

**CHALMERS**

Regional Circular Economy  
**Industrial Symbiosis**  
**CIRCUMAT WORKSHOP**

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TU Delft 4th of December 2019



Supported by Circu-Mat project from European Institute of Innovation & Technology - Raw Materials KIC

## **Objectives**

Introduce industrial symbiosis concept

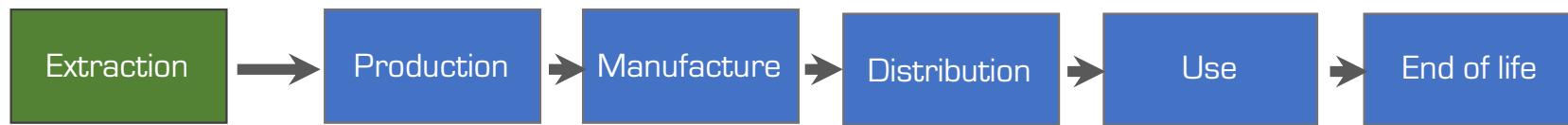
Show examples

Identify important factors for initiation

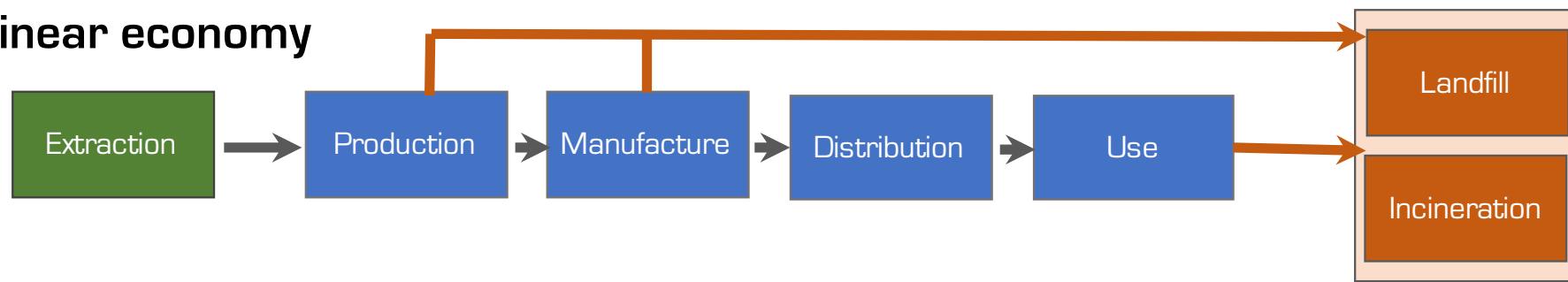
