Industrial Symbiosis: A Circular Manufacturing Strategy for Industry 4.0

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#technology4.0

SHAREBOX
SECURE SHARING

IRIS business lines

IRIS MONITORING

CYBER-PHYSICAL SYSTEMS

Turnkey spectroscopy-based solutions for process monitoring and quality control

IRIS SMAC

SMAC: ‘Social, Mobile, Analytics & Cloud’

New levels of business productivity and client engagement.

IRIS INNOVATION

>20 ongoing EU-Funded projects on:

Resource efficiency via Industry 4.0 mainly for:

- Process Industries (SPIRE),
- BioBased Industries (BBI),
- Advaned materials and high value manufacturing (NMBP),
- Factories of the Future (FOF)

SHAREBOX: Secure Management Platform for Sharing Process Resources

- Funded under SPIRE PPP (Sustainable Process Industry through Resource and Energy Efficiency)
- **SPIRE-06-2015:** Energy and resource management systems for improved efficiency in the process industries
- Sep 2015 – Aug 2019 (4 years)
- 16 partners (4 clusters, 5 SMEs, 6 universities, 1 association)

- EC funding: €5.416.544,75
- Total Cost: €5.914.000,00

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CHEMIE-CLUSTER BAYERN
DECHEMA
ESKISEHIR CHAMBER OF INDUSTRY
GRUPO GUZMAN
IBERICA DE SUSPENSIONES, S.A.
INTERNATIONAL SYNERGIES LTD.
ASOCIACIÓN DE INVESTIGACIÓN DE LAS INDUSTRIAS CERÁMICAS
KERAFRIT, S.A.
KEROS CERAMICA, S.A.
NEPIC
UNIVERSITY OF LEEDS
UNIVERSITAT POLITÈCNICA DE CATALUNYA
UNIVERSITY OF TWENTE
UNIVERSITY OF STRATHCYCLE
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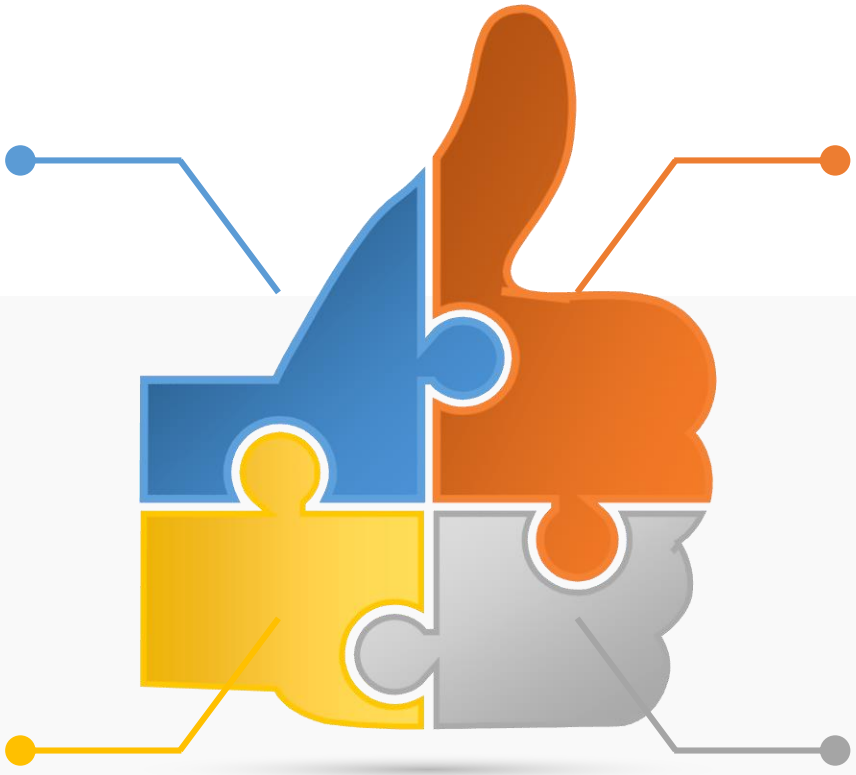
SHAREBOX project in a nutshell

1. The EU/ SPIRE needs

"solutions for more efficient processing and energy systems for the process industry, including industrial symbiosis"



2. The Project Solution

A secure ICT platform that functions as byproduct and waste inventory, supply chain management and decision support system, allowing companies to identify and manage win-win situations in trading byproducts and sharing resources.

