

Meta-analysis of Energy Innovation System of 40 Countries ~~X~~

39

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**A TRADITION OF
INDEPENDENT
THINKING**



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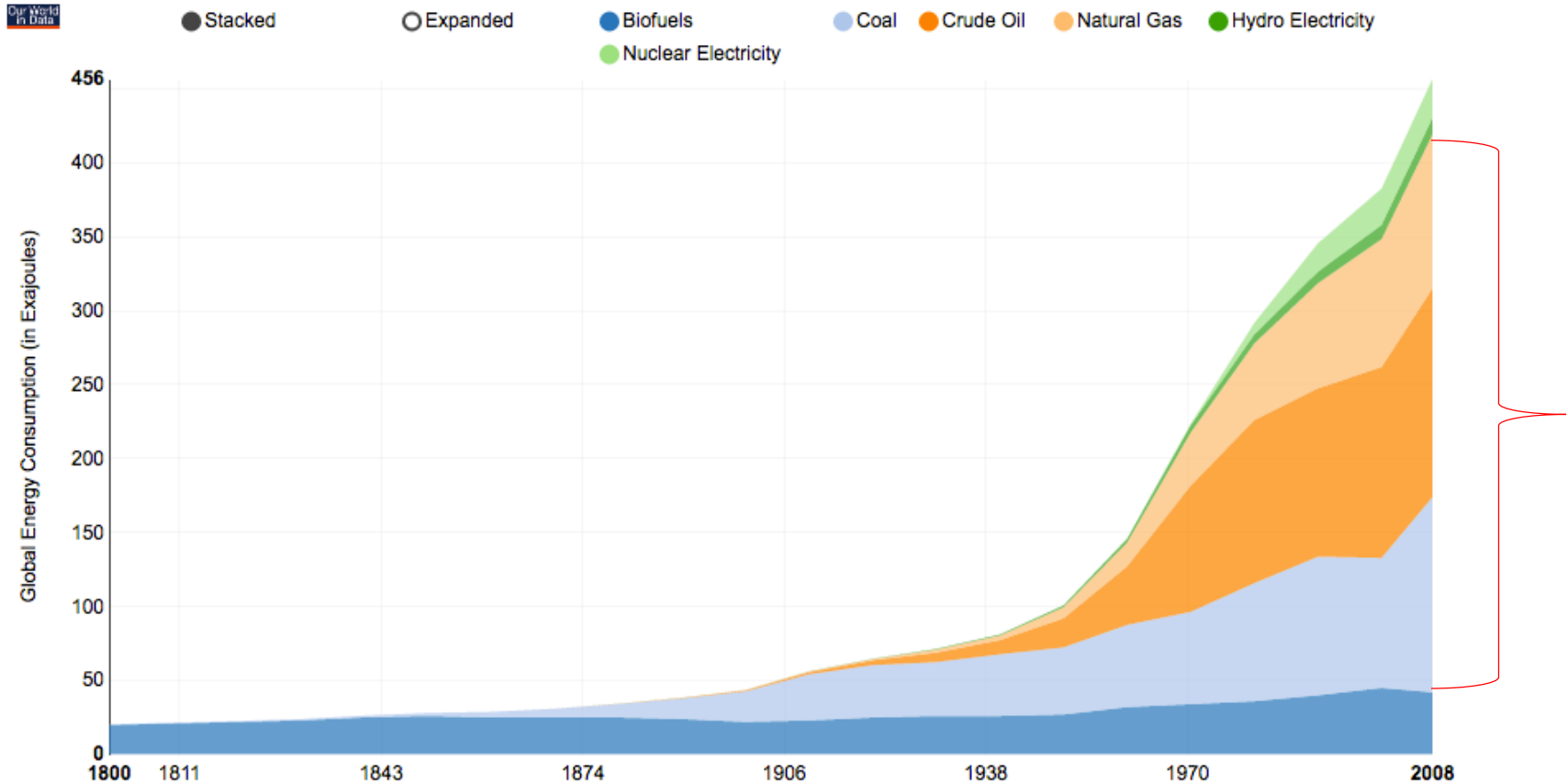
39 Countries



