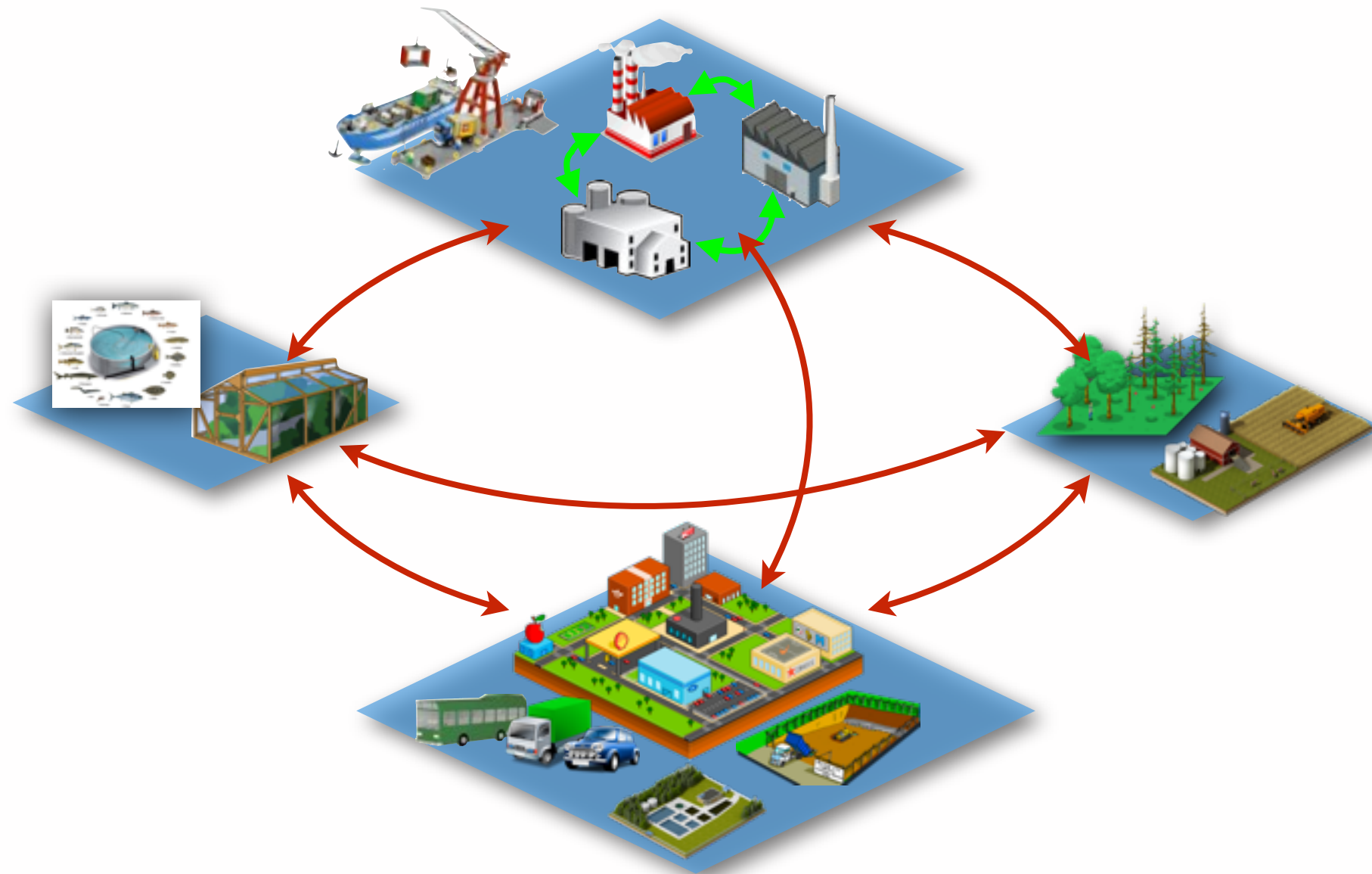


INDUSTRIAL SYMBIOSIS

Innovative Collaborations For Sustainable Businesses, Cities & Economies



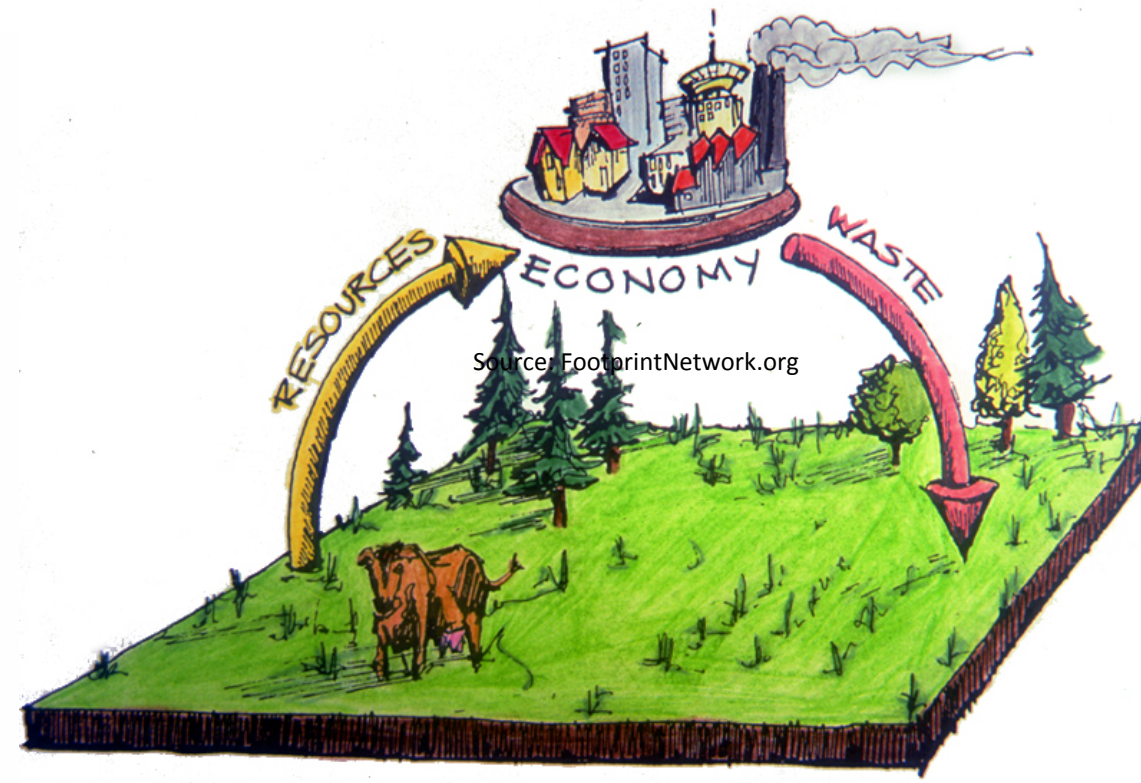
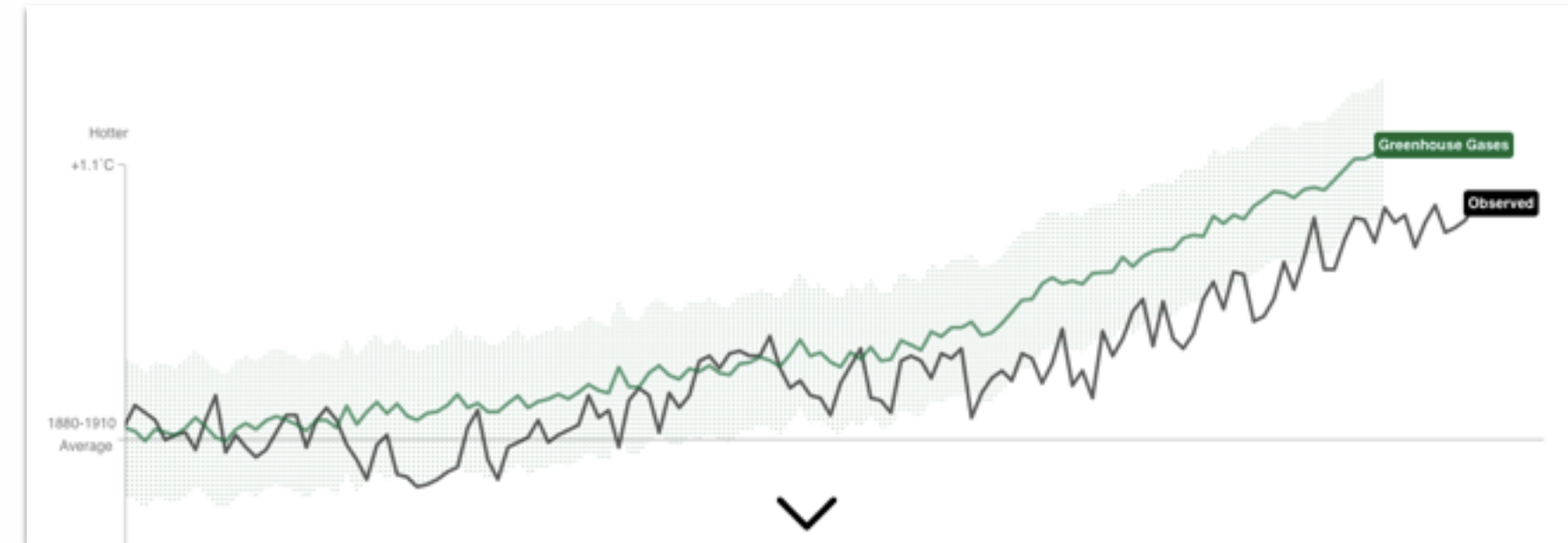
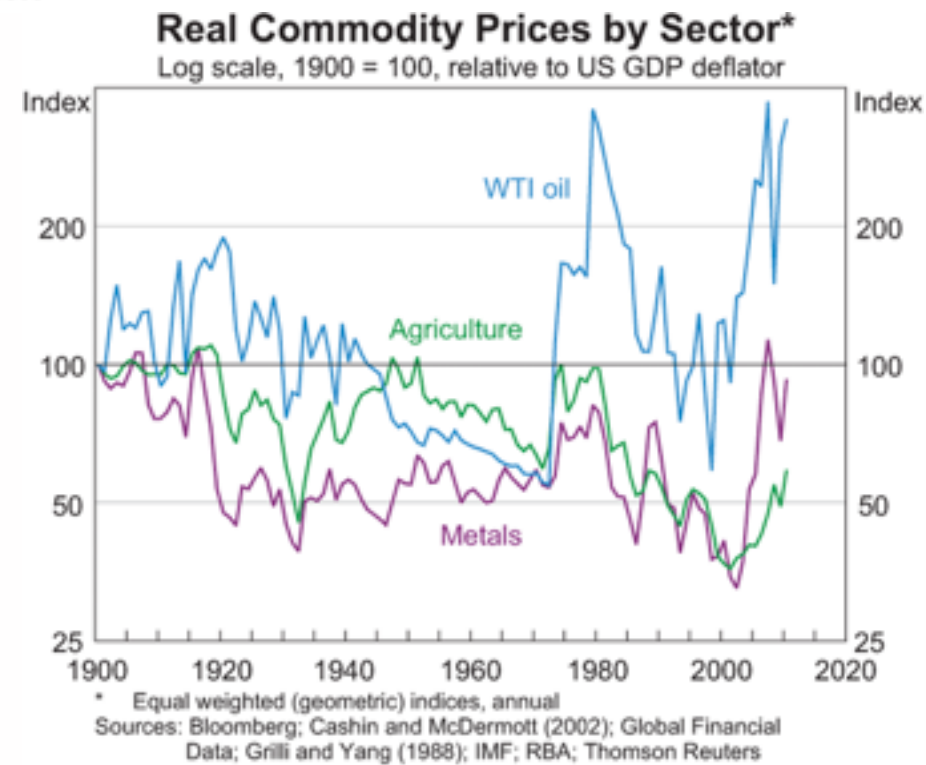
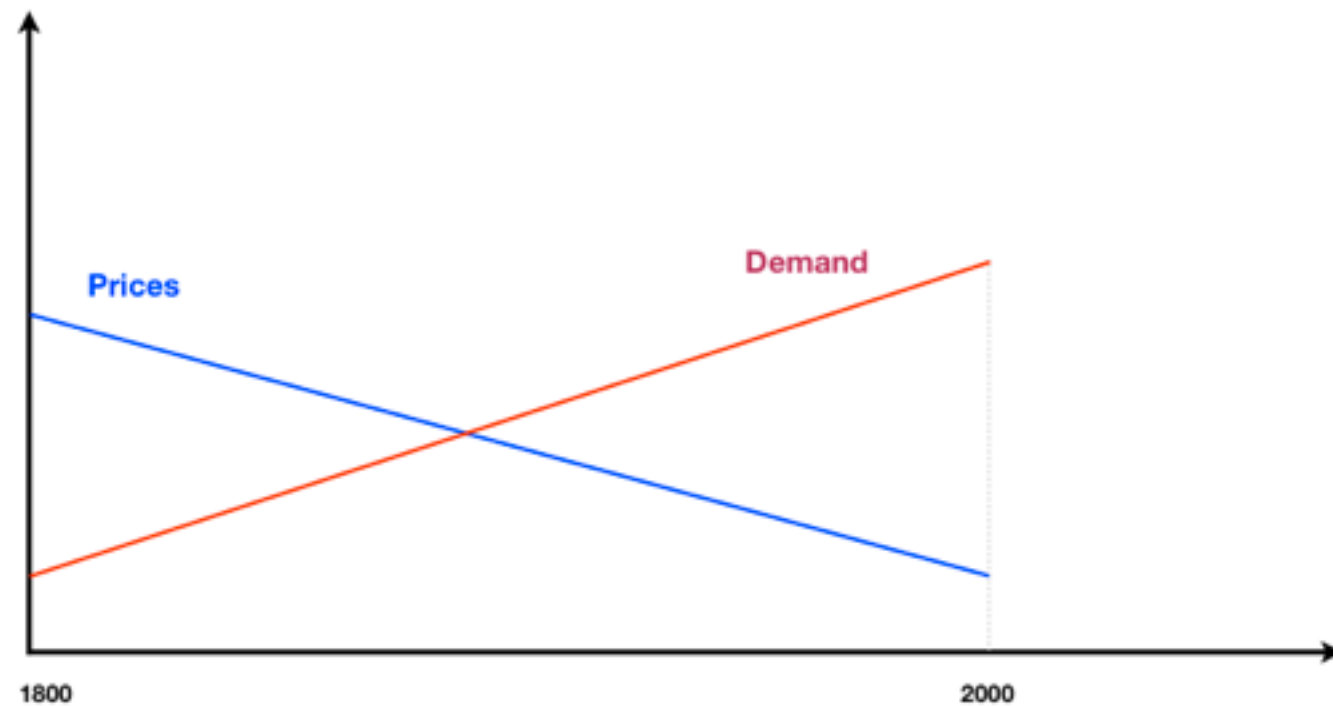
Murat Mirata

*Department of Management and
Engineering*

TRIS & CENSE Project Meeting

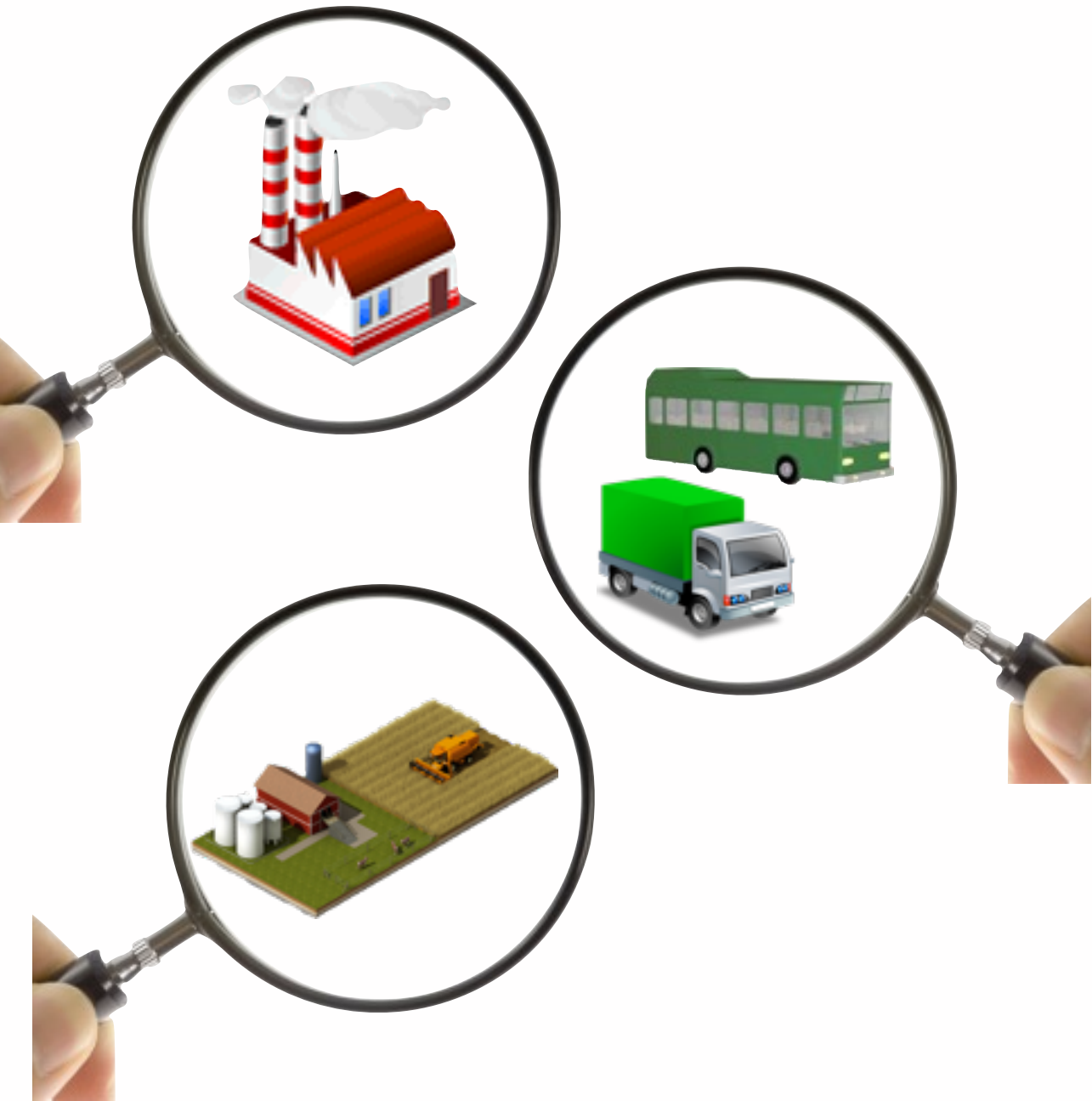
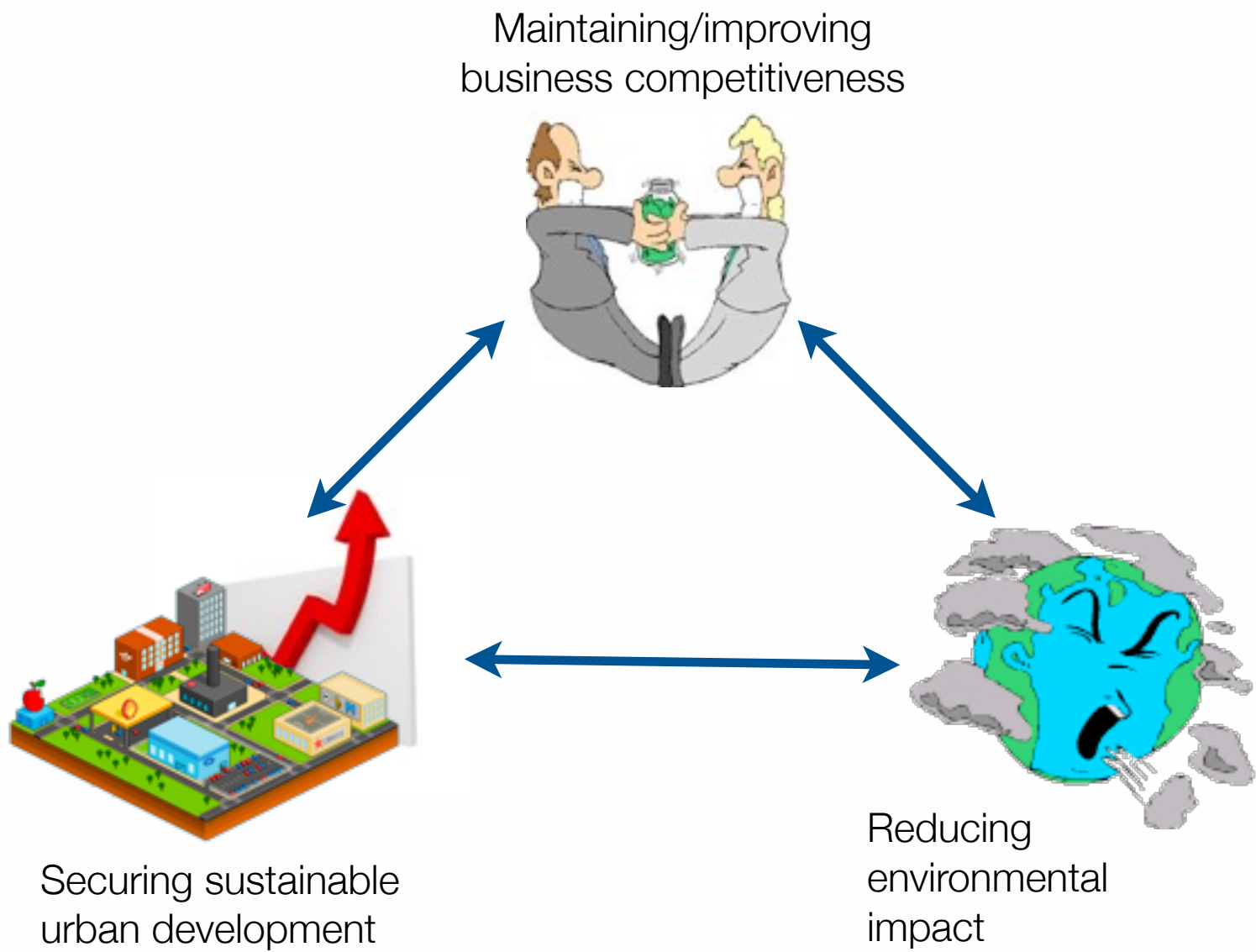
25 January 2017, Växjö

Why a resource revolution?



