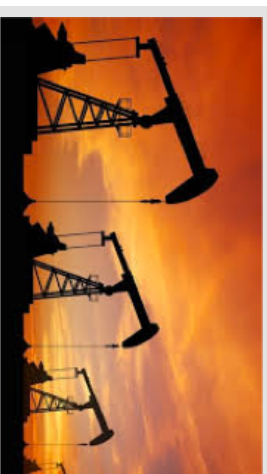


International Energy Security

Energy Journal Club – March 9, 2018

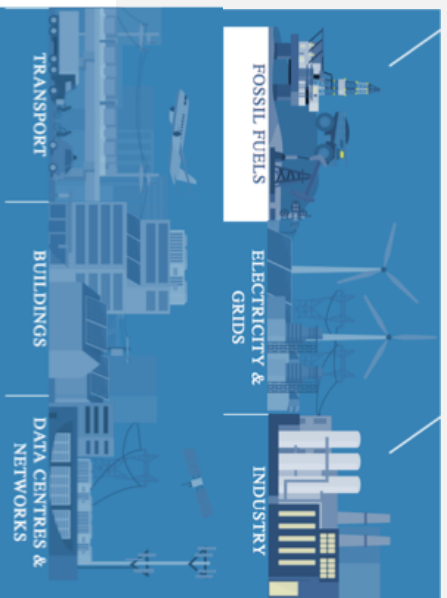


Outline

- What is energy security?
- How is it measured?
- A look at the rankings
- Historical events effecting energy security
- Changes that could effect future energy security

What is Energy Security?

- Def #1: The ability to supply energy at a reasonable price
- Def #2: Low vulnerability of vital energy systems
- Energy systems



- Vulnerability:
 - Sovereignty – who is in control of an energy system, imported or domestic production
 - Robustness – will the system last, will resources run out
 - Resilience - can the system respond/ recover from a disturbance

B. W. Ang, W. L. Choong, and T. S. Ng, "Energy security: Definitions, dimensions and indexes," *Renewable and Sustainable Energy Reviews*, vol. 42, pp. 1077–1093, 2015.
Jessica Jewel, IASA Energy Program Research Scholar
<https://www.youtube.com/watch?v=YVQLg0tIYo>

What is Energy Security?

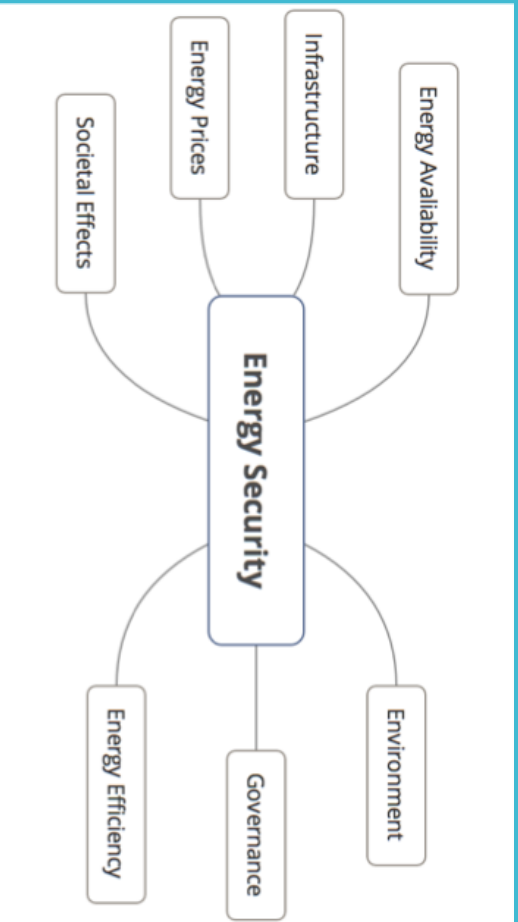
Def #3: The uninterrupted physical availability at a price which is affordable, while respecting environment concerns

1. Availability
2. Affordability
3. Acceptability

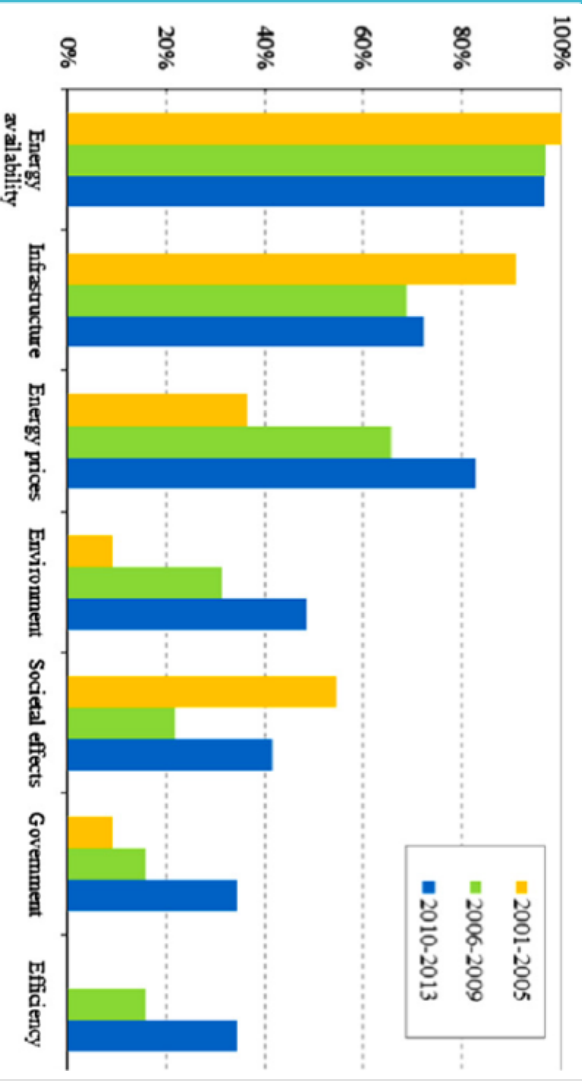
Approaches to achieving energy security:

- Reduce energy consumption
- Restrict demand to secure sources

What is Energy Security?



Themes in 83 definitions:



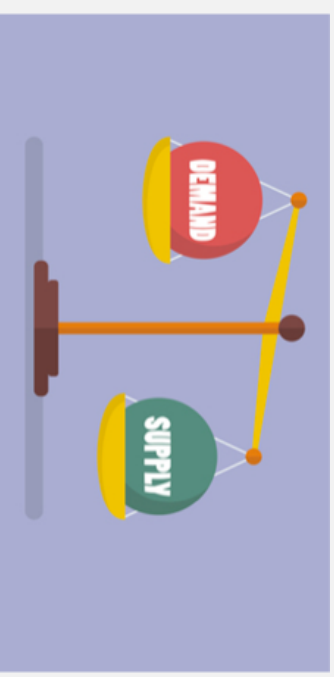
B. W. Ang, W. L. Choong, and T. S. Ng, "Energy security: Definitions, dimensions and indexes," *Renewable and Sustainable Energy Reviews*, vol. 42, pp. 1077–1093, 2015.

