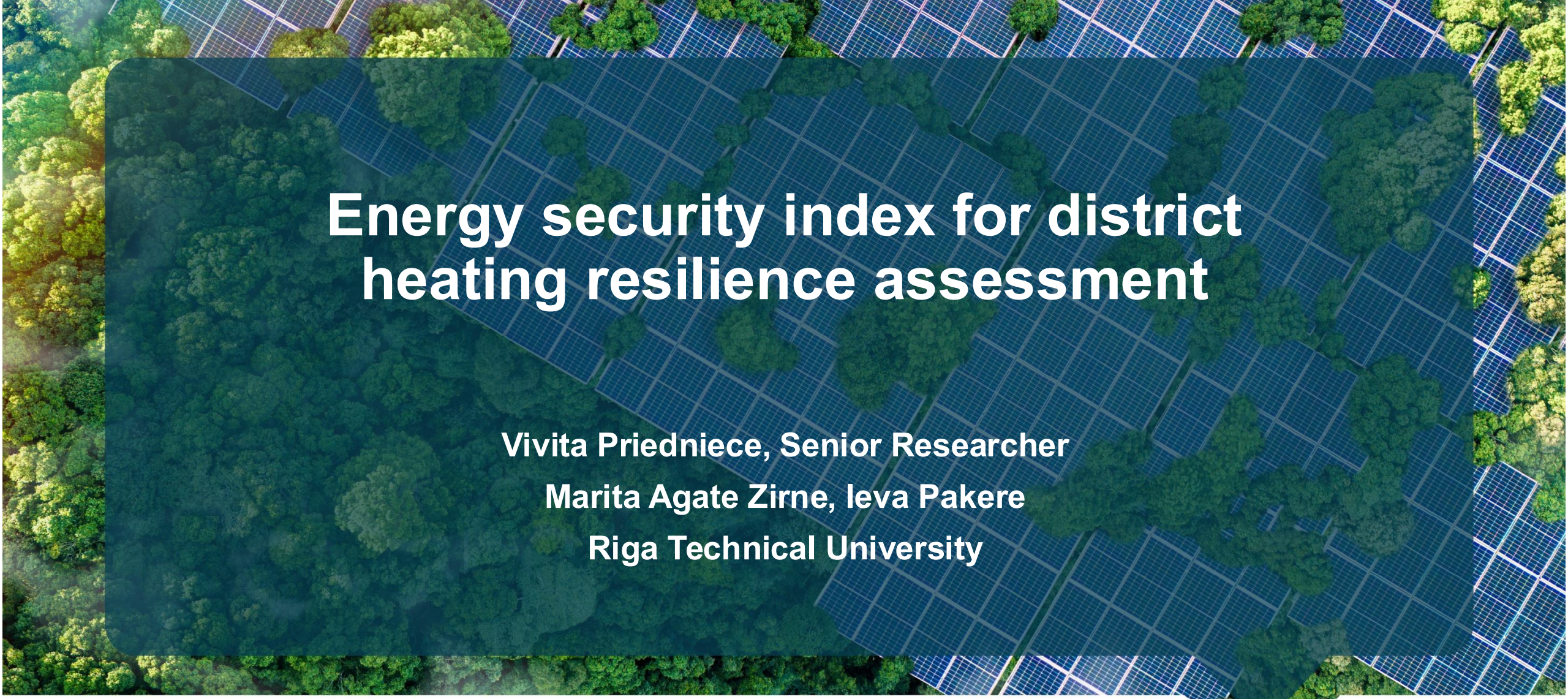


Energy security index for district heating resilience assessment

Vivita Priedniece, Senior Researcher
Marita Agate Zirne, Ieva Pakere
Riga Technical University