Source: Reserve Bank of Australia

Key societal challenges



Conventional way of dealing with these

Key societal challenges

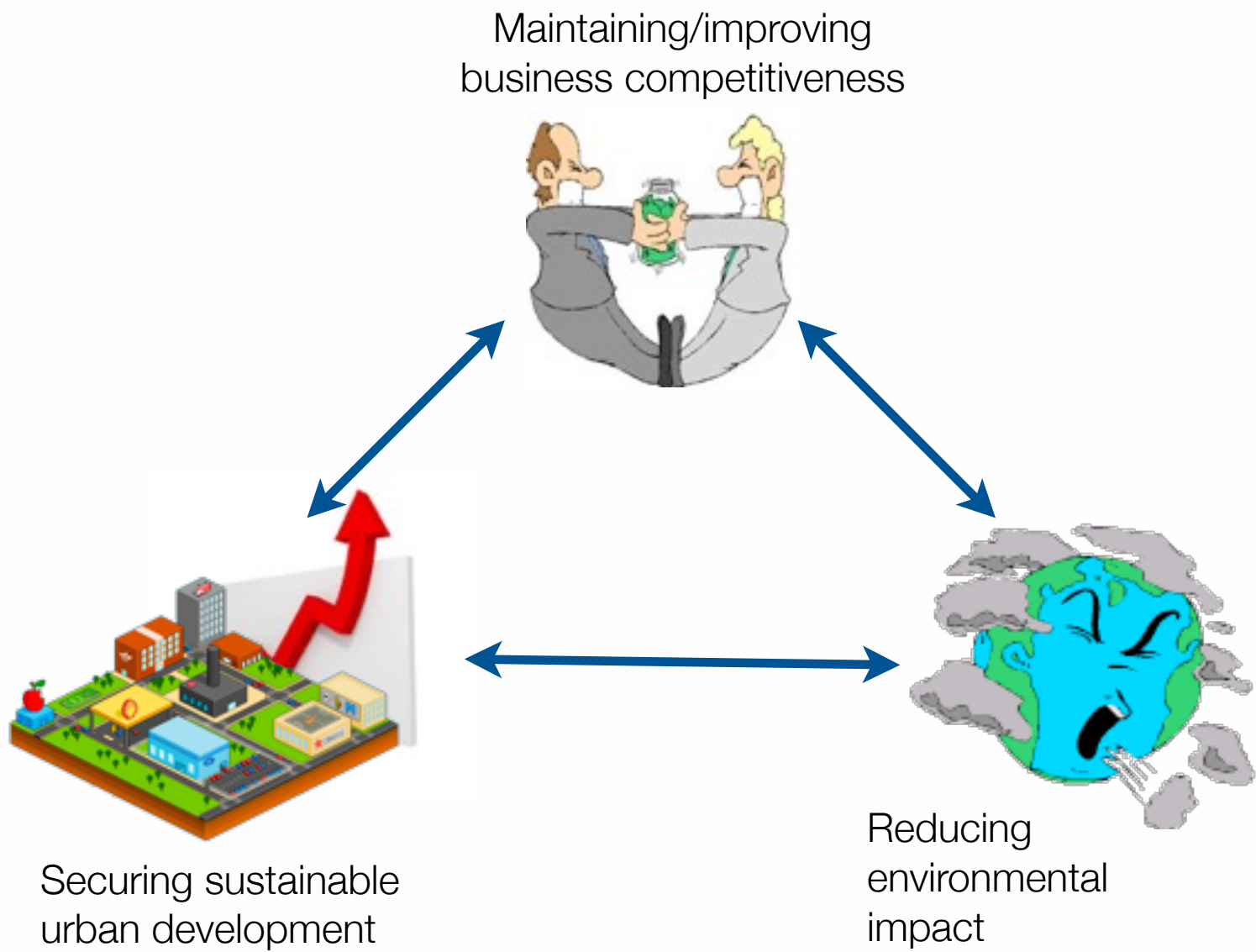
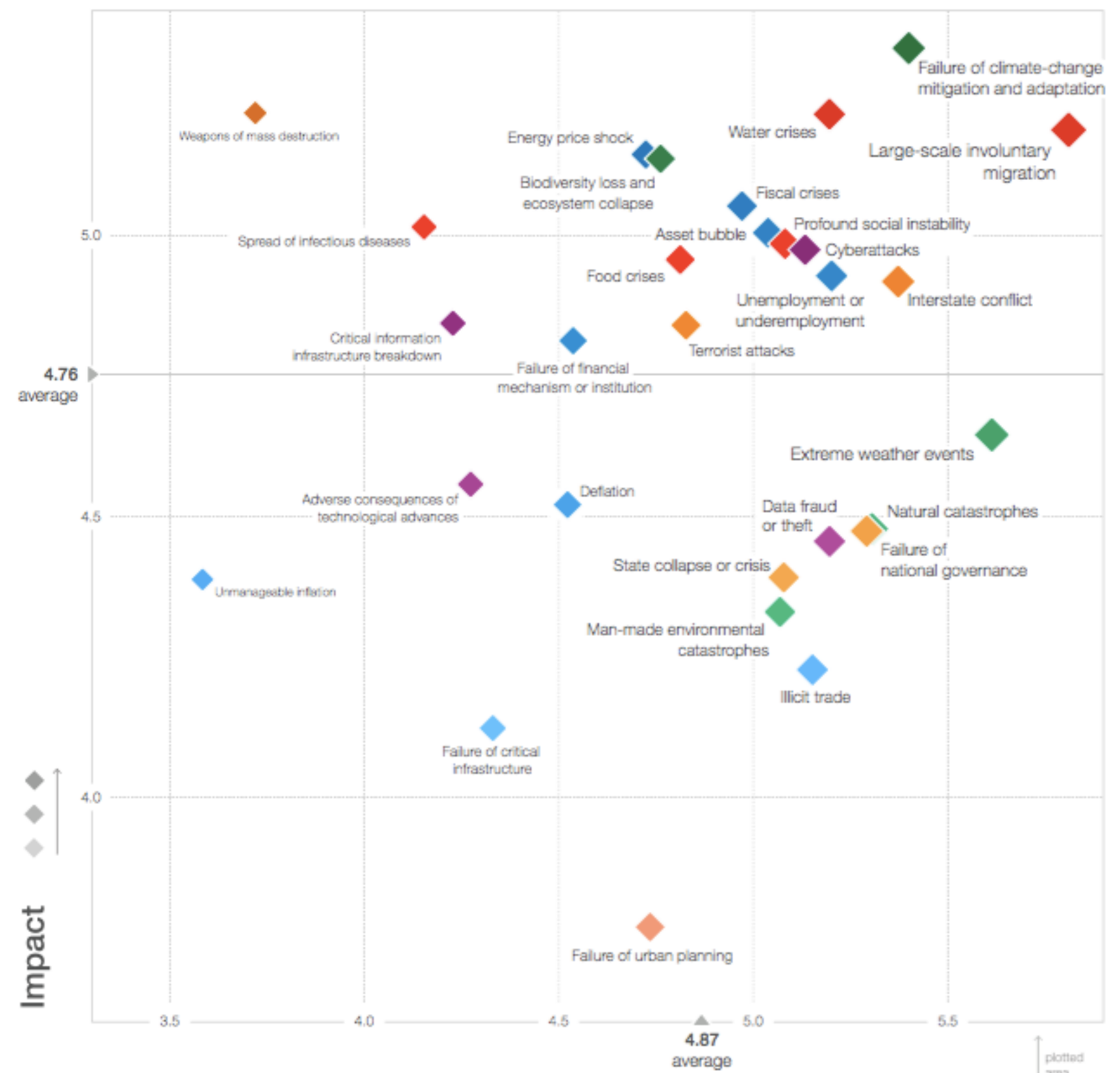


Figure 1: The Global Risks Landscape 2016



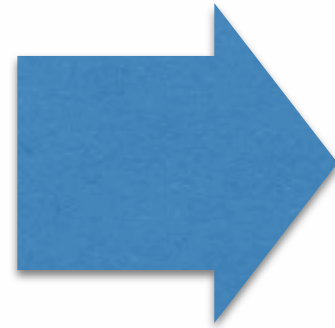
Why a resource revolution?

Global middle class:

1980 = 1.1 billion

2009 = 1.85 billion

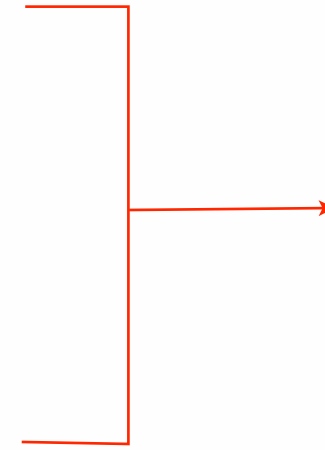
2030 → 4.8 billion



Factor 4

Factor 10

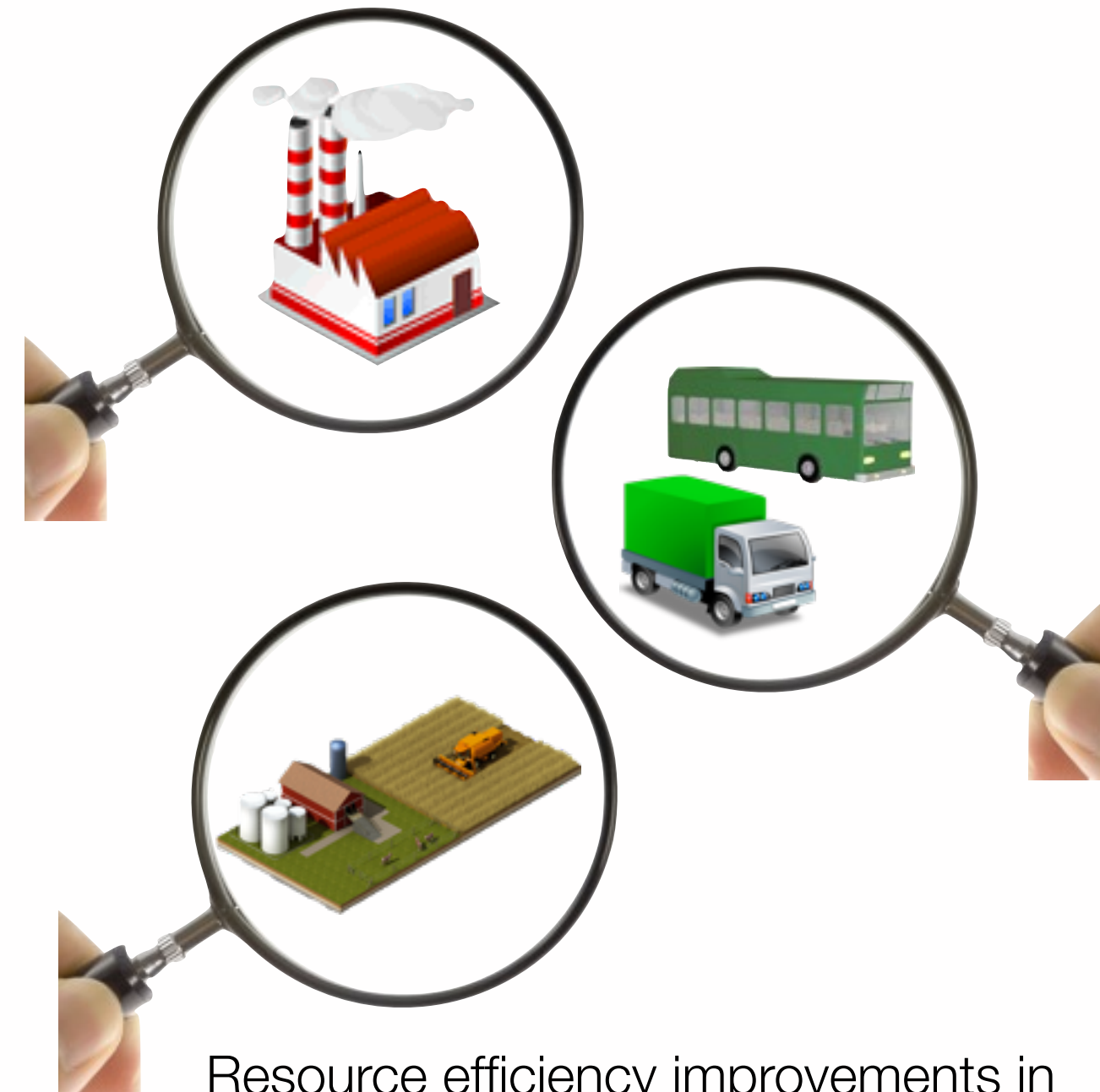
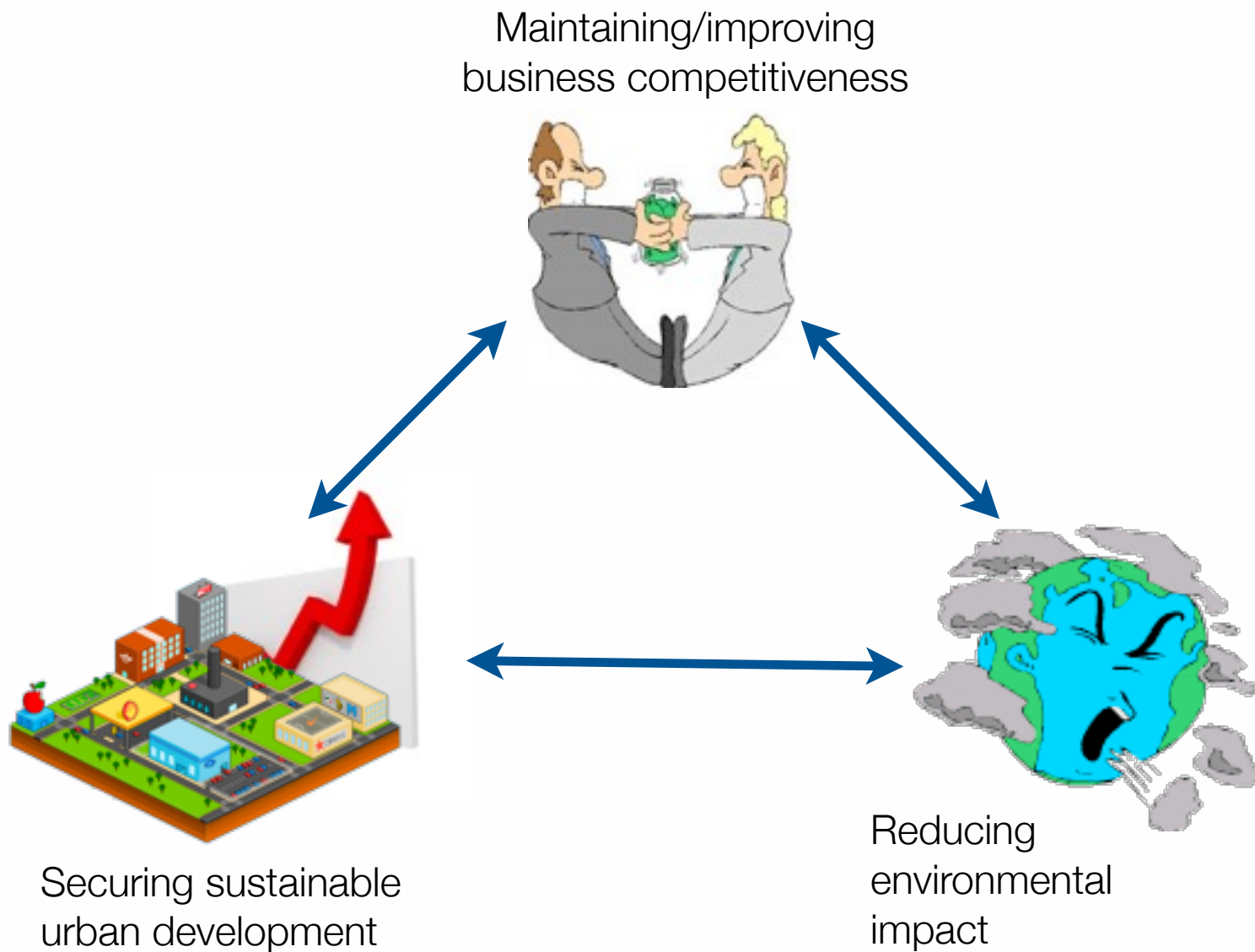
Factor 20



improvements
needed

McKinsey Global Institute, 2011

Key societal challenges



Resource efficiency improvements in mature industrial systems is **< 5%** per year

