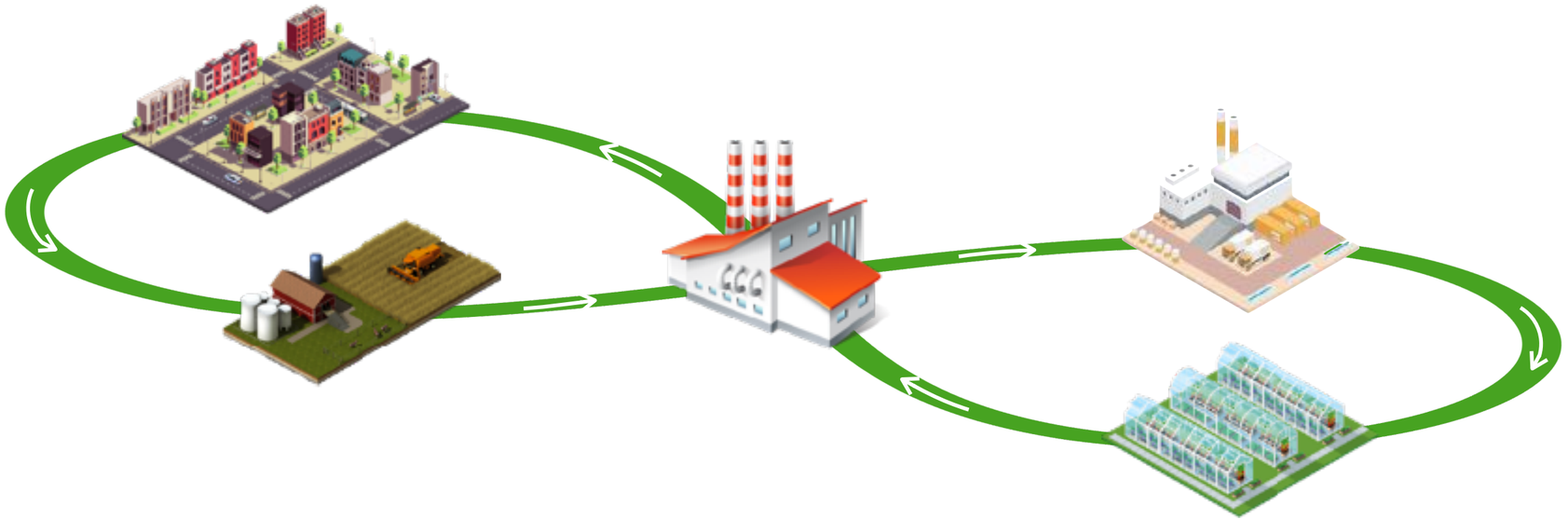
Industrial Symbiosis Practitioner Training



Part 2: Industrial symbiosis forms, examples, benefits and potentials.

by

Murat Mirata

Environmental Technology & Management

LINKÖPING UNIVERSITY

BALTIC INDUSTRIAL SYMBIOSIS

Interreg Baltic Sea Region

EUROPEAN UNION

EUROPEAN REGIONAL DEVELOPMENT FUND

Some inspiration - from a Swedish tomato

Image: freepik.com

CO_2

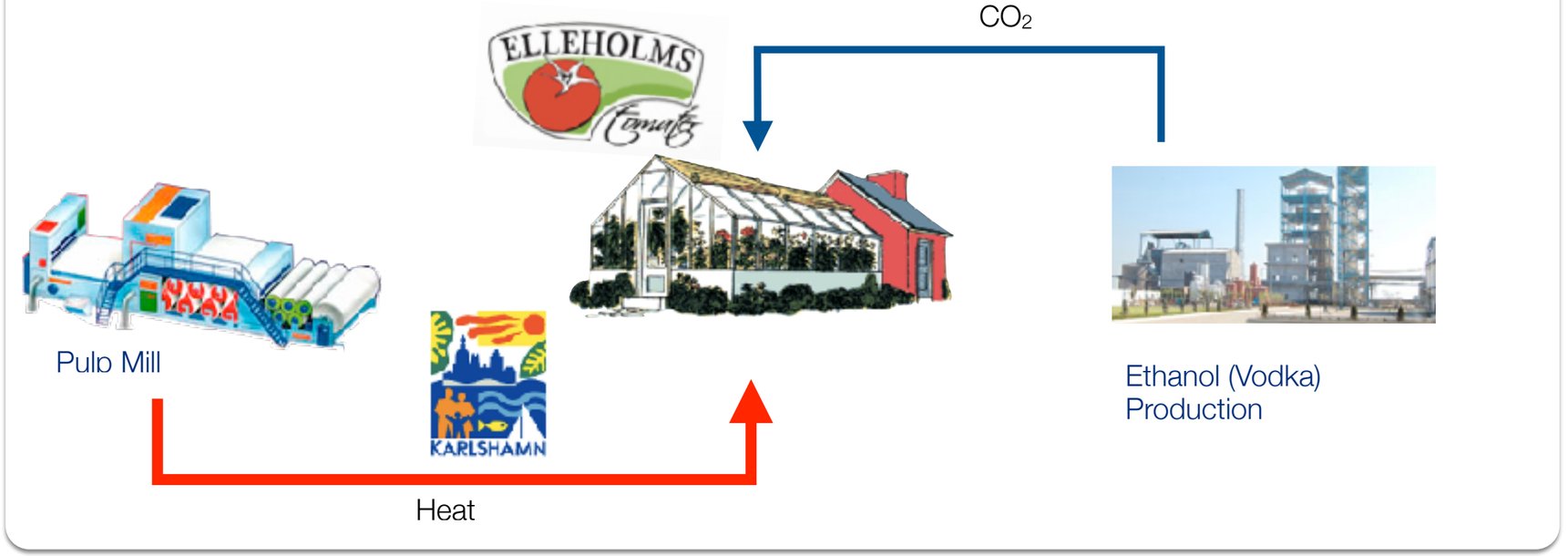
Comparable price & quality AND

superior environmental performance

x 20 CO_2 reduction over Swedish average

x 50 CO_2 reduction over fossil-based production

Karlshamn

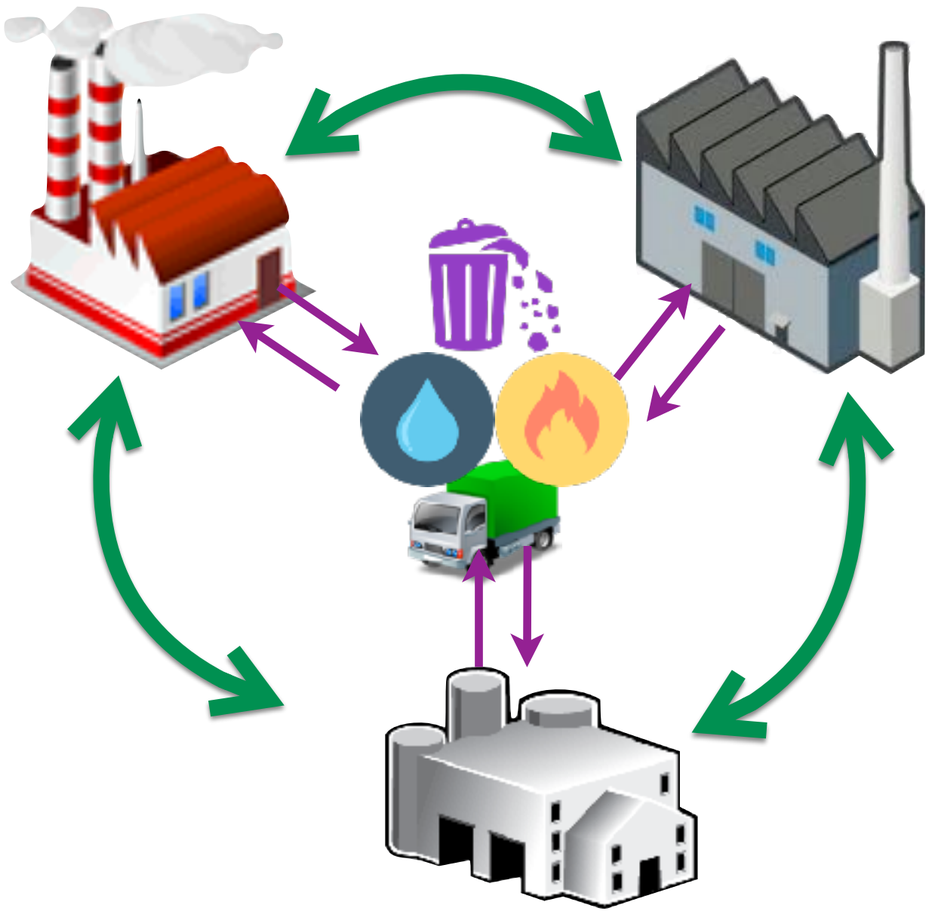


Industrial Symbiosis

Collective approach to resource productivity.

Regionally concentrated, long-term partnerships among diverse actors and sectors enabling higher value from diverse under-utilised resources and fostering eco-innovations.

A complementary strategy with large potential

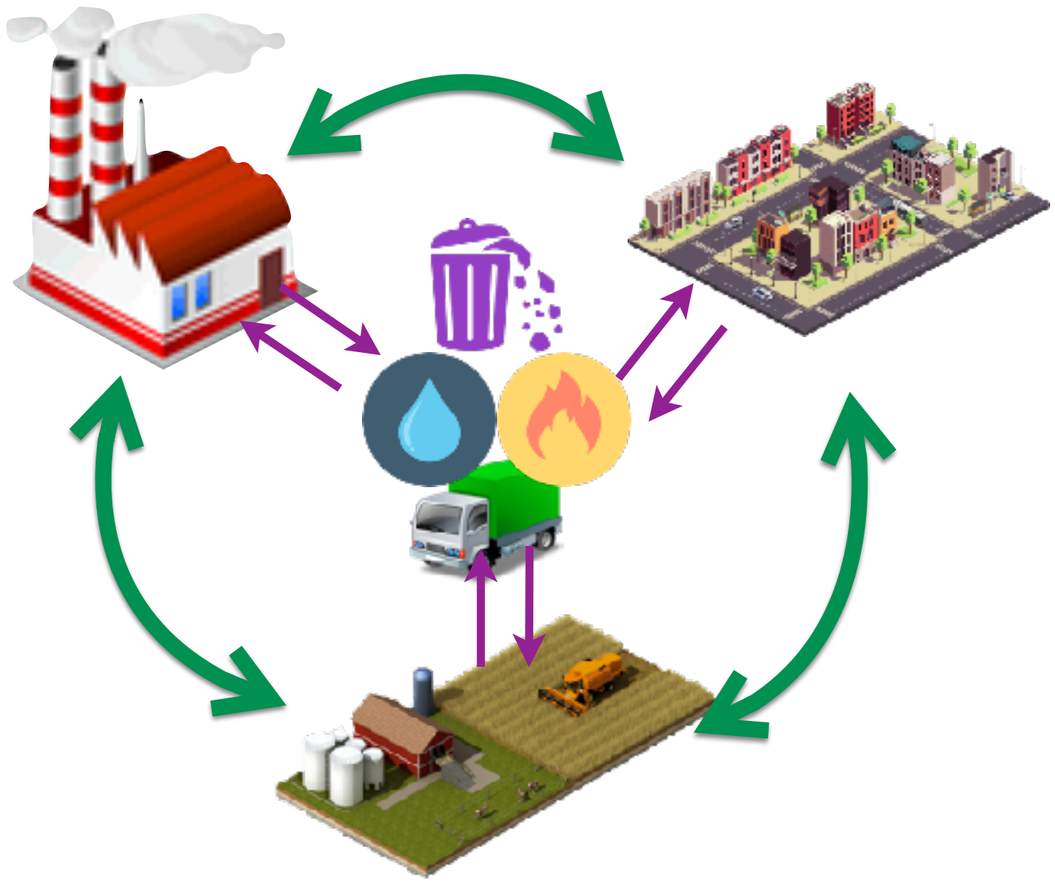


Industrial and Urban Symbiosis

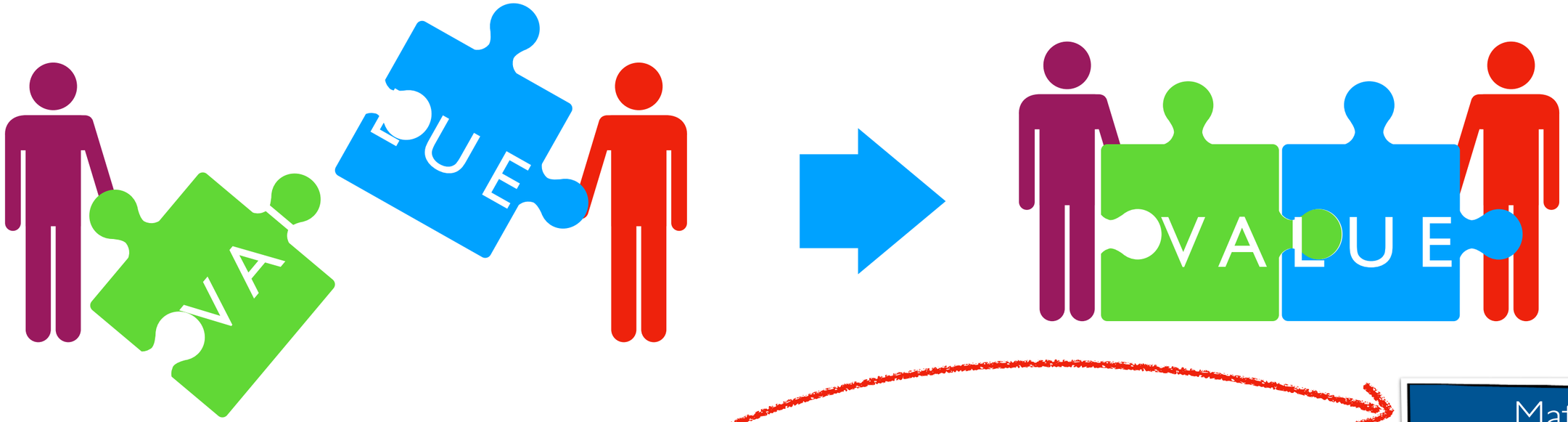
Collective approach to resource productivity.

Regionally concentrated, long-term partnerships among diverse actors and sectors enabling higher value from diverse under-utilised resources and fostering eco-innovations.

