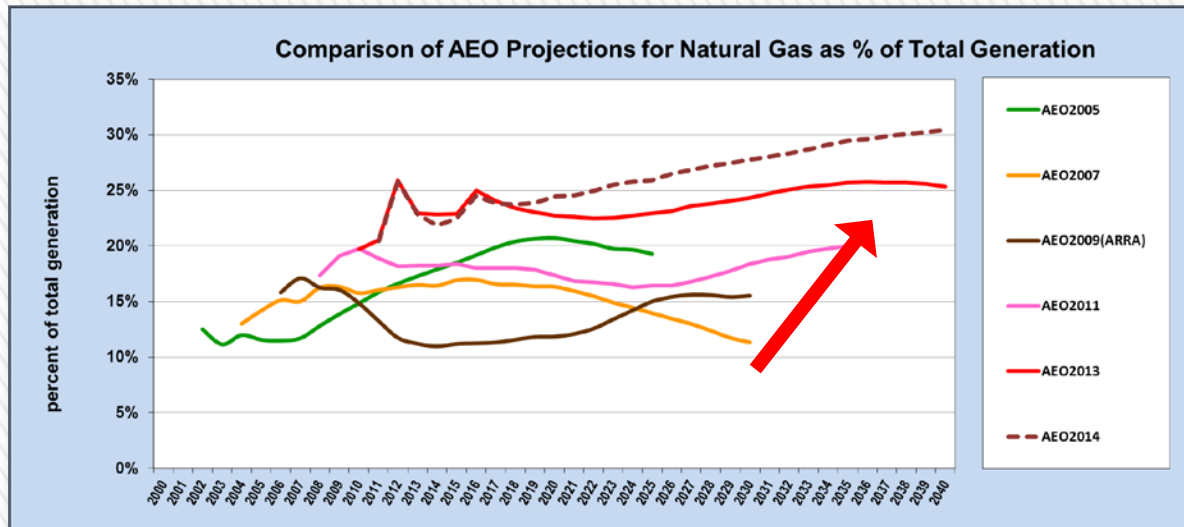
With domestic supply trending markedly higher, prior notions of growing import needs have now turned into the U.S. becoming a major net gas exporter.

Lower Natural Gas prices are increasing gas generation share in the U.S. power market

... increasing natural gas's share of power generation



US Energy Information Administration, "Coal regains some electric generation market share from natural gas," *Today in Energy*, May 23, 2013, <http://www.eia.gov/todayinenergy/detail.cfm?id=11391>.

