

# WEC European Regional Study:



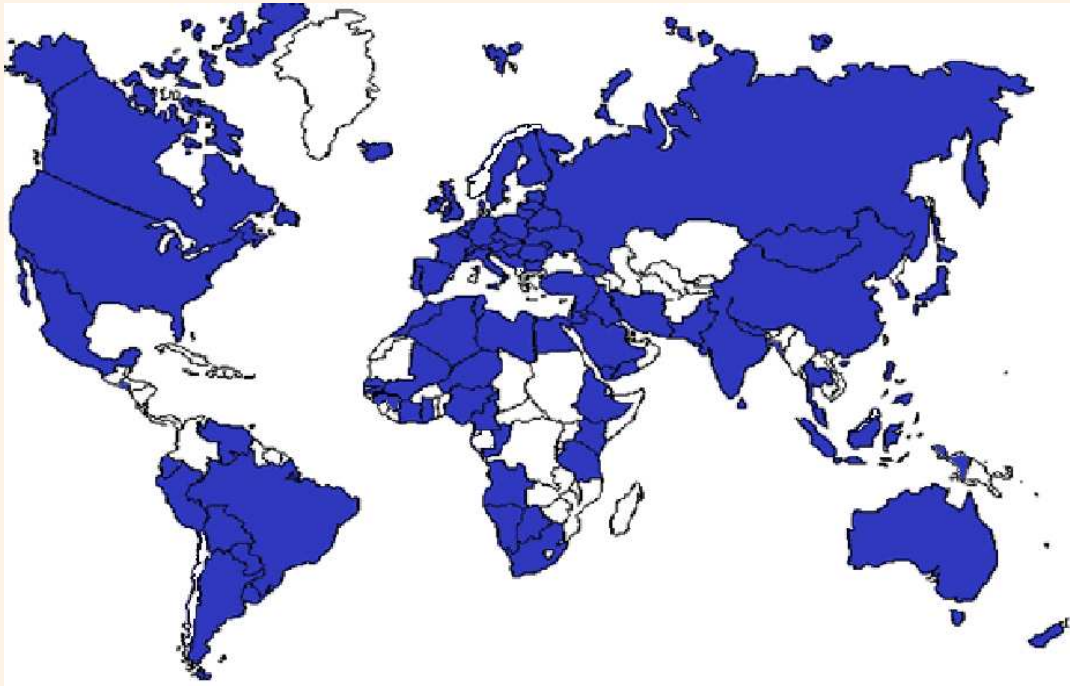
## Vulnerability of Europe and its Economy to Energy Crises: Focus on Vulnerability Indicators

UNECE Energy Week « Investing in Europe Security »

16th Session Committee on Sustainable Energy and Related Meetings – 26-28 November 2007

Genève, 28 November 2007

# What is World Energy Council (WEC)



WEC has Member Committees in about 100 countries in the world, including most of the largest energy-producing and energy consuming countries.  
(2/3 of developing countries)

The World Energy Council (WEC) is one of the foremost multi-energy organisation in the world today. Established in 1923, the organisation covers all types of energy, including coal, oil, natural gas, nuclear, hydro, and renewables, WEC is non-governmental, non-commercial and non-aligned. WEC is a UK-registered charity, headquartered in London.

***To promote the sustainable supply and use of energy for the greatest benefit of all people***

# Objectives of the Study

1. Assessment of the vulnerability of the European economies to a possible energy crisis (physical disruption or price rise)
  - ▶ Is this assessment possible ?
2. Establishment of the vulnerability indicators for comparing the vulnerability of a few selected European countries with different energy sector structures to an energy crisis ;
  - ▶ What are meaningful indicators ?
3. Elaboration of recommendation for mitigating the impact of an energy crisis.
  - ▶ What recommendations to politicians?

# Definitions

The vulnerability of an energy system is the *degree to which that system is unable to cope with selected* adverse events.

Vulnerability is a context dependent concept.

The main goal is to design or operate the energy system in such a way that *security of energy supply* is ensured at the required level and at a cost that is affordable to the consumers.

Energy security means:

- limited vulnerability to transient or longer disruption of supply ;
- the availability of local and imported resources to meet, over time and at reasonable prices, the growing demand for energy.



## The context in which vulnerability is assumed

The growing European dependence on energy imports

The anticipated rises in energy prices in the coming years due to :

- substantial energy demand growth in emerging economies
- unstable political climate

Uncertainty about full implications of market liberalisation and competition and their impact on security of supply

# Indicators for Vulnerability

- Europe: EU-27 + Switzerland + Norway
- Vulnerability is a multi-dimensional quantity → Variety of influence factors
  - Energy dependency/independency
  - Costs of energy imports
  - Price volatility
  - Exchange rates (US-\$ vs. €)
  - Technology
  - International relationships
  - Political and regulatory influence
  - Storage of energy
  - Facilities of energy transport
  - ...