Identify the steps for implementation

Identify opportunities

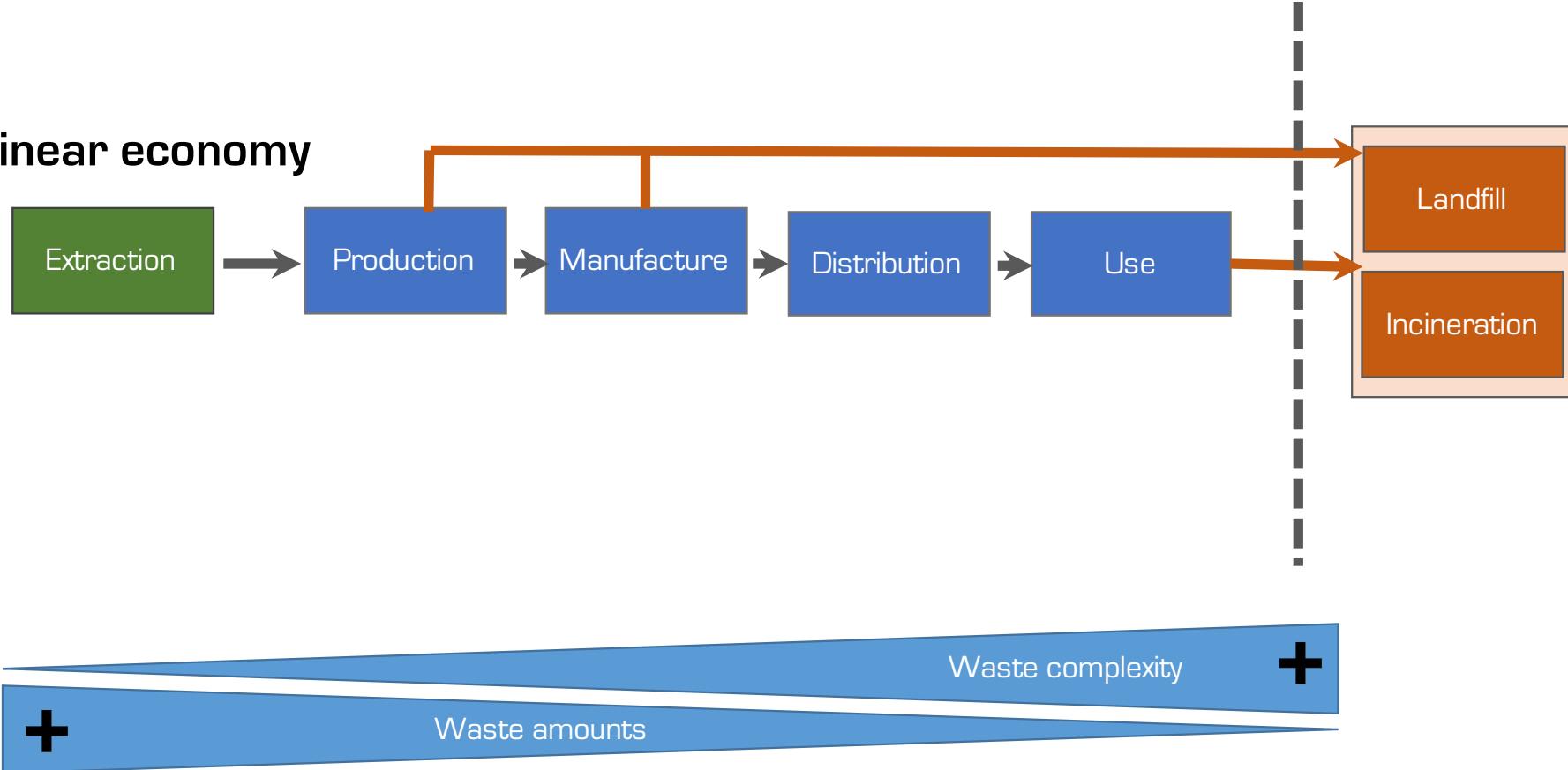
## Supply chain



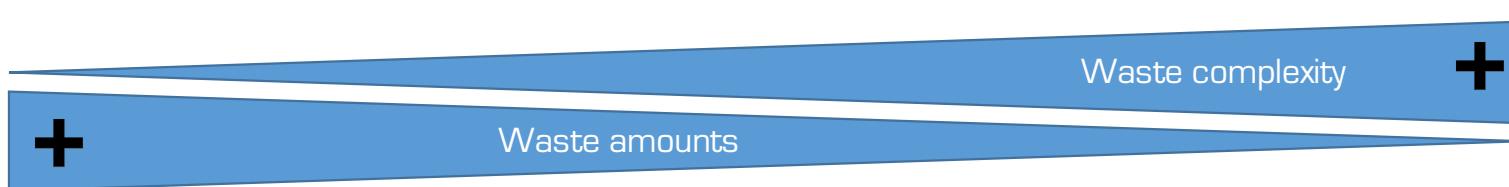
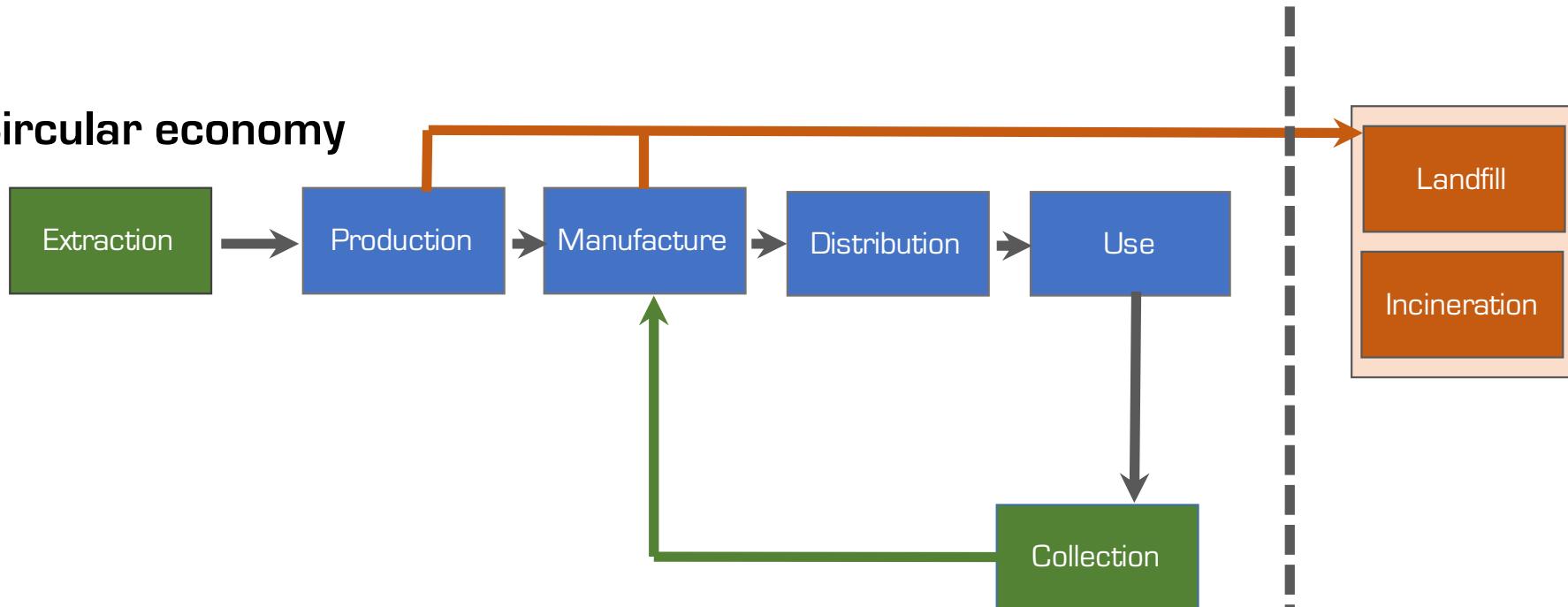
## Linear economy