4. How will this happen?

1. Adoption by companies in existing industrial parks and clusters
2. Reaching critical mass of users for national and international byproduct and waste trade
3. Regulatory change for decharacterising outputs as "waste" when they are part of value chains

3. Value to Customers

Cost Savings: Avoid costs related to waste handling and management
Boost Revenues: Create additional income by commercialising byproducts
Cut expenses: Benefit from the lower prices of resources considered byproducts
Lower risk: Through **d**iversifying both supplier base and clientele

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Circular Economy

The Circular Economy Goal: Decouple as much as possible industry and nature (minimise waste and extraction of non-renewable resources)

- **Commercial Opportunity**: $4.5 Trillion by 2030 (Accenture)
- **Business Threat**: 40% of S&P500 may go out of business in 10 years (SAP)
- **Competitive Advantage**: Early adopters outperform competition (SAP)

Circular Economy Core Strategies:

1. Close supply chains (recycle, reuse, remanufacture, recover)
2. **Sell your waste (byproduct synergies)**
3. **Share resources (co-working, facilities, etc.)**
4. Increase resource and energy efficiency (process optimization)
5. Extend product/asset useful life (inspection & maintenance)

Industrial Symbiosis: Background & Basics

TENTATIVE DEFINITION: Industrial Symbiosis is ***the practice of trading waste, byproducts and excess resources between industries***.

BENEFITS:

- ***Minimize interaction with natural environment*** (resource extraction, waste disposal, pollution)
- ***Increase value per unit of resource*** (avoiding waste treatment/transport costs, creating new income, diversifying supply chain and portfolio)
- ***Increase economic activity per unit of resource*** (ie more jobs)

KEY CONCEPTS:

1. **Synergy**: The sharing of a single byproduct/waste/resource between industries
2. **Symbiotic Network (ISN)**: A group of industries engaging systematically in synergies
3. **Eco-industrial park**: A special case of ISN where all sites are co-located in the same industrial area
4. **Designed or Planned symbiosis**: Top-down approach where a governmental body dictates the type of synergies and the structure of the symbiotic network
5. **Spontaneous symbiosis**: A symbiotic network formed without conscious strategic planning from the involved actors and without awareness of the overall network structure or existence
6. **Facilitated symbiosis**: The uncovering and/or nurturing of symbiotic practices between companies from third parties

Industrial Symbiosis: 1989 - A promising start

A little bit of history: 1989 – A key year for Industrial Symbiosis

- **Frosch & Gallopoulos, Strategies for Manufacturing, Scientific American:** Define the ***Industrial Ecosystem***. *In such a system… the effluents of one process… serve as the raw material for another process… An ideal industrial ecosystem may never be attained in practice, but both manufacturers and consumers must change their habits to approach it more closely…"*
- ***The Kalundborg Industrial Park*** is recognised as the first instance of intentional Industrial Symbiosis

Case study: Denmark - Kalundborg (2010)

- 30 exchanges of water, energy and other by-products between 10 sites
- 3 million cubic metres of water saved
- 150,000 tons of yeast replaces 70% of soy protein in feed mix for more than 800,000 pigs
- $15 million collective annual savings across firms in the park.
- 250,000 tons per year in CO2 savings
- 30% savings in overall water consumption

