EPOS INSIGHTS #17

Led by: GHENT UNIVERSITY

INDUSTRIAL SYMBIOSIS GENERIC CASES AND EU IMPACT POTENTIAL

EPOS insights are publications summarising the most relevant outcomes of the EU funded EPOS project. The overall aim of the EPOS project is to enable cross-sectorial industrial symbiosis and provide a wide range of technological and organisational options for making business and operations more efficient, more cost-effective, more competitive & more sustainable across process sectors.

CONCEPT

The idea of generic industrial symbiosis (IS) cases was conceived from the wider potential of some specific cases when explored and researched in the EPOS clusters. Based on the similarities of partners and sectors, on the type or size of resource streams, the local conditions or incentives, some high potential IS solutions in the EPOS clusters can find application and/or replication across Europe. When appropriate, the symbiosis was virtualised as a generic case and summarised in an EPOS one-page document. In this way, the cases are made available for testing and use by other companies in other industrial clusters in Europe (and wider).

Each one-page document has four different sections.

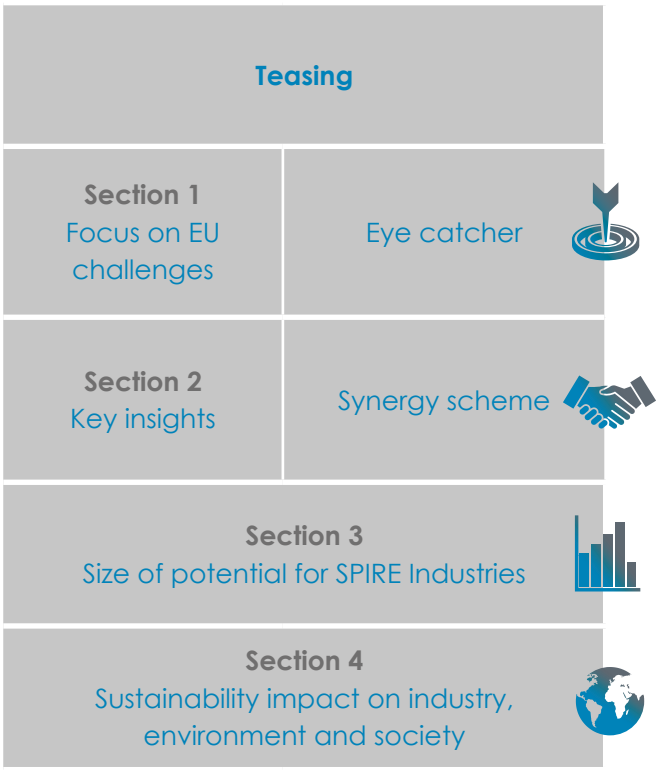

Figure 1: Generic case sections

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The elaboration of the generic cases is based on the learnings in the EPOS clusters while exploring and advancing specific IS cases between EPOS partners. It follows the industrial **ASDEO approach**: appraise, select, define, execute and operate. The process started when the generic potential of an IS case was appraised from the EPOS IS list in agreement with the concerned EPOS industries.

The most promising generic cases can be selected from the long list of industrial cases built from literature review and cluster expertise using a selection criterion based on four impact factors.

Factor	Description
Policy relevance	Fits into a policy agenda towards sustainability
Market potential	Initial appreciation to establish a virtual market place
Cluster reality	Interest in a cluster within EPOS to be further investigated
Simulation potential	Modelling capacity in the toolbox, as streams and technology are in there already

Table 1: Generic case selection factors

Next, the generic case was defined in two stages, (1) based on the research needed to generalise the case for a given (cross-)sector, and (2) by interacting with the EPOS industries and sector associations. In the execution phase, there is a triple approach of basic research, impact and feedback from academics, industry and a graphic designer to improve the quality of the content and its communication.

By sharing the generic cases via the EPOS User Club web platform, the project reaches out to all companies in clusters across Europe to test valid IS opportunities and facilitate their implementation (operation phase).

MATRIX OF GENERIC IS CASES

The 21 generic IS cases elaborated on in EPOS suggest cross-sectorial collaborations on specific streams or interests that are relevant in a European context.