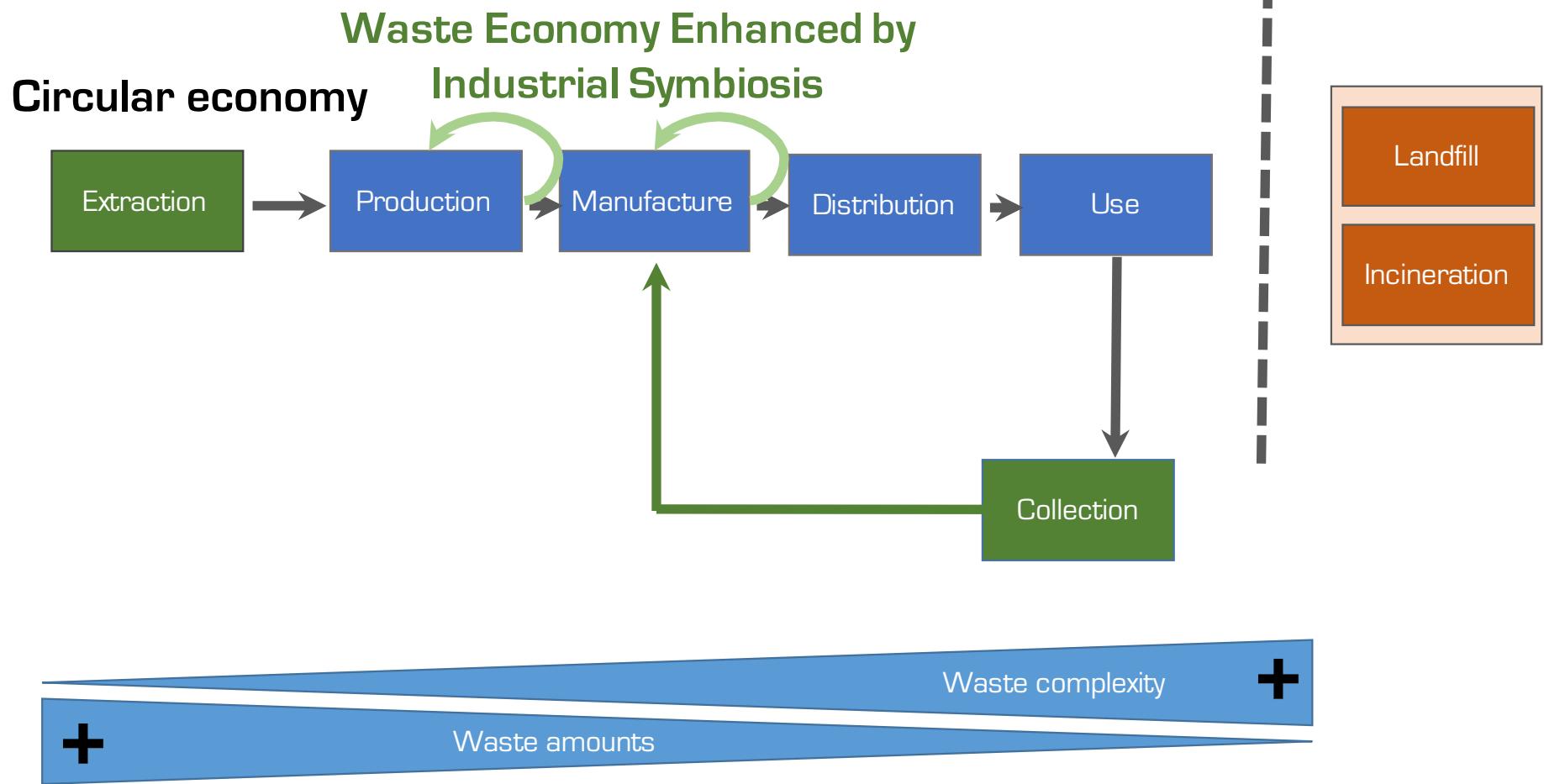


## Linear economy



## Circular economy





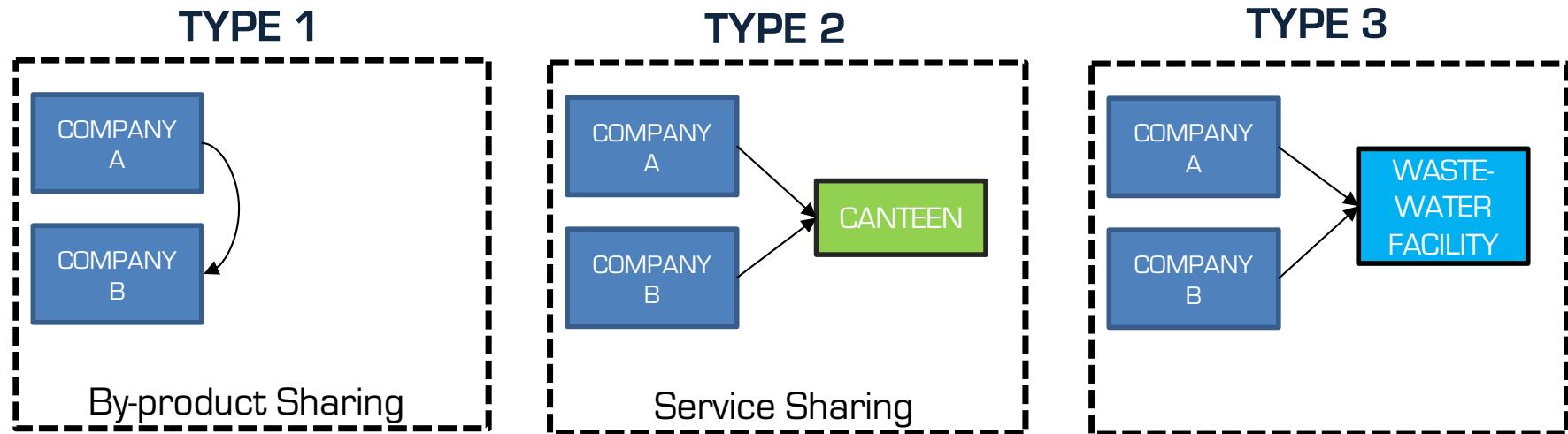
## Coffee example

Second largest trade commodity in the world after petroleum



Examples of solutions for the waste:

- Converting pulp into nutrient-rich compost
- Convert agriculture pulp into biogas
- Making tea from dried coffee (innovative process)
- Convert coffee pulp into Coffee Flour (innovative process)



## Industrial Symbiosis

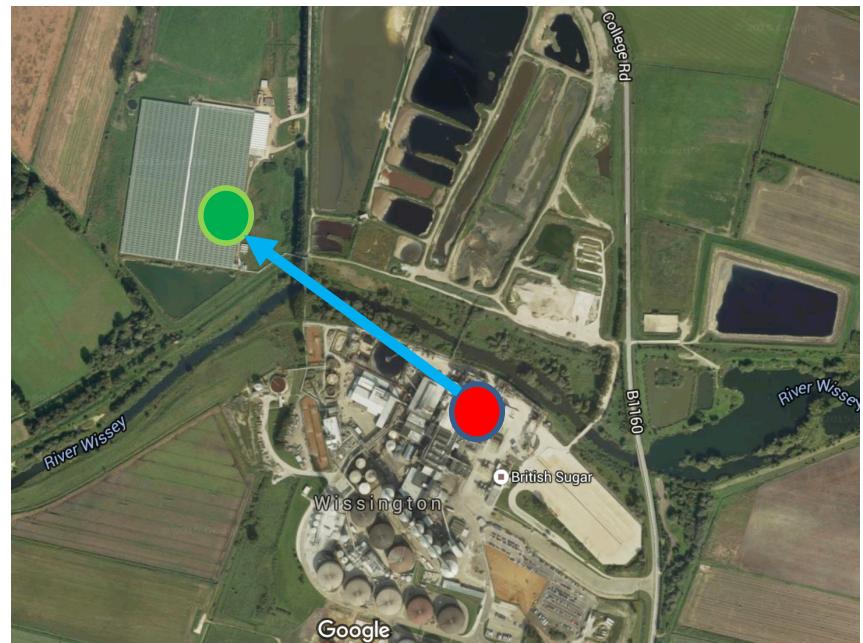
“**inter-firm sharing**, which include **physical exchanges** of wastes, energy, water and by-products, or **infrastructure** and **services** sharing.”

## **Industrial Symbiosis examples**

# Sugar factory and a Greenhouse

Location: Norfolk, United Kingdom

- **Waste heat and carbon dioxide** are transported to a greenhouse (18ha).
- Natural agents are used to **pollinate the crop - over 8,500 bees**
- More than **115 million liters of rainwater** is annually collected on the roof