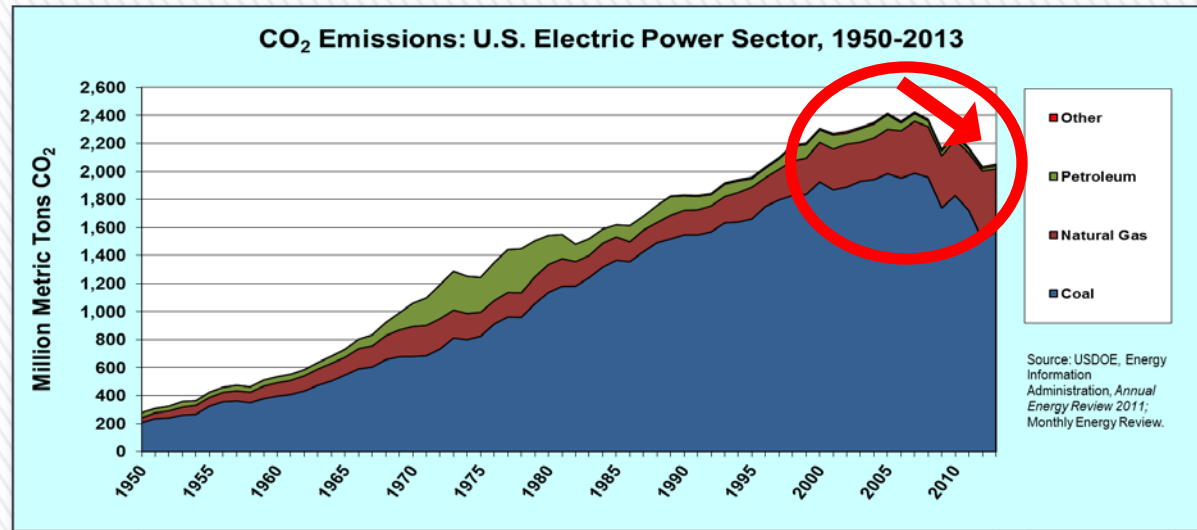


... with a greater role for natural gas in future electric power generation

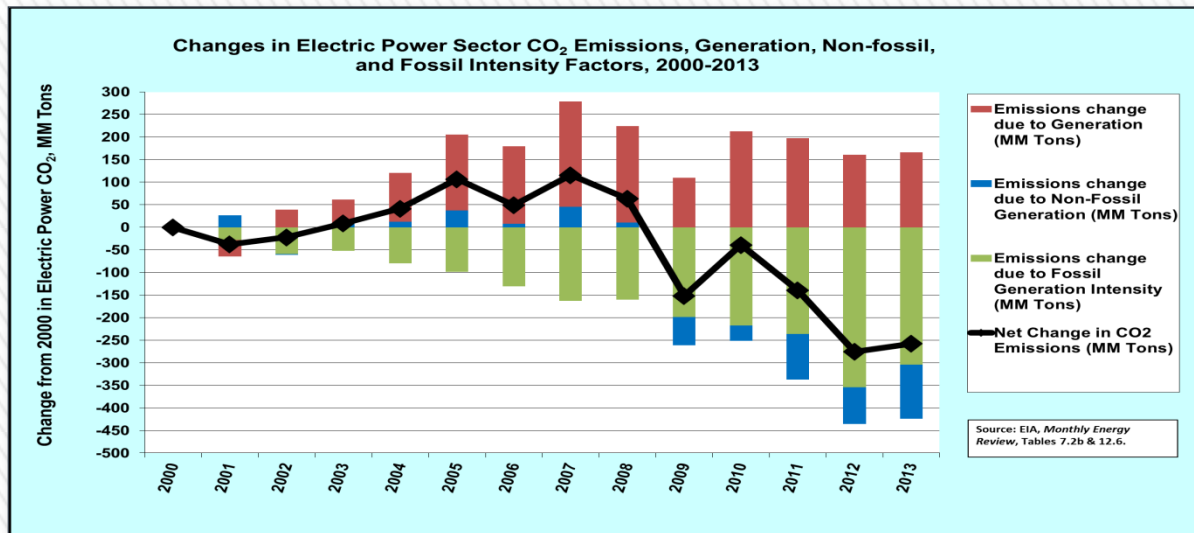
Developed from US Energy Information Administration, *Annual Energy Outlook*, multiple years.

Growth in Natural Gas use is driving down CO₂ emissions in the electric power sector

... already leading to a reversal of a decades-long trend in electric power CO₂ emissions growth.....



Developed from US Energy Information Administration, *Monthly Energy Review*.