A complementary strategy with large potential



Foundations of industrial symbiosis

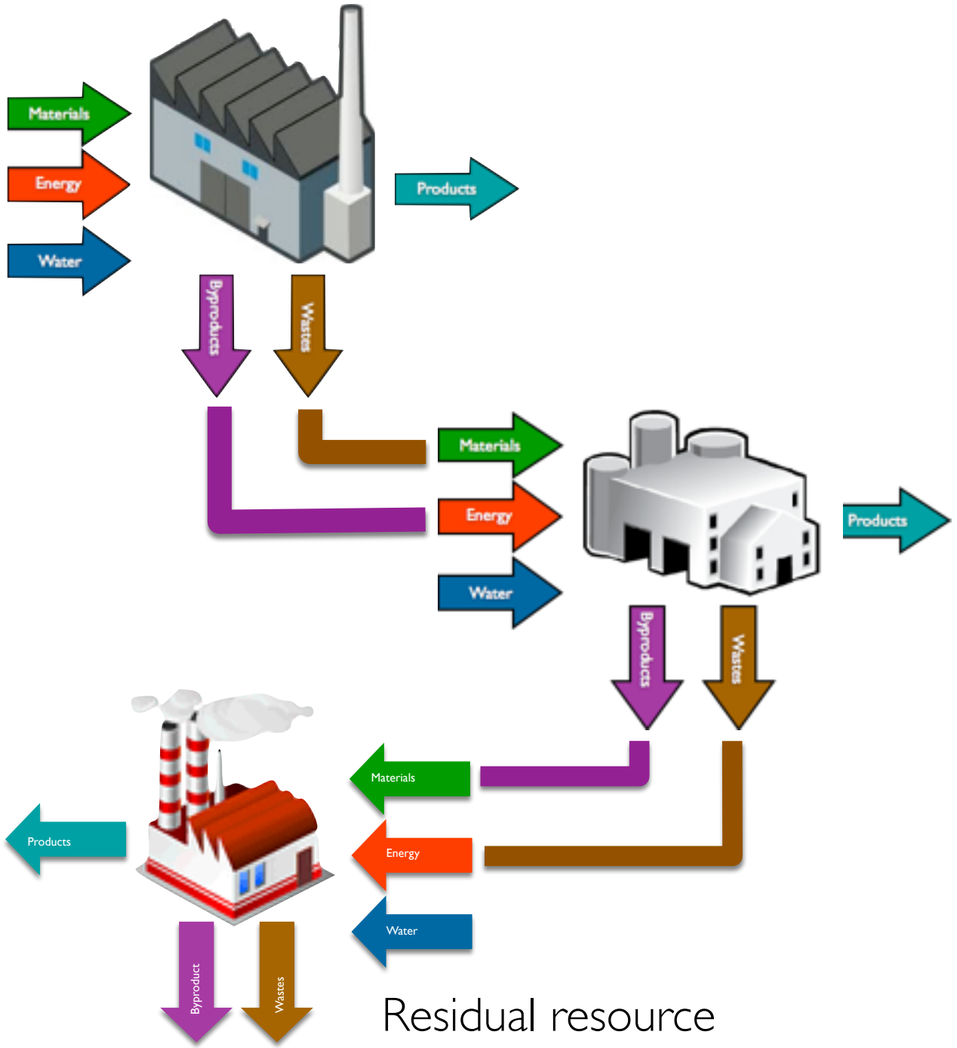


- Some resources are only, or more, valuable if exchanged, combined, shared with others.

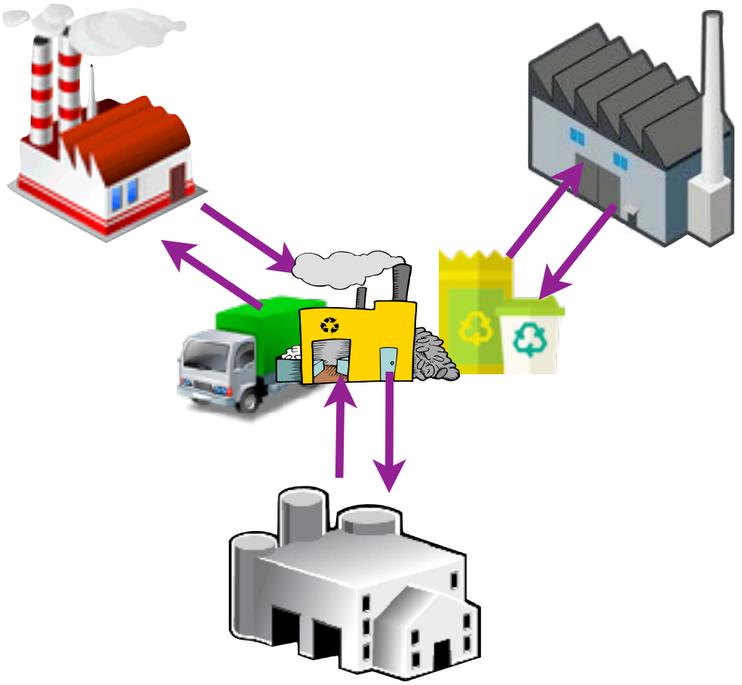
- Common needs can be met better collectively.

Materials
Energy
Machinery
Land
Storage
Infrastructure
People
Knowledge

Industrial symbiosis value mechanisms



Residual resource synergies

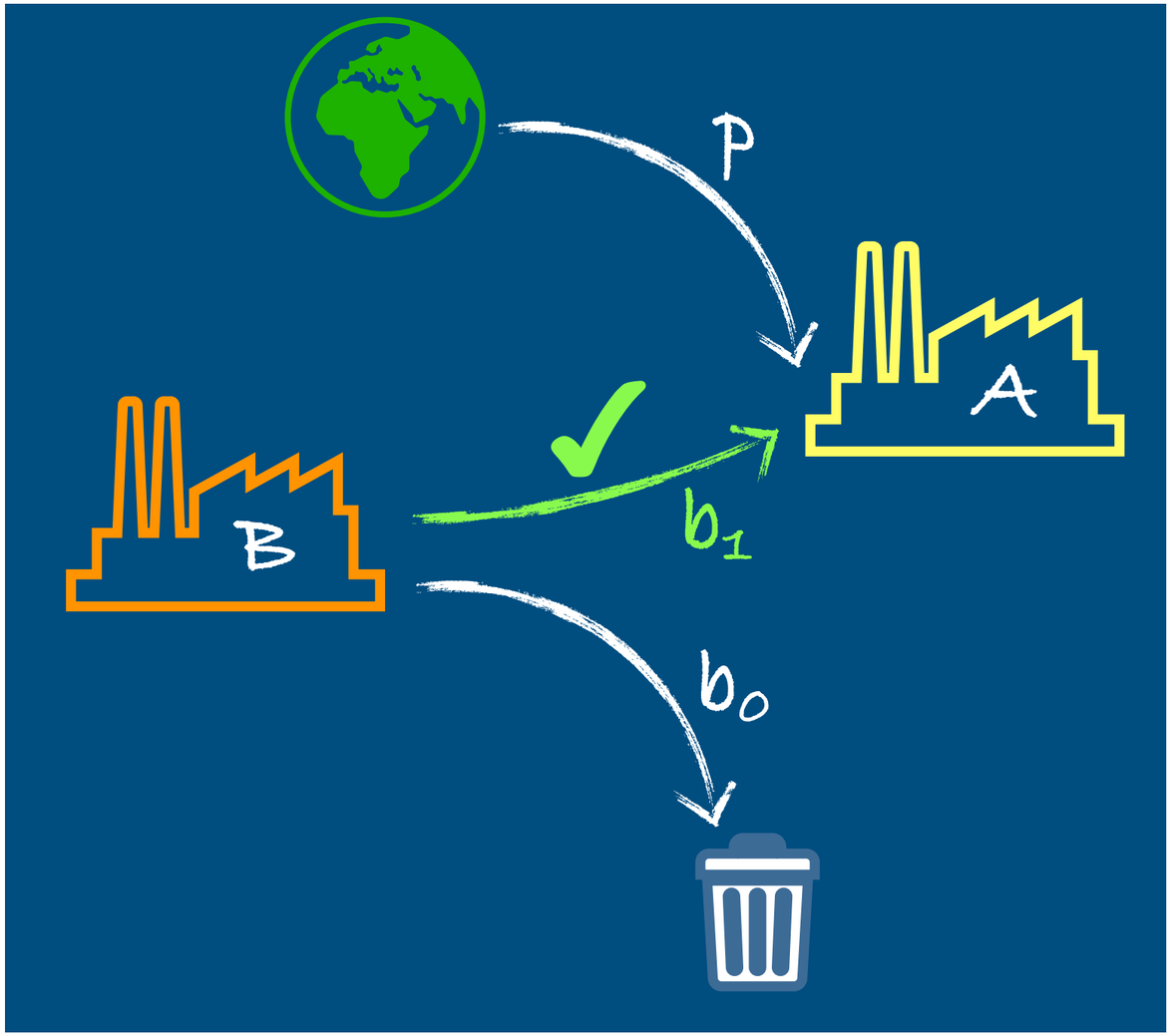


Utility/service synergies

Knowledge/competence synergies

Image: freepik.com

Residue/By-product synergies

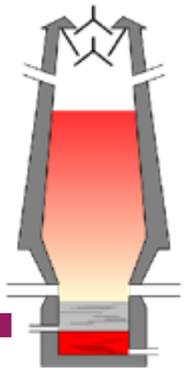


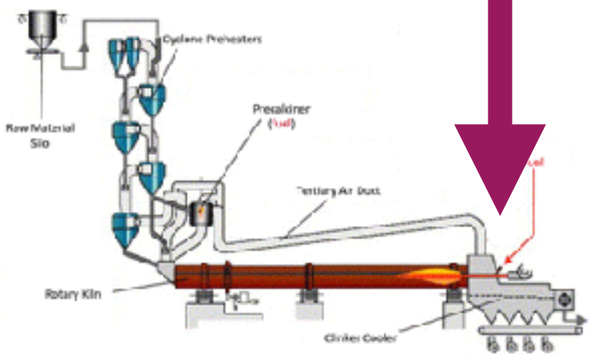
A non-product output of one actor (A) that is otherwise discarded or disposed (b_0), is used as a productive input (b_1), by another actor (B) substituting primary resources (p).

