



EPOS

SYMBIOSIS IN INDUSTRY

Interim Report

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EPOS - Enhanced energy and resource Efficiency and Performance in process industry Operations via onsite and cross-sectorial Symbiosis – is a project which received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 679386. This work was also supported by the Swiss State Secretariat for Education, Research and Innovation (SERI) under contract number 15.0217

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1. Summary of the context and overall objectives of the project

The EPOS project develops a simple and single management tool for exploring industrial symbiosis (IS) across process sectors. A wide range of technology and management solutions are suggested for supporting collaboration between sectors, by making process manufacturing sites more efficient, more cost-effective, more competitive and more sustainable.

Thanks to the recruitment of PhD students embedded in the EPOS industries – also in the EPOS SMEs and in both research labs – the entire EPOS consortium was able to build and share understanding on each industrial site and process sector. Using the UGent cluster management surveys and the EPFL site optimisation platform, cluster sites were studied, references set, opportunities for cross-sectorial symbiosis spotted and first IS potential was mapped for each EPOS cluster. Both long and short lists of potential collaborations were drawn on energy, materials, and waste streams; also on services, facilities and technologies; and on sharing activities or information; etc. High-potential exchanges were selected for case-based exploration.

Two IS pilot cases in two different EPOS clusters were investigated in further detail. The first case is the (longstanding) recovery of heat from the ArcelorMittal demo site in Dunkirk (FR) as feed for the local district heating network; the second is the (new) reuse of a liquid waste stream from INEOS in the cement kilns of CEMEX as a cross-sector symbiosis in the Hull region (UK). Both cases pointed to success factors for IS: business enablers, policy incentives, sustainability gains, stakeholder interests, technical and spatial drivers, extension plans, added value, etc. Likewise, they served as industry-driven input for developing a realistic IS methodology, a first prototype of the EPOS toolbox and a mock-up foot printer. Meanwhile the site management of the involved partner industries is taking up the business cases.

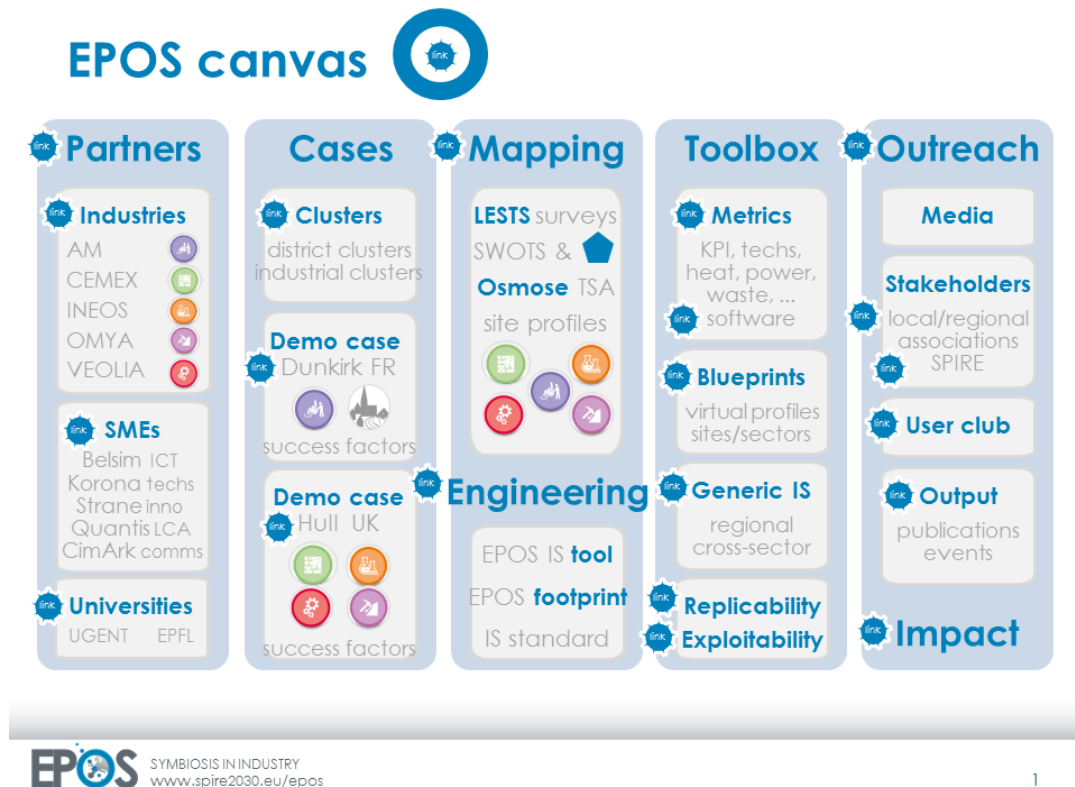
In the first 18 months of the EPOS project, the following achievements of each listed objective are reached or are in progress:

- A deeper cross-sectorial understanding is achieved for all sites and clusters of the EPOS process industries facilitating the integration of process streams (energy, materials, waste), engineering (technologies, utilities, facilities) and organisational solutions (management systems, business schemes, services). This has resulted in long lists of potential symbiosis opportunities for all clusters.
- An integrated methodology for using the basic EPFL and UGent tools is being developed. The introduction of a system thinking approach in industry is believed to pave the way for triggering industrial symbiosis in the clusters.
- A prototype IS tool is under development; the EPOS team is working towards a user-friendly interface. The objective of improved resource and energy management in energy-intensive process industries remains and IS cases are being developed in all clusters.
- First technical, environmental and economic performance scenarios are being tested in two symbiosis pilot cases, in an industrial and in a district cluster. Industry, sector and cross-sector business and sustainability driven KPIs have been defined, based on the long lists of potential IS streams and exchanges.
- First discussions on generic and replicable business cases have taken place but the core tasks feeding into this objective are scheduled in the second half of the project.

The EPOS project is on track, there are no delays nor are major concerns in view. By month 24, the partnership expects to present a prototype toolbox for enabling symbiosis across process industries.

2. Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far

In the first 18 months, the EPOS consortium has challenged its process industry sites to not only get to know nearby companies from other sectors in the EPOS clusters, but to also understand their plants, operations, basic streams and management. They have explored new ways of doing cross-sectorial business. The work performed since the beginning of the project was collected in a midterm project canvas and presented to the project officer and the EPOS advisory board.



Loyal to the EPOS concept, all work done has taken an industry viewpoint, is SPIRE driven and case based – the progress is in line with the flexible EPOS roadmap (WP1).

By using LESTS surveys (WP1), a common understanding of the different EPOS sectors was gained and comprehensive first analyses of any interactions within the EPOS clusters were made. The current level of collaboration was mapped in pentagons and new potential for cross-sectorial collaboration was extracted. Long lists of IS potential were drawn for all EPOS clusters and first cases have been put forward for triggering industrial relevance.

In parallel, all process industries have completed detailed energy studies on most of the EPOS sites (WP2) using the EPFL energy optimisation platform Osmose. This engineering approach has confirmed and deepened the LESTS findings and has led to a databased mapping of the sharable streams on the lead sites. A thorough understanding of performance indicators per site and sector was gained and harmonised energy profiles were established across the EPOS industries. Currently virtual sector profiles (WP2) are built from the site analyses; it enables a systems approach for spotting symbiosis potential and thus facilitates software-based tool development. The IS potential found via LESTS surveys (WP1) and Osmose studies (WP2 and WP4) is currently being fed into business cases (WP6) and first footprint calculations have started; the findings serve as interactive input for the EPOS toolbox development (WP3).

