58ème séance du Séminaire PSL de recherches en économie de l'énergie

LA SOLIDARITÉ GAZIÈRE EN EUROPE

Solidarity Measures: Assessment of Strategic Gas Storage Coordination Among EU Member States on EU Natural Gas Supply Resilience

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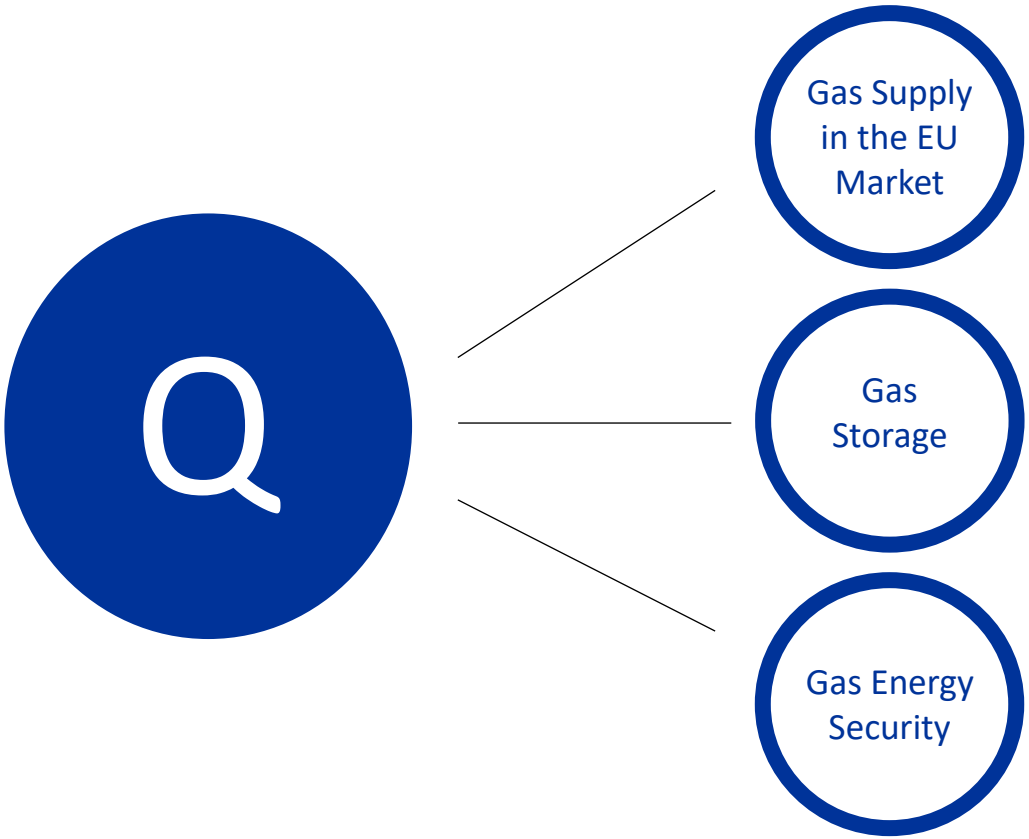
Context

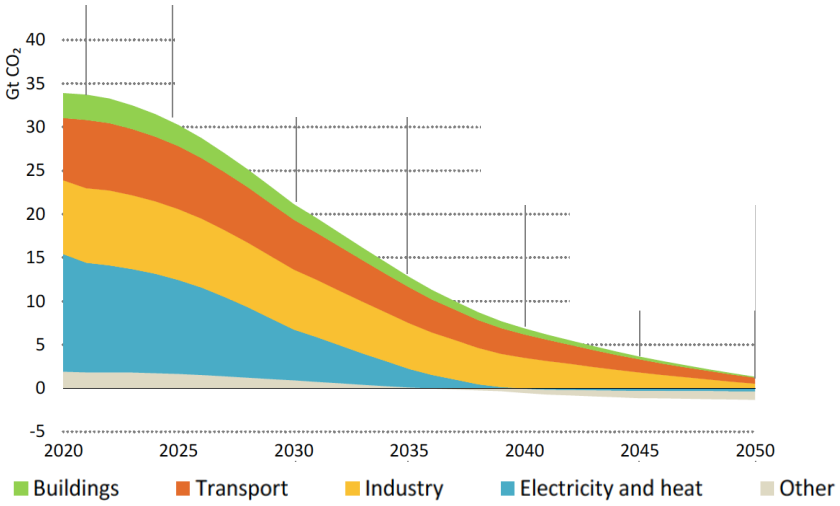
Context

➢ **Can energy security be enhanced by solidarity among EU member states in response to natural gas supply crises?**