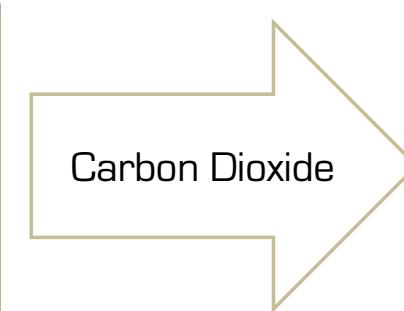


# Geothermal energy production and methanol

Location: Iceland



**Geothermal Plant**

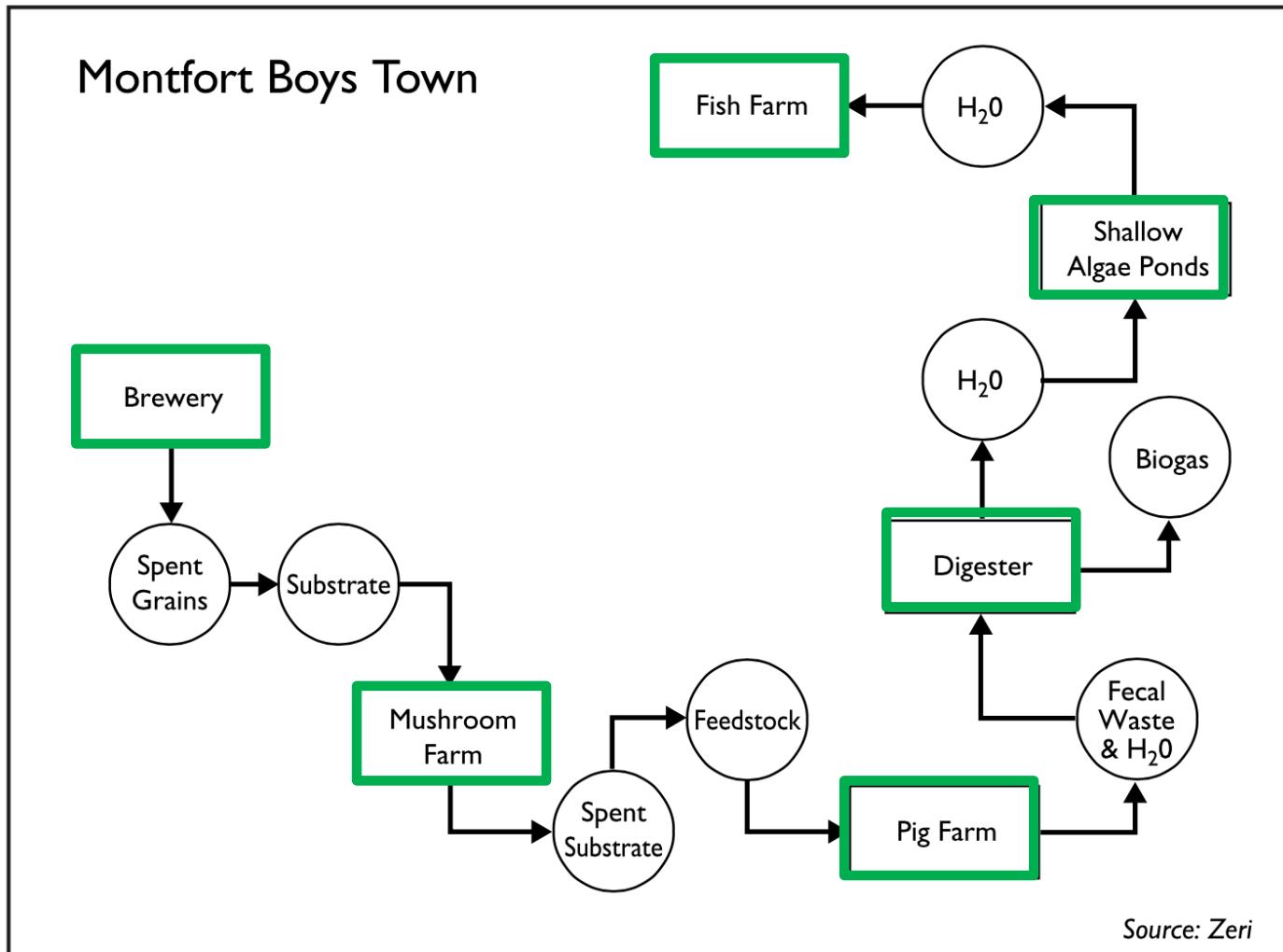


**Methanol Plant**

- **Methanol production:** 5 million liters a year
- **Carbon dioxide utilization:** 5.5 thousand tones per year
- **Energy Sources:** hydro and geothermal sources

