

ASSESSING EU MEMBER STATES' VULNERABILITY TO SECURITY OF ENERGY SUPPLY: BEYOND THE AVAILABLE INDICATORS.

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- Introduction
- the SECURE project
- Energy security indicators
- Dependence indicators for oil and gas
- Vulnerability indicators for oil and gas
- Summarising indicators' information
- Conclusions

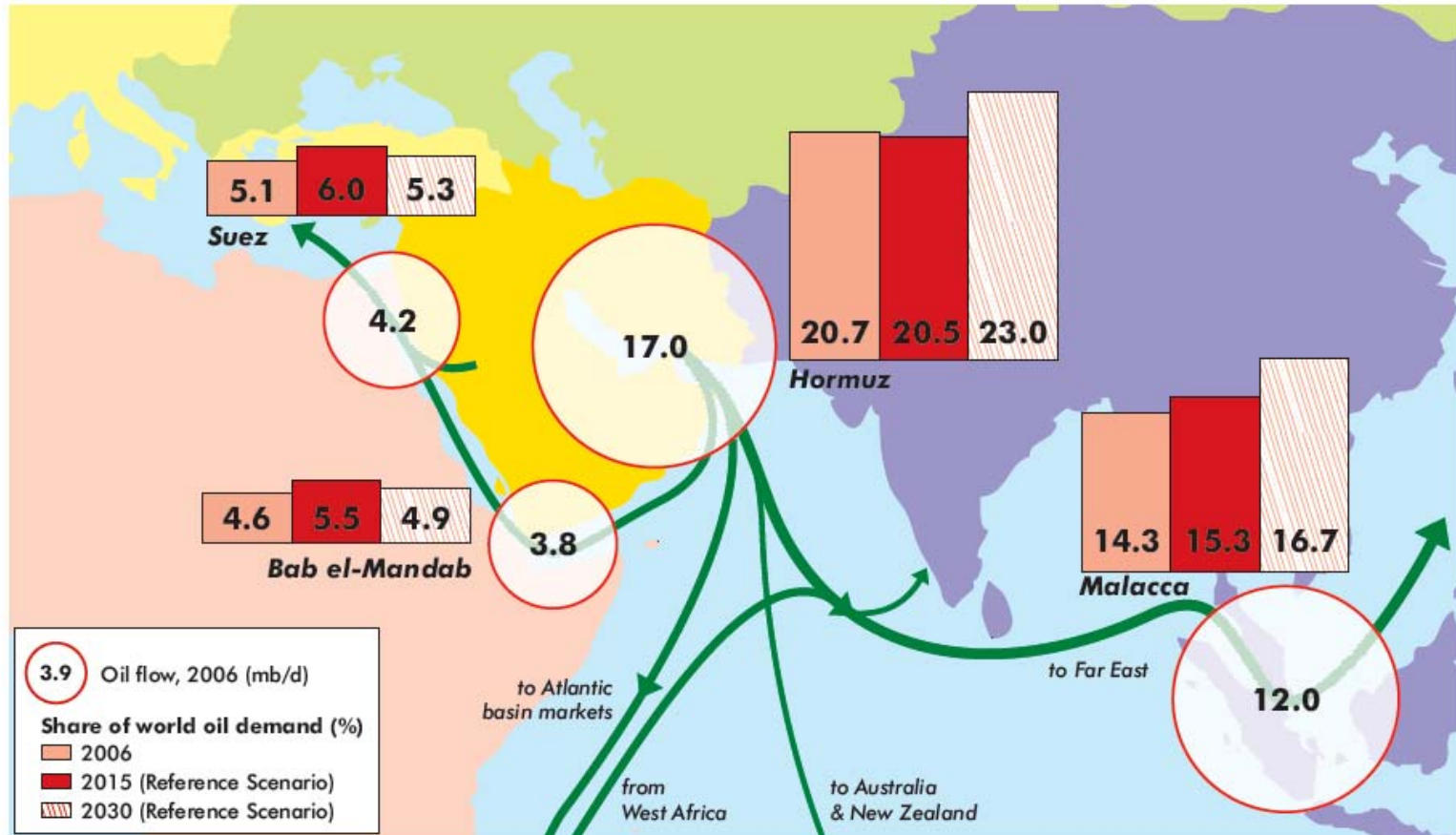
- In the Green paper "A European strategy for competitive, sustainable and secure energy", (2006) the European Commission emphasizes that the EU is facing three issues:
 - climate change mitigation by reducing CO₂ emissions,
 - promoting EU economic competitiveness and competition within the energy sector,
 - and strengthening the safety of energy supplies in a context of increasing import dependency.

Introduction: the broad picture (ctd.)

- The EU domestic energy system is widely considered as not reliable enough to support sustained and stable economic growth over the next decades. OECD European countries' energy consumption is steadily increasing while domestic sources are becoming exhausted, leading to growing import dependence, especially for oil and gas.
- The IEA's 2008 World Energy Outlook predicts that the Europe's dependence on oil will continue to increase, at least to 2030. With a continuation of current policies and expected economic growth, OECD Europe, sees a sharp rise in net import dependence, from 65% to 84%, as a result of the projected rapid decline in North Sea production.
- As to gas, according to IEA, resources are sufficient to meet the projected increase in global demand, but production is set to become much more concentrated in the most resource-rich regions.
- Oil and gas dependence increases less in case of adoption of GHG mitigation policies.

Introduction: the broad picture (ctd.)

- The IEA's 2008 WEO points out that "Much of the additional oil imports will come from the Middle East, the scene of most of the biggest supply disruptions in the past, and will transit vulnerable maritime routes to both eastern and western markets. Almost all Middle East oil and gas exports, for example, transit the Straits of Hormuz at the mouth of the Arabian Gulf".



Source: IEA WEO 2008



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- Main aim: to address Security of Supply issues from the EU perspective in a comprehensive way. In particular:
 - to build a consistent framework covering all the issues related to security of supply, including geopolitics, price formation and the design of energy markets inside and outside the EU.
 - to develop tools to evaluate EU's vulnerability to the different risks which affect energy supplies in order to help optimising EU's energy insecurity mitigation strategies. Costs and benefits are evaluated for different energy demand scenarios.
 - to address all major energy vectors from upstream to downstream with both a global and sectoral analysis studying technical, economic/regulatory and geopolitical risks, as well as demand issues related to energy security.
 - to propose policy recommendations on how to improve energy security taking into account costs, benefits and risks of various policy choices.