We need to think & act in new ways



An inspiring tomato

Equal or better quality &
economic performance



But superior environmental performance

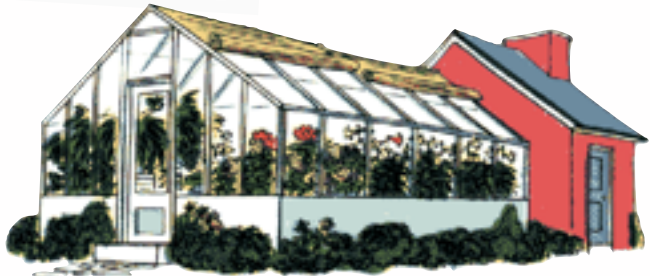
x 20 CO₂ reduction over Swedish average

x 50 CO₂ reduction over fossil-based production

Innovative collaborations



Pulp Mill



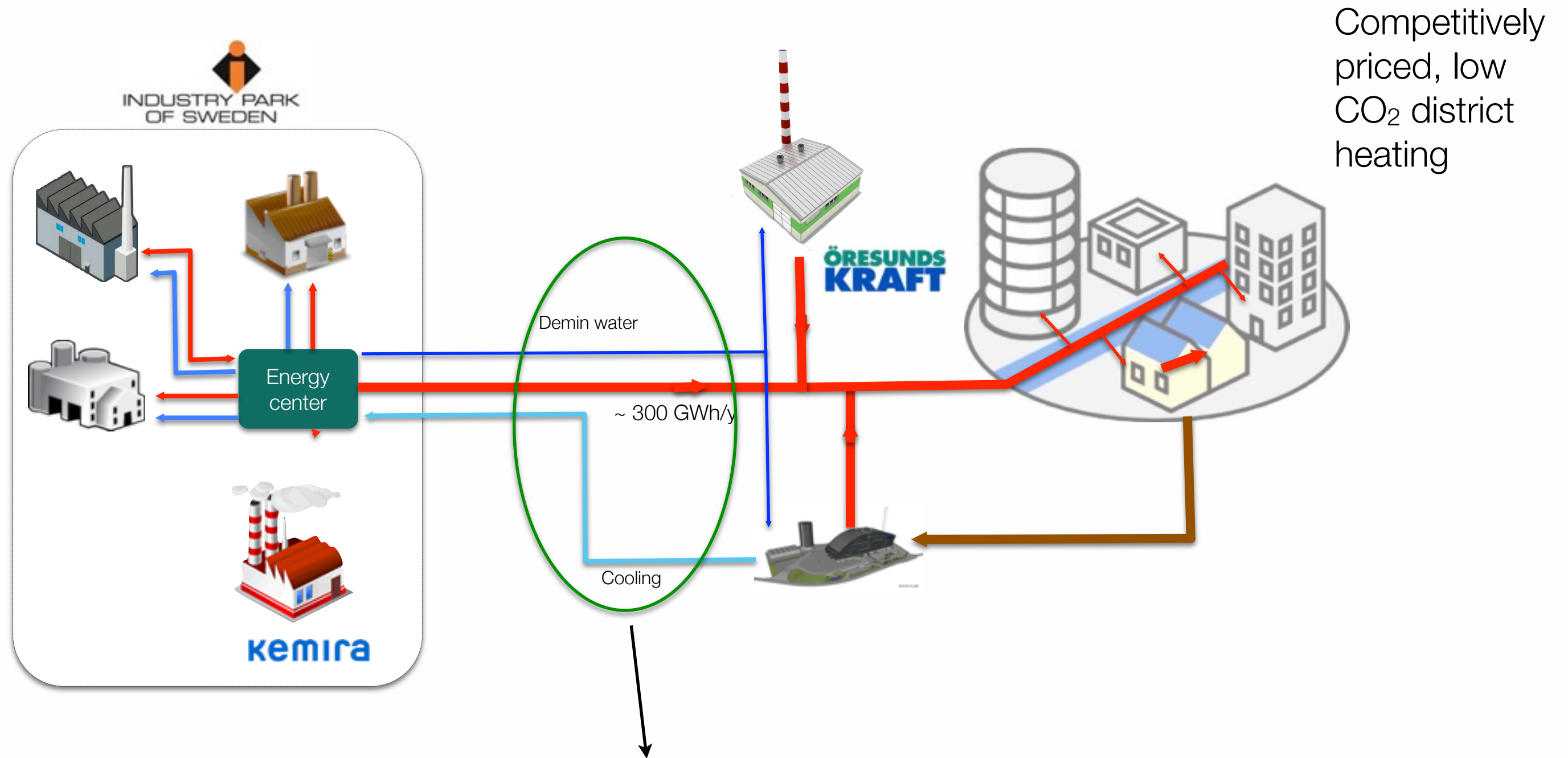
CO₂



Vodka/Ethanol Production

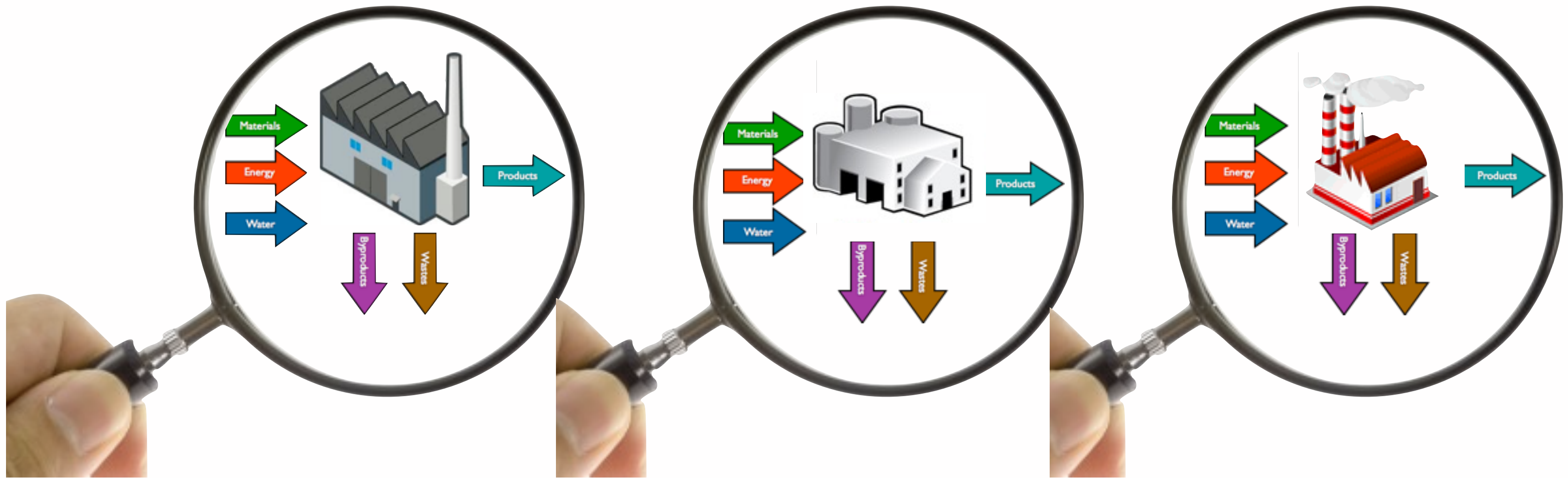
Heat

Industry park of Sweden, Helsingborg

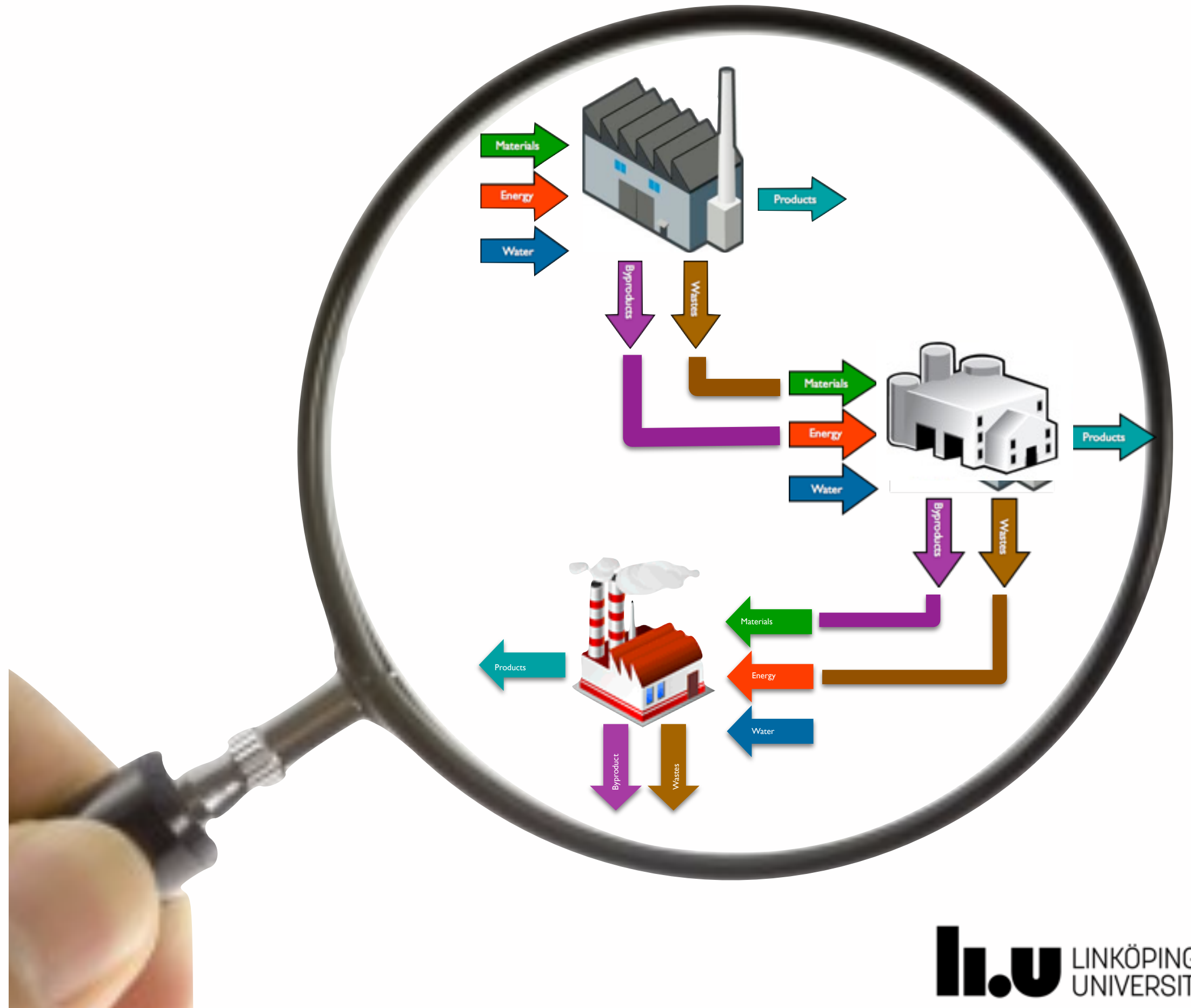


Double digit percentage of revenues

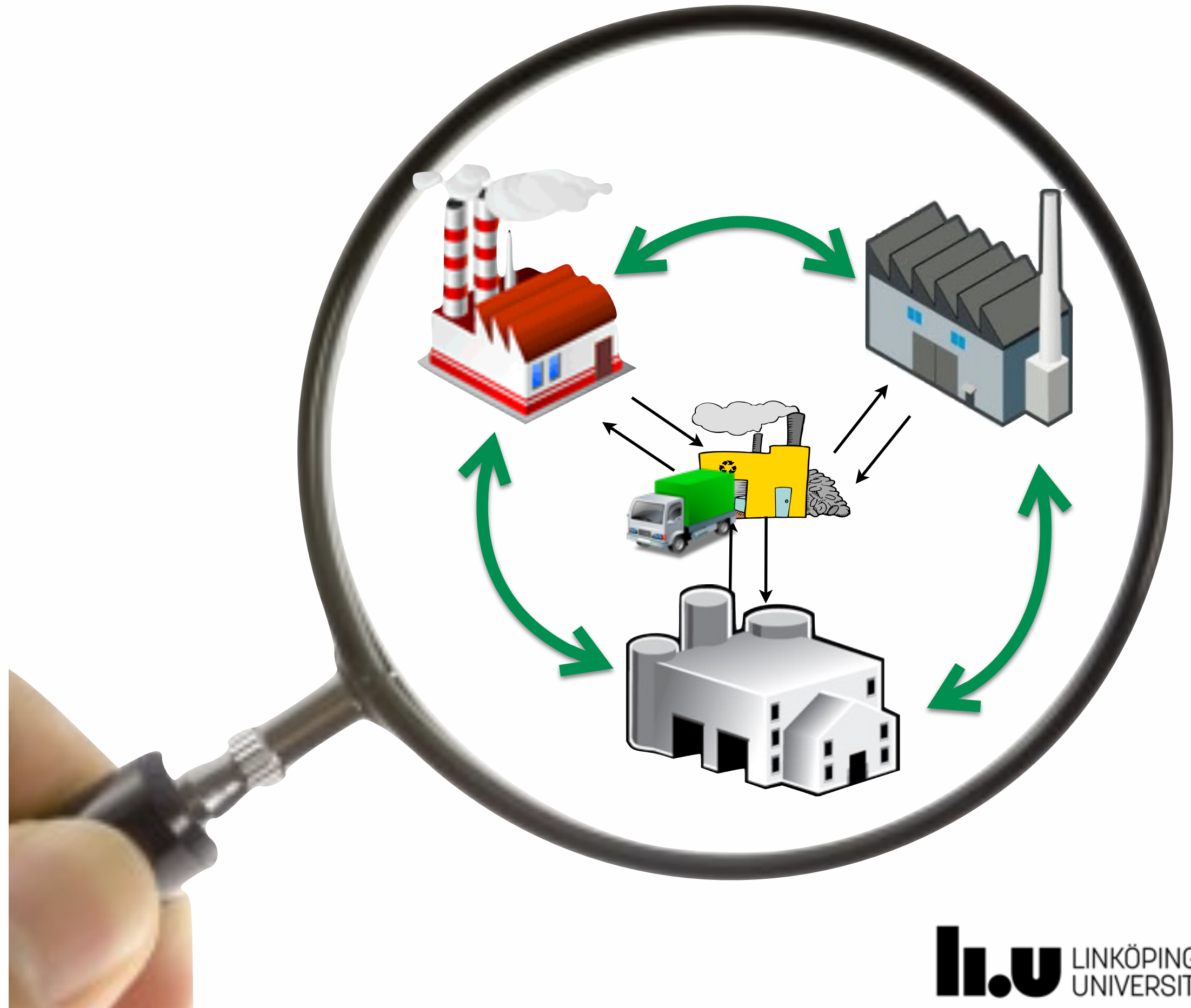
Industrial symbiosis



Industrial symbiosis



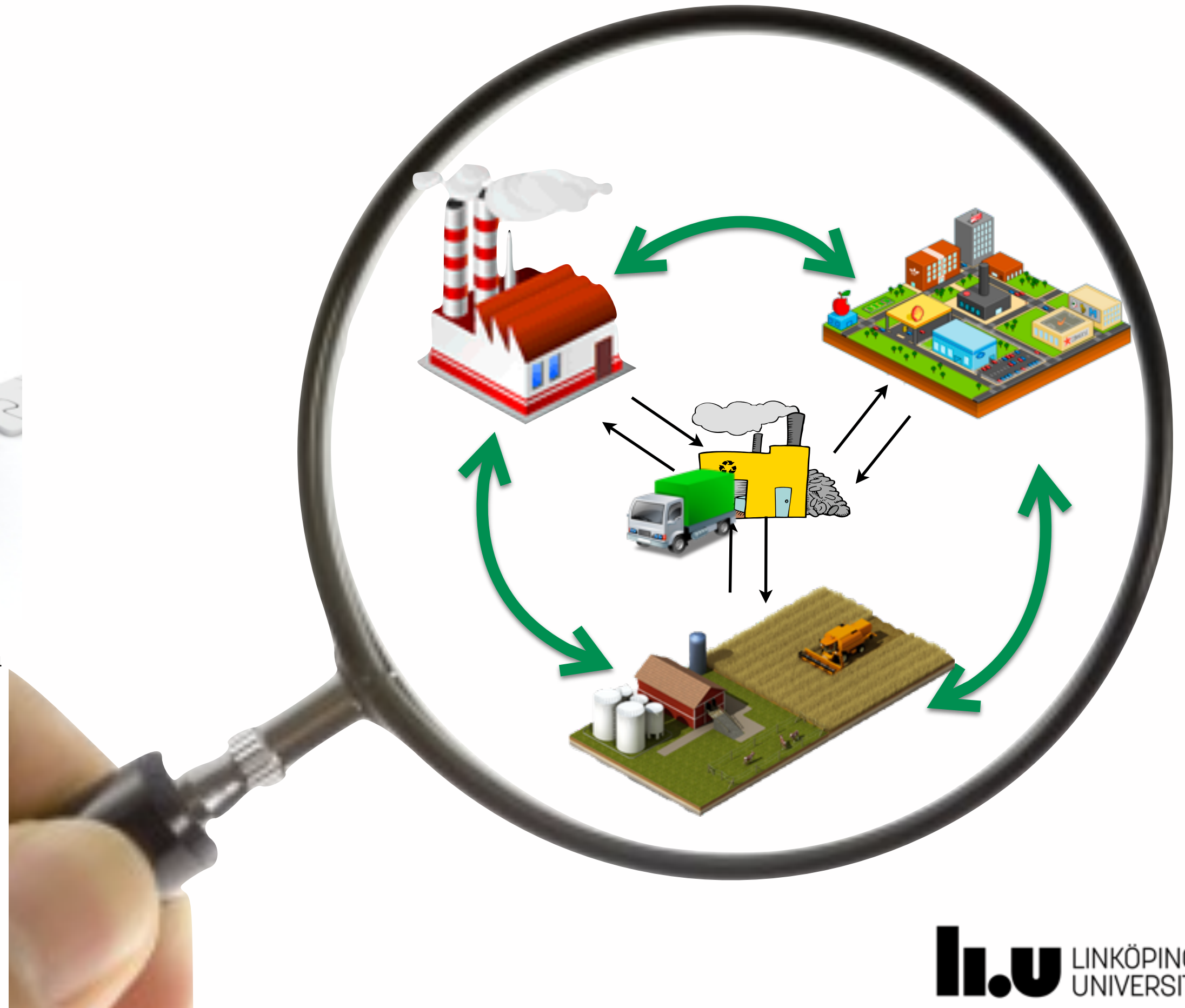
Industrial symbiosis



Industrial and urban symbiosis



Intellectual & organizational capita



Industrial and Urban Symbiosis

Collaborative processes for collective resource management where diverse actors jointly identify and develop solutions that create additional **economic**, **environmental** and **social** value, among others, by:

- turning under-utilised or wasted resources into productive inputs;
- developing more efficient and effective shared utility and service solutions;
- facilitating and enabling innovation.

