International Performance on Energy Security

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Central Challenge

- Can the world have secure, reliable and affordable supplies of energy while also transitioning to a low-carbon energy system?

(1) Evolution of the "Energy Security" Concept

- Energy security has long centered on questions of reliable supplies of energy, the regional concentration of energy resources, and the implications of the strategic withholding of energy.
- Additional dimensions of energy security have begun to surface, embracing the entire energy supply chain and infrastructure.

Ensuring Energy Security

Daniel Yergin

From *Foreign Affairs*, March/April 2006

(2) Diversification of the "Energy Security" Concept

- With rising energy costs, affordability and economic competitiveness have joined supply security as common objectives.
- The volatility of energy prices and growing uncertainties about available imports of both oil and natural gas have elevated the role of policies to promote energy efficiency
- With climate change and air pollution damages gaining greater clarity, the sustainability of energy systems have also become an objective of a secure energy future
- Most recently, approaches incorporating a wide range of dimensions have begun to emerge.

(3) Integrated Approaches to "Energy Security" Concept

- While supply availability remains the core concern of the energy security debate, the more current literature recognizes that priorities with respect to global warming, air pollution, economic growth and energy affordability will define how this transition will occur.
- There is an emerging literature suggesting that integrated approaches to energy security can achieve significantly deeper reductions in oil consumption.
- Integrated approaches can also address tradeoffs across dimensions of energy security.

(4) Socio-demographics and Attitudes toward "Energy Security"

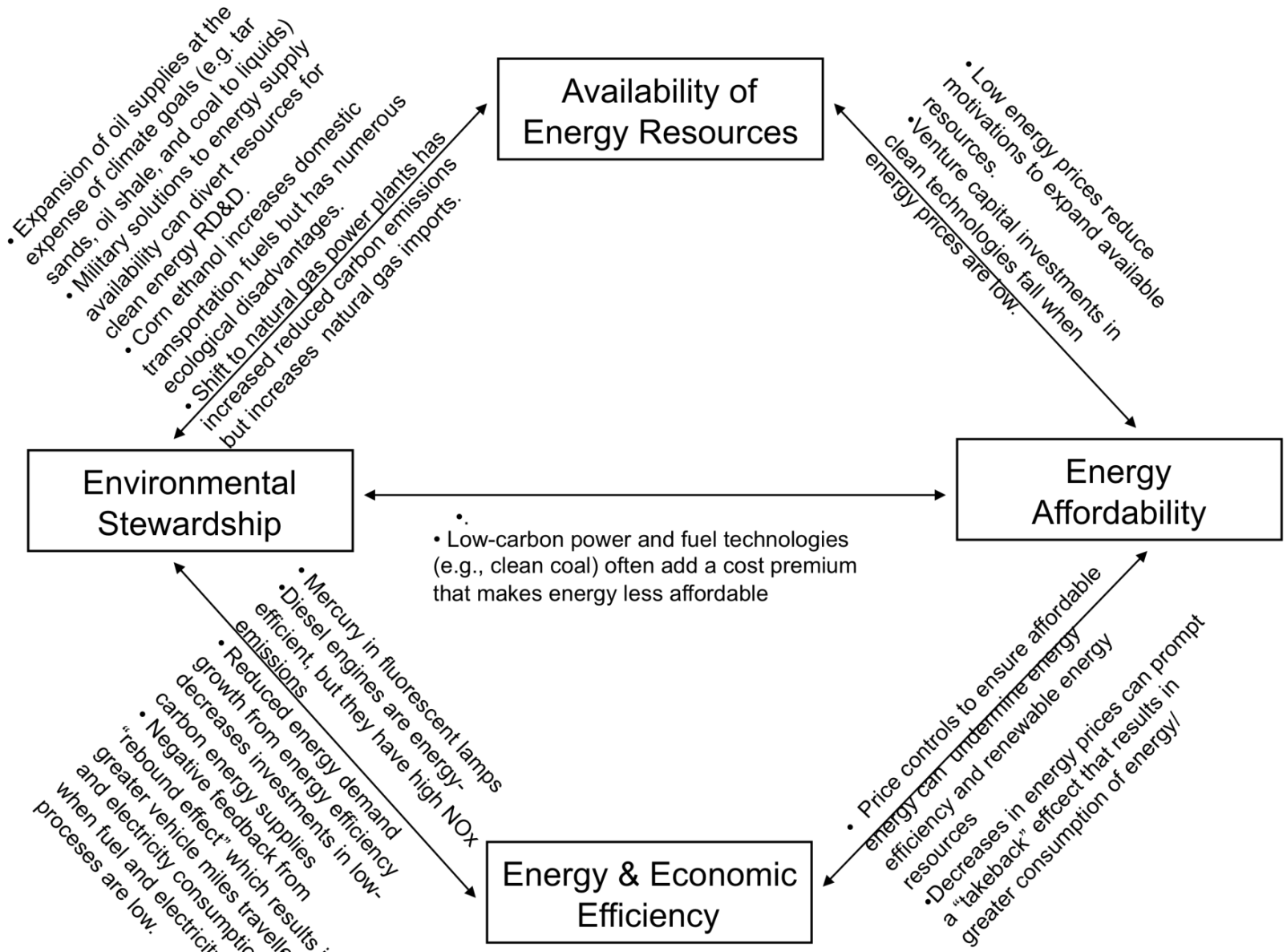
- The impacts of energy security and of climate change are not universally shared. A number of factors influence the level of vulnerability of different countries, communities and individuals.
- The literature suggests that socio-demographic characteristics have a strong impact on vulnerability. As a result, perceptions about energy security and climate change are also likely to be subject to considerable socio-demographic variation.
- Energy security is embedded in factors that constitute the social environment in which individuals are immersed, including everything from education, to access to resources to policy and cultural values of particular places.
- It is important to understand the factors that shape individual perspectives on energy security, because this influences policy responses.