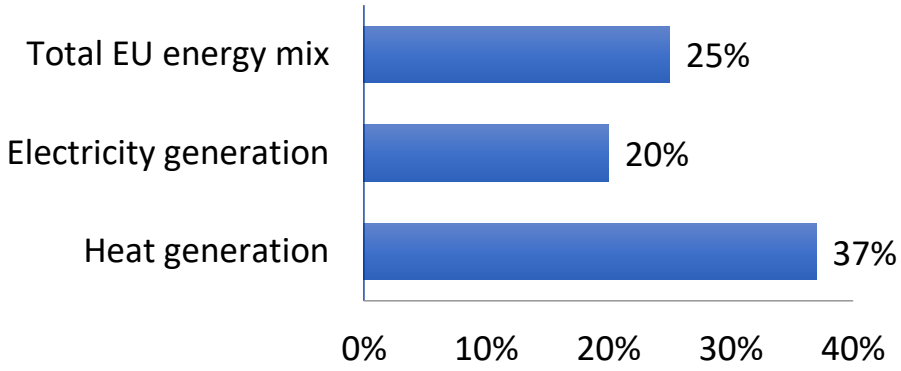


Gas Supply in the EU Market

- **The EU goal of carbon neutrality by 2050 is going to require a significant system transformation.**
- **Natural gas today is the second largest-primary energy source in the EU.**



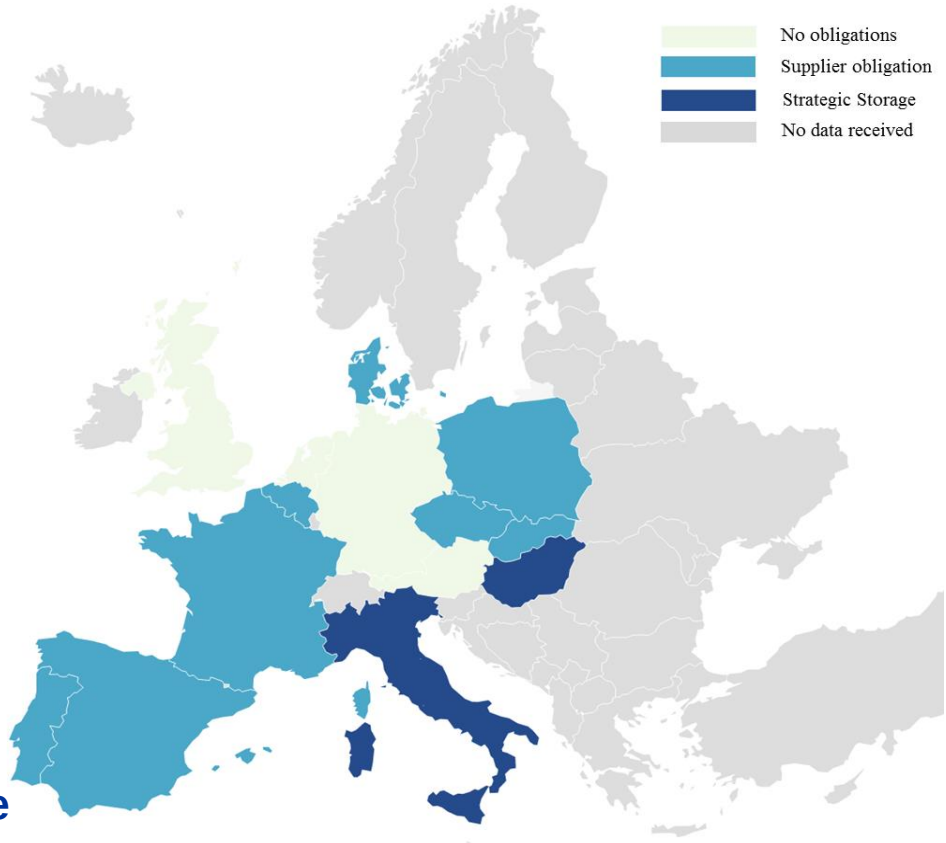
Pathway to net zero (Source: IEA, 2021)



