



UNITED NATIONS
Economic Commission for Europe



COMMITTEE ON SUSTAINABLE ENERGY

ENERGY SECURITY AND THE FINANCIAL CRISIS

18-20 November 2009

Indicators of Energy Vulnerability

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Concerns about Energy Insecurity Risks

- High volatility of energy prices increases the perceived risks for investments in energy sector
- Global financial crisis worsens the situation
- Reserve margins of energy transformation capacities increase initially due to reduced energy demand. However, they will shrink significantly when the economic growth will resume.

Concerns about Energy Insecurity Risks

- Increasing energy demand may result in the rise of energy prices, and that may be even worse in the case of geopolitical tensions
- On the other hand, surging energy prices may contribute to the reduction of energy demand due to slowdown of the economic growth
- Due to the link between oil prices, economic growth and energy sector investments, the energy supply systems are becoming more and more instable and vulnerable (Bust and Boom effect)

Energy Insecurity Risks and WEC Activities

- *Europe's Vulnerability to Energy Crises* – Report issued in 2007
- *Assessment of Energy Policy and Practices (AEPP)* - Report published in October 2009 under the title « World Energy and Climate Policy » 2009 Assessment
- *Indicators of Energy Vulnerability* – Report of the UNECE based on collaborative work with the WEC

Objectives and Scope

- **Application of the WEC indicators of energy vulnerability to the selected UNECE countries**
- **Feasibility of the energy vulnerability assessment of all UNECE member states**
- **Investigation how the energy vulnerability indicators can enhance the energy security dialogue**

Assessment Framework

Sustainable energy policies to mitigate energy insecurity risks, an indicators system based on resilience: three levels