Argentina	Finland	Japan	Singapore
Australia	France	Korea	Slovenia
Austria	Germany	Mexico	South Africa
Belgium	Greece	Netherlands	Spain
Brazil	Hungary	Norway	Sweden
Bulgaria	India	Poland	Switzerland
Canada	Indonesia	Portugal	Turkey
China	Ireland	Romania	UK
Czech Republic	Israel	Russia	USA
Denmark	Italy	Saudi Arabia	

Challenge

Energy transition: decarbonize in a generation?



Source: <https://ourworldindata.org/>

Methodology

Energy transition: decarbonize in a generation?

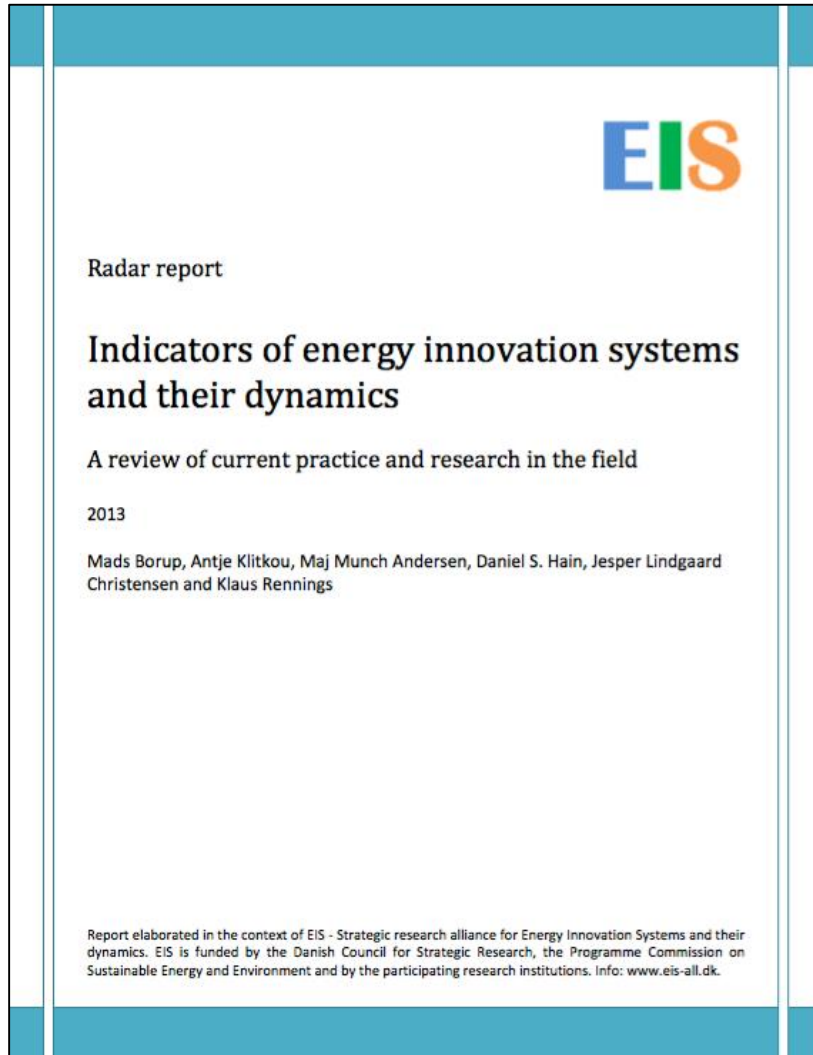
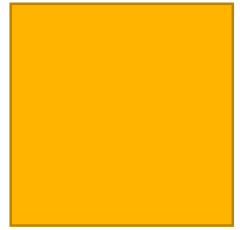
Energy Innovation System

- Policy context
 - Legislative context
 - Human capacity
 - Knowledge
 - Finance & investors
 - Business & entrepreneurship
 - Communities
 - Society/Values
- ### Energy System

 - Model technology pathways to 2050, 2100
 - Decarbonization technically feasible, but...