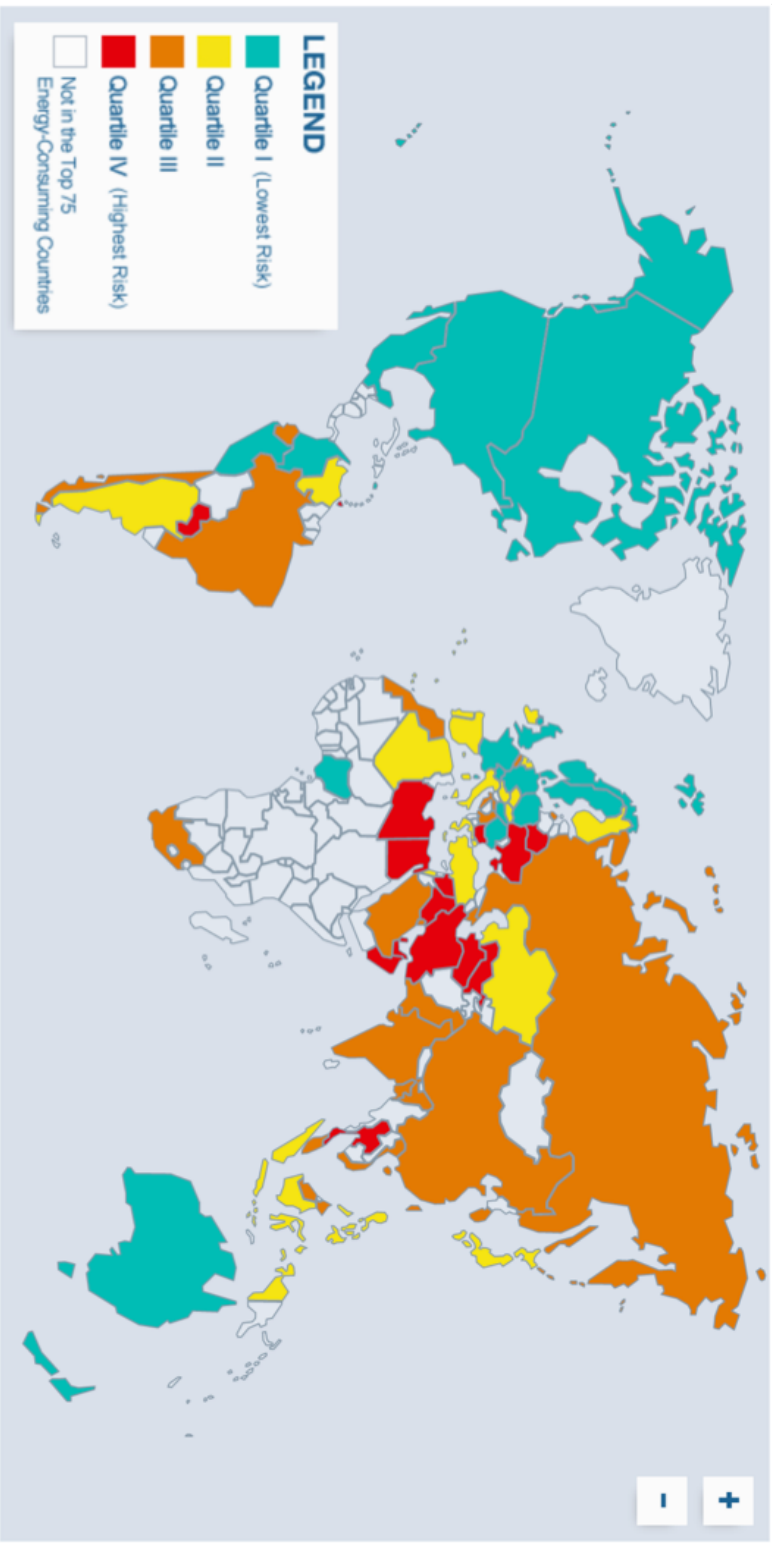
Long Term vs Short Term Security

- Long-term: investments that should be made to supply energy in line with economic developments and environmental needs



- Short term: ability of the energy system to respond to sudden changes in supply-demand

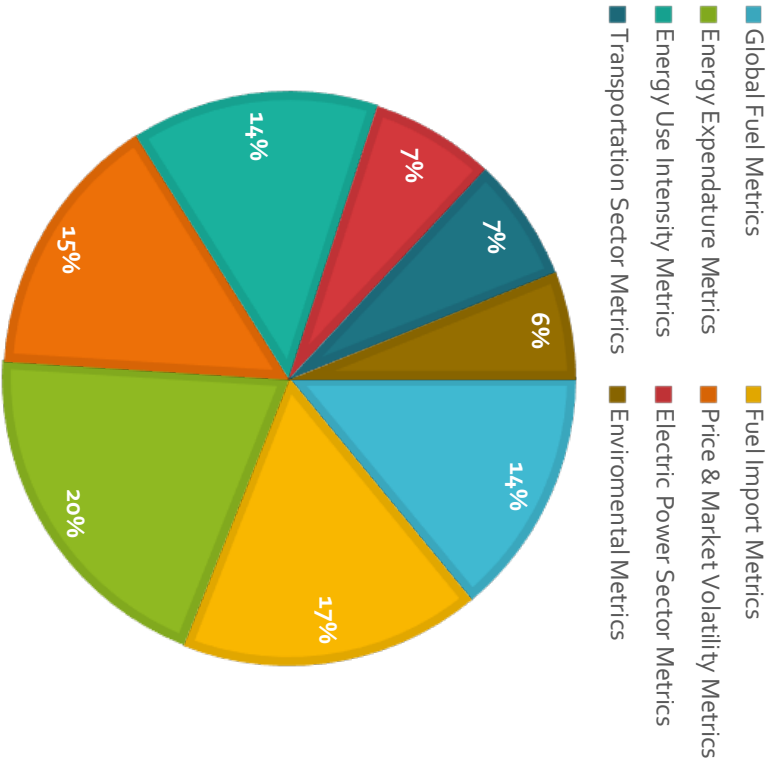




International Energy Security Risk Index

Global Energy Institute, US Chamber of Commerce

Metric Categories and Weightings



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 national economies to unreliable and concentrated supplies of oil and natural gas, and coal. Higher supply reliability and diversity and lower import levels mean a lower risk to energy security.
3. Energy Expenditures	5. Energy Use Intensity Measure energy use in relation to population and economic output. Lower use of energy by industry to produce goods and services means a lower risk to energy security.
4. Price & Market Volatility	6. Electric Power Sector Measure indirectly the reliability of electricity generating capacity. Higher diversity means a lower risk to energy security.
	7. Transportation Sector Measure efficiency of energy use in the transport sector per unit of GDP and population. Greater efficiency means a lower risk to energy security.
	8. Environmental Measure the exposure of national economies to national and international greenhouse gas emission reduction mandates. Lower emissions of carbon dioxide from energy mean a lower risk to energy security.