- Interdisciplinary approach
- Innovative methodology
- Multi- dimensional and multi- sectoral approach
- Quantitative tools (models and indicators)
- Value of energy security for the consumers
- Policy focus
- Multicriteria analysis
- Stakeholder involvement inside and outside the EU

SECURE's partners

Partner	Acronym	Country
Observatoire Méditerranéen de l'Energie	OME	France
Fondazione Eni Enrico Mattei	FEEM	Italy
Ramboll Oil & Gas	RAMBOLL	Denmark
Lietuvos Energetikos Institutas	LEI	Lithuania
Fraunhofer- Institute	Fraunhofer	Germany
Joint Research Centre	JRC	Belgium
Technische Universität Dresden	TUD	Germany
Paul Scherrer Institut	PSI	Switzerland
CESI RICERCA S.p.A.	CESI-RI	Italy
Energy Research Institute Russian Academy of Sciences	ERI RAS	Russian Federation
The University of Bath	Bath	United Kingdom
Gulf Research Center Foundation	GRCF	Switzerland
Centre for European Policy Studies	CEPS	Belgium
Vienna University of Technology, Energy Economics Group	TU-WIEN	Austria
Centre National de la Recherche Scientifique	CNRS	France

SECURE's scope: dimensions, sectors and disciplines

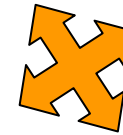
- Short term vs Long term security
- External vs internal energy security
- Sectoral analysis and global scenarios

Short term unforeseen supply disruptions, price swings, blackouts;
Long term: structural supply shortages, cut-off of regional supplies due to long term regional crises, etc.

External energy insecurity: energy imports related elements such as geopolitical issues, international transit, upstream technical issues in non EU countries, etc.

Internal energy insecurity: uncertainty related to European energy demand, infrastructure, energy policy orientations and institutional developments. Market risks in the framework of liberalisation, either due to bottlenecks, market power or regulation, etc.

Geopolitics
Technology
Economics
Environmental Sciences



Sectors:
• Oil,
• Natural gas,
• Coal,
• Nuclear,
• Renewable sources
• Electricity
• Demand management

- The project relies on a number of state-of the art quantitative models for its quantitative analysis. More than one model is needed due to the specificities of energy sectors. Models include:
 - POLES (global energy scenarios simulation model)
 - ERA (Energy Risk Assessment)
 - GASMOD (EU natural gas supply model)
 - Ramboll Oil&Gas security of natural gas supply model
 - Green-X (renewable energy sources model)
 - DISPAEREA (energy/power dispatch by areas electricity model)

WP8. Scientific coordination

WP9. Administrative management

WP1. Methodological developments

Definition of concepts and general methodology of the project

WP2. Value of energy security
Estimation of consumers' risk aversion and willingness to pay for security

WP3. Long term policy lines
Qualitative analysis of energy policy options and scenarios for the EU

WP4. Quantitative global models

- Long term energy scenarios based on policy lines
- Adaptation of the POLES model to include risk assessment
- Development of energy risks assessment model (ERA)
- Quantitative analysis of policy recommendations

WP5. Models and tools by energy source

5.1. Oil

5.2. Natural gas

5.3. Coal

5.4. Nuclear

5.5. Renewable energy sources

5.6. Electricity

5.7. Impact of accidents and terrorist threats

5.8. Demand dimension of energy security

- External supply
- Internal supply
- Geopolitical risks
- Technical risks
- Economic & regulatory risks

WP6. Results and policy recommendations

WP7. Stakeholders consultations and dissemination

- The main focus of the project during its first year has been on building the methodological pillars that will underpin the research activities for the rest of its duration. In particular it has yielded:
- the development of a shared methodological basis to study energy security issues;
 - the setting up of an international survey to elicit the willingness to pay for improvements in energy security, from European households and industrial consumers;
 - the development of "storylines" : the qualitative basis for the quantitative scenarios, which are analysed using the POLES model;
 - the development of specific modelling tools and in particular, the adaptation of POLES to run according to the storylines.

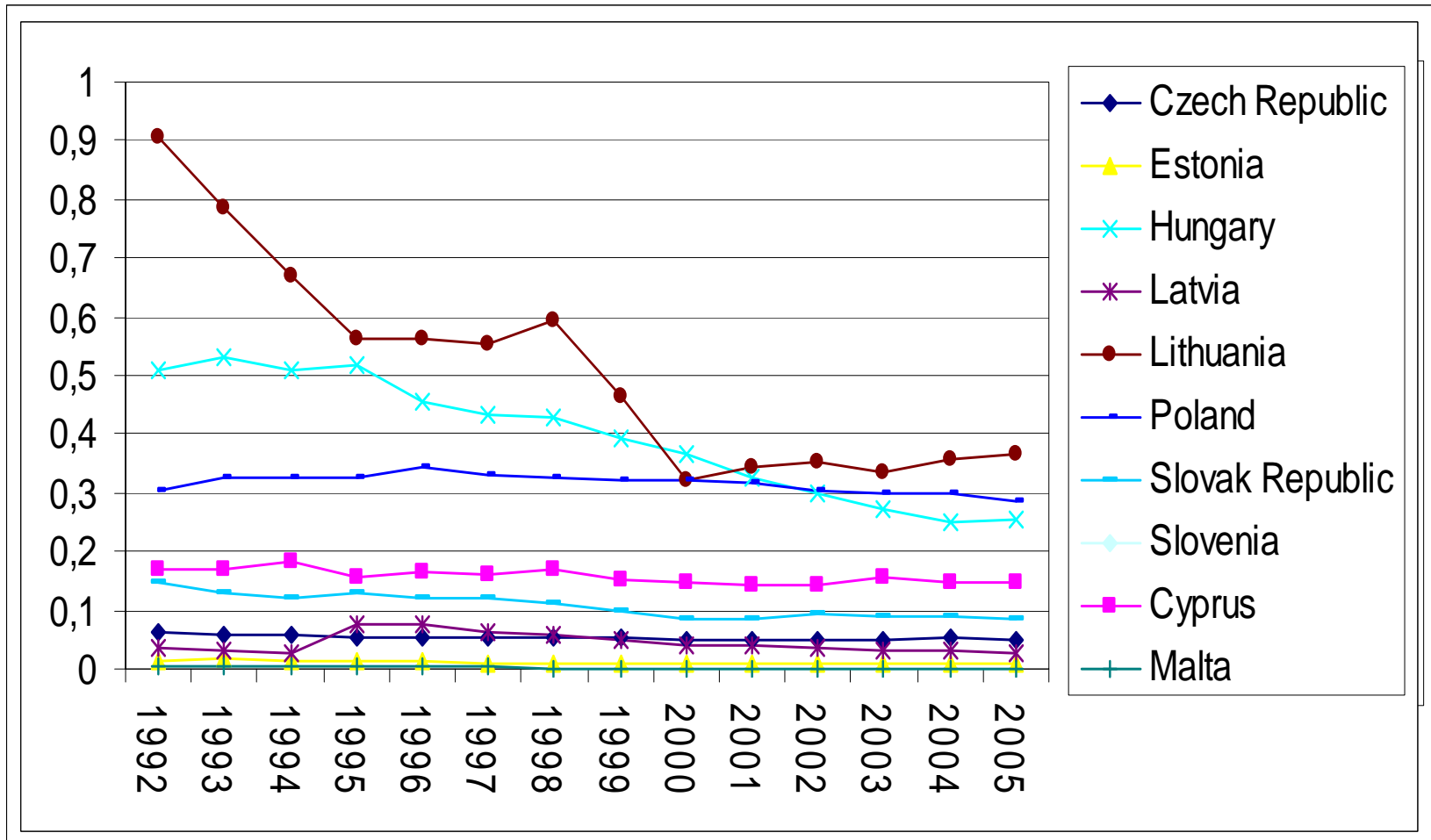
- Indicators are needed for quantitative analyses of security of supply.
- Indicators for measuring security of energy supply are key instruments for policy-makers in the EU: they help to assess the level of import dependence and economic vulnerability of different European countries.
- However, the available indicators seem to be inappropriate for this purpose.
- A substantial effort to harmonize and fine-tune these indicators is needed to include all energy sources and to integrate both quantitative and qualitative information according to the geopolitical and technical context.
- Specific sectoral/regional characteristics must not be overlooked.