Methodology

Energy innovation system indicators

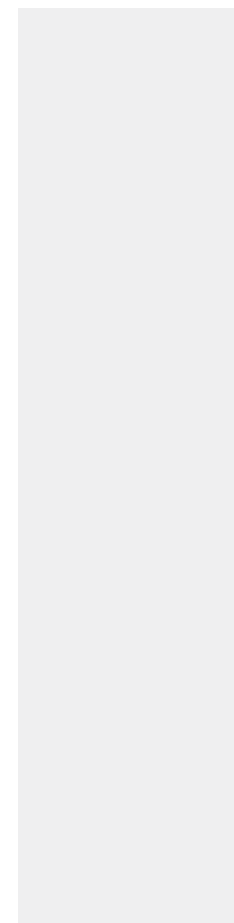
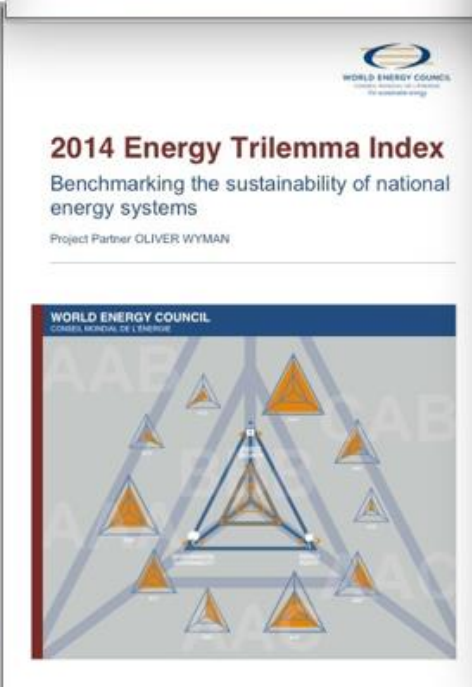
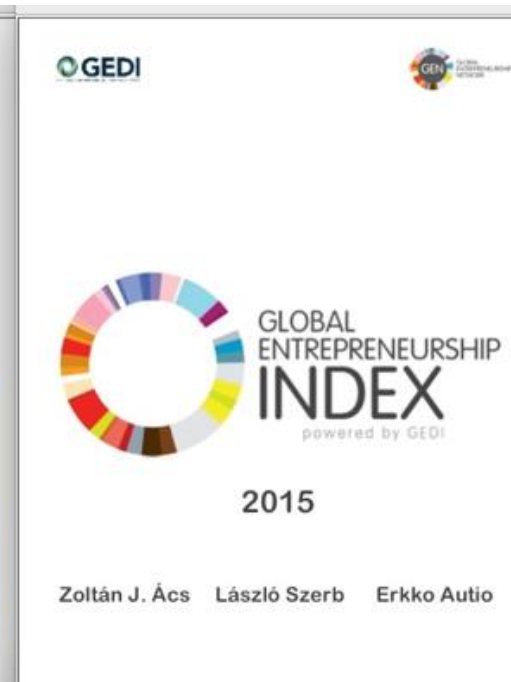


Different perspectives

- Research focused
- Firm focused
- Changed focused

Different indicator types

- Input
- Output
- Throughput



Innovation

- Political, regulatory & business environment
- Tertiary education
- R&D
- ICT infrastructure
- Ecological sustainability
- Credit
- Investment
- Innovation linkages
- Knowledge creation

Competitiveness

- Institutions
- Infrastructure
- Macroeconomics
- Health, education & training
- Goods market efficiency
- Labor market efficiency
- Financial markets
- Technological readiness
- Market size