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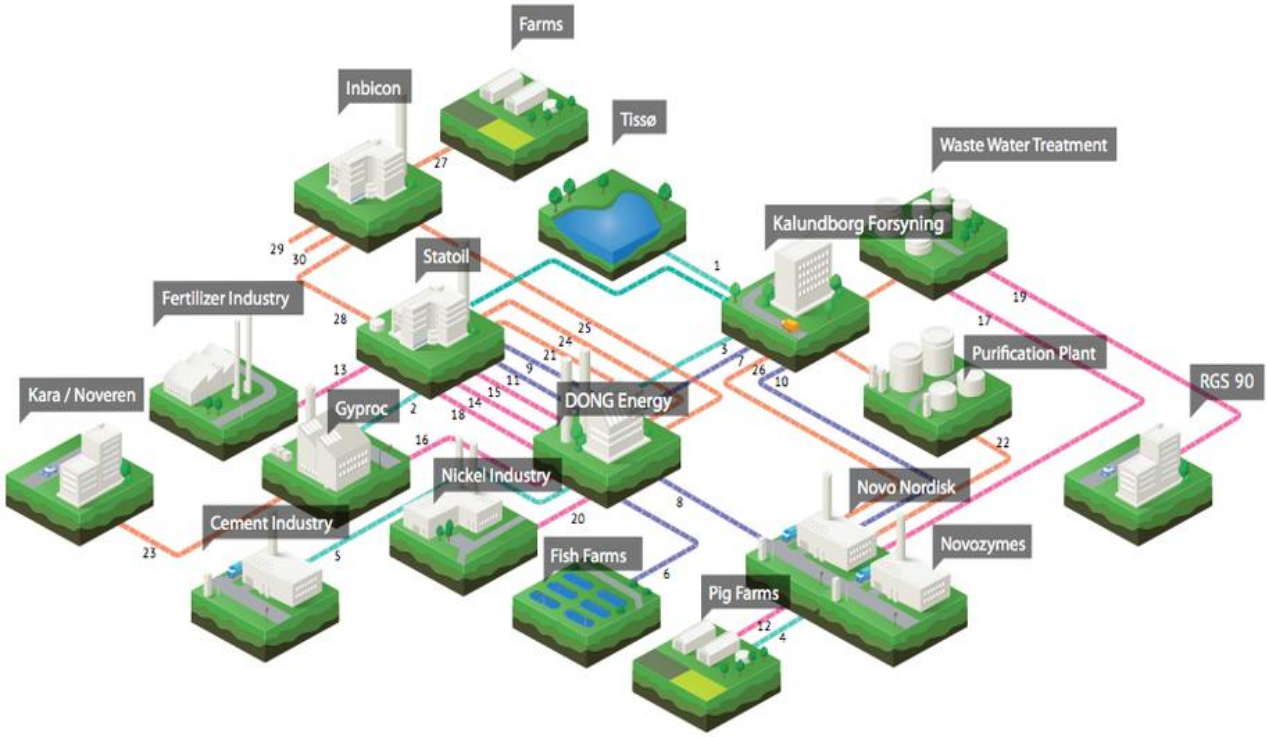


Industrial Symbiosis: Stagnation and success

What happened in the 90s?