Definition of vulnerability indicators is possible

- for different sectors
- for different energies
- market related:
  - supply & demand
- Macro-economically

Costs & Prices

# Global approach: energy dependence

## Energy independency - 2005

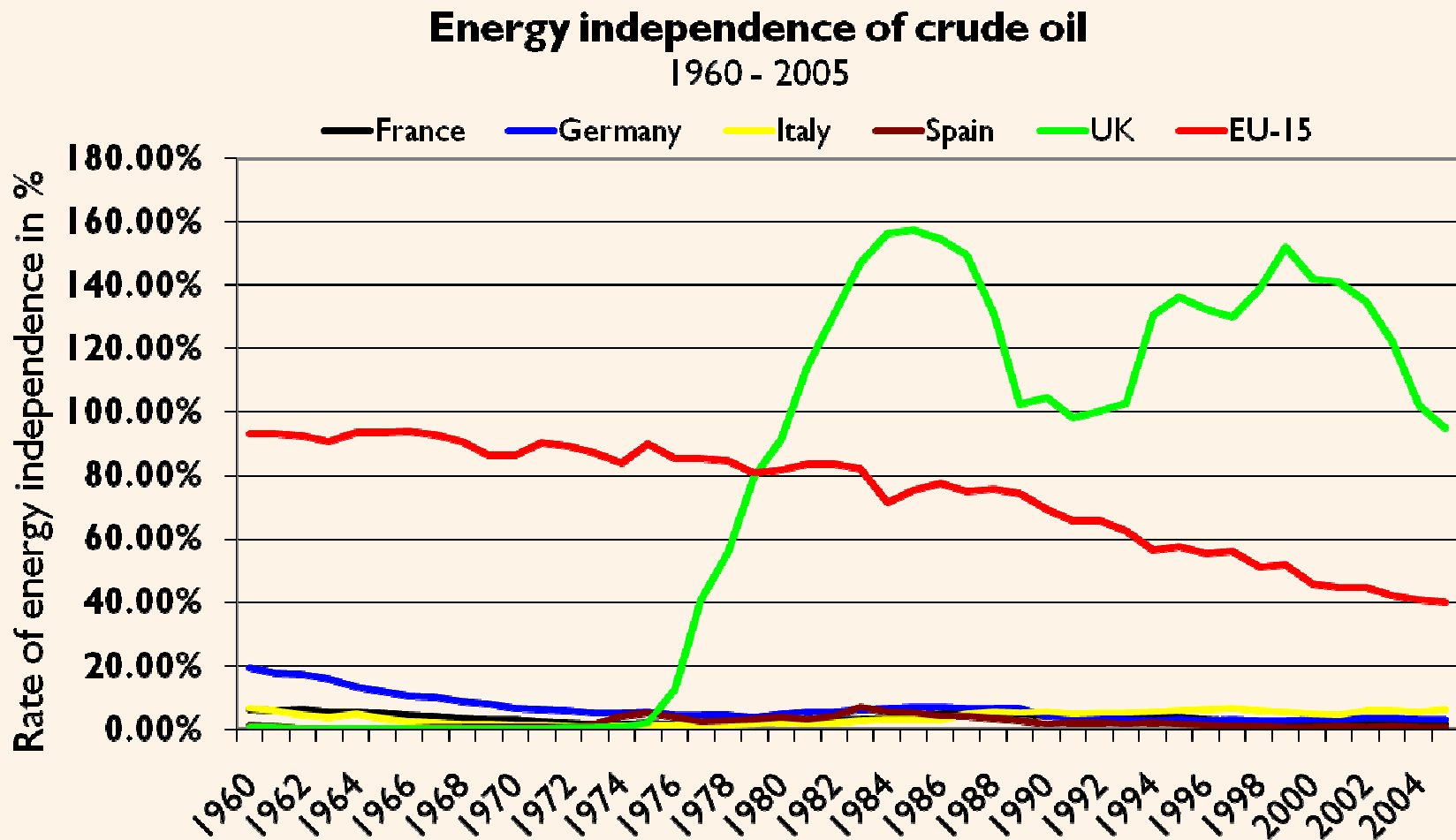
Spain :	17%	(28% in1995)
France:	50%	
UK:	92%	(129% in1999)
Italy:	14%	(20% in1995)
Germany:	35%	(40% in1995)