Examples

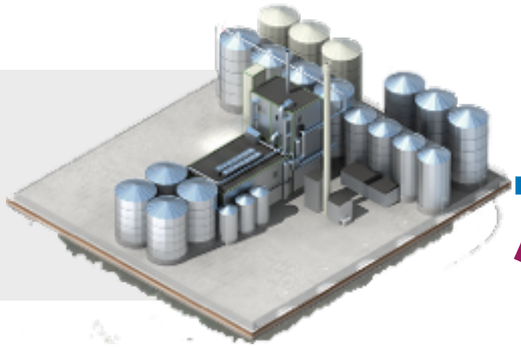
Gypsum for plasterboard Production

Blast furnace slag for cement production





Example - bioethanol production

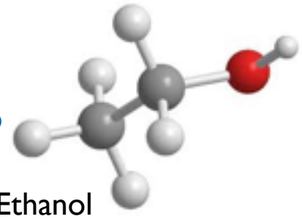


1/3

Spent grain & yeast

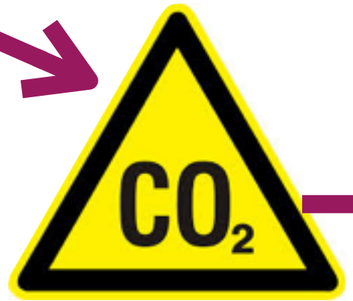
Fodder

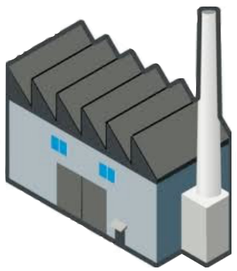
1/3



Ethanol

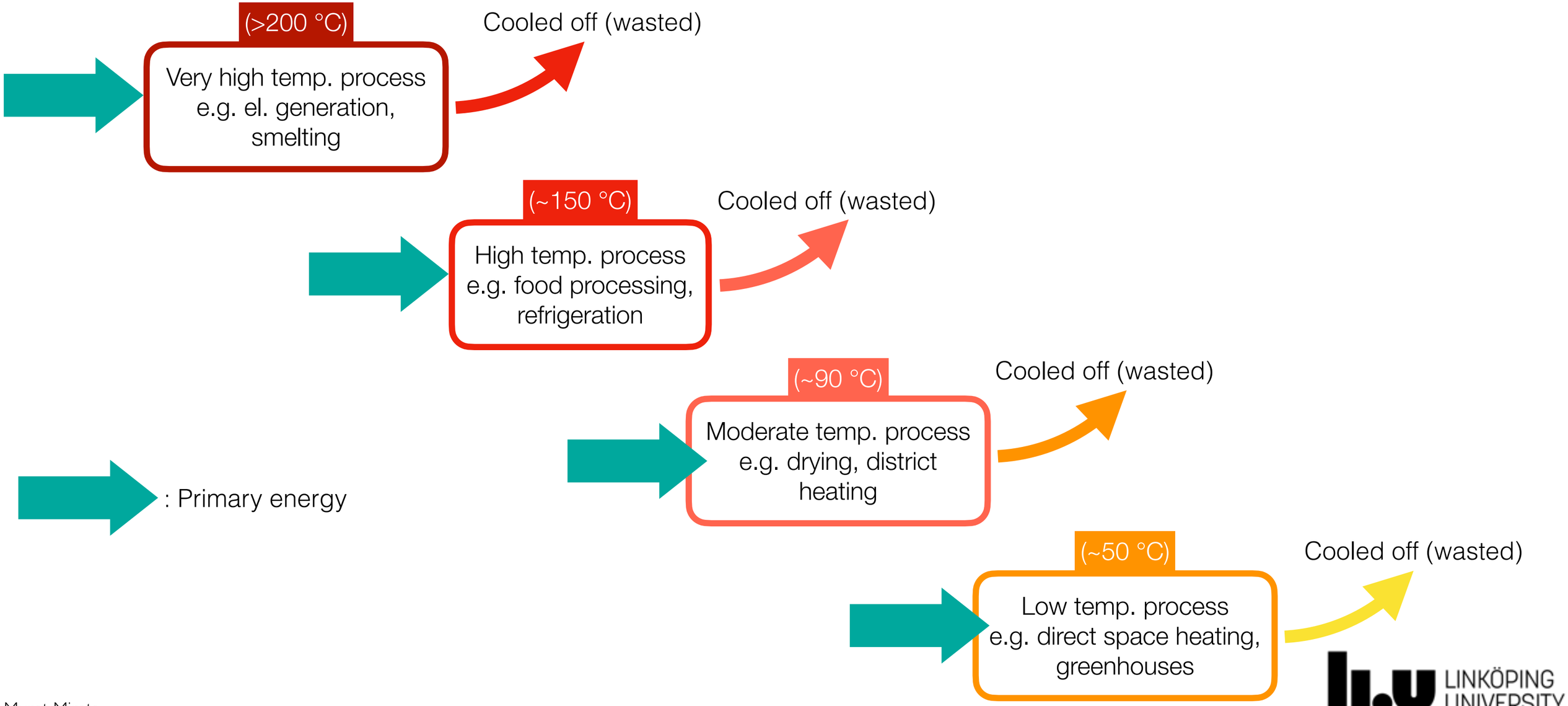
1/3



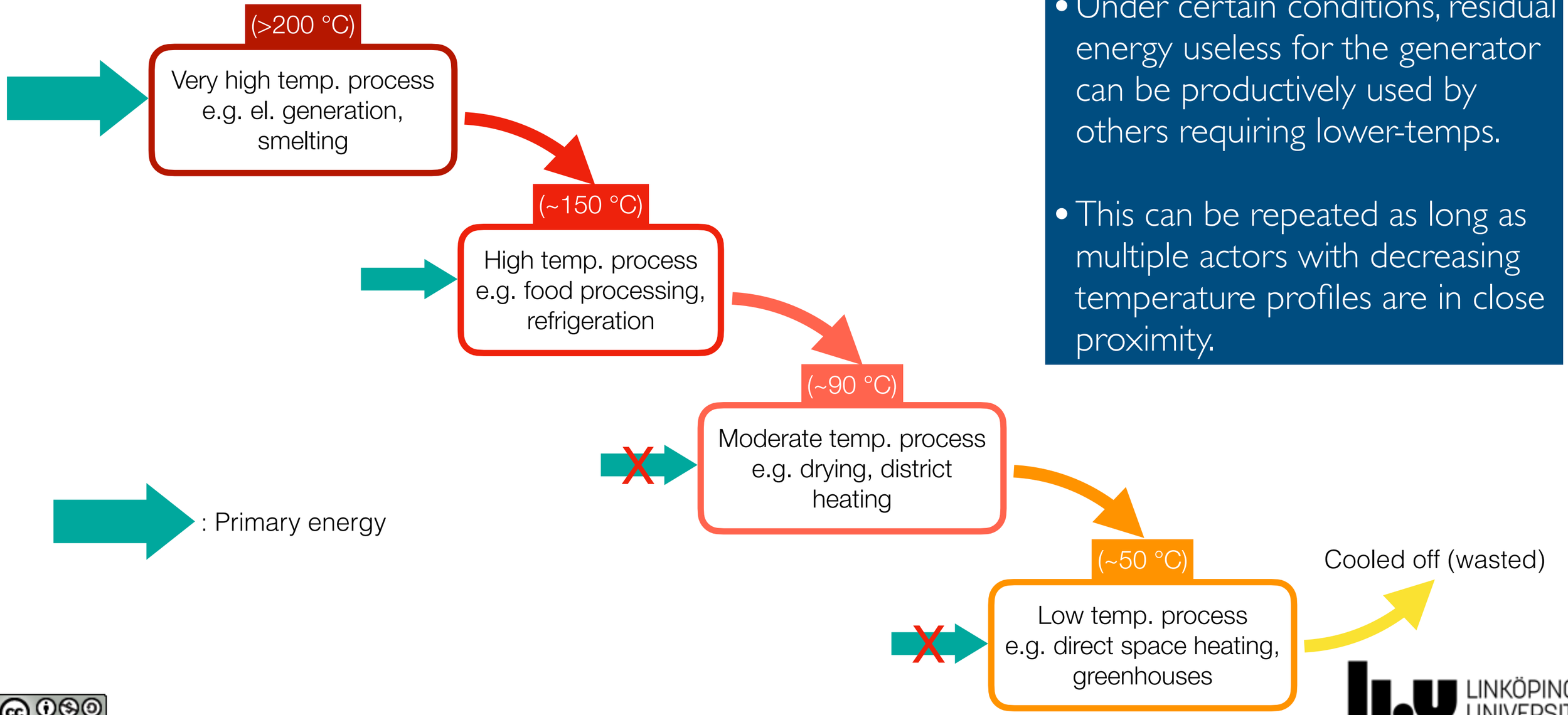


Biogas production

Energy cascading



Energy cascading



- Under certain conditions, residual energy useless for the generator can be productively used by others requiring lower-temps.
- This can be repeated as long as multiple actors with decreasing temperature profiles are in close proximity.

Murat Mirata

Example

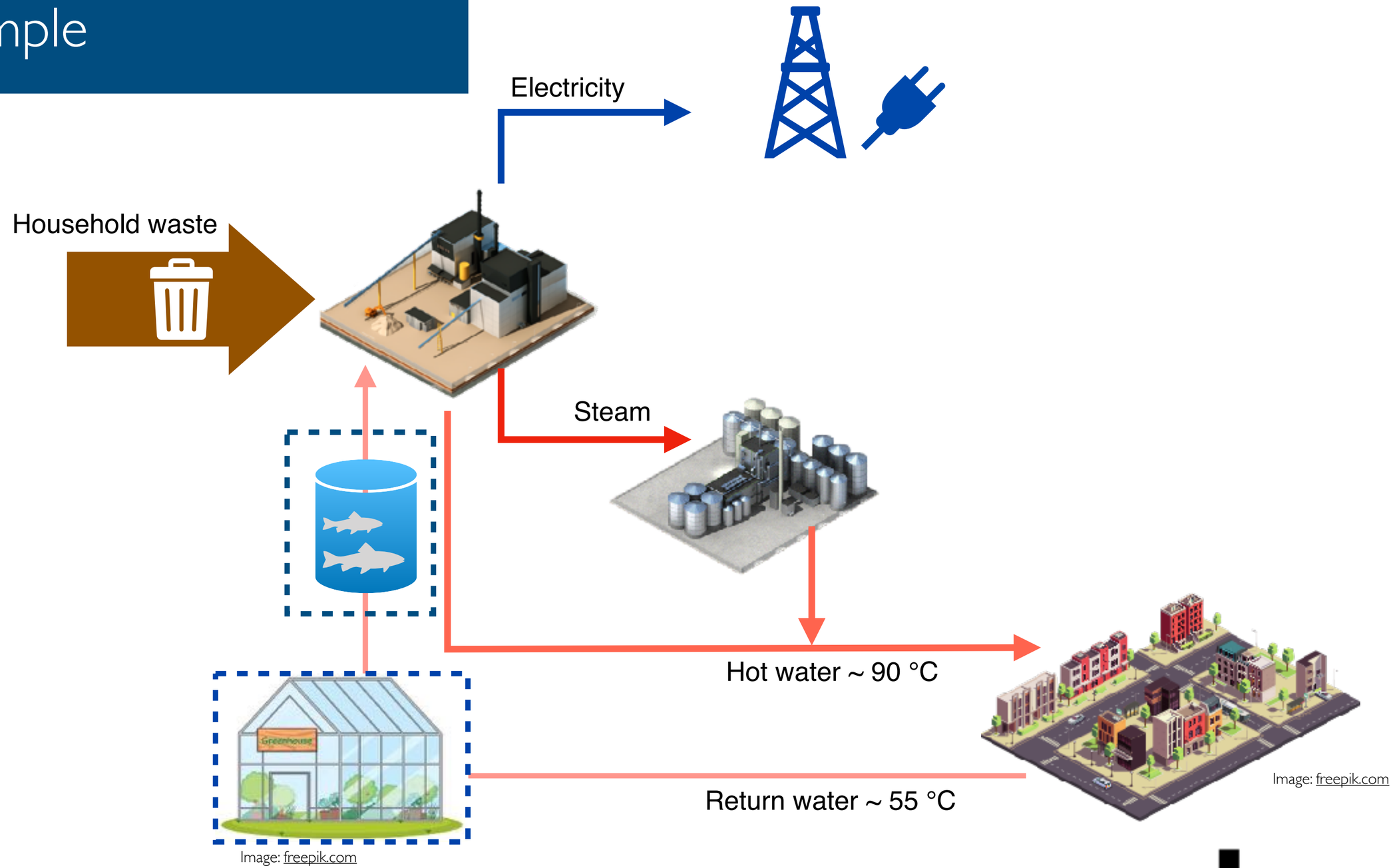
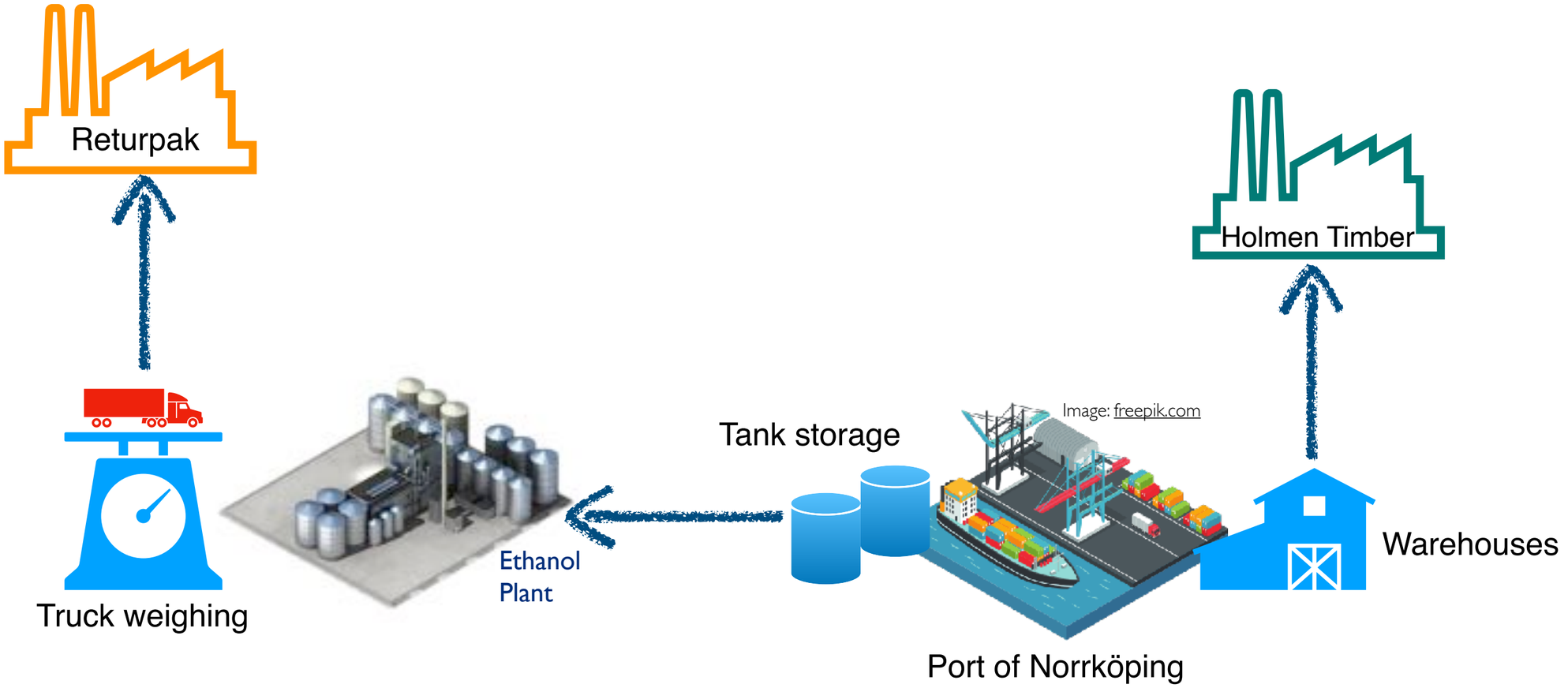


