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SHAREBOX on-line training

Industrial symbiosis and its benefits

What is industrial symbiosis?

Definition:

“Industrial symbiosis is the use by one company or sector of underutilised resources broadly defined (including waste, by-products, residues, energy, water, logistics, capacity, expertise, equipment and materials) from another, with the result of keeping resources in productive use for longer. It presents a systems approach to a more sustainable and integrated industrial economy that identifies business opportunities to improve resource utilisation and productivity.”

Source: CEN (European Committee for Standardization):
Workshop Agreement CWA 17354:2018. Industrial Symbiosis: Core Elements and Implementation Approaches, p. 7

Rationale of industrial symbiosis

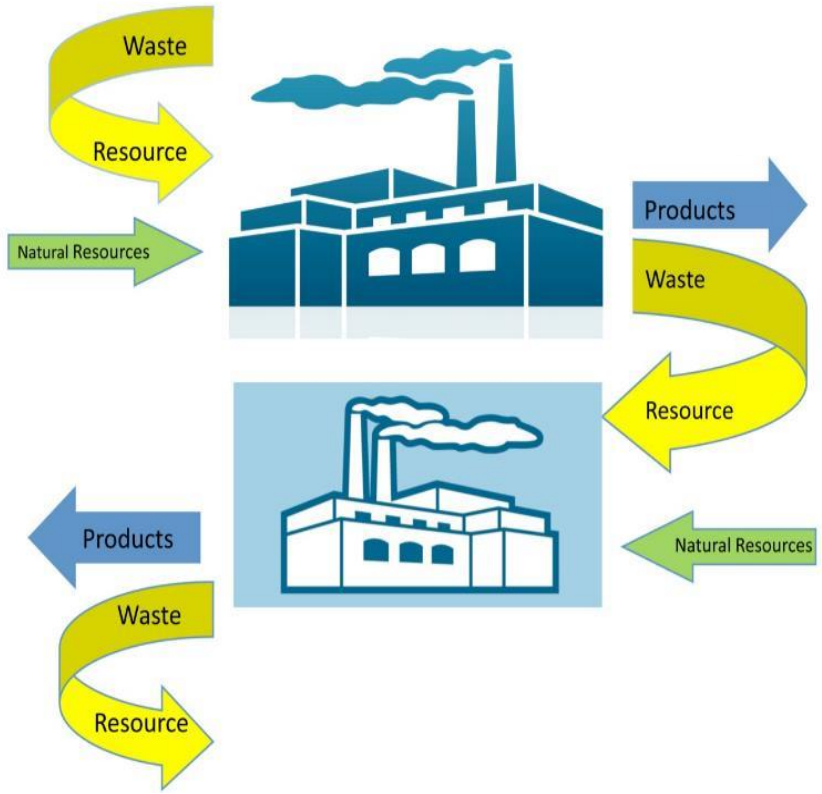


Image source and ©: Industrial Synergies Ltd. 2019

Cooperation with external partners to replace natural or fossil resources by secondary resources

- By-product exchange
  (materials, energy, service providing capacity)
- Utility and infrastructure sharing
- Common service sharing

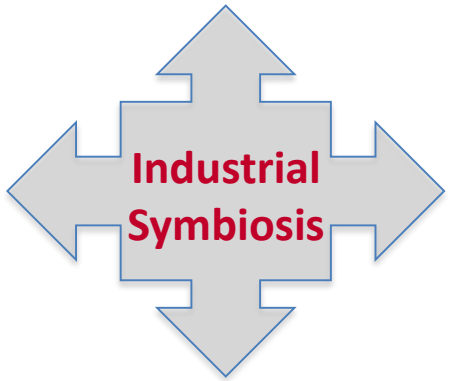
Industrial Symbiosis is adding value to global agendas

Resource Efficiency

G7 Alliance for Resource Efficiency
European Resource Efficiency Programme
Roadmap to a Resource Efficient Europe
Manufacturing Commission
COWI Report

Circular Economy

Circular Economy Package,
Accenture, UNIDO,
The Circulars,
Globe Scan 2015,
FP7 POLFREE & DYNAMIX, EEA



Climate Change

UK FCO
Financial Times
Nature Climate
Turkey INDC

Green Growth

Global Green Growth Forum
Global Green Bus. Summit
GLOBE Series
DG Regions & DG GROW
Technopolis Report 2018

UN Sustainable Development Goals

Decent Work & Economic Growth (8)
Industry Innovation & Infrastructure (9)
Sustainable Cities (11)
Responsible Cons'n, Prod'n (12)
Climate Action (13)
Partnerships (17)

Eco-innovation

UNEP, WWF,
OECD, ETAP,
DG Innovation,
Worldwatch Institute

Ecological benefits of industrial symbiosis

Non-symbiotic System A **–** Symbiotic System B **=**

Benefit:
Saved material input
Saved resource use
Saved emissions
Saved wastes
(System A – System B)