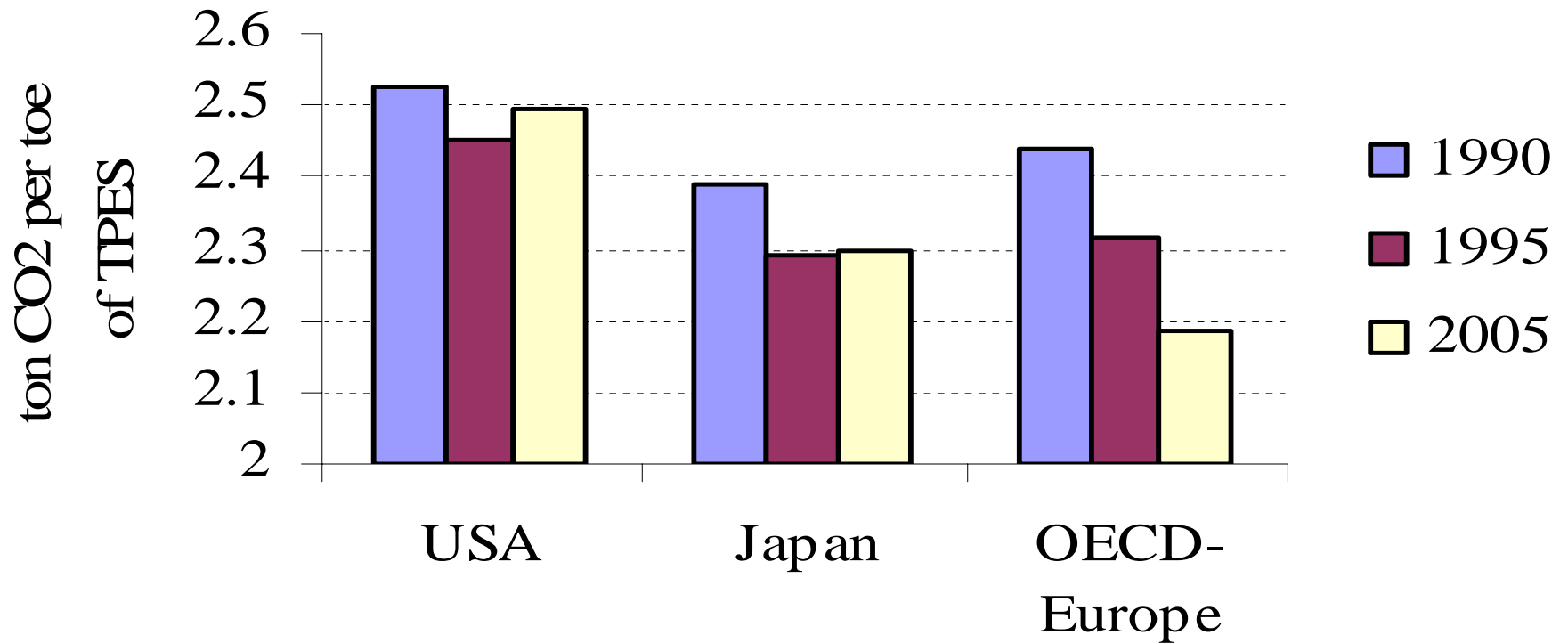
- Economy
- Environment
- Society

Assessment Framework: Economy Level

Economy sub-levels	Indicators	Quantitative vs qualitative
Macroeconomic sub-level	<i>Energy intensity</i>	quantitative
	<i>Energy dependence</i>	quantitative
	<i>Sensitivity to volatility of energy prices</i>	qualitative
Microeconomic sub-level	Consumer perspective <ul style="list-style-type: none"> - Stock requirements in short term per fuel and type of consumers - Vulnerability of electricity delivery 	qualitative
	Supplier perspective <ul style="list-style-type: none"> - Vulnerability related to electr. unbundling - Vulnerability related to electr. cross-border exchanges - Vulnerability related to reliance on fossile fuel for transportation - Vulnerability related to energy regulatory uncertainty 	qualitative

Assessment Framework: Environment Level

CO₂ Intensity of the TPES



Assessment Framework: Society Level

- Fuel poverty (qualitative)
- Risk of social rejection of energy technology, e.g. nuclear (qualitative)