A search of 91 academic, peer-reviewed articles revealed four dimensions to energy security

Four Dimensions	Explanation	Percent of Articles	Ten Indicators [a]	Measurement Units
Availability	Diversifying the fuels used to provide energy services as well as the location of facilities using those fuels, promoting energy systems that can recover quickly from attack or disruption, and minimizing dependence on foreign suppliers	82%	–Oil import dependence; –Natural gas import dependence; –Dependence on petroleum transport fuels	% of oil consumption that is imported % of natural gas consumption that is imported % of transport fuel that is petroleum-based
Affordability	Providing energy services that are affordable for consumers and minimizing price volatility	51%	–Retail electricity prices; –Retail gasoline/petrol prices	US 2007¢/kWh US 2007$/liter
Energy and Economic Efficiency	Improving the performance of energy equipment and altering consumer attitudes to reduce energy price exposure and mitigate energy import dependency	34%	–On-road fuel intensity of passenger vehicles; –Energy per GDP intensity; –Electricity use per capita	Gallons per mile 1000Btu/US2007$GDP kWh/capita
Environmental Stewardship	Protecting the natural environment and future generations	26%	–Sulfur dioxide emissions; –Carbon dioxide emissions	Million tons Million tons

[a] For measurement of the indicators, see Sovacool and Brown, 2010, Table 2&3 for data.

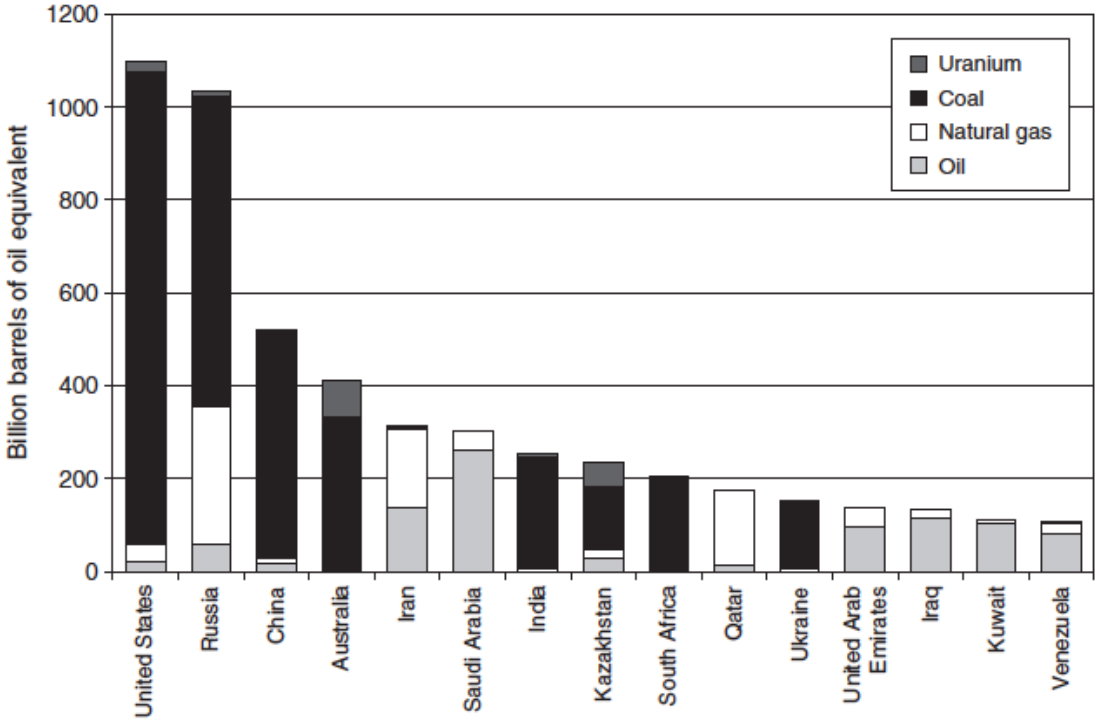
Trade-offs Across Dimensions



The Interdependence of Countries

- Globally, trade in energy commodities amounted to more than $3 trillion in 2011, including almost two-thirds of the oil produced in the world, and much of it was in natural gas, coal, and uranium.
- Few countries are truly energy independent.
  - ✓ Saudi Arabia is the largest exporter of crude oil but must import refined gasoline.
  - ✓ Russia exports natural gas but must import uranium.
  - ✓ The United States is a net exporter of coal but imports oil.
- This interdependence explains why any discussion of energy security must consider the interactions between countries. Energy security does not stand abstractly by itself; rather, it is most meaningful in a geographic context.