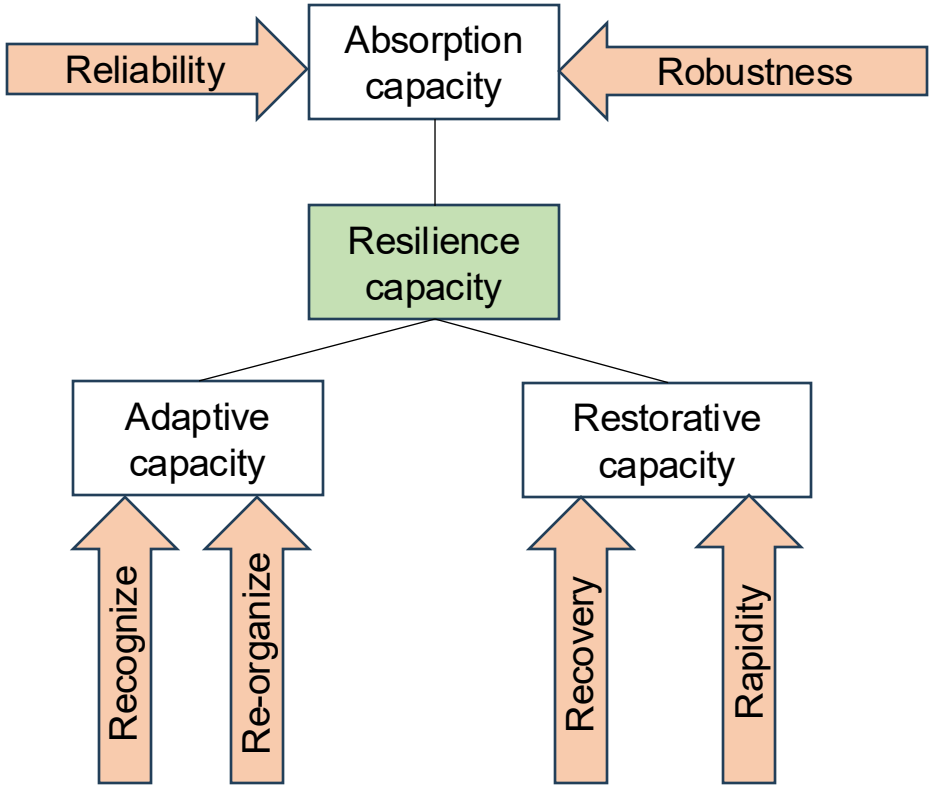
CONECT 2025

FLPP
FUNDAMENTAL AND APPLIED RESEARCH PROJECTS

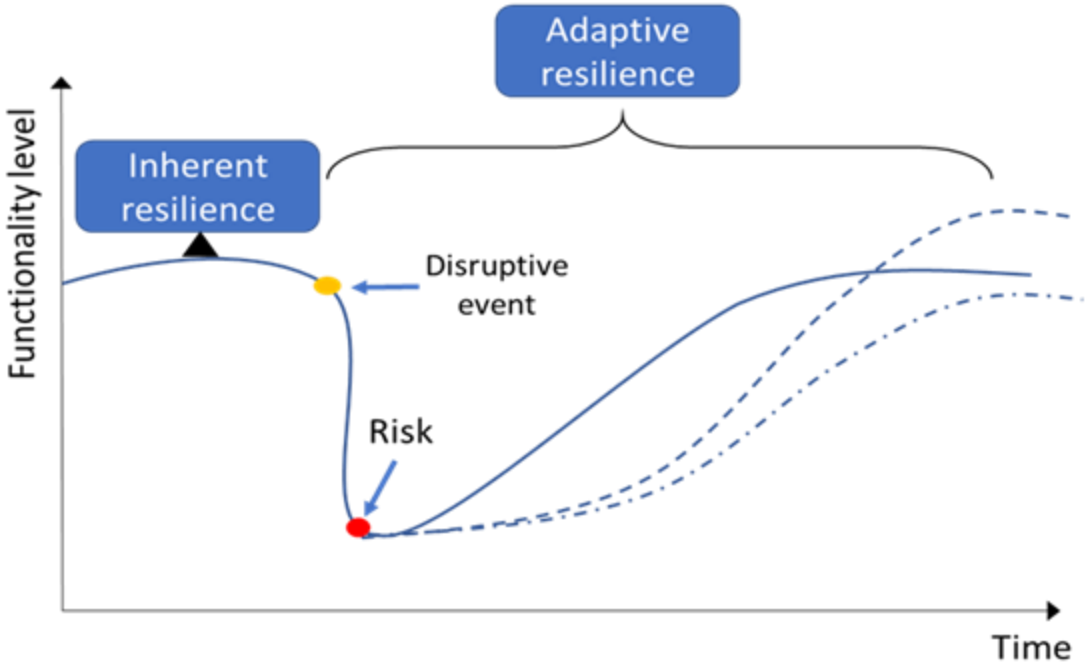
14-16 May 2025 | Riga, Latvia

General framework of resilience assessment

- **Resilience** - ability/capacity of a system in resisting, absorbing, buffering and recovering from effects of hazards in a timely and efficient manner.