# Industrial park

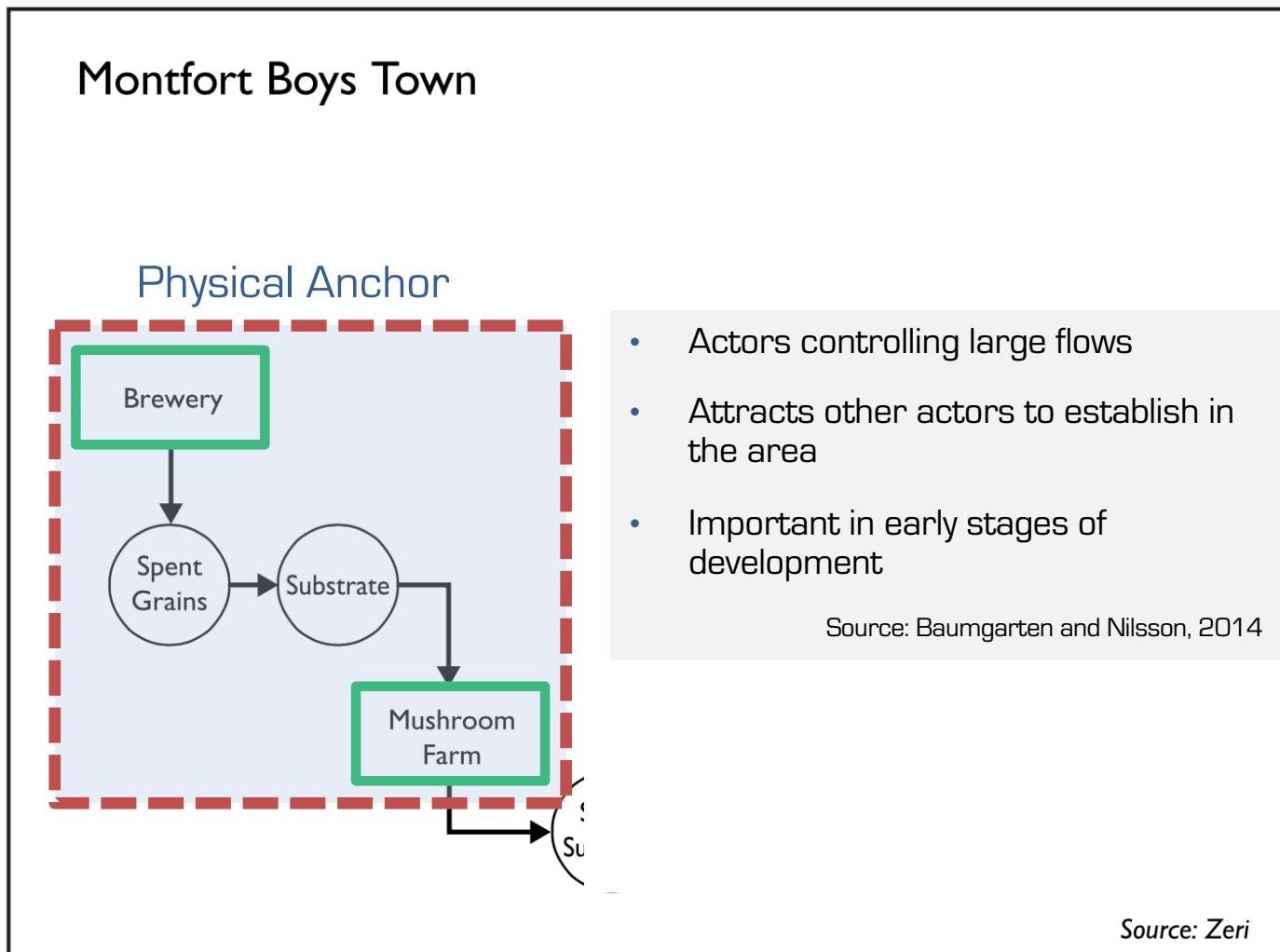
Location: Suva, Fiji



A Model IBS (Montfort Boys' Town, Suva, Fiji)