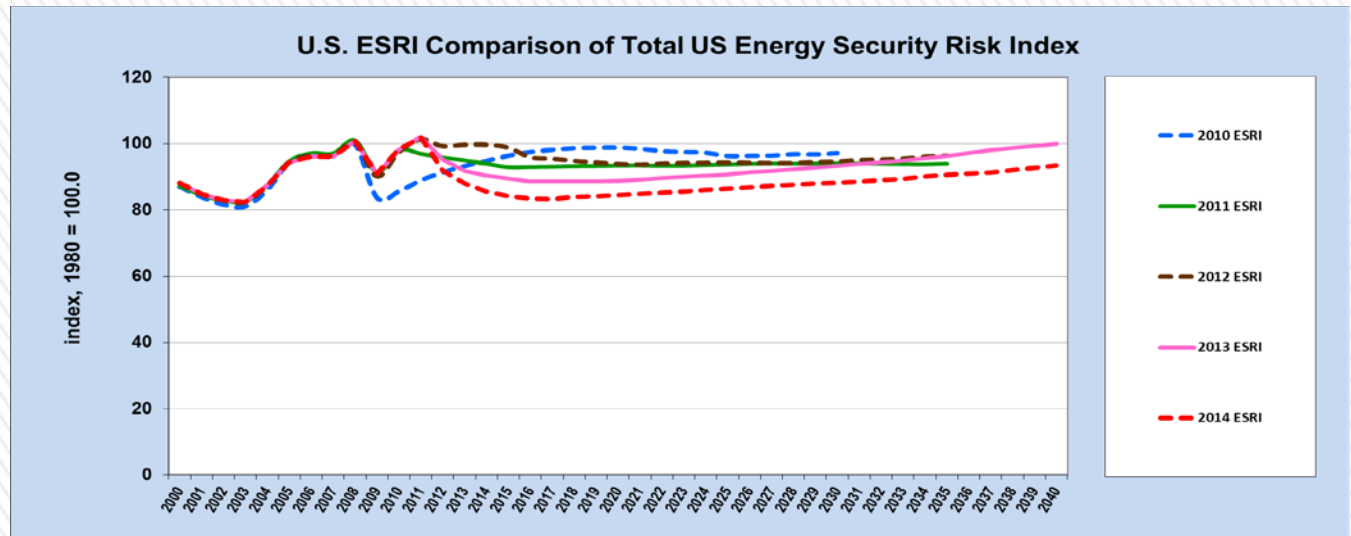


Developed from US Energy Information Administration, *Monthly Energy Review*, Tables 7.2b & 12.6.

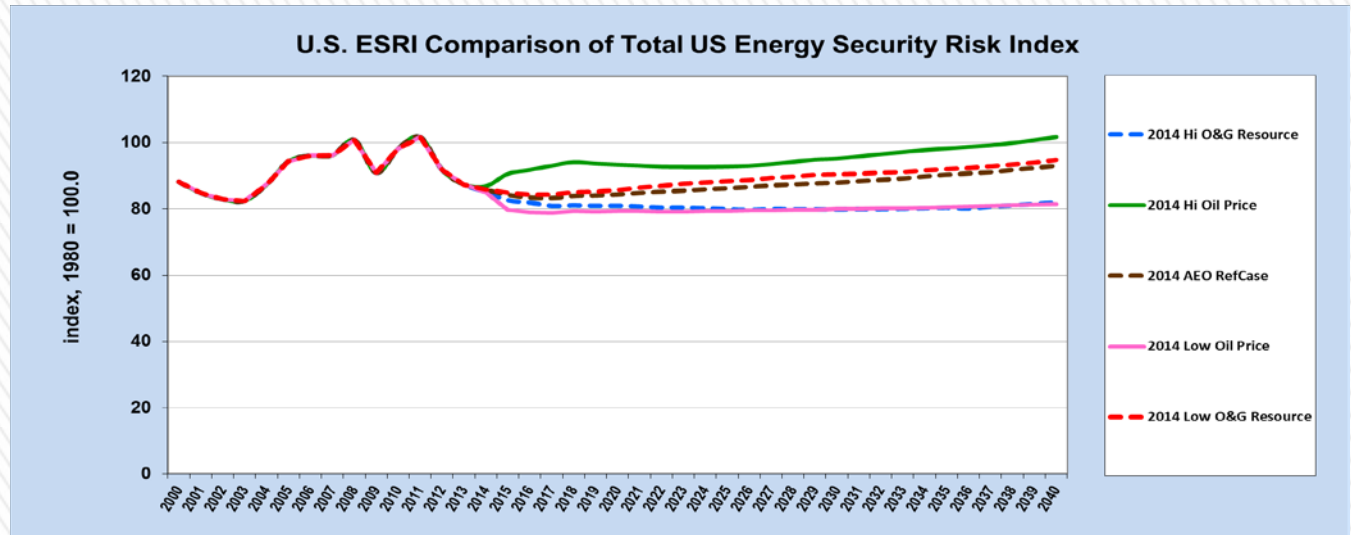
The changes due to fossil CO₂ intensity have been much greater than the changes in non-carbon generation ...

Leading to Improved U.S. Energy Security Risk

Significant improvement over 5 years' of ESRI reports



Oil & Gas scenarios are a major uncertainty and/or opportunity



Summary Thoughts

» Energy security risks can be defined, measured, tracked and forecast.

1. We are all in this together

- > Energy security risks are linked in a global energy market
- > A disruption anywhere can affect consumers everywhere
- > Improvements anywhere causes improvements everywhere

2. Each country is unique

- > Energy security affected by factors countries have control over and those they don't
- > Global factors
- > Country-specific resource endowment, economy, geography, etc.

3. Policies matter

- > Technologies: supply and demand
- > Investment
- > Efficiency and environmental

Questions?

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