The Interdependence of Countries

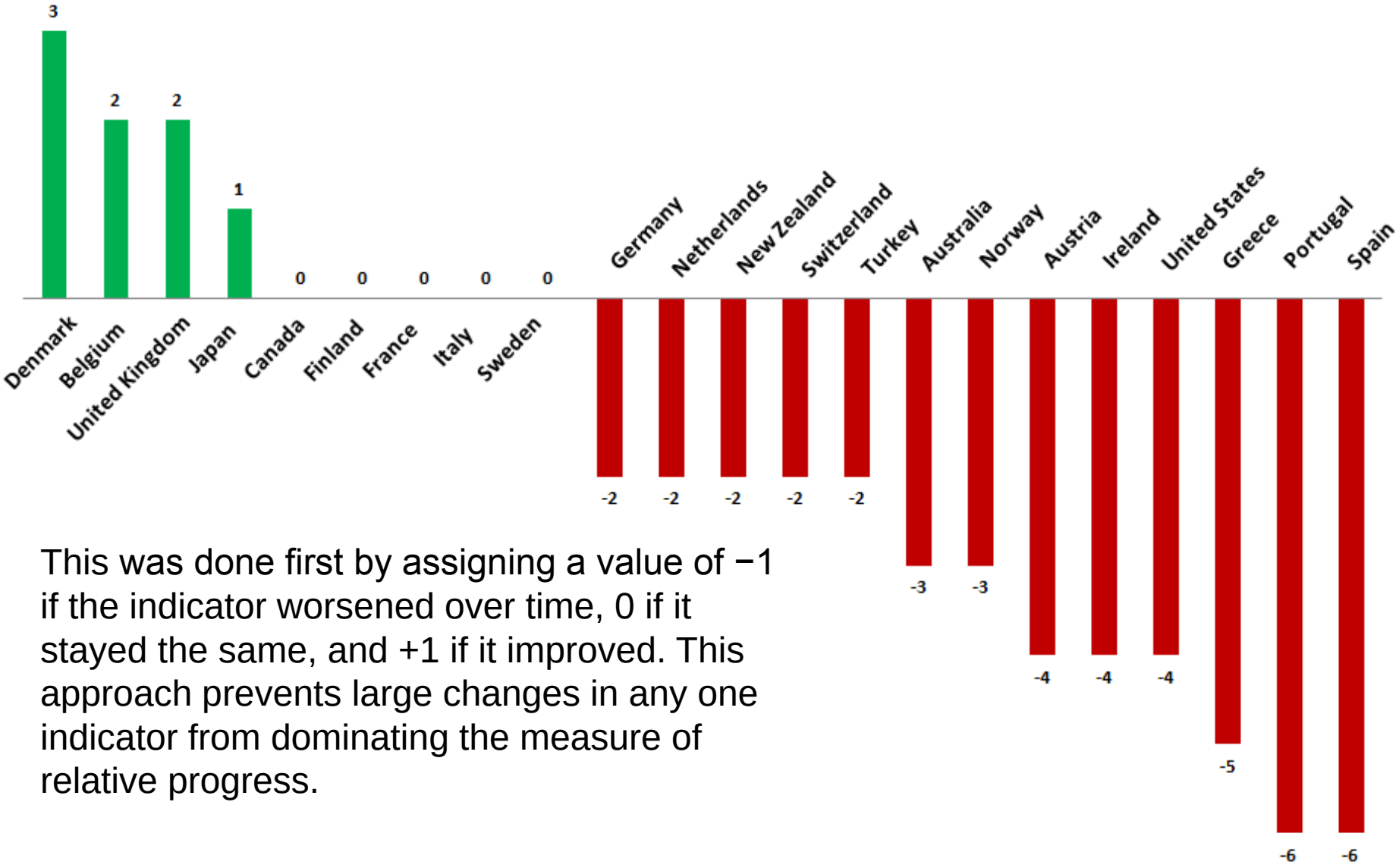


(Source: Brown and Sovacool, 2011)

Analysis of 22 OECD Countries

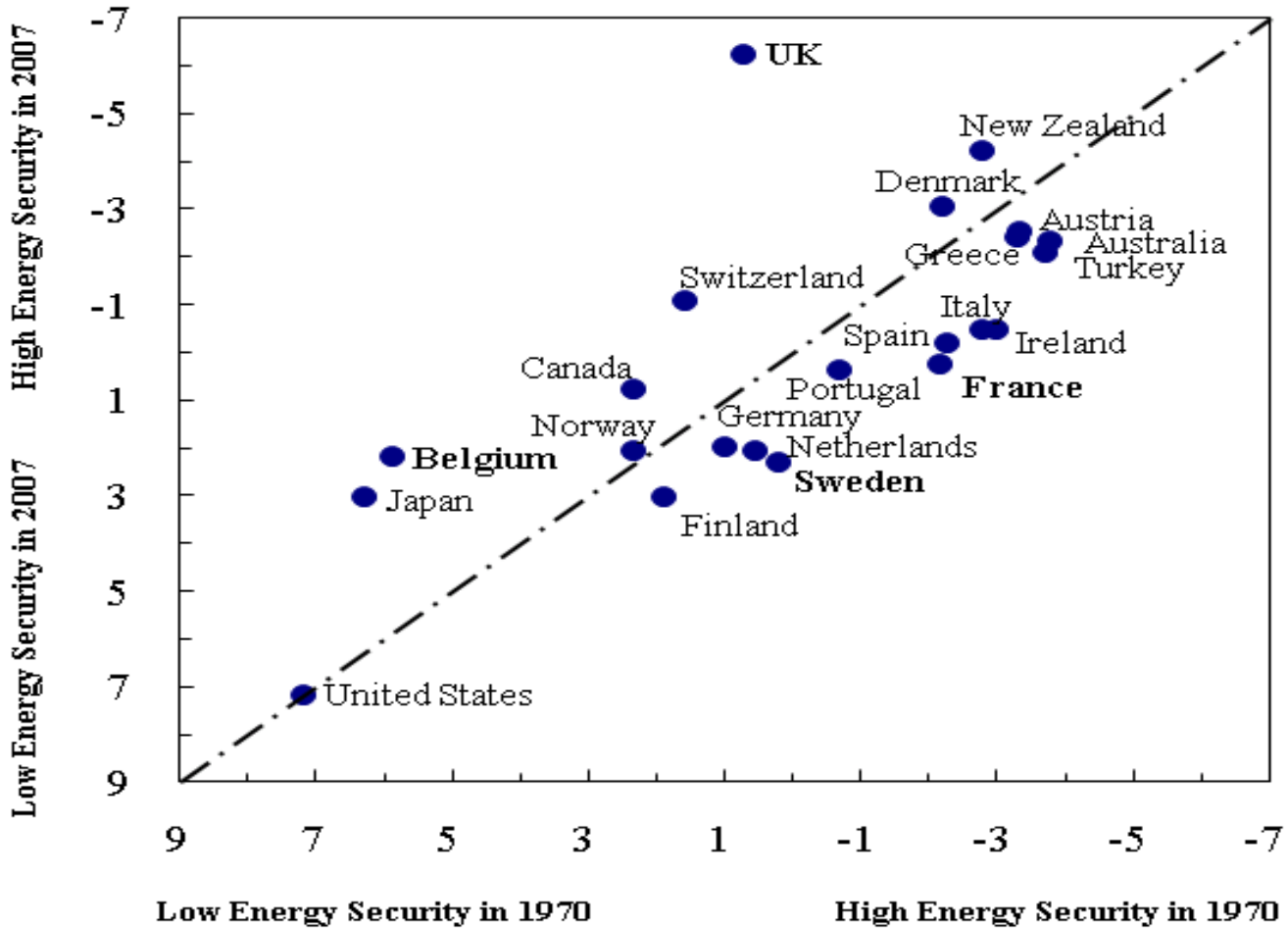
- Data on patterns of energy production and use have been collected and compiled since the 1950s
- Many OECD countries comprise important multilateral organizations associated with energy (UN, IEA)
- Representative sample of different cultures and markets
    - UK and NZ privatized
    - Denmark and US states highly regulated
    - Australia, Japan, Greece, and Turkey
- High energy consumers
- Industrialized economies, meaning they (ideally) have the resources necessary to change