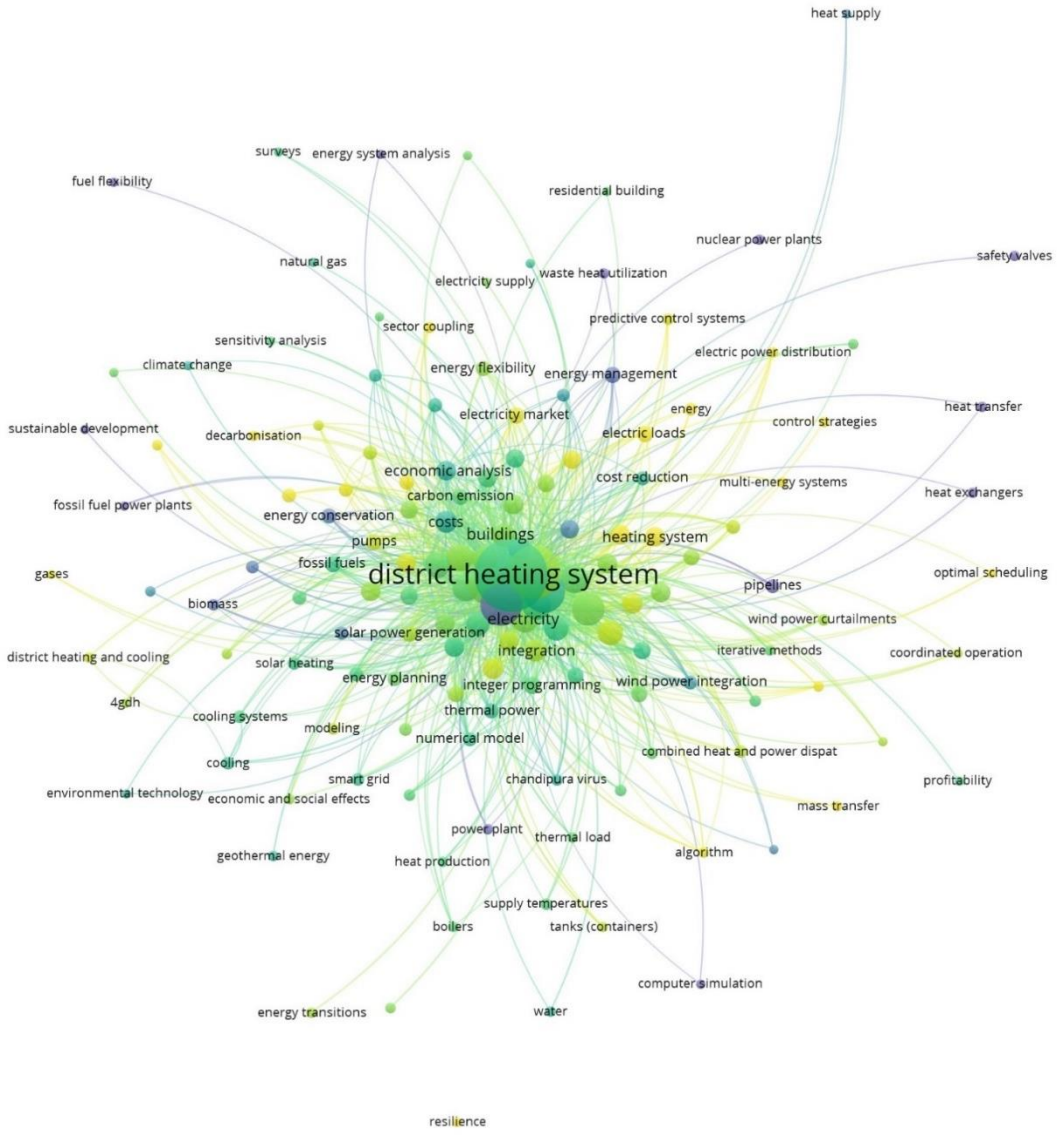
Source: R. Francis and B. Bekera, "A metric and frameworks for resilience analysis of engineered and infrastructure systems," Reliab. Eng. Syst. Saf., vol. 121, pp. 90–103, 2014



Source: Feofilovs, Maksims. Dynamics of Urban Resilience to Natural Hazards. PhD thesis. Rīga: [RTU], 2020. PP 179

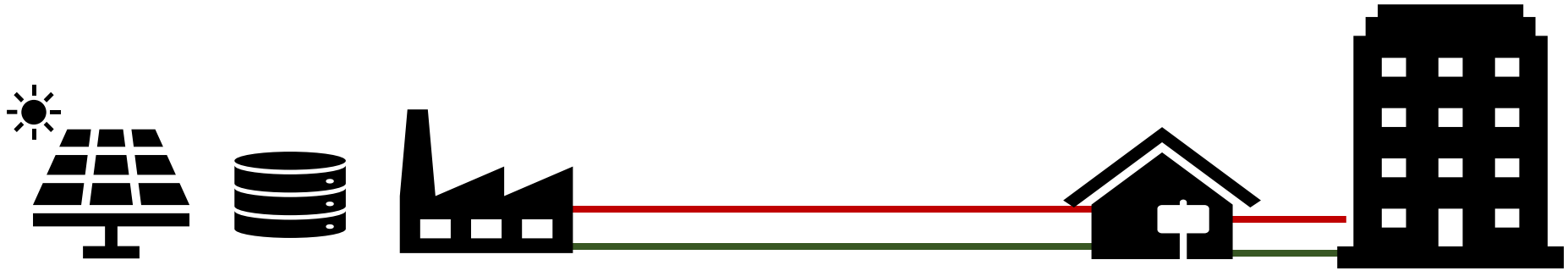
DH system assessment keyword network

- Research focusing on separate heating system elements, evaluating:
  - flexible,
  - vulnerable,
  - cost-optimal,
  - secure operation of district heating (DH).
- A need for a fundamental generic quantitative and quality approach for resilience assessment.



