Security of Energy Supply – Indicators for Measuring Vulnerability and Risk

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Agenda

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Weltenergierat - Deutschland

- Approach
- Ex-post results
- Ex-ante results
- Conclusions

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Background

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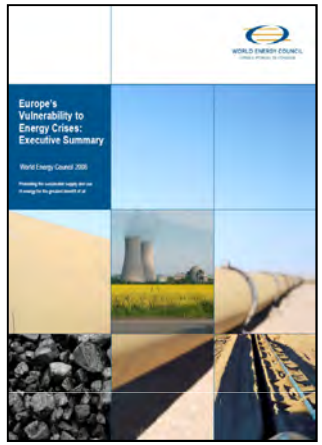
Main idea

- quantify security of supply

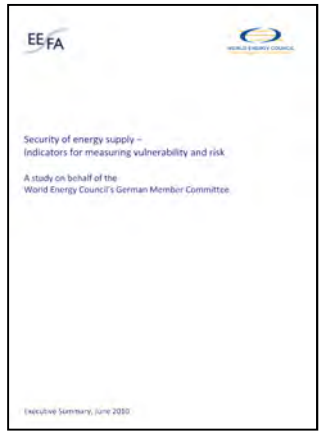
WEC-study (2008)

- examined the concept of vulnerability
- provided a conceptual framework based on indicators



German case study (2010)

- hooked on WEC-concept using broad empirical data
- compressed indicator for vulnerability of a nation
- Ex-post analysis: Validate empirical results with historical data (to gauge the model)
- Ex-ante-analysis: Develop future scenarios elaborate different policies and their impact on vulnerability



Indicator-set

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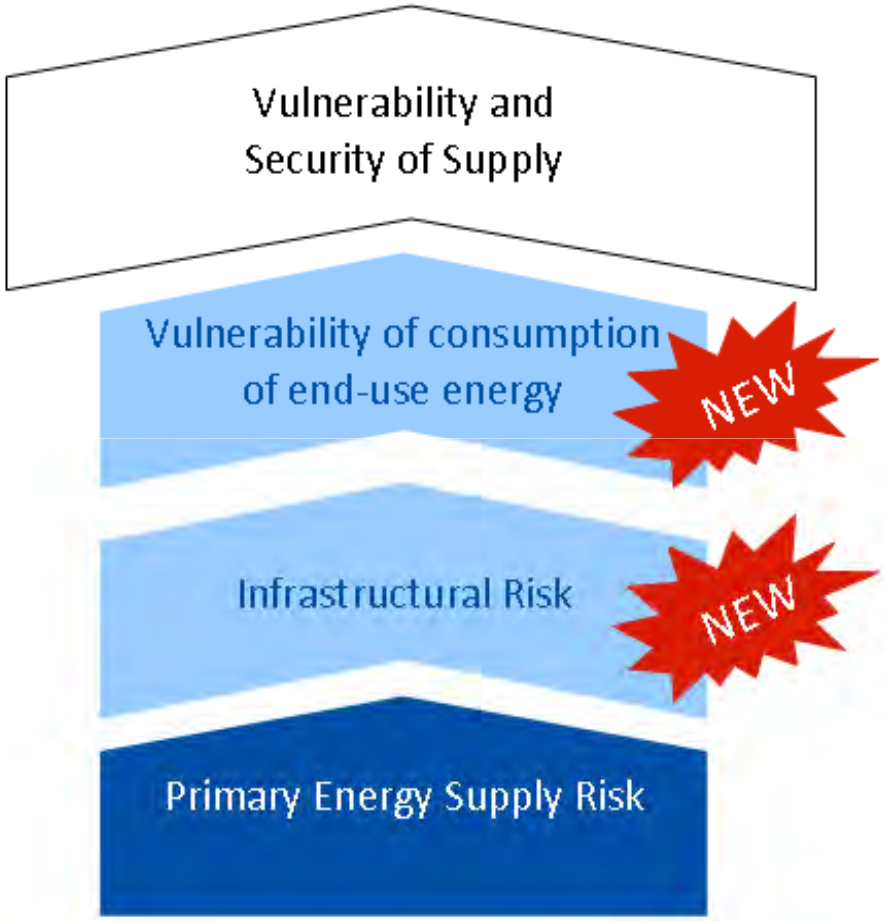

- Energy efficiency
- Energy costs
- Demand-structure

- Gas: Availability & reach of storage
- Electricity: Interconnection-grade, reserve-capacity, demand-volatility

- Import-dependency
- Regional diversification
- Primary energy mix

NEW: To compress/merge all indicators into one single indicator (value betw. 0-1)