The Progress of Each Country on the Ten Indicators

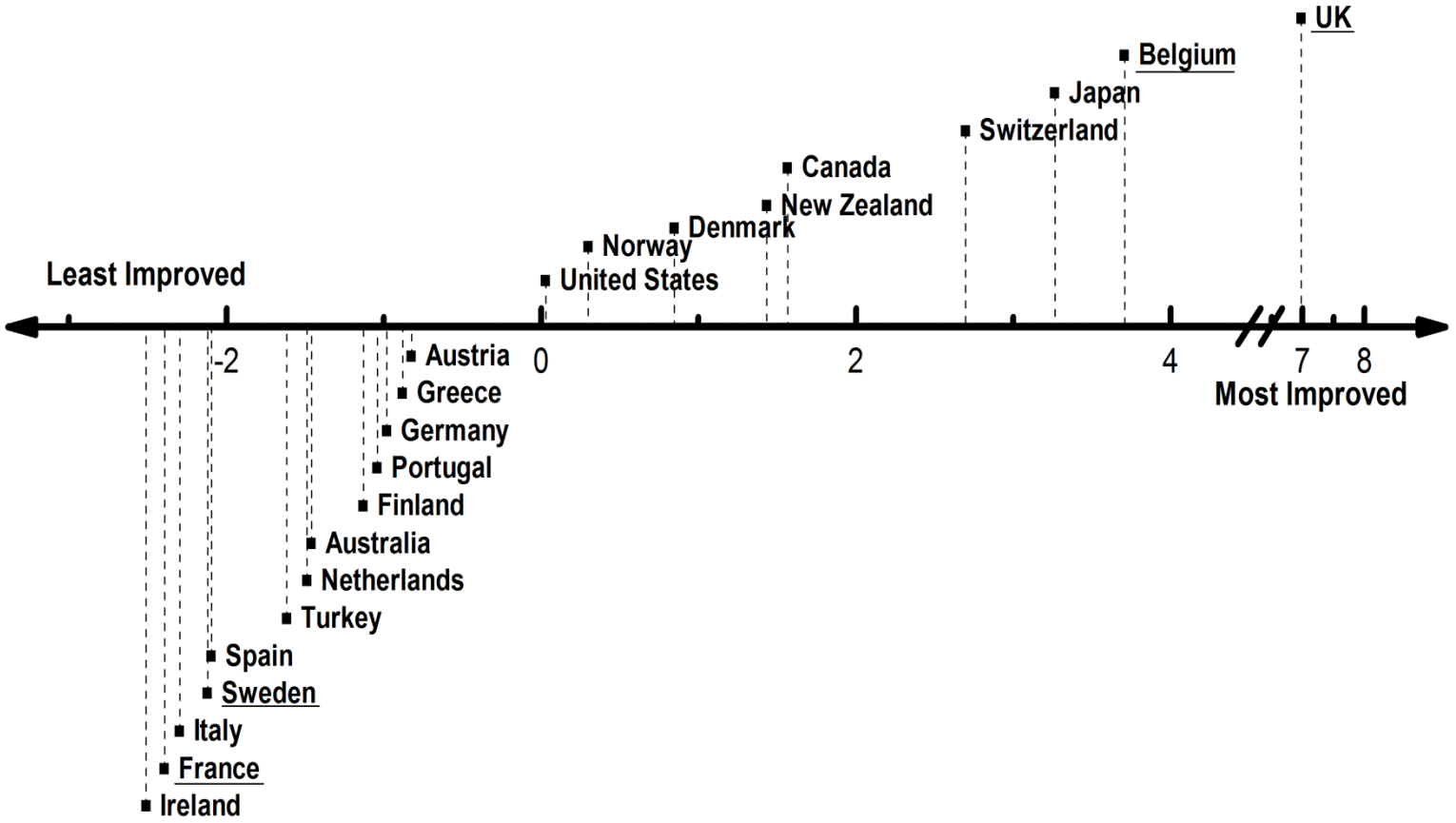


This was done first by assigning a value of −1 if the indicator worsened over time, 0 if it stayed the same, and +1 if it improved. This approach prevents large changes in any one indicator from dominating the measure of relative progress.

Energy Security "Z-Scores" in 1970 and 2007



Most to Least Improved Energy Security – Based on Differences in Z-Scores: 1970 and 2007



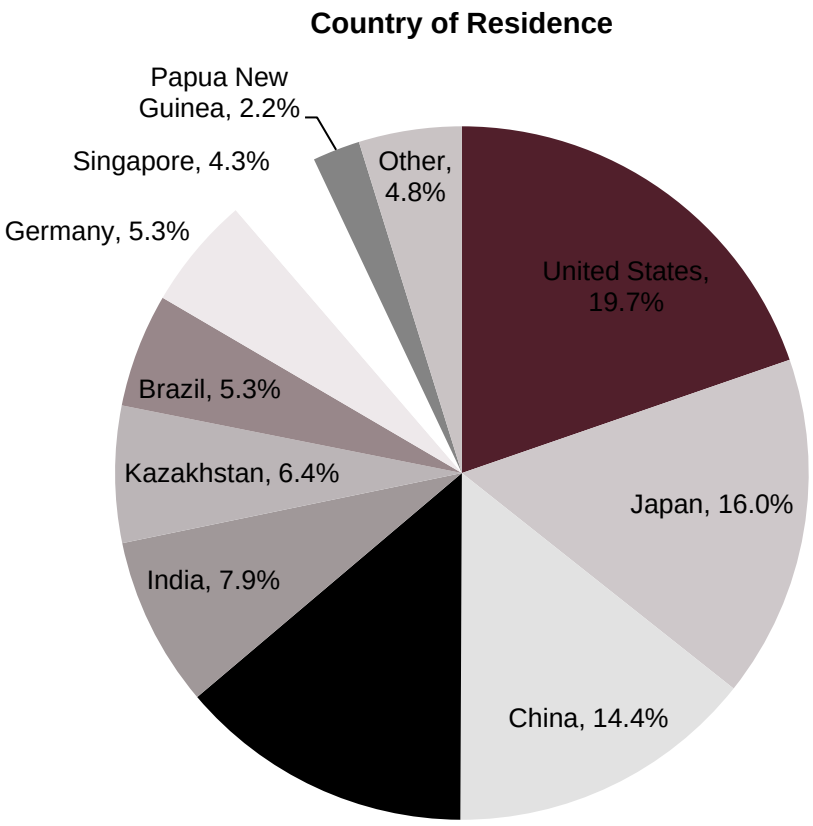
Understanding Attitudes Toward Energy Security