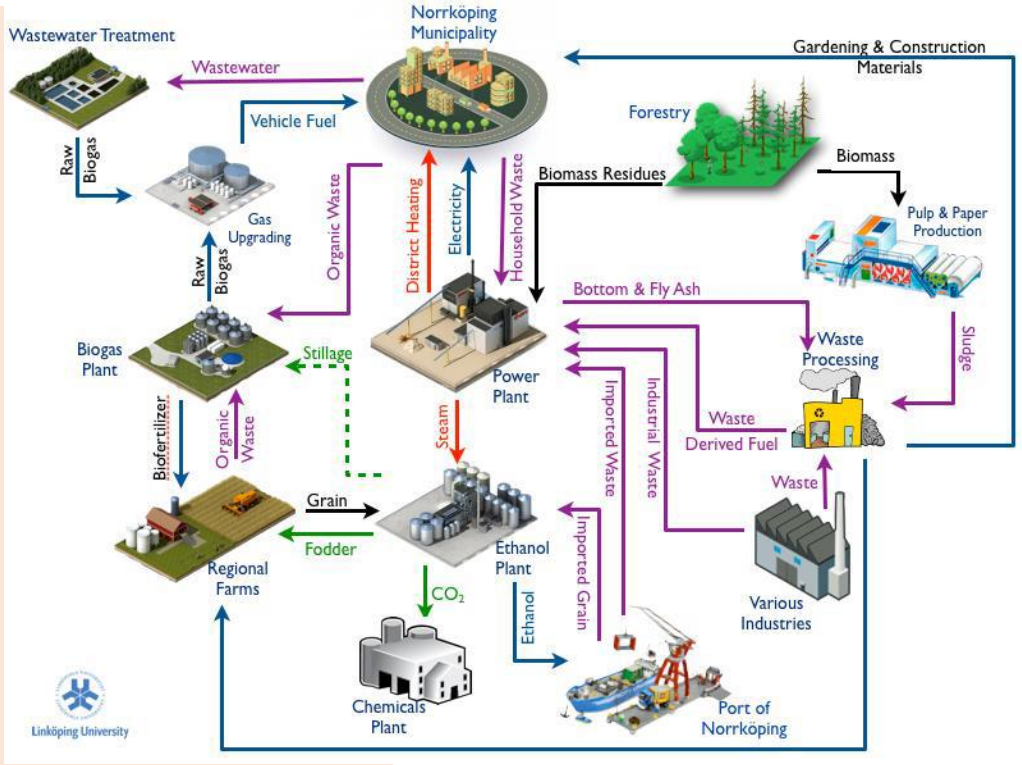
- Industrial Ecology was established as a research field (1992)
- The Journal of Industrial Ecology was launched (1997)
- *Several "planned Industrial Symbiosis" attempts were made in the USA and Europe with equivocal results*
- *The concept is limited to academia with little to no impact in policies and business/industrial practices*

<u>2000 – 2010: UK National Industrial Symbiosis Programme:</u>

1. UK Government funds NISP with €100 Million to deliver nationwide facilitated symbiosis over 10 year period
2. **The programme exceeds expectations** (2005 to 2013):
    1. 12,500 members (90% SMEs)
    2. 47 million tonnes of landfill diversion
    3. 42 million tonnes of CO2 reduction
    4. 45 million tonnes of materials recovered and reused
    5. €1.3 Billion in cost-savings
    6. €1.3 Billion in additional sales
    7. 10,000 jobs.
3. 2013: Despite its success the programme is ceased due to budget cuts (Source)

Industrial Symbiosis: Today

KEY FIGURES:
EU investment in Circular Economy (2012-2020):
€707.644.200
EU investment in Symbiosis (2012-2020):
€172.612.456 (24%)
Nr of Eco-industrial parks in Europe:
116 (DE-25, FR-14, ES-12, IT-9)
Nr of Eco-industrial parks around the world:
300 in 27 countries (CH-13, USA-11)
Potential savings in Europe
€1.4bn/year
Potential additional sales in Europe
€1.6bn/year
(Source: COM(2011) 571) (Source: ENEA)



Norrköping industrial symbiosis network, Sweden

Industrial Symbiosis at the core of international and national governments
- EC´s strategy for Resource Efficiency,
- OECD´s fututre of eco-innovation
- WBCSD best practices for resource efficiency
- National IS programmes in the UK (NISP), Scandinavia, Italy