US Chamber of Commerce Foundation, "International Index of Energy Security Risk," p. 64, 2016.

2016 Rankings International Energy Security Risk Index

Country	Risk Score	Large Energy User Group Rank
Norway	733	1
Mexico	766	2
New Zealand	799	3
United States	824	4
Denmark	827	5
United Kingdom	828	6
Canada	832	7
OECD	869	
Australia	903	8
Germany	930	9
France	932	10
Poland	959	11
Spain	1,017	12
Italy	1,038	13
Turkey	1,064	14
Japan	1,068	15
Netherlands	1,091	16
Indonesia	1,123	17
South Africa	1,185	18
India	1,186	19
Russia	1,192	20
China	1,212	21
South Korea	1,290	22
Brazil	1,297	23
Thailand	1,627	24
Ukraine	1,944	25

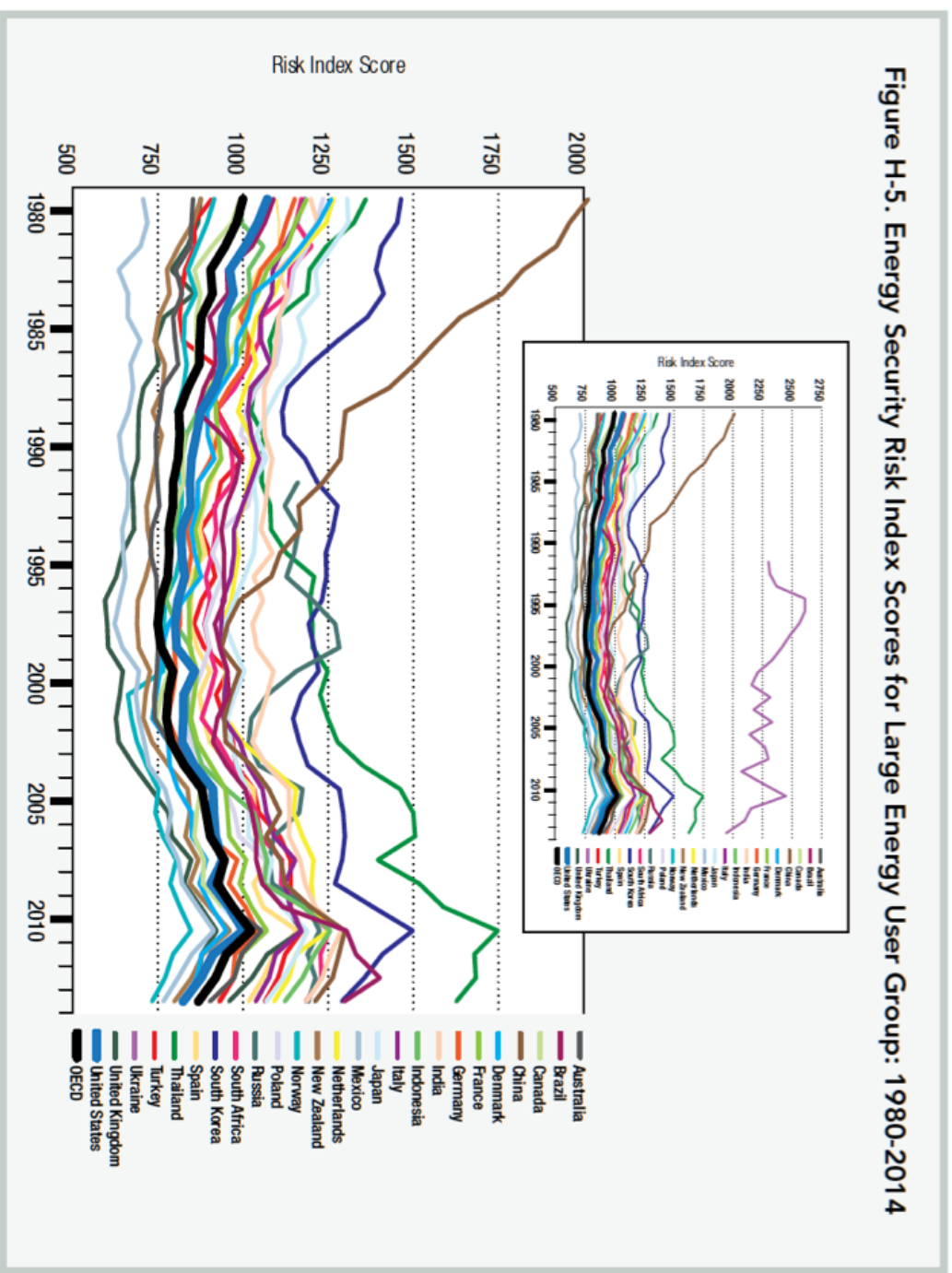
OECD – Organization for Economic Co-operation and Development

Australia	Iceland	Slovak Republic
Austria	Ireland	Slovenia
Belgium	Israel	Spain
Canada	Italy	Sweden
Chile	Japan	Switzerland
Czech Republic	Korea	Turkey
Denmark	Latvia	United Kingdom
Estonia	Luxembourg	United States
Finland	Mexico	
France	Netherlands	
Germany	New Zealand	
Greece	Norway	
Hungary	Poland	
	Portugal	

US Chamber of Commerce Foundation, "International Index of Energy Security Risk," p. 64, 2016.

Trends

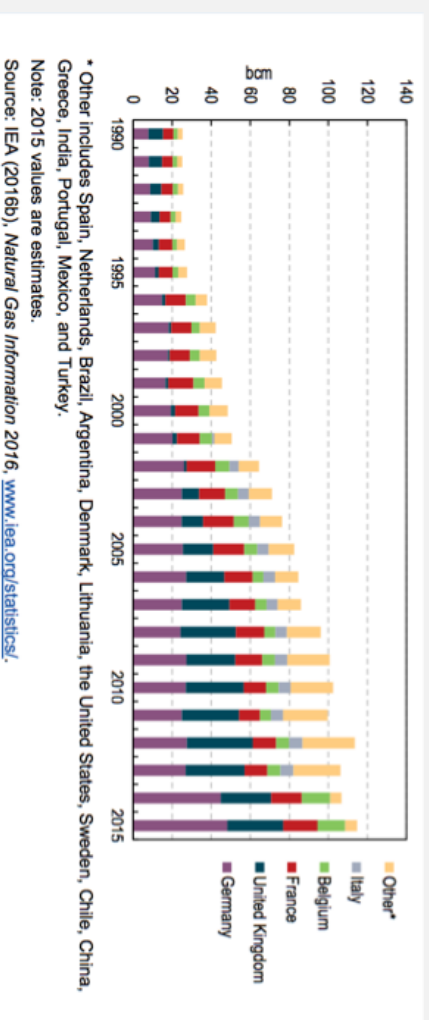
International Energy Security Risk Index



US Chamber of Commerce Foundation, "International Index of Energy Security Risk," p. 64, 2016.