Calculation example: primary energy level

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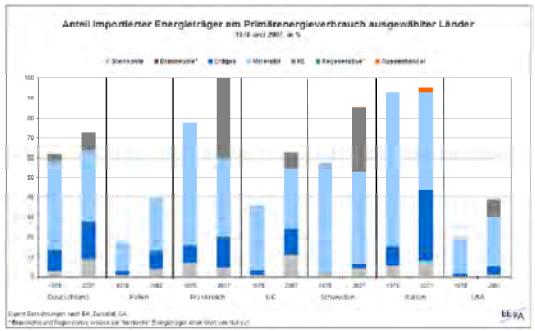

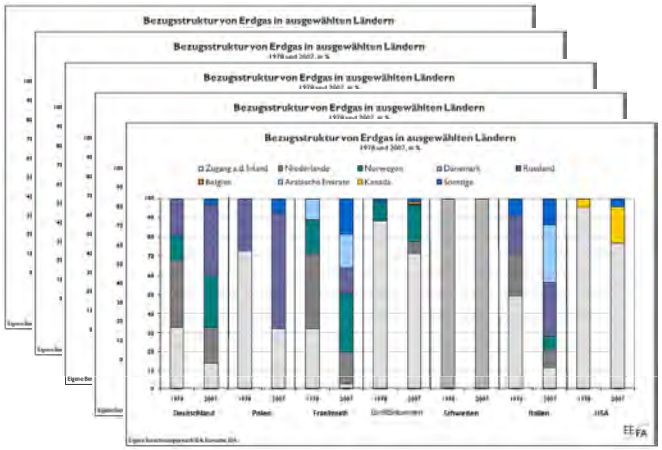

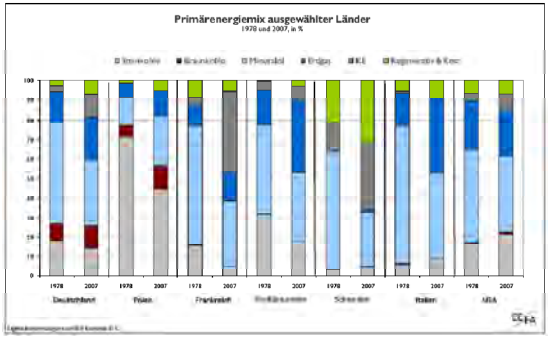

Import dependency regional concentration primary energy mix

$$Risiko := w^T X^T R X w = w^T \Pi w.$$

Risk value at primary energy level

Methodology: System of indicators to measure vulnerability

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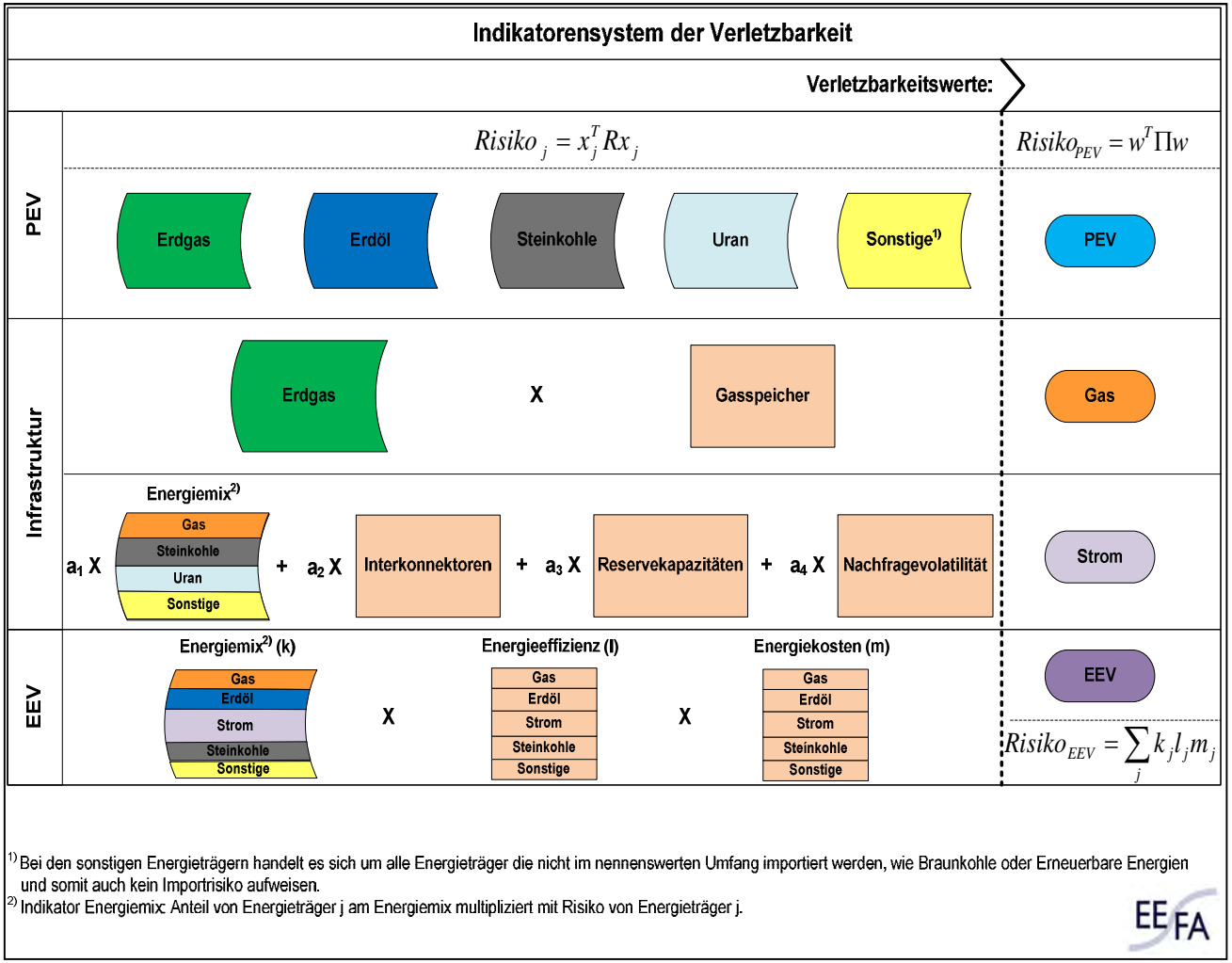