Threats to DH systems

Heat source	Heating network	Consumers
• Fuel price increase • Resource limitation • Shortage of capacities • Extreme weather conditions • Infrastructure damages	• Aging infrastructure: pipe corrosion, leaks and inefficiencies • Extreme heat carrier parameters • Power outages	• Heat load changes • Substation damages • Disconnections • Customer resistance • Energy powerty • Declining population in Latvia



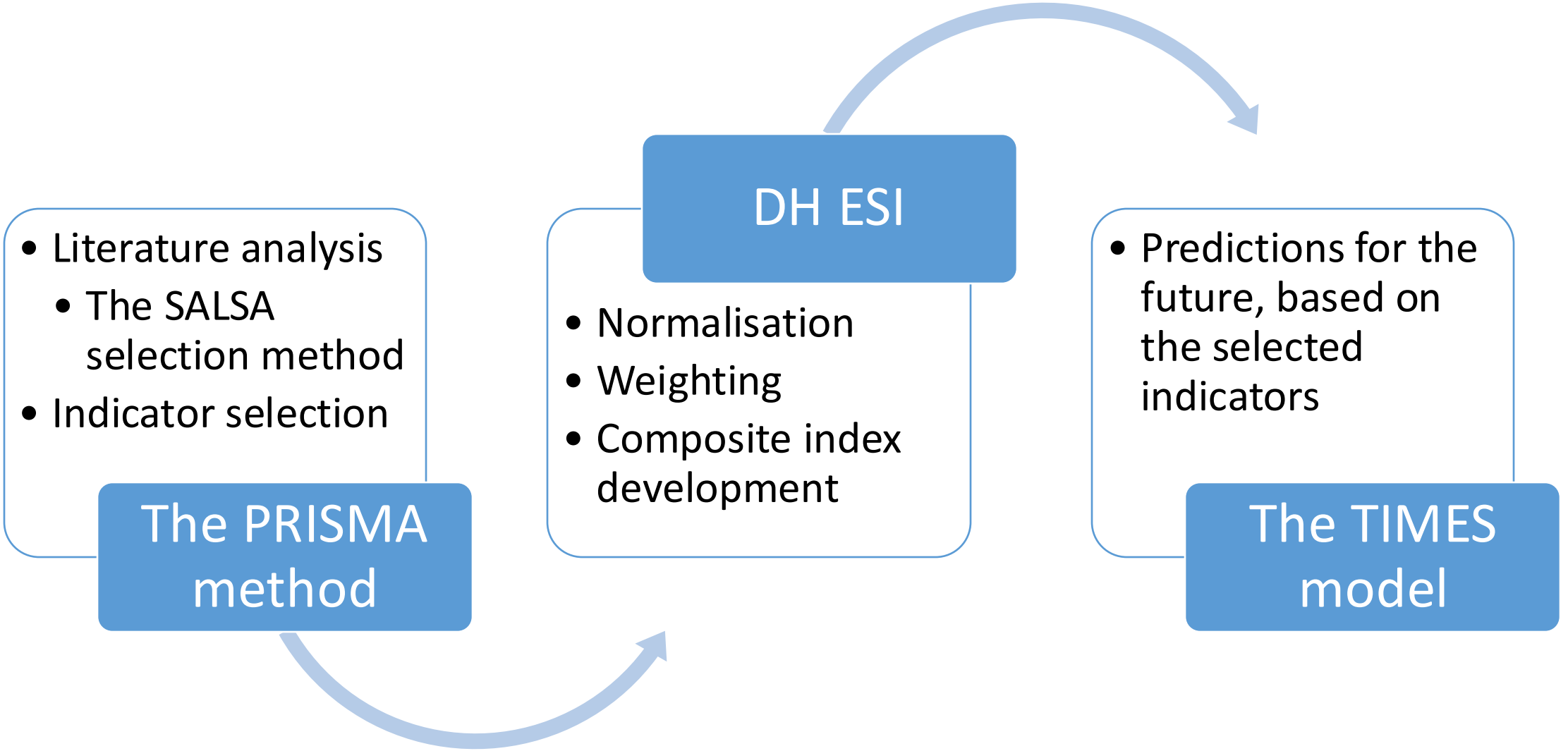
- Cyber attacks
- Governmental policies

Research questions

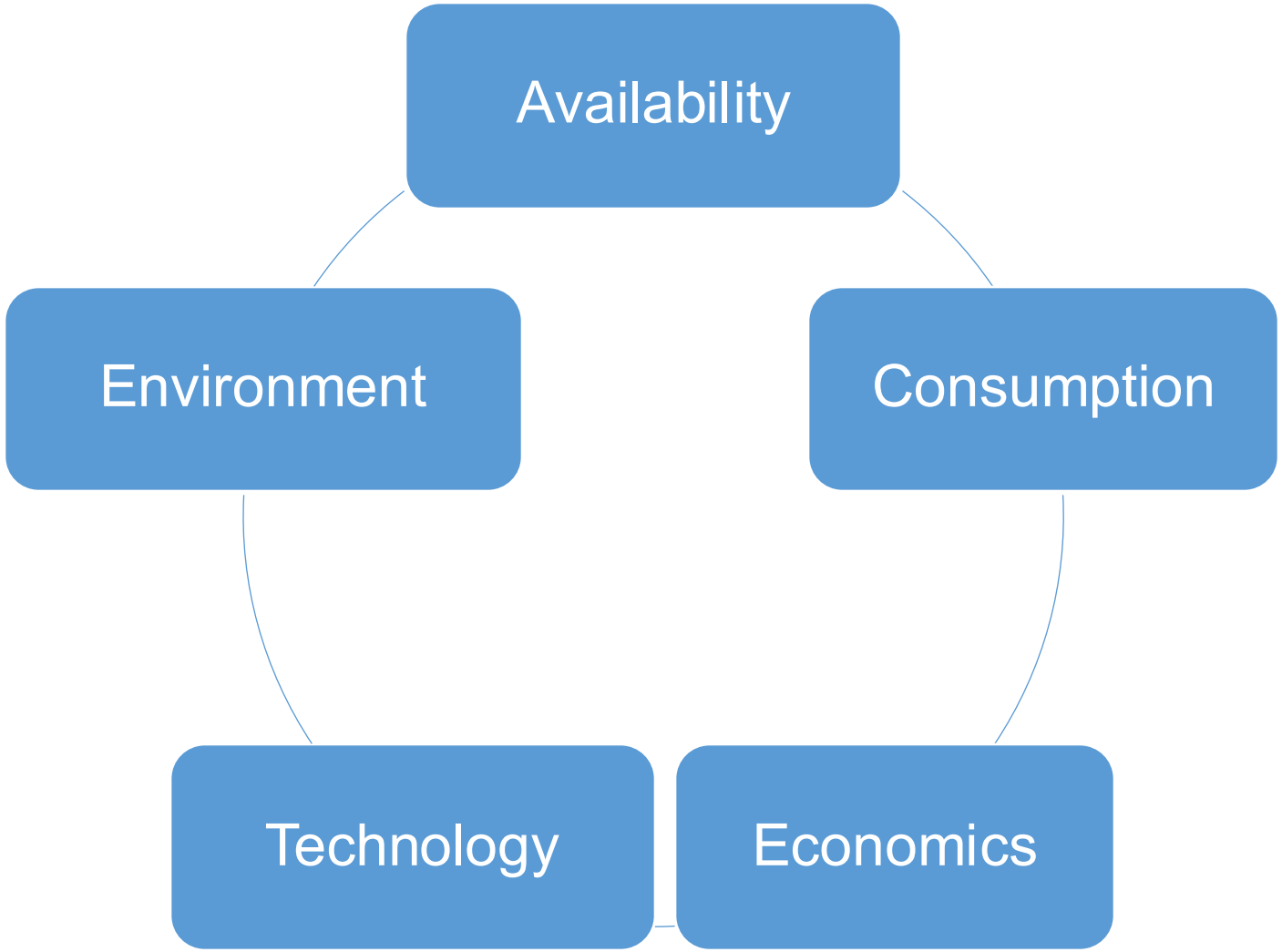
What are the key factors that determine the energy security (ES) of DH systems?

Can we use the developed ES index to predict the future performance of DH systems?