#	Title	Description	Cement	Chemic	Minerals	Steel	Enginee	District
1	**Waste fuel valorisation**	Transform waste streams with high-calorific value into alternative fuels for process industry	x	x		x	x	x
2	**CO_2 mineralisation**	Capture and purify CO_2 emissions for reuse as raw material in process industry	x	x	x	x	x	
3	**District heating**	Reuse low-temperature waste heat from process industry to supply district heating networks	x	x		x	x	x
4	**Energy optimisation**	Optimise energy use in process industry and seek synergies with other process industries	x	x	x	x	x	x
5	**Wind power cogeneration**	Jointly invest in wind power generation for shared use of renewable electricity in industry and communities	x	x	x		x	
6	**Coke valorisation**	Transform industrial steam cracker coke into raw materials for steel and cement industries	x	x		x	x	
7	**Solar power cogeneration**	Jointly invest in solar power generation for shared use of renewable electricity in industry and communities	x	x	x	x	x	
8	**Industrial heat networks**	Optimise heat use in process industry via heating networks in industrial clusters		x		x	x	
9	**Industrial water networks**	Optimise water use in process industry via water networks in industrial clusters	x	x	x	x	x	x
10	**Co-product valorisation (minerals)**	Use inorganic residues as raw materials in minerals industry	x		x	x	x	
11	**Co-product valorisation (cement)**	Transform industrial co-products into raw materials for the cement and construction sector	x	x		x	x	x
12	**Demand side response**	Optimise electricity sourcing and use via demand-response flexibility in industry clusters	x	x	x	x	x	

13	**CO valorisation from steel**	Transform rich CO off-gases into raw materials for the chemical industry		x		x	x	
14	**Industrial CO_2 capture and utilisation**	Transform rich CO_2 streams into raw materials for the chemical industry	x	x		x	x	
15	**Waste water treatment**	Optimise water treatment in process industry and seek synergies with other industries		x		x	x	x
16	**Industrial CO_2 capture and storage**	Store CO_2 streams from process industry via piping or shipping in empty gas fields	x	x		x	x	
17	**Waste plastic valorisation in steel**	Use plastic waste as raw material in steel industry	x	x		x	x	x
18	**Solar heat**	Jointly invest in solar heat plants for shared use of renewable heat in industry	x	x	x		x	
19	**Steel slag valorisation**	Transform steel slag into raw materials for the chemical and cement industries	x	x		x	x	
20	**Waste plastic valorisation in cement**	Use plastic waste as raw material in cement industry	x	x		x	x	x

Table 2: Generic IS case matrix

Generic cases are not mutually exclusive, rather, they are comprehensive in nature. Combinations of generic cases can also occur, e.g. by expanding IS opportunities to a local industry cluster or to the wider community. An example is a company in the minerals industry jointly developing water network infrastructure with other companies (Case #9) while simultaneously capturing and utilising CO_2 emissions in their mineralisation processes (Case #2). Hence, in each generic IS case, the EPOS list can be seen as a building block for multiple IS solutions.

IMPACT OF GENERIC IS CASES

The sustainability impact analysis of the 20 generic cases allows for the identification of 6 main categories of high relevance for Europe. The first one is the creation of virtual market places generating relevant cost reductions in the process industry. The second category is CO_2 reduction indicating the carbon emissions avoided or mitigated due to the symbiosis. The third category is energy efficiency, referring to the savings in primary energy use and energy generation.

The fourth one is material efficiency pointing to the savings in (virgin) resources. The fifth one covers renewable energy related to joint investments or flexible use. The last category collects competitiveness impacts due to other costs avoided.

EU impact category	Generic case #
Virtual market	1, 2, 3, 8, 9, 10, 13, 14, 16, 17, 19, 20
CO_2 reduction	2, 5, 7, 11, 13, 14, 16, 18, 19
Energy efficiency	1, 3, 4, 6, 8, 20
Material efficiency	6, 9, 10, 11, 15, 17
Renewable energy	5, 7, 12, 18
Other cost reduction	1, 6, 15, 16, 17, 19, 20

Table 3: EU impact categories

Based on market studies and European hotspots for IS [2], an impact estimation of various generic cases in Europe is made. The chemicals industry is used as the starting point since the sector is involved in the highest number of cases. This is related to its high ability and capacity to transform resources and its long-standing experience with business clustering [3],[4].

