ECN

Energy research Centre of the Netherlands

Long term energy services security: some metrics and policy issues

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What is ‘energy security’? (1)

- Policymakers face a hard time when:
  - The lights go out or gasoline filling stations are closed
  - Consumer energy bills suddenly surge
- Yet SoS is a complex multi-faceted and multi-timeframe issue
- Because of inertia (long investment cycles, lock-ins) **adverse long-term security trends cannot be quickly redressed but tend to be neglected**
- Stakeholders in the game of SoS tend to be myopically constrained by **time-bounded rationality**
- It is therefore socially desirable when SoS is monitored **periodically** over **several timeframes** **including notably the long term i.e. >10 years**

What is ‘energy security’? (3)

- In 2001/3/6/8 the European Commission pictured a situation of increasing dependence with regard to oil and natural gas on a few producing countries with potentially unstable/unreliable political regimes

- ‘Energy security’ as conceived by USDOE and IEA has evolved from an *oil supply problem* to a *fossil fuels supply problem*
  - Emphasis on improved functioning of fossil fuel markets and
  - good external relations with exporting nations

Concepts

Energy Services Security (1)

- Walt Patterson (2007): There's abundant ambient energy (solar, wind, flow-of-the-river hydro)….
- Besides, stored energy (in the form of hydro storage, biomass + fossil, including uranium) can be utilised
- Energy **can not** be produced and **does not** get lost (1st Law of Thermodynamics) !
- Hence, 'energy security' is strictly speaking a non-issue
- What's at stake is: a secure supply of energy ***services***

Energy Services Security (2)

- The key concern is the uninterrupted and sustained ability of consumers to meet desired, (at least) essential energy ***services*** at adequately short notice and adequate service level and at affordable costs
  - o ‘essential’, ‘adequate’, etc. **context-dependent**
  - o Consider e.g.: value of a few seconds power flickering
    - for ICT company
    - for household lighting

Energy Services Security (2)

- **End-user centered** approach considering **integrally**:
  - Energy savings through behavioural change (reduce wasteful usage) and more energy-efficient appliances + sustainable spatial and public transportation planning
  - Alternative less fuel-intensive service delivery opportunities
  - Reduction of direct fossil fuel use through alternative electricity-based services
    - Towards the Electricity (and Hydrogen?) Economy
    - Multi-fuel-source based ➔more secure
  - Reducing fuel resource requirements over the *full* energy supply chains (life cycle basis)

Do we need indicators?

- **Metrics that summarize adequately the current and projected future status of ESS** (scenario analysis) could be useful analysis tools for ESS policy design:
  - **Simple metrics,** covering (an ESS apect for) a specific class of energy services
  - **Composite metrics** for the whole energy services system

- Ideally indicators are:
  - **Adequate summary metrics** of the complex ESS world
  - **Transparent**
  - **Readily interpretable** by key stakeholders, e.g. on a [0,1] or [0%, 100%] scale
  - **Applicable to official policy scenarios**

Applications of composite ESS indicators

- **Useful ST ESS indices may focus on physical shortages risks. Simple fuel- and aspect specific indicators seem preferable. E.g. s.t. scope fuel substitution low**
- **Both composite and simple LT ESS indices can be useful; composite indices for:**
- **Benchmarking**/comparison tool: e.g. EU Member States allowing for country specifics
- **Component analysis**: what is relevant; what are the key vulnerabilities/resilience factors?
- Comparison: ESS in the **future** **(scenarios)** **vs. today**
- Comparison: **ESS impacts of different policies** (baseline vs. policy scenarios)
- **May e.g. help to trigger alarm bells to policy makers for required action procedures at pre-set set points**
- **Supplementary detailed analysis is a must!**

Introduction to “ECN” long-term indicators

- ECN has developed two sets of **composite SoS indicators**
  - (Jansen et al. 2004) designed four long-term **diversity-based indicators**
  - (Scheepers et al. 2007) developed in collaboration with Clingendael International Energy Program (CIEP):
    - A ‘**Supply/Demand Index**’ for the **medium/long run**
    - A ‘**Crisis Capability Index**’ for the **short run**

Diversity-based indicators (1)

Objective

Design of energy security indicators for application to long-term global GHG emission scenarios, allowing for geopolitical and resource depletion

Approach

- First ECN study did quick literature scan (mid 2003): **no instant composite metrics** for the whole energy sector
- Given the long-term perspective its focus was on **supply-side-oriented indicators**
- Based on **Andy Stirling**'s work on diversity indicators
- For its simplicity the **Shannon-Wiener Index taken as point of departure**

Diversity-based indicators (2)

- Designed and applied **4 long-term indices** allowing for a **stepwise increasing number of major factors**.
  - All 4 are based on the simple Shannon diversity index
  - **Normalised into a [0,100] scale**
  - Two last ones also include elements which were assumed to be amenable to rough extrapolation.