Necessary re-scaling according to KOM:

"Tools for Composite Indicator Building"

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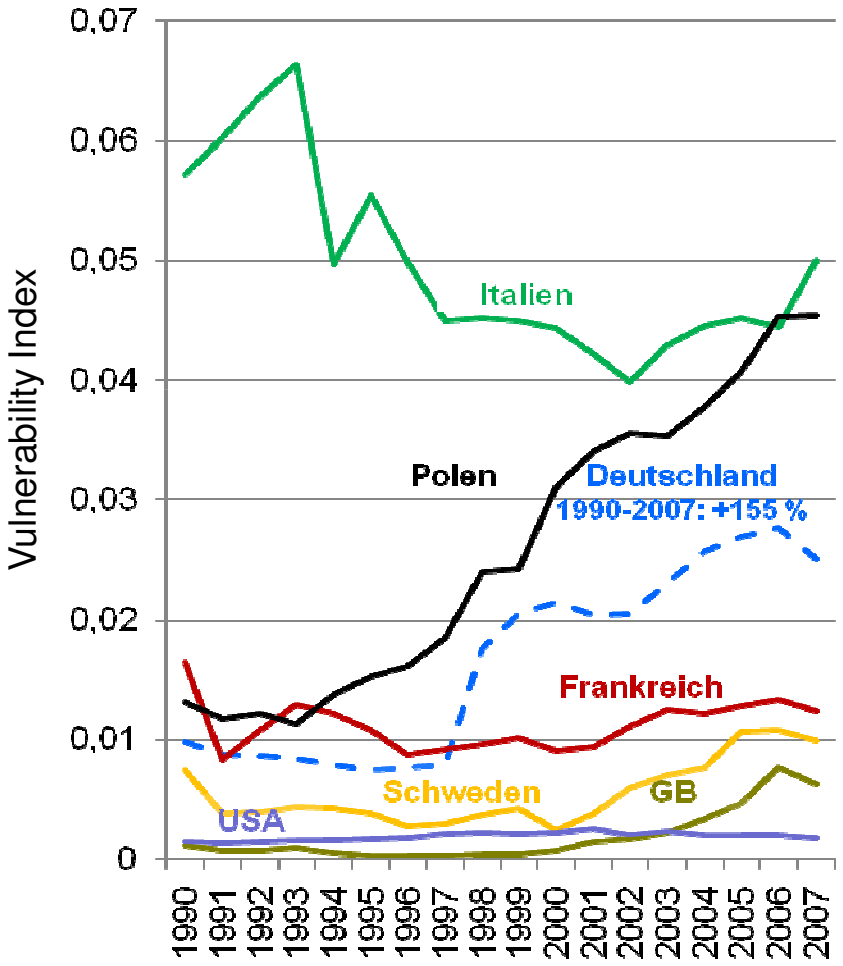
Comparison of primary energy supply risks (international results)



POL & **ITA** show the highest vulnerability:

→ *noticeable: both countries without nuclear*

→ ***POL**: low diversification; domestic coal replaced by import-fuels (gas, oil)*

→ ***ITA**: indicator dominated by oil due to very high share, reduction path mainly driven by changes in import-structure*

In **GER** PE-supply risk more than doubled:

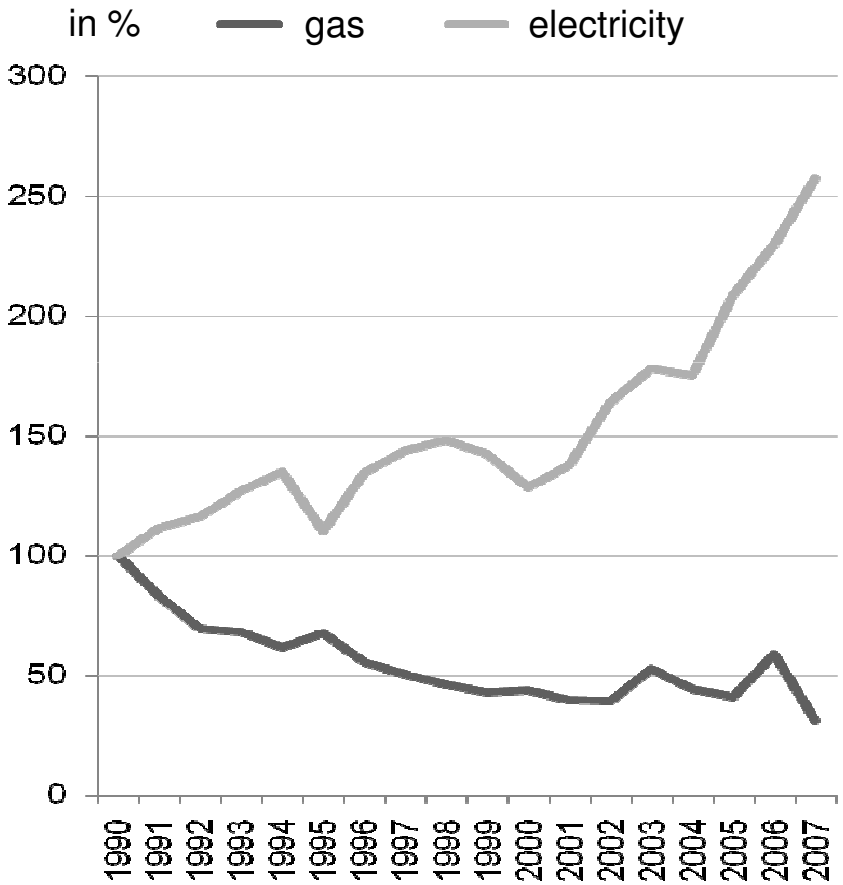
→ *Higher import-dependency from regions with higher geopolitical risks*

FRA, UK, SWE & USA relatively secure:

→ ***FRA**: high share of nuclear and diversified oil-import-structure*

→ ***SWE, UK, USA**: relatively high level of indigenous sources and nuclear*

Vulnerability of grid-bound energy (results for Germany)



Gas: Decreased vulnerability

→ higher import-share

→ substantial investments in infrastructure (e.g. storage doubled)

investments could over-compensate the increasing vulnerability due to higher import-share

Electricity: Increased vulnerability

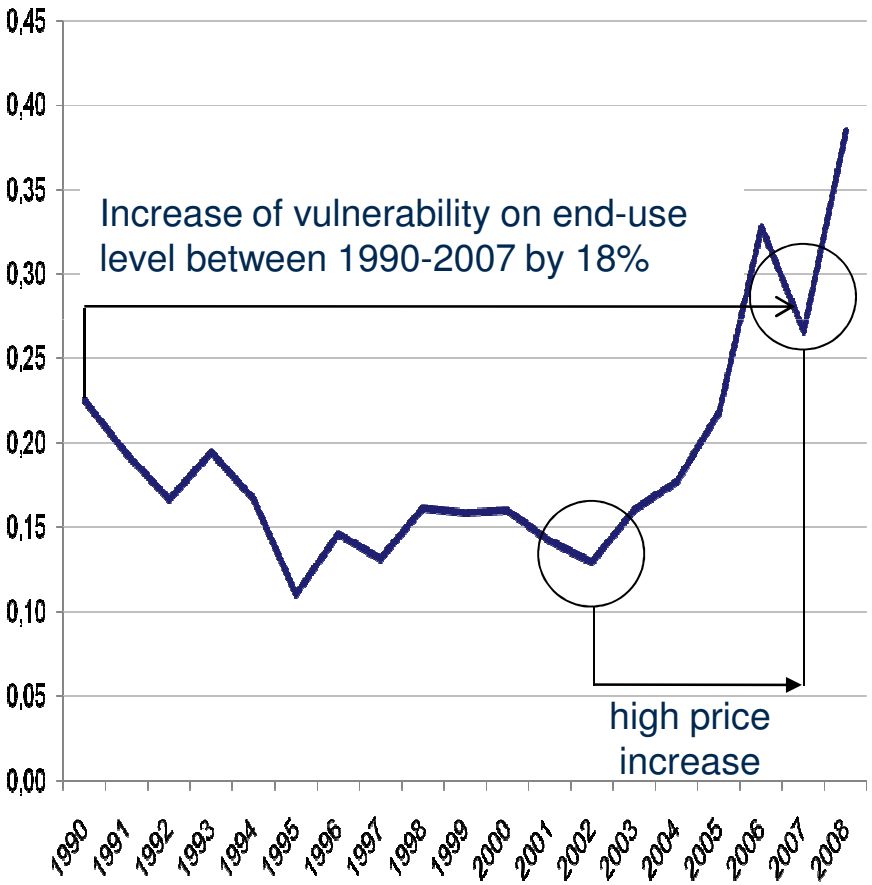
→ declining power-plant reserve capacity