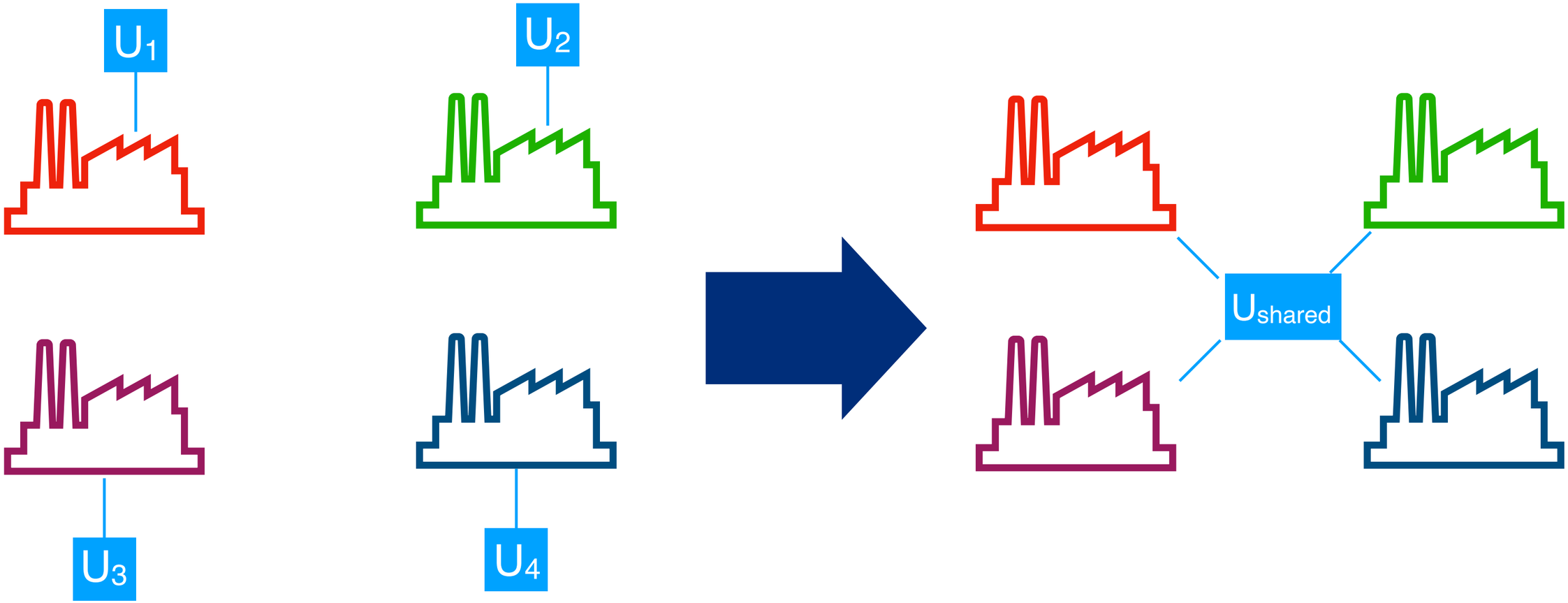
Image: freepik.com

Image: freepik.com

Facility/equipment synergies - Example

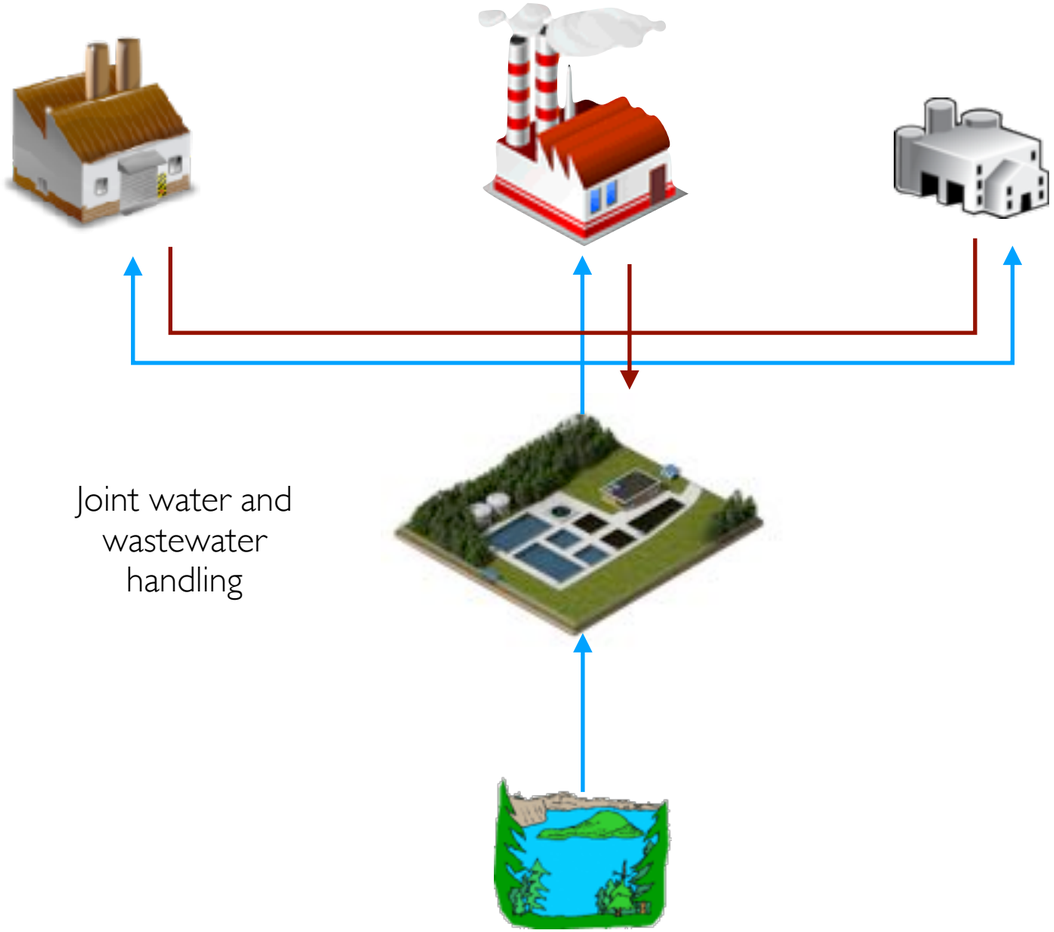


Utility & Service Synergies



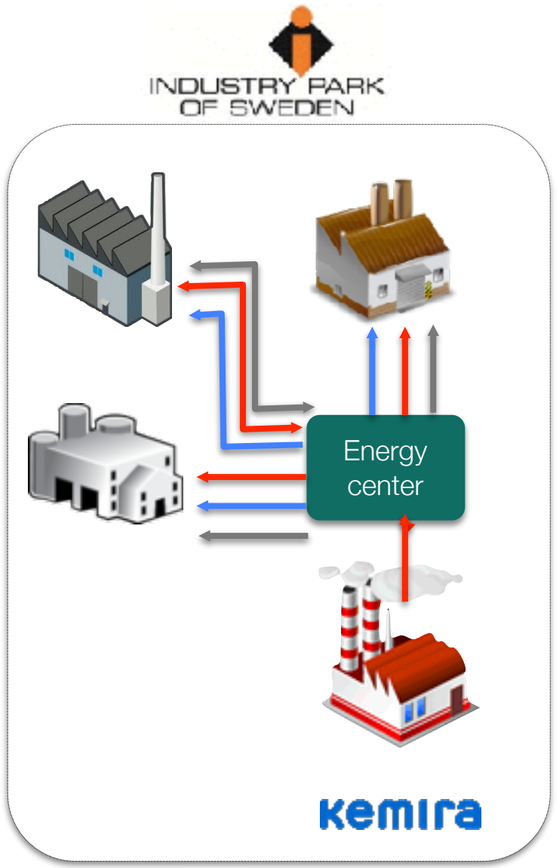
Examples

Kalundborg



Joint water and wastewater handling

Helsingborg



Steam
Process water
Compressed air

Knowledge and Capability Synergies

… better ideas for new products & services

… better conditions to act on ideas.

Image: freepik.com

Example - A sustainable transport solution

Etha

More info at: https://www.etha.se

Arla

Sustainable transport solutions

Sustainable fuel with >90% CO_2 reduction

Lantmännen Agroetanol

Sekab

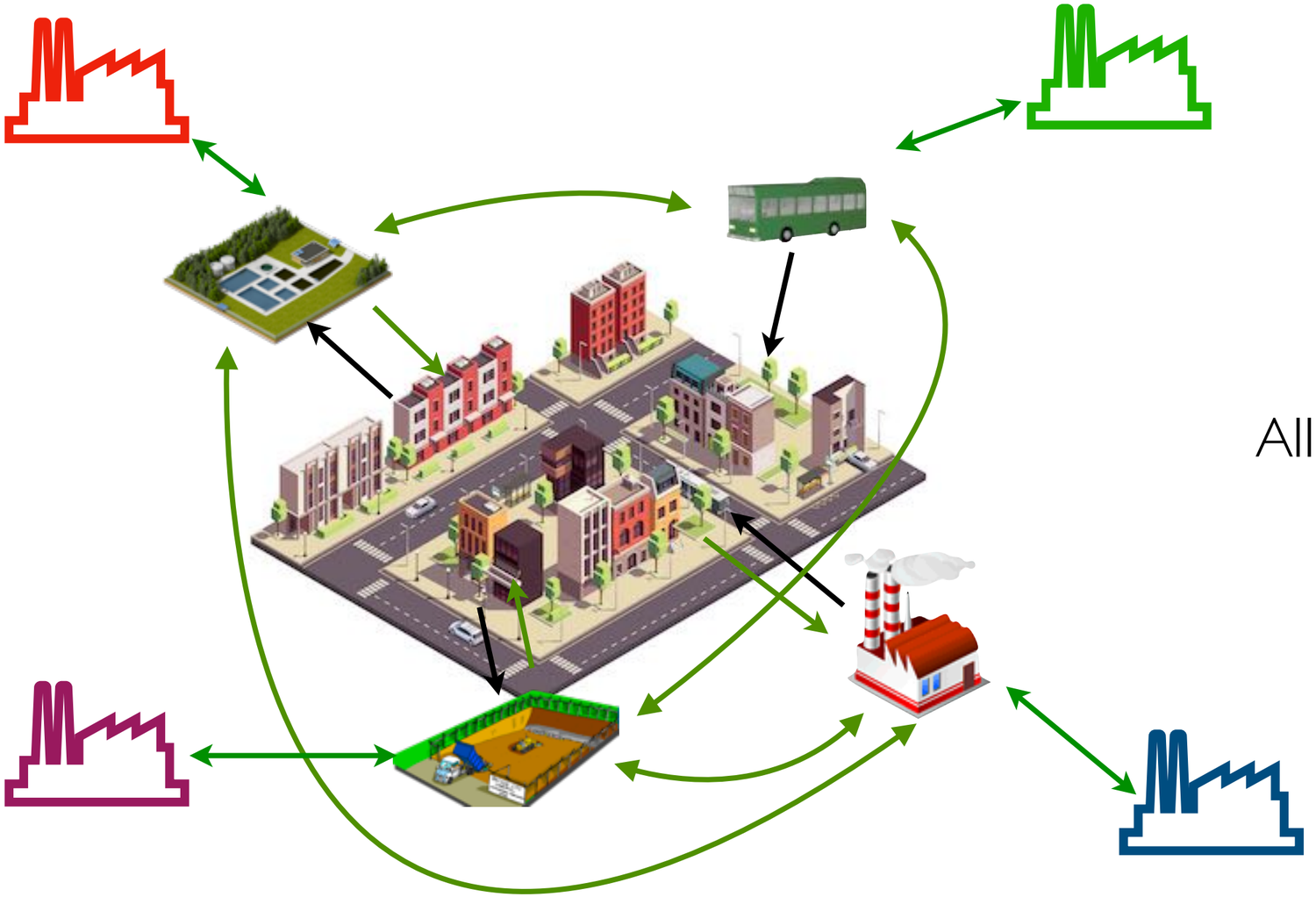
SWEDISH ETHANOL CHEMISTRY

Customised distribution solutions

SCANIA

Latest generation ethanol vehicles with diesel principle

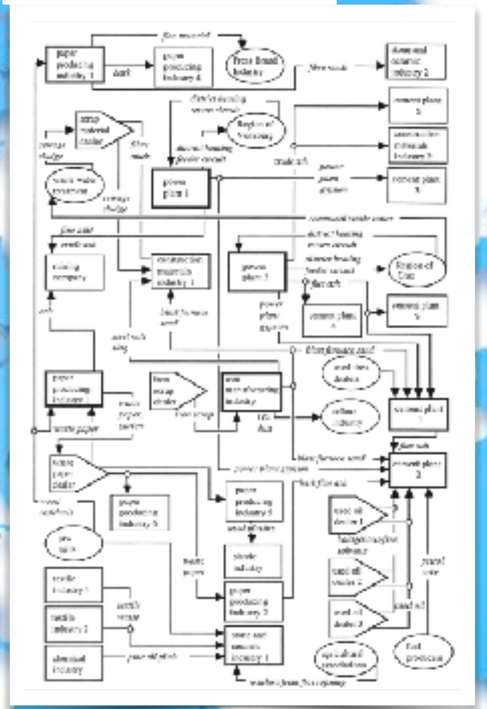
Urban Synergies

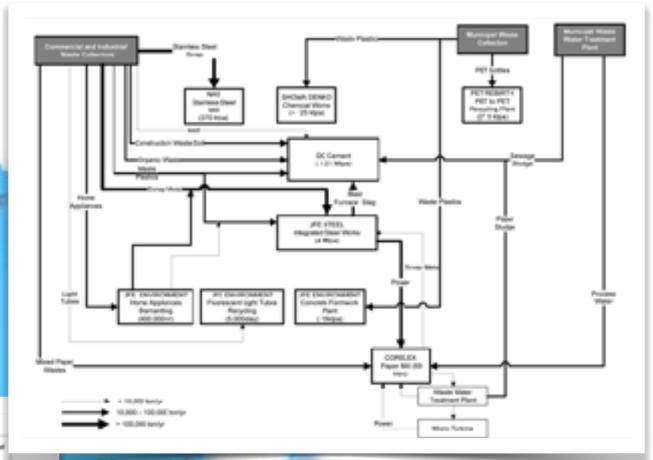


All synergy forms involving resource flows connected to urban areas.