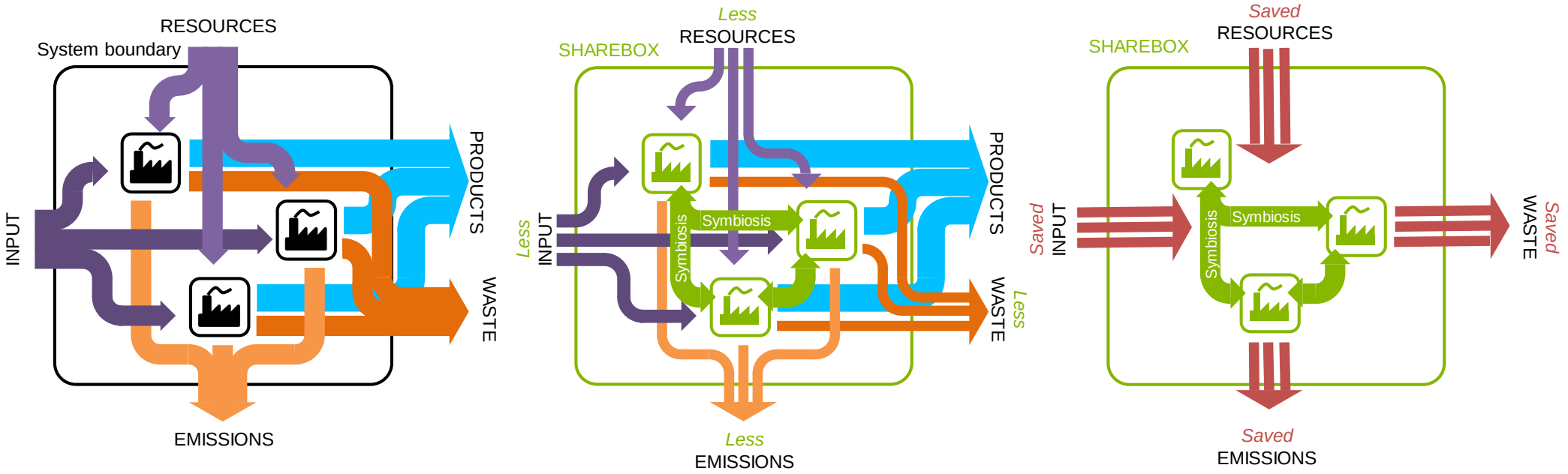
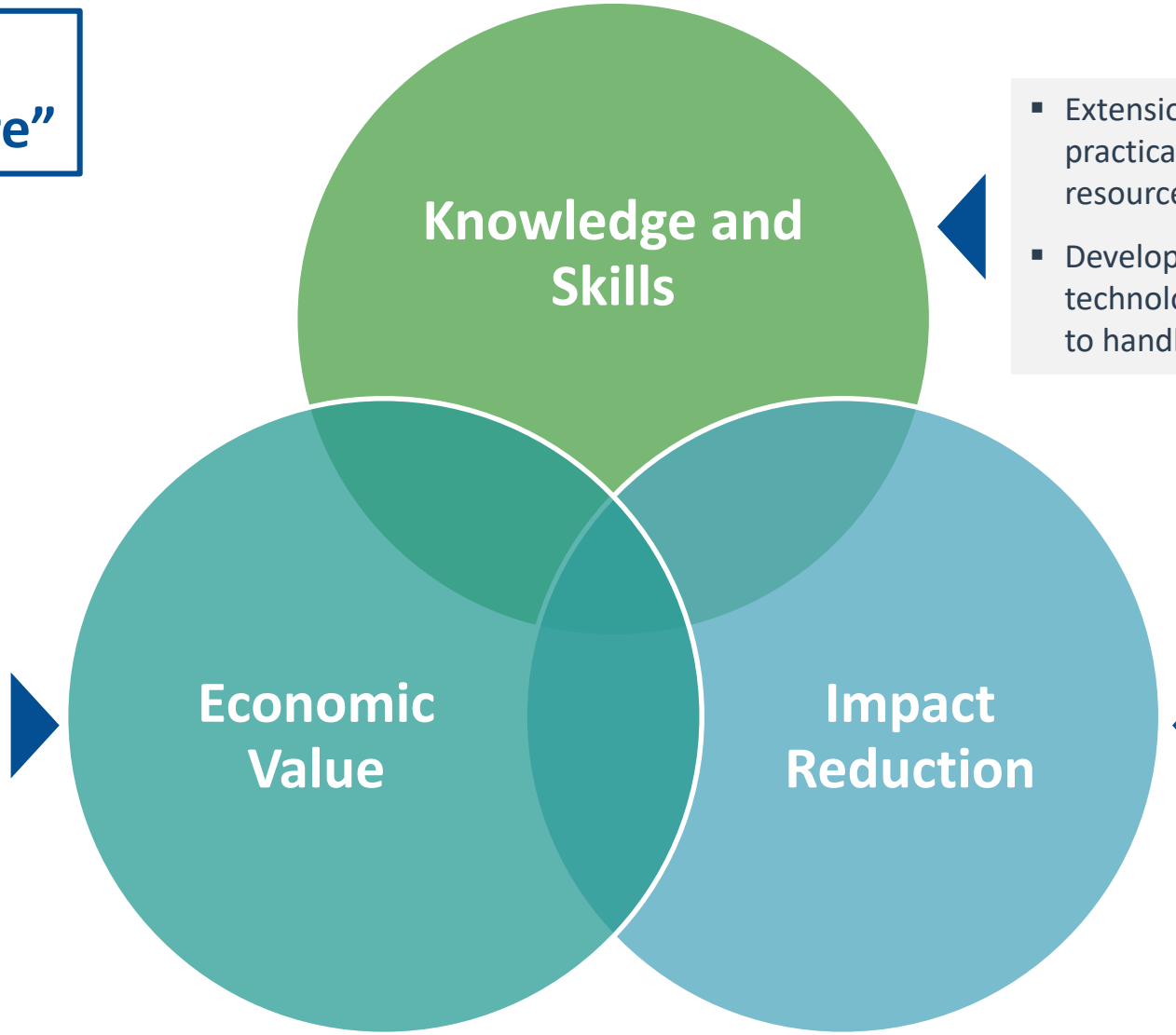