→ higher risks on fuels (import-share)

→ increasing volatility of demand

no sufficient compensation

Vulnerability of end-use-level (results for Germany)



Observations

→ **Overall increase of vulnerability by 18 %**

→ **Efficiency effects and substitution-processes led to decrease between 1990-2002**

→ **Dramatic increase of energy-prices since 2002 had high negative impact on vulnerability value**

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Scenarios (Germany)

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Characteristics

Ref:	Phase-out nuclear & hard coal; 40% RES in 2030; 40% GHG-reduction by 2030
SZ-I:	Lifetime extension for nuclear power plants to 60 years
SZ-II:	Retention of domestic hard coal production from 2012 at the level 12 Mio. t/a *)
SZ-III:	Extension of the renewable-goal to 50 % of power-demand until 2030
SZ-IV:	Extension of the GHG-goal to 50 % until 2030 (Baseline 1990)

*) incl. Invest subsidies for high efficient coal PP (2013-2016 from ETS)

Qualitative effects on selected parameters (Germany)

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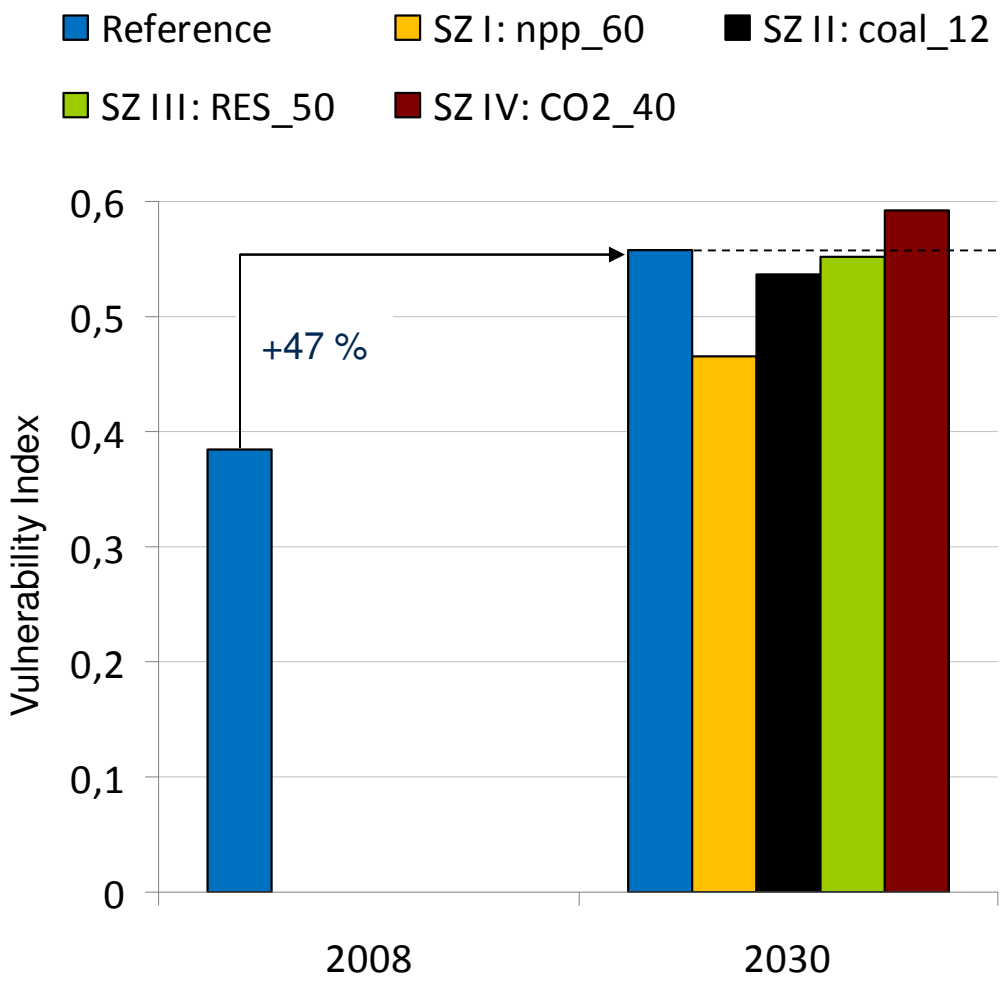
	GDP/ jobs	PE-demand	Energy imports	Shift in Energy mix	Prices: Electr./ CO2
…compared to reference					
SZ-I: Nuclear 60a	+/+	++	- - **)	Uran	low/low
SZ-II: Domestic hard coal (12 Mio. t) *)	+/+	+	-	Coal	low/high
SZ-III: RES goal extension (2030: 50 %)	-/-	-	-	RES	high/low
SZ-IV: CO2 goal extension (2030: 50%)	-/-	- -	+ +	Gas	high/high