Entrepreneurship

- Opportunity Perception
- Startup Skills
- Risk Acceptance
- Networking
- Cultural Support
- Opportunity Startup
- Technology Absorption
- Human Capital
- Competition
- Product/Process Innovation
- Process Innovation
- High Growth
- Internationalization
- Risk Capital

Cleantech

- General Innovation Drivers
- Cleantech-Specific Innovation Drivers
- Evidence of Emerging Cleantech Innovation
- Evidence of Commercialised Cleantech Innovation

Energy

- Energy Security
- Energy Equity
- Environmental Sustainability
- Political Strength
- Societal Strength
- Economic Strength

Environment

- Health Impacts
- Air Quality
- Water and Sanitation
- Water Resources
- Agriculture
- Forests
- Fisheries
- Biodiversity and Habitat
- Climate and

Research Question 1

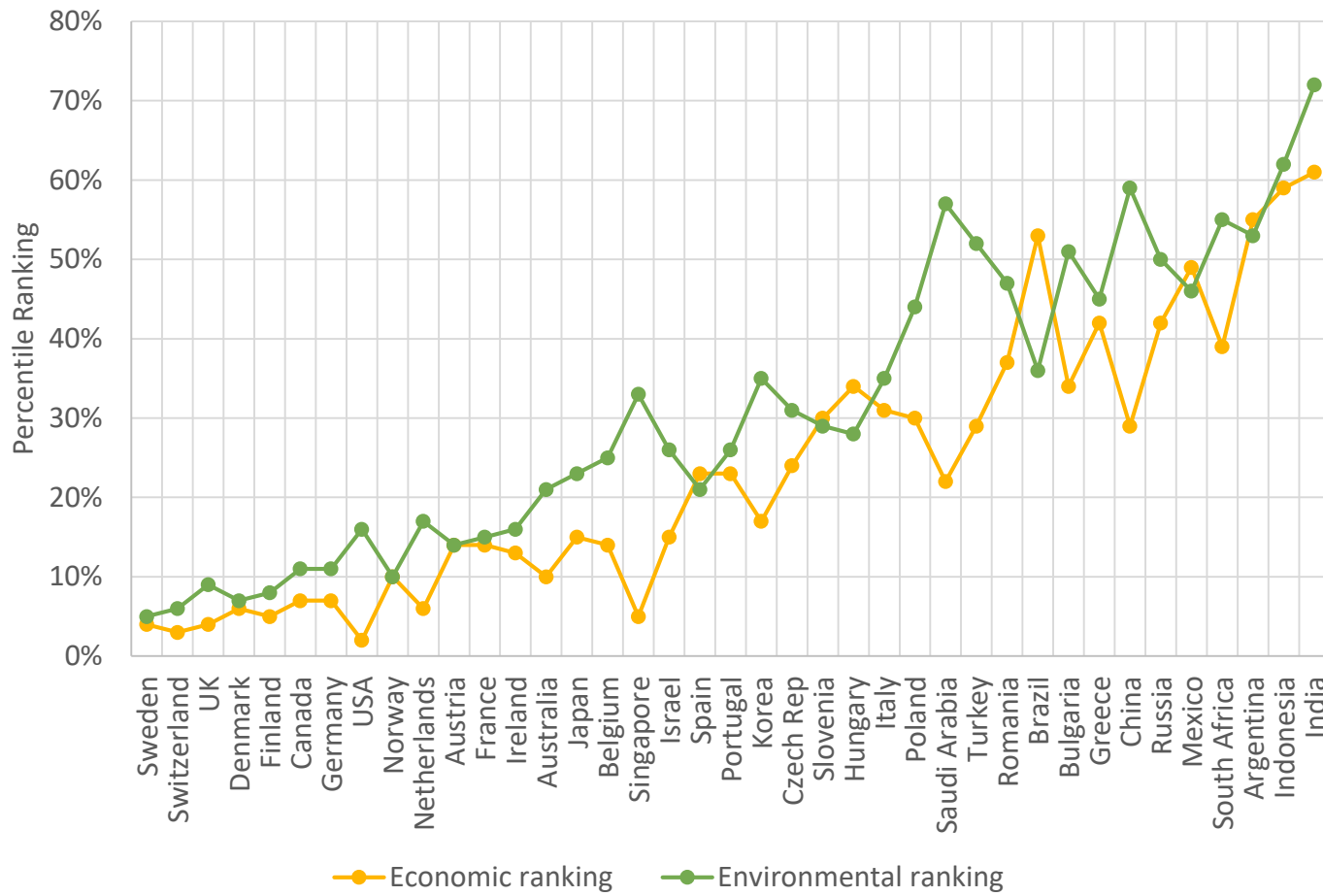
Research Question

- Are countries that are ranked highest for **economic metrics** (i.e. innovation, competitiveness, and entrepreneurship) also ranked highest for **environmental metrics** (i.e. energy sustainability, clean-tech, environmental performance)?

Methodology

1. For 39 countries, what are rankings for six metrics?
2. Convert to rank percentiles
3. Average performance for **economic metrics** & **environmental metrics**