A non exhaustive list of available indicators

	Vulnerability	Dependence
Physical Dimension	Imported oil used in transportation (Mtoe)/Total energy used in transportation (Mtoe)	Imports of energy/Total primary energy supply
	Imported Oil and Gas-fired electricity generation (gWh)/Total electricity consumed (gWh)	Country's oil imports/Total oil consumption
	Per capita oil consumption (Ktoe)	Country's gas imports/Total gas consumption
	Degree of supply concentration for oil and gas	
	Shannon-Weiner Index for supply	
	Per capita gas consumption (Ktoe)	
Economic Dimension	Value of oil (or gas) imports/Value of total exports	Oil consumption (Toe) per \$ of real GDP
		Gas consumption (Toe) per \$ of real GDP

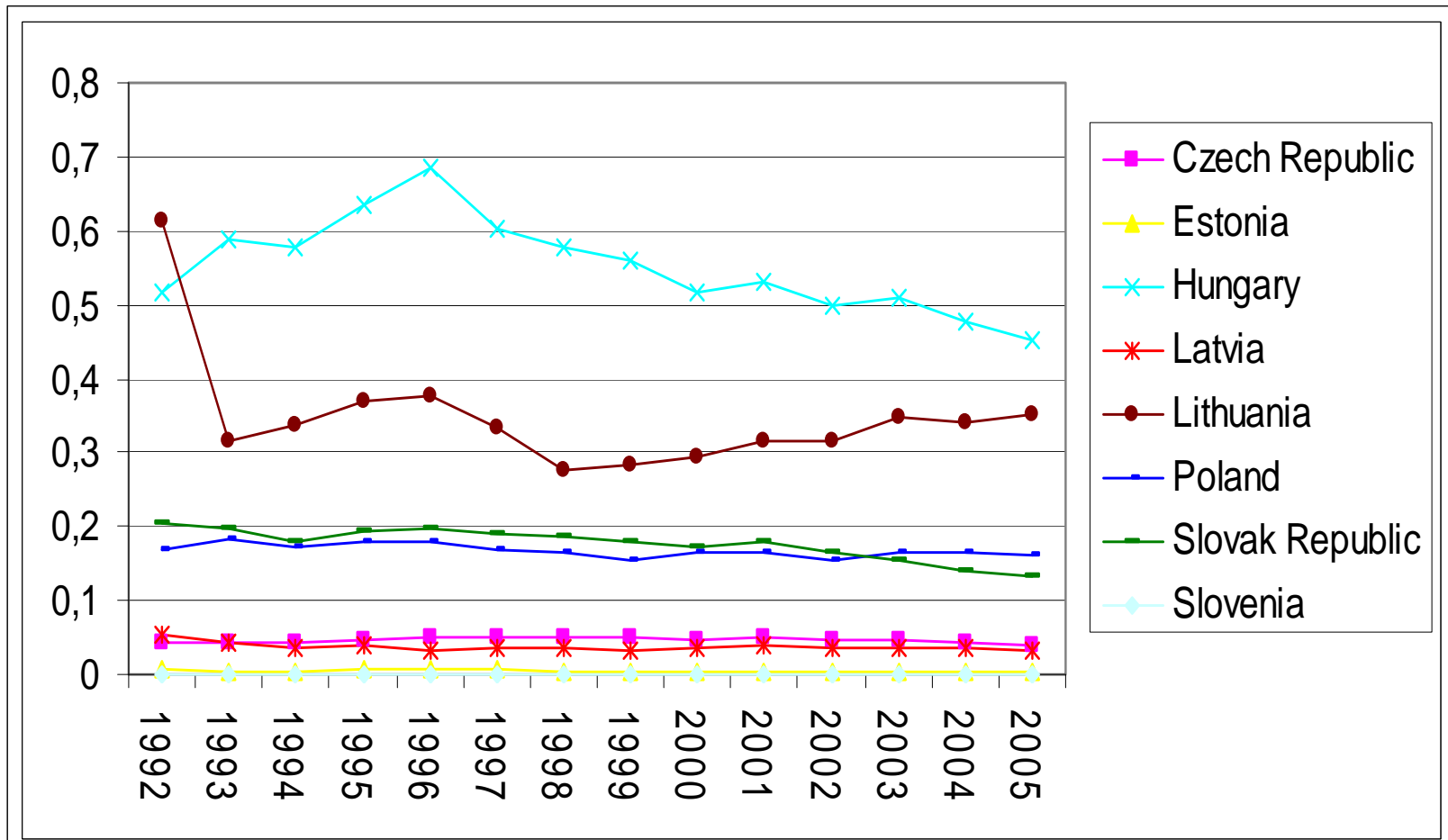
Dependence is a measure of how much the domestic economy relies on sources of energy that are not under its control. **Vulnerability** is a measure of the likelihood of domestic disruption in case some external energy source is reduced or cut off.