Role of gas in the EU energy system in 2017 (Sesini et al., 2021)

Gas Storage in the EU

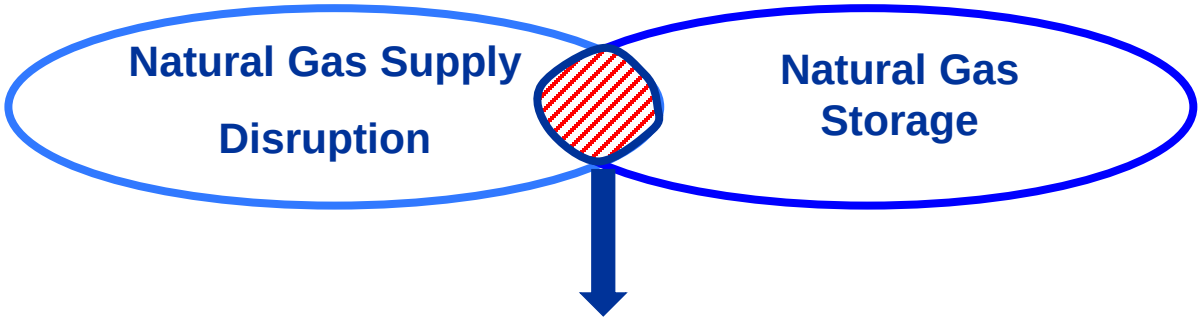
- **Dual role**
  - ✓ **Market value (flexibility)**
    - **Commercial storage**
      - ✓ **Declining indigenous production**
  - ✓ **Insurance value**
    - **Strategic storage**
    - **Storage Obligation (9 Member States) vs Strategic Storage (2 Member States)**
      - ✓ **Heavy import dependence**
      - ✓ **Little diversification of sources**



Mandatory storage security of supply interventions in the EU by type (Source: CEER, 2014)

