Energy security: perceptions and reality, systemic and reductionist

Francesco Gracceva
Peter Zeniewski
JRC-IE Energy Security Unit

EUROPEAN COMMISSION JRC

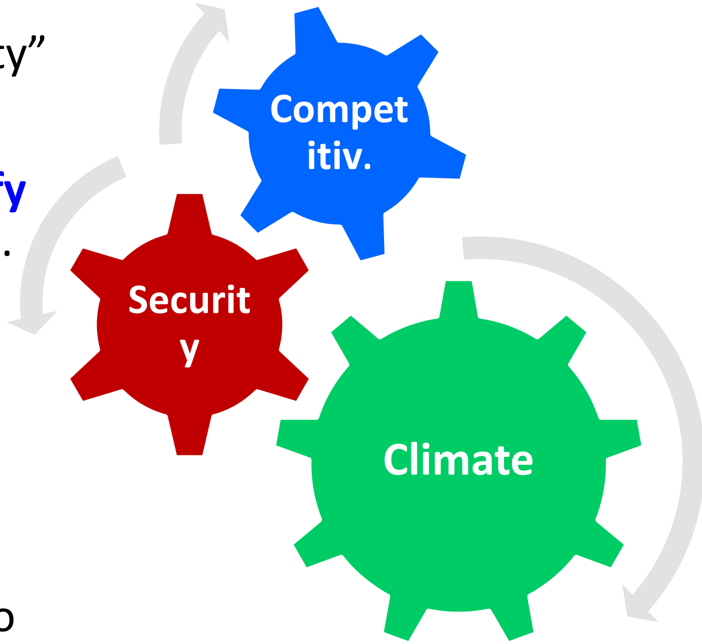
Overview

Institute for Energy

- Background
- Two approaches to energy security: reductionist vs systemic
- JRC-IE Energy security
  - A systemic multidimensional view
  - Modelling efforts
  - Policy support: EU approach to energy security: perception and reality?

Background

- “While **EU** has been successful in institutionalizing a climate policy, it **has not been able to formulate a successful energy security policy**” (Mitchell 2009)
- “In contrast to other energy policy objectives, there is **no obvious or universally accepted measure** of supply security” (UK-DBERR, 2007)
- “the concept of energy security is frequently **used to justify various policies** or actions at the same time” (Loschel et al. 2009)
- “in numerous countries far reaching **interventions** in the market have been established in order to secure energy supplies, **often without any economically rational justification**” (Schmitt 2009)
- “increasingly **urgent need for a framework** within which to analyse: the **impact** of specific security events, the level of **risk** attached to such events, and the **cost** of measures which would provide insurance against them”. (…) “In the absence (…) any statement about energy security is meaningless.” (Stern 2004)



Two Approaches to Energy Security

Reductionist

- Understand the energy system by focusing on specific components
- Narrow the domain of analysis to a manageable level, such as the level of spare capacity in the energy system
- Select the essential features of the system that largely determine energy security and assign corresponding weights (e.g. diversity)
- Focus on "vulnerabilities" (e.g. proxies for the potential risk and/or magnitude of an energy security impact, should it actually occur)

Systemic

- Energy system property/state System dynamics (system constantly changing): Understand the energy system as a complex dynamic system, by considering all the significant elements and emphasizing their relations, interactions synergies (also trade-offs with other energy policy goals)
- Resilience/robustness to uncertain adverse events: risk, uncertainty, ignorance (Stirling, 2009): Focus on "outcomes" (e.g. measure the actual consequences of energy insecurity and consider associated costs and benefits)
- The "adequate" level of energy security: f(cost, value)

*Energy security as a condition of an energy system **evolving** over time with a **adequate capacity to absorb** adverse events and keep satisfying the **energy service needs** of the society*