- It is important to understand the factors that shape individual perspectives on energy security.
- The literature suggests that demographic factors play a considerable role in determining perception of and exposure towards energy security.
- However, social identity as influenced by place of residence is also important in shaping perceptions of security.
- Energy security is embedded in factors that constitute the social environment in which individuals are immersed, including everything from education, to access to resources to policy and cultural values of particular places.

Survey Data

- From January 2010 to July 2010, a total of 2,167 surveys were completed providing the measurement of sixteen dimensions of energy security.
- The number of respondents from Russia was too small for inclusion in our cross-national statistical analysis. Thus, our study is limited to ten countries.
- The survey was distributed in seven languages both in print and online.
- The survey results represent the opinions of an informed audience with a mix of demographic characteristics.
- Our survey is biased toward postgraduates and university employees, and countries with more respondents.

Country of Origin



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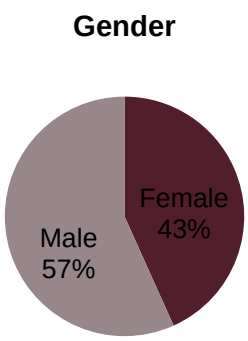
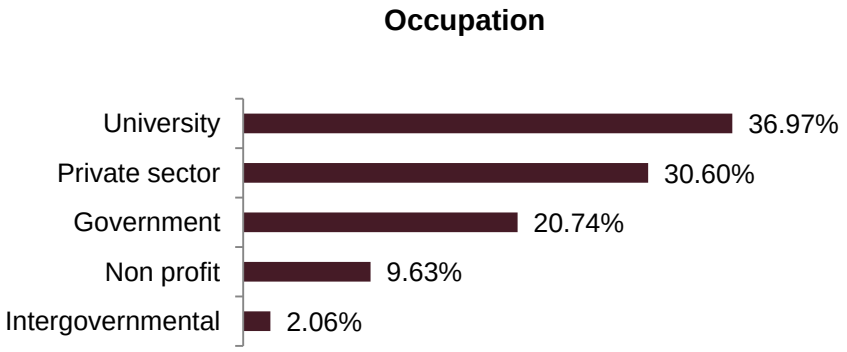
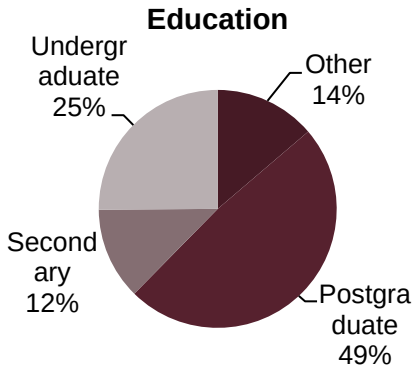
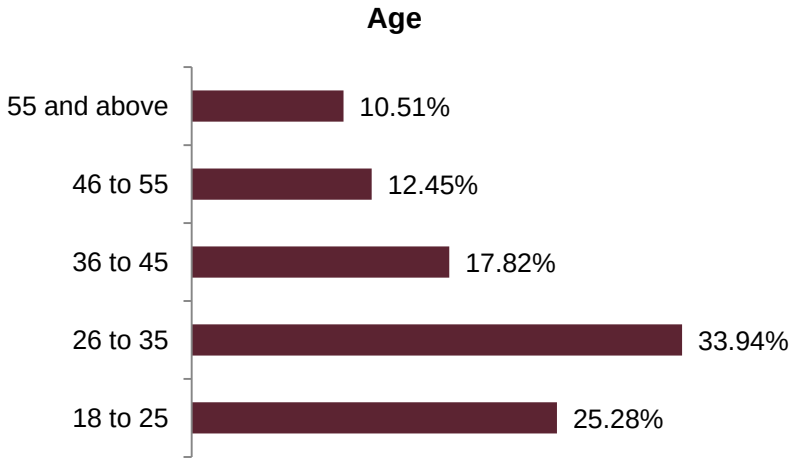
Socio-demographics









- Our survey is biased toward postgraduates and university employees.

The Role of Gender

- The literature:
  - ✓ Women express a significantly greater belief in negative outcomes as a result of climate change than men. The gender gap is indicative of perceived vulnerability to risk.
  - ✓ In the U.S., energy supply security was found to be the top priority for males in all but the younger age groups. For females, the environment and climate is of highest importance regardless of age (Jordan, et al., 2012).

The Role of Gender

- Our findings:
  - ✓ Across the board, women express a greater concern for aspects of energy and climate security than men.
  - ✓ Each of the eight scaled variables is judged to be more important by female than by male responses. The differences are particularly significant for the transparency and affordability scales.