Research Goal

LITERATURE GAP



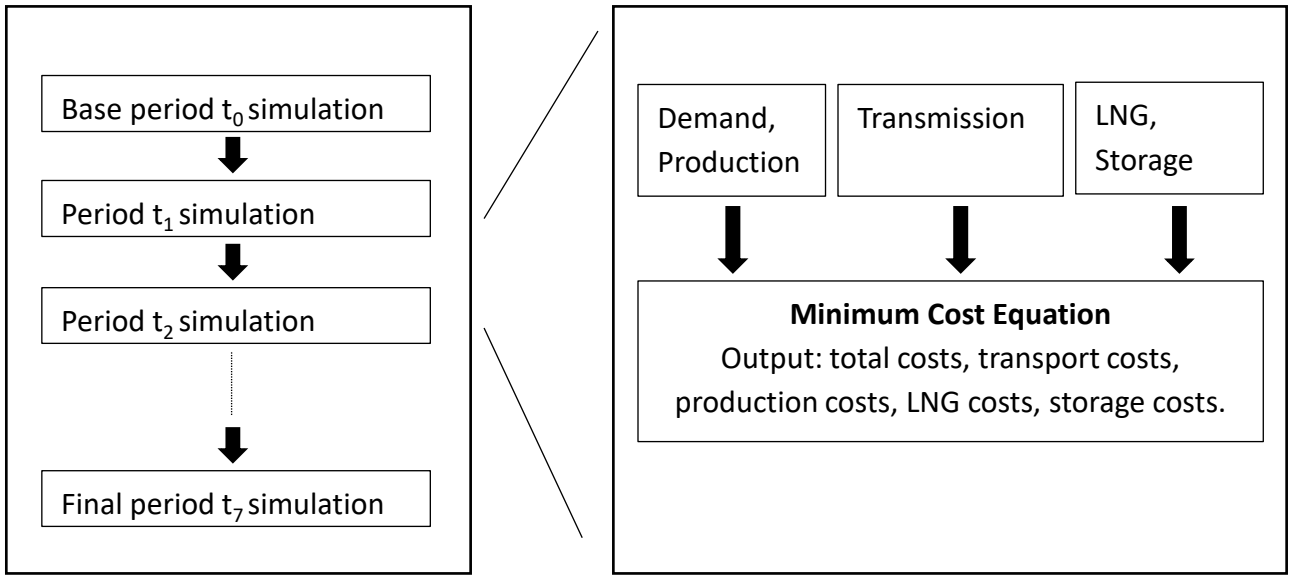
NOVELTY

Definition	Contribution
HILP ("high-impact, low-probability" events): mega-disasters where the market is unable to meet demand and policy intervention is required	**Absent in the literature**
Strategic storage: pre-fixed volume of gas taken out of the market	
Solidarity: cooperation of Regional Risk Groups	
Resilience: ability of supply chain to respond to unexpected events and maintain continuity of operations	**Absent in terms of strategic storage**

Methodology

HILP Model

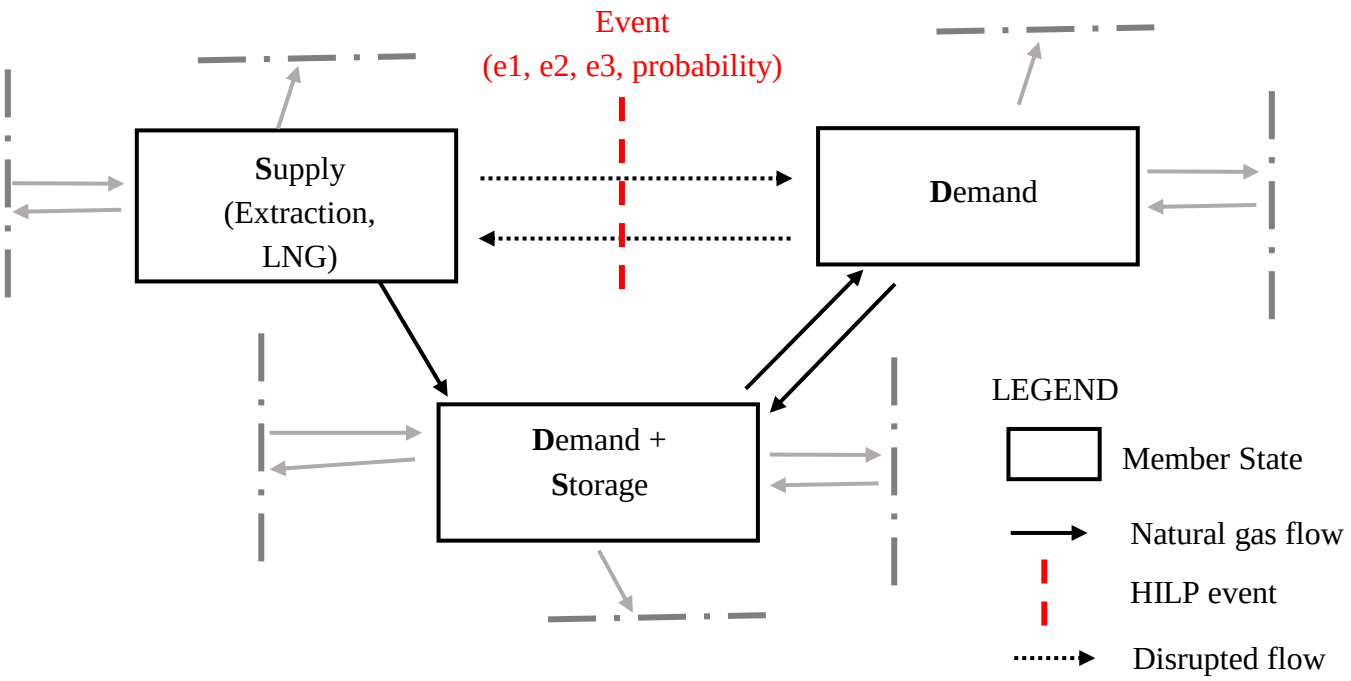
- **Linear programming optimization modelling the natural gas supply chain**
- **Stochastic approach with a short-term optimization framework (i.e., 7 days) based on real-world data (i.e., Burian).**