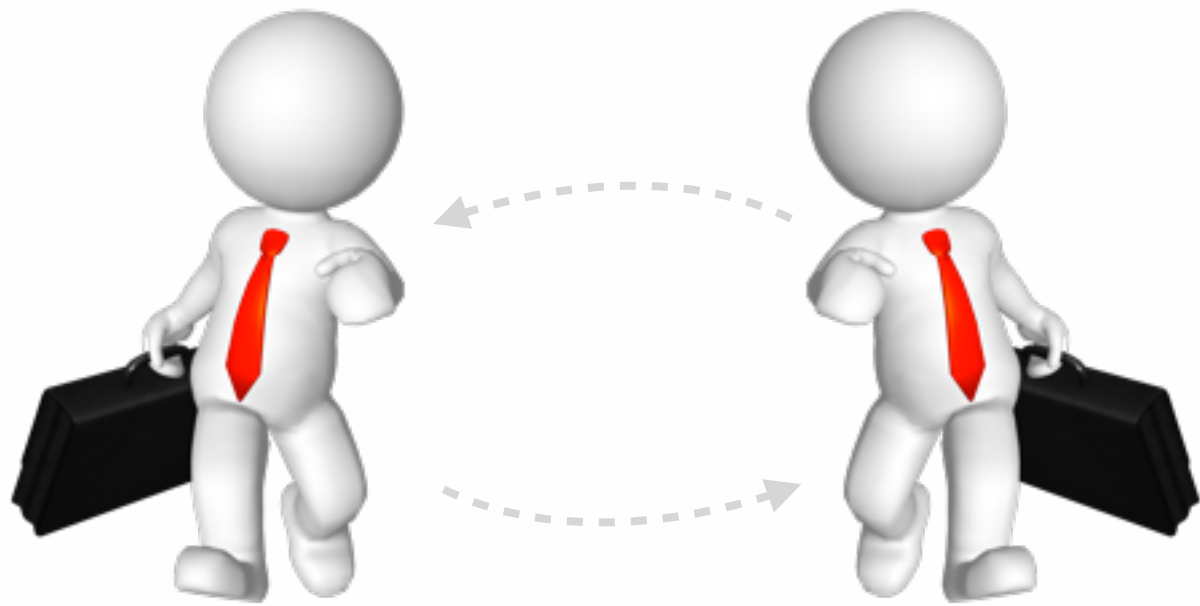
Resulting in

Business
competitiveness

environmental
performance

Local/regional
development

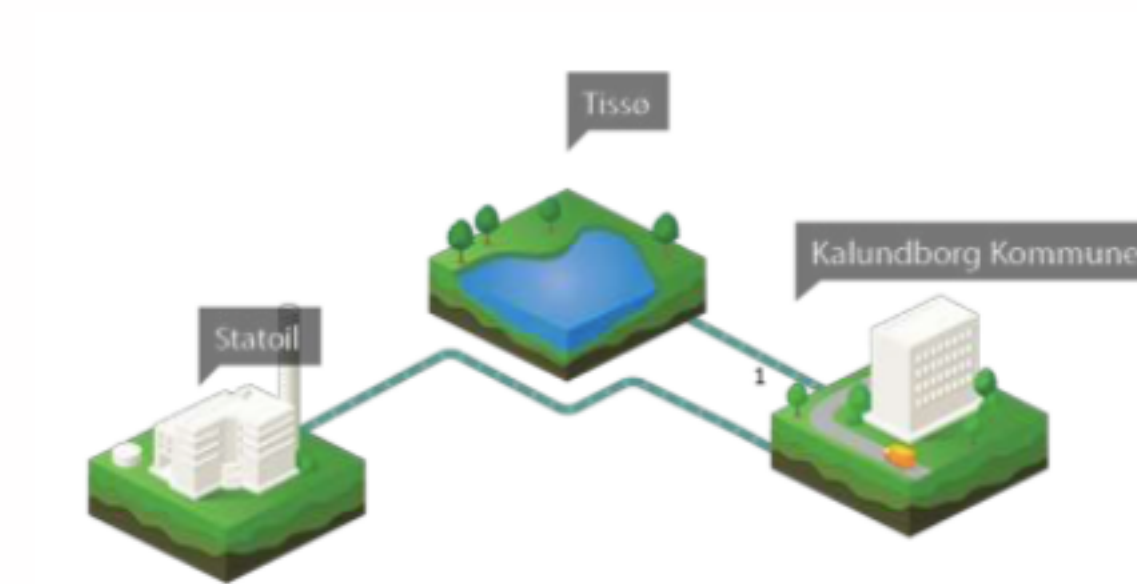
Nature of relationships



Kalundborg, Denmark

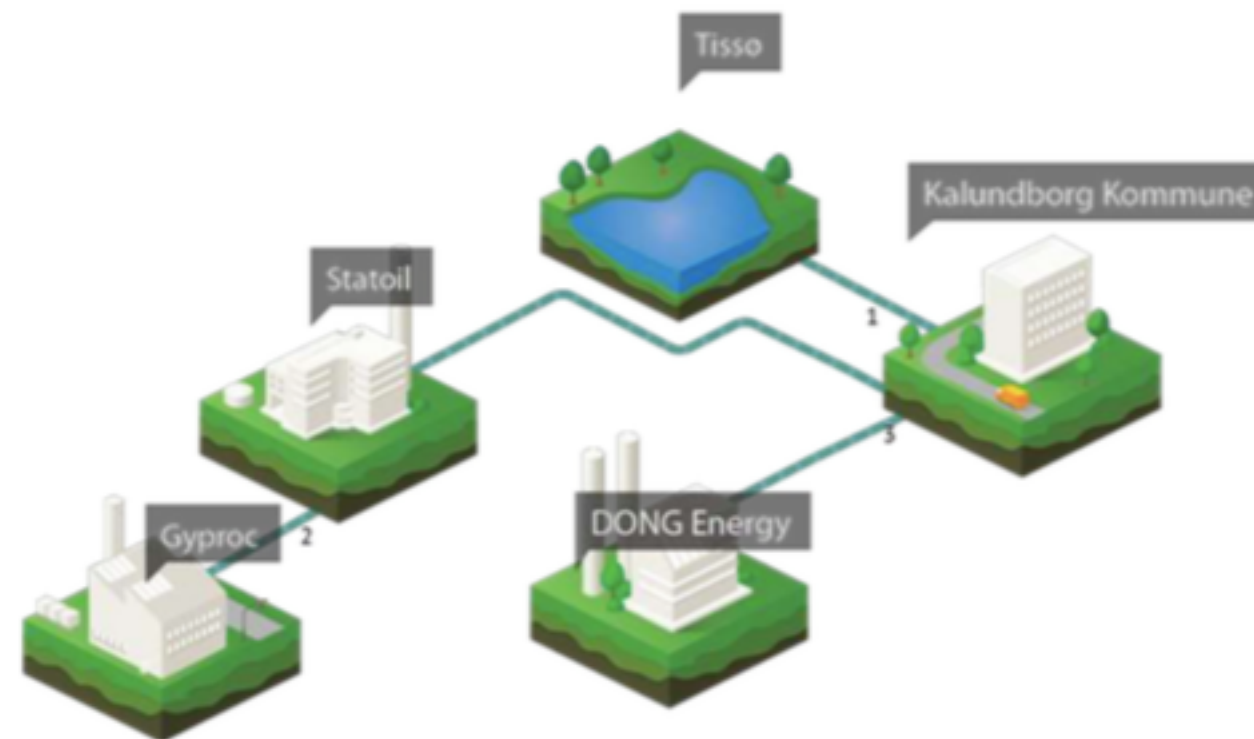


1961



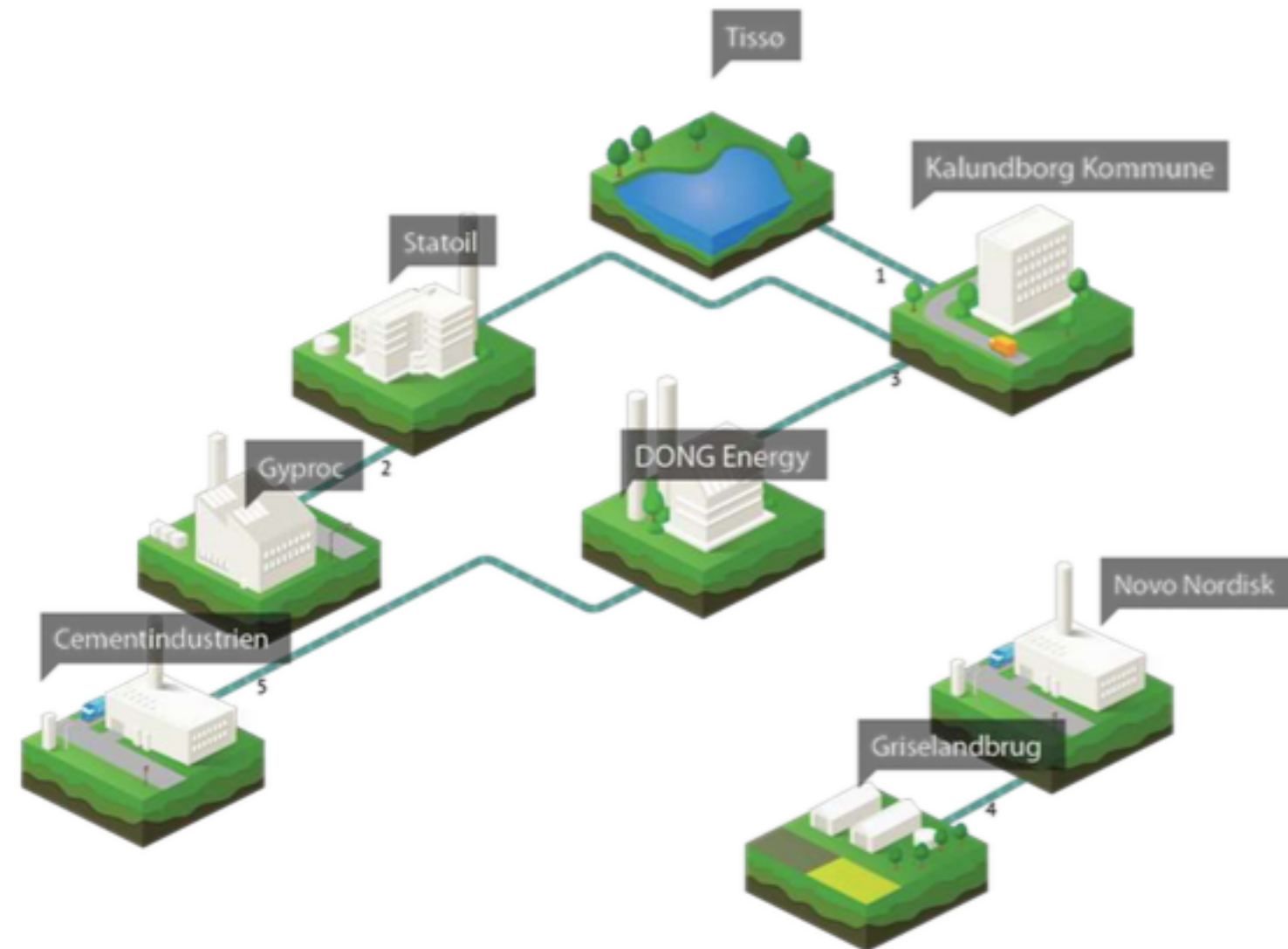
Graphic Source: Randers, 2014

1972



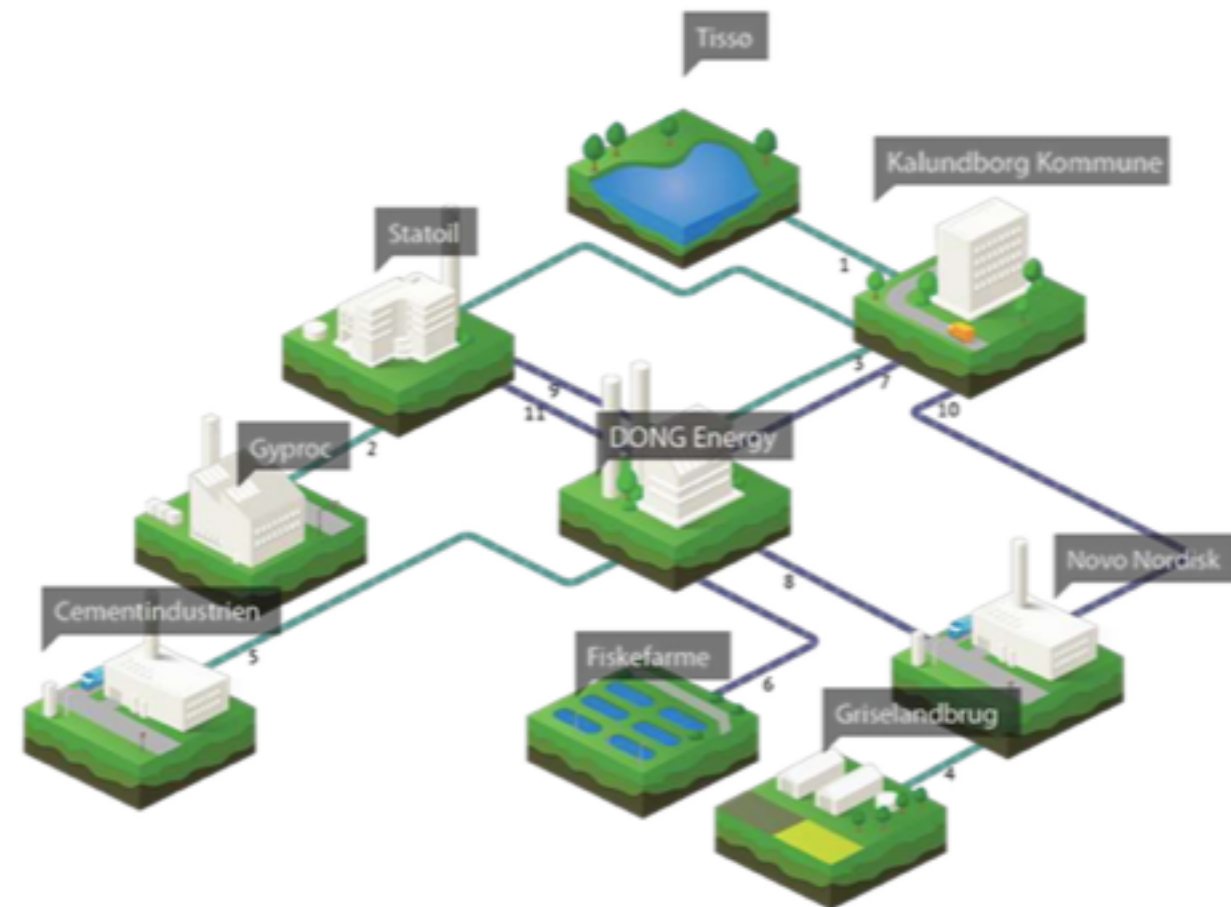
Graphic Source: Randers, 2014

1979



Graphic Source: Randers, 2014

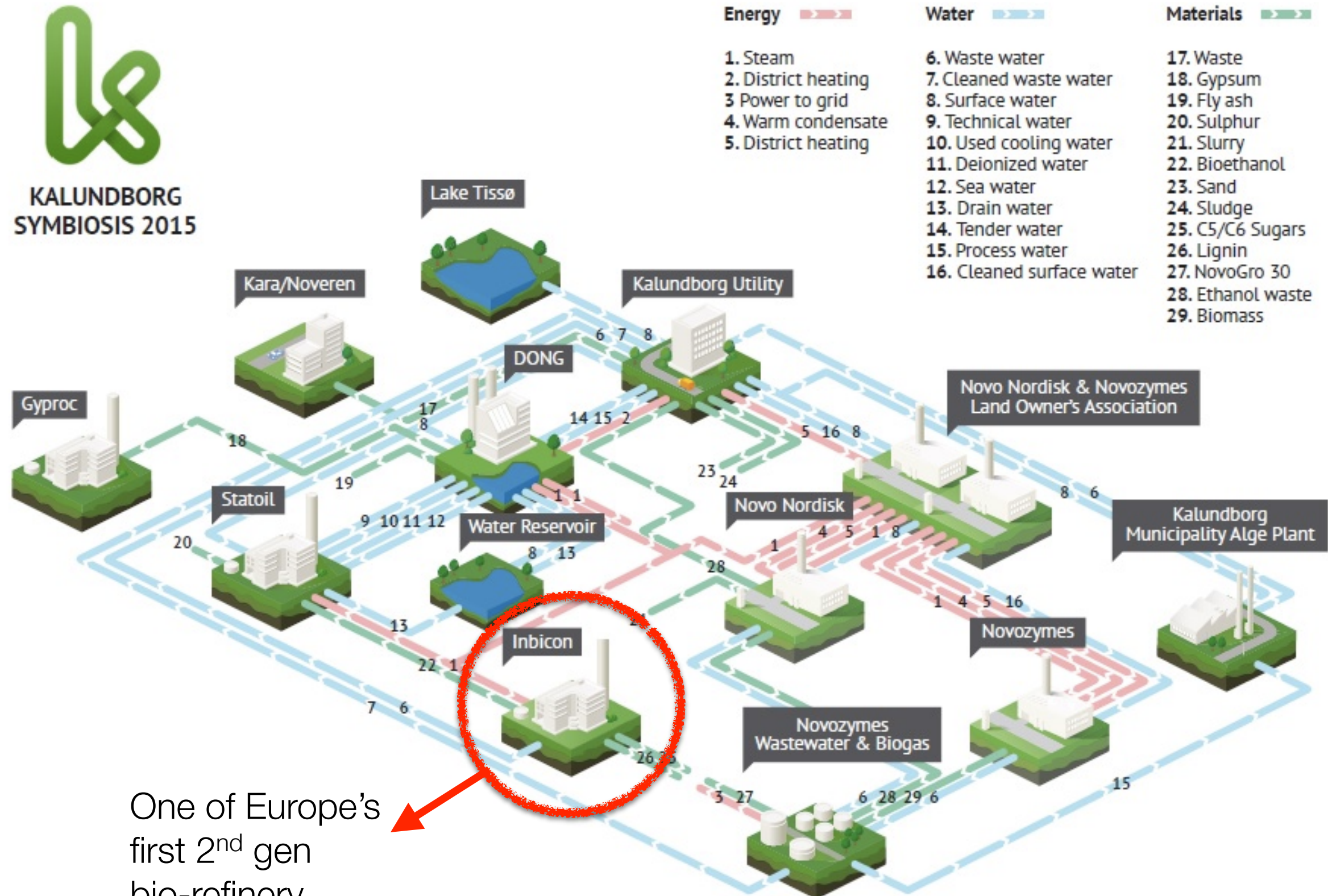
1980-89



Graphic Source: Randers, 2014



KALUNDBORG SYMBIOSIS 2015



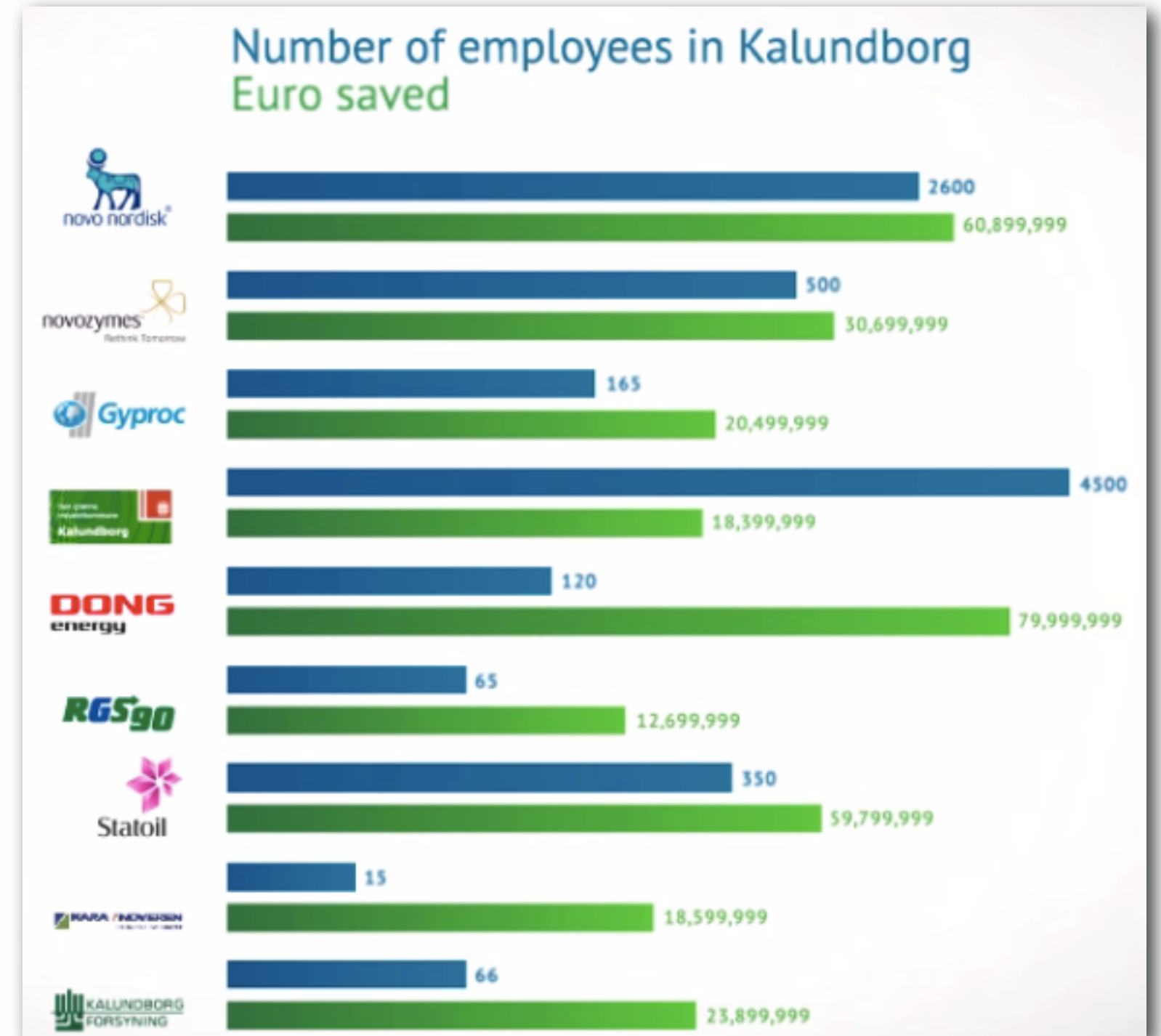
One of Europe's
first 2nd gen
bio-refinery

Gains

Environmental (annual)

- 2.1 M m³ water
- 30 000 ton of coal
- 19 000 ton fuel oil
- 80 000 ton bottom ash
- 200 000 ton Gypsum
- 200 000 ton of fly ash
- > 130 000 ton CO₂

Source: Curtin Uni., 2007.