Industrial Symbiosis Barriers

Types of barriers for IS

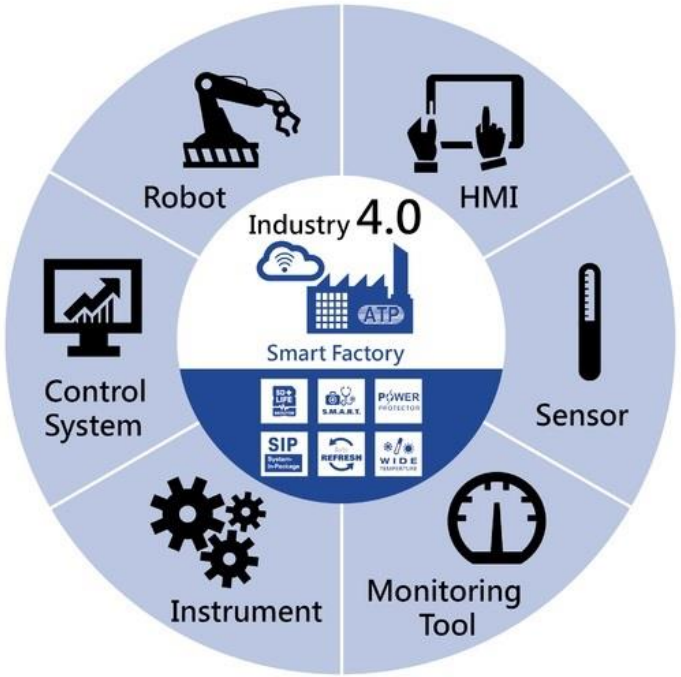
1. **Technical** – Sometimes synergies are not posible due to technical reasons
2. **Economic** – IS requires investment in time and resources
3. **Informational** – Companies lack info on other companies´ byproducts or needs
4. **Organizational** – Lack of trust between companies
5. **Regulatory** – Limitations in handling material characterised as waste
6. **Risk & Uncertainty** – IS is still considered unknown and unfamiliar to professionals

MAYBE INDUSTRY 4.0 CAN HELP ADDRESS SOME OF THESE ? ? ?

Industry 4.0

Among many valid views to describe the **Industry 4.0 paradigm**, the IRIS' one:

- Effectively collecting a huge amount of **reliable and informative data** - not only about the process conditions but also about what is really taking place within the process.
- **Unveiling** relevant information from the data by supporting the involved ICT tools with **science-based** resources in order to build **learning and objective** decision support systems while continuously improving data collection.