# Global approach: energy dependence

Country	Year	Rate of energy independence in % for		
		Solid mineral fuels	Oil	Gas
France	2005	1.8	1.5	2.0
	1995	36.6	2.8	10.8
UK	2005	31.9	120.1	93.7
	1995	66.9	189.3	102.3
Italy	2005	0	7.1	15.2
	1995	0.8	5.4	40.8
Spain	2004	32.9	0.4	1.3
	1995	51.8	1.2	7.2
Germany	2005	65	3	18
	1995	82	2	22

Ratio of energy domestic production to energy consumption: this ratio exceeds 1, in case of net export

# Energy production in EU-15 declining



Source: own calculations based on data from EUROSTAT

# Global approach: Imports Concentration

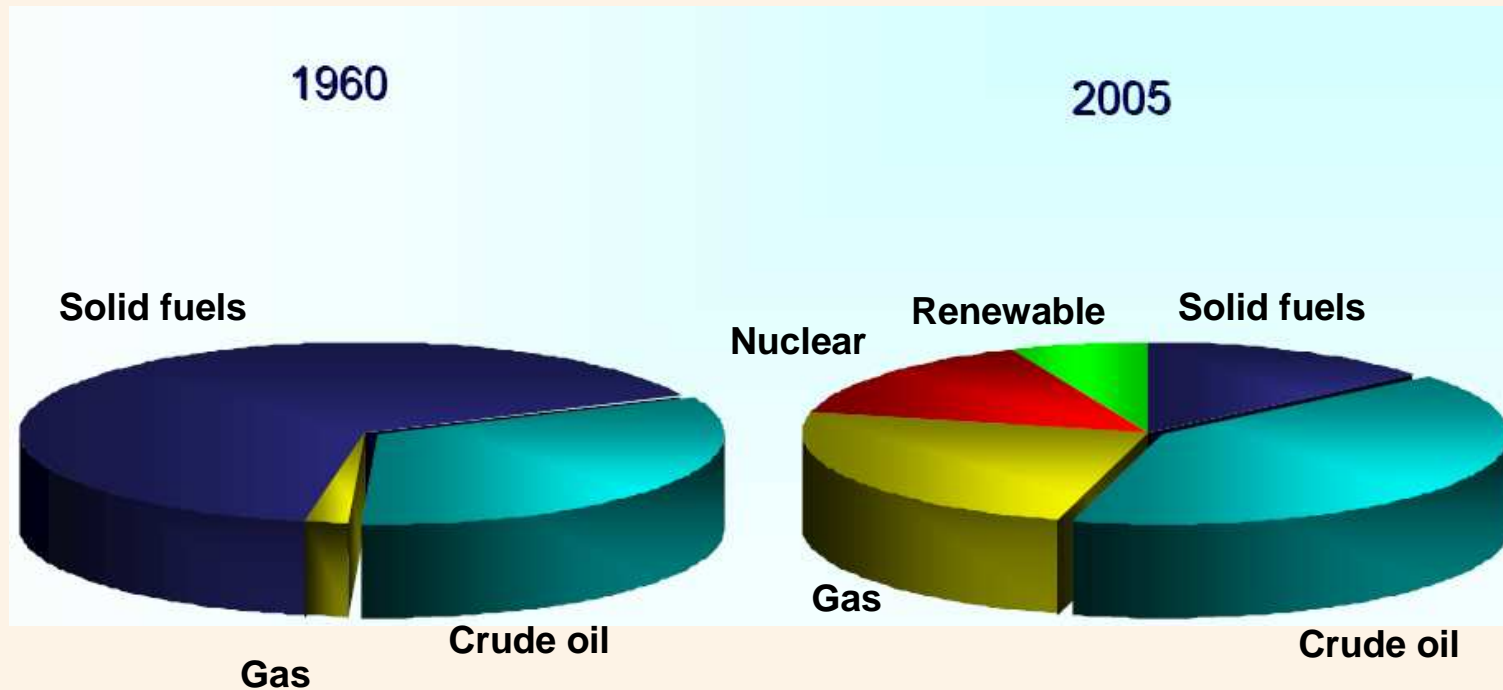
1. The Hirschmann-Herfindahl Index is the sum of the squared market shares held by the various suppliers; namely:

$$HHI = \sum_i s_i^2$$

2 An alternative way is the Shannon-Wiener Index, formulated as follows:

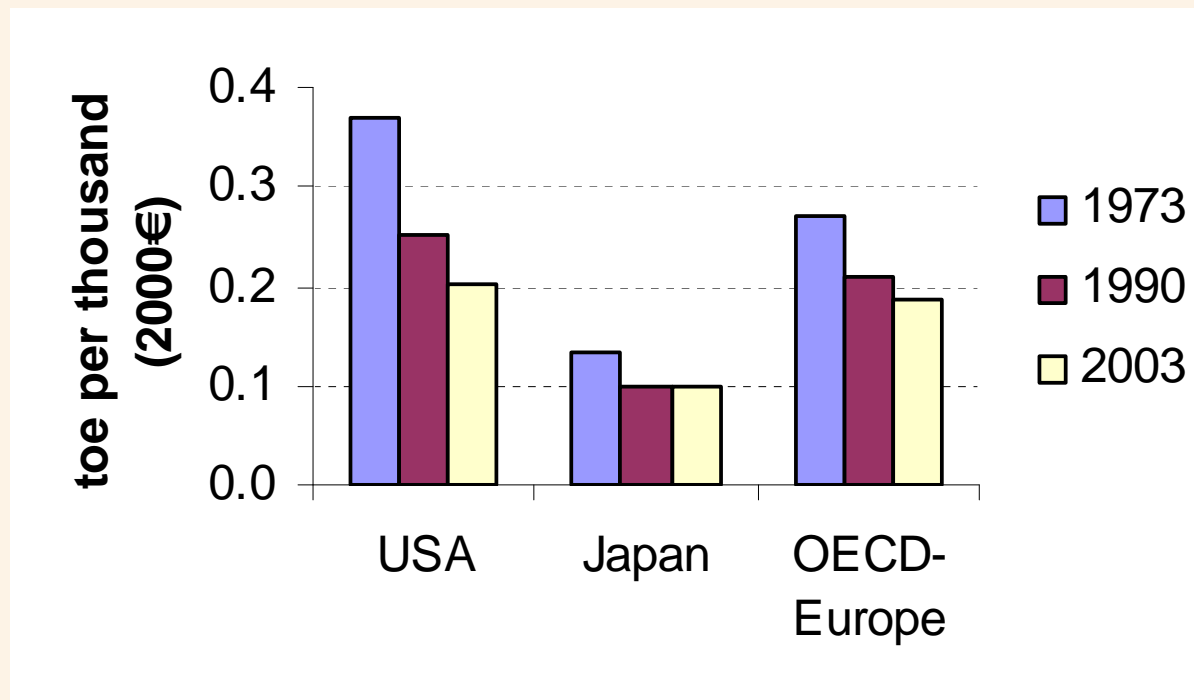
$$SWI = -\sum_i s_i \times \text{Log}(s_i)$$

# Global approach: Energy Mix for EU-15



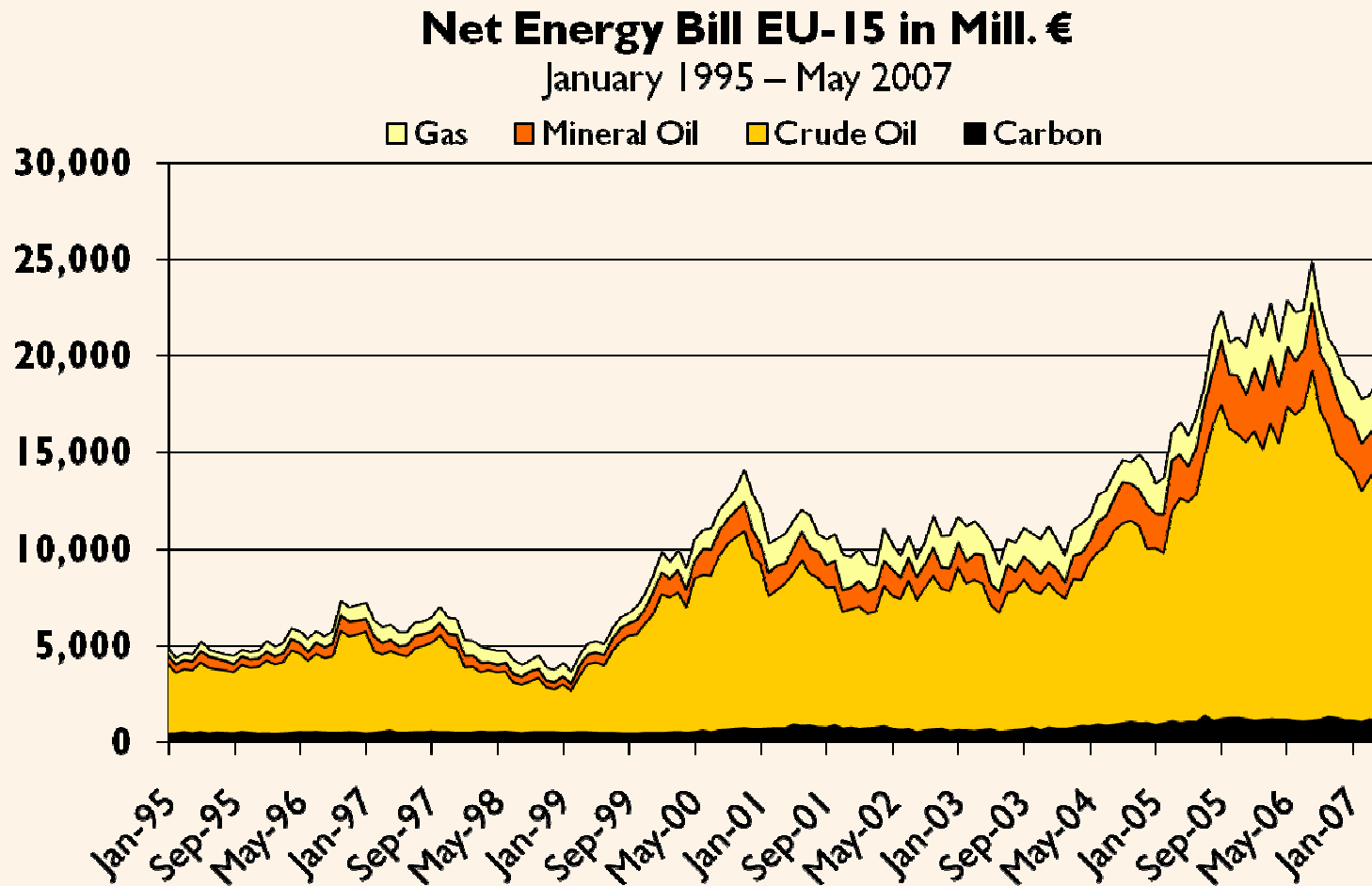
Energy mix within the EU-15 broadened → Reduced risk  
But some of the new energy sources show high price volatility (e.g. gas) or  
production volatility (e.g. renewable)