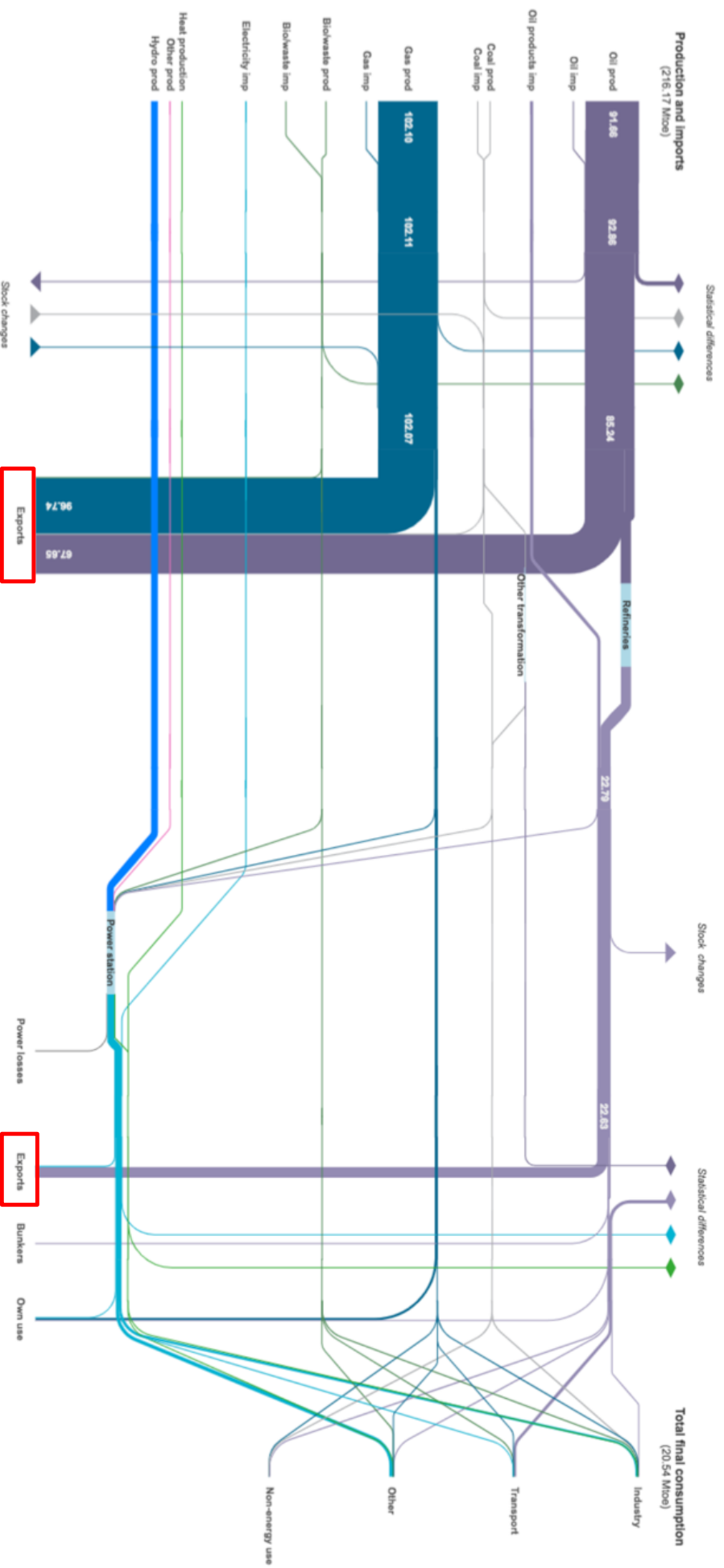
Norway

- Oil (2 million barrels/day) and natural gas (120 billion cubic metres/day) production is the largest sector of their economy
- Contribute greatly to global energy security
 - Consistent and predictable regulations
 - Manages resources and revenues with transparency
- 1/3 discovered and undiscovered gas resources and 1/2 of the oil resources have been produced



IEA, "Energy Policies of IEA Countries Norway," 2017.
<http://www.iea.org/publications/freepublications/publication/EnergyPoliciesofIEACountriesNorway2017.pdf>

Millions of tonnes of oil equivalent



Norway

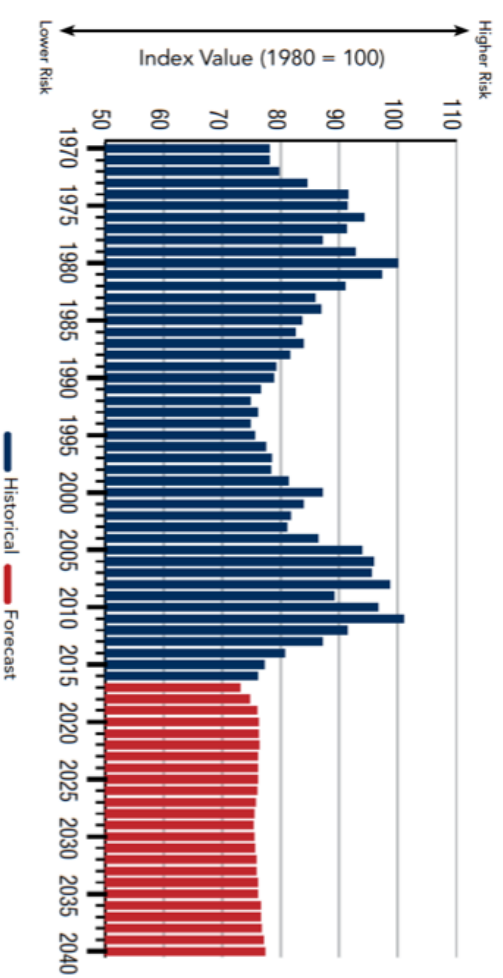
- The least secure part of energy in Norway is electricity
 - Most electricity intensive country of IEA
- Supply
 - Has further potential to provide electricity security through 85 terawatt hydropower reservoir capacity
 - Import
- Demand – energy efficient technology
- Government Tech Focus: Green Energy and Efficiency over Mature Production



IEA, "Energy Policies of IEA Countries Norway," 2017.
<http://www.iea.org/publications/freepublications/publication/EnergyPoliciesofIEACountriesNorway2017.pdf>

United States

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



- The decrease over the last five years has been most rapid in history
- The shale revolution: unconventional oil and natural gas production
- Metrics US has had greatest improvement:
 - Fuel Import
 - Energy Expenditure
 - Energy Use Intensity
 - Environmental
- In 2013, the US produced more oil than it imported
- Largest consumer of petroleum products in the world (19.5 million barrels /day – 2016)
- Produces 9.6 million barrels of crude oil/day -2017

Global Energy Institute, "Index of U.S. Energy Security Risk," pp. 1–90, 2017.