Design of Indicators System

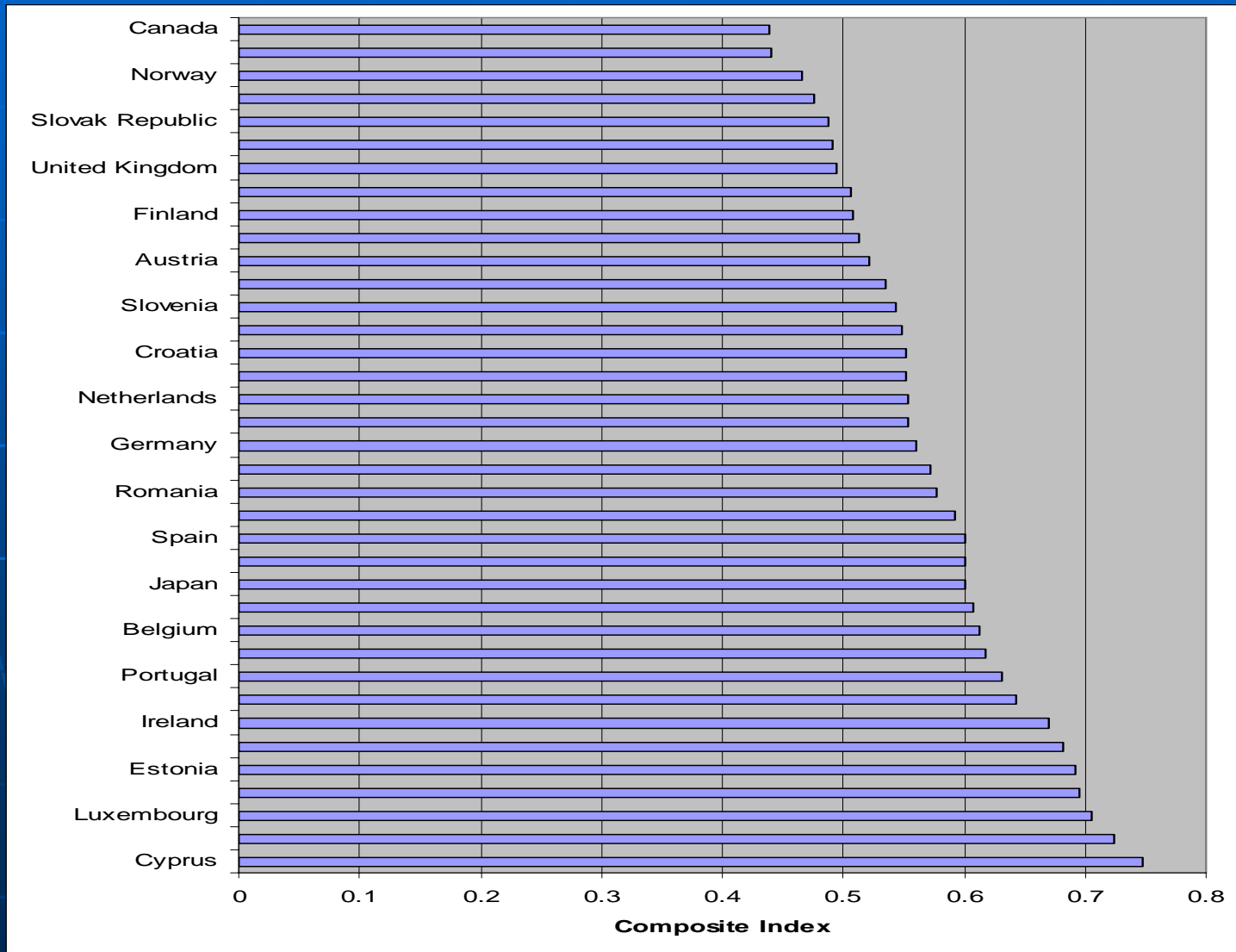
➤ Five vulnerability measures

- *Energy intensity (1)*
- *Adjusted Oil and Gas imports dependence taking into account diversity of import origins and geopolitical risks (2)*
- *Carbon intensity of TPES (3)*
- *Electricity supply risks taking into account non diversity of electricity generation mix and potential social rejection of large dominant and risky technologies (4)*
- *Non-diversity in transport fuels (5)*

Design of Indicators System

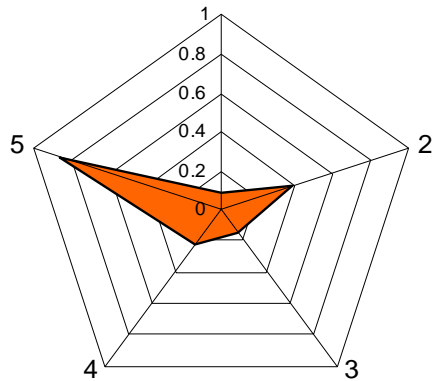
- Indicators are normalised between 0 and 1
- An aggregated index of energy vulnerability is assessed based on the distance to the ideal case

Pilot Implementation (37 countries, year 2003 data)