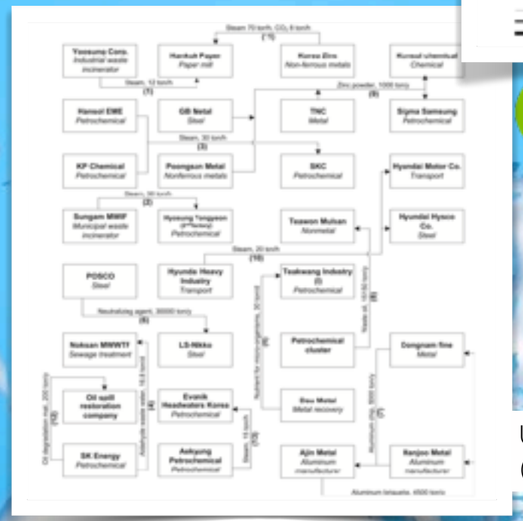
Operational Industrial Symbiosis examples

Styria, Austria
(Schwarz & Steininger, 1997)



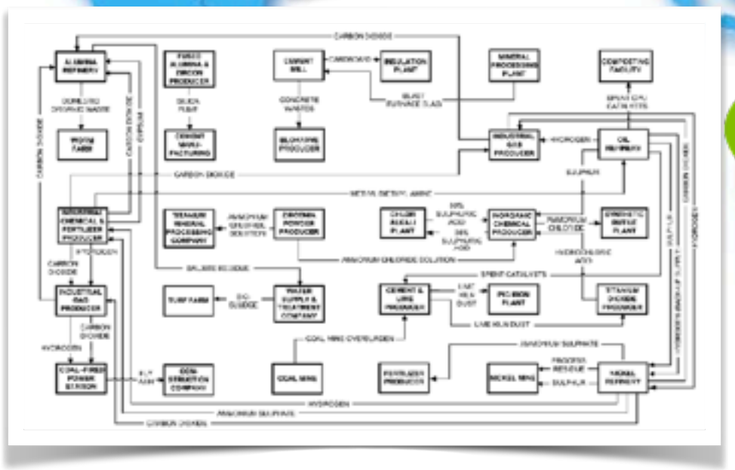


Kawasaki, Japan
(Van Berkel et al., 2009)



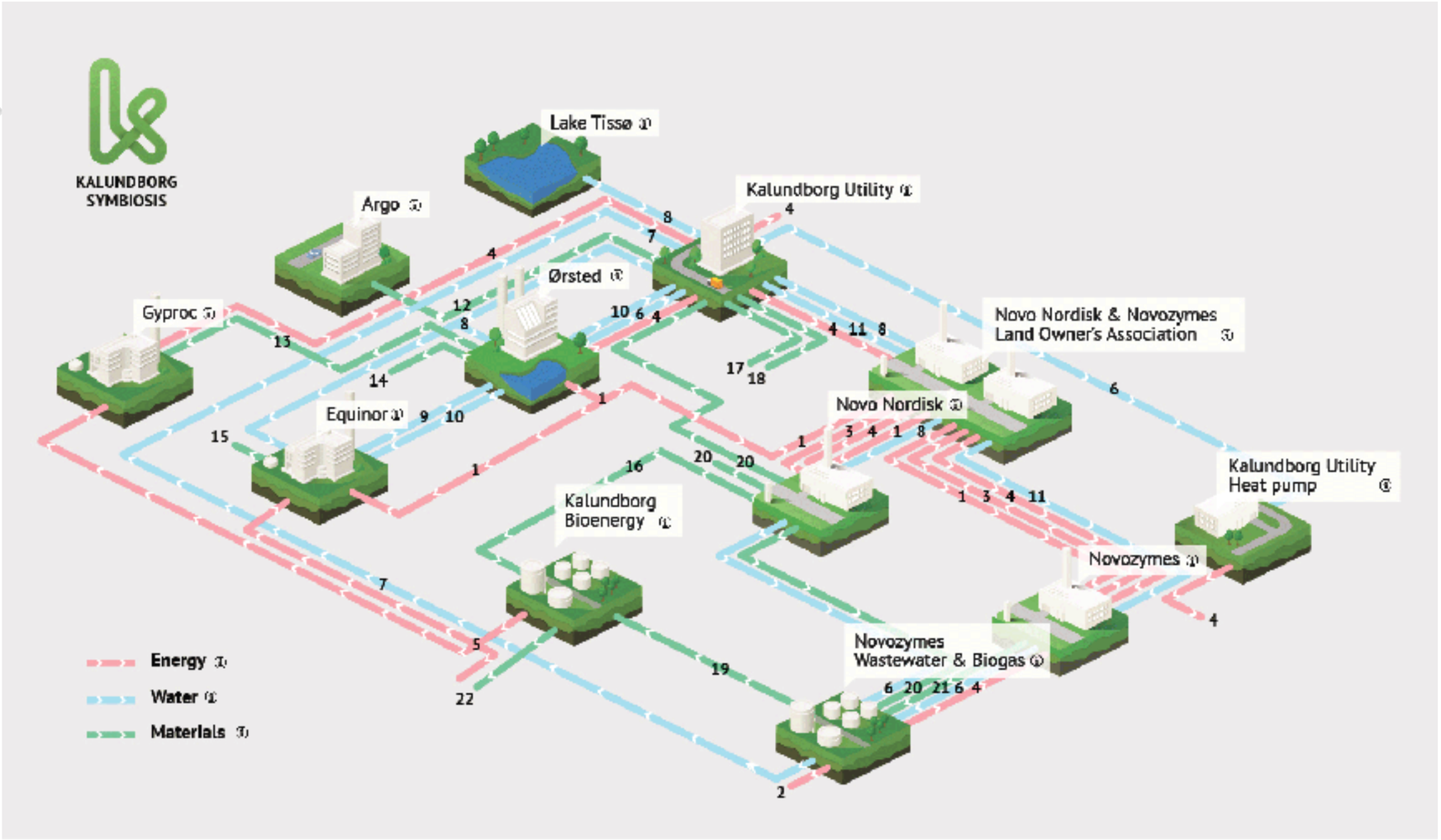
Ulsan, South Korea
(Behera et al., 2012)

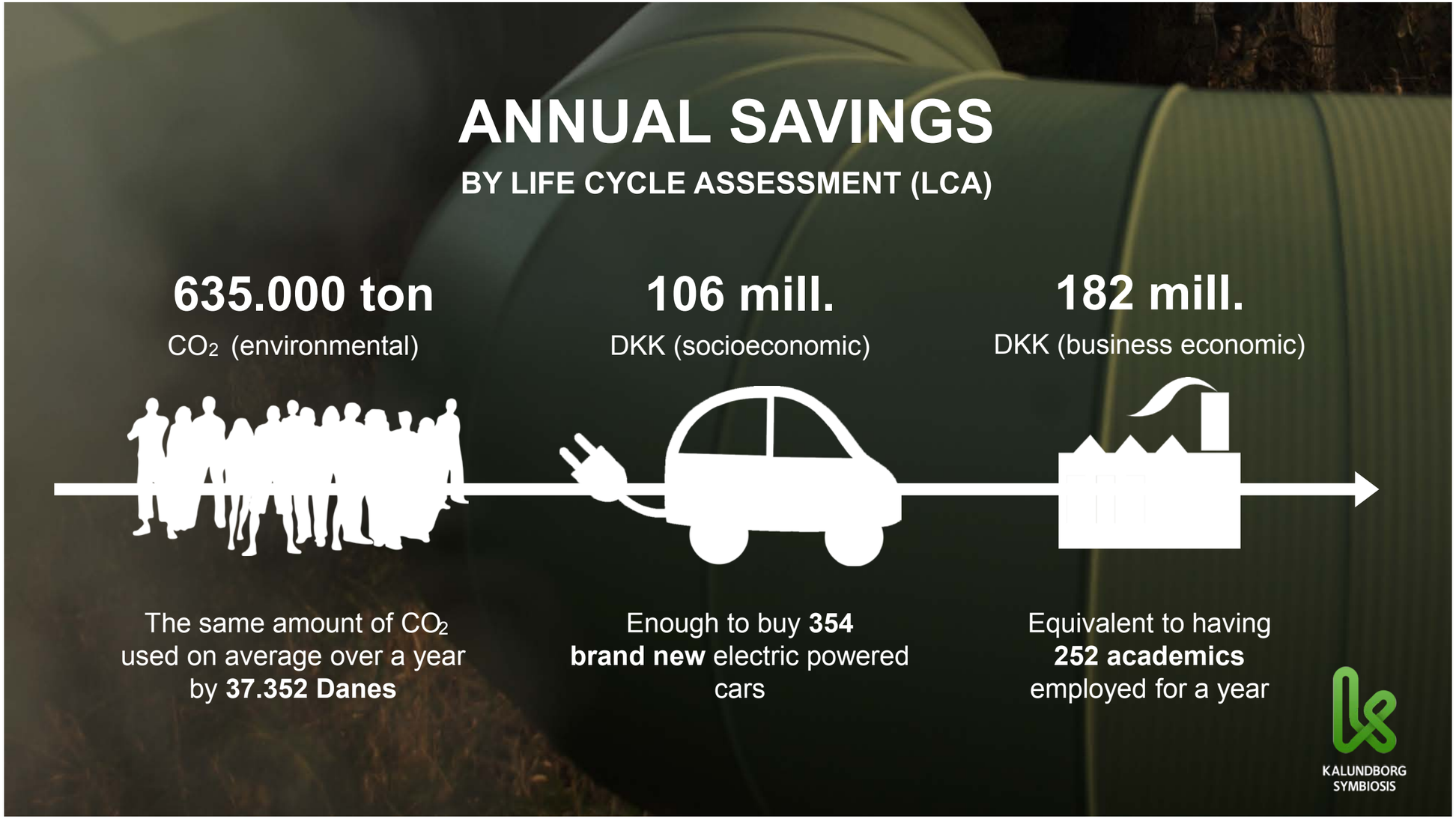
Many global examples from heavy fossil/ mineral industry sites.



Kwinana, Australia
(Van Beers et al., 2009)

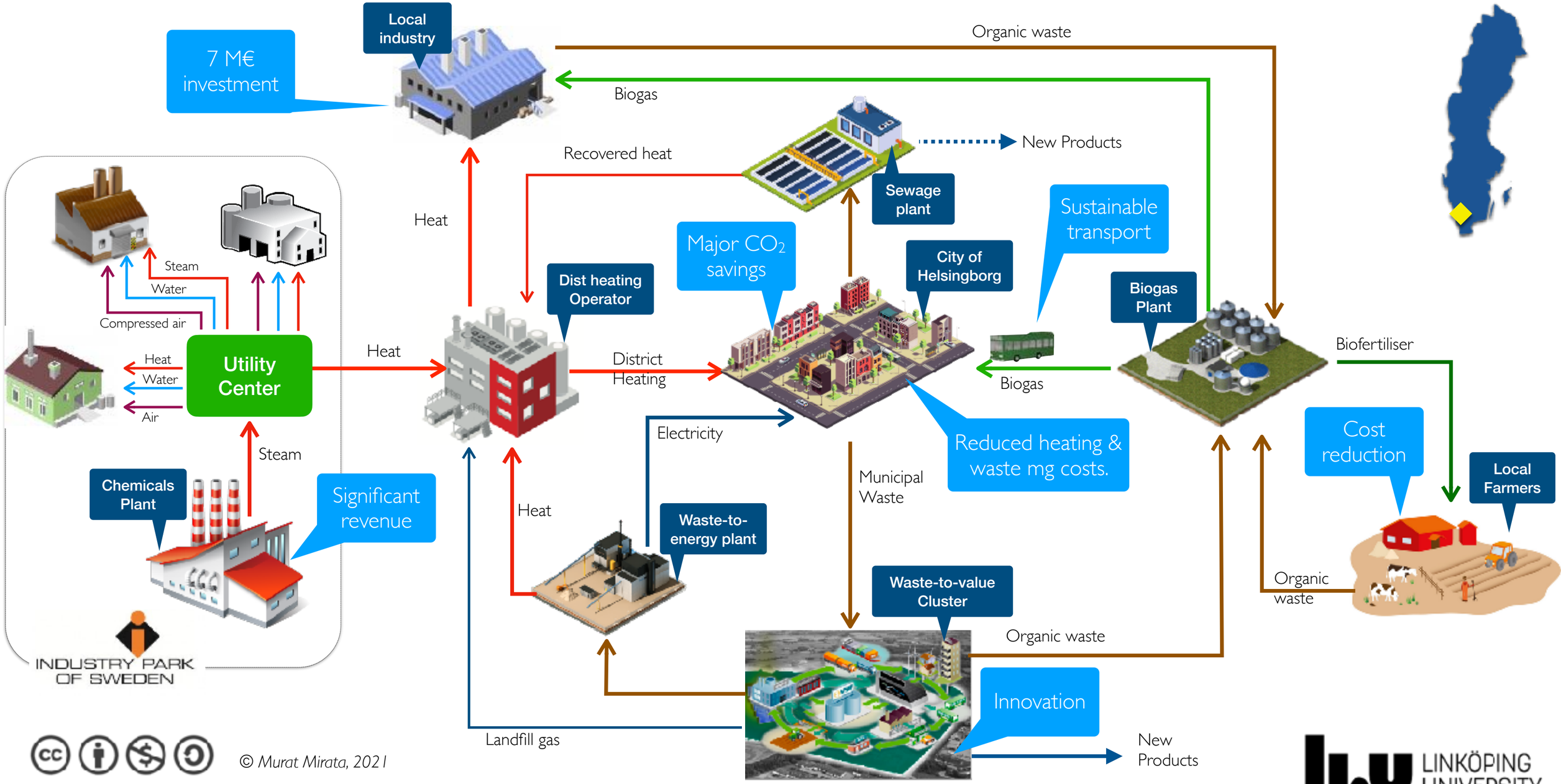
Kalundborg, Denmark





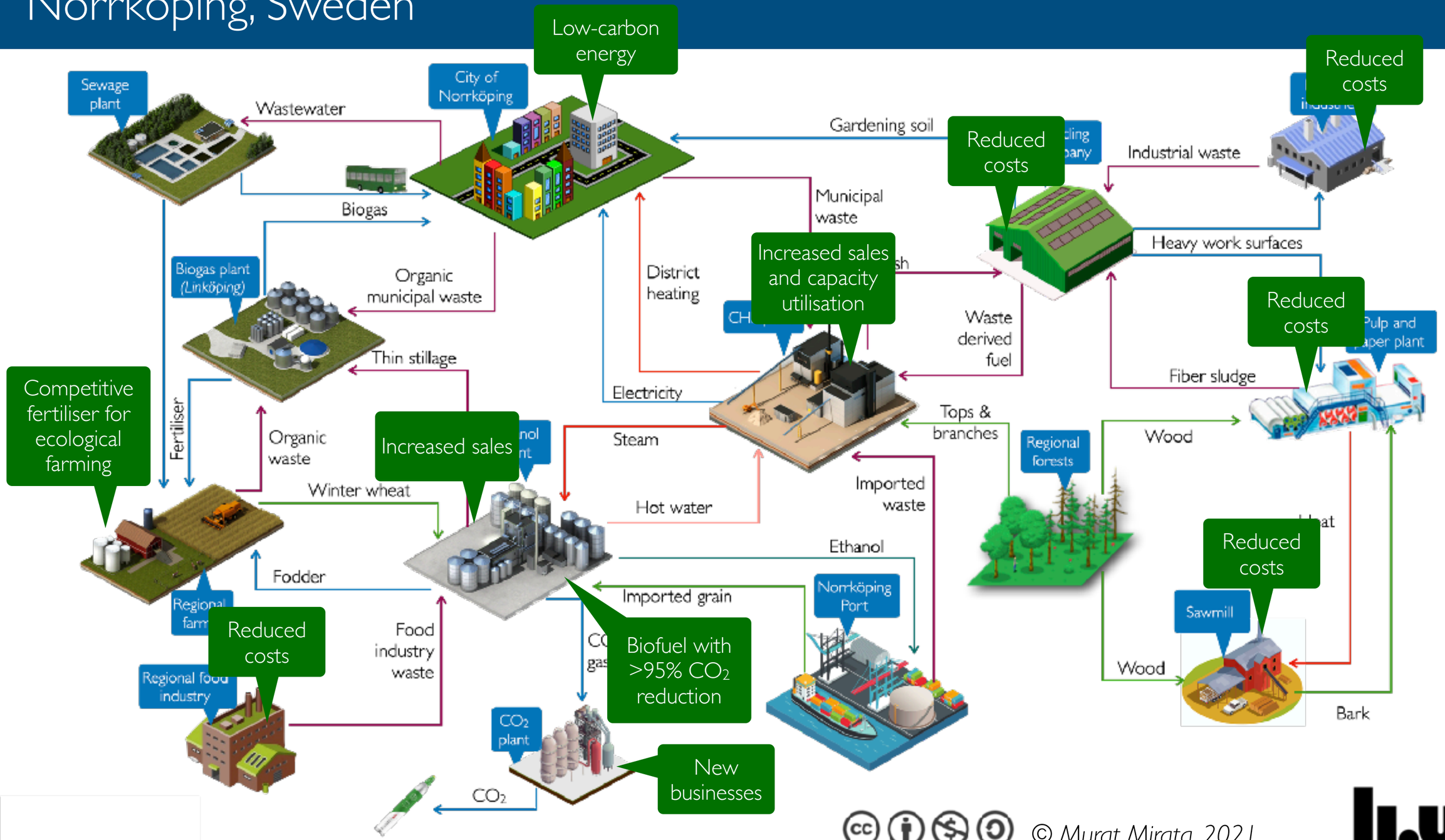
Courtesy of Per Møller, Kalundborg Symbiosis.