# Global approach: reducing Energy Intensity





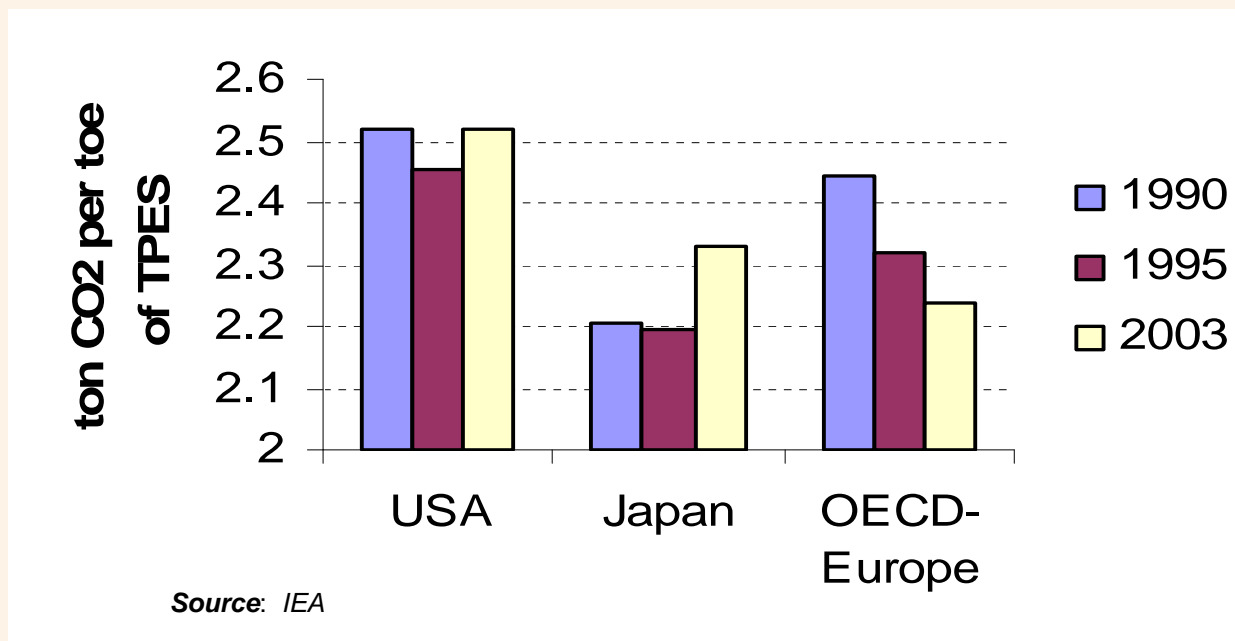
# Global approach: Net Energy Bill



Source: Comext

Genève, 28 November 2007 – Slav Slavov & Jean Eudes Moncombe

# Global approach: Carbon content

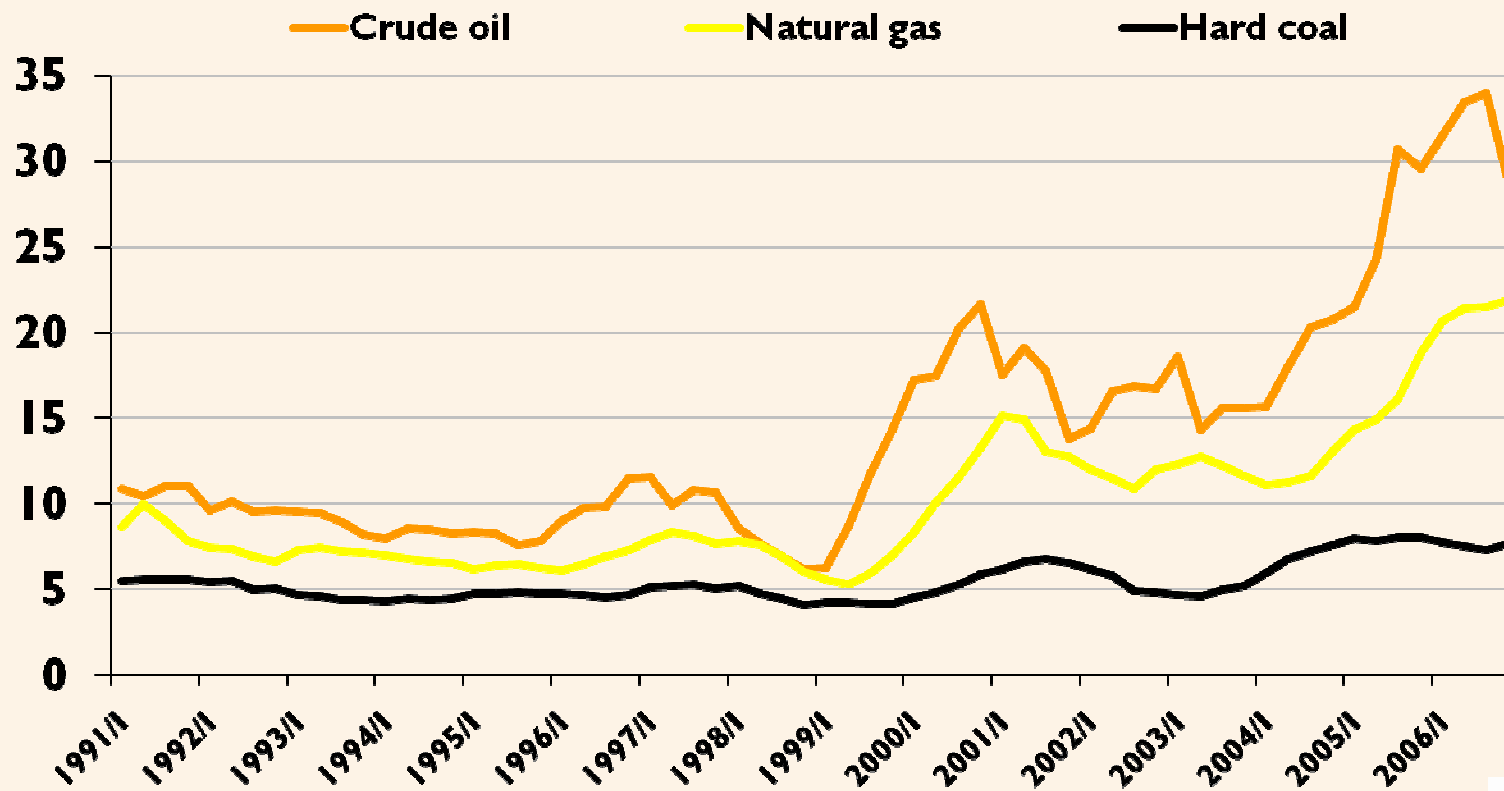


Ratio of CO<sub>2</sub> emissions to total primary energy supply

# Global approach: Price development and Volatility

## Price development of import energy

1st quarter 1991 - 4th quarter 2006 in €/MWh

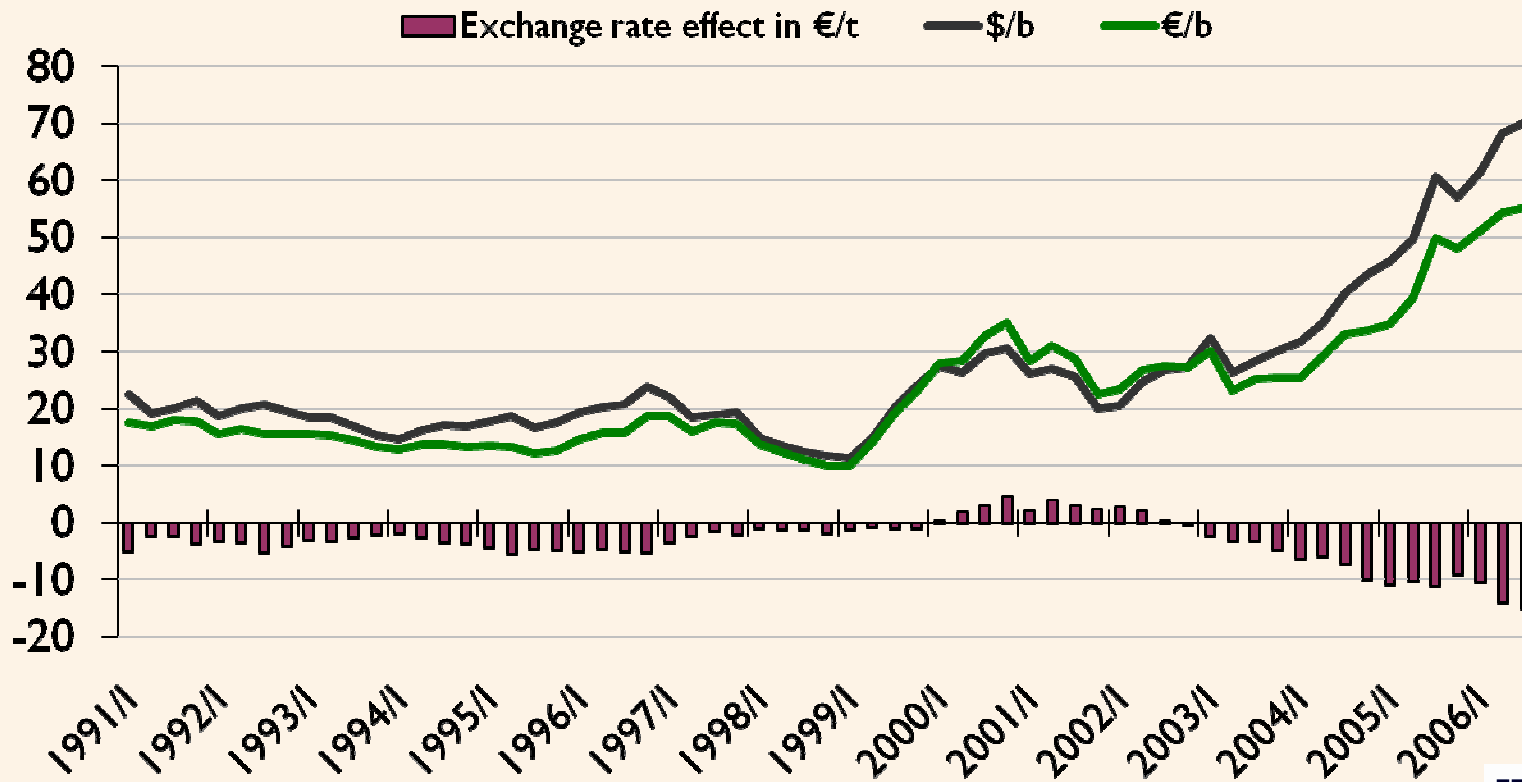