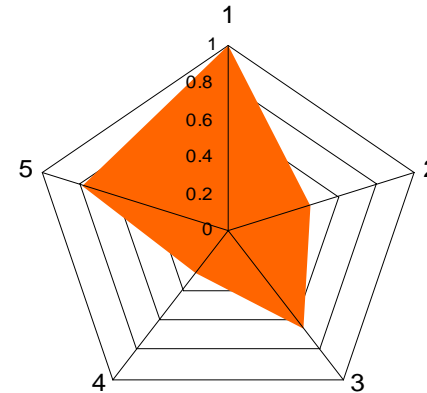


Pilot Implementation

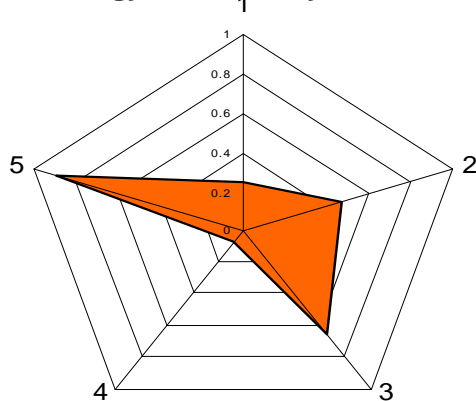
Energy Vulnerability of Sweden



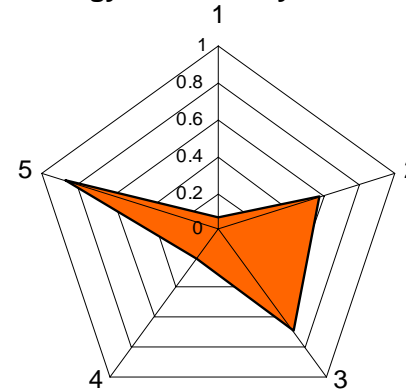
Energy Vulnerability of Bulgaria



Energy Vulnerability of Croatia



Energy Vulnerability of Germany



Pilot Implementation

Country rank	Strengths	Weaknesses
Sweden (2 nd)	<i>Carbon intensity of TPES</i>	Low diversity of electricity generation based only on hydro and nuclear
Croatia (15 th)	<i>Electricity supply (5th)</i>	Energy intensity (28 th)
		Carbon intensity of TPES (26 th)
Germany (19 th)	<i>Energy intensity (9th)</i>	Oil and gas diversity (22 nd)
	<i>Transport fuels diversity (9th)</i>	Carbon intensity of TPES (24 th)
Bulgaria (32 nd)	<i>Transport fuels diversity (5th)</i>	High Energy intensity (37 th)
		High carbon intensity of the TPES (23 nd)
		Electricity vulnerability (25 th)

Main Findings

- All countries exhibit low performance for *transport fuels diversity*
- *Energy intensity* is low for most of the countries except for economies in transition such as Bulgaria, Croatia, ...
- *Oil and gas import dependence* and *CO₂ intensity of TPES* are the most discriminative indicators

Feasibility of Extension to all UNECE Member States

Data	Description	Sources	Availability	References
Total Primary Energy Supply TPES	Energy production + net import – net input to international marine and aviation bunkers – net input to stock	International Energy Agency (IEA)	High	IEA (2009a) EA (2009b)
Energy Intensity	Ratio of TPES to the Gross Domestic Product (GDP)	International Energy Agency (IEA)	High	idem
Ratio of net oil import to the TPES	Contribution of net oil import to the TPES	International Energy Agency (IEA)	High	idem
Petroleum Stocks	The stocks include : crude oil (including strategic reserves) natural gas plant liquids, refinery feedstocks, additives and oxygenates, other hydrocarbons, and refined petroleum products.	Energy Information Administration (EIA)	Average	Energy Information Administration (EIA)
Ratio of net gas import to the TPES	Net import gas is imports of Natural gas minus exports	International Energy Agency (IEA)	High	IEA (2009a) IEA (2009b)

Data	Description	Sources	Availability	References
Share of various origins in the net oil import	Distribution of the net oil import between the different import origins	International Energy Agency (IEA)	Average	IEA (2009c)
Share of various origins in the net gas import	Distribution of the net gas import between the different import origins	International Energy Agency (IEA)	High	IEA (2009d)
Ratio of the CO ₂ emissions to the TPES	CO ₂ are from fuels combustion, for biofuels combustion the emission factors are based on <i>IPCC Guidelines</i>	International Energy Agency (IEA)	High	IEA (2009e) IEA (2008)
Self-sufficiency in electricity supply	Ratio of electricity generation to apparent electricity consumption	International Energy Agency (IEA)	High	IEA (2009a) IEA (2009b) IEA (2009f)
Electricity generation mix	Annual electricity generation by fuel type	International Energy Agency (IEA)	High	IEA (2009f)
Transport fuels mix	Transport energy consumption by fuel type	International Energy Agency (IEA)	High	IEA (2009a) EA (2009b)
Energy affordability	Energy expenses related to the income of a vulnerable household	Research works	Low	e.g. Fankhauser and Tepic (2007)

Enhancing Energy Security Dialogue: Potential Role of Indicators

- **Quantify improvement of mutual energy security with regard to secure energy trade among the member states**
- **Benchmark the national efforts and identify best practices among the member states**
- **Promote Public/Private initiatives for securing investment environment in energy sector in order to cope with the uncertainties induced by energy prices volatility and financial crises**

Enhancing Energy Security Dialogue: Potential Role of Indicators

➤ Promote common initiatives for :

- improving diversity in transportation fuels mix
- fostering R&D on clean fossil fuels and renewable energy technologies
- improving the safety of nuclear power plants
- enhancing safe transit of energy
- reinforcing interconnection network among the member states

Enhancing Energy Security Dialogue: Potential Role of Indicators

Develop the indicators system not only for analysis of the past and present situations, but also as a tool for simulating the potential outcomes of enhanced energy security dialogue