- Indices introduced are:
  - **Diversification of energy sources in energy supply (I_1)**
  - **Diversification of imports with respect to imported energy sources (I_2)**
  - **Long-term political stability in import regions (I_3)**
  - **The resource base in regions of origin, including the home region itself (I_4)**.

Supply/Demand Index (1)

Objective

- Indicator that covers all key elements of the energy supply system
- Assessment of energy supply security in the medium and long term
- Comparison between EU Member States
- Measuring the level of energy supply security changes over time

Approach

- Quantitative comprehensive indicator
- Based on the demand and supply structure

Features

- Transparent branch structure, weights and scoring rules
- Linkages to (supply and demand side) resilience enhancement policies
- Somewhat complex

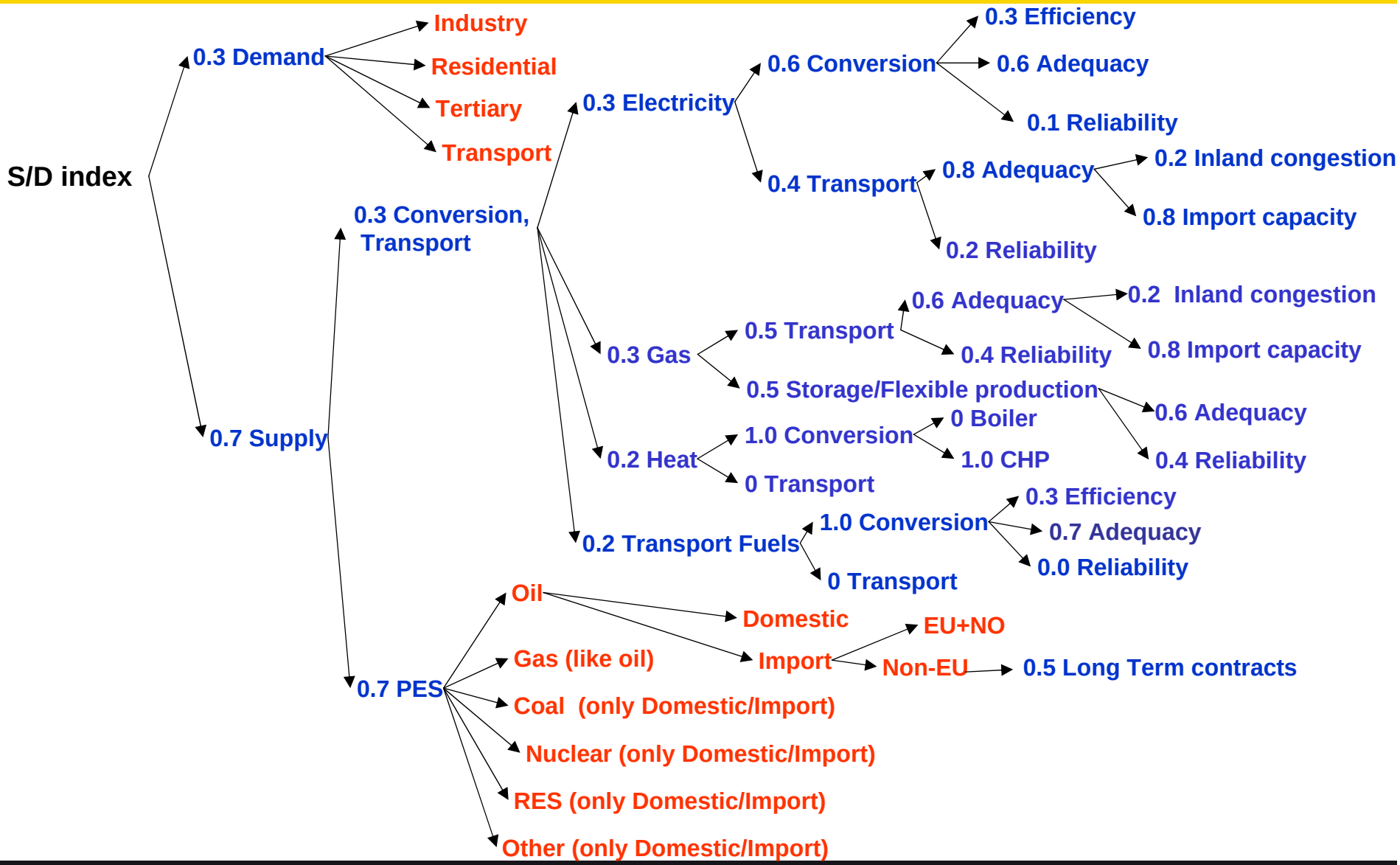
Supply/Demand Index (2)