Two Approaches to Energy Security

***Reductionist approach in policy**:*

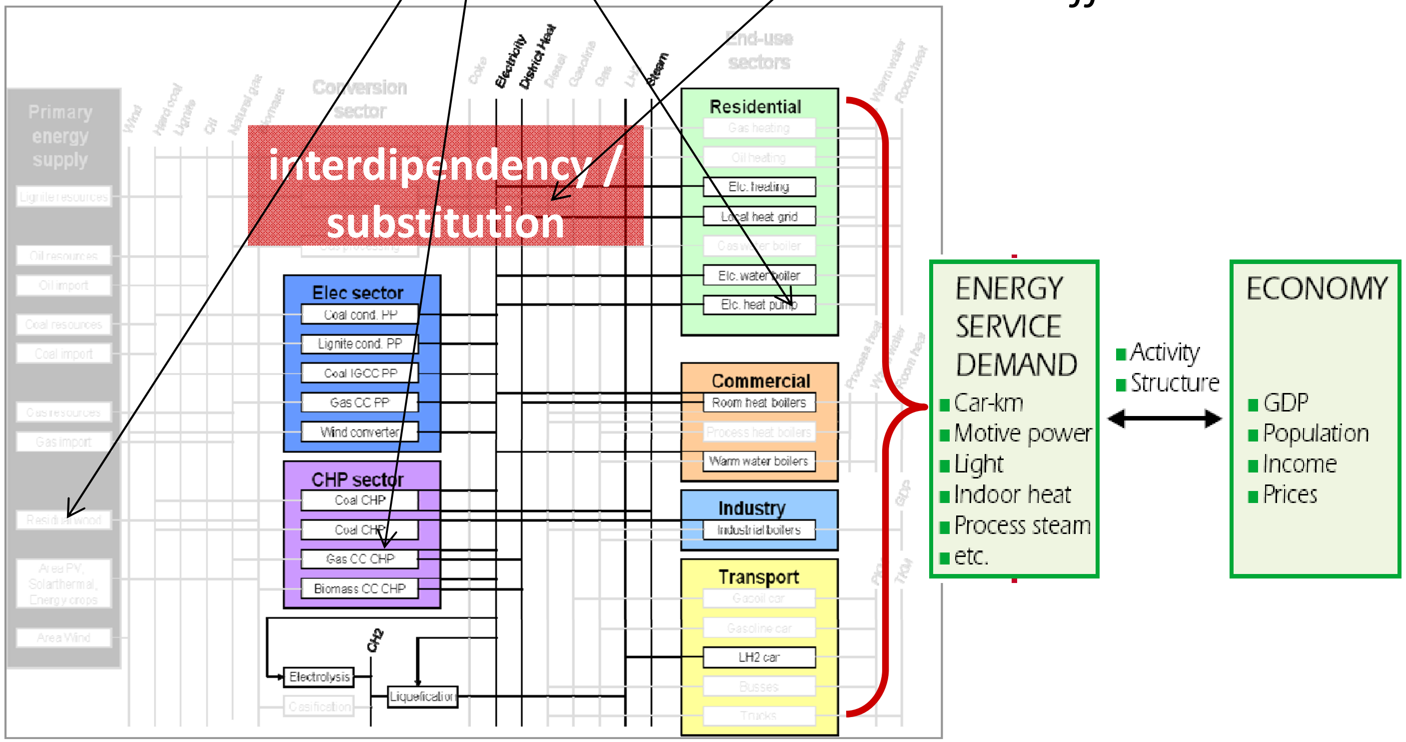
- *Germany (subsidized indigenous coal, nuclear)*
- *Polish diversification*
- *Nabucco?*
- *…*

➔ *Indicators + weights*

➔ *Diversity*

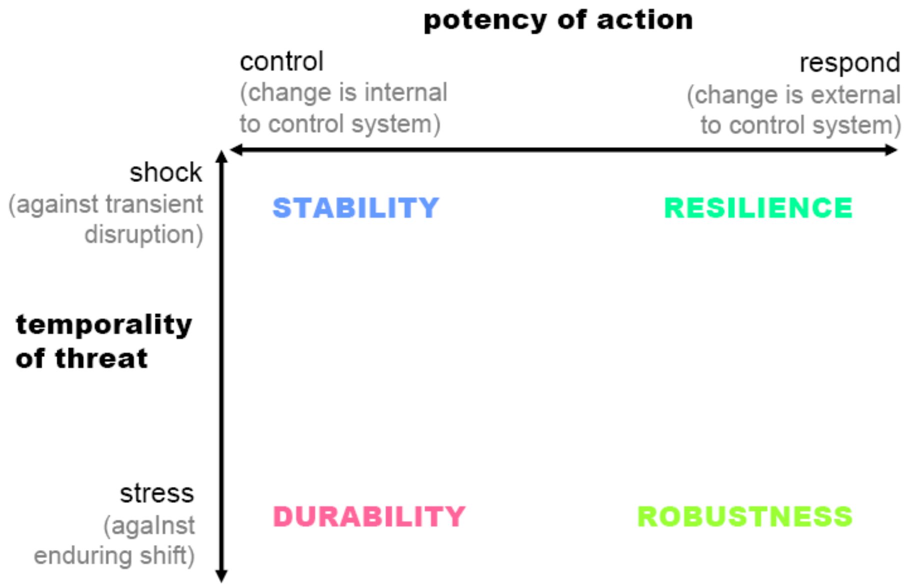
***Riductionist and systemic in literature**:*