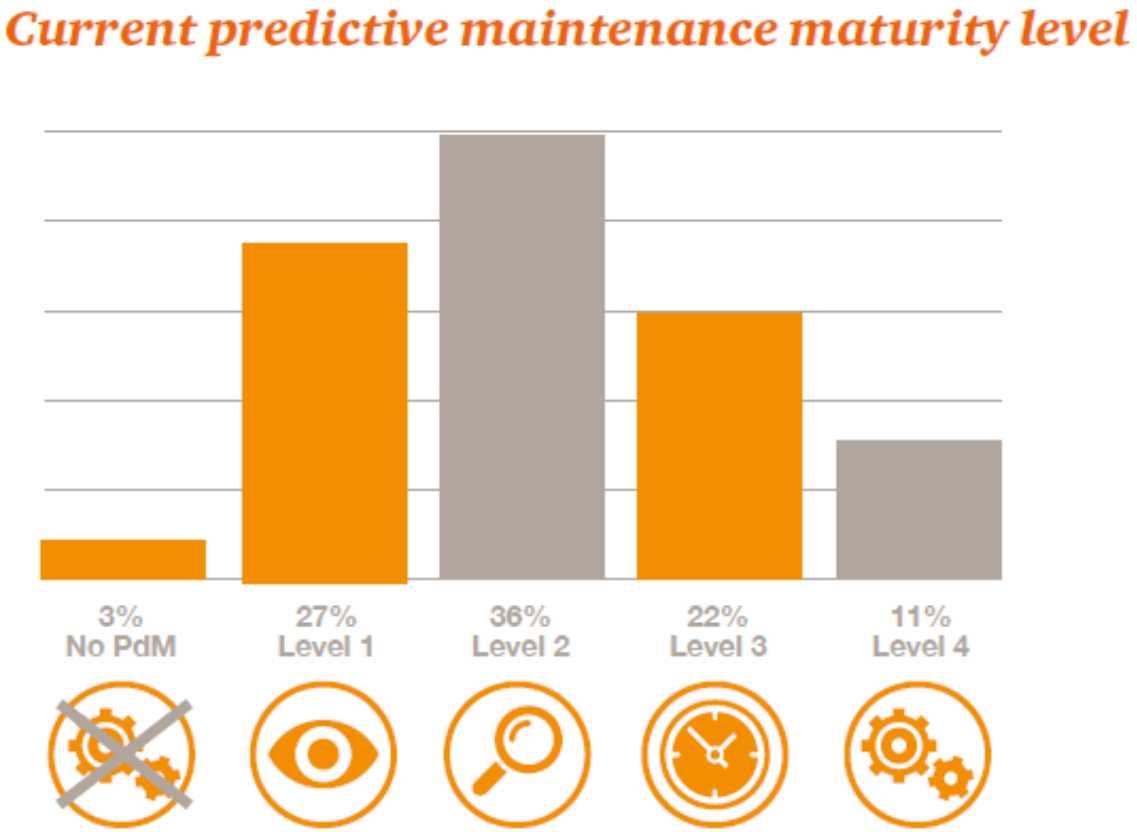


Key digital trends shaping Industry 4.0:

- ❑ **Internet of Things (IoT):**
  - ✓ 30–50 billion devices online, creating a market of $267Bn by 2020 (Forbes)
- ❑ **Big Data Analytics:**
  - ✓ Global revenues for big data analytics will exceed $203 billion in 2020 (IDC)
- ❑ **3D-printing and digital twin**:
  - ✓ 3D printing: the making of a physical object from a three-dimensional digital model
  - ✓ Digital twin: a three-dimensional digital model of a physical object, **updated in real-time**
- ❑ **Mobile devices/connectivity:**
  - ✓ 60-90% of time spent online is through mobile devices (comScore)

Industry 4.0 vs Industry 1.0 – An example

- **Evolution of Asset Maintenance**
  - **Level 1** ***Visual inspections:*** periodic physical inspections; conclusions are based solely on inspector's expertise.
  - **Level 2** ***Instrument inspections:*** periodic inspections; conclusions are based on a combination of inspector's expertise and instrument read-outs.
  - **Level 3** ***Real-time condition monitoring:*** continuous real-time monitoring of assets, with alerts given based on pre-established rules or critical levels.
  - **Level 4** ***Predictive Maintenance 4.0:*** continuous real-time monitoring of assets, with alerts sent based on predictive techniques, such as regression analysis.



Industrial Symbiosis 4.0

(At least) three ways in which the digital transformation enables Industrial Symbiosis:

1. Mathematical and computer models to provide decision-making support and optimize industrial symbiosis practices.
2. Operational data-driven analyses to optimize resource usage
3. Understanding of resource usage optimization and disclosure of operational data to develop universally applicable metrics for industrial symbiosis.