Energy dependence indicators in the EU



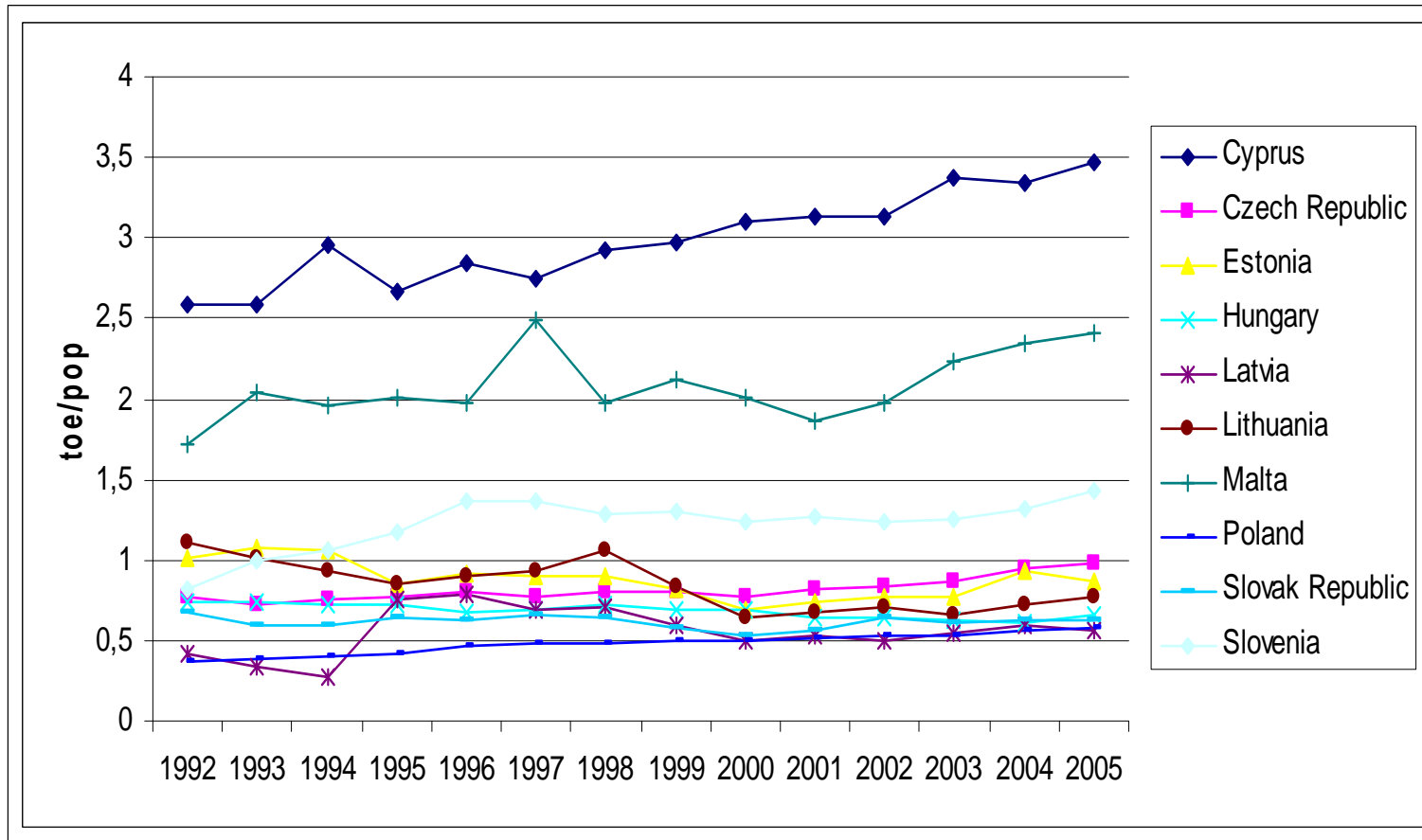
Oil Consumption (ktoe) per MUS\$ of real GDP

Energy dependence indicators in the EU



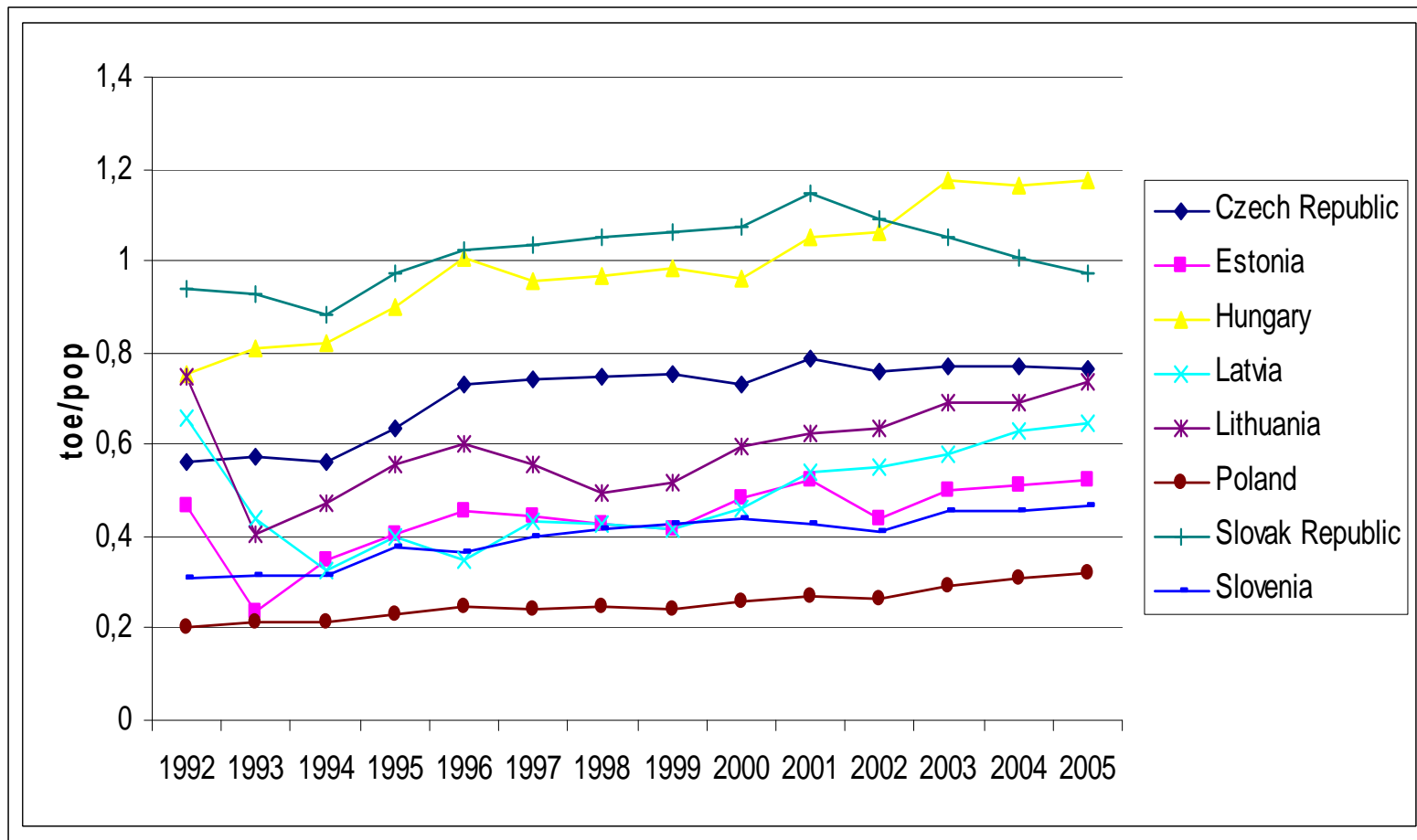
Gas primary consumption (Ktoe) per MUS\$ of real GDP