- *System models*
- *Indicators (practical way to solve the same impossible problem?*
- *Different results?*



Systemic Nature of Energy Security

- **Energy security is a property of energy systems,** where we take the energy system to include people and their institutions as well as technologies and energy sources. It is not meaningful to assess the security of particular components of these systems (…) Furthermore, energy systems are dynamic and are changing rapidly due to the imperative of transitioning to more low carbon forms of energy provision and the growth in resource demands from developing countries and regions.
- Energy systems are subject to **a range of different risks or threat**s to energy security – and these vary with geography and timescale
- There is a **range of strategies** that governments and other actors can use to try to deal with the causes of insecurity – or to strengthen an energy system's ability to withstand disruptions.



Energy Security in a Multi-polar World

JRC - IE Energy security

- to support strategies based on economically rational assessment of costs and benefits of policy options (while rectifying reductionist tendencies)
- to develop frameworks for rigorous, transparent and quantitative approach to energy security within a satisfactory theoretical definition
- by identifying what a "secure" EU energy system means in terms of energy technologies and sources, infrastructures as well as institutions policies and agents behavior
- to taking into account synergies and trade-offs between energy security and other goals (e.g. sustainability and competitiveness) through a multidimensional approach
- to contribute to the Commission's systemic vision, ensuring it is matched by the use of appropriate tools to assess energy security

… to help align systemic perceptions with systemic tools that correspond to reality