Image source: Zurich University of Applied Sciences (adapted)

Strategic benefits of industrial symbiosis

“One’s trash, another’s treasure”



- Extension of knowledge and practical know-how in resource management
- Development of new technologies and procedures to handle IS cases

- Creation of economic value from waste or underused resources
- Reduction of energy and raw materials costs
- Reduction of waste disposal fees

- Reduction of energy and materials consumption
- Reduction of GHG production
- Reduction of emissions for virgin material production
- Reduction of land consumption for dumps and landfills

Importance for European competitiveness

Save money

- > 300 Mrd. €/a for the EU‘s process industry

! Raw material costs rise twice as fast as personnel costs!

Create innovation

- New industrial processes and technologies

Protect the environment

- Less fossil resources
- Less emissions

Basic principles of industrial symbiosis

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1.) Industrial symbiosis refers to all kinds of resources and to all industrial sectors.

2.) All symbiotic relationships follow the principle of economic profitability.

3.) Industrial symbiosis occurs in organized structures:

a) within the boundaries of industrial parks

b) in facilitated networks

KALUNDBORG SYMBIOSIS

Mainsite
INDUSTRIESERVICE NACH MAß

InfraServ
GENDORF

NISP®
NATIONAL INDUSTRIAL SYMBIOSIS PROGRAM

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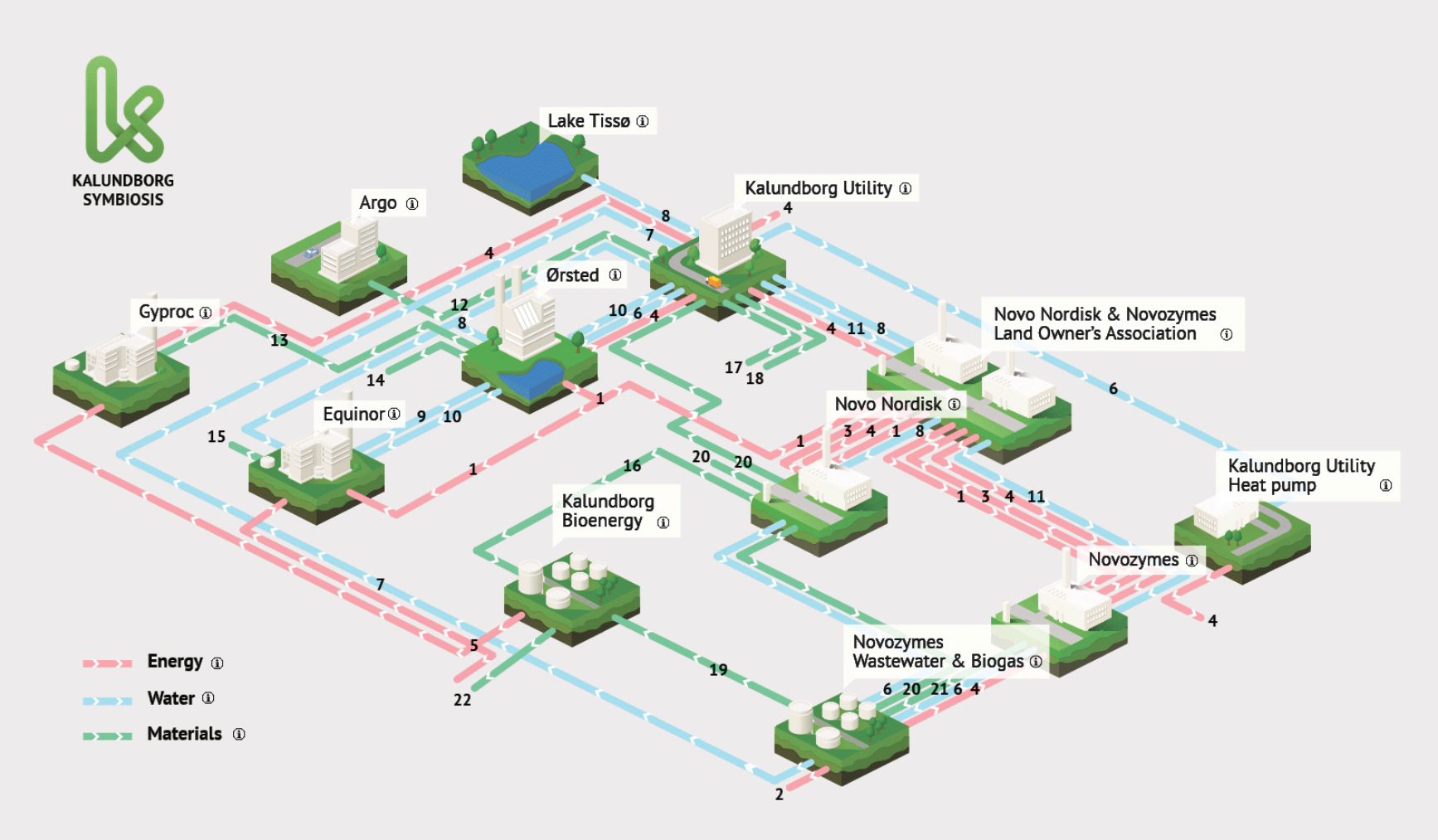
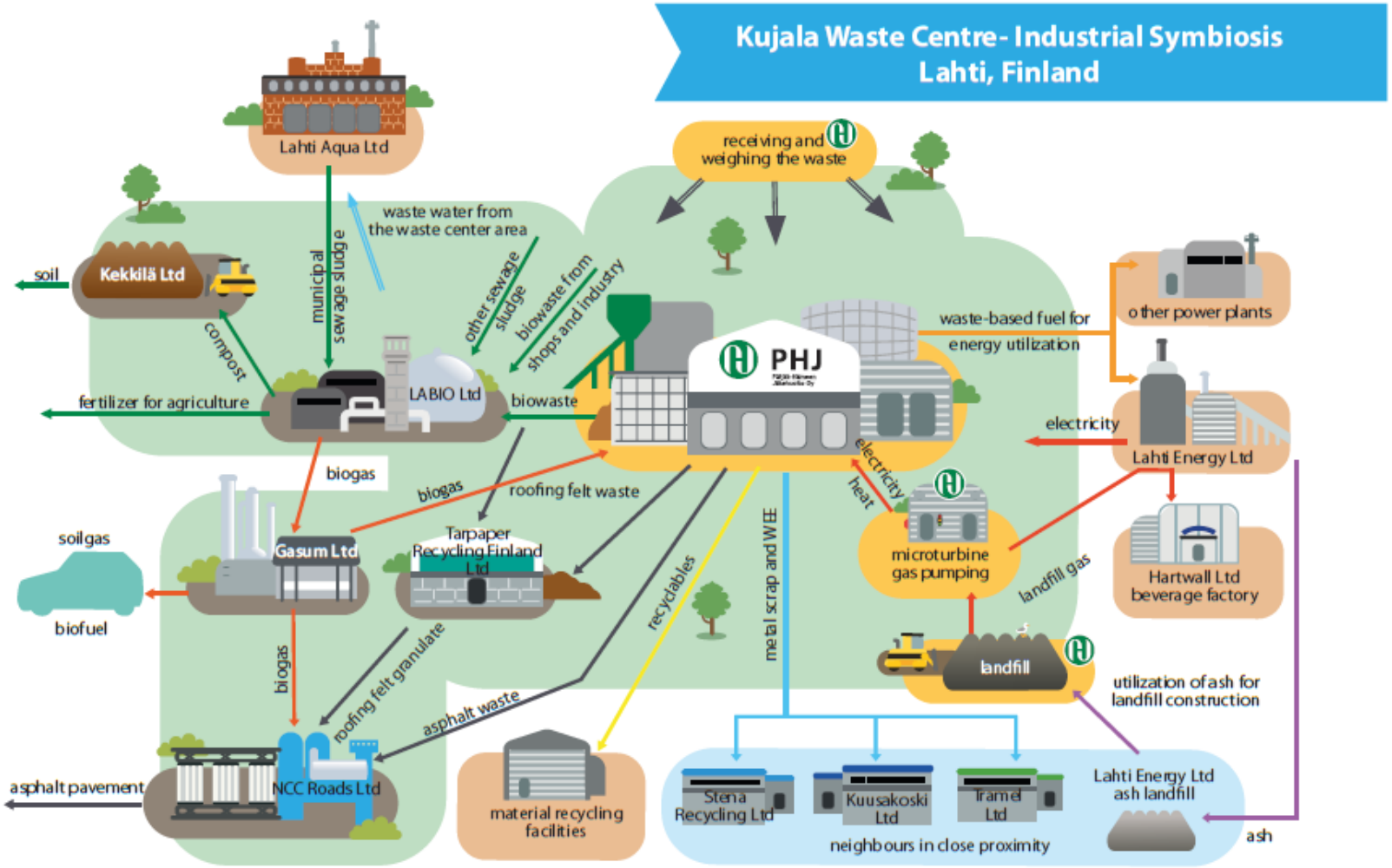