The Range of Energy Security: Sufficiency to Dependency

Sufficiency (Kazakhstan, Saudi Arabia, Papua New Guinea, Brazil–0-25% oil imports)

Dependency: Singapore, Japan, Germany–98-100% oil imports)

Average Country Responses on 8 scales

Variables	Availability Scale	Welfare Scale	Efficiency Scale	Affordability Scale	Environment Scale	Transparency Scale	Climate Scale	Equity Scale	Energy Security Scale
High oil import dependence									
Singapore	4.10	4.34	4.10	4.15	4.41	4.19	4.33	4.28	4.19
Japan	4.31	4.30	4.17	4.24	4.40	4.07	4.29	4.21	4.29
Germany	4.07	4.40	4.40	4.35	4.48	4.27	4.48	4.36	4.33
Moderate oil import dependence									
China	4.38	4.58	4.20	4.23	4.70	4.20	4.59	4.44	4.43
United States	4.17	4.64	4.43	4.35	4.70	4.52	4.60	4.62	4.45
India	4.64	4.70	4.56	4.53	4.77	4.60	4.67	4.70	4.65
Self-sufficient (little to no dependence)									
Kazakhstan	4.55	4.54	4.31	4.37	4.61	4.37	4.40	4.53	4.47
Saudi Arabia	4.57	4.67	4.57	4.62	4.71	4.64	4.58	4.69	4.62
Papua New Guinea	4.61	4.75	4.62	4.67	4.73	4.78	4.68	4.80	4.66
Brazil	4.73	4.83	4.71	4.76	4.87	4.75	4.86	4.81	4.77
Mean	4.41	4.58	4.41	4.43	4.64	4.44	4.55	4.54	4.53

Note: the underlying attitudinal variables used a five-point Likert response scale from 1 = Extremely Unimportant to 5 = Extremely Important.

Conclusions

Perceptions of energy security are shaped by both socio-demographic as well as regional characteristics. Numerous conditions influence the vulnerability of different countries, communities and individuals to different energy security threats.

Since socio-demographic characteristics have a strong impact on vulnerability, perceptions about energy security are likely to be subject to considerable socio-demographic and geographic variation.

These perceptions inform intersubjective understandings of the issue, which in turn shape the political response to the issue. By surveying individuals across a range of geographies, we have begun to establish the intersubjective structures that shape political responses to energy security.

FOR MORE INFORMATION

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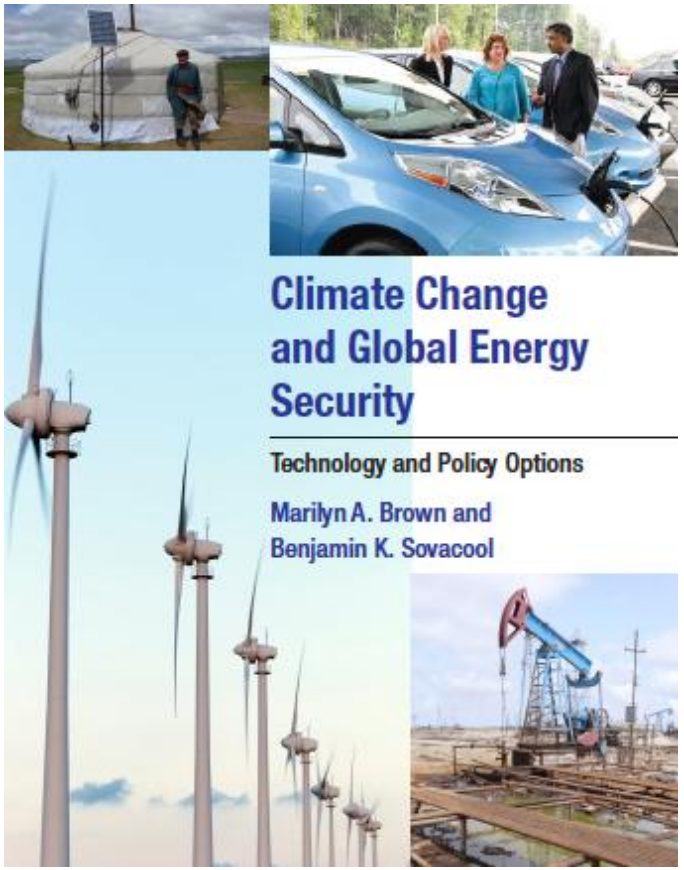

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ACKNOWLEDGMENTS & REFERENCES

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ADDITIONAL TABLES

Energy Security Indicators for 22 OECD Countries in 1970*

	Availability			Affordability		Energy and Economic Efficiency			Environmental Stewardship	
	Oil import dependence (%)	Petroleum transport fuels (%)	Natural gas import dependence (%)	Real electricity retail prices (US¢/kWh)	Real gasoline prices ($/liter)	On-road fuel intensity (gpm)	Energy per GDP intensity (thousand BTU/US$GDP)	Electricity use (kWh/capita)	SO_2 emissions (million tons)*	CO_2 emissions (million tons)
Australia	67%	96.1%	0%	3.7	0.26	0.059	10.3	3,919	1.6	147.63
Austria	57%	94.3%	34%	18.0	1.32	0.048	8.5	3,302	0.4	50.69
Belgium	100%	98.4%	99%	18.5	1.74	0.045	12.2	3,399	1.2	125.62
Canada	46%	97.3%	1%	3.7	0.37	0.071	18.7	9,529	4.1	341.47
Denmark	99%	98.1%	0%	9.5	0.42	0.042	8.8	3,211	0.3	62.15
Finland	100%	97.7%	100%	5.3	0.53	0.045	12.6	4,885	0.4	40.39
France	98%	96.3%	35%	7.9	0.74	0.036	8.7	2,882	3.5	438.98
Germany	92%	96.4%	24%	15.9	1.16	0.042	9.8	2,962	6.9	1,027.00
Greece	99%	98.3%	0%	2.1	0.58	0.048	6.0	1,118	0.3	24.16
Ireland	98%	97.2%	0%	6.9	0.58	0.045	9.0	1,956	0.2	19.41
Italy	97%	98.7%	0%	6.3	0.42	0.036	7.1	2,262	2.6	296.72
Japan	100%	98.2%	32%	48.6	1.27	0.050	7.8	3,445	5.1	768.81
Netherlands	97%	98.0%	0%	15.3	1.00	0.040	12.9	3,110	1.4	141.93
New Zealand	100%	95.6%	0%	3.2	0.48	0.053	11.0	4,941	0.1	14.20
Norway	100%	97.5%	0%	2.6	0.42	0.043	16.4	14,785	0.2	28.01
Portugal	99%	98.0%	0%	20.6	1.59	0.043	4.4	830	0.1	15.26
Spain	99%	97.3%	85%	5.8	0.37	0.037	7.0	1,623	1.1	116.93
Sweden	100%	97.5%	0%	3.2	0.32	0.050	13.7	8,048	0.9	92.37
Switzerland	100%	96.9%	100%	4.0	1.59	0.043	7.6	4,693	0.1	40.29
Turkey	53%	97.7%	0%	21.1	0.11	0.067	5.0	241	0.8	42.64
UK	100%	97.7%	7%	5.3	0.58	0.048	9.9	4,489	8.6	653.06
United States	22%	95.1%	4%	7.0	0.42	0.077	14.7	8,022	31.2	4,412.97
Median	99%	97.5%	1%	6.6	0.56	0.045	9.4	3,351	1.0	104.65
Mean	87%	97.2%	24%	10.7	0.74	0.049	10.1	4,257	3.2	404.58

*For each indicator, the higher the number, the lower the energy security.