Source: own calculations based on data from BAFA

# Global approach: Exchange rate

## Price development of crude oil and exchange rate effect

1st quarter 1991 to 3rd quarter 2006



Source: own calculations based on data from BAFA



## Global approach: Exchange rate (2)

A few figures (France) :

	Oil price	Euro rate	Imports
2001	24 \$/bl	1€ ~ 0,9\$	2,05 Mbl/j
2007	69 \$/bl	1€ ~ 1,36\$	1,95 Mbl/j

Energy Bill : 20 G€ → 36 G€

Without Euro effect : 20 G€ → 55 G€       $\Delta = 19 \text{ G€}$

Without Imports effect : 20 G€ → 38 G€       $\Delta = 2 \text{ G€}$

# Global approach: Technology

Number of patents

	OIL	GAS	BIOMASS	SOLAR
Germany	293	19	131	42
France	255	12	34	4
GB	299	17	37	9
Italy	51	1	16	3

Source: IFP

## Try to merge all indicators into a single one ?

Example - Proposition and evaluation of vulnerability index based on five distinct dimensions (Gnansounou, 2006)

- 1 - Energy intensity of the Gross Domestic Product
- 2 - Energy import dependency
- 3 - Energy related CO2 emissions as against the TPES
- 4 - Electricity supply vulnerability
- 5 - Non diversity in transport fuels