Helsingborg, Sweden



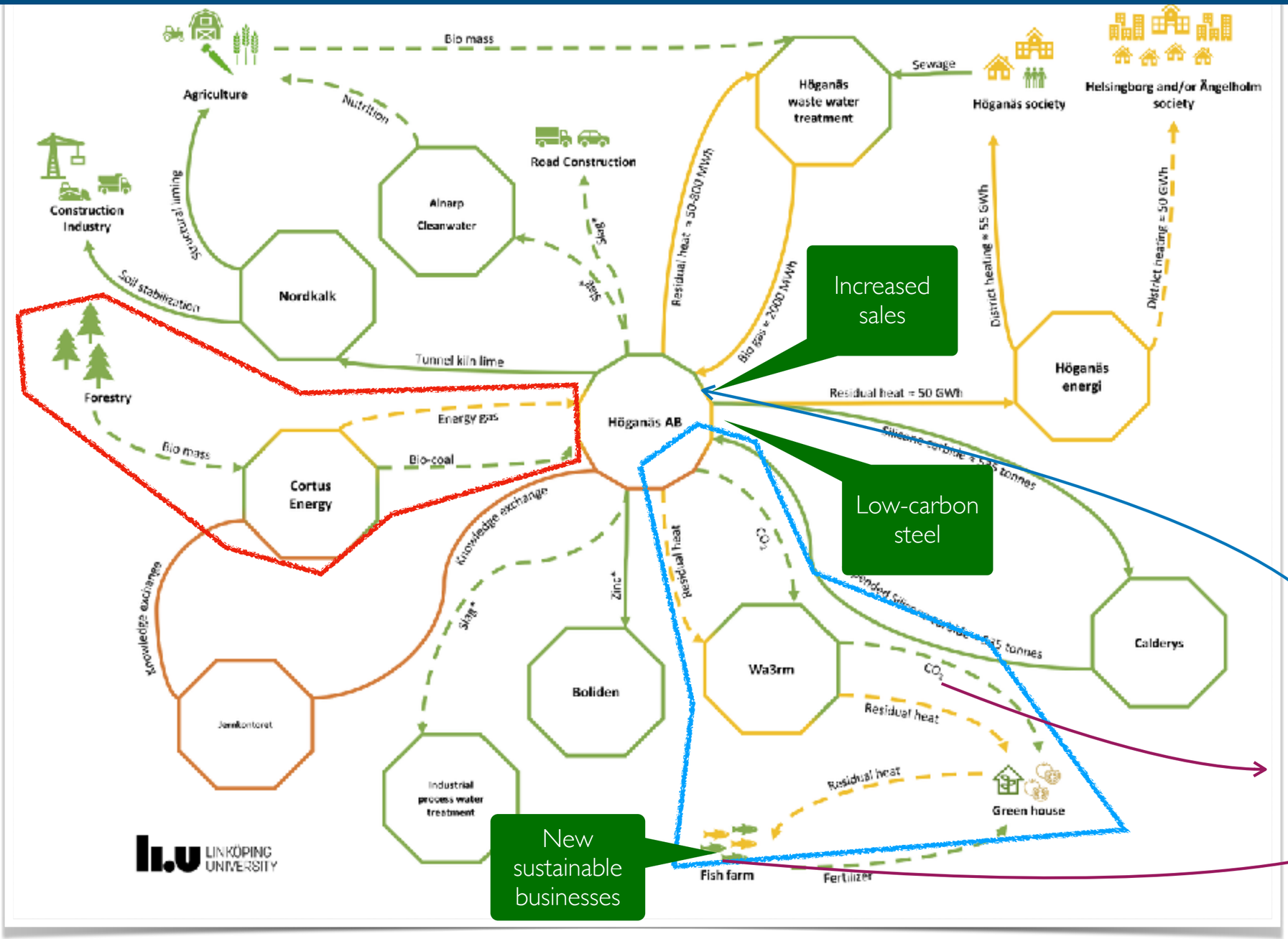
LINKÖPING UNIVERSITY

Norrköping, Sweden



LINKÖPING UNIVERSITY

Höganäs, Sweden



Increased sales

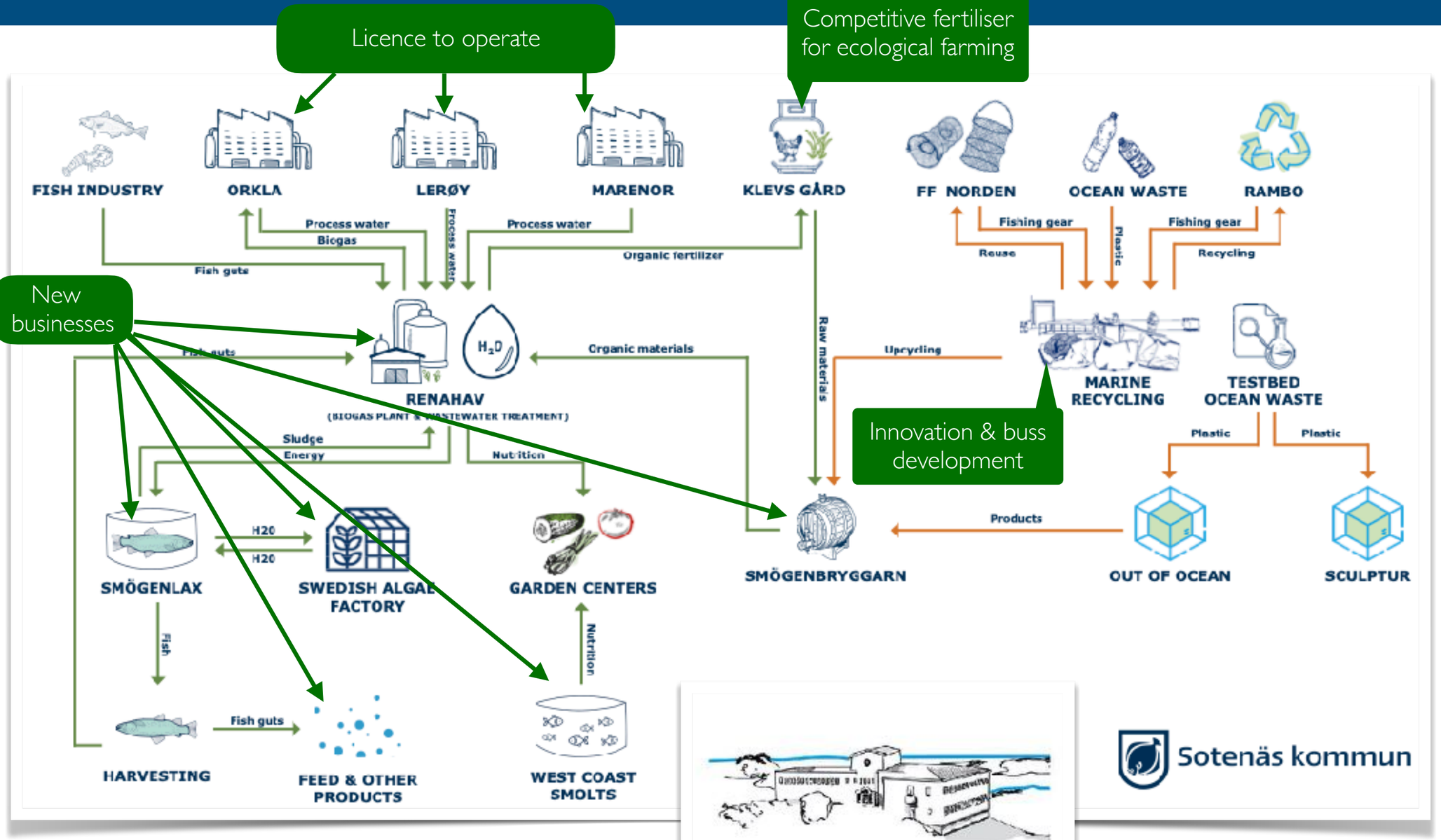
Low-carbon steel

New sustainable businesses

LINKÖPING UNIVERSITY

Murat Mirata

Sotenäs, Sweden



VISA ALLA BILDER (3)

SOTENÄS

20 miljarder investeras i fiskindustri i Sotenäs

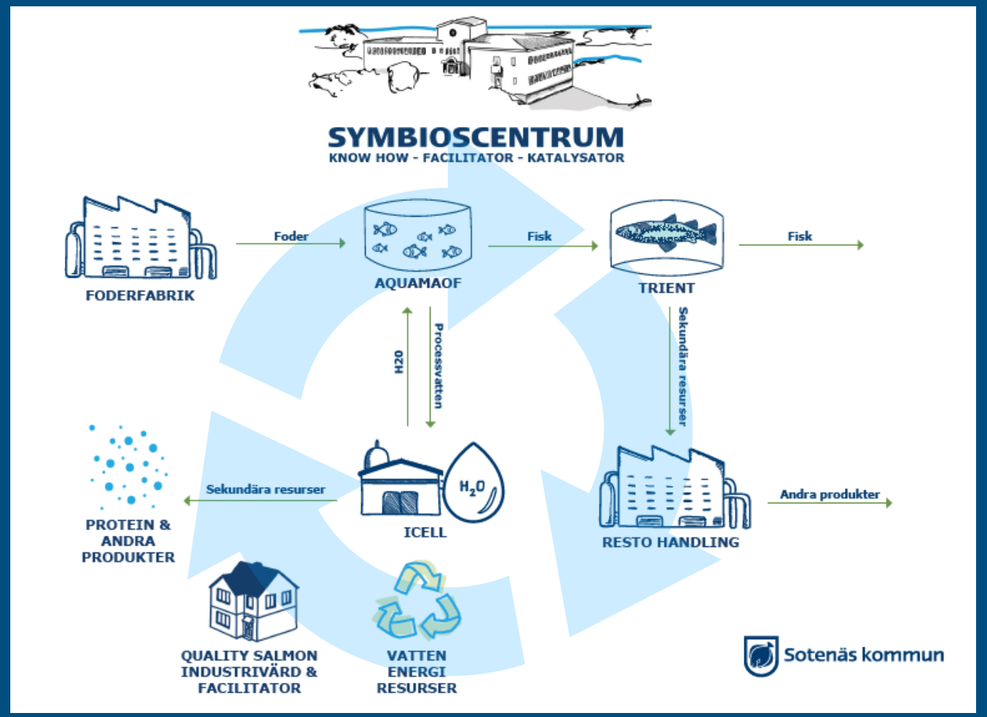
2:28 min Min sida Dela

Publicerat torsdag 19 mars kl 12.10

- Sotenäs kommun och norska Lighthouse finance är överens om en mångmiljardsatsning på bland annat fiskodling i kommunen.
- Man ska bygga Europas största landbaserade fiskodling. Det är en etablering värd mellan 17 och 20 miljarder kronor. Anläggningen i Sotenäs kommer att ha produktionskapacitet på upp till 100 000 ton atlantisk lax.
- "Det kommer att innebära cirka 2 000 nya arbetstillfällen, på ett 75 hektar stort industriområde", säger kommunstyrelsens ordförande Mats Abrahamsson (M).