- Branches have weights
  - Expert judgement (subjective) of contribution to overall (in)security
  - Physical (objective) relative shares (primary energy supply (PES), energy demand per sector)

- End of branches: scores 0-100 by scoring rules
  - Scoring rules combination of physical entities and criteria

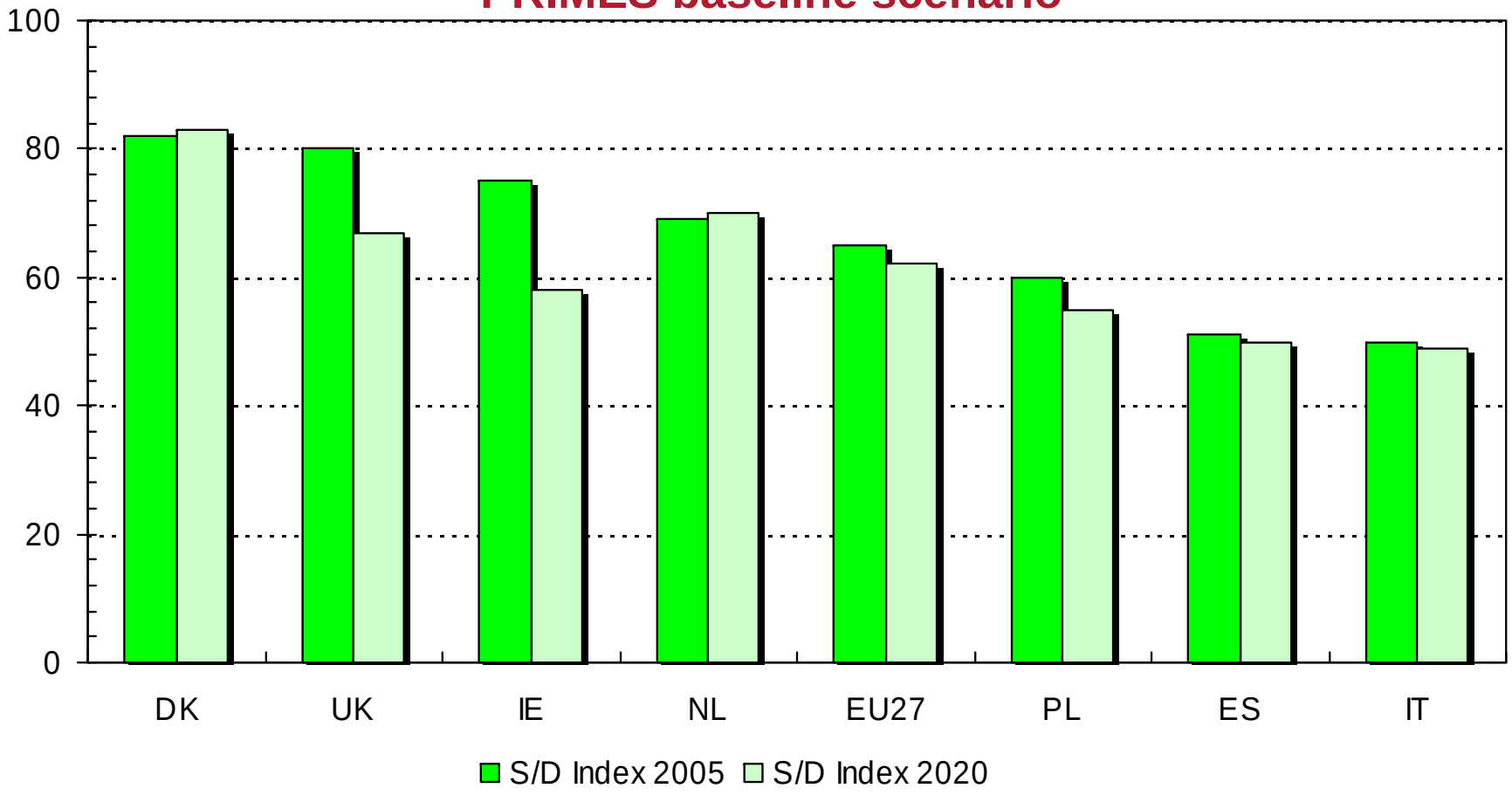
- Total S/D index score by combination of weights and sub-scores