Energy vulnerability indicators in the EU



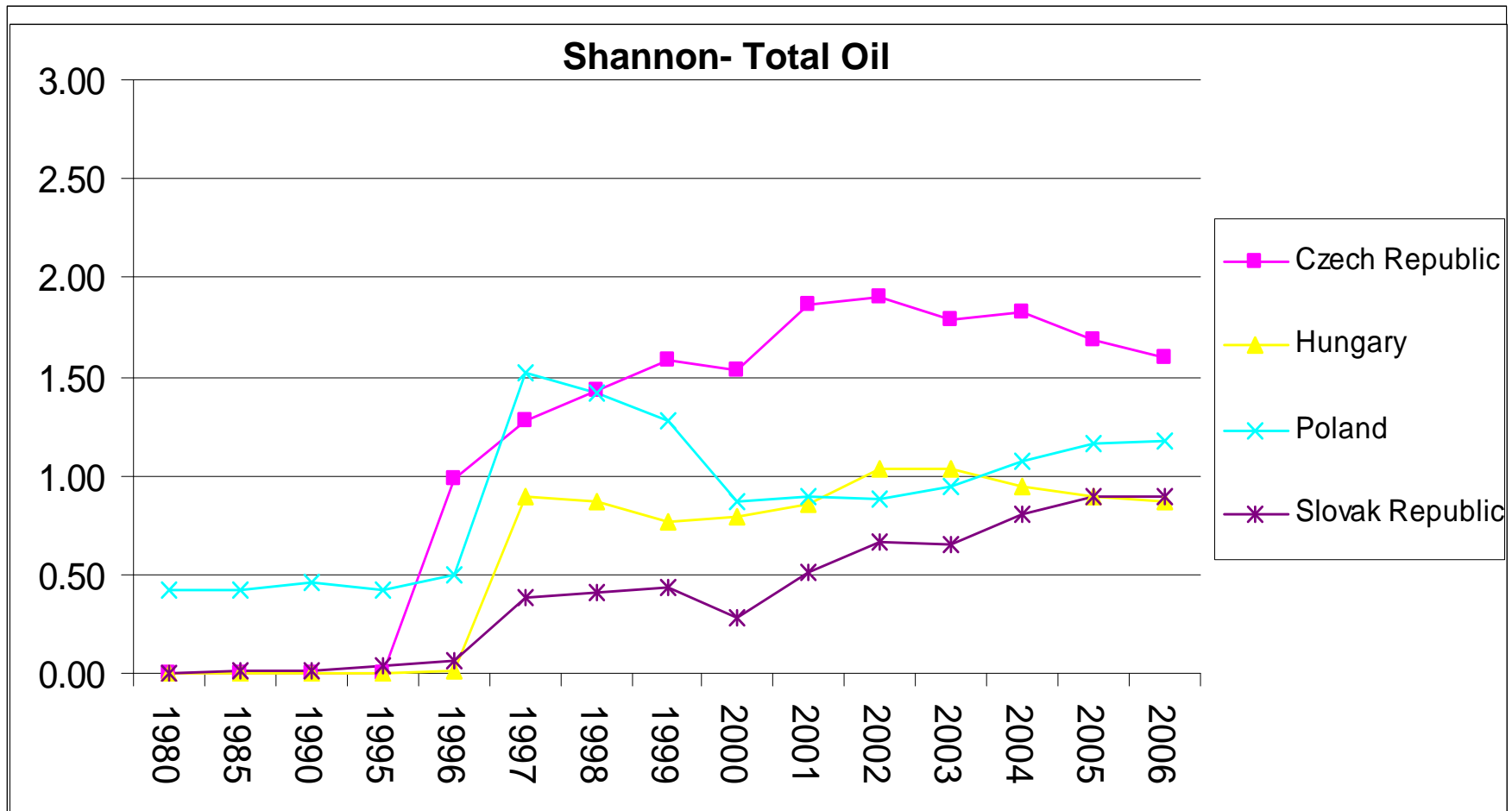
per capita oil consumption, in selected EU countries (toe/pop)

Energy vulnerability indicators in the EU



per capita gas consumption, in selected EU countries (toe/pop)