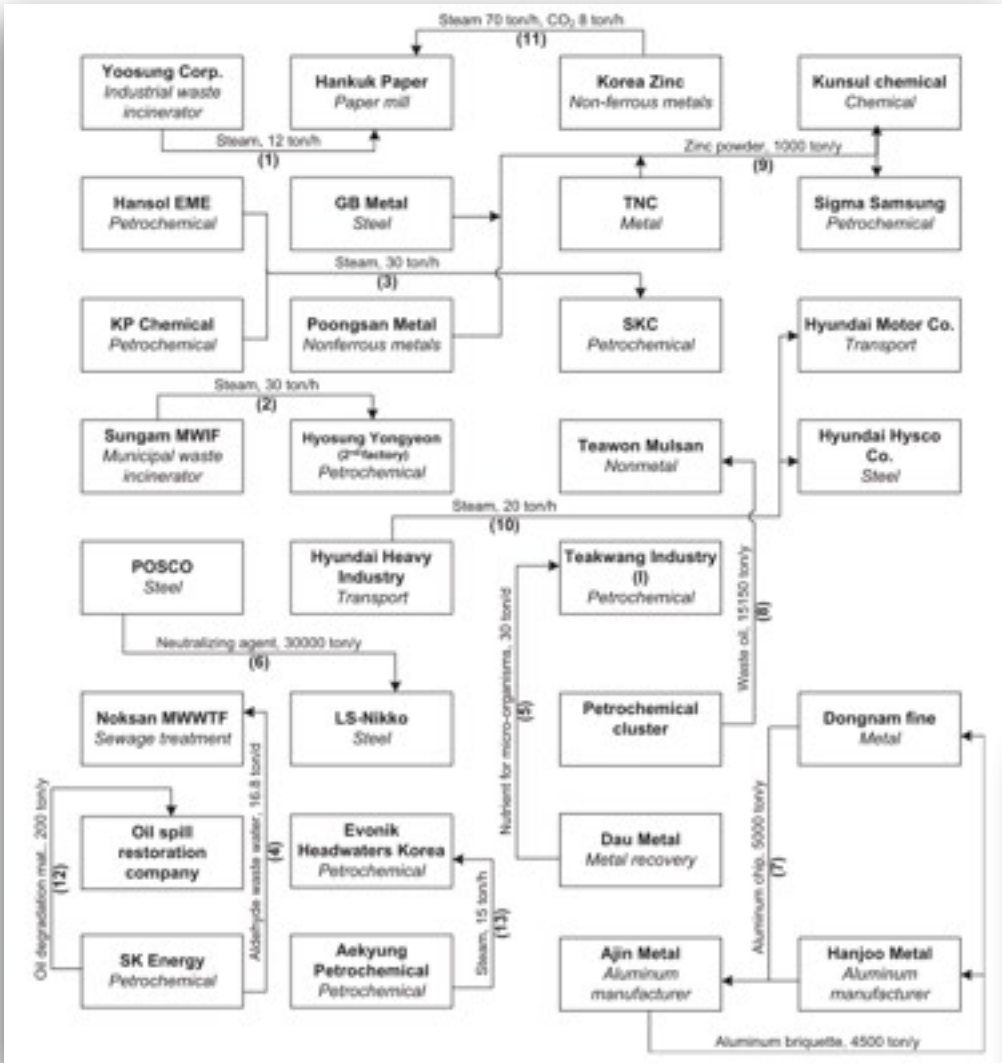


Source: Kalundborg.dk

Numerous uncovering & support programs



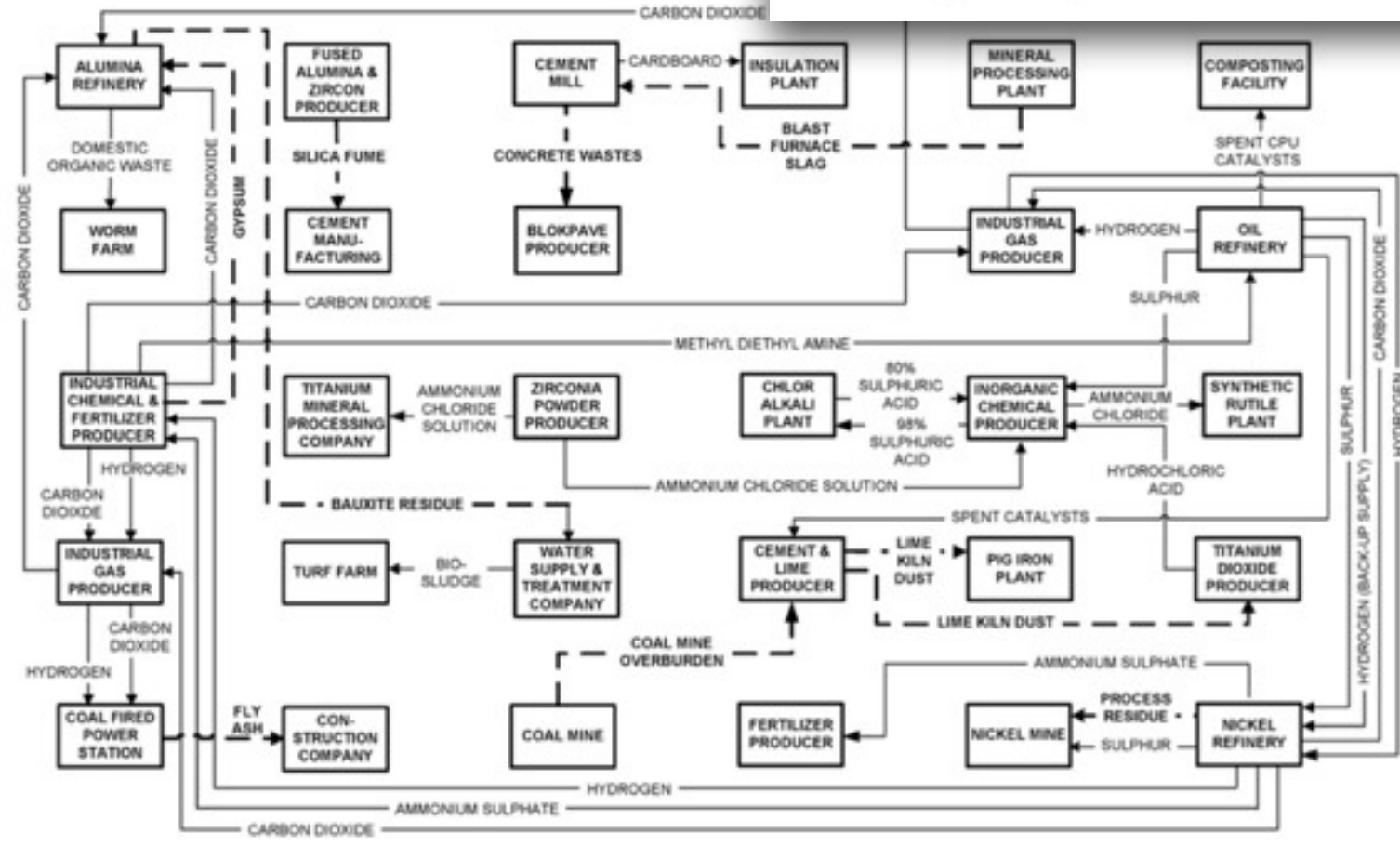
Ulsan, South Korea



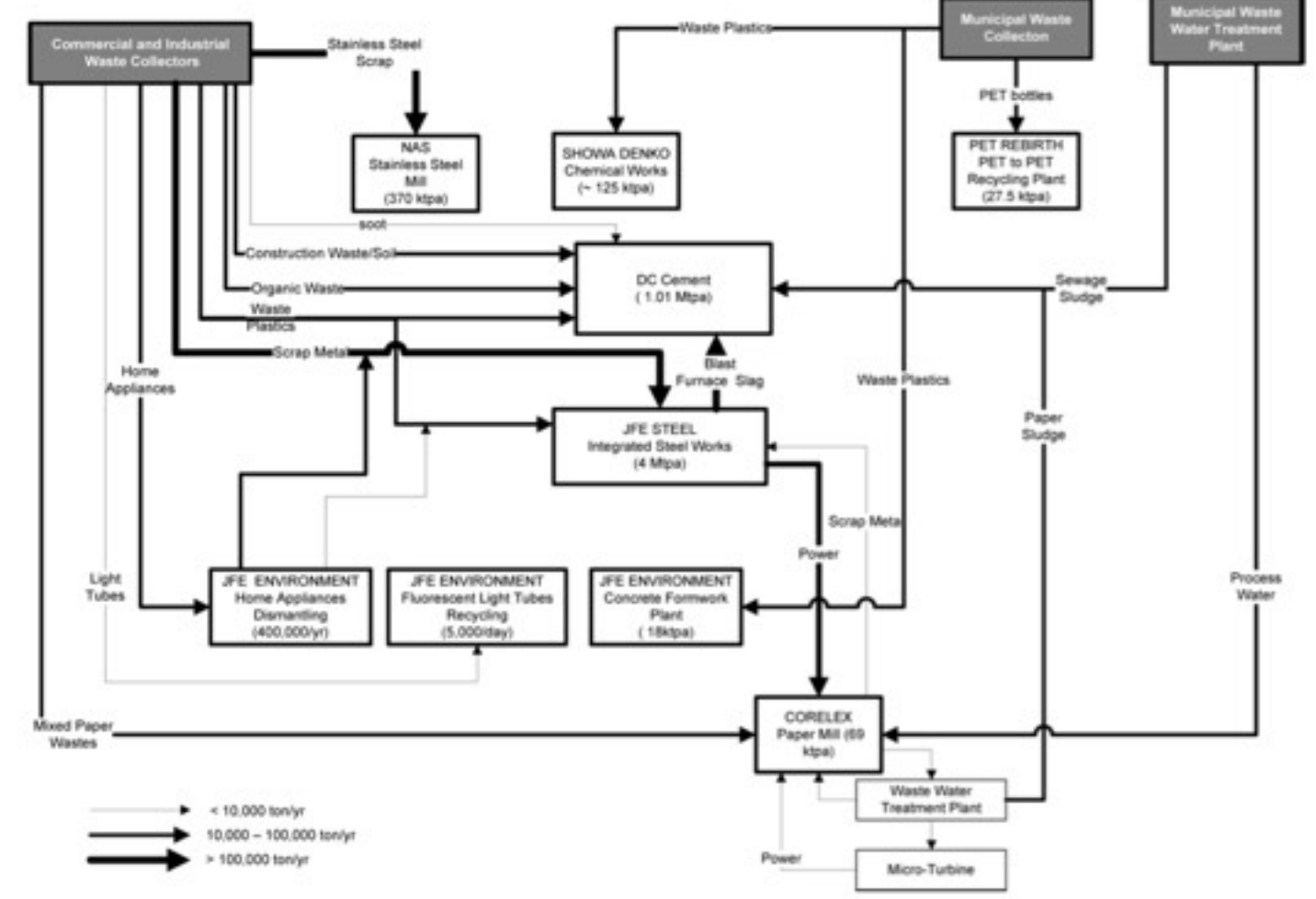
Behera et al., 20012

Kwinna, Australia

Van Beers et al., 2009

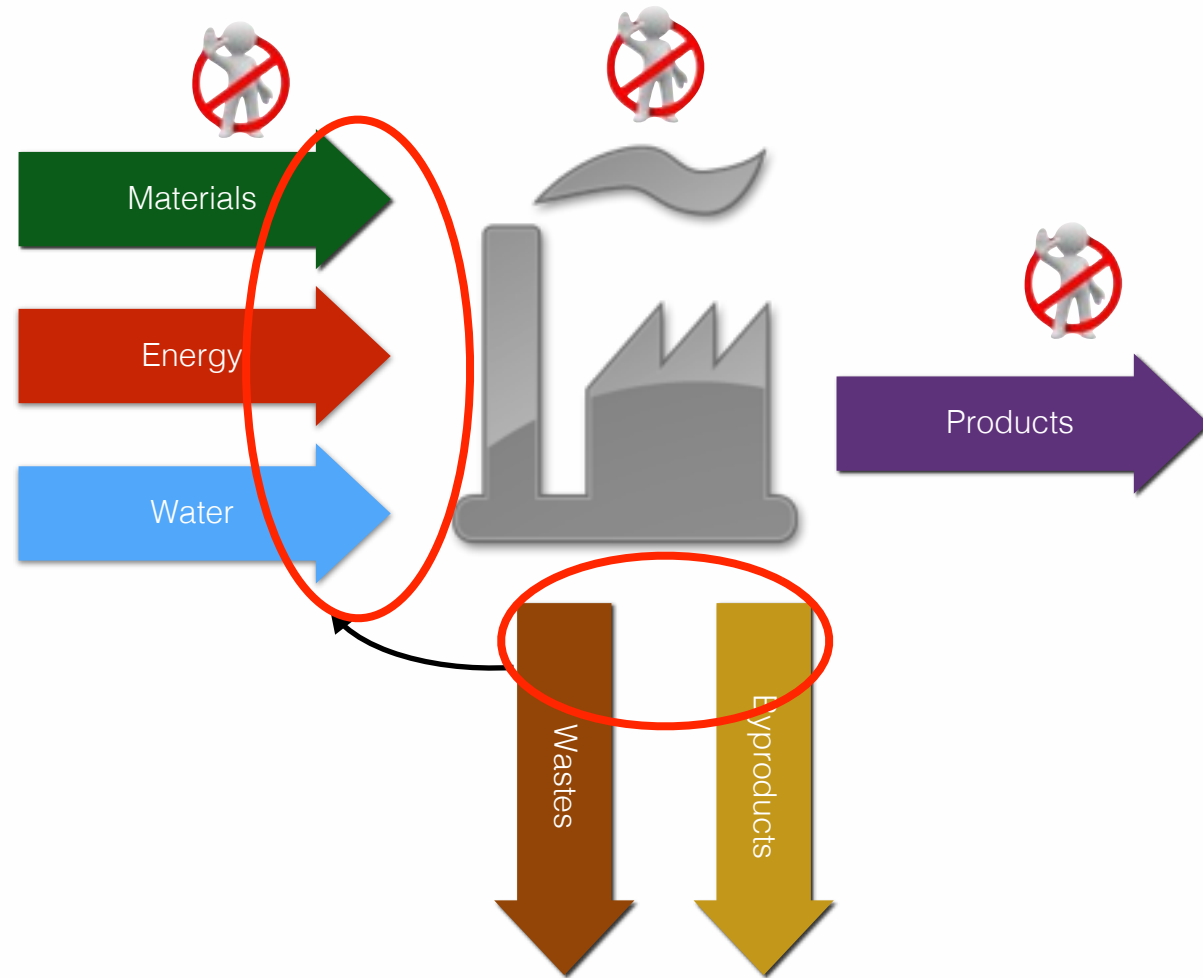


Kawasaki, Japan



van Berkel et al., 2009

Typical characteristics



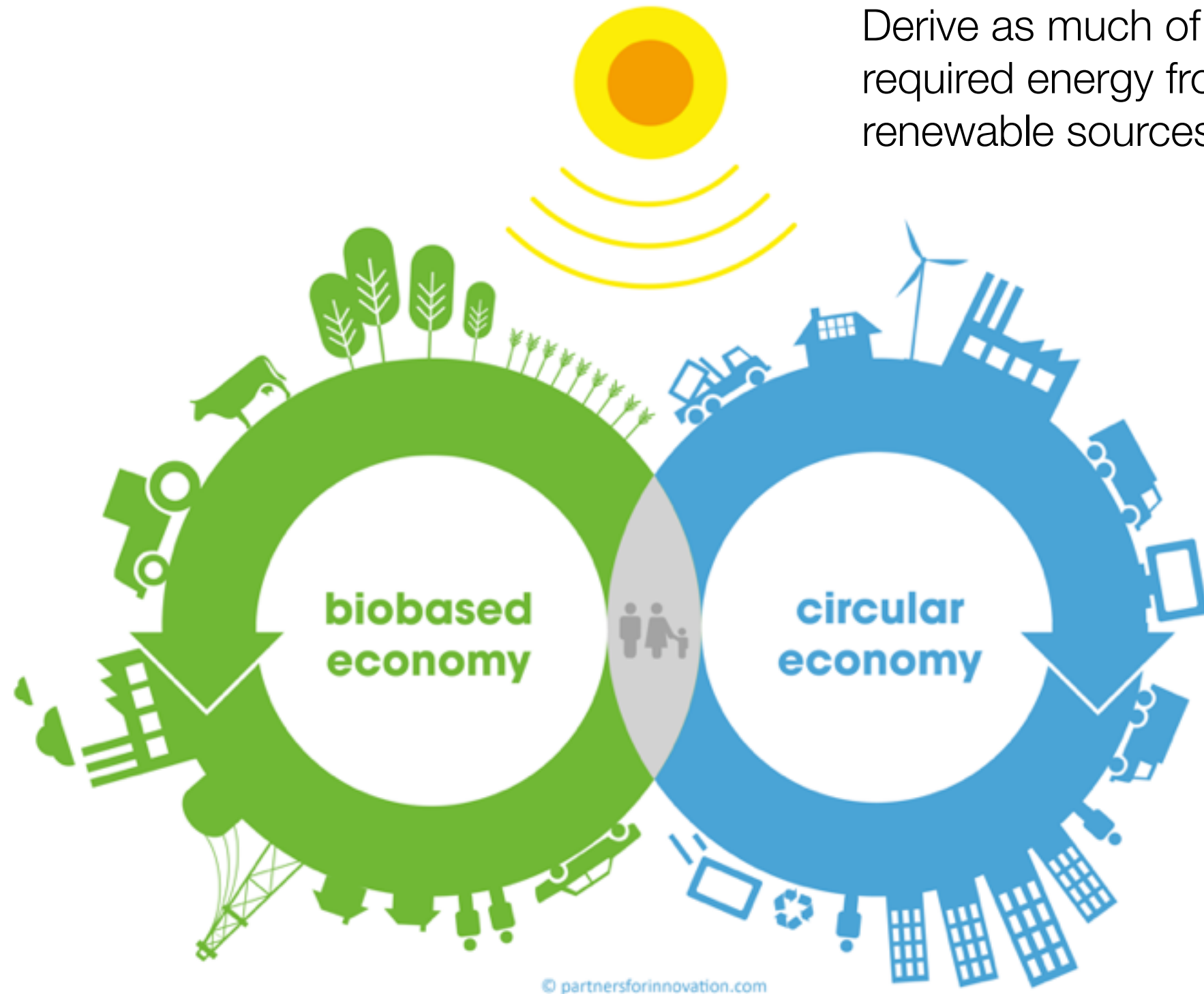
Conventional, and often fossil based, production becomes more efficient

Limited systemic change

Circular and bio-based economies

Sustainably

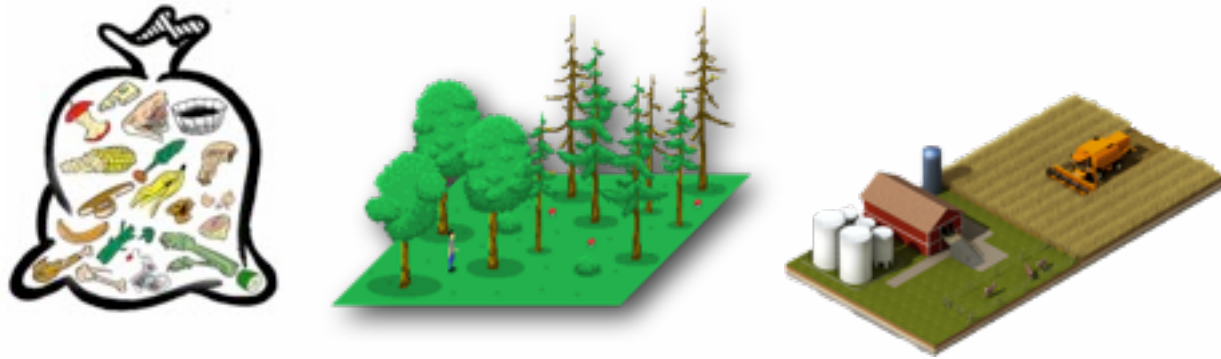
increase the share of bio-based resources in the economy



Derive as much of the required energy from renewable sources

Keep materials **feasibly** in productive use – with an eye on quality & minimal emission to natural system

Challenges for circular & bio-based businesses



Resources of interest are typically:

- Dispersed
- Highly heterogenous
- Low “value/volume” ratio

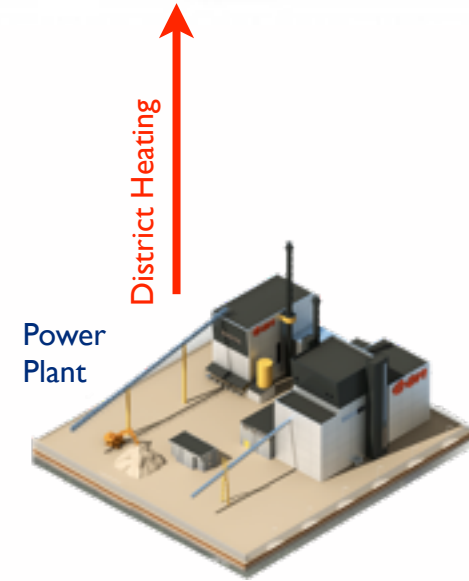
Resulting in

- Energy intensive collection and processing
- Low conversion efficiency (for singular outputs)
- Diverse by-products
- Limited long-distance transport
- Limited scope for scale economies