Percentile ranking: economic & environmental performance

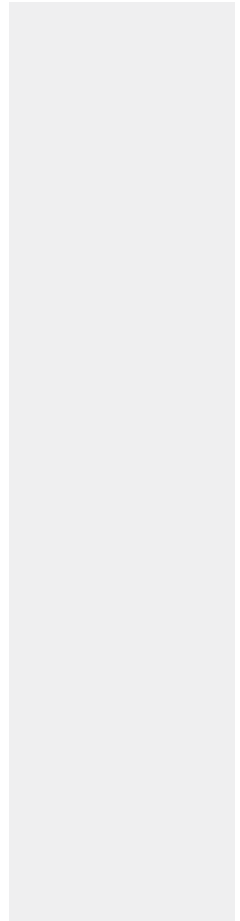


$R^2 = 0.81$

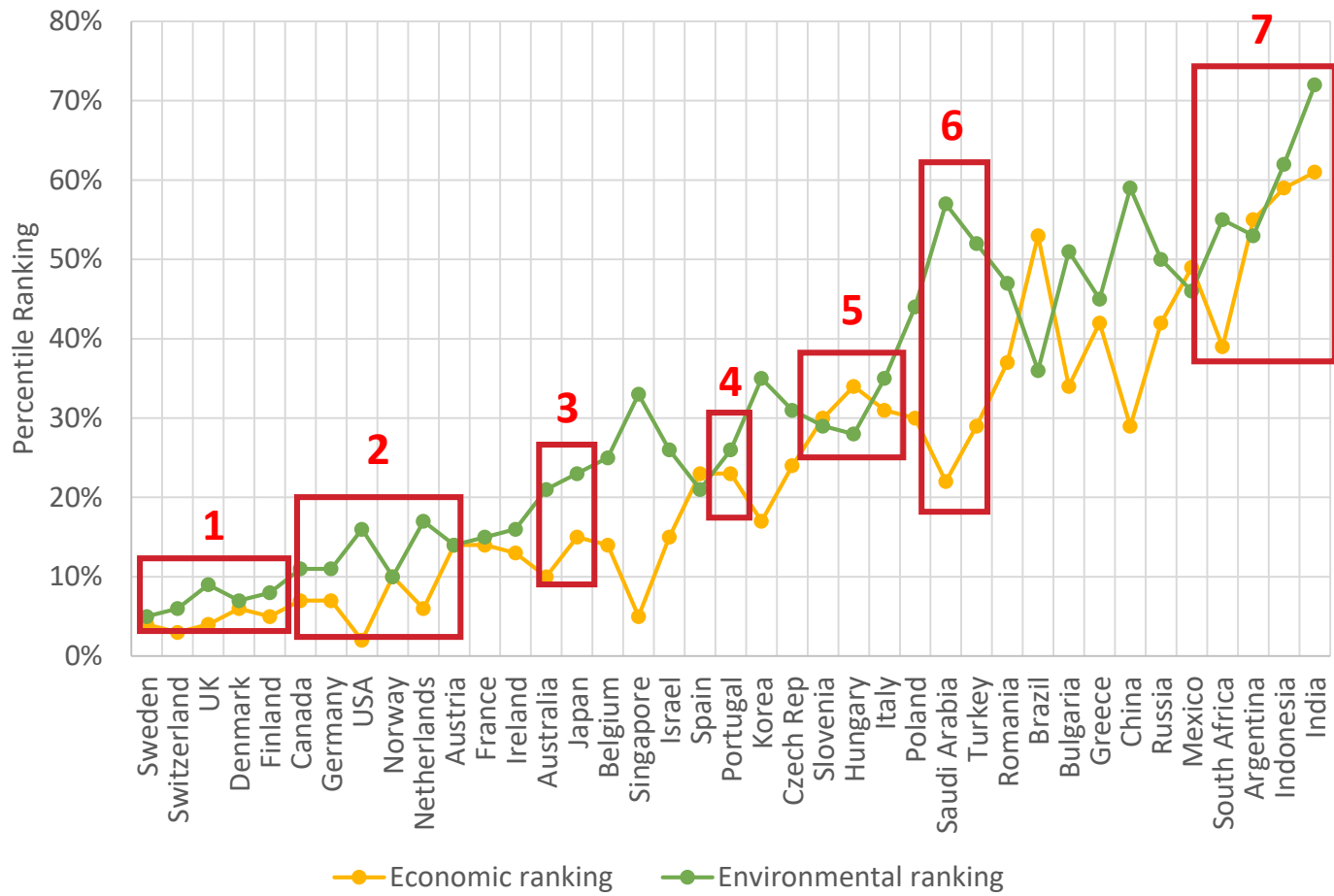
Country categories



- Scoring distribution for:
 - Economic
 - Environmental
- Scoring distribution for:
 - Innovation
 - Competitiveness
 - Entrepreneurship
 - Environmental
 - Energy
 - Cleantech
- Are the scoring distributions consistent or divergent?



Country categories



Country Categories



	Category	Description
1	TOP (consistent)	Consistently high scoring or top ranking on all or nearly all metrics
2	TOP (exceptions)	Consistently high scoring or top ranking with notable exception of one or two moderate scores
3	MODERATE (exceptions-high)	Moderate rankers with exception of one or two top score
4	MODERATE (consistent)	Moderate rankers with consistent moderate scoring on all nearly metrics
5	MODERATE (exceptions-low)	Moderate rankers with notable exception of one or two very low score
6	CATEGORY DIFFERENCE	Very high economic score with very low environmental score
7	LOW	Consistently lowest scorers and rankers on nearly all metrics

Research Question 2

Research Question

- What are the key explanatory variables underlying the innovation, competitiveness, entrepreneurship metrics and environmental performance, energy sustainability and cleantech metrics?

Methodology

1. Country categories and individual countries
2. Ranking, scoring and performance for key energy innovation system metrics
3. Cross-check with IEA & OECD energy data

TOP ranking_consistent



Countries

- Sweden
- Switzerland
- UK
- Denmark
- Finland

Characteristics

- Long-term energy/climate plan
- Limited fossil fuel reserves; higher levels of renewables; often hydro
- R&D budgets more likely to be renewables focused (IEA data)
- Score high for environment; negative health effects minimal
- Technology developers and exporters (not necessarily energy)
- Entrepreneurship scores high; though commercialisation challenges for cleantech remain
- Within-country collaboration levels (university-industry) generally high; international collaboration levels not top ranked