BOTTLENECKS

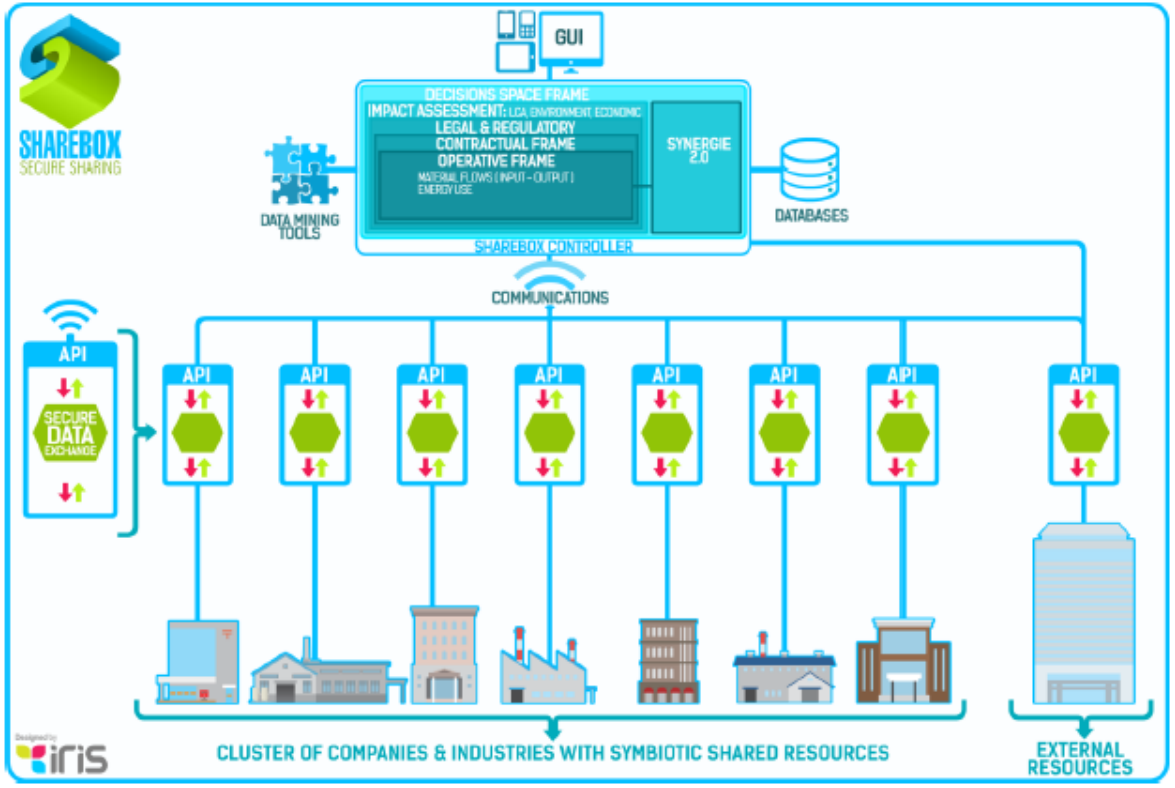
1. Industry 4.0 has been successfully applied either to **single corporate entities or single supply chains** with a clear history of cooperation and mutual trust
2. Can Industry 4.0 tools drive the deployment of IS initiatives that require collaboration **across traditional supply chains**?
3. Very little research on the nexus of Industrial Symbiosis and Industry 4.0.