Special focus was given to the Dunkirk district heating network in the north of France (WP4), which has been fed by ArcelorMittal since 1985. This longstanding case of heat recovery is a proven example of symbiosis in a district cluster (industry plus community) and thus serves as a demo case for the EPOS research on management (organisational) and especially engineering (technical) solutions for IS. It points to success factors (WP5) such as business enablers, policy incentives, sustainability gains, stakeholder interests, technical and spatial opportunities, etc. In addition, it provides a welcome base case for investigating the business drive over the full 30 years of operation and even extension of the network (WP6). Actors and driving forces of IS were listed, starting from the energy and material streams at the ArcelorMittal site in Dunkirk (WP4). A database of technical and non-technical indicators was built, leading to back-and-forth discussions with the tool developers (WP3) and the heat recovery findings for the steel complex are now ready for testing in the other EPOS clusters (WP5).

A second pilot case concerned a newly spotted opportunity for cross-sector symbiosis in the Hull industrial cluster (UK). From the LESTS surveys (WP1), a liquid waste stream with high calorific value was identified at the INEOS site, which is considered suitable for reuse in the cement kilns of a nearby CEMEX plant. Such streams are as common in the chemicals industry as kilns are in the cement sector, therefore this case accounts for a generic IS solution of cross-sectorial nature (WP5). It led to an EPOS Insight (WP7) and is now being investigated from a technical and organisational point of view, providing input to all work packages of the EPOS project.

Both cases are being used to support the building of an integrated IS toolbox that points to successful symbiosis solutions. They served as industry-driven input – from a district as well as industrial cluster perspective – for producing a list of metrics and system settings (WP1) and defining the functionalities for developing a realistic IS methodology (WP3). By merging IS management options listed in the non-technical guidelines (WP1) with engineering methods (WP3) and including sustainability criteria, a mock-up foot printer could be developed and presented for discussion (WP3). In addition, an in-depth technology watch was performed (WP1) selecting 25 technologies for uptake in the toolbox (WP3). The next step, developing a user interface that integrates and discloses IS solutions in an apprehensive way, has been started. A first integrated prototype of the EPOS toolbox is expected to be ready for testing in the EPOS clusters by month 24.

The cross-sectorial testing of the EPOS toolbox and IS solutions (WP5) is scheduled for the second half of the project. It aims at assessing their reproduction potential in different process sectors and for diverse IS activities. In preparation, IS success factors were drawn from literature and benchmarked with the findings in both pilot EPOS business cases (WP6). Likewise, an in-depth market study on the potential for industrial symbiosis in Europe was performed and the interest in using and exploiting an integrated IS toolbox was sounded with the EPOS partners (WP6).

Existing symbiosis cases at Lavera & Dunkirk were investigated and new cross-sector IS cases in Hull were researched for their business potential. Meanwhile the above-mentioned Hull case between INEOS and CEMEX has been taken up by the respective site managements. A report on IS business models is expected by month 36 (WP6). Likewise ideas are being gathered and interest explored for exploiting the EPOS toolbox, which will, in due time, include the writing of a business plan.

As to guarantee a deep build-up of understanding of the EPOS SPIRE sectors and their capacities to engage in cross-sector symbiosis, a plan for IS training and dissemination was developed (WP7). All EPOS PhDs, working in industry or SMEs were trained by the universities, especially by EPFL on the use of the Osmose platform. Online tools are selected and used to ease internal and external communication, the website being the 'EPOS face to the world'. Likewise first presentations were given and articles written as to reach out to industry associations, policymakers and academia. Once the EPOS tool is ready for use, a next step will be to launch the User Club (WP7).

To achieve the above, the EPOS project was managed with a strict and strong female lead of the coordinating team, the management bodies and the overall project ambitions.

3. Progress beyond the state of the art, expected results until the end of the project and potential impacts (including the socio-economic impact and the wider societal implications of the project so far)

As an intermediate evaluation, the EPOS impact achieved at month 18 is reported based on the SPIRE KPIs and the impact survey sent to SPIRE in March.