Examples

EC Regulation 994/2010

Gas and electricity: from system models to network models

Energy system model assessments: Shale Gas Report

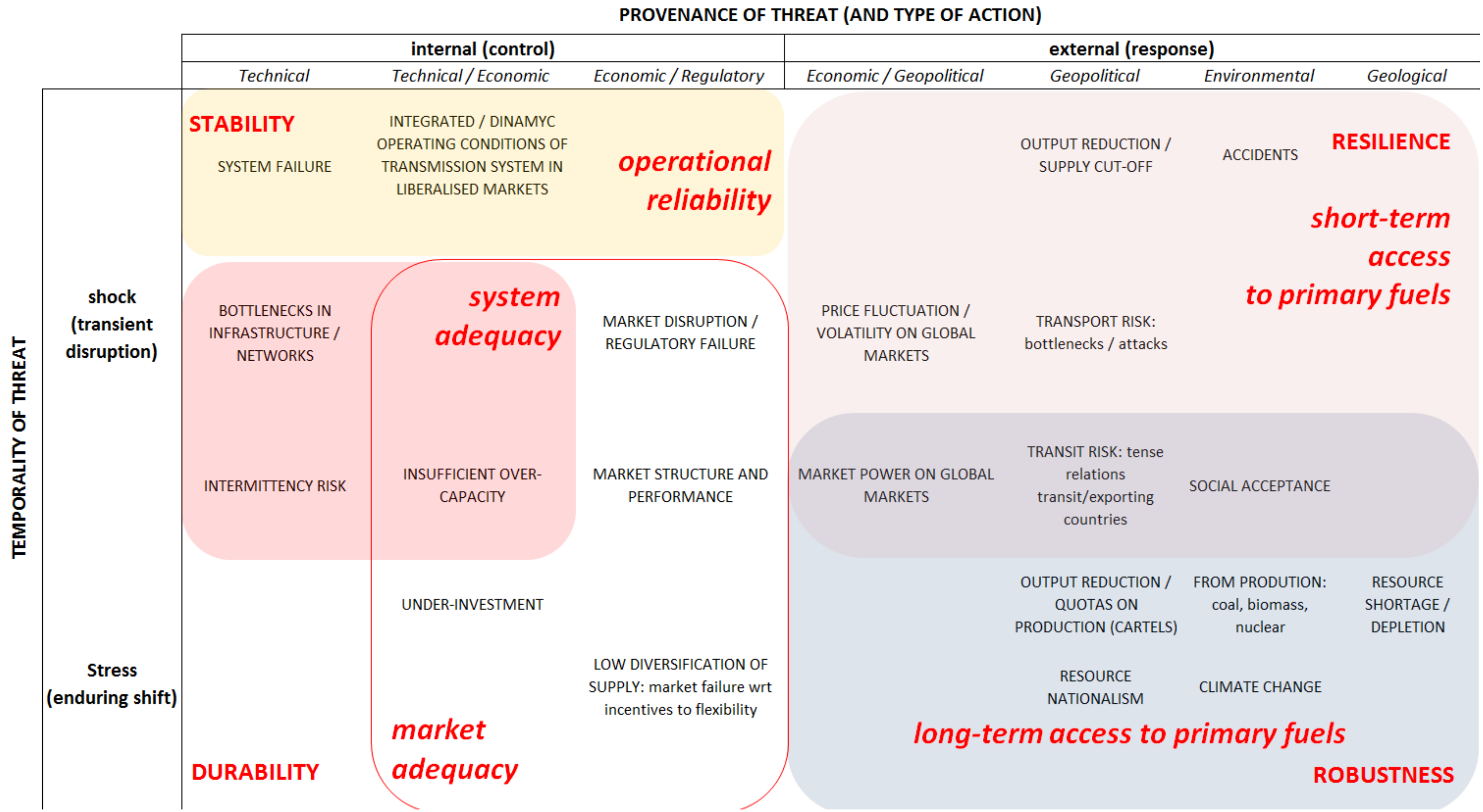
Threats – a list

Table 1. Classification of security of supply risks in the EU

Type of risk	Events	Price rise Intl.	Price rise Domestic	Probability in 20 years	Duration	Fuel affected Oil	Gas	Coal	Nuclear	RES	Elec.
Geological risks											
Resource depletion/shortage	Lack of investment; extraction difficulties; unsustainable global demand; political constraints	Yes	Yes	Low	Decades, permanent	x	x	x	(x)	–	–
Geopolitical risks											
Voluntary output reduction	Quotas on production (by OPEC cartel; by a possible gas cartel); supply cut-off	Yes	Yes	Low-medium	Months, days	x	x	–	(x)	(x)	–
Involuntary output reduction	Civil unrest; political turmoil; war; terrorism	Yes	Yes	Low-medium	Variable	x	x	–	–	–	–
Transport and transit risk	Transport: sea-lane bottlenecks; lack of investment; piracy Transit: political instability of transit countries; tense relations with exporting countries	Yes	Yes /No	Low-medium-high	Variable	x	x	–	–	–	x
Resource nationalism	Limited access for foreign investors to producing countries' resources	Yes	Yes	High	Years	x	x	–	(x)	–	–
Economic risks											
Under-investment	Transition towards liberalisation; lack of investment incentives; capital shortage; public opinion opposition	No	Yes	High	Years	x	x	x	x	x	x
Market disruption	Regulatory failure/shortcoming	Yes	Yes	Medium	Variable	x	x	–	–	x	x
Price fluctuation	Supply-demand imbalance; lack of spare capacity; speculation	Yes	Yes	High	Months, years	x	x	–	–	–	x
Environmental risks											
Accidents	Major oil spill (land or sea)	No	Yes	Medium	Variable	x	–	–	–	–	–
	Nuclear accident	No	Yes	Low	Variable	–	–	–	x	–	x
Climate change	Increasing greenhouse gas emissions	Yes	Yes	High	Permanent	x	(x)	x	–	_	x
From production	Coal extraction and combustion	No	Yes	Medium	Variable	–	–	x	–	–	x
	Radioactive waste form nuclear	No	No	Medium	Permanent	–	–	–	x	–	–
	Unsustainable biomass production	No	No	High	Decades	–	–	–	–	x	–
Technical risks											
System failure	Extreme weather conditions; under-investment; technical neglect; major pipeline burst	Yes/no	Yes	Medium	Days, weeks	x	x	x	x	x	x
Intermittency risks	Absence/low inputs (e.g sun, wind)	No	No	Medium	Hours, days	–	–	–	–	x	x