Symbiotic industrial parks: The Kalundborg example



- Industrial park in Denmark, established since 1972
- 30 different material, water and energy streams between 13 different companies and a range of farms and municipal institutions
- Collaboration and its environmental implications arose unintentionally through private initiatives

Image source: Kalundborg Symbiosis, http://www.symbiosis.dk/en/

Symbiotic industrial parks:
The Kujala Waste Centre example, Finland



- Treatment of municipal and industrial waste from a population of about 200,000
- Cooperation with 5 industrial plants on the site
- Waste Management is striving to achieve a 50% recycling rate by processing waste into raw materials for industry and by minimising the amount of waste incinerated or taken to landfill

Kujala Waste Centre Flow-Chart. Designed by Anna Polkutie, Esa Ekholm and Hanna Bergman, supported by Lahti region Development (LADEC).
Source: Päijät-Häme Waste Management, 2017, available at: https://www.phj.fi/wp-content/uploads/2019/01/Kujala-waste-symbiosis-2018.pdf

Industrial symbiosis in facilitated networks: The NISP® example, England

Department for Environment Food & Rural Affairs

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- Partnership between UK national government (Department for Environment, Food and Rural Affairs - Defra) and International Synergies Limited
- the world's first facilitated national industrial symbiosis programme
- Operated between 2005 and 2013
- More than 15,000 companies involved
- Numerous awards received
- Replicated in more than 20 other countries