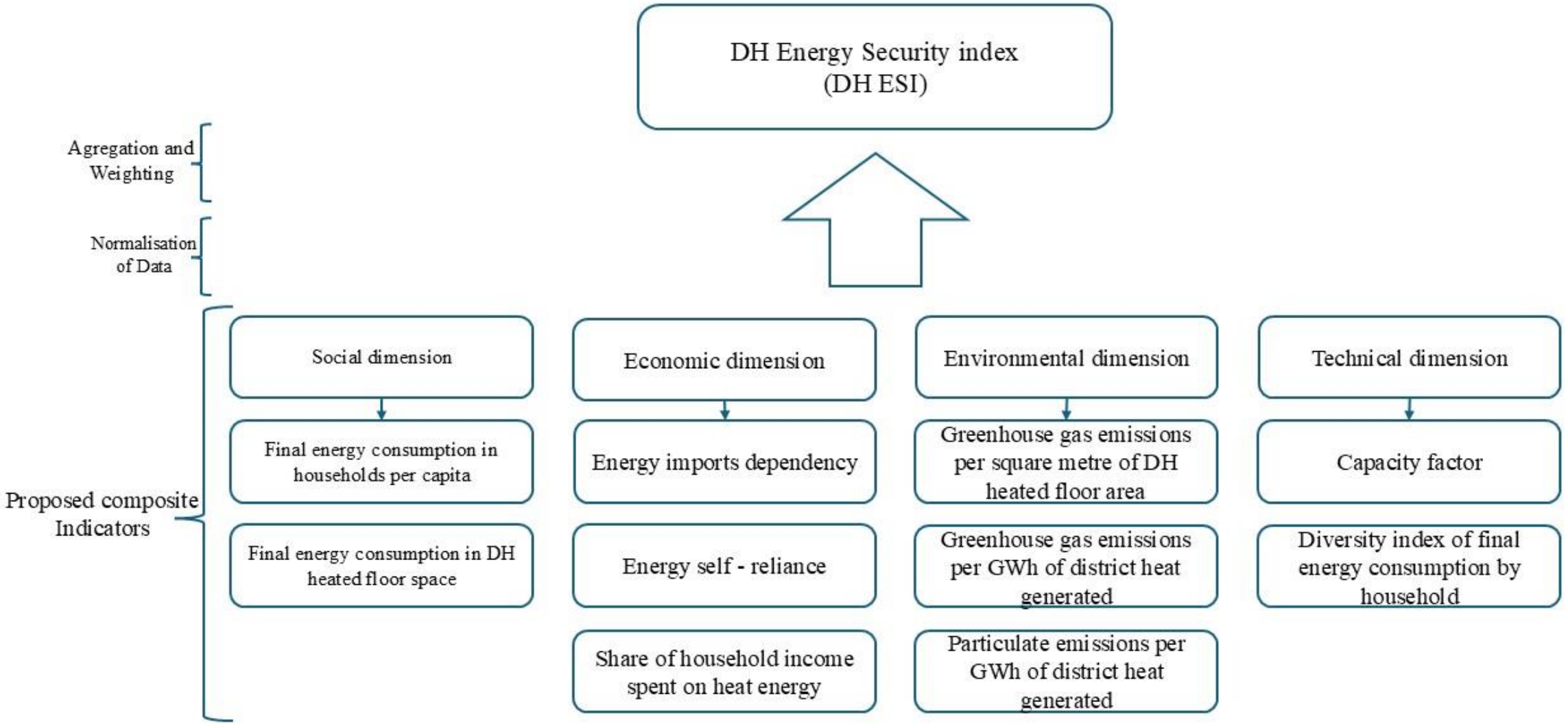
Methodology



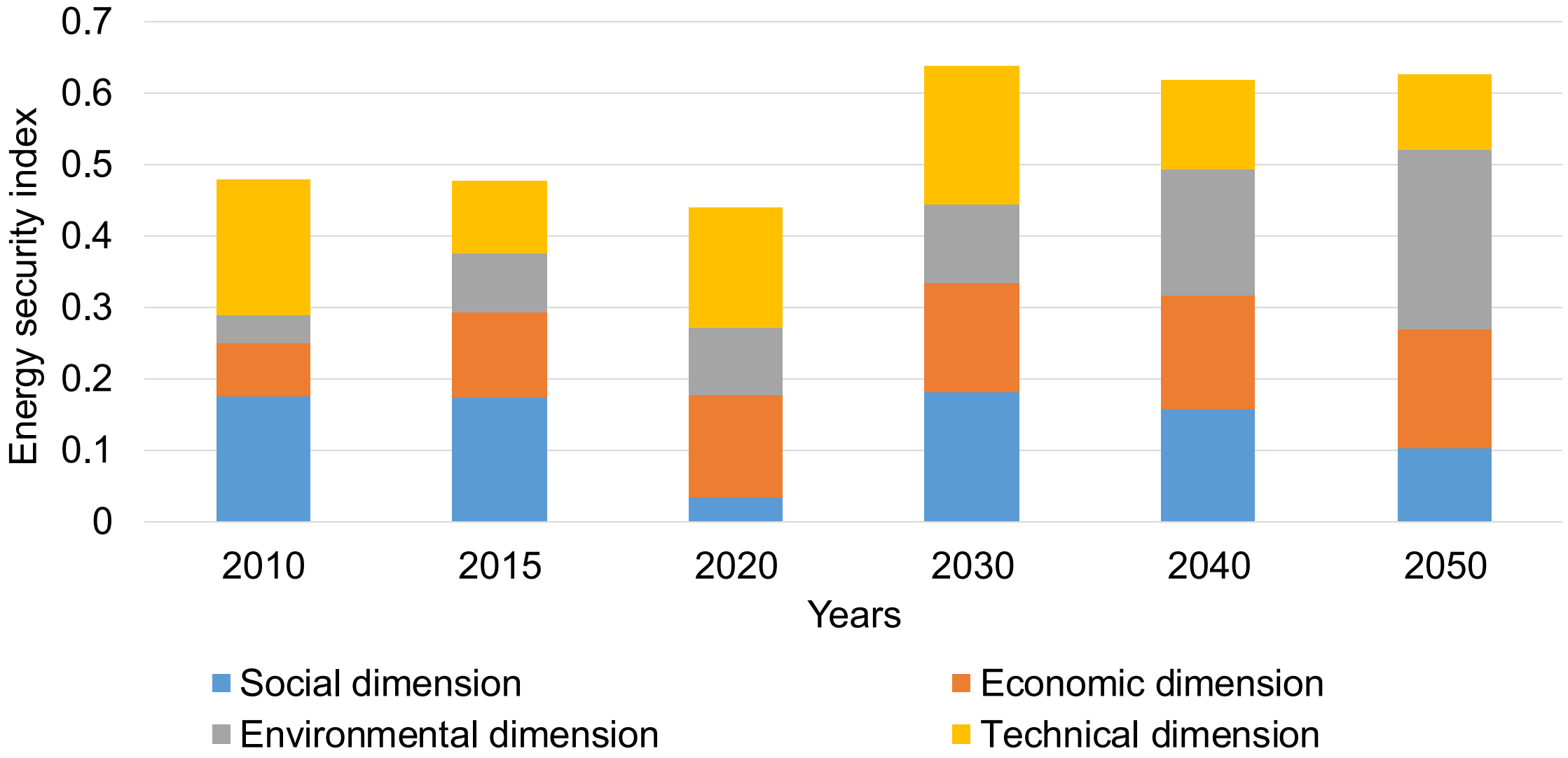
ES indicators used in research articles