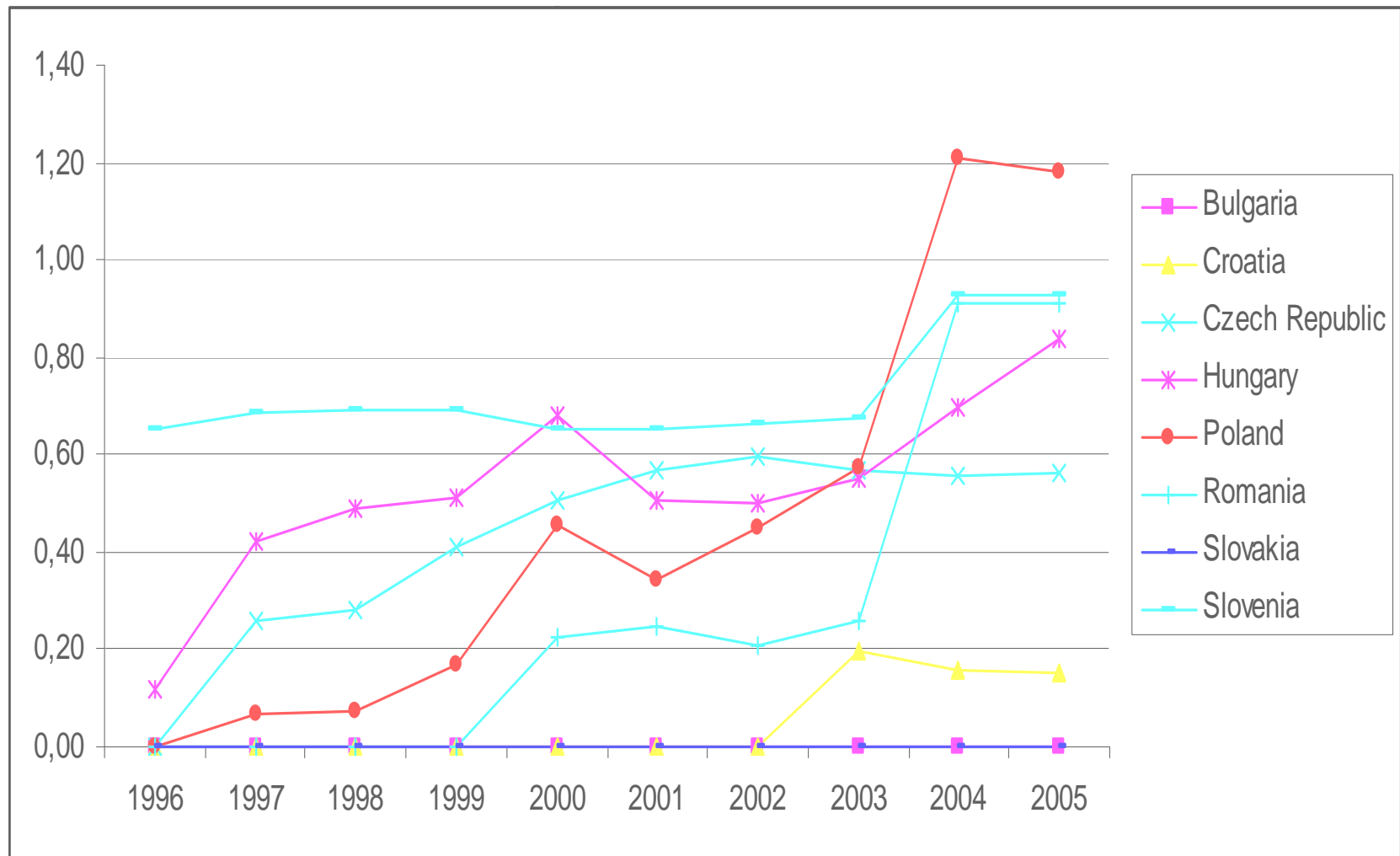
Vulnerability indicators: Shannon -Weiner index



$$SW = -\sum_i x_i \ln x_i$$

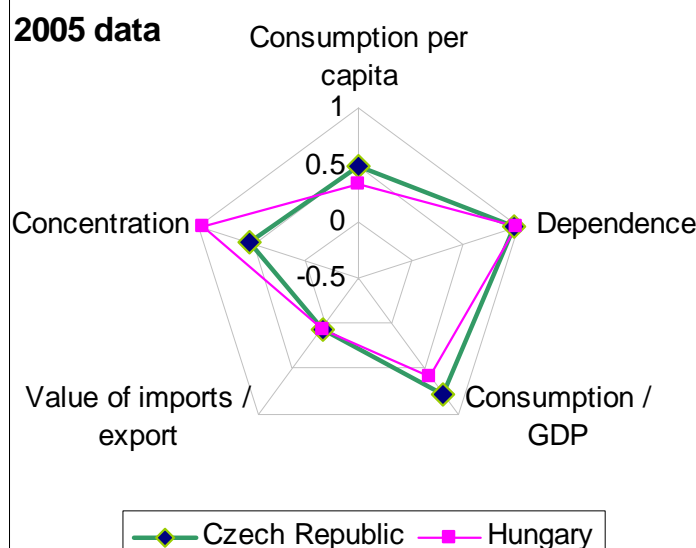
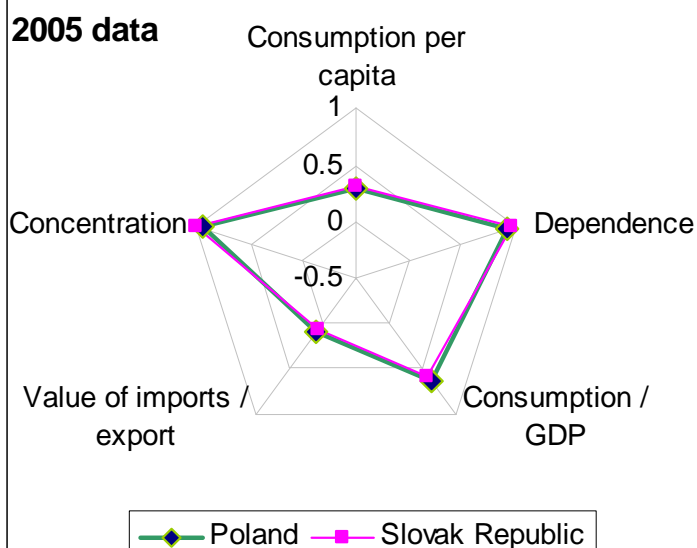
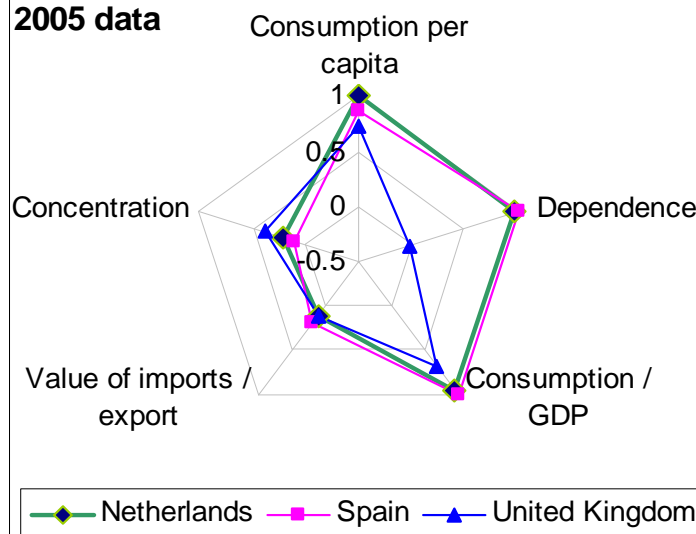
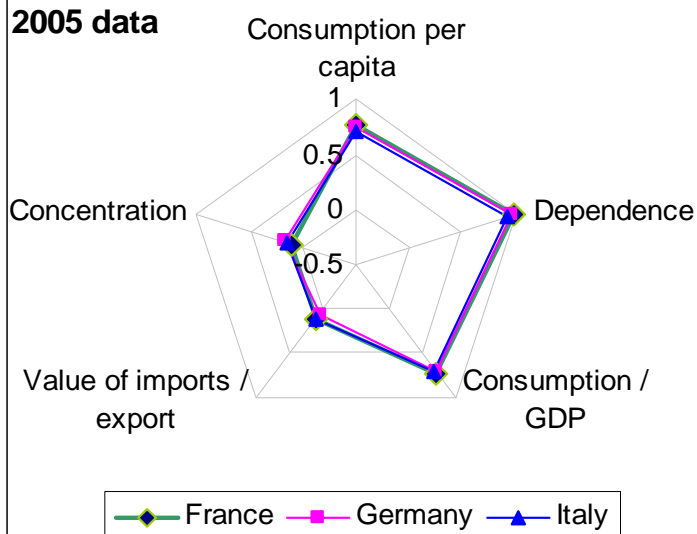
the higher the better