Important enablers through Ind Sym

Economies of
Scope

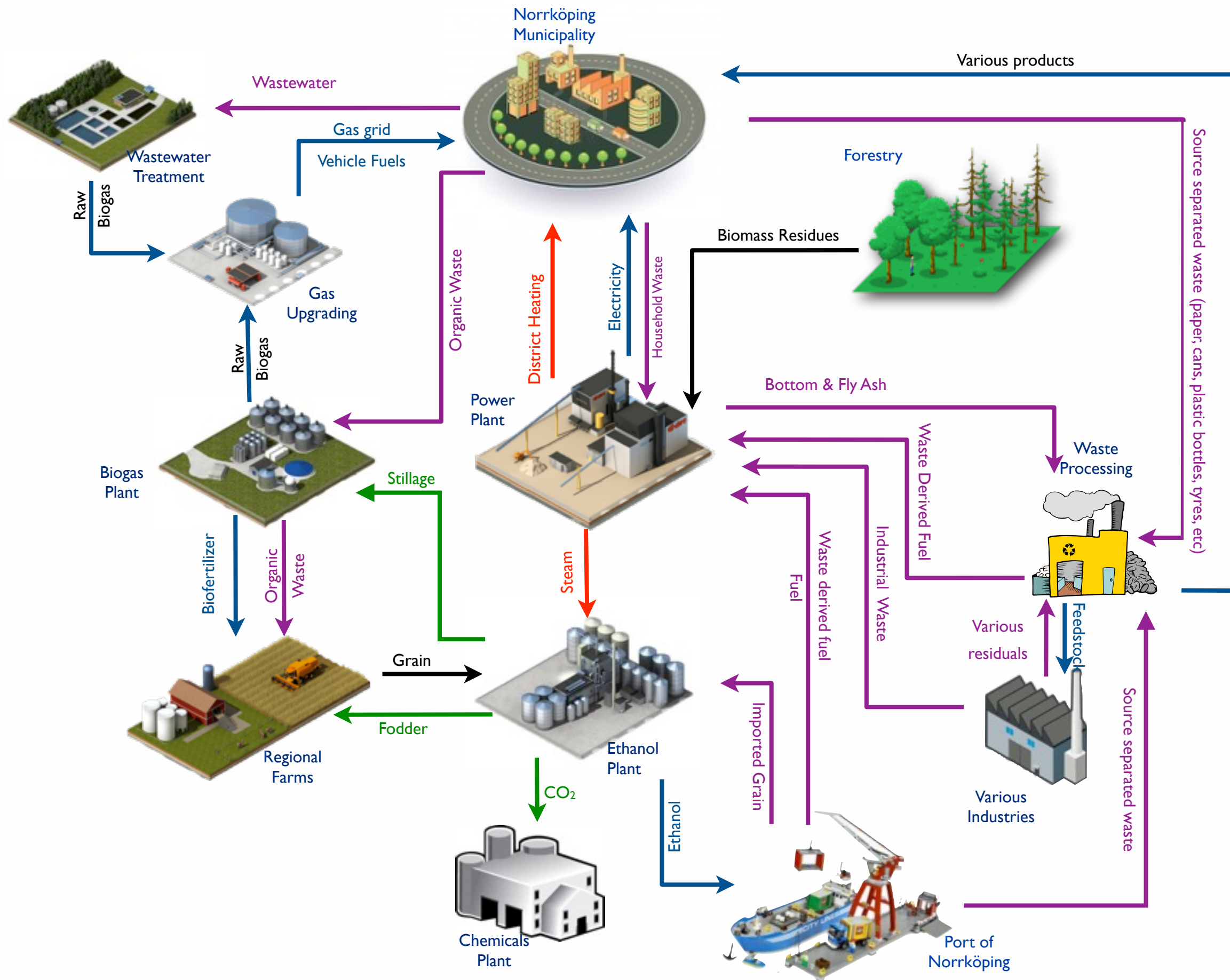
Economies of
Networking



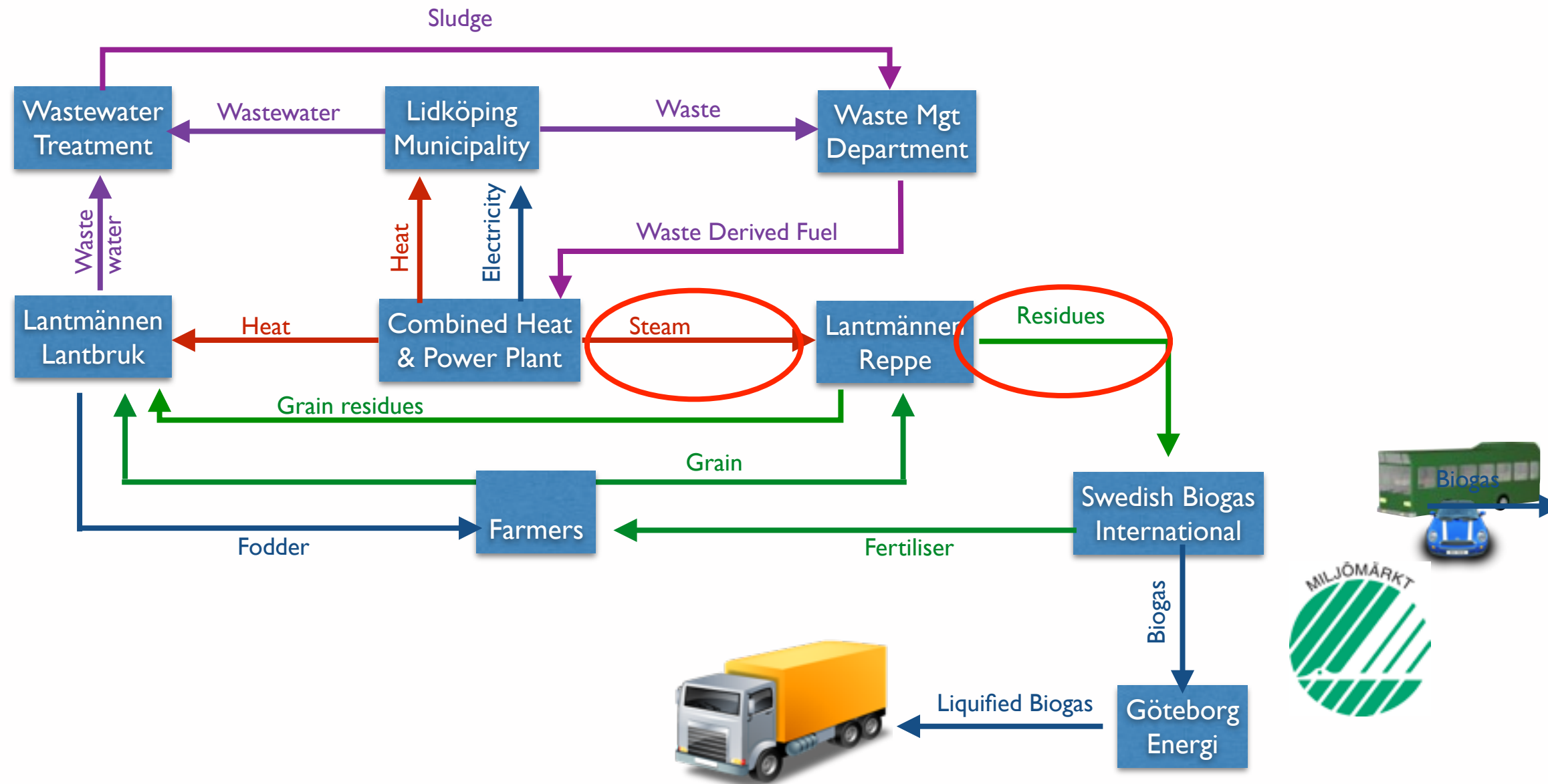
Norrköping



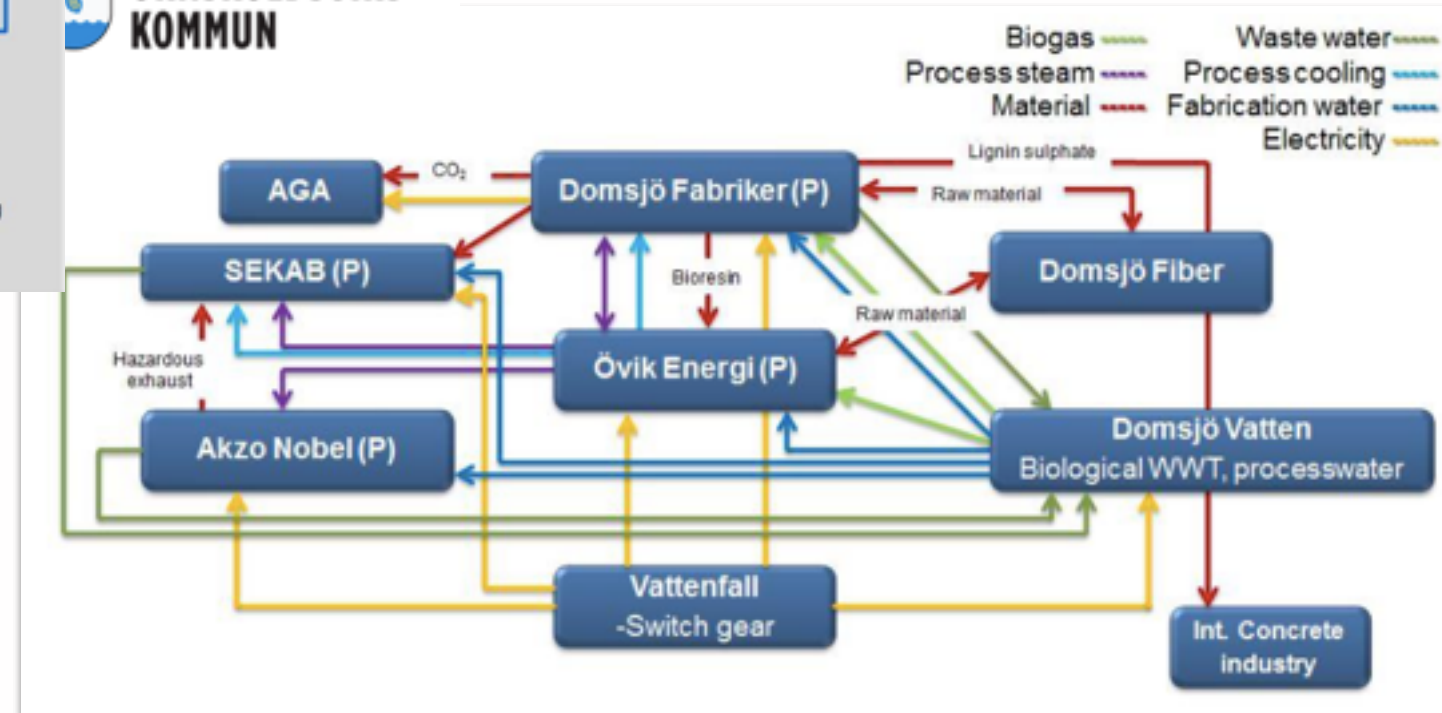
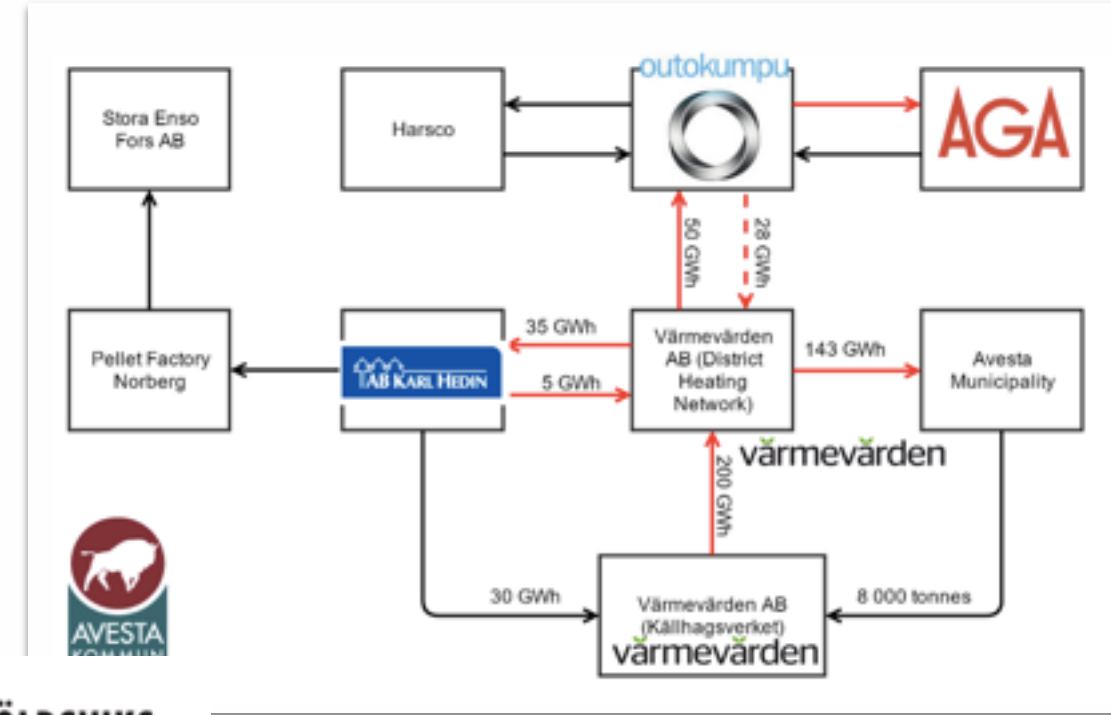
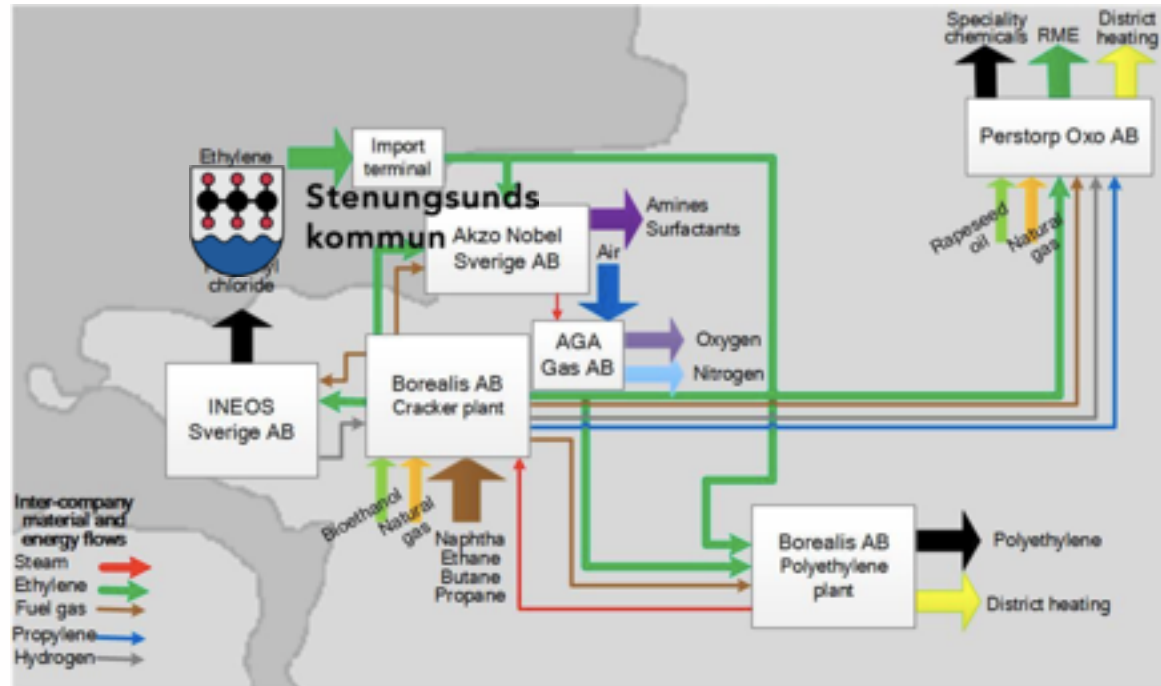
Norrköping



Lidköping



Many operational examples



Many operational examples

Industrial Symbiosis in Sweden

Home | About the project | Reports | Submit an Idea

Welcome

Industrial symbiosis refers to relationships among economic activities with geographic proximity where environmental and development benefits are obtained through exchanging resources or through other forms of synergistic relations. The concept is gaining increasing attention within the domains of academic research, public policy, as well as corporate and regional strategy. Sweden is rich in industrial symbiosis networks, but little is known about these. The primary purpose of this project is therefore to share information about industrial symbiosis networks operational in Sweden and make the learnings they provide available to a wider audience.

The original research for the networks included in this portal is performed by the Master's students and researchers in Linköping University.

Use the map on the left, or the links below, to jump to a section and learn more about an industrial symbiosis network.

- Industrial symbiosis in Lidköping
- Industrial symbiosis in Norrköping
- Industrial symbiosis in Helsingborg
- Industry Park of Sweden
- Industrial symbiosis in Enköping
- Industrial symbiosis in Stenungsund
- Industrial symbiosis in Avesta

A project of Environmental Technology and Management at Linköping University

Inter-company material and energy flows

- Steam →
- Ethylene →
- Fuel gas →
- Propylene →
- Hydrogen →

AGA

Avesta Municipality

Waste water
Process cooling
Fabrication water
Electricity

er

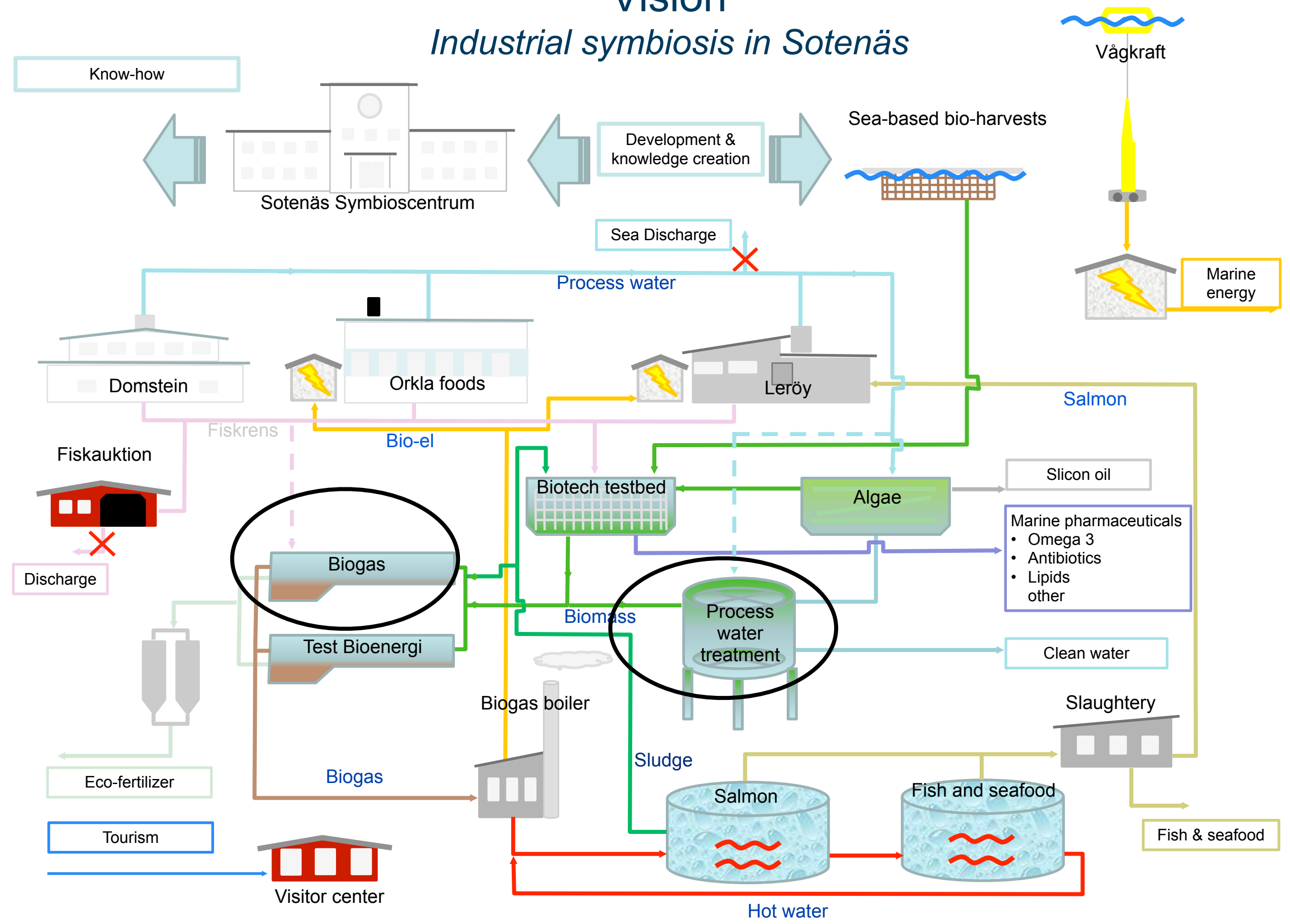
Jö Vatten
VT, processwater

Int. Concrete industry

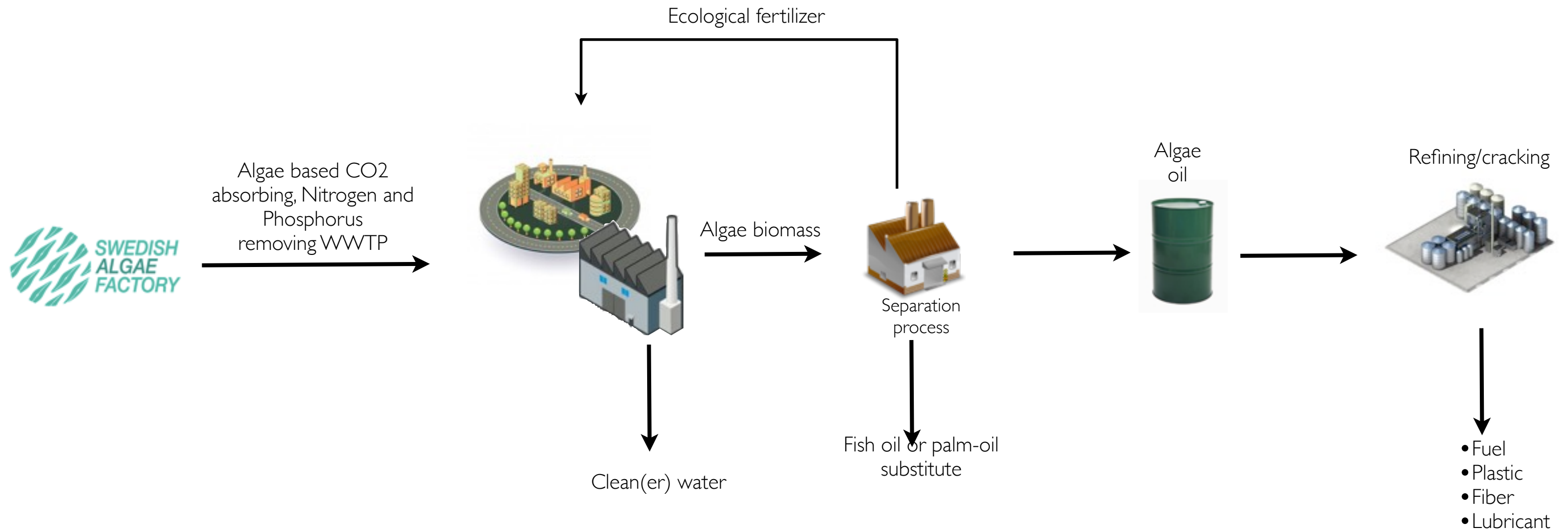
<http://www.industriellekologi.se/symbiosis/>

Vision

Industrial symbiosis in Sotenäs



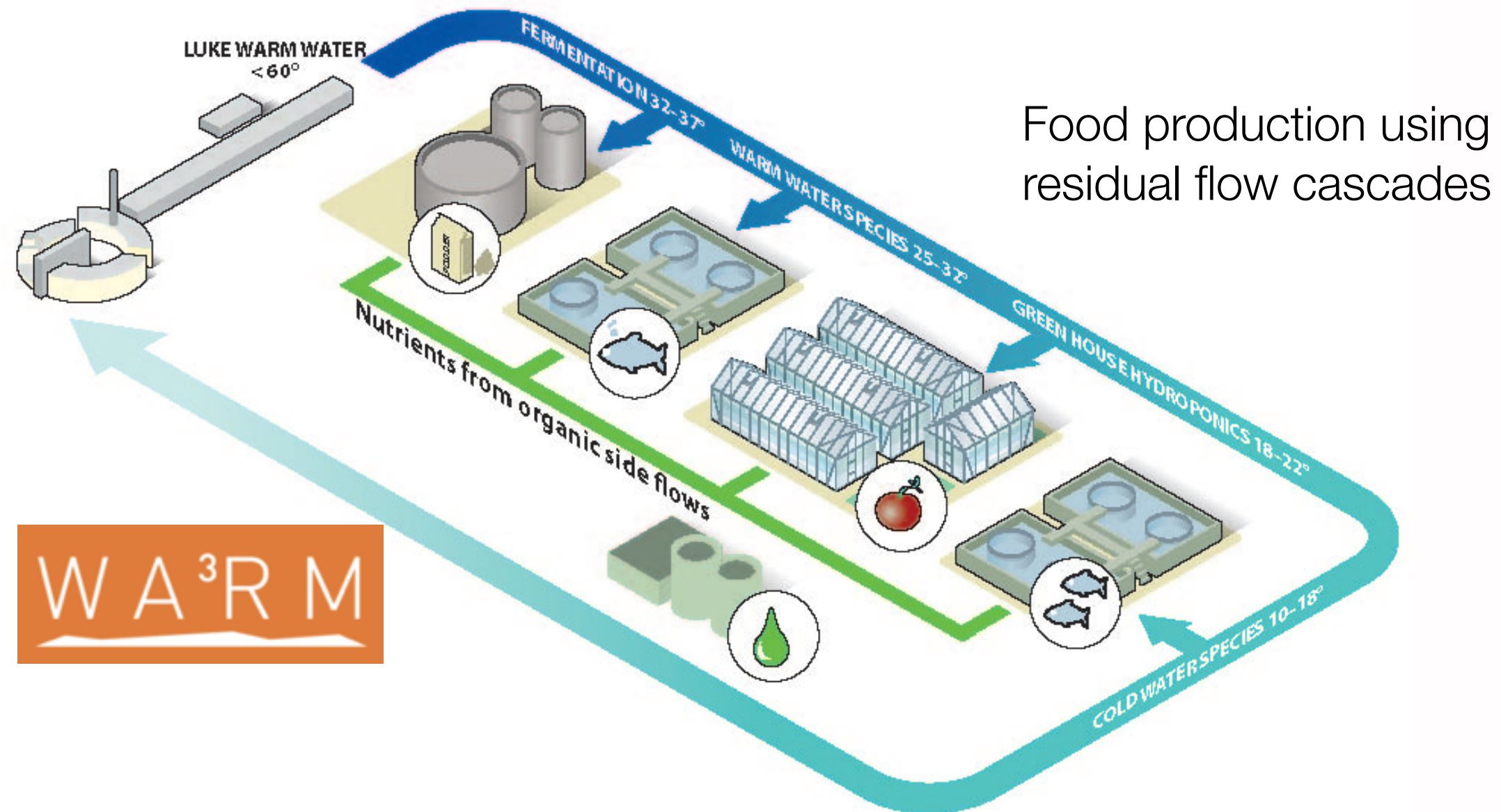
Promising system innovations



Adapted from Sofie Allert, 2016

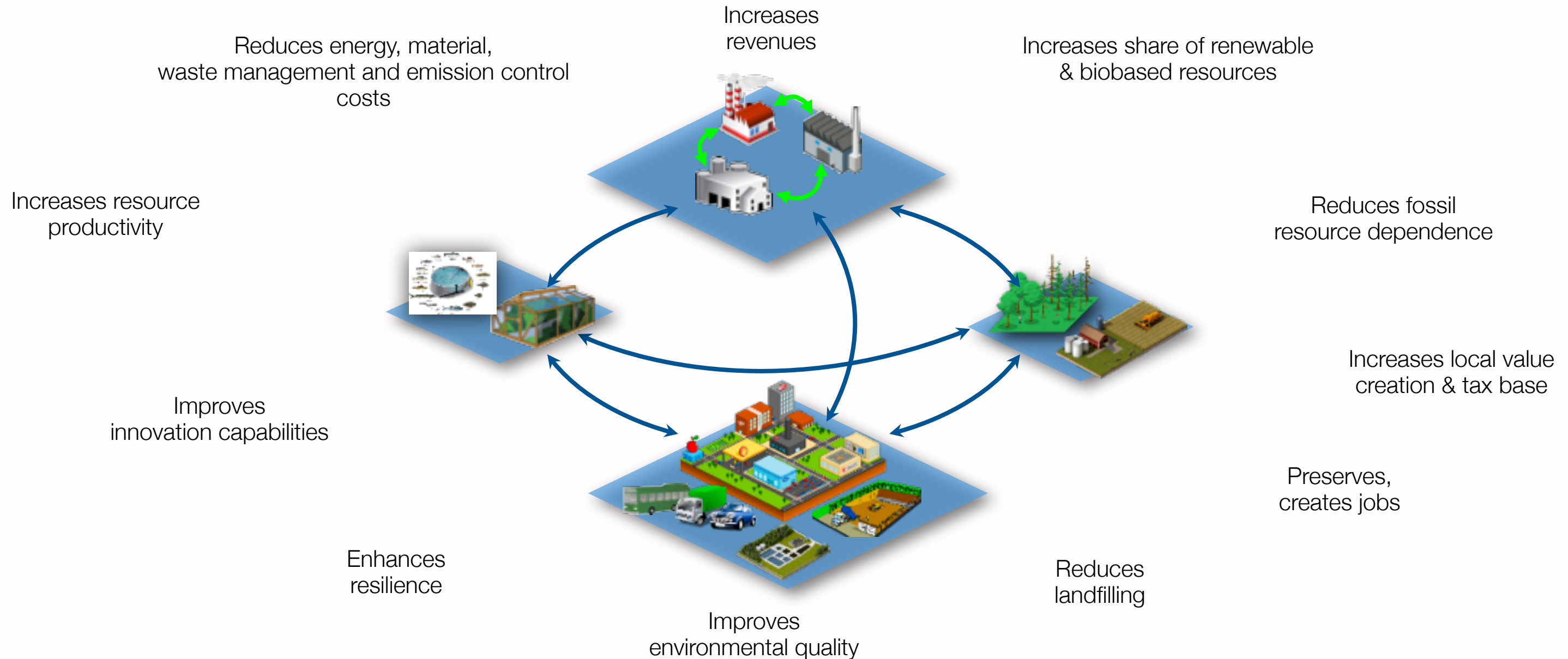
- Silicon with special nano-porous structure
- 60% more effective solar light absorption capacity