NISP® methodology

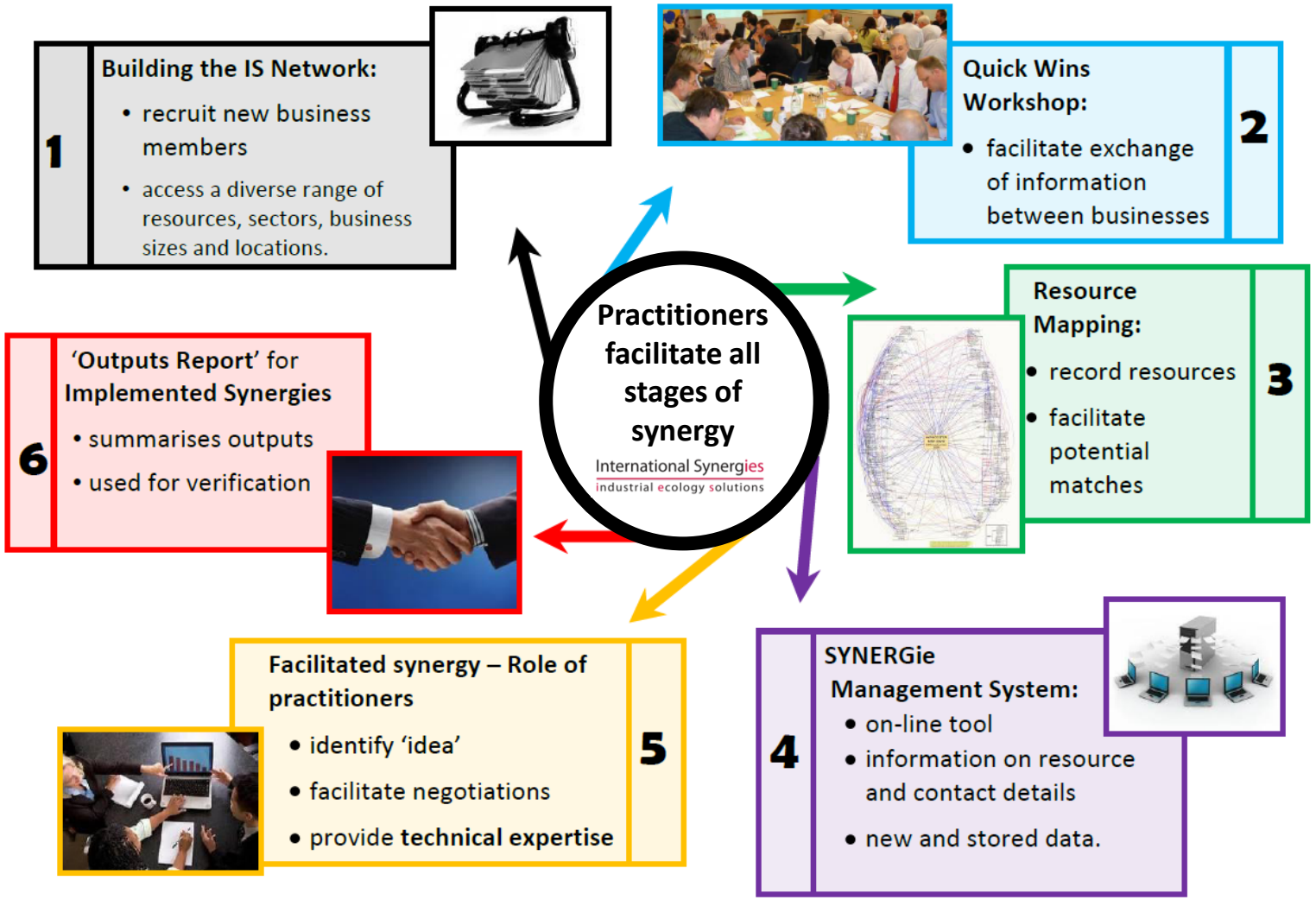

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Image source and ©: Industrial Synergies Ltd. 2019

- Facilitating the exchange of information and best practice between businesses
- Workshops can generate 300+ potential synergies from a facilitated ½ day session
- On-line project and data management tool

NISP® success factors

Data:

- Quality NISP data & limited access to regulatory data

Practitioners:

- Industrial expertise
- Long term relationship building & facilitation
- Marrying data & expert knowledge
- Working with the regulator and technology providers to 'enable' IS activity

Engagement Model:

- Extensive, diverse network
- Business opportunity programme
- History of exemplary performance
- Demand pull on innovation

Source: Laybourn, P. (2012): Industrial Symbiosis: Positive Action for Green Growth, presentation at Circular Economy Conference, Horsens, Denmark, 29th November 2012 (adapted). Presentation available at: https://slideplayer.com/slide/3549386/

Example from the NISP® programme (1)

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Terra Nitrogen:

- Industry produces derivatives of nitrogen and methanol
- Waste: 12,500 tonnes of CO2 released to atmosphere, hot steam and ammonia.