Basic HILP model structure

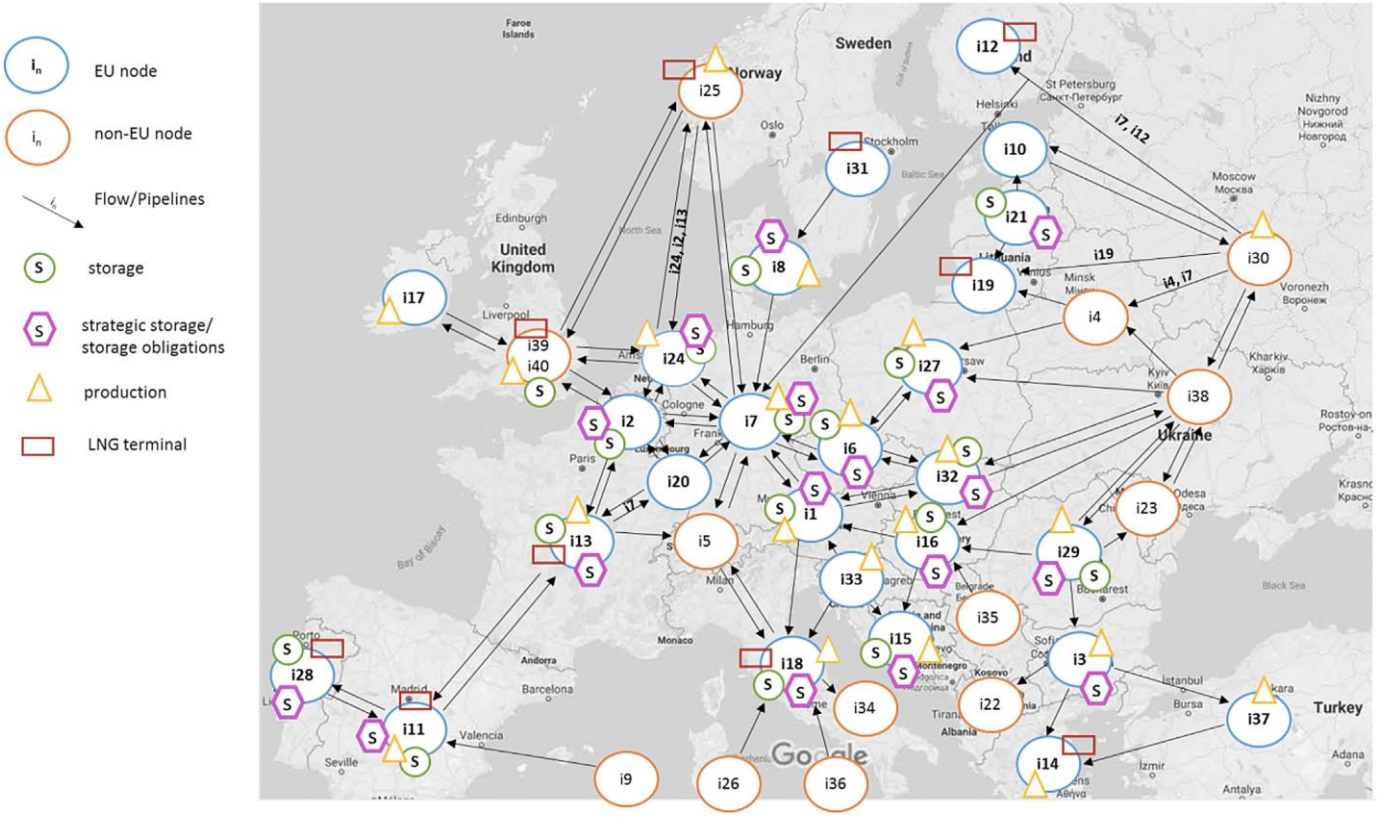
HILP Model: Structure

- **Illustrative model structure:**



HILP Model: Network Structure

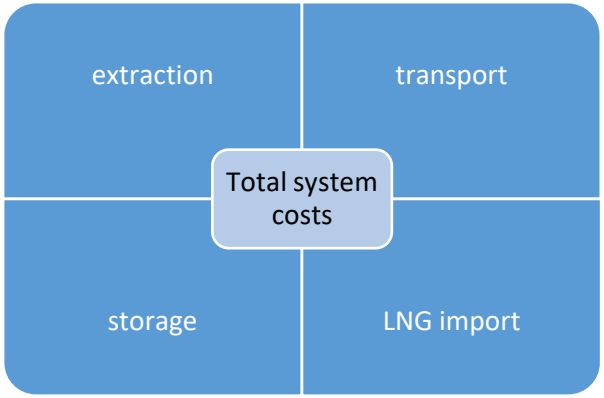
- **Illustrative network structure:**



Source: Sesini M, Giarola S, Hawkes AD. Strategic natural gas storage coordination among EU member states in response to disruption in the trans Austria gas pipeline: A stochastic approach to solidarity. Energy 2021;235:121426.

HILP Model: Stochastic Formulation

min **total system costs**



s.t. **Constraints:**

- ✓ **Demand**
- ✓ **Resource availability**
- ✓ **Storage capacity**
- ✓ **Infrastructure capacity**
- ✓ **LNG port capacity**

First stage variables	Second stage variables
Amount of stored natural gas	Natural gas transmission
	Natural gas production
Amount of natural gas withdrawn from storage	Natural gas supplied through LNG terminals

HILP Model: Applications

- Cold spell (validation)
- HILP
- **Solidarity**

Focus: Coordinated strategic storage for energy security

Method: HILP model based on full Natural Gas Supply Chain Model