Source: Checchi et al. 2010, Secure EU FP7 project

Threats – a (multidimensional) map



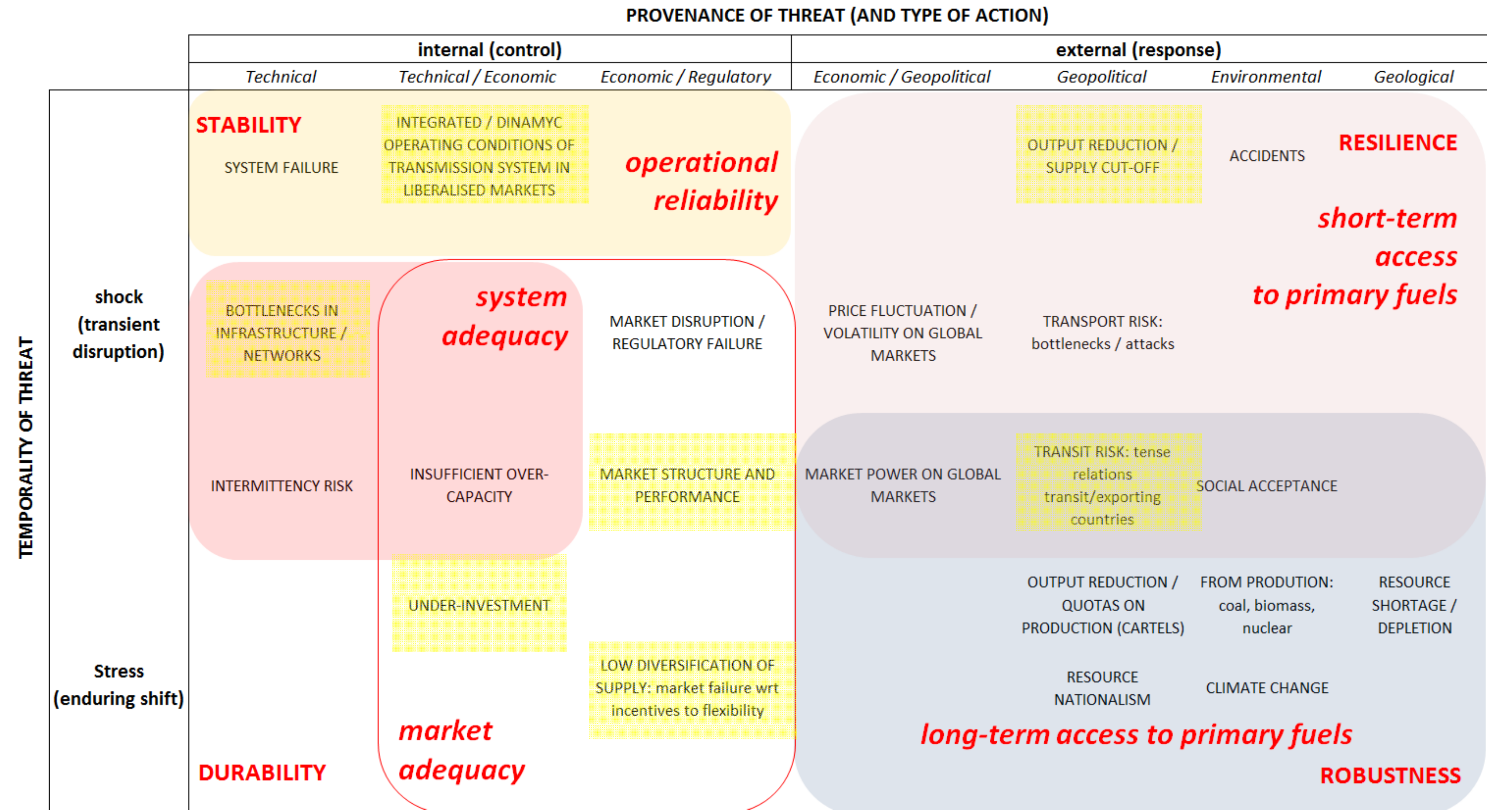
Lessons from the past: January 2009 gas supply disruption to EU (a)

- There are **no common scenarios** for dealing with emergency situations, involving regional/EU risk assessments and detailed assessments of the market situation, i.e.:
  - **demand** patterns
  - main **suppliers**
  - **alternative sources**
  - **storage** possibilities, etc.
- Scenarios could be usefully **coordinated with infrastructure planning** procedures
- **Insufficient physical network integration**, inadequate transparency in network utilisation, as well as **inflexibility in capacity reallocation and congestion management, inadequate price response mechanisms and lack of coordination** are all factors which undermine the market's response to a gas supply disruption
- It was mainly the inadequacies in gas transport which constrained flows (capacities, reverse flow capabilities, unusual routes, insufficient integration of gas networks in Central and South Eastern Europe), not an aggregate shortage of gas.