Källa: sverigesradio.se

Planned new developments



100 000 t salmon/y

+

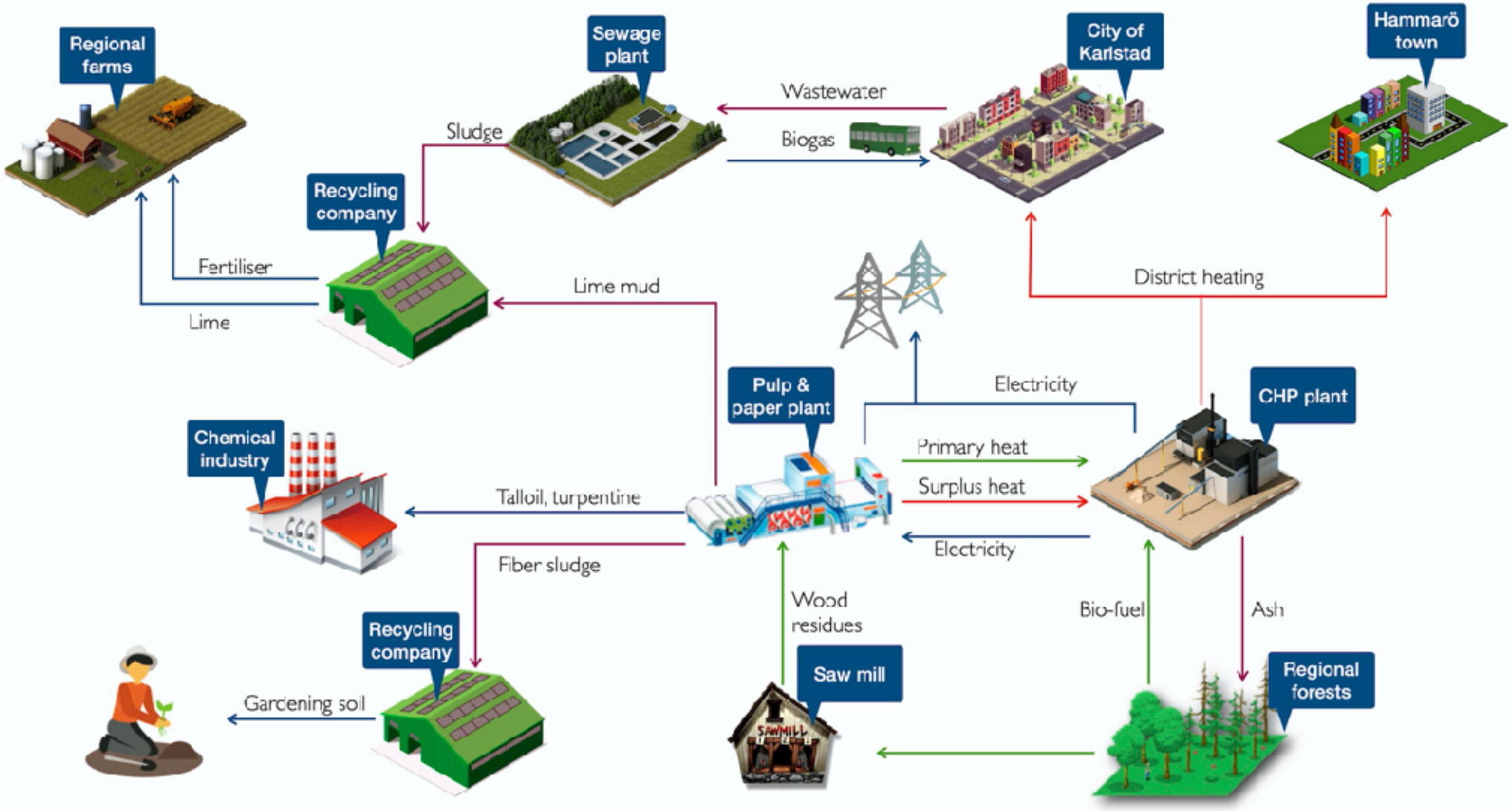
Feed

Feedstock

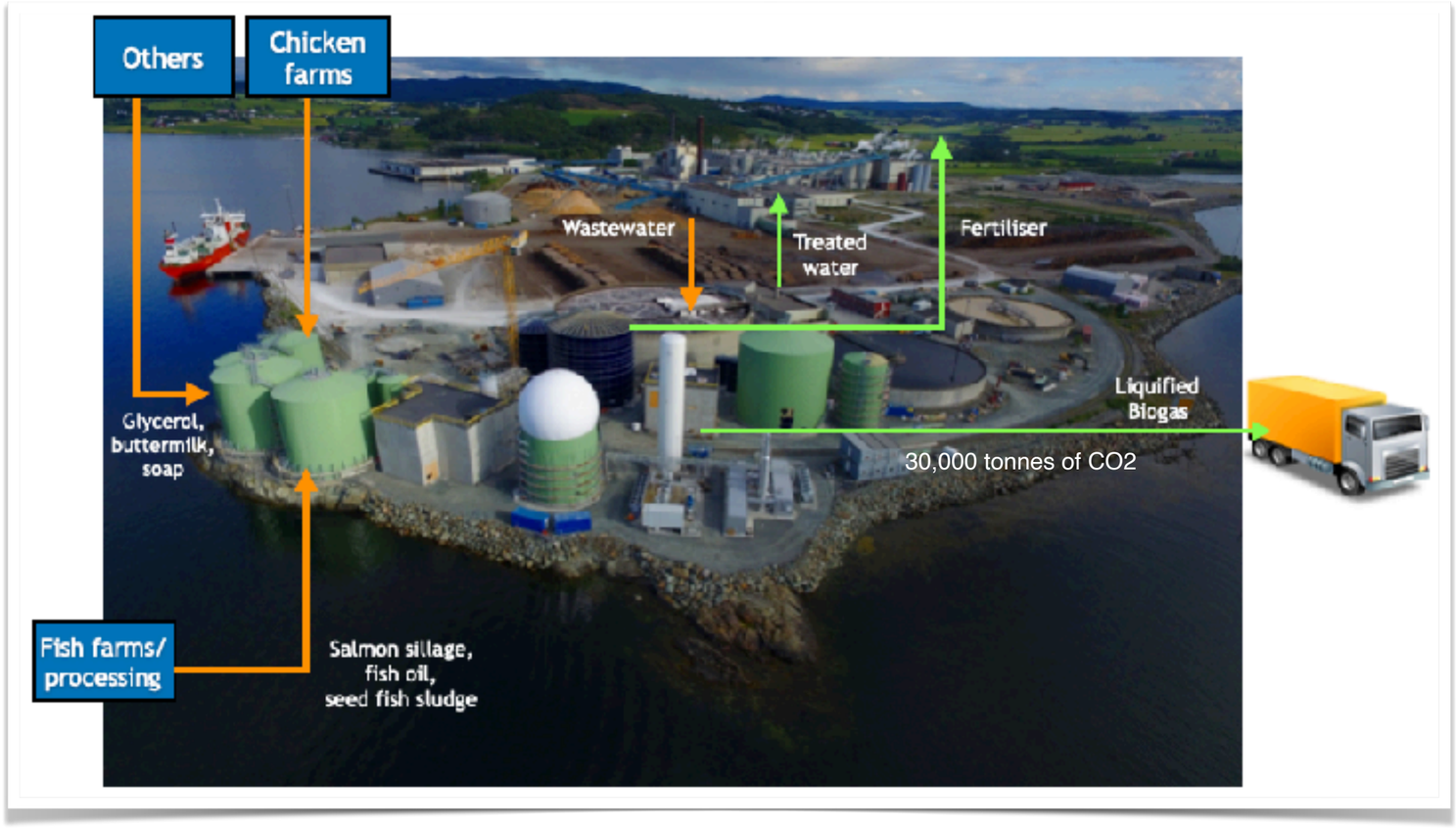
Fuel

LINKÖPING UNIVERSITY

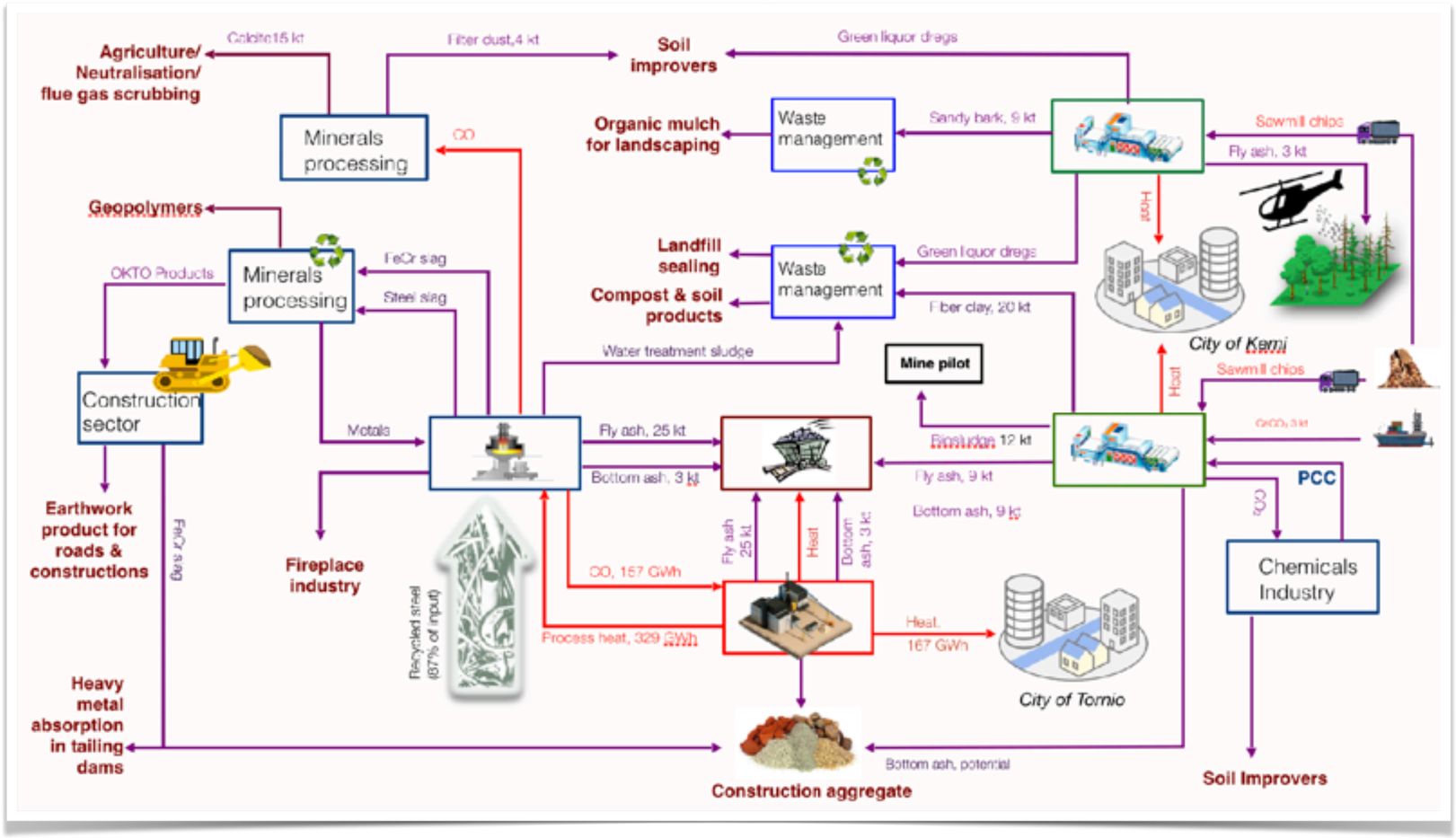
Karlstad, Sweden



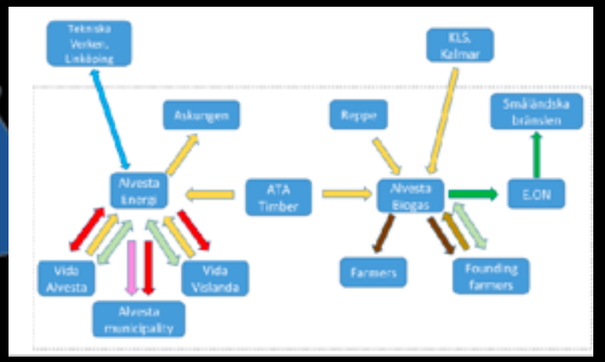
Skogn, Norway

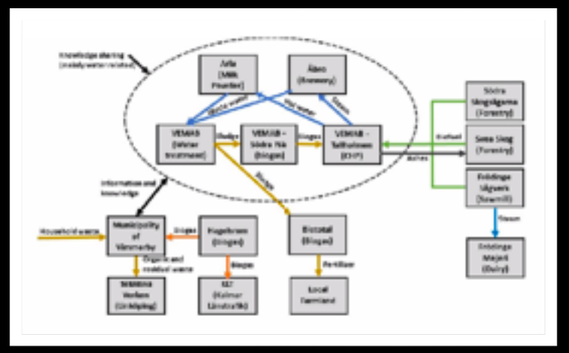


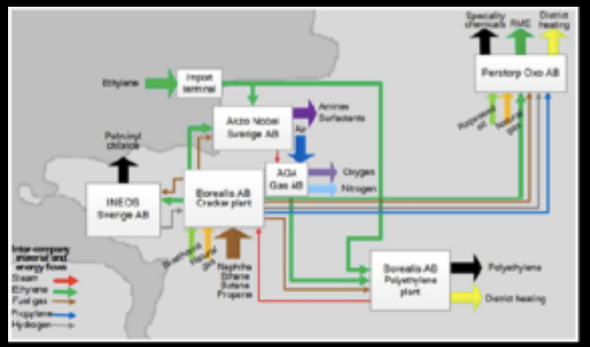
Kemi-Tornio, Finland

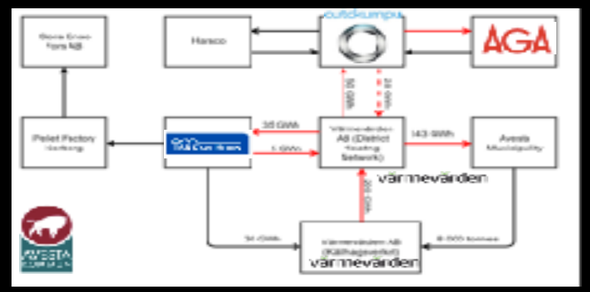


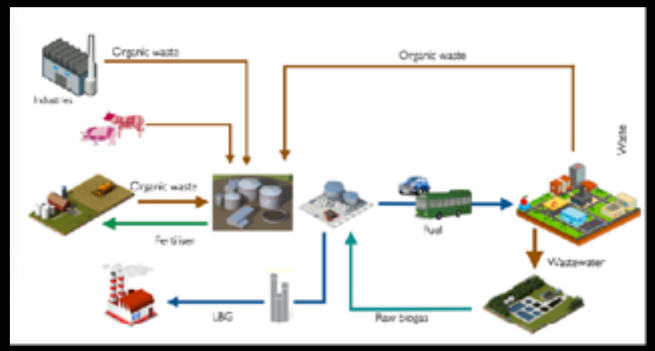
Courtesy of Digipolis, Finland.