Regenerative production



Source: Sandin, 2015

New industrial & urban symbiosis

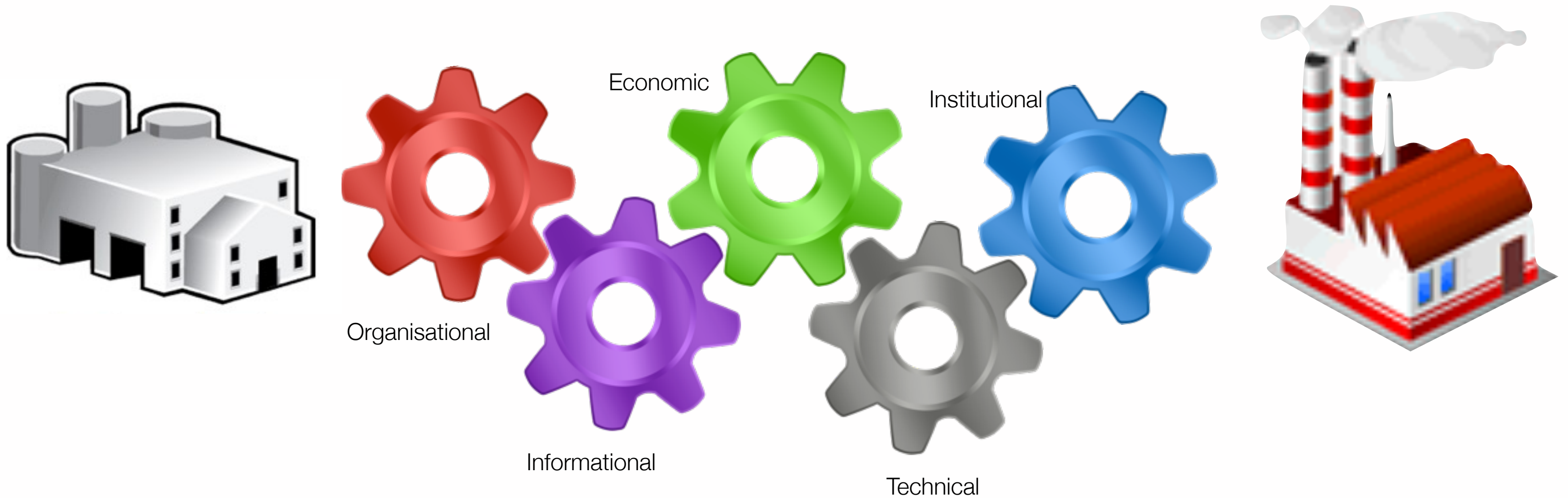


Local/regional collaboration as a competitive resource

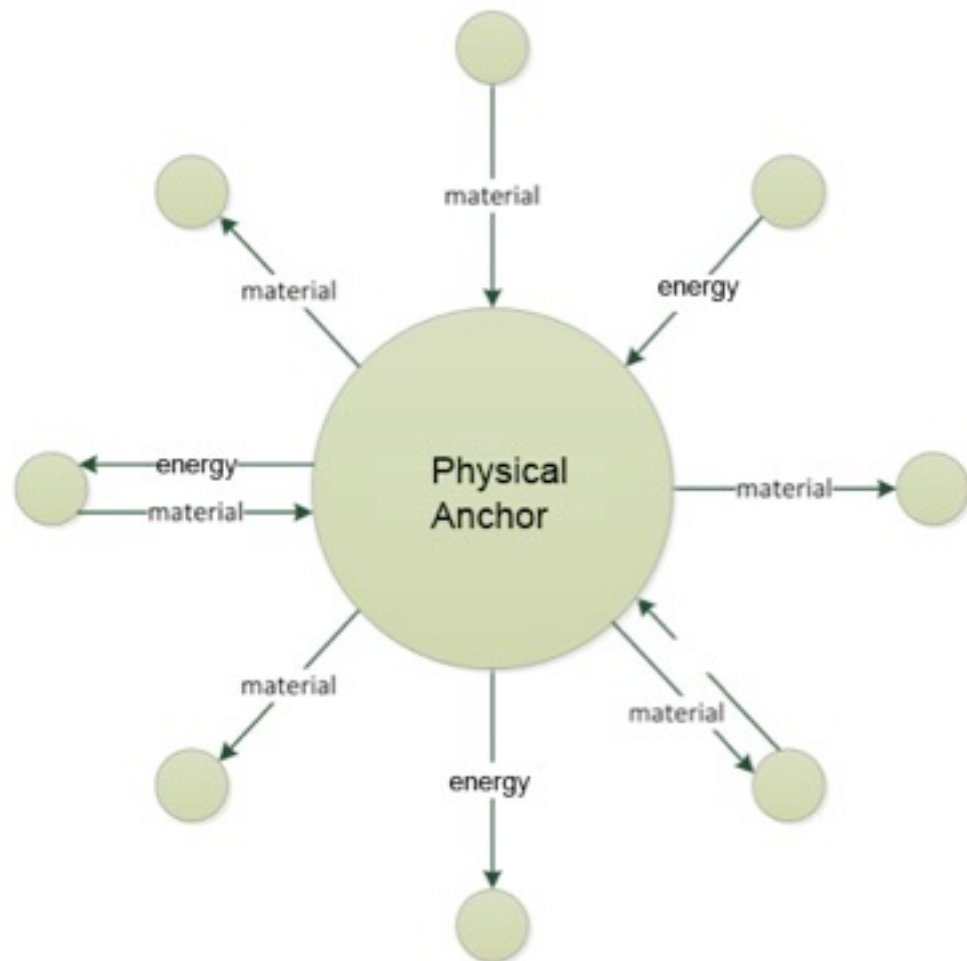
Example strengths influencing earlier cases

- National/EU level policies and policy tools
- Local governance ambitions, policies and capabilities
- Business culture & environmental strategies
- Technical infrastructure assets
- Public-private-partnerships
- Availability of financial support
- Social dynamics

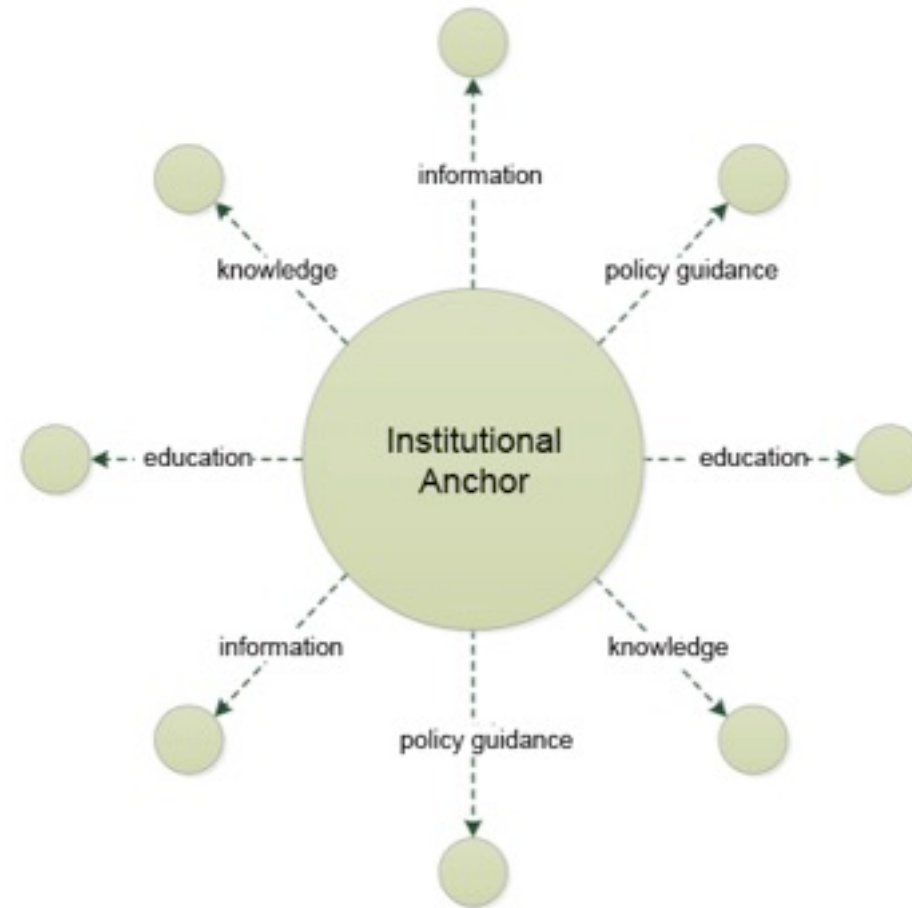
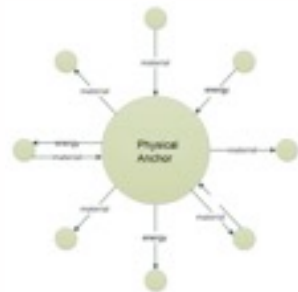
Key determinants



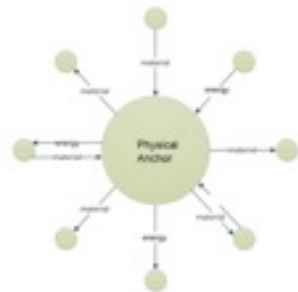
Key roles



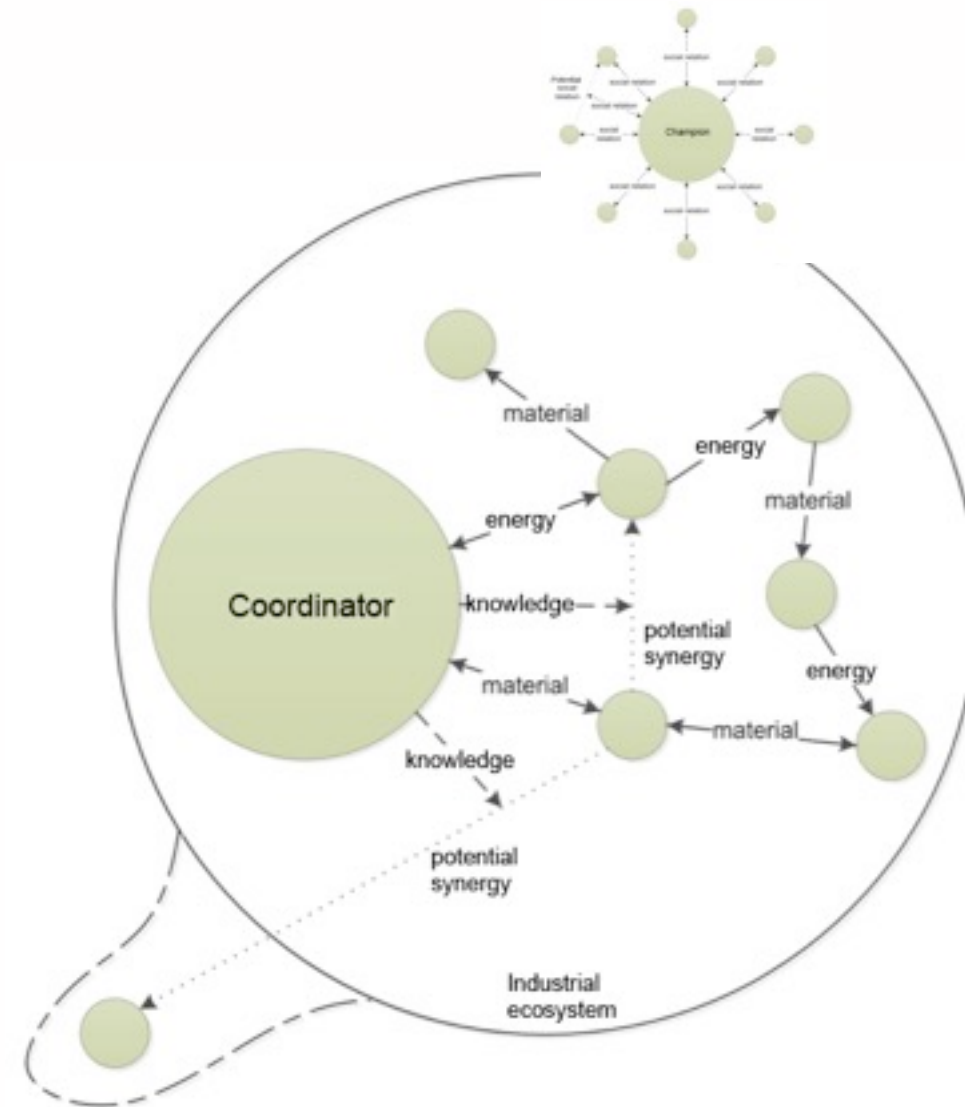
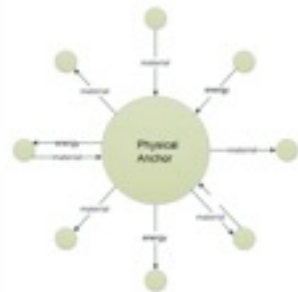
Key roles



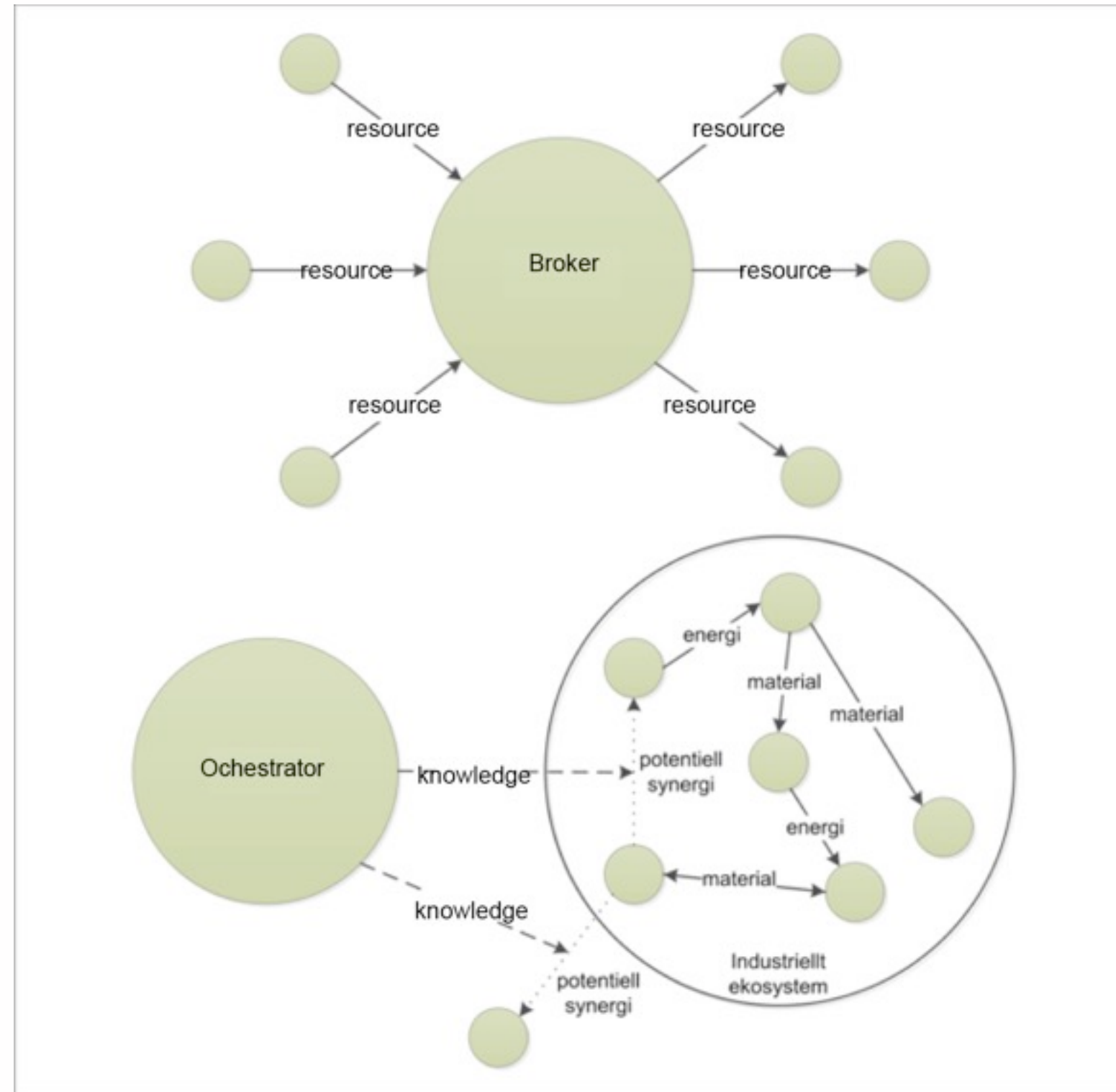
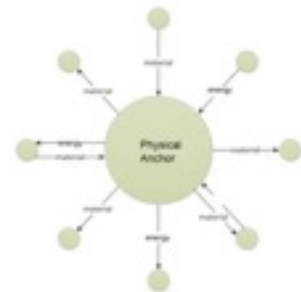
Key roles



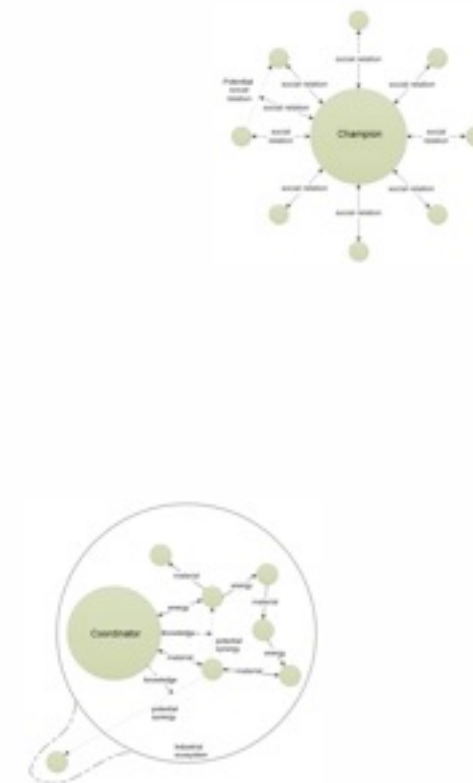
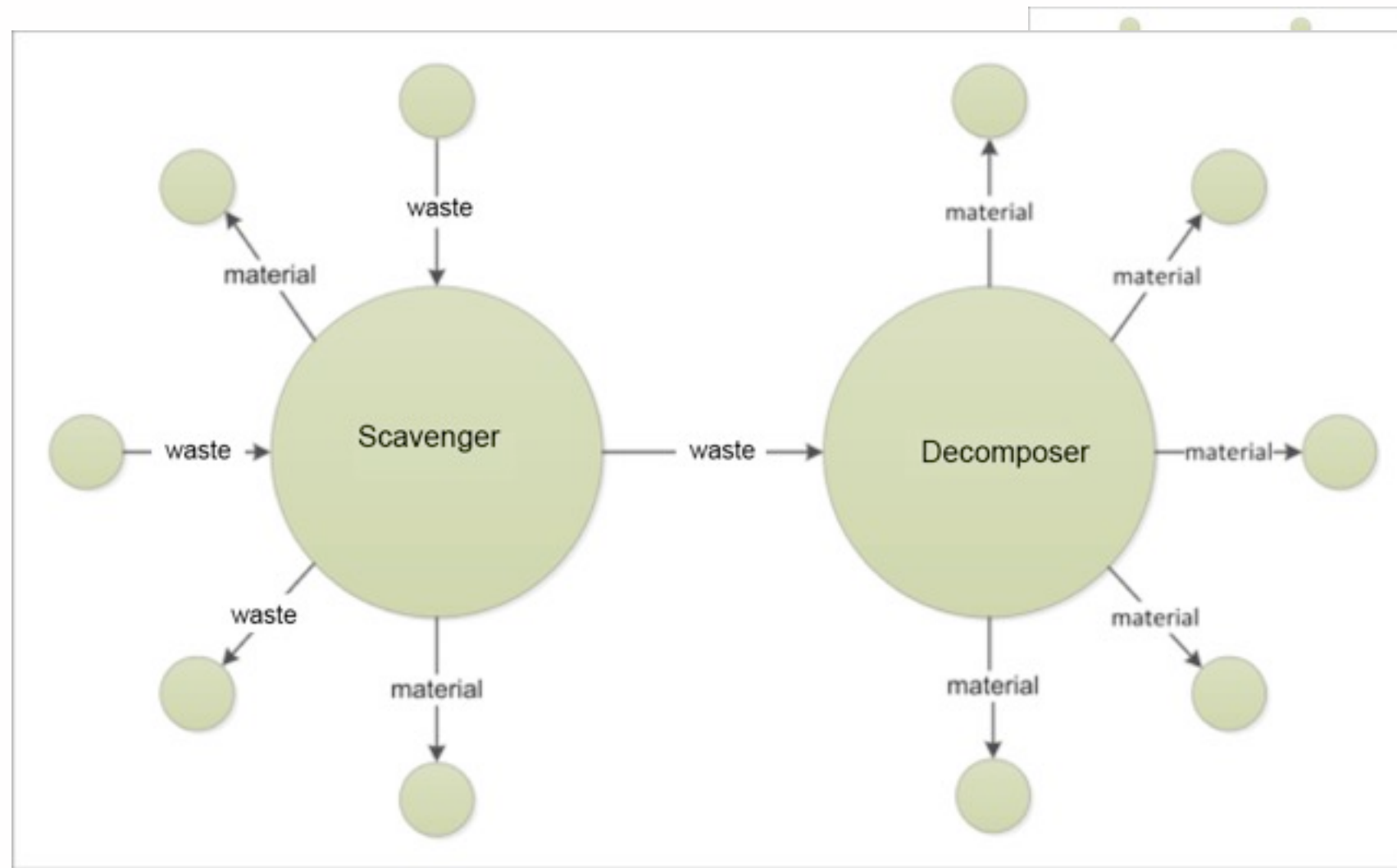
Key roles



Key roles



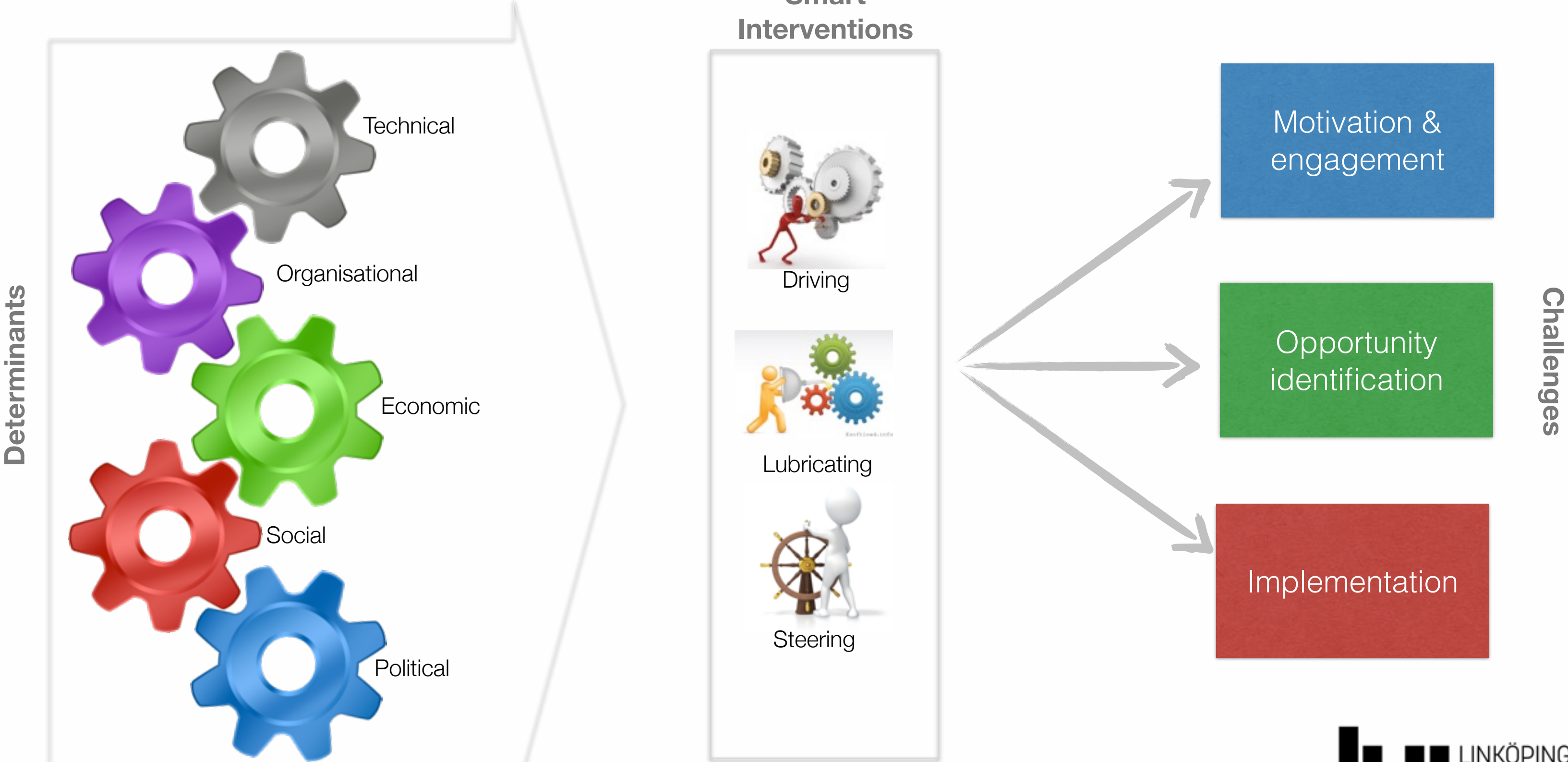
Key roles



Scaling up

- Majority of operational Ind Sym networks are outcomes of self-organization
 - Emerged in pursuit of opportunities identified in bi-lateral interactions
- There is growing interest to diffuse and scale up ind sym with concerted action.