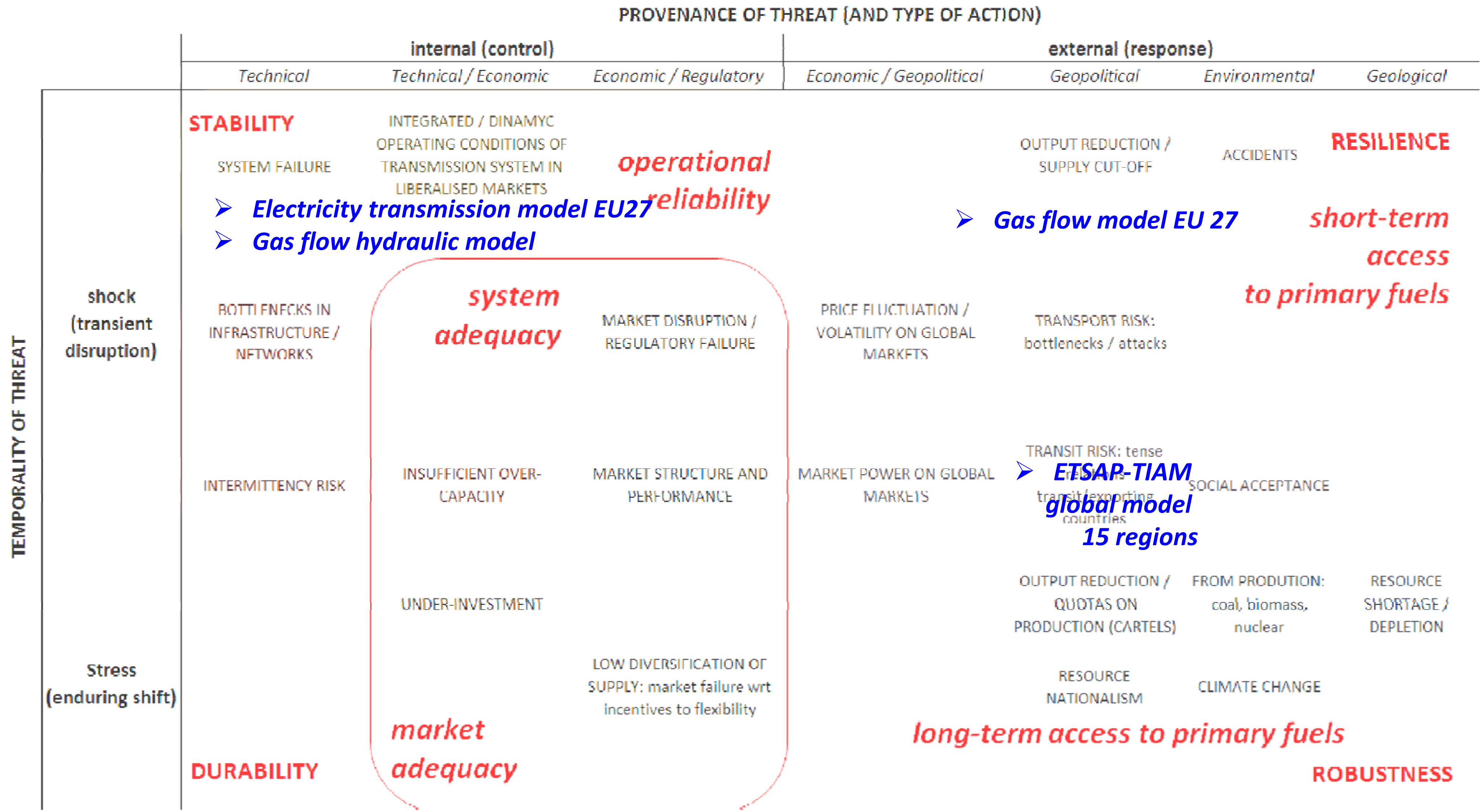
➔ **How lack of interconnections and diversification options (route and fuel source)** can exacerbate a supply crisis