Energy Security Indicators for 22 OECD Countries in 2007*

	Availability			Affordability		Energy and Economic Efficiency			Environmental Stewardship	
	Oil import dependence (%)	Petroleum transport fuels (%)	Natural gas import dependence (%)	Real electricity retail prices (US¢/kWh)	Real gasoline prices ($/liter)	On-road fuel intensity (gpm)	Energy per GDP intensity (thousand BTU/US$GDP)	Electricity use (kWh/capita)	SO_2 emissions (million tons)	CO_2 emissions (million tons)
Australia	37%	98.3%	0%	12.5	1.24	0.038	9.0	11,309	2.6	394
Austria	91%	96.3%	95%	22.6	1.81	0.032	7.0	8,090	0.2	66
Belgium	99%	98.1%	100%	16.5	2.20	0.034	9.2	8,688	1.3	103
Canada	0%	98.8%	0%	7.6	1.08	0.043	13.8	16,766	2.9	573
Denmark	0%	97.7%	0%	38.2	2.05	0.033	5.2	6,864	0.1	50
Finland	96%	98.1%	93%	17.1	2.12	0.034	8.8	17,178	0.3	64
France	96%	98.1%	97%	17.3	2.03	0.031	7.2	7,585	1.3	353
Germany	94%	98.1%	79%	23.1	2.10	0.034	7.0	7,175	2.4	790
Greece	99%	98.1%	99%	13.0	1.19	0.034	6.8	5,372	0.8	97
Ireland	100%	98.1%	86%	24.7	1.77	0.034	4.9	6,500	0.1	44
Italy	93%	97.5%	85%	27.2	2.06	0.030	5.8	5,762	1.5	430
Japan	97%	98.2%	93%	17.8	1.46	0.045	6.5	8,220	2.6	1,227
Netherlands	91%	98.1%	59%	24.2	2.28	0.033	9.8	7,057	1.0	179
New Zealand	69%	97.1%	0%	17.8	1.35	0.034	9.1	9,746	0.1	36
Norway	0%	98.1%	0%	17.5	2.32	0.034	12.8	24,295	0.6	36
Portugal	98%	98.1%	100%	23.3	2.07	0.034	5.9	4,799	0.2	55
Spain	98%	98.1%	100%	18.7	1.64	0.032	7.1	6,213	2.1	346
Sweden	99%	98.1%	100%	12.7	1.99	0.036	9.1	15,230	0.3	45
Switzerland	99%	98.1%	100%	15.6	1.65	0.034	5.8	8,279	0.1	38
Turkey	94%	96.3%	97%	15.8	2.60	0.034	6.1	2,053	2.1	266
UK	4%	96.3%	8%	22.7	2.07	0.032	6.0	6,192	1.6	524
United States	59%	97.1%	17%	10.3	0.82	0.050	9.1	13,515	17.8	5,725
Median	94%	98.1%	90%	17.7	2.01	0.034	7.1	7,838	1.2	141
Mean	73%	97.8%	64%	18.9	1.81	0.036	7.8	9,404	1.9	520

*For each indicator, the higher the number, the lower the energy security.

Changes in Energy Security Z-Scores (1970 to 2007) highlight "unique" approaches*

	Availability			Affordability		Energy and Economic Efficiency			Environmental Stewardship		
	Oil import dependence	Petroleum transport fuels	Natural gas import dependence	Nominal electricity retail prices	Nominal gasoline prices	On-road fuel intensity	Energy per GDP Intensity	Electricity use	SO2 emissions	CO2 emissions	Final score
Australia	0.051	-1.731	0.835	0.310	0.271	0.336	-0.455	-0.474	-0.432	-0.169	-1.460
Austria	-1.808	-0.459	-0.436	0.140	1.200	0.614	-0.083	-0.031	0.041	0.000	-0.823
Belgium	-0.117	0.580	1.206	1.108	1.209	-0.050	-0.022	-0.119	-0.139	0.050	3.706
Canada	0.094	-1.388	0.862	1.050	0.847	0.435	-0.232	0.152	-0.140	-0.111	1.568
Denmark	2.436	0.888	0.835	-3.022	-1.173	-0.155	0.778	0.181	0.053	0.026	0.847
Finland	-0.039	-0.036	1.395	-0.233	-1.101	-0.050	0.261	-1.330	0.014	-0.009	-1.128
France	-0.127	-1.269	-0.455	-0.017	-0.473	-0.261	-0.115	-0.059	0.206	0.176	-2.394
Germany	-0.340	-1.181	-0.337	-0.135	0.237	-0.396	0.273	0.045	0.416	0.440	-0.979
Greece	-0.162	0.492	-1.447	0.083	1.037	0.147	-0.681	-0.159	-0.137	-0.054	-0.880
Ireland	-0.232	-0.476	-1.147	-1.229	-0.232	-0.050	0.963	-0.127	0.038	-0.015	-2.508
Italy	-0.093	1.702	-1.124	-1.664	-1.195	-0.063	0.053	0.110	0.017	-0.040	-2.297
Japan	-0.065	0.261	-0.444	3.764	1.863	-1.935	-0.058	-0.014	0.092	-0.200	3.265
Netherlands	-0.040	0.228	-0.525	-0.358	-0.486	-0.307	-0.090	0.113	-0.027	0.004	-1.488
New Zealand	0.670	-0.457	0.835	-0.541	0.482	0.605	-0.307	0.140	0.023	-0.014	1.436
Norway	2.480	-0.212	0.835	-0.549	-1.764	-0.231	-0.429	0.267	-0.098	0.001	0.300
Portugal	-0.135	0.228	-1.470	0.280	1.185	-0.231	-0.730	-0.134	-0.004	-0.028	-1.039
Spain	-0.135	-0.388	0.828	-0.427	-0.379	-0.352	-0.537	-0.171	-0.371	-0.162	-2.095
Sweden	-0.117	-0.212	-1.470	0.233	-1.247	0.107	0.432	0.005	0.089	0.063	-2.119
Switzerland	-0.117	-0.741	1.233	-0.130	2.104	-0.231	0.190	0.351	0.023	0.012	2.696
Turkey	-2.063	2.535	-1.401	1.460	-3.013	1.886	-0.652	0.225	-0.416	-0.175	-1.614
UK	2.375	2.535	0.840	-1.079	-0.889	0.614	0.733	0.698	0.888	0.262	6.977
United States	-2.515	-0.898	0.551	0.955	1.518	-0.431	0.706	0.333	-0.135	-0.056	0.029

