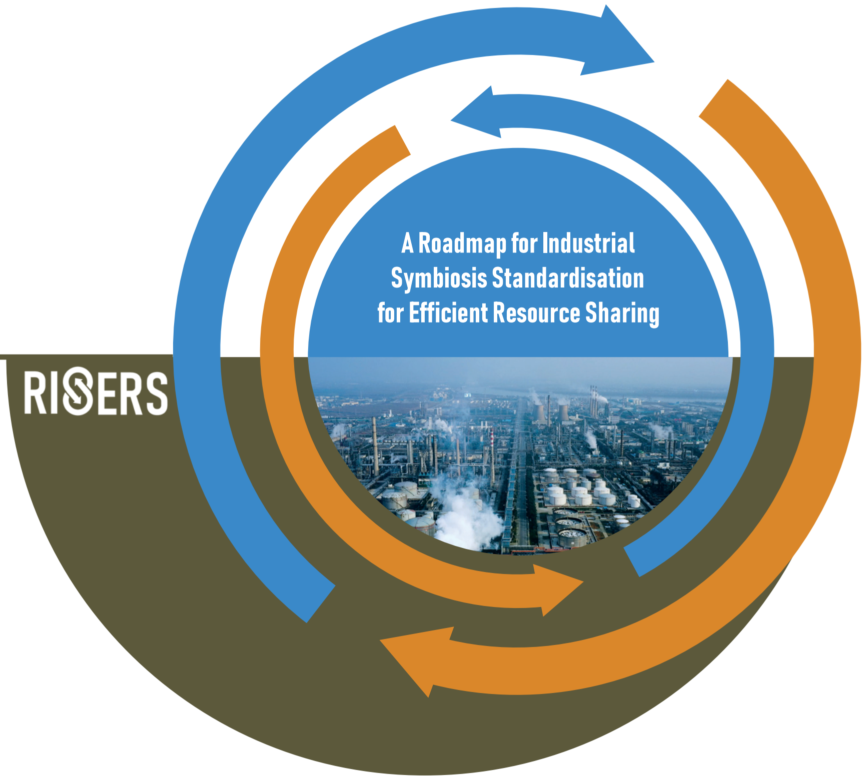
Synergy Fact Sheet

ENERGY DATA

Optimise electricity sourcing and provide flexibility via demand-response



Introduction

Industrial clusters rely on innovative approaches to improve their energy management with a strong focus on flexiblility mechanisms, above all demand response mechanisms. With the increasing spread of renewable energies, **their inherent fluctuations pose a challenge for the coordination of supply and demand, requiring flexible solutions across the system. Advanced systems, including virtual power plants (VPPs)**, help harmonise the industry's energy use with the real-time dynamics of the grid. **Flexibility mechanisms, such as sophisticated negotiation techniques, ensure that the industry can respond effectively to demand response events without disrupting operations.** Studies using greenhouse simulations, for example, show the effectiveness of such coordination in meeting grid demand (Clausen et al., 2016).

Managing the variability of renewable energy sources such as wind and solar is essential for archieving flexibility in industrial clusters. Advanced techniques, such as statistical sampling in combination with clustering, categorise energy loads into primary, secondary and tertiary groups, each with specific characteristics. Supplying sectors such as manufacturing, transport and heavy industry provide flexible energy resources, while receiving sectors such as the energy sector grid operators utilise these resources to balance and optimise grid performance. Combined with emissions trading schemes and integrated solutions for hydrogen and heat, this model increases economic outcomes and operational efficiency. These approaches not only rationalise the interactions between energy producers and consumers, but also reduce the costs and uncertainties of energy supply (Cao et al., 2024). With the increasing importance of renewable and decentralised energy resources, complex problems arise in terms of grid control, communication, and market dynamics. Flexible energy systems address these challenges by connecting decentralised generators, storage solutions, and electric vehicles into unified networks capable of delivering reliable energy and ancillary services. The supplying sectors contribute decentralised resources, such as renewable generators and energy storage, while the receiving sectors benefit from stable energy flows and ancillary services. Innovations such as the incorporation of blockchain technology further enhance performance by improving coordination and management across system levels. These advances enable flexibility solutions to effectively address market challenges while optimising resource allocation (Roozbehani et al., 2022).