The Supply/Demand Index Model



S/D Index: comparing future vs. today

2005 and 2020 forecast for selected EU MS
PRIMES baseline scenario



‘Energy security’ dimensions typically classified by main aspect in supply-oriented fashion

Example: (APERC, 2007)dimensions at ***given*** demand:

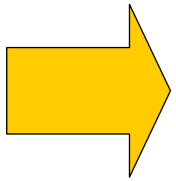
- **Availability**
  - Depletion; (in)adequacy upstream investments
- **Accessibility**
  - Interventions by GVTs of fuel exporting countries
  - Other supply disrupting events
- **Affordability**
  - Supply cost may compromise social security
- **Acceptability**
  - Supply barriers because of option-specific environmental/health concerns; social/cultural attitudes

‘Energy services security’ approach is more encompassing

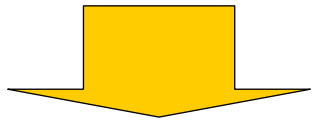
- Not only supply risks determine the security of energy services for a country’s population
- Also elements of resilience, including the demand side
- ‘Energy’ demand is ***not*** given:
  - The energy-resource needs, risks and of current energy services are mapped considering fuel chains from downstream to upstream
  - Alternative ways to meet current energy services, their fuel requirements and risks are mapped as well
  - Resource savings potentials all along the fuel supply chains are considered
  - Substitutions options and saving potentials determine the scope for boost the resilience of a country to vulnerabilities in meeting energy services

Supply vulnerabilities, resilience and impact

Resource depletion (fuels, minerals)
Interventions export/transit countries
Inadequate upstream investments
Inadequate midstream infra
(transport, conversion, distribution)
Technical failures and accidents
Terrorism / war damage / internal unrest
Natural disasters
Climate change impacts



Resilience of the energy services demand/supply system



I M P A C T

Energy services security: proposed dimensions

- **Exposure to supply-side vulnerabilities**

- **Resilience on the demand side**
  - End use efficiency
  - Waste reduction (lifestyles, good housekeeping)
  - Flexibility (ICT-based demand adjustment, substitution)
  - Advancing the Electricity (Hydrogen?) Economy, e.g. road pax transport
- **Resilience on the supply side**
  - Extraction rate, T&D losses, conversion efficiencies
  - Regulatory environment
  - Market transparency (available capacity; fuel stocks data)
  - ICT based, flexible T&D system operations management
  - International economic co-operation / integration
  - Diversification suppliers, transport routes / mode
  - Storage options, commercial/strategic reserves

Is the ESS approach only suitable for fuel importing countries?

- (Alhaji, 2007): Security of demand is just the opposite of security of supply…
- Yet:
  - Populations of every country has to meet their requirements for energy services
  - The Paradox of Plenty
  - Also exporting countries face resource depletion
  - Demand-side resilience mitigates vulnerability to skidding world fuel prices

Two possible avenues for future research

1. Improved methodology of the S/D (or rather D/S) indicator
2. Develop branch structure by main dimension / theme (/ sub-theme, etc.) to **include also more qualitatative relevant aspects**

   ➔find single indicator(s) per theme incl. Yes/No ones

- For adoption of (simple/composite) indicators **close dialogue with policymakers and other stakeholders is essential**
- Include interactions with other policy domains

Conclusions

- **No silver bullet indicator** to encompass all security of supply complexities and policy needs

- Yet **comprehensive approach** warranted to address key issues and for design of indicators, based on **energy *services* security**

- **S/D Index** would seem a notable step in the right direction for new composite ESS indicator tools to facilitate the formulation of ESS policy strategies

Thank you

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