Various indicators can therefore be normalised to values between 0 and 1, with following formula

$$I_j = \frac{X_j - \min_k (X_k)}{\max_k (X_k) - \min_k (X_k)} \quad k = 1, 2, \dots, n$$

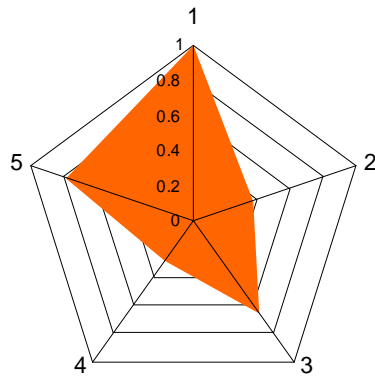
# Synthesis

Country	I	I1	I2	I3	I4	I5
	Synthetic index	Energy intensity	Import dependency	CO <sub>2</sub> content of TPES	Electricity supply vulnerability	Transport fuels non-diversity
<b>Low vulnerability index: <math>I \leq 0.53</math></b>						
1. Canada	0.439	0.186	0.000	0.553	0.155	0.773
2. Sweden	0.441	0.080	0.386	0.147	0.232	0.861
3. Norway	0.467	0.022	0.000	0.331	0.478	0.866
4. Switzerland	0.475	0.002	0.569	0.368	0.256	0.778
5. Slovak Rep.	0.488	0.557	0.600	0.541	0.220	0.421
6. Iceland	0.492	0.217	0.275	0.000	0.293	1.000
7. United King.	0.495	0.036	0.000	0.630	0.148	0.896
8. France	0.506	0.075	0.508	0.295	0.339	0.903
9. Finland	0.509	0.152	0.450	0.482	0.062	0.912
10. New Zealand	0.512	0.152	0.381	0.462	0.159	0.951
11. Austria	0.521	0.048	0.586	0.601	0.150	0.792

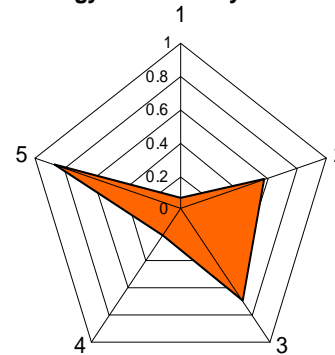
# Synthesis

.. or graphic representation ?

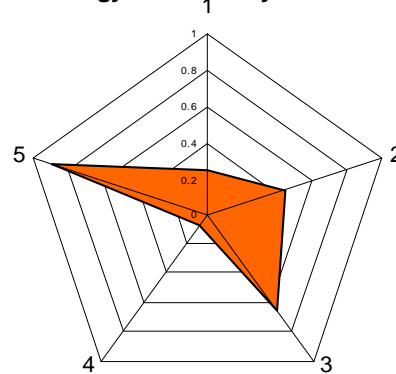
Energy Vulnerability of Bulgaria



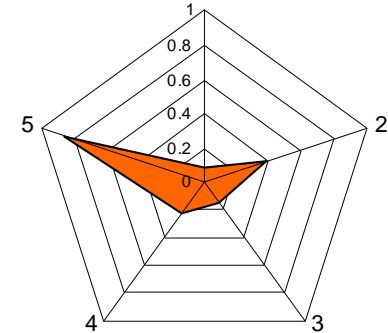
Energy Vulnerability of Germany



Energy Vulnerability of Croatia



Energy Vulnerability of Sweden



## Remarks on the microeconomic dimension (sectoral approach)

- ✓ *Consumers of fossil fuels* : Vulnerability mitigated by strategic reserves
- ✓ *Consumers of Electricity* : Margin of surplus capacity ; interconnection rate (interconnection generally decreases vulnerability)
- ✓ De-integration → more vulnerability (financial risk)
- ✓ Privatization → risk of control loss
- ✓ Size decreases vulnerability
- ✓ Regulation uncertainties

## Remarks on the microeconomic dimension

*Vulnerability and consumers: protection, mainly by substitution*

- *Companies and Energy systems*
- *Households*

*Time scale: investments, behavior changes*

*Vulnerability: inertia*

# Recommandations for Policy Makers

1. Enhance the level of policy co-operation in Europe
2. More pragmatism in policy implementation
3. Enhance the promotion of energy efficiency and market for renewable energies
4. Mitigate tensions and vulnerability level in electricity and gas markets
5. Encourage further diversification in each national energy mix
6. Re-integrate the nuclear option in policy and public debate
7. Achieve more consistent and targeted R&D policies for new technologies
8. Promote a “fact based” debate on energy issues
9. Encourage the European countries to assess their vulnerability level by applying the vulnerability indicators, as proposed by this study.

## Last word

### Thanks to

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