*Negative numbers indicate worsening energy security trends relative to other OECD countries.

Country Profiles of Key Characteristics

Country	Per capita carbon footprint (tCO2/capita)	Energy Intensity (Total Primary Energy Supply /GDP) (toe/$1000)[a]	TPES per capita (toe/capita)	Electricity Consumption per capita (kWh/capita)	% petroleum import	Gross national income per capita [b] ($)	Electricity retail prices for household ($/kWh)	Polity Score	Freedom Rating	Income Gini Coefficient (%, 2000-2010)
High oil import dependence										
Singapore	9.7	0.13	3.83	8,186	100.0%	48,893	0.19	-2	4.5	42.5
Japan	9	0.14	3.88	8,072	99.8%	34,692	0.206	10	1.5	24.9
Germany	9.8	0.14	4.08	7,148	98.0%	35,308	0.263 [c]	10	1	28.3
Moderate oil import dependence										
China	4.9	0.81	1.6	2,453	50.4%	7,258	0.076	-7	6.5	41.5
United States	18.4	0.19	7.5	13,647	68.7%	47,094	0.113	10	1	40.8
India	1.3	0.75	0.54	566	79.3%	3,337	0.047 [d]	9	2.5	36.8
Self-sufficient (little to no dependence)										
Kazakhstan	12.9	1.9	4.52	4,689	24.8%	10,234	0.052	-6	5.5	30.9
Saudi Arabia	15.8	0.64	6.56	7,576	0.0%	24,726	-	-10	6.5	-
Papua New Guinea	0.7	0.16	0.31	47	0.0%	2,227	-	4	3.5	50.9
Brazil	1.9	0.15	1.29	2,232	21.6%	10,607	0.171	8	2	55
Median	9.7	0.19	3.88	6,443	37.6%	15,258	0.142	4	3.5	41.15

Highest and Lowest Rated Dimensions of Energy Security

Country	Highest rated	Second highest rated	Third highest rated	Fourth highest rated	Lowest rated	Second lowest rated	Third lowest rated	Fourth lowest rated
High oil import dependence								
Singapore	Water availability	Air pollution	Energy R&D	Security of supply	Energy decentralization	Domestic fuel depletion	Transparency in energy decisions	Energy intensity
Japan	Air pollution	Energy R&D	Land degradation	Security of supply	Energy decentralization	Transparency in energy decisions	Education	Equitable distribution
Germany	Energy R&D	Climate change mitigation	Energy intensity	Land degradation	Security of Supply	Domestic fuel depletion	Transparency in energy decisions	Price stability
Moderate oil import dependence								
China	Security of supply	Land degradation	Air pollution	Water availability	Energy decentralization	Trade	Education	Transparency in energy decisions
US	Water availability	Energy R&D	Air pollution	Land degradation	Energy decentralization	Domestic fuel depletion	Affordability	Security of supply
India	Water availability	Security of supply	Energy R&D	Land degradation	Energy decentralization	Price stability	Equitable distribution	Energy intensity
Self-sufficient (little to no dependence)								
Kazakhstan	Water availability	Land degradation	Air pollution	Security of supply	Energy decentralization	Energy intensity	Climate change adaptation	Transparency in energy decisions
Saudi Arabia	Water availability	Air pollution	Security of supply	Energy R&D	Depletion	Energy intensity	Transparency	Decentralization
Papua New Guinea	Water availability	Land degradation	Affordability	Equitable distribution	Domestic fuel depletion	Energy intensity	Energy decentralization	Trade
Brazil	Energy R&D	Land degradation	Water	Climate change mitigation	Energy decentralization	Energy intensity	Transparency in energy decisions	Domestic fuel depletion

Note: Cells in the same color code indicate they rank the same.

Energy Policy Profiles

Country	Energy Education Programs	Energy Use in Buildings			Renewable Energy			Transport			Climate Change Action Plan
		Building Energy Standards	Solar Water Heating	Combined Heat and Power Incentives	Electricity Target/ Portfolio Standard	Feed-in Tariff	Investment /Production Tax Credits	Biofuel Blending Mandates	Congestion Pricing	Clean Vehicle Mandates	
High oil import dependence											
Singapore	?	X	?	?	?			?	X		X
Japan	X	X	X	X	X	X				X	X
Germany	X	X	X	X	X	X	X	X		X	X
Moderate oil import dependence											
China	X	X	X	?	X	X		X		X	X
United States	X	X	X	X			X	X		X	?
India	?	X	?	X	X	X	X	X			X
Self-sufficient (little to no dependence)											
Kazakhstan	?	?	?	?	?	X		?	?	?	?
Saudi Arabia	?	?	?	?	?	?	X?	?	?	?	?
Papua New Guinea	?	?	X	?	?	?	?	X	?	?	?
Brazil	?	?	?	?	X	X		X		X	X

Sources: (Cory et al., 2009; DSIRE, 2011; International Energy Agency, 2011b; Reiche, 2010; REN21, 2011; Singapore Ministry of Trade and Industry, 2007; World Bank, 2004; World Future Council, 2007)