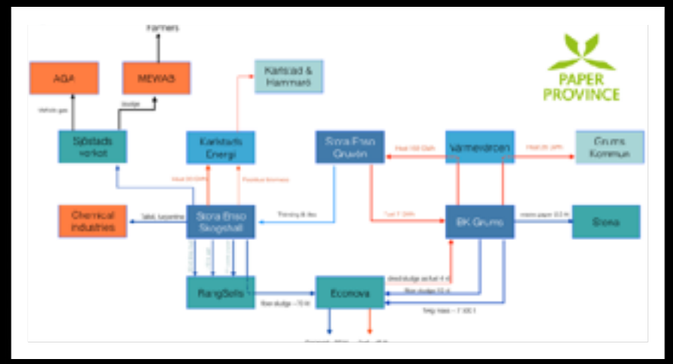


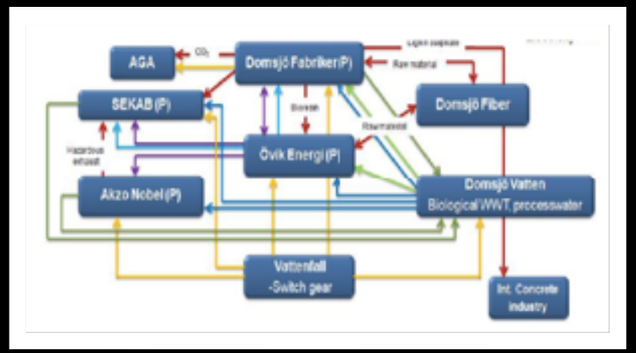












Murat Mirata

LINKÖPING UNIVERSITY

Business benefits

Enhancing:

- Sales
- Market & product diversification
- Operational efficiency and stability
- Compliance
- Stakeholder relations
- Innovation capabilities

Reducing costs & risks for:

- Inputs
- Residue handling
- Operations
- Transport

Socio-economic benefits

- Improved services at lower costs
- Improved environmental quality
- Jobs creation and retention
- Increased tax base
- Economic resilience
- Place branding
- New sustainable investments and businesses

Stimulating new business development

Operational

- Collection
- Processing
- Distribution
- Transfer/storage

Supportive

- New technologies/applications
- New services/workflows;
- New services (platforms, knowledge, connections)
- New business models;

ECONOVA

WA³RM

ecoloop

biototal

RAGN SELLS

SWEDISH ALGAE FACTORY

Gasum

againity

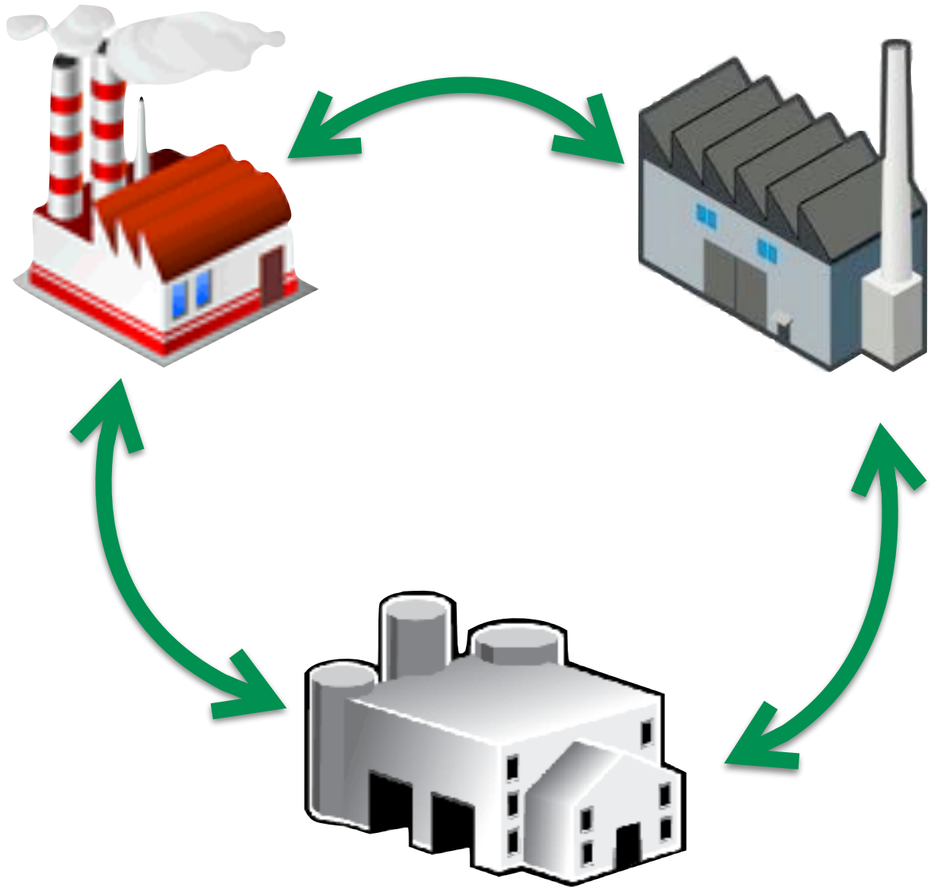
Renahav

ectogrid™ POWERED BY e·on

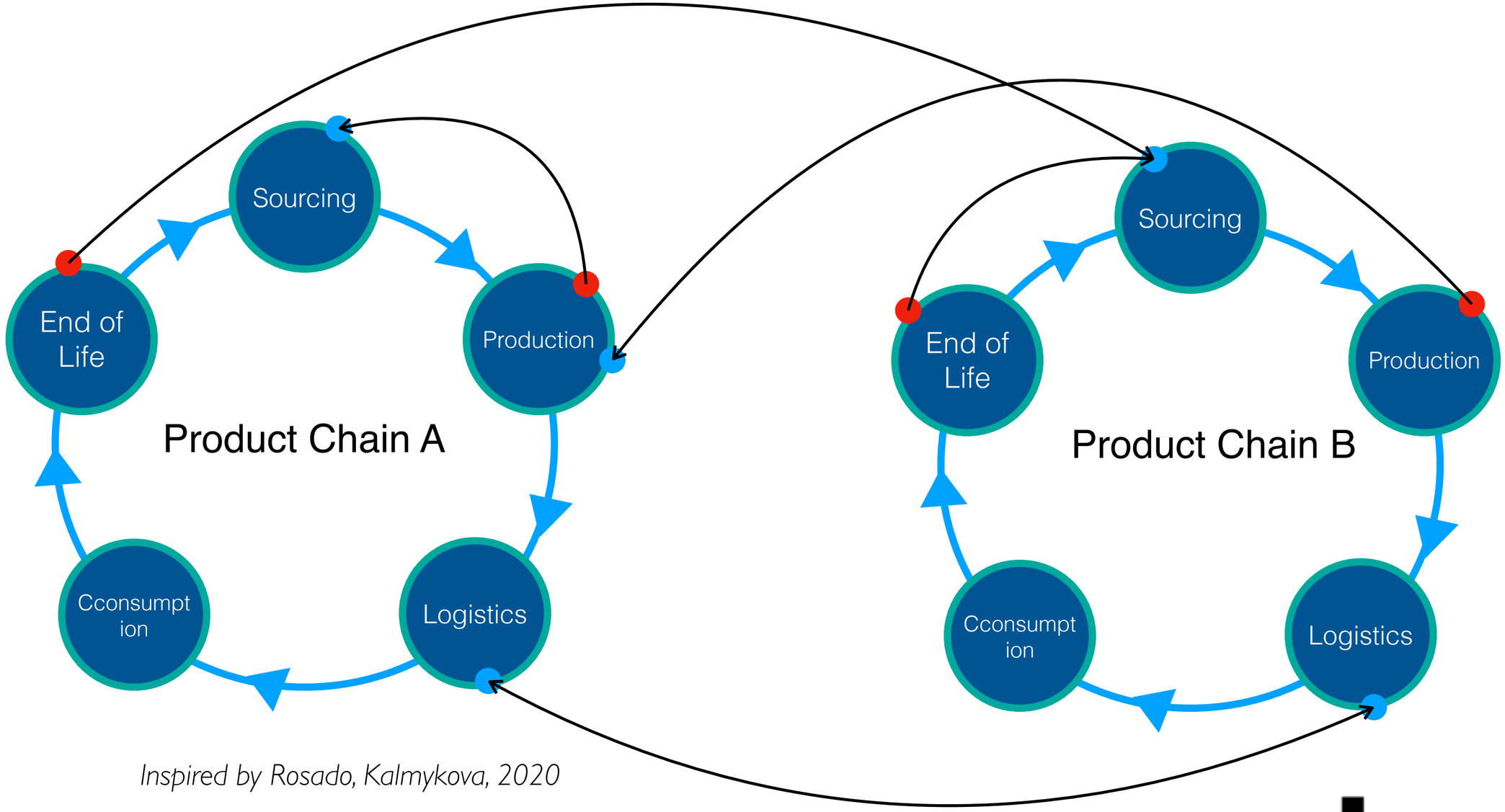
Environmental benefits

- Reduced need for primary resource extraction, processing and transport
- Reduced waste and emission generation
- Reduced fossil-resource and increased renewables usage

IS – circularity in production

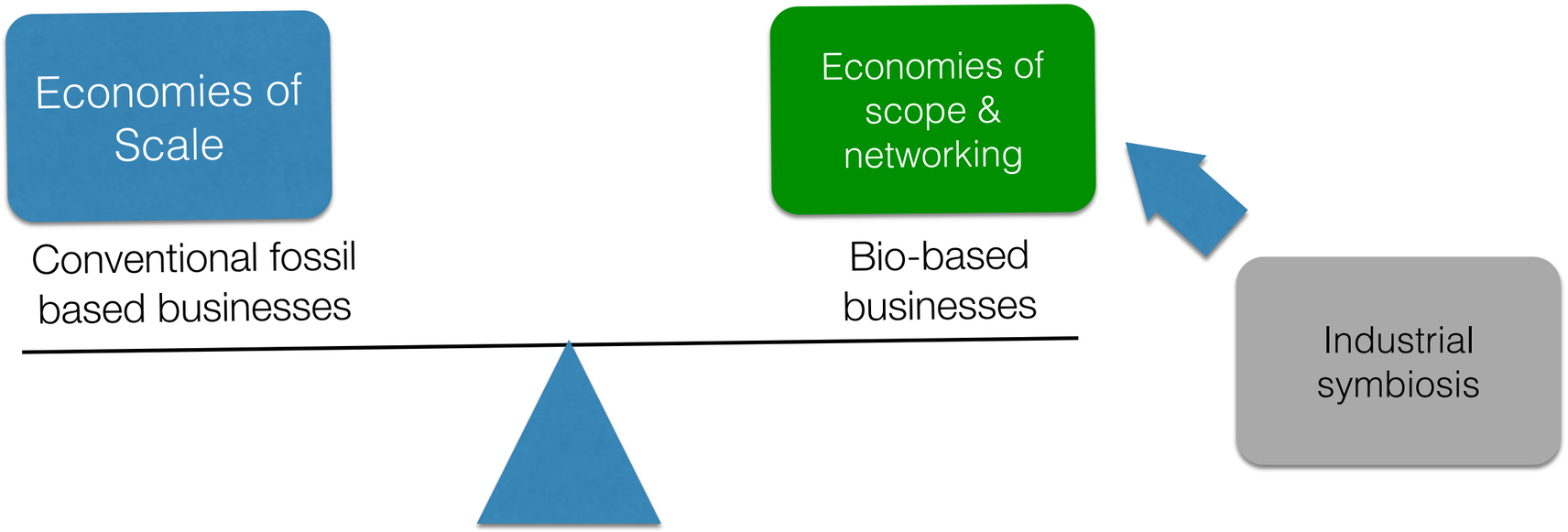


IUS takes circularity to next level



Inspired by Rosado, Kalmykova, 2020

Emerging importance of IS for Bio-based economies



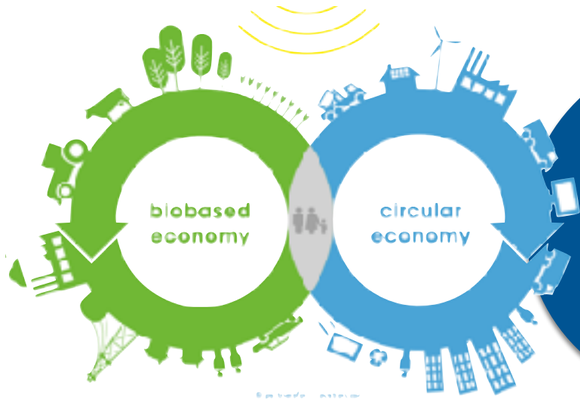
- Reduced supply, production & waste mgt. costs
- Access to more socially acceptable feedstock;
- Diversification of marketable products and increased revenues.
- Collectively driving regime change

Industrial & Urban Symbiosis is an enabler

Business competitiveness

Innovative collaborations

Collaborative innovations



Bio-based & circular economies

Sustainable urban & rural development

Large potential to be harvested

Based on Material Economics, 2018

13 Billion SEK (24%)

55 Billion SEK

42 Billion SEK (76%)

87 %

LOSS OF PLASTICS VALUE

58 %

LOSS OF STEEL VALUE

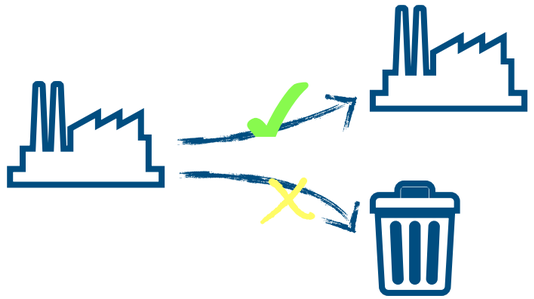
62 %

LOSS OF ALUMINIUM VALUE

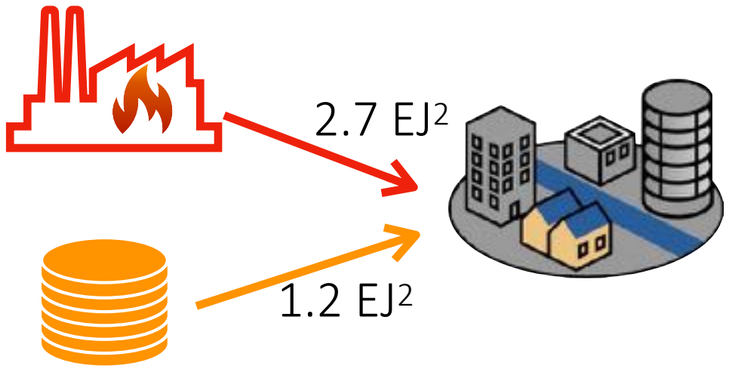
Murat Mirata

LINKÖPING UNIVERSITY

Big opportunities remain to be harvested in the EU



€ 86 billion/year[1]



€ 16 billion/year[3]

1: Domenech et al., 2018.
2: Wheatcroft et al., 2020.
3: Calculated based on 15 €/kWh value for heat and without considering savings from primary energy purchase.

Self-organised

Facilitated

Industrial and Urban Symbiosis

BALTIC INDUSTRIAL SYMBIOSIS

QUESTIONS & INQUIRIES

Murat Mirata (PhD)

murat.mirata@liu.se

Interreg Baltic Sea Region

EUROPEAN UNION

EUROPEAN REGIONAL DEVELOPMENT FUND

LINKÖPING UNIVERSITY