In addition to efficiency gains, the environmental benefits of **flexibility strategies, including demand response**, are significant. By utilising renewable energy during production peaks and storing surplus energy for later use, these systems significantly reduce greenhouse gas emissions while promoting a circular economy. In addition, they enable smaller companies within industrial clusters to access energy markets by utilising shared infrastructure to reduce costs and increase resilience. The interaction between supplying and receiving sectors promotes industrial symbiosis, which brings mutual benefits to participants and strengthens the overall energy framework (Cao et al., 2024; Clausen et al., 2016, Baetens, 2022, Trilate, 2021). To summarise, the integration of demand-driven flexibility in industrial clusters **is a transformative strategy. These solutions not only promote industrial efficiency and sustainability but also contribute to the development of a more robust and environmentally friendly energy framework**.

Supplying sector(s)	Receiving sector(s)
Various Various sectors	Energy Energy sector VPP operator

TECHNICAL FEASIBILITY

- **Industrial scale:** Virtual Power Plants (VPPs) are designed for large-scale implementation, enabling industry to efficiently manage large amounts of energy across multiple sites and clusters. This adaptability makes VPPs suitable for energy-intensive applications.
- **Moderate technical requirements:** VPPs utilise accessible and scalable technologies that simplify integration into existing systems while being cost-effective.

PPP IMPACT – EU wide potential

Profit

Wins in industry

reduction of power instability (smartEN, 2030)
ca. 5-10% electricity cost savings
ca. 11-29 bn EUR in grid investments
ca. 71 bn EUR saved at consumer level
ca. 2.7 bn EUR avoided peak generation

- **Optimising power consumption:** By using advanced demand-response strategies, VPPs enable the industry to match energy consumption to supply, improve overall efficiency and reduce waste.
- **Securing power supply:** Pooling decentralised energy resources ensures a reliable and stable power supply, which is essential for uninterrupted industrial operations.
- **Integrating sites and clusters:** VPPs connect industrial sites and clusters into a cohesive energy management network, improving coordination and resource allocation.
- **Enabling renewable energy:** By supporting the integration of renewable energy sources, VPPs reduce dependence on fossil fuels and pave the way for cleaner and more sustainable energy systems.

Planet

Environmental gains

Flexible power plants are key to supporting the integration of renewables and driving the transition to cleaner energy systems (smartEN, 2030). By reducing overall energy demand by 10-45% and preventing the curtailment of 16 TWh of renewable energy, these systems help to reduce greenhouse gas emissions by around 38 million tonnes of CO_2 equivalent.

People

Wins for society

VPPs contribute to stronger and safer electricity grids while reducing associated costs. Beyond the economic benefits, they create new jobs and promote skills development, support local economies and advance EU-wide sustainability goals

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About this factsheet

This fact sheet is based on the findings of the RISERS project. Led by Ghent University with the support of project partners, the study involved a systematic assessment of 600+ industrial symbiosis (IS) cases across urban-industrial and cross-sectoral clusters in Europe. These cases formed the basis for the mapping of over 300 MES (Materials, Energies, Services) streams, categorised by output (source) and input (sink) sectors.

The fact sheet provides a detailed overview of a high-potential and high-impact IS synergy, evaluating its implementation feasibility and sustainability impact. Supported by data from public databases (MAESTRI, SCALER, EPOS, AIDRES, etc.) and literature, it offers a generalised insight into the economic, environmental, and social benefits per synergy.

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About the RISERS project

RISERS is a Horizon Europe project aimed at developing an Industrial Symbiosis Standardisation Roadmap supporting the uptake of high impact synergies and resources considering:

- identification of the needs, gaps and opportunities,
- revision of current standards and standardisation efforts relevant for CE and the priority synergies and resources,
- initiating the process of new standards development (especially for newer technologies and pilot-scale synergies).

The RISERS project was launched in January 2024 with a duration of 3 years.

For more information visit: https://risers-project.eu

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