Vulnerability indicators: Shannon -Weiner index



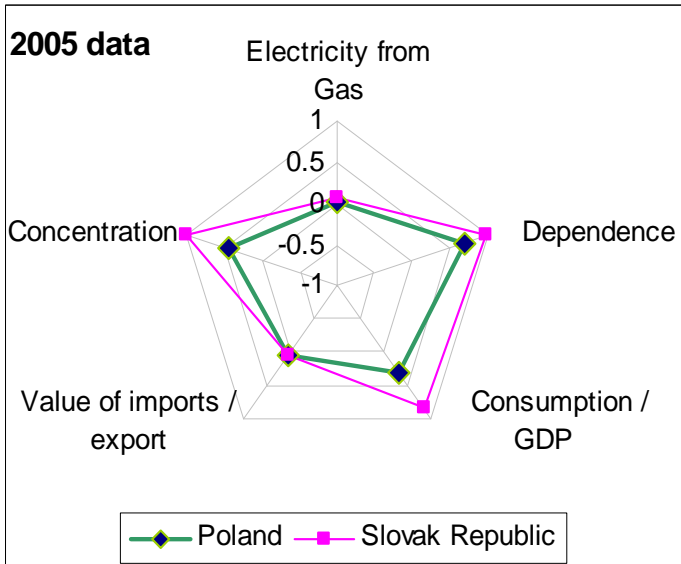
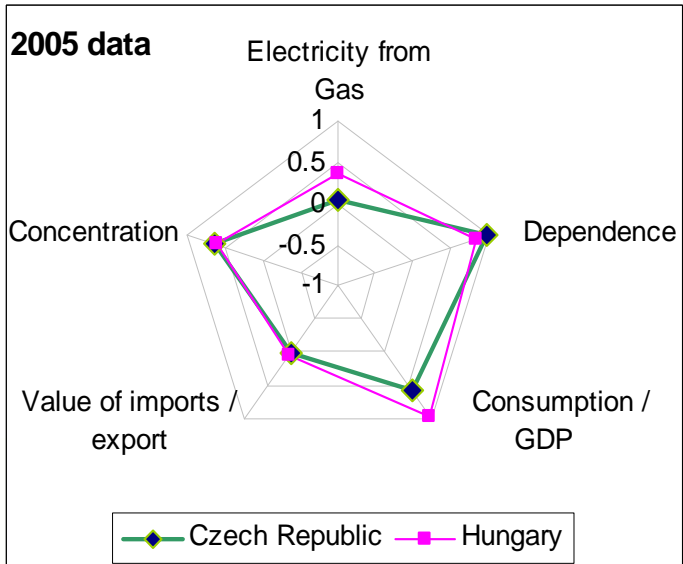
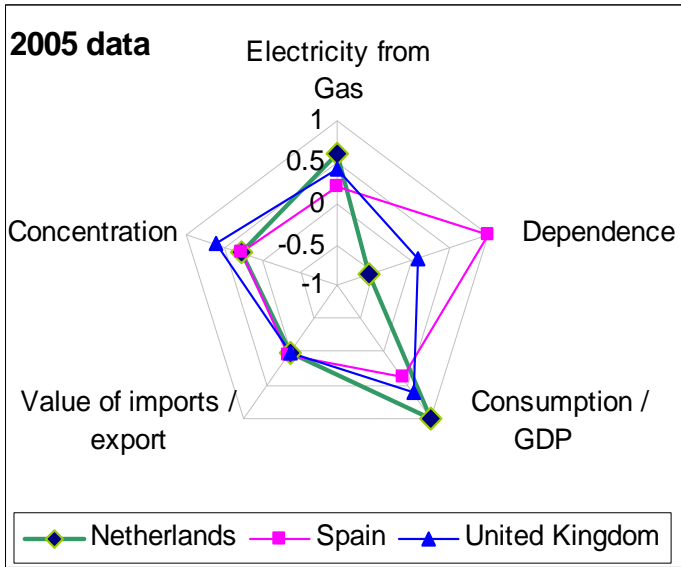
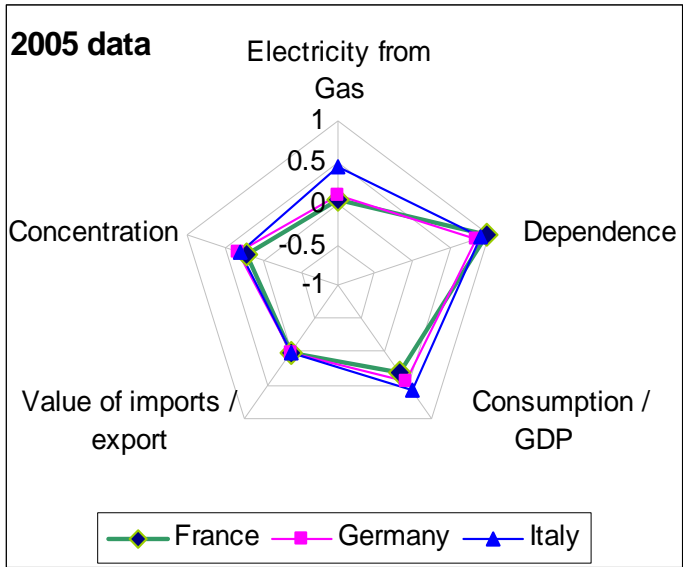
- The amount of information on the various aspects of security of supply that can be conveyed through the indicators is quite abundant and it can be difficult to get a clear picture of the situation of energy security in Europe.
- This is not unexpected, as different indicators capture different aspects of energy security, which may have different degrees of correlations between each other across Europe.