CO2

Waste heat

John Baarda:

- Tomato producer
- Additional production capacity limited due to high costs of energy

Partnership:

- Elimination of CO_2 emissions
- Construction of a greenhouse with a capacity of 300,000 tomato plants
- Investment of £15M
- Creation of 65 new jobs
- Recovery of heat from steam

Example from the NISP® programme (2)

DENSO

- Manufacturer of air conditioning units and engine cooling systems for cars
- Waste: 15 tonnes of potassium aluminium fluoride, a hazardous waste product
- Disposal costs: £30,000 a year

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milvermetals

- Aluminium producer
- Interest in reduction of procurement costs

Potassium aluminium fluoride
Hazardous waste

Reprocessing

Rotary furnace melting technology

Aluminium ingots
Car wheel production

http://www.designingourtomorrow.com/business/EX_waste/

NISP® delivered outcomes 2005 - 20013

METRICS	In Year Benefits	Lifetime Impact (Max 5 year)
Landfill diversion	9.4 million tonnes	47 million tonnes
CO2 reduction	8.4 million tonnes	42 million tonnes
Virgin material savings	12 million tonnes	60 million tonnes
Hazardous waste eliminated	0.4 million tonnes	2.1 million tonnes
Water savings	15 million tonnes	72 million tonnes
Cost savings	€ 243 million	€ 1.21 billion
Additional sales	€ 234 million	€ 1.17 billion
Jobs		10,000 +
Private investment		€ 374 million

- Government income vs. government investment ratio: 8.9 : 1
- Total Economic Value Added vs. government investment ratio: in excess of 32 : 1

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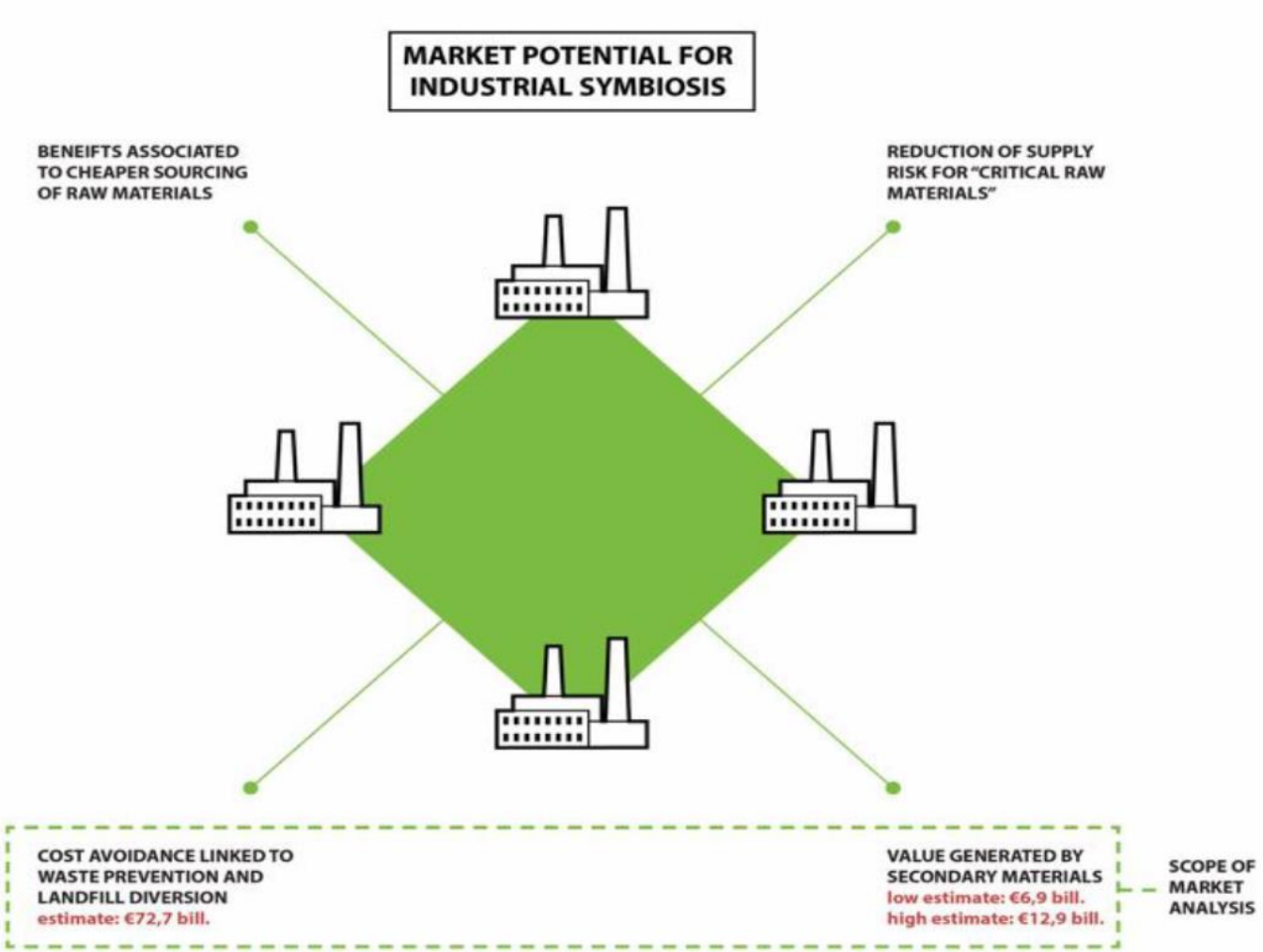
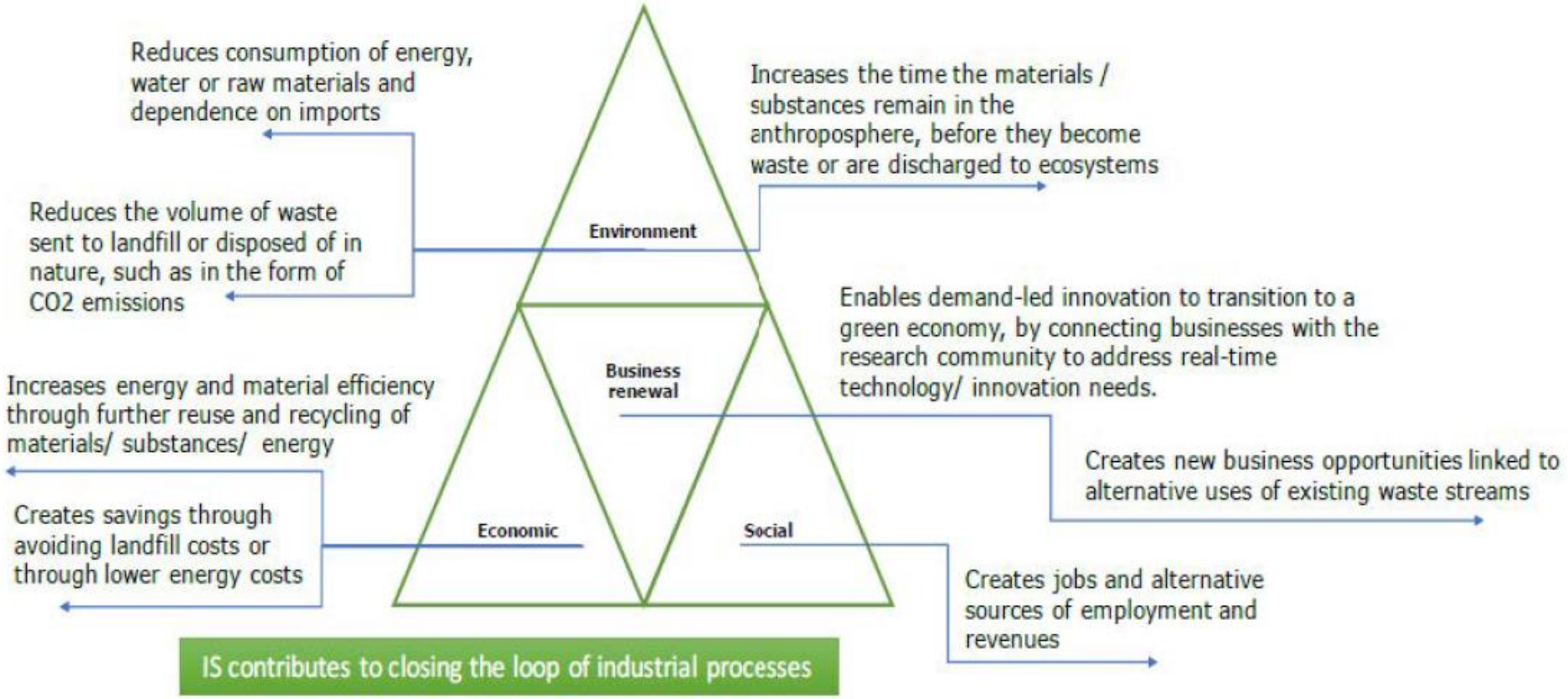
Industrial Symbiosis – Economic opportunity for Europe