Eastern gas supply risk group: 1 (a) Ukraine as in EU Regulation 2017/1938.
Includes: Bulgaria, Czech Republic, Germany, Greece, Croatia, Italy, Luxembourg, Hungary, Austria, Poland, Romania, Slovania, Slovakia

Results and Conclusions

Solidarity: Scenarios

- ✓ **Two-stage stochastic optimization-based linear programming minimum cost with increase temporal and geographical scope.**
- ✓ **Solidarity and Regional Risk Groups in case of HILP**

Disruption scenarios

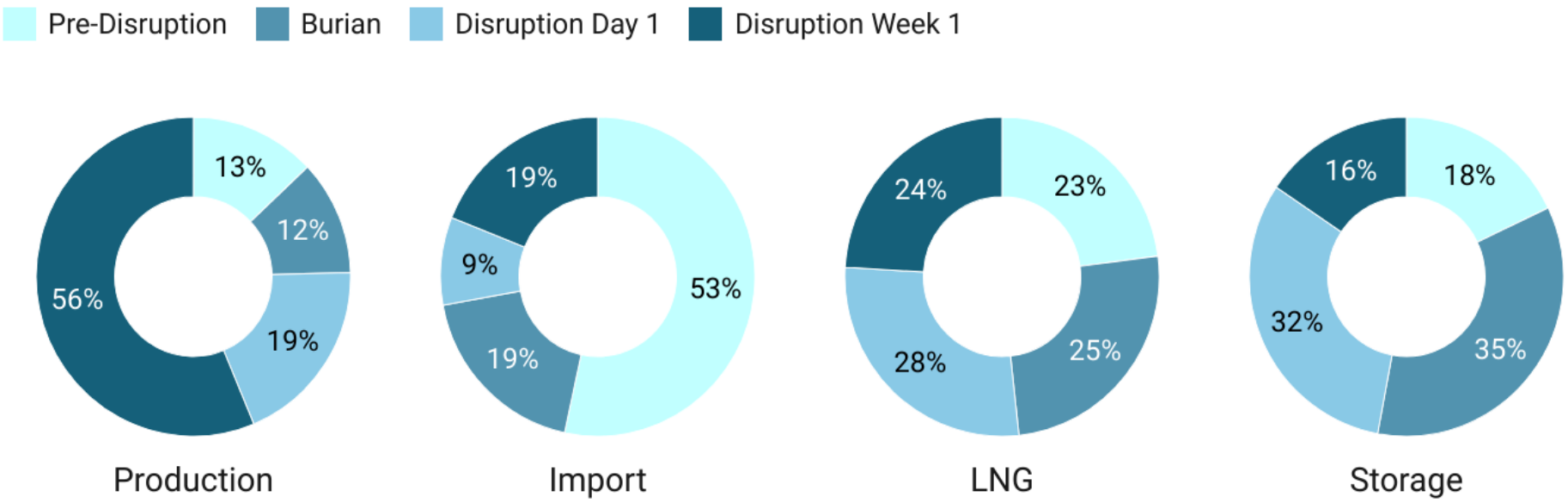
Scenario Assumption	*Reference* Scenario	*Ukraine disruption* Scenario	*Russia disruption* Scenario	*Norway disruption* Scenario	*North Africa disruption* Scenario
Origin of loss of gas transmission	-80% from Russia	-100% from Ukraine	-100% from Russia	-100% from Norway	-100% from North Africa
Destination of loss of gas transmission	Germany and Italy	1.Eastern gas supply (a) Ukraine - RR	1.Eastern gas supply (d) North Eastern - RR	2.North Sea gas supply (a) Norway - RR	3.North Africa gas supply (a) Algeria - RR
Gas reserve	No strategic storage	With strategic storage	With strategic storage	With strategic storage	With strategic storage