Systemic facilitation



Systemic facilitation



Identify, engage,
capacitate



Facilitate communication
& interaction



Systemically
Identify & assess

Understanding actors

Outside-in

- Inputs
- Outputs



Inside-out

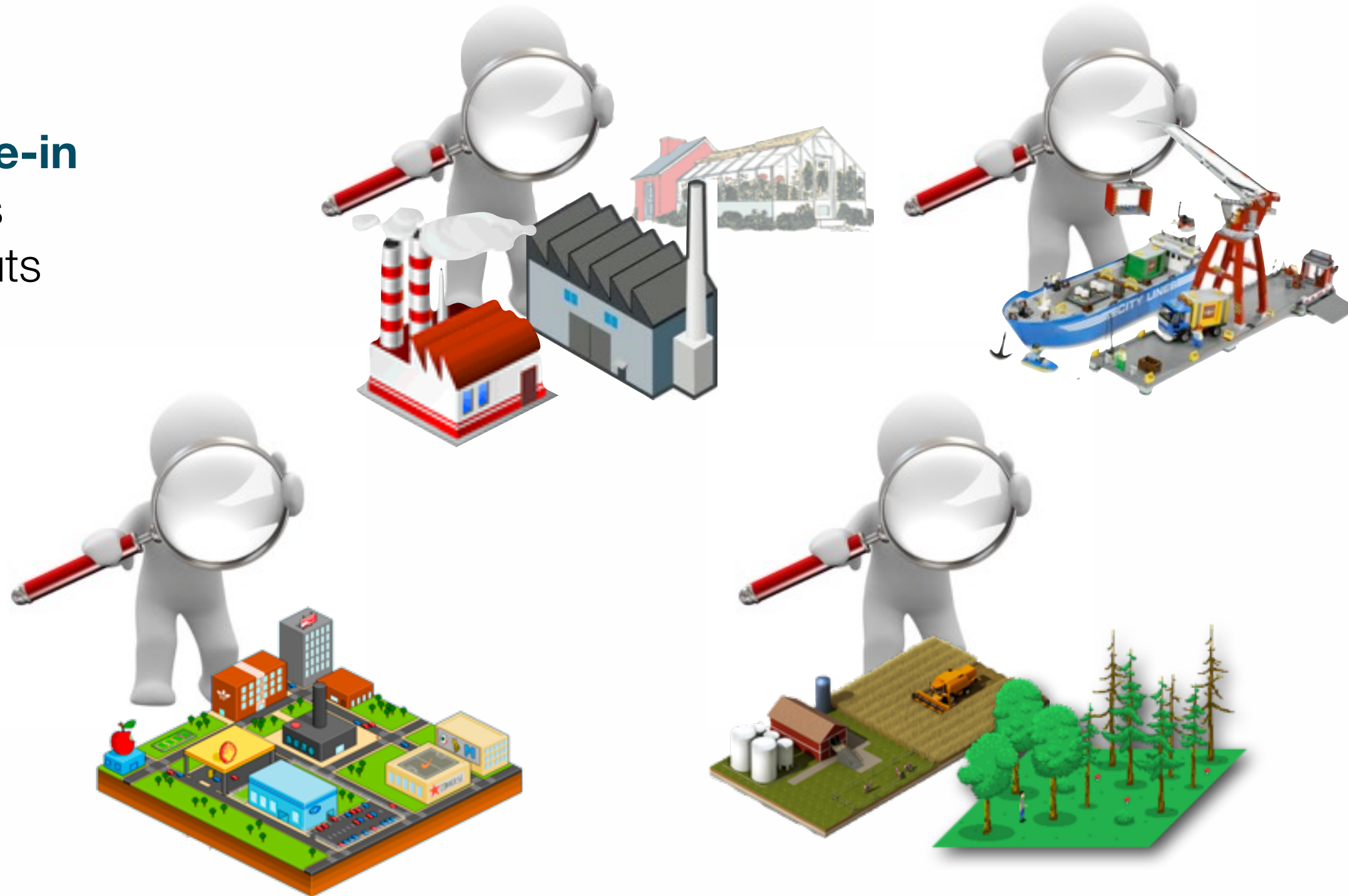
- Needs
- Capacities
- Interests
- Concerns



Understanding actors

Outside-in

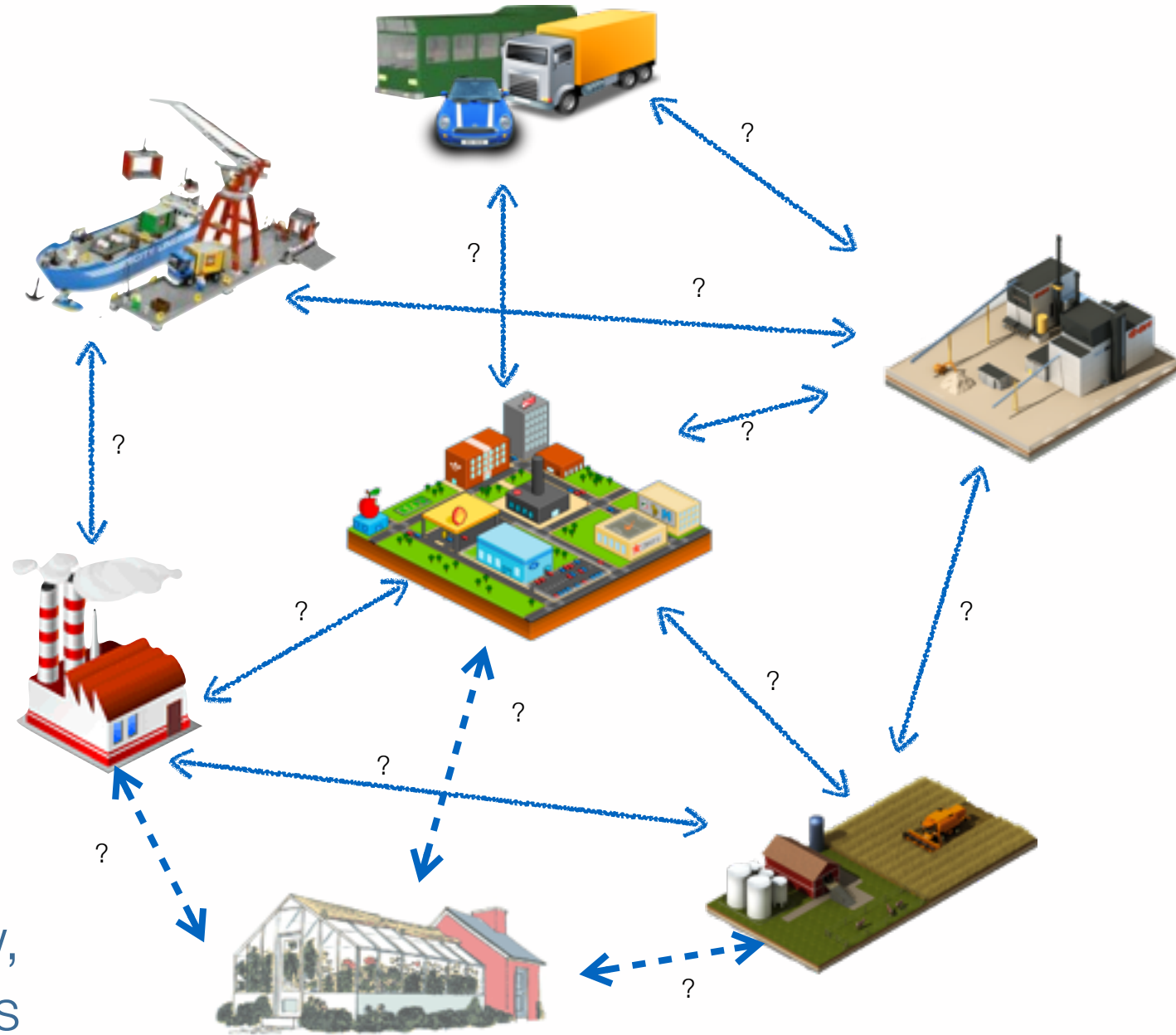
- Inputs
- Outputs



Inside-out

- Needs
- Capacities
- Interests
- Concerns

Identify complementarities



With a view of new,
complementary activities

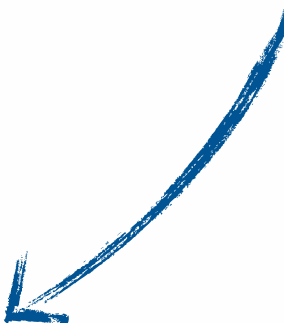
Systemic facilitation



Identify, engage,
capacitate



Facilitate communication
& interaction



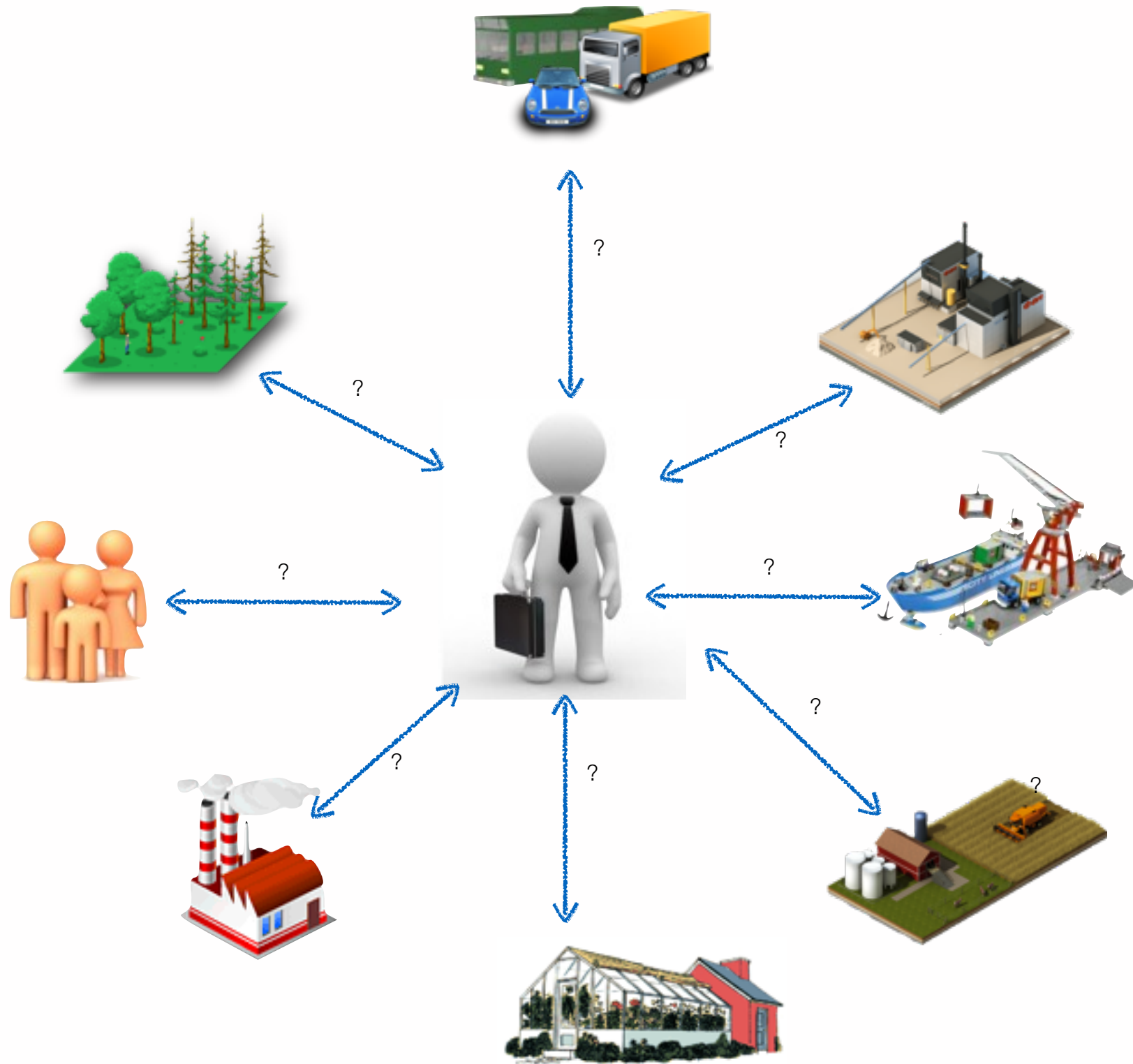
Formulate & mobilize



Identify & assess



Business mobilization



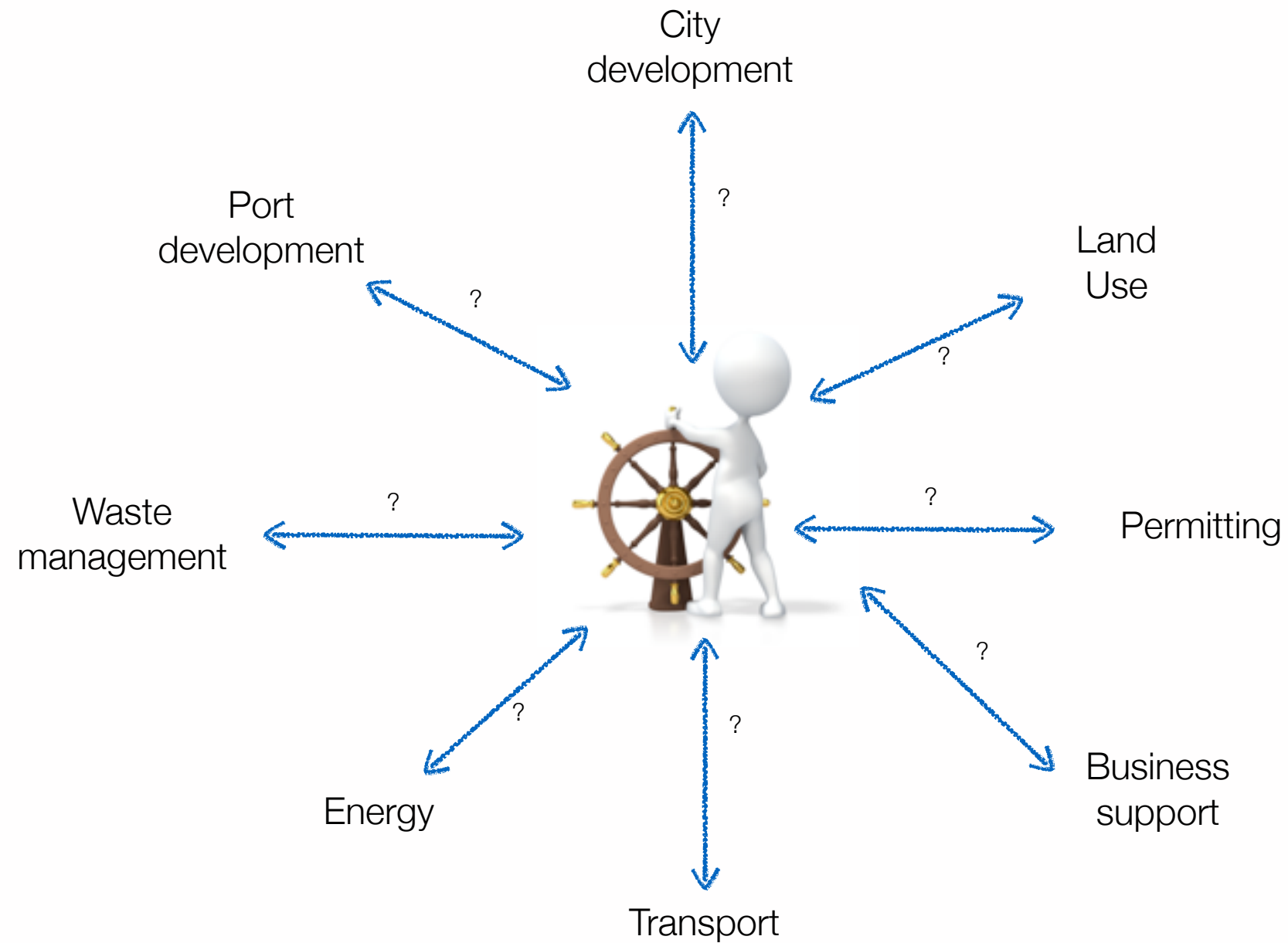
Commitment

Open dialogue

Scrutinize potential
opportunities

Formulation of
business models

Policy mobilization

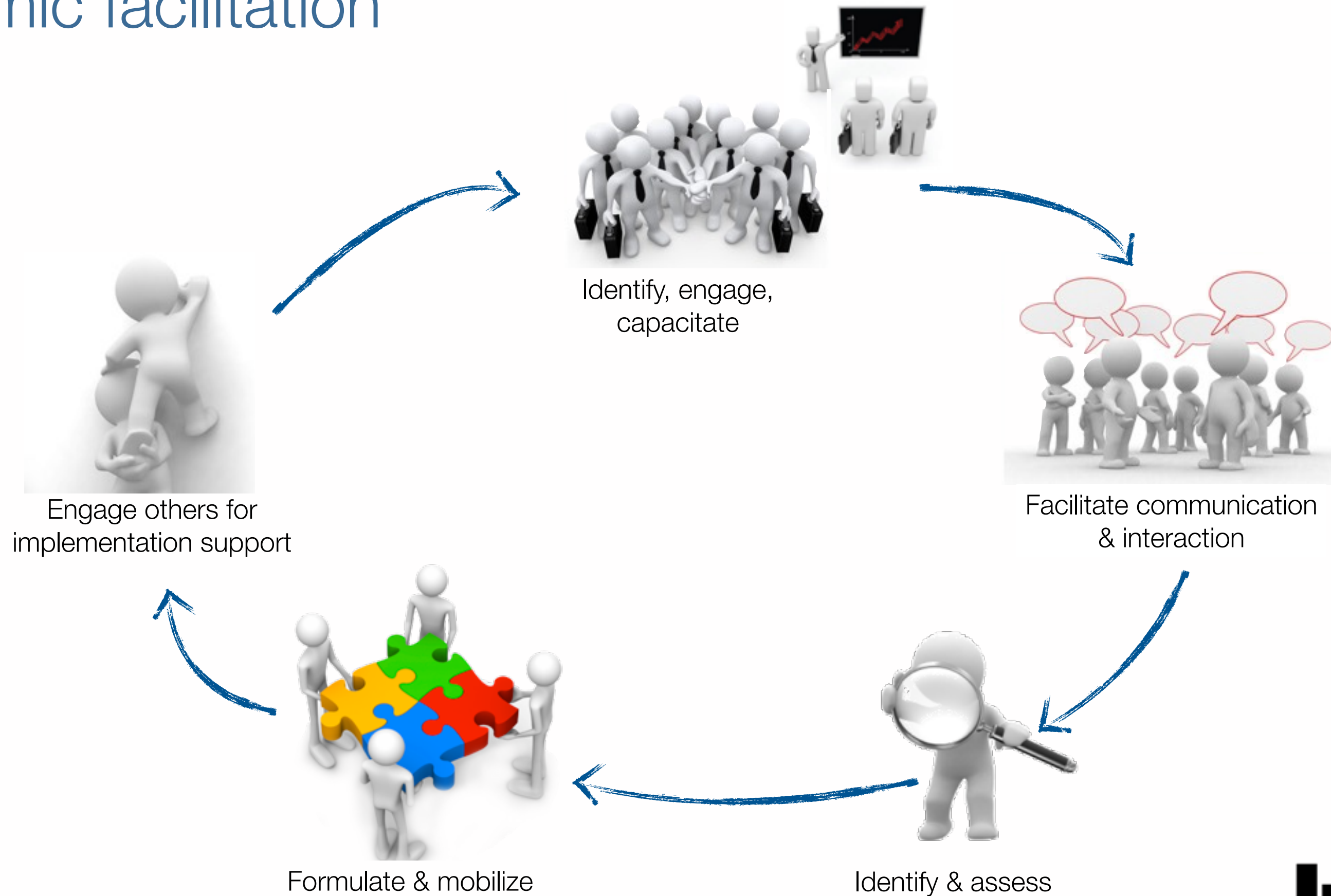


Create support systems

Create incentives

Remove barriers

Systemic facilitation



Identify and engage others



Financial institutions



Business partners



Policy makers at
higher levels



Technology providers



Entrepreneurs

To conclude



Local/regional collaboration among diverse actors hold a significant and under-utilized potential for contributing to more sustainable businesses, regions and economies

Harvesting this potential requires new ways of thinking and acting – with particular focus on inter-sectoral and inter-organizational communication and interaction.

Systemic approaches are effective in accelerating progress, but need action from diverse actors and at different levels

Thank you



murat.mirata@liu.se