<https://www.cnn.com/2013/07/30/world/oil-and-gasoline-fast-facts/index.html>

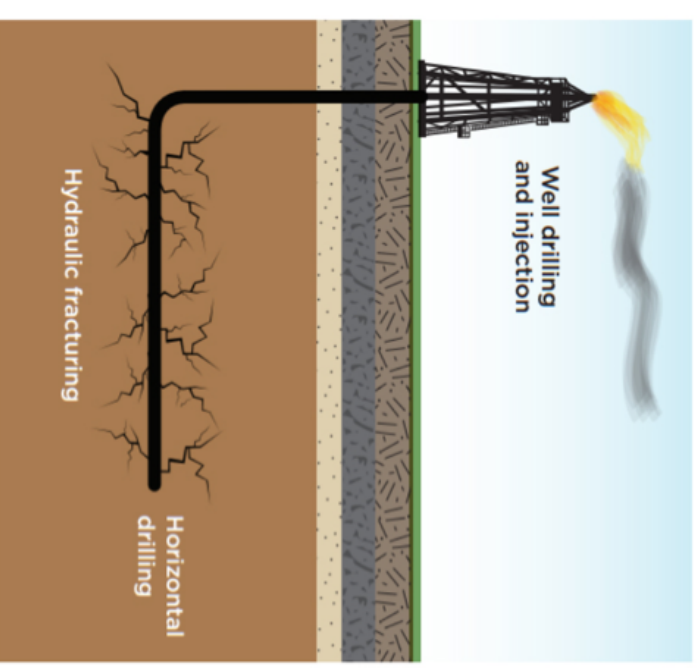
United States: The Shale Revolution

The use of hydraulic fracturing and horizontal drilling to increase its oil and gas production from tight oil formations

Success of shale oil in the US

- Owner of land owns hydrocarbon resources
- Regulations have a stable permitting process
- Infrastructure to support expansion of this sector
- Expertise in US geology

Extracting Tight Oil Using Hydraulic Fracturing



Ukraine

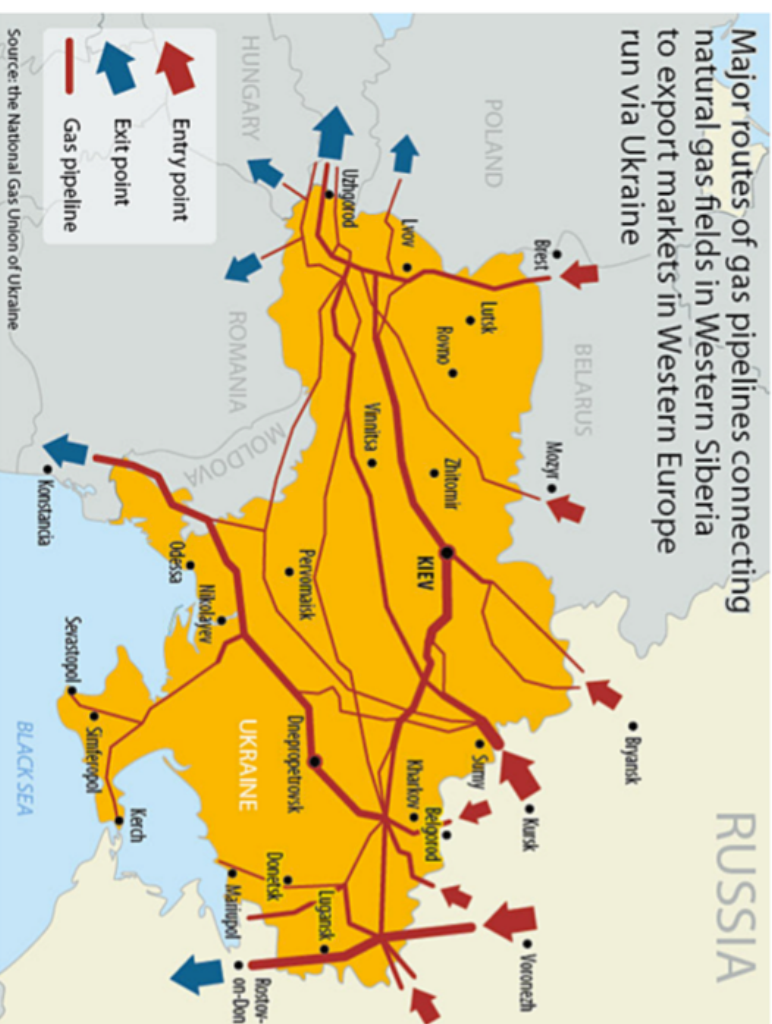
- Critical dependence on energy imports
- Highly inefficient use of energy (ie municipal heating sector)
- Aging infrastructure, widespread corruption
- Momentocracy – short-term policies are dominant
- “Energy Strategy of Ukraine for 2030” – government policies contradict the strategy objectives and lack implementation strategy