Composite indicators for DH ESI



The district heating energy security index

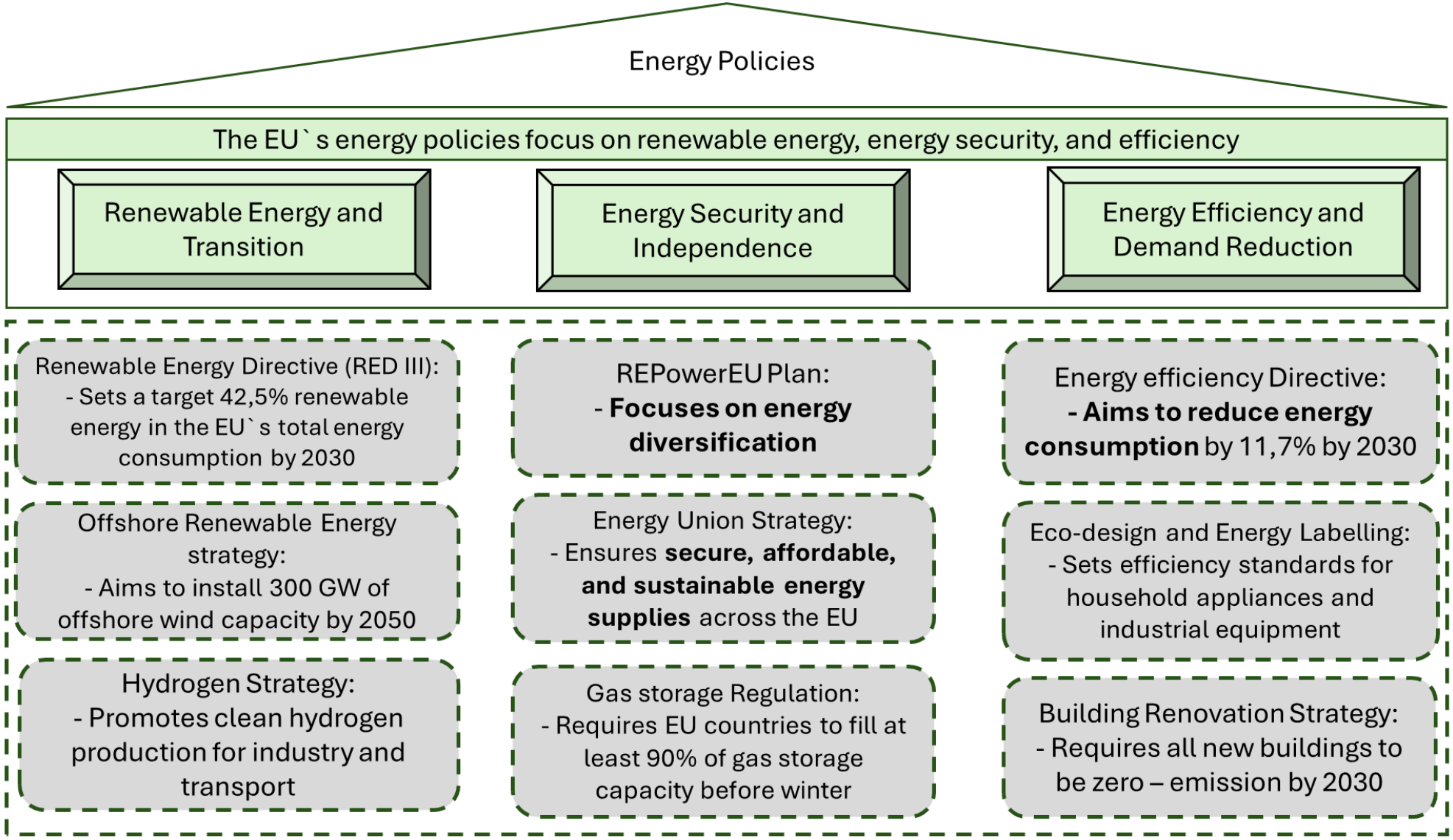


DH ESI improvements (in progress)