Source: Domenech, T. et al. (2018). Cooperation fostering industrial symbiosis market potential, good practice and policy actions. Final report. Luxembourg: Publications Office of the European Union, p. 81

- **Market potential: €73 billion** estimated across EU on cost reduction alone
- Public sector supported **facilitated industrial symbiosis is best model** to address market failures
- **No evidence of operative fully commercial facilitation** (of industrial symbiosis) in Europe
- Success of industrial symbiosis initiatives is largely dependent on the **policy environment**

Long-term environmental and social impact of industrial symbiosis



Source: CEN (European Committee for Standardization) (2018). Workshop Agreement CWA 17354:2018. Industrial Symbiosis: Core Elements and Implementation Approaches, p. 15

Barriers for implementation of industrial symbiosis

TYPE	ROLE PLAYED
Absence of trust and emotional barriers	The absence of trust inhibits communication between actors and willingness to cooperate.
Informational barriers	Companies may lack information about other companies' by-products and waste flow
Regulatory barriers	Regulatory obstacles to the exchange of by-products or the creation of alliance (e.g. anti trust law in US)
Economic barriers	Divergences in investment cycles or uncertainty of the benefits derived from IS exchanges
Technological barriers	IS exchanges may pose some technological challenges as transformations and adaptations of the by-products before exchange need to be undertaken. Dynamics of technological change.
Risk and uncertainty	IS exchanges may generate uncertainties regarding the outcome, performance or cost-benefit ratio. Increase inter-dependency and thus vulnerability to context changes.
Cultural barriers	Obstacles for the shift from competition to cooperation culture for companies. Conception of waste, as opposed to quality. Lack of environmental consciousness among companies; Resistance to change.

Source: Domenech, T. (2010). Social Aspects of Industrial Symbiosis Networks. PhD thesis, University College London, p. 90 (adapted).