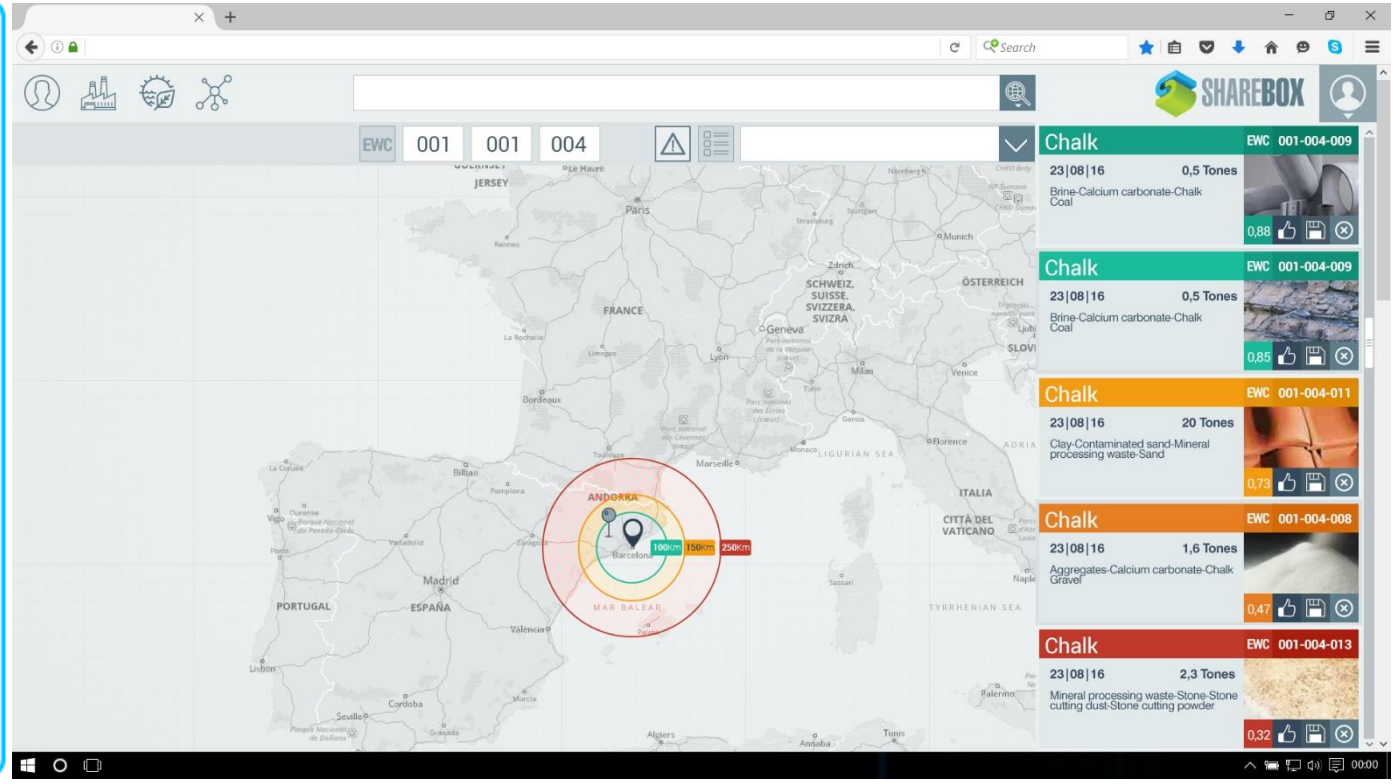
However…

Industrial Symbiosis 4.0 - SHAREBOX

Enabling next generation Industrial Symbiosis through a smart online platform for sharing byproducts and resources

- **Secure** B2B information exchange guaranteeing anonymity and data protection (API-based architecture)
- **Intelligent** decision support tools for the flexible management of shared process resources (ABM and game theory)
- **Robust and reliable** information to optimise byproduct synergies across companies (SQL database)
- "**Smart**" identification and realisation of new cross-sectorial interactions (CBR Recommender Systems)
- **Provision** of personalised services and solutions (link to external databases and solution providers)





Industrial Symbiosis 4.0 – SHAREBOX Impacts

In the context of Sharebox we invite companies to facilitated workshops where potential synergies are identified, some of which evolve to actual synergies.

Impact based on 17 active synergies (18 as of Feb 2018)

Indicator	Impact at M24 (Aug 2017)	Impact at M48 (worst case scenario)
Global Warming Potential (mainly CO2 emission reduction)	682,000 tonnes of CO2 saved (74,8% reduction)	1.170.000 tonnes
Total material consumption	345,600 tonnes of virgin resources saved (23,2% reduction)	617,900 tonnes
Waste avoided	273,000 tonnes of waste turned resources (27% reduction)	498.700 tonnes
Turnover from green activities (incl. savings and new sales)	€20.300.000 of additional revenue from cost savings and new sales	€34.700.000
Job creation	18 new Jobs (both direct and indirect)	48 new jobs

Worst case scenario: No more synergies established after M24

Relevant European Projects

- SHAREBOX - Secure Management Platform for Shared Process Resources (www.Sharebox-Project.eu)
- MAESTRI - Energy and resource management systems for improved efficiency in the process industries
- EPOS - Enhanced energy and resource Efficiency and Performance in process industry Operations via onsite and cross-sectorial Symbiosis
- SYMBIOPTIMA - Human-mimetic approach to the integrated monitoring, management and optimization of a symbiotic cluster of smart production units
- FISSAC - Fostering Industrial Symbiosis for a Sustainable Resource Intensive Industry across the extended Construction Value Chain
- PAPERCHAIN - New market niches for the Pulp and Paper Industry waste based on circular economy approaches
- SCALER - Scaling European Resources with Industrial Symbiosis
- SYMBI - Industrial Symbiosis for a resource efficient economy
- TRIS - Transition Regions towards Industrial Symbiosis
- STORM - Industrial Symbiosis for the Sustainable Management of Raw Materials

Questions - Discussion

Thank you for your attention ! ! !

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www.sharebox-project.eu