<https://www.usaid.gov/ukraine/energy-energy-security>

<https://transatlanticrelations.org/wp-content/uploads/2012/01/Chapter-5.pdf>

Ukraine

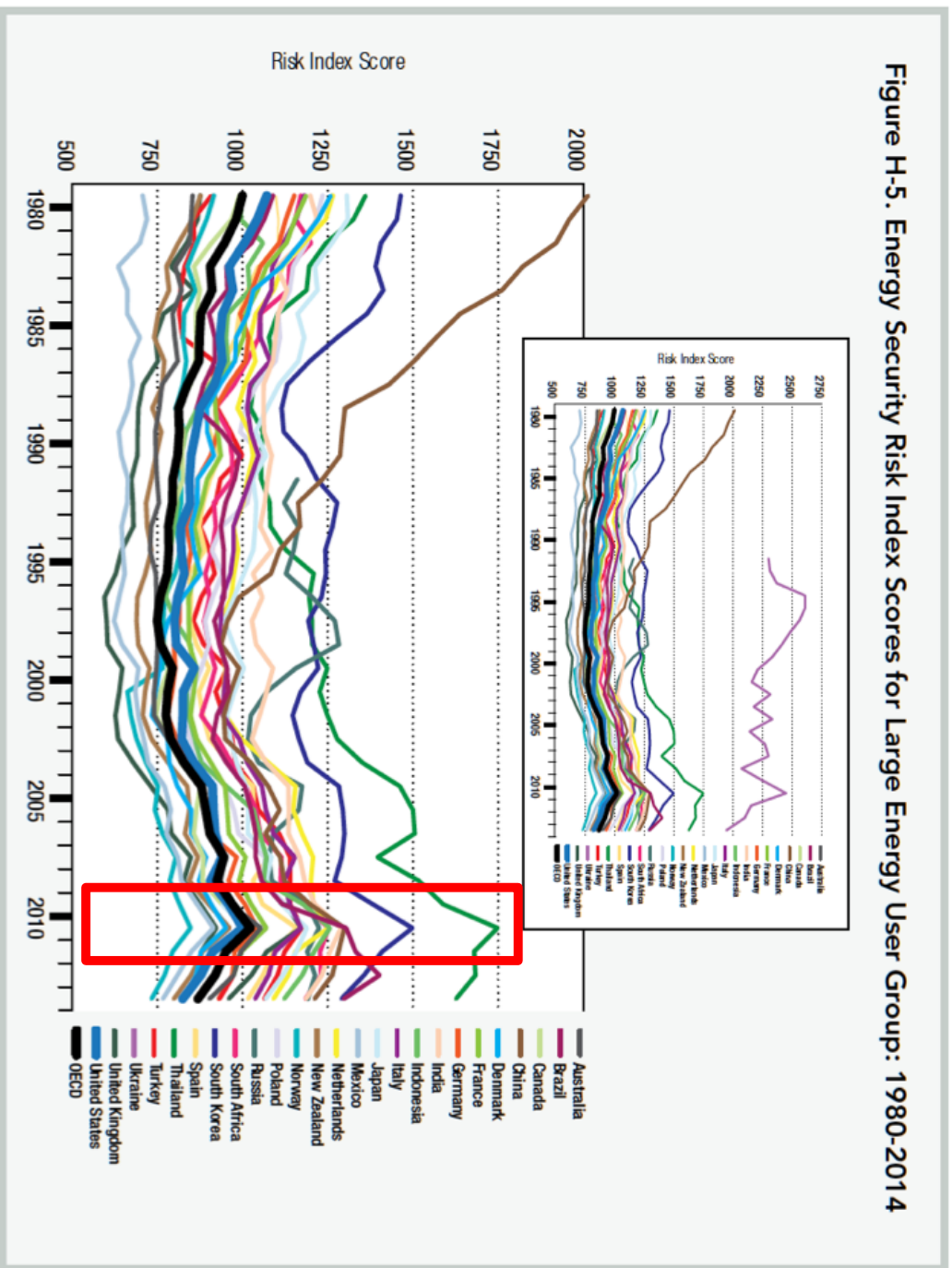
Key to energy security
for 15 European countries
38,600 km gas
transmission system



<https://www.weforum.org/agenda/2017/07/why-ukraine-is-central-to-europe-s-energy-security/>

Another Look

Figure H-5. Energy Security Risk Index Scores for Large Energy User Group: 1980-2014



Japan - Fukushima Daiichi incident – 2011

<https://www.youtube.com/watch?v=BdbitRlBlDc>

- March 11, 2011
- Major earthquake (9.0 Richter Scale) on the east coast of Honshu Island
- Followed by a tsunami that engulfed power station reactors



<http://www.world-nuclear.org/information-library/safety-and-security/safety-of-plants/fukushima-accident.aspx>

Japan - Fukushima Daiichi incident – 2011

- Shut down of all 54 of Japan's nuclear reactors
- Already resource poor and dependant on imports
- Increased Japan's demand for liquefied natural gas
- Worldwide effect on availability and affordability of natural gas
- Increase in liquid natural gas price in Asian countries
- Germany and Italy stopped production and shut down nuclear reactors

M. Hayashi and L. Hughes, "The Fukushima nuclear accident and its effect on global energy security," *Energy Policy*, vol. 59, pp. 102–111, 2013.

Japan - Fukushima Daiichi incident – 2011

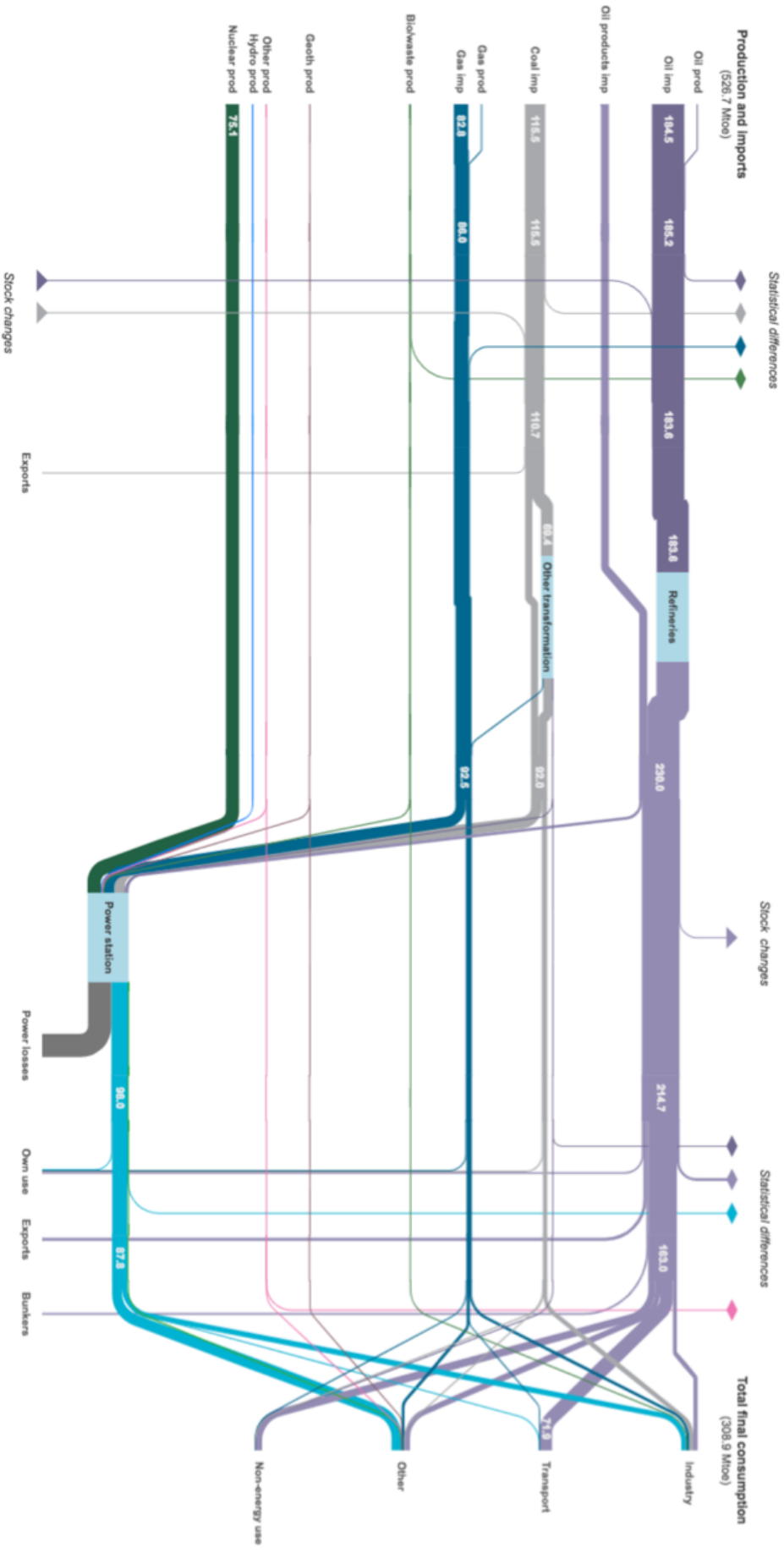
- Reduce electricity demand by 18%
- 18% increase in liquid natural gas imports
- Increased cost of nuclear power plants (safety features)
- Price of uranium falls

M. Hayashi and L. Hughes, "The Fukushima nuclear accident and its effect on global energy security," *Energy Policy*, vol. 59, pp. 102–111, 2013.