Key factors for the emergence of IS networks

KEY FACTOR	ROLE PLAYED
Complementary activities	Industrial activities need to be complementary in their needs of resources
Suitable regulatory framework	A suitable pollution control regulatory framework may create the incentives for by-product exchanges
Trust	Trust among the involved partners reduces transaction costs, risk and uncertainty of IS exchanges and is key in the creation of collaborative structures
Reciprocity	Together with trust, reciprocity assures that cooperation is mutually beneficial for all the actors involved
Self-organisation/ bottom-up approach	The involvement of key stakeholders, and especially industries, in the process is essential for its further development.
Short mental distance	Short mental distance assures convergence of goals and visions and facilitates communication.
Spatial proximity	Transportation costs and other transaction costs are significantly reduced when companies are located in close geographical proximity. Distance may have a discouraging effect on the establishment of collaborative linkages.

Source: Domenech, T. (2010). Social Aspects of Industrial Symbiosis Networks. PhD thesis, University College London, p. 92 (adapted).

Standardization: The CEN Workshop Agreement CWA 17354 on industrial symbiosis

Why standardization?

- Consensus on the core elements of industrial symbiosis to enable its implementation
- Dissemination of good practice approaches to industrial symbiosis implementation across Europe and beyond
- Basis for policy, recommendations and implementation.

Effective adoption of industrial symbiosis as a mainstream approach by the public and private sector

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CWA 17354 (1): Core elements of industrial symbiosis

- Returning **underutilised resources** (often called waste) to productive use;
- Information about **opportunities** (e.g., data on other organisations' resources, or new technologies) is required to advance a synergy;
- **Business conditions** incentivising industrial symbiosis, which may be through market conditions or through policies and regulations.

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CWA 17354 (2): Drivers for industrial symbiosis

- **Economic impacts** delivered through mutually beneficial transactions that reduce cost or risk, generate revenue, or otherwise solve a business problem for the parties
- Industrial symbiosis as a form of **systemic eco-innovation** 'vital for future green growth'
- **Regional economic development** that draws on existing key industrial activity and resource streams can lower the carbon footprint of development, while strengthening local economies through improved material and energy security
- **Resource security:** Risks associated with critical resource supply may be managed in part through managing demand, and in part through resource recovery at end of life, increasing supply
- **Energy security and climate change mitigation:** by improving efficiency (of generation, distribution, and processes), and by decarbonisation

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CWA 17354 (3): Approaches to industrial symbiosis

- **Self-organised:** a bottom up approach resulting from direct interaction among industrial actors, without any external coordination, generally motivated by business concerns arising from context, including resource risk, pending legislation, and economic gains.
- **Facilitated:** where a third-party intermediary coordinates the activity, working with organisations to identify opportunities and bring them to fruition.
- **ICT-supported:** Market failure of information in relation to resource efficiency can be addressed through mechanisms that improve information flow between actors.
- **Strategic or planned:** a top-down approach where networks are formed following a central plan or strategic vision that includes attracting new businesses to regeneration sites or purpose-built developments.

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CWA 17354 (4): Industrial symbiosis implementation: good practice

Factors Enabling Good Practice:

- Facilitation; public sector investment; supportive policies, regulation and legislation; readiness for investment; ICT support; favourable market conditions; industrial diversity in a region; a diverse network engaging business across all sectors and sizes; a clear monitoring and evaluation framework; strategic targets and constraints

Actions Representing Good Practice:

- Fully **characterise** the resources available: think broadly about resources (including waste, by-products, residues, energy, water, logistics, capacity, expertise, equipment and materials); and reassessing waste for value as a resource.
- **Identify and assess opportunities** to return underutilised resources to productive use: statistically, most (not all) reuse opportunities are outside one's own sector, so employ cross-sector knowledge as required.
- **Match** the available resource with the appropriate opportunity, addressing technical, economic, and legal requirements. Intermediate transformation steps may also be required.

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Industrial symbiosis as a challenge for business management

Change of the inside perspective:

- Know about your potentials
  - Available resources
  - Resource processing capacity
  - Value of opportunities
- Bundle activities
  - Define responsibilities
  - Define procedures

Change of the outside perspective:

- Get ready for cooperation beyond sectoral limits
- Get ready to start co-opetition relationships
- Get access to external competence
  - Technological advice
  - Facilitators
  - Clusters and networks

How SHAREBOX supports symbiotic cooperation between industrial sites:

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Web-based:

- Universal access via Application Programming Interface (API)
- Can be integrated into different IT systems
- Available world-wide

Intelligent:

- Integration of diverse classification systems
- Software based classification tool
- Tools for technical and decision making support
- Learning system

Secure:

- User identification
- Anonymous handling of data until concrete start of negotiations on cooperation

Literature for further studies

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Authors of this presentation

SHAREBOX
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Chemie Cluster Bayern

- Ansgar Rudolph

Funded by the Horizon 2020 Framework Programme of the European Union

International Synergies
industrial ecology solutions

- Peter Laybourn
- Rachel Lombardi

SPIRE
Sustainable Process Industry through Resource and Energy Efficiency

www.spire2030.eu

Zurich University of Applied Sciences
zhaw
Life Sciences and Facility Management
Institute of Natural Resource Sciences

- Jürgen Ebert
- René Itten

The project: SHAREBOX

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www.sharebox-project.eu

Secure Management Platform for Sharing Process Resources

- Joint project funded by EU (Horizon 2020)
- 16 project partners from 8 countries
- EC funding (A): 5.416.544,75 €
- Private investment (B): 1.500.000 €
- Funding period: 2015-2019

Funded by the Horizon 2020 Framework Programme of the European Union

SPIRE
Sustainable Process Industry through Resource and Energy Efficiency

www.spire2030.eu