*) incl. Invest subsidies for high efficient coal PP (2013-2016 from ETS) **) Nuclear eq. to domestic due to high level of storage possibilities

Quantitative results for the overall vulnerability (Germany)



general observations

- Continuation of current policy (early 2010) leads to significant increased vulnerability by 2030
  ► +47 % compared to 2008

scenario effects/impact

- Lifetime ext. npp 60a with largest impact: could halve increase
  +47 % ► +22 %
- Increased use of domestic coal:
  +47 % ► +41 %
- Increased RES-share:
  +47 % ► +45 %
- More ambitious CO2-target:
  +47 % ► +56 %

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Summary of the results for Germany

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Primary energy level

- Vulnerability in Germany has more than doubled (1990–2007)

Infrastructural & end-use level

- The relatively high level of solid infrastructure & efficiency could absorb vulnerability increases at end-use level; even though raise of 18 %

Scenario results

- “Current-policy-path” leads to further vulnerability-increase of 47 % until 2030
- Meaningful policy could lower the vulnerability-increase
  - → Largest impact: lifetime-extension for npp to 60a (could halve the increase)
  - → Other policies also improve supply-security (Coal/RES-scenario)
  - → No single measure change the trend of increased vulnerability
- Mix of measures essential!

Uncertainties / Open questions

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- What does the absolute value of vulnerability tell us?
- Is the selection of indicators sufficient for sound results?
- What is the impact of the necessary simplifications of the highly complex and multidimensional task, e.g. scaling, weighting?
- Availability of input data!
- Reliability of input data!
- …

Thank you!