Japan

BALANCE (2010)

Millions of tonnes of oil equivalent



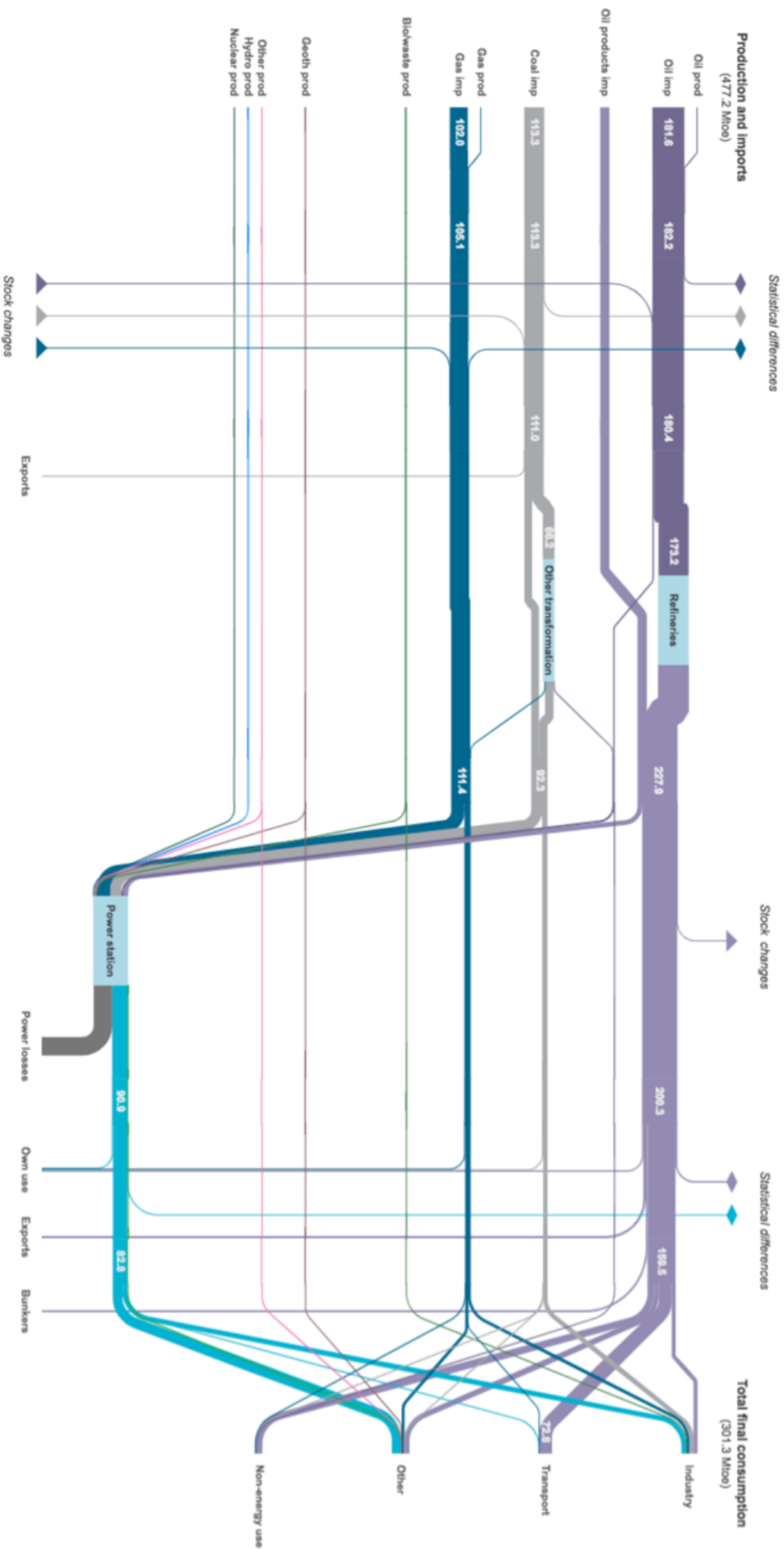
Country List | Colour Legend | Time Graph | Move Flows | Pie Chart | Glossary | Help | Print Mode

1973 1.72x | 1975 | 1977 | 1979 | 1981 | 1983 | 1985 | 1987 | 1989 | 1991 | 1993 | 1995 | 1997 | 1999 | 2001 | 2003 | 2005 | 2007 | 2009 | 2011 | 2013 | 2015

© NCMM/IA

Japan BALANCE (2012)

Millions of tonnes of oil equivalent

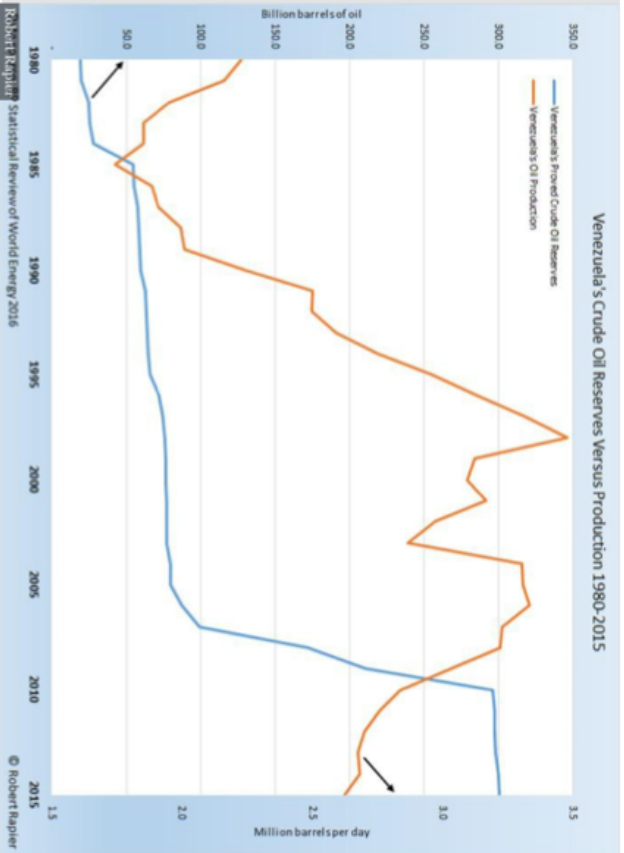


Country List | Colour Legend | Time Graph | Move Flows | Pie Chart | Glossary | Help | Print Mode