Source: (SEC(2009) 977)

Lessons from the past: January 2009 gas supply disruption to EU (b)



Model based assessment of multidimensional energy security



Energy security at the heart of the energy policy

2006
Green Paper
European Energy Policy
Action Plan Energy Efficiency

2007 Jan
First strategic review

2008 Nov
Second Strategic Review
Energy Action Plan

2008 Dez
Energy and Climate Package
(adopted)

2009 June
Third Internal Energy Market Package
(adopted)

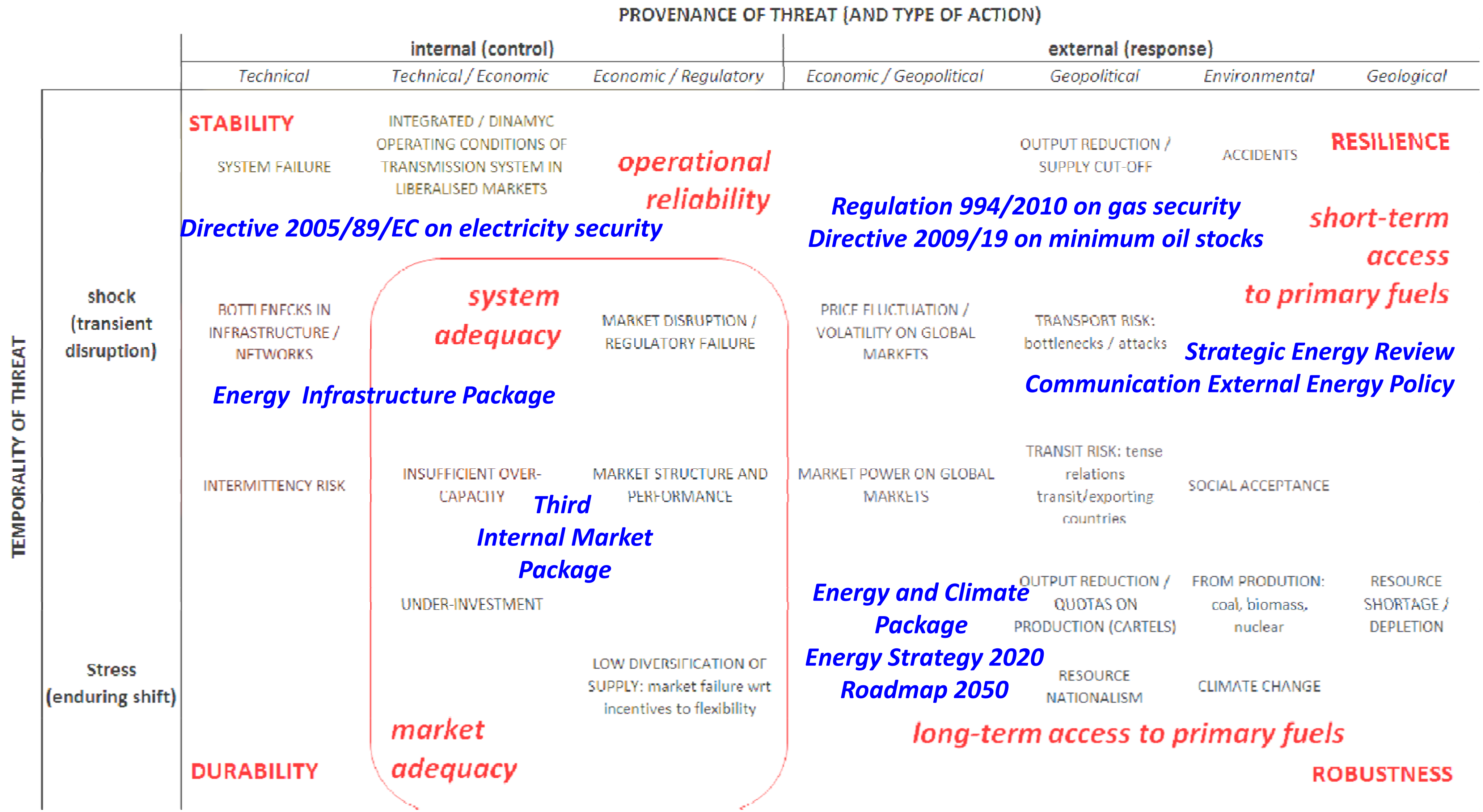
2009 July
Energy Programme for Recovery (EEPR)
(adopted)