Virtual Market

- For **district heating networks** in the **chemical sector** the potential for **virtual market creation** is estimated at 400-700 M€/y involving around 140 sites in Europe.
- For **industrial water networks** in the **chemical sector** the potential for **market creation** can amount to 1 M€/y at around 140 sites in Europe collaborating with **cement, minerals and steel** sectors.
- For **CO valorisation from steel** in the **chemical sector** the potential for **market creation** can amount to 250 M€/y at around 35 sites in Europe.
- For **industrial CO_2 capture and utilisation** in the **chemical sector** the potential for **market creation** can amount to 100 M€/y at around 35 sites in Europe collaborating with **cement and steel** sectors.
- For **industrial CO_2 capture and storage** in the **chemical sector** the potential for **market creation** can amount to 300 M€/y at around 28 sites in Europe collaborating with **cement and steel** sectors.

CO_2 reduction

- For **wind power cogeneration** in the **chemical sector** there is a potential for **CO_2 reduction** of 200-300 ktCO_2/y CO_2 at around 30 sites in Europe collaborating with **cement and minerals** sectors.
- For **industrial CO_2 capture and storage** in the **chemical sector** there is a potential for **CO_2 reduction** leading to low-carbon clusters at around 28 sites in Europe collaborating with **cement and steel** sectors.
- For **industrial CO_2 capture and storage** in the **chemical sector** there is a potential for **CO_2 reduction** up to 90% at around 28 sites in Europe collaborating with **cement and steel** sectors.
- For **CO_2 mineralisation** in the **chemicals sector** there is a potential for **reducing CO_2** with 20-70% on 22 sites in Europe collaborating with **cement and minerals** sectors.

Energy efficiency

- For **district heating networks** in the **chemical sector** there is a high potential for **increasing heat efficiency** for around 140 sites in Europe.
- For **energy optimisation** projects in the **chemical sector** there is a potential to recover 10-40% of the heat produced at around 140 sites in Europe collaborating with **cement, minerals and steel** sectors.
- For **energy optimisation** projects in the **chemical sector** there is a potential to reduce the **heat requirement** with 2-10% for around 140 sites in Europe collaborating with **cement, minerals and steel** sectors.

Material efficiency

- For **industrial water networks** in the **chemical sector** there is a potential for saving up to 40% fresh water at about 140 sites in Europe collaborating with **cement, minerals and steel** sectors.
- For **co-product valorisation (to cement)** in the **chemical sector** there is a potential for reducing waste involving around 35 sites in Europe collaborating with **cement and steel** sectors.

Renewable energy

- For **demand side response** in the **chemical sector** there is a potential for using **renewable energy** to reduce grid instability for around 140 sites in Europe collaborating with **cement, minerals and steel** sectors.
- For **demand side response** in the **chemical sector** there is a potential for using **renewable energy** to reduce peak power demands by up to 40% for around 140 sites in Europe collaborating with **cement, minerals and steel** sectors.
- For **wind power cogeneration** in the **chemical sector** there is a potential for **renewable energy** with 20-50% return of investment for around 30 sites in Europe collaborating with **cement and minerals** sectors.

- For **solar power cogeneration** in the **chemical sector** there is a potential for **renewable energy** with 6-16% return of investment for about 5 sites in Europe collaborating with **cement, minerals and steel** sectors.
- For **solar heat** in the **chemicals sector** there is a potential for **renewable energy investments** with 5-20% return for about 5 sites in Europe.

Other cost reduction

- For **coke valorisation** in the **chemical sector** there is potential for **cost reduction** through industrial symbiosis at roughly 35 sites in Europe collaborating with **cement and steel** sectors.
- For **joint wastewater treatment** in the **chemical sector** there is a potential for **cost reduction** through economies of scale for around 35 sites in Europe collaborating with **cement, minerals and steel** sectors.

FURTHER RESEARCH

The generic cases in this insight can be used as basic schemes to model and simulate industrial symbiosis cases and set out scenarios.

The list of generic cases is not exhaustive. The EPOS partners have started from a long list of over 100 IS opportunities and selected the most appropriate and most likely cases for ASDEO progress in the project. Many more IS cases have a potential for generalisation, building from current knowledge and experience but added with new technologies and synergies following evolving energy and resource profiles as well as cluster management and district engineering aspects.

REFERENCES

[1] EPOS, Deliverable D6.1 Market study. 2016
[2] EPOS generic cases collection. September 2019
[3] Barsoumian, S., et al. Eco-innovation in cluster organisations in the chemical and textile- clothing-leather sectors. Greenovate! Europe EEIG. 2011
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