Summary of main oil indicators in selected countries



- Indicators included:
- oil (gas)/gdp;
 - oil (gas, energy) dependence;
 - per capita oil (gas) consumption; oil (gas) concentration;
 - Shannon indexes for oil and gas;
 - oil used in transportation;
 - oil (and gas) used in electricity generation;
 - value of oil (gas) imports /value of total exports

Summary of main gas indicators in selected countries

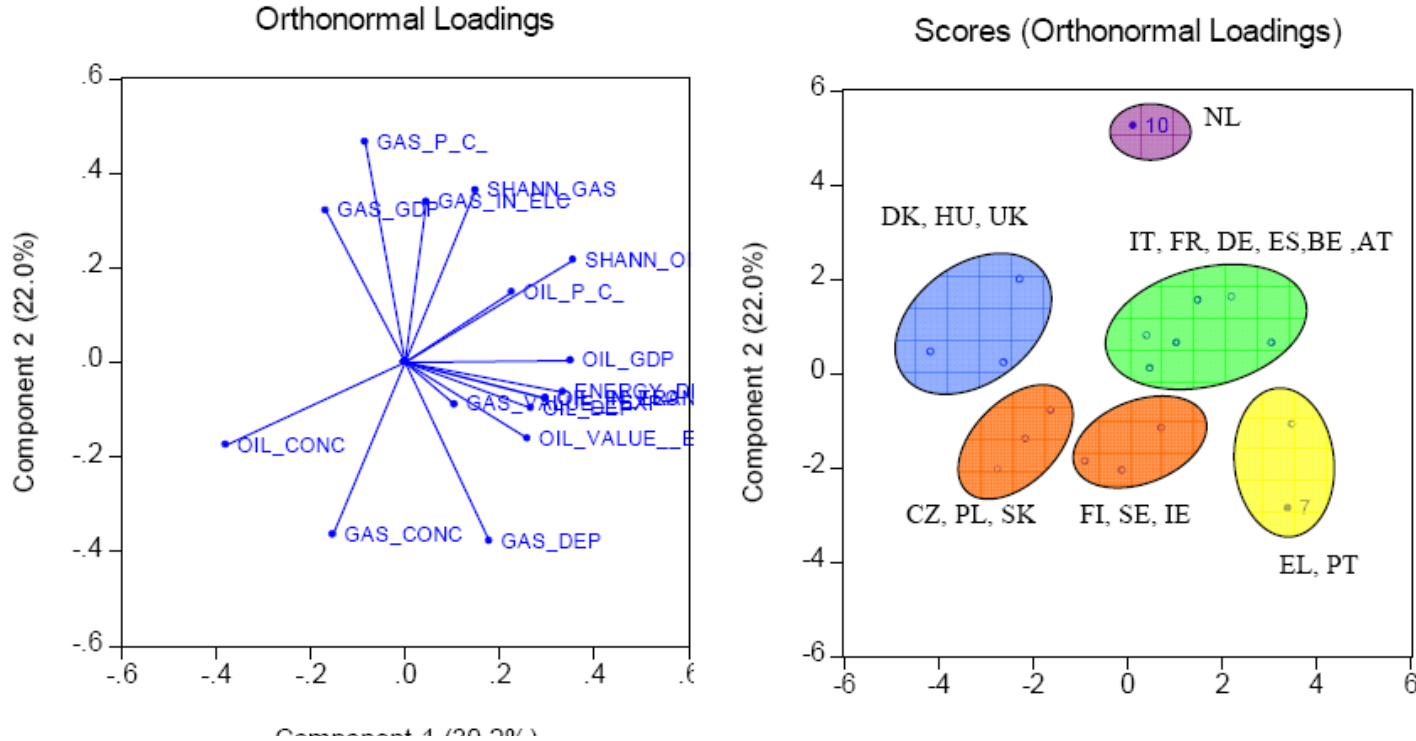


- The principal components (PCs) analysis is a statistical technique to single out the main variance trends in a given sample.
- It transforms a number of possibly correlated variables into a smaller number of uncorrelated variables called principal components. The first principal component accounts for as much of the variability in the data as possible, and each succeeding component accounts for as much of the remaining variability as possible.
- The outcome is a set of "artificial" variables characterized by the fact that they condense the variation in a handful of uncorrelated variables, which however have no direct (economic) meaning.
- The interpretation of the PCs is given by their correlation with the original variables.

We can use this approach to group indicators that behave more or less in the same way:

- The first principal component (PC1) is negatively correlated with oil concentration (-0.83) and positively correlated with oil/GDP (0.77) and oil Shannon (0,79) indicators. PC2 is negatively correlated with gas dependency (-0.71) and gas concentration (-0.68), while is positively correlated with gas consumption per capita (0.87) and gas Shannon index (0.68).
- In other words, PC1 is related mainly to oil indicators while PC2 is related to gas indicators and this two variables together explain 52% of total variance. This seem to point to a statistically significant difference in the behavior of oil indicators and natural gas indicators.
- **At least in Europe, dependence and/or vulnerability from oil does not imply the same pattern for natural gas, and vice versa.**

Principal component analysis of energy security indicators (3/3)



Country can be classified in four main categories (distinguished by colors in the graph) according to how they are positioned in the PC space:

Orange: New accession countries (excluding Hungary) plus Finland, Ireland and Sweden: high level of concentration on imports

Blue: Denmark, United Kingdom and Hungary: high level of concentration but relative low level on oil and gas dependence and also a low level on oil /GDP indicator

Green: Main euro-area countries (FR, DE, IT, SP, AT, BE): high level of oil dependence and low level on concentration (imports of oil are diversified)

Yellow: Greece and Portugal: high level on value of oil imports on total exports (Greece in particular) and high level on oil consumption per unit of GDP

- A shared approach is still lacking in the literature about security of supply. Many indicators have been proposed, many variants are possible and a number of alternative indicators retain their merits.
- On the quantitative side, there is significant variation among European countries in terms of their dependence from imported fuel and in terms of the vulnerability of their economies, although some clusters of significantly similar countries can be identified.
- The information summarized by means of SoS indicators must not be taken acritically: it is important to frame it organically in its geopolitical and technical context.

- Oil market are global and trade flows can be shifted with relative ease. This implies that the prevalence of a single provider in the oil imports of a given country may be not so much worrying as it may sounds since the provenience and the concentration of oil flows can be modified also in the short run.
- Logistics may play a more relevant role.
- Time horizon: in all major oil crises, production cuts from a producer were eventually compensated by production increases by others, thus leaving global supply scarcely affected in the medium run.
- The situation is more critical in the case of natural gas, for which trade flows are much less flexible and strictly dependent from the available infrastructures.

- The challenge of going beyond existing indicators involves
 - combining quantitative information (indicators) with qualitative information
 - harmonising these information within an organic model as far as possible
 - recognising the common elements and the peculiarities of the various energy sectors
 - keeping in mind the full picture.

Thanks for your attention!

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