2010 Nov
Energy Strategy 2020
Energy Infrastructure Package
Regulation on security of gas supply

2011
Energy Infrastructure Instrument
Roadmap 2050
Energy Efficiency Plan
Communication external energy policy

Source: J.A. Vinois, An integrated approach on energy security, 18/10/2010

EU approach to energy security



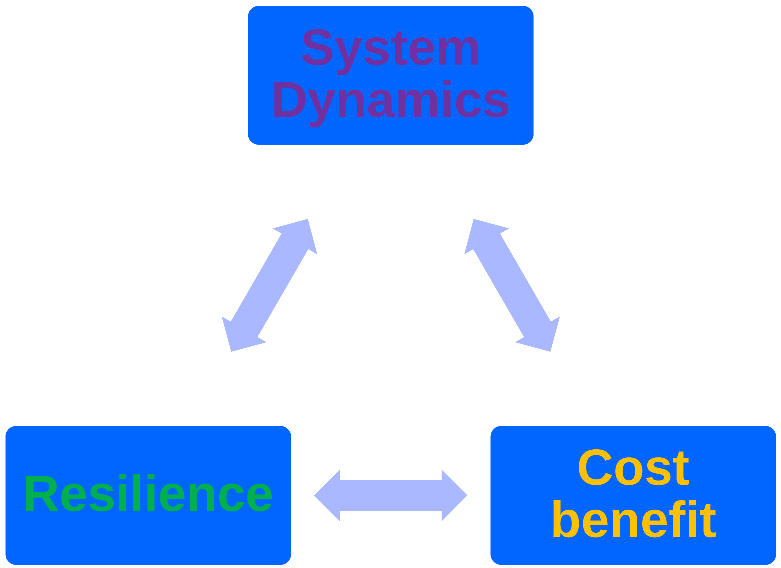
Regulation 994/2010 on gas security

RESILIENCE / OUTCOME BASED ASSESSMENT - **running various scenarios** of exceptionally high gas demand and supply disruption, such as failure of the main transmission infrastructures, storages or LNG terminals, and disruption of supplies from third country suppliers, taking into account the history, probability, season, frequency and duration of their occurrence as well as, where appropriate, geopolitical risks, and **assessing the likely consequences** of these scenarios (ARTICLE 9)

COST BENEFIT - objectives should be achieved through the **most cost-efficient measures** in order not to affect the relative competitiveness of this fuel compared to other fuels. (3)
The final question concerns **how security of gas supply be strengthened at the lowest cost**... exposing market participants to the full costs of disruption, incentive to provide flexible answers to risks based on the willingness to pay. (SEC 2009 979 Final)

SYSTEM DYNAMICS - **taking into account all relevant national and regional circumstances**, in particular market size, network configuration, actual flows, including outflows from the Member State concerned, the possibility of physical gas flows in both directions including the potential need for consequent reinforcement of the transmission system, the presence of production and storage and the role of gas in the energy mix, in particular with respect to district heating and electricity generation and for the operation of industries, and safety and gas quality considerations (ARTICLE 9)

Systemic Perception



Regulation 994/2010 on gas security

…Reductionist Implementation?

System dynamics?

Resilience?

Cost-benefit?

<u>(REDUCTIONIST) STANDARDS and OBLIGATIONS</u>

- Infrastructure Standard, based on N-1 Indicator: a national gas supply capacity indicator
- Supply Standard (based on definition of protected customers)

➔ vulnerability or proxies for them (n-1)

<u>(SYSTEMIC) RISK ASSESSMENT:</u>

- Risk identification: identifying/characterising the sources of risks for the energy system (and the level of probability attached to such events)
- Risk analysis: assessing how adverse events can affect the energy system, by considering the ability of the system to cope with it
- Risk evaluation: comparing the level of risk found with a risk criteria, i.e. assessing the "appropriate" level of security for the energy system under study (if based on economic criteria, it implies to accept the costs of insuring against adverse events)

Thanks