RR = EU Regional Risk Groups MS

Sesini M, Giarola S, Hawkes AD. Solidarity measures: Assessment of strategic gas storage on EU regional risk groups natural gas supply resilience. Applied Energy 2022;308:118356.

Solidarity: Supply Mix

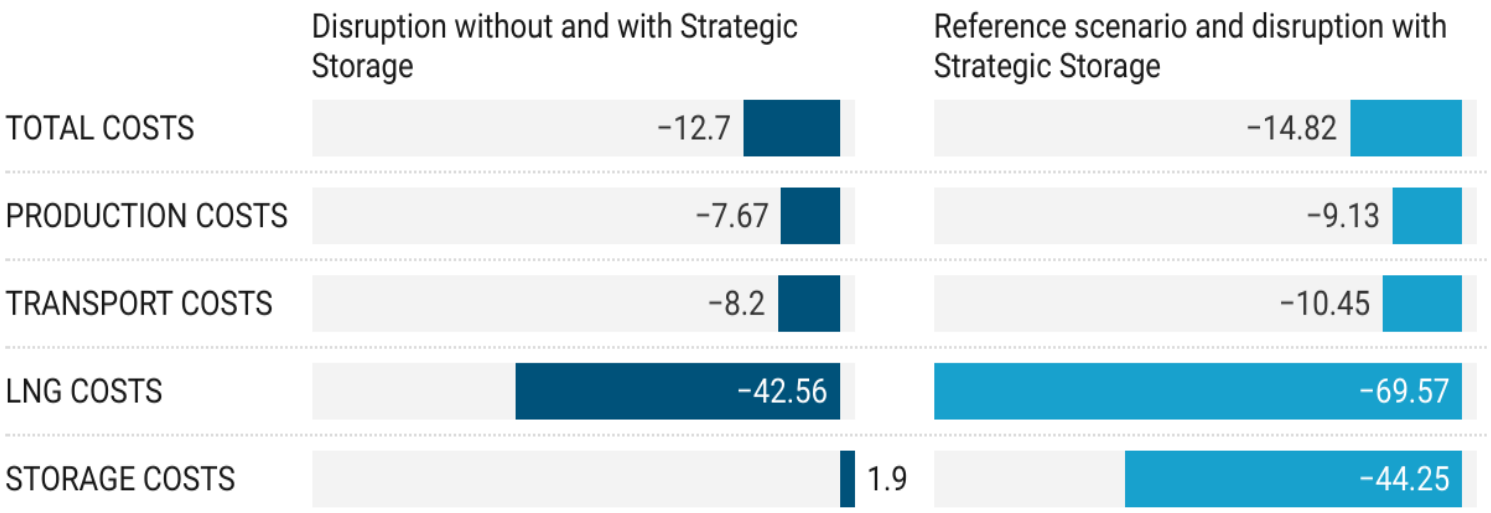
✓ Use of strategic storage is favoured



Natural gas supply mix at European level comparison (%)