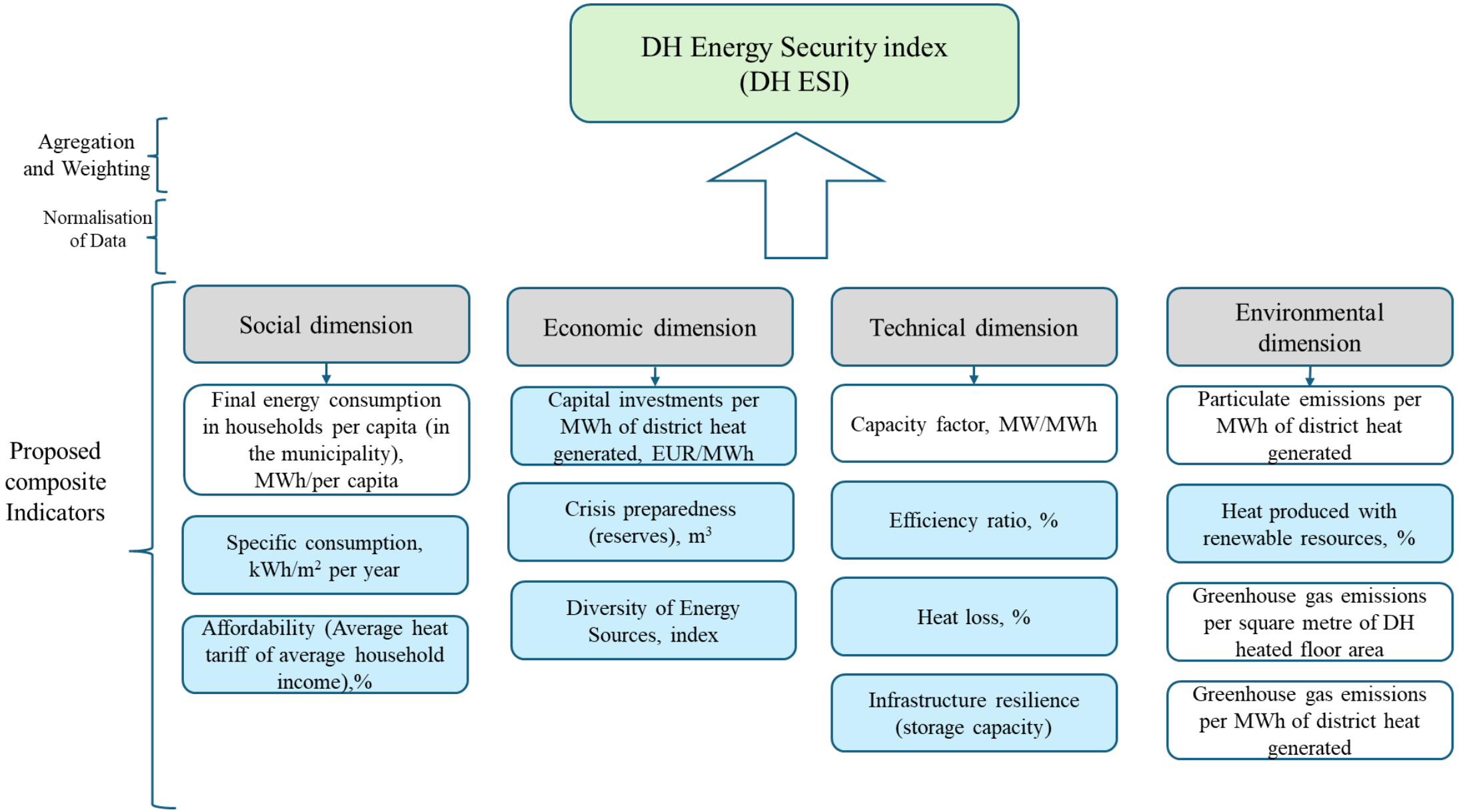
- Critical Infrastructure strategy: Protection vs. Resilience

Aspect	Traditional Protection Approach	Modern Resilience Strategy
Primary Goal	Prevent damage or disruption	Ensure continued operation and quick recovery
Focus	Defensive and reactive	Adaptive and proactive
Scope	Safeguarding specific key assets and systems	Addressing whole systems and networks across sectors
Main Threats Addressed	Terrorism, cyberattacks, sabotage	Complex risks, interdependencies, climate change, emerging risks
Operational Mindset	Static, protection-based	Dynamic, resilience-based
End Objective	Avoid disruption	Maintain essential functions under stress

DH ESI improvements (in progress)



A case study for more precise indicator selection



Conclusions

- The findings emphasized the importance of incorporating multiple dimensions into the analysis and choosing appropriate composite indicators.
- The distribution of results across the sub-dimensions revealed significant differences. Specifically, the results for the social dimension and the sub-index for the environmental dimension showed a steady increase in the ESI over the years, while the social dimension displayed varying results, with the sub-index reaching its lowest point in 2020.
- The DH ESI can serve as a valuable tool for policymakers in formulating energy strategies. By utilizing the DH ESI, policymakers can enhance their decision-making processes during the implementation of energy policies.
- This ESI method, along with the selected indicators, could be integrated into the Climate and Energy Plan to complement established targets and monitor their achievement.
- The results of the DH ESI can inform the public about energy security. By explaining these results, citizens can become more engaged and actively participate in energy policymaking.

Acknowledgement

The research has been done within Fundamental and Applied Research Project **“Resilience Metrics for District Heating Systems: A Comprehensive Framework (DH INERTIA)”** project No. lzp-2023/1-0039, funded by the Latvian Council of Science.

Vivita Priedniece

vivita.priedniece@rtu.lv

CONECT 2025

XVIII International Scientific Conference of Environmental and Climate Technologies