TOP ranking_exception



Countries

- Canada
- Germany
- USA
- Norway
- Austria
- France

Characteristics

- Less likely to have long-term energy/climate plan
- Most countries significant energy exporters
 - Partial lock-in from energy tax take high ranking
- R&D budgets slightly more peaky and less likely focused on renewables than top ranking countries
- Environmental scores are high, though some negative side-effects on air quality & health
- Technology developers and exporters (not necessarily energy)
- Very high or top entrepreneurial rankings; not reflected in cleantech commercialisation ranking

MODERATE ranking_exception_high



Countries

- Netherlands
- Australia
- Japan
- Israel
- Spain
- Czech Republic

Characteristics

- Tend not to have long-term energy/climate plan
 - Decade prior to 2011, Japan had a “de-facto” long-term nuclear plan
- Varied scoring distribution: weaknesses impacting strengths
- Japan & Israel score very differently for entrepreneurship & competitiveness
- Low entrepreneurship rankings for Japan severely weaken impact of world leading energy R&D spend
- High entrepreneurship ranking for Israel, especially for cleantech; low for energy sustainability (especially due to absence of a long term plan)
- Netherlands, Spain and Czech Republic all score high for environment, but low for cleantech
- Some countries world leaders in technology development (including, but not necessarily in energy)

MODERATE ranking_consistent



Countries

- Ireland
- Belgium
- Portugal
- Korea
- Hungary
- Italy

Characteristics

- No long-term energy/climate plans
 - Policy instability is likely to be high ranking “problematic factors for doing business” (competitiveness indicator)
- Not energy producing countries (have energy import dependency)
- Consistent moderate-high scoring on economic & environmental metrics
- Some technology exporters, but some successful followers too, e.g. Portugal & Ireland (for wind energy)
- Moderate energy R&D spenders (exception, Korea)
- Korea (similar to Japan), high ranking for patents and R&D spend, but low ranking for entrepreneurship
- Environmental scoring main weakness is air quality with associated health impacts

MODERATE ranking_exception_low



Countries

- Slovenia
- Poland
- Romania
- Brazil
- Bulgaria
- Greece
- Russia
- Mexico

Characteristics

- No long-term energy/climate plans
- Likely to be large energy exporters (with associated carbon lock-in from high energy tax take)
- Environmental degradation and air pollution and link to health evident, especially for indoor air quality
- Quality of electricity negatively affecting economy and society; though energy access not generally a problem
- Quality of governance and institutions having a negative impact; corruption rated as a barrier to business
- Partial or negligible cleantech investment; cleantech R&D budgets low or zero (indigenous capacity in terms of renewables very low)
- Entrepreneur scores: institutional lower than individual

Category difference



Countries

- Singapore
- Saudi Arabia
- Turkey
- China

Characteristics

- Countries with large energy reserves (exception, Singapore) with carbon lock-in and high energy tax take lock-in
- Environmental, energy, climate considerations demoted in preference to economic metrics
- Consequences for environment, air quality, health (e.g. child mortality) very negative
- Very little or contradictory investment in cleantech
- Quality of electricity system negatively affecting quality of life

LOW



Countries

- South Africa
- Argentina
- Indonesia
- India

Characteristics

- All countries have less than 100% access to electricity (75%-94%).
- Negative environmental impacts from lack of
 - Electricity access
 - Technology access (e.g. indoor air pollution from biomass burning)
- Energy access a pressing issue, e.g. Argentina net energy exporter even though 12% of population have no access to electricity
- Lack of access to capital, financial and human
- Quality of institutions and governance poor
- Entrepreneurial indicators: higher for individual than institutional
- Water system/quality also poor

Conclusions

- Importance of a long-term plan
- Different challenges for different types of countries
- Carbon lock-in
- Role of entrepreneurship
- Governance challenges

Next steps

- Deepen the analysis, continue to sense-check and formalise results
- Extend the analysis of different country types
- Extend the analysis on entrepreneurship within the energy innovation system

Thank you

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