Back-up

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The Energy Trilemma

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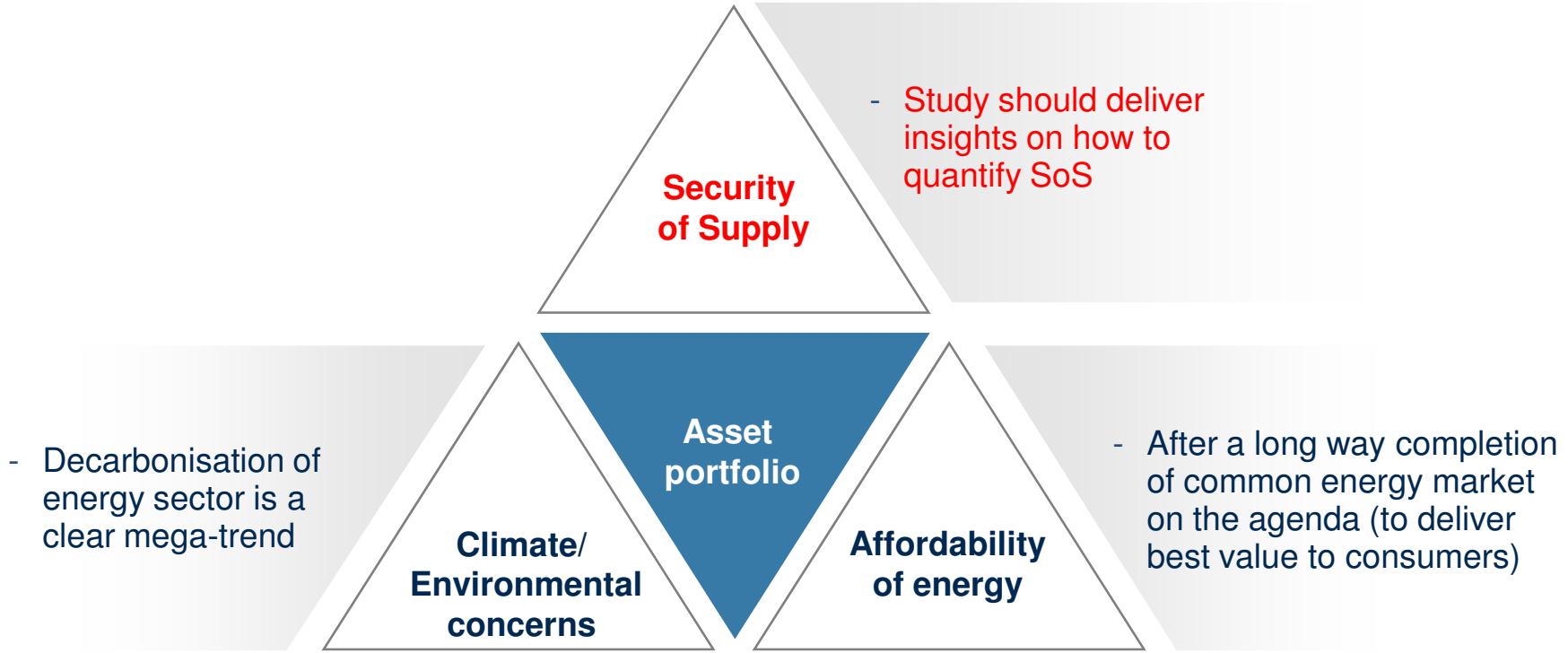

Political Challenge:
Create the right framework for a well balanced triangle

Definition & leading questions

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Possible Definition by WEC:

"…vulnerability of an energy system can be measured by its ability to cope with adverse events"

- Is vulnerability measurable (beyond single aspects, e.g. import-dependency)?
- Which meaningful indicators for vulnerability could be identified?
- How vulnerable are we in Europe?
- Which starting points can we identify to reduce our vulnerability?

Initial WEC-study 2008

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Motivation:

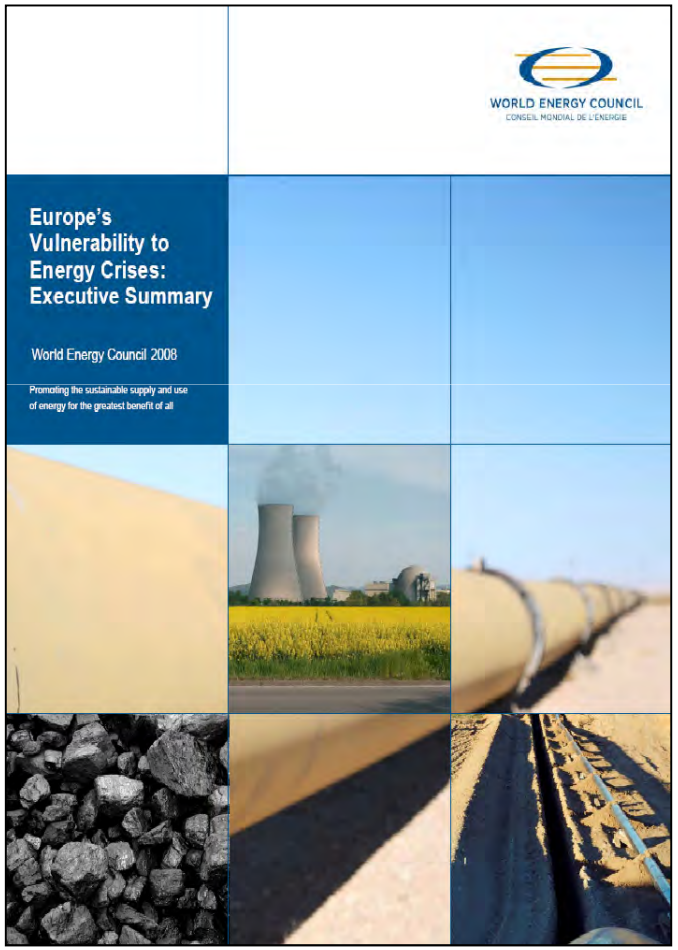
- Anticipated increases in energy prices
- Growing import dependency of Europe
- Reinforce concerns about meeting the energy demand in the future

Objective:

- Assessment economies could respond to a possible energy crisis provoked by various thinkable events

Main result:

- Principles for indicator based approach
- Development of an indicator-set to evaluate the levels of vulnerability



Proposal of the initial WEC-study

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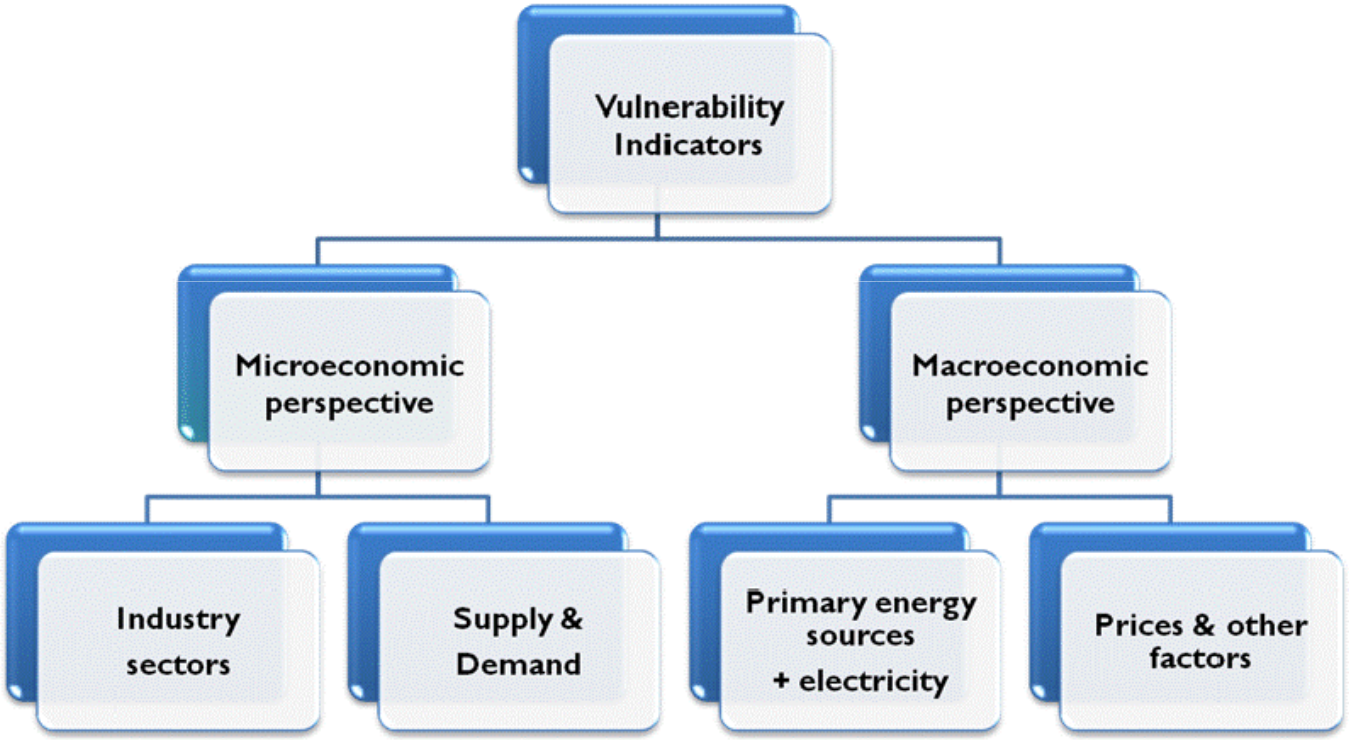
Structure of the set of indicators (WEC proposal)



Source: own illustration

EEFA

Reference scenario (Germany)

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Nuclear
- Phase-out decision unchanged (last npp around 2020)

Hard coal
- Phase-out decision (last production 2018)

Renewables
- Political targets will be met ► 30% in 2020, 40% in 2030

GHG
- National reduction-target anticipated 30% in 2020, 40% in 2030

Emission Trading
- Energy industry: full auctioning from 2013
- Other industry: 20% in 2013 up to 100% in 2027

Alternative scenarios (Germany)

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Scenario description	
SZ-Ia:	Lifetime extension for nuclear power plants to 60 years
SZ-Ia:	Lifetime extension for nuclear power plants to 40 years
SZ-IIb:	Retention of domestic hard coal production from 2012 at the level 12 Mio. t/a *)
SZ-IIb:	Retention of domestic hard coal production from 2012 at the level 8 Mio. t/a *)
SZ-III:	Extension of the renewable-goal to 50 % of power-demand until 2030
SZ-IV:	Extension of the CO2-goal to 50 % until 2030 (Baseline 1990)

*) incl. Invest subsidies for high efficient coal PP (2013-2016 from ETS)