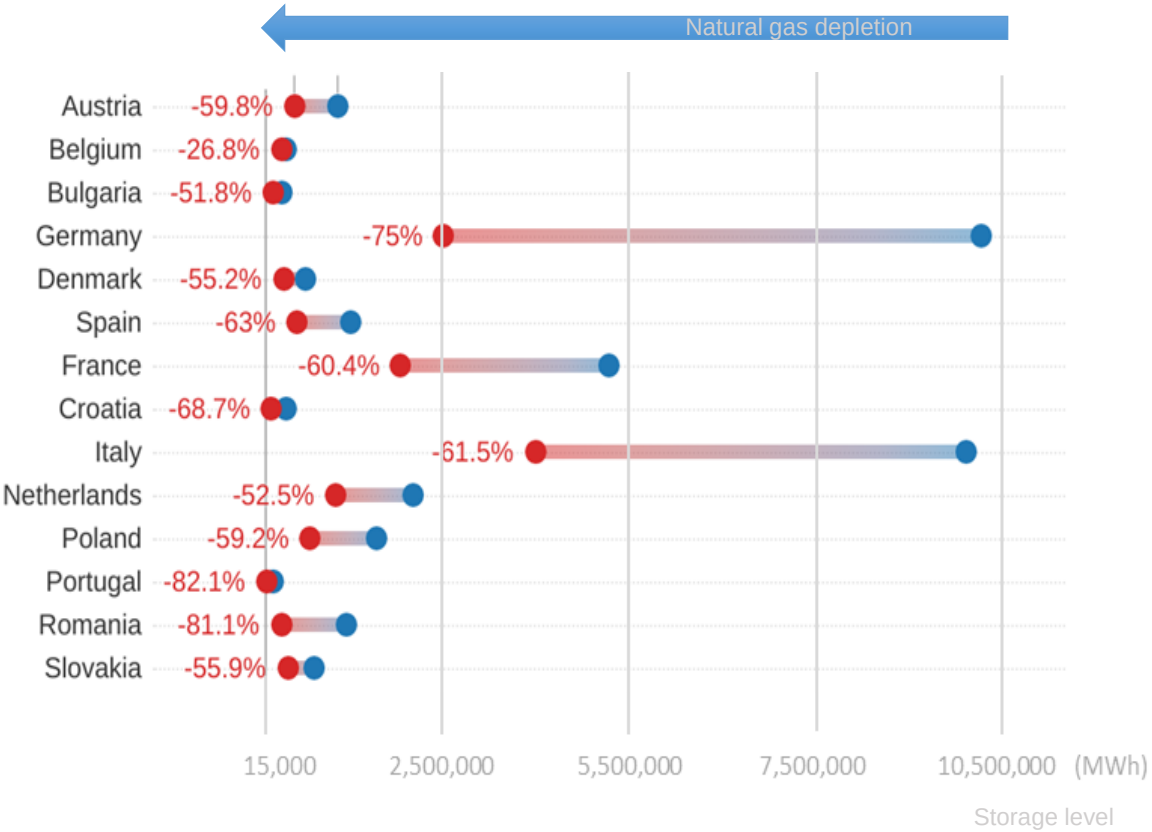
Solidarity: Systems Costs

✓ Solidarity reduces up to 15% total system costs



Cost efficiency between scenarios without and with strategic storage at European level comparison at disruption week 1 (%).

Solidarity: Resilience



Strategic storage depletion during a seven-day emergency at European level (%).

Conclusions

- ✓ **There is a strong interplay between LNG and storage during emergencies.**
- ✓ **Non-market based measure could be a cost-effective alternative to market-based ones, highlighting the reliability and insurance value of strategic storage benefitting overall system costs.**
- ✓ **Solidarity among member states during HILP significantly lessens the impact of the event in terms of costs and increases system resilience.**

Hence, it points out how in an increasingly interconnected EU energy market and system, the role of strategic storage and solidarity should gain traction in the path towards an Energy Union.

Thank you!