The EPOS project aim to develop a generic toolbox for cross-sector industrial symbiosis (IS) can be considered a new method. It is a management methodology combining both a technological and non-technological approach to facilitate symbiosis in process industries. In the running up to achieving this ambition, three valorisation routes have been initiated and will be further explored during the months and years to come.

1. **The EPOS toolbox.** By autumn 2017 a prototype platform will be ready which allows for rapid screening of IS potential between process industries based on overall economic and sustainability gains. The toolbox merges three existing tools: Osmose, a techno-environmental optimisation platform for energy integration and optimisation in industry; LESTS, a legal, economic, spatial, technical & social survey for IS screening; and an IS foot printer for quantifying economic, ecological and social benefits. The EPOS toolbox will enable users to identify, assess, prioritise and manage IS projects. During the second half of the EPOS project, it is anticipated that the toolbox will be tested for its robustness and replicability in the five cross-sectorial clusters. Once confirmed, it is planned to select the best way to bring the toolbox to the market.

2. **The EPOS IS Hull case.** In the first year of the EPOS project, the existing components of the EPOS IS toolbox were applied to the EPOS sites and clusters. Via LESTS screening of the EPOS partner sites in Hull (UK), a novel, symbiotic way of doing business was identified between CEMEX and INEOS. A liquid waste stream with a high-calorific value was detected at the INEOS site (chemicals industry) while at the CEMEX site (cement industry) a cement kiln was spotted with a potential to increase its efficiency. The kiln is currently topped-up with 20% primary fuel, which could be replaced by the INEOS waste stream. A series of business models and related sustainability gains are being developed and negotiations between the EPOS partners have started. This case is believed to lead to a generic cross-sectorial IS recommendation for nearby cement and chemicals industries.

3. **The EPOS sector blueprints.** To enable a broad outreach of findings from process industries collaborating in R&I projects, production data need to be anonymised and processes simulated. Virtual sector profiles are a new, open-innovative way to share industrial information in and across sectors but also facilitate discussions with academics, policy makers and other stakeholders. In the EPOS blueprints typical operating modes of a given industry sector are simulated with the aim of sharing findings across sectors and generalising solutions. A methodology for drawing the profile of a typical site for each EPOS sector is developed based on essential units and realistic data gathered from existing plants and sites. The methodology has been discussed with the sector associations and was appreciated for its multi-use purpose. First blueprints for all EPOS sectors are expected by the end of 2017.

In the long run, the EPOS project has the ambition to screen the potential for an IS standard. Through the advisory board, standardisation bodies such as ISO and CEN/CENELEC are updated on the EPOS tool development and invited to join the discussions. Concerted actions with colleague SPIRE 6 projects have started and will continue in the months and years to come.

As to socio-economic impact and wider societal implications of the EPOS project, the SPIRE KPIs on SME participation and high-skilled workforce are mentioned.

In the EPOS consortium, five R&I minded SMEs show an active business interest to boost their sales through the project progress and results. Two SMEs have each created a new job, both MSc in engineering; all three others have an MSc graduate dedicated to the project tasks.

Overall, in the EPOS project nine new jobs were created, i.e. six PhDs students (4 male – 2 female) and three new researchers and employees. All recruits have been at the MSc level. The PhD students acquire new high-skilled profiles in the field of process engineering with a focus on site/cluster optimisation and industrial symbiosis in particular. The EPOS young graduates have been trained in, and thus have the knowledge and skills required for, using the Osmose & EPOS tools. This has allowed the universities to understand the requirements for launching an open online training course. With the decision on new curricula pending, the EPOS results are integrated in existing courses and theses at the participating universities.

Finally, the EPOS project contributes to the SPIRE work programme challenge of reducing the overall costs in energy-intensive industries. The foot printer in the EPOS toolbox, currently being built, calculates both economic and sustainability gains as a result of energy, materials or waste symbiosis across industry sectors.