1973 1975 1977 1979 1981 1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007 2009 2011 2013 2015

© NCmVA

Nationalization of Oil in Venezuela



Robert Rapier Statistical Review of World Energy 2016
Venezuelan oil production versus proved reserves

- Largest amount of proven oil reserves in the world (300 billion barrels in 2016)
- Orinoco Belt - extra-heavy crude oil
- International companies were invited to develop reserves

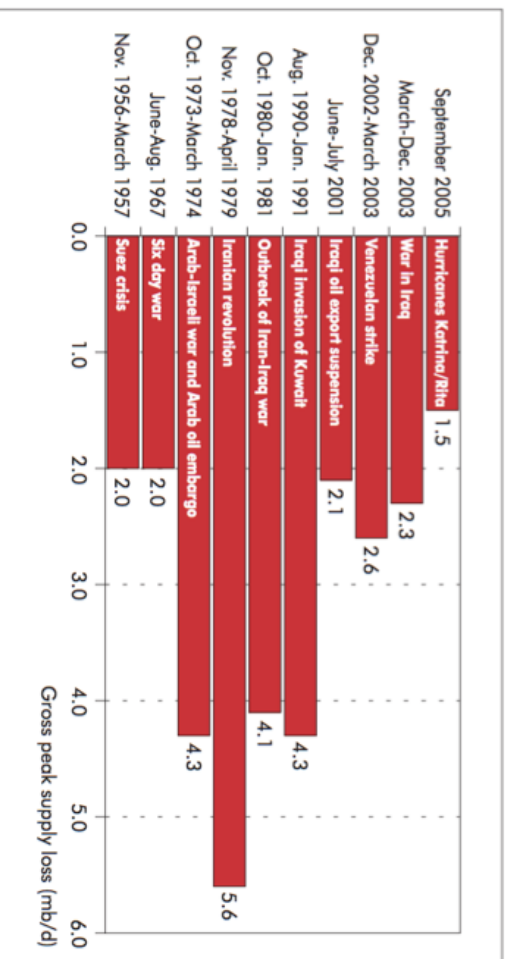


- Implemented law
 - Impose high taxes on crude production
 - Transfer oil projects to companies in which the government had major control and would profit
 - Exports changed from US to China and India

<https://www.forbes.com/sites/rapier/2017/05/07/how-venezuela-ruined-its-oil-industry/2/#3c2d3781e33>
<https://www.strauscenter.org/energy-and-security/venezuela.html>
<https://www.oj.com/articles/print/volume-115/issue-8/general-interest/case-study-the-nationalization-of-the-venezuelan-oil-industry.html>

Disruptions in Oil Supply

Major Oil Supply Disruptions



https://www.iea.org/publications/freepublications/publication/oil_security.pdf

Suez Canal Crisis: blocked half oil traffic
1973 Oil Embargo: US decision to supply the Israeli military

- High dependence on foreign oil imports
- Increase in oil prices (\$3/barrel to around \$12/barrel) and risk of global recession
- 1975 - US President Ford established Strategic Petroleum Reserve mandating a stockpile of one million barrels of petroleum



<https://history.state.gov/milestones/1969-1976/oil-embargo>

IEA Oil security

- International Energy Agency founded in 1974, directly following the embargo
- International Energy Programme – emergency oil stocks of 90 days of oil imports
- In an emergency these stocks are released to increase supply
- Restraint campaigns to decrease demand

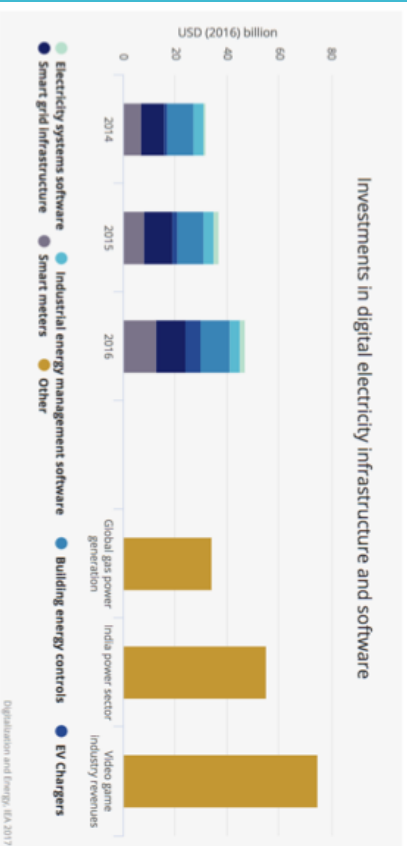
<https://www.iea.org/topics/energysecurity/>

IEA Natural Gas Security

- Previously natural gas markets have existed regionally
- Today the markets are becoming global and interdependent
- Importers will have the opportunity to diversify their suppliers
- They become subject to events/vulnerabilities outside of their regular market

<https://www.iea.org/topics/energysecurity/>

Digitalization and Energy Security

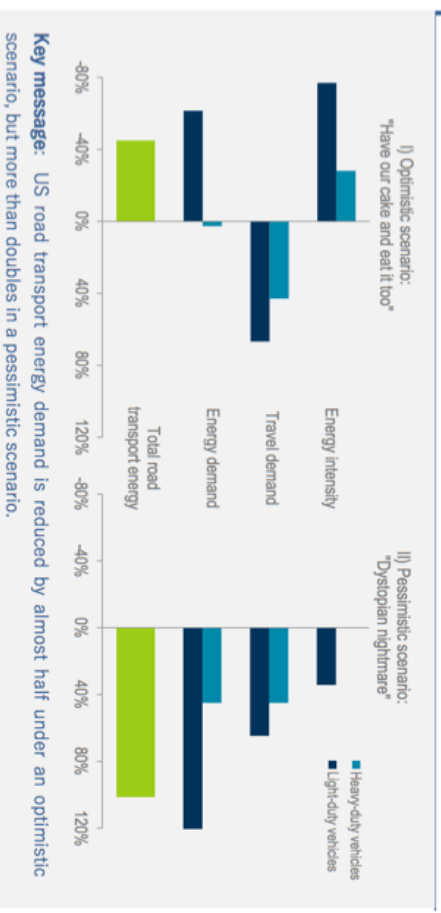


- Global investment in digital electricity infrastructure and software reaching 47 billion USD in 2016

Video: <http://www.iea.org/digital/#section-2>

- Automated, connected, electric and shared (ACES) mobility:
- consumer behaviour
 - policy intervention
 - technology

Figure 2.2 Range of possible energy impacts from vehicle automation in the United States



Key message: US road transport energy demand is reduced by almost half under an optimistic scenario, but more than doubles in a pessimistic scenario.