# Industrial park

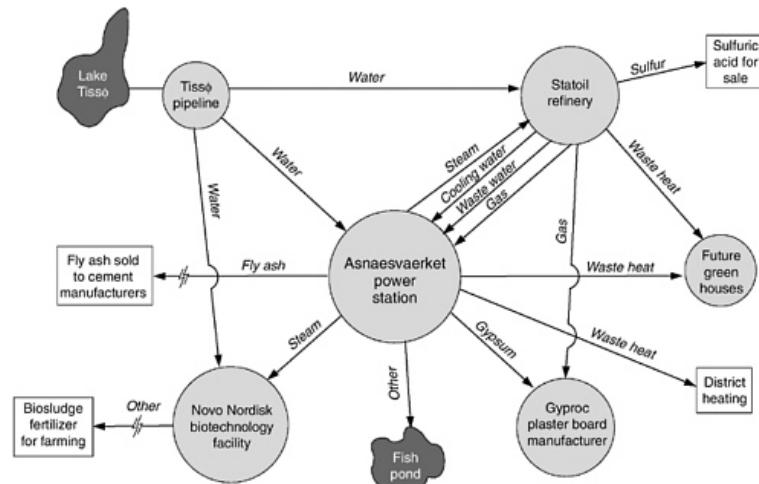
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A Model IBS (Montfort Boys' Town, Suva, Fiji)

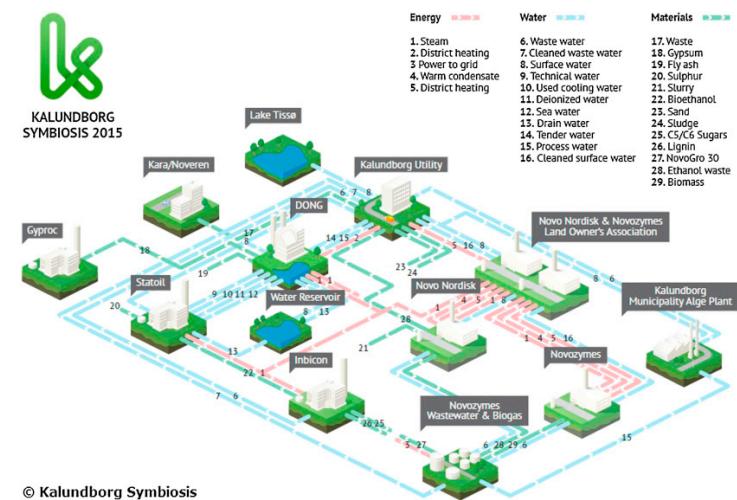
# Industrial park

Location: Kalundborg, Denmark



1993

Source: <https://www.nap.edu>



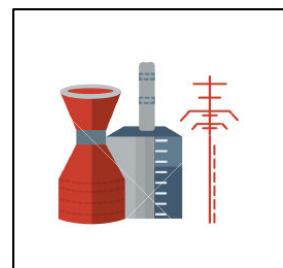
2019

Source: <http://www.symbiosis.dk/en/>

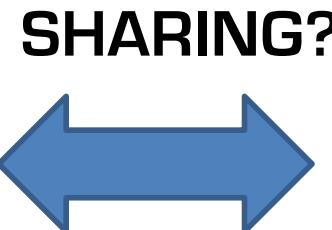
## **Exercise**

groups of 3

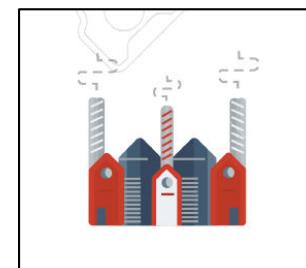
identify one example of industrial symbiosis that includes at least a company from the following industrial sectors: Agriculture, Food processing and Wood



**Donor**

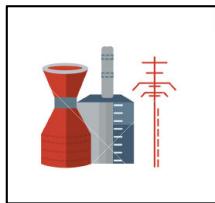


**SHARING?**



**Receiver**

# Agriculture example



Farm



Mushrooms  
Leftovers

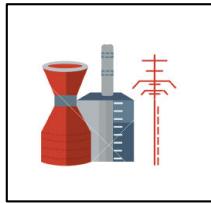


Pig raising



Mushrooms sauce

# Wood example



Sawmill

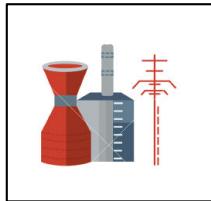


Sawdust



Plywood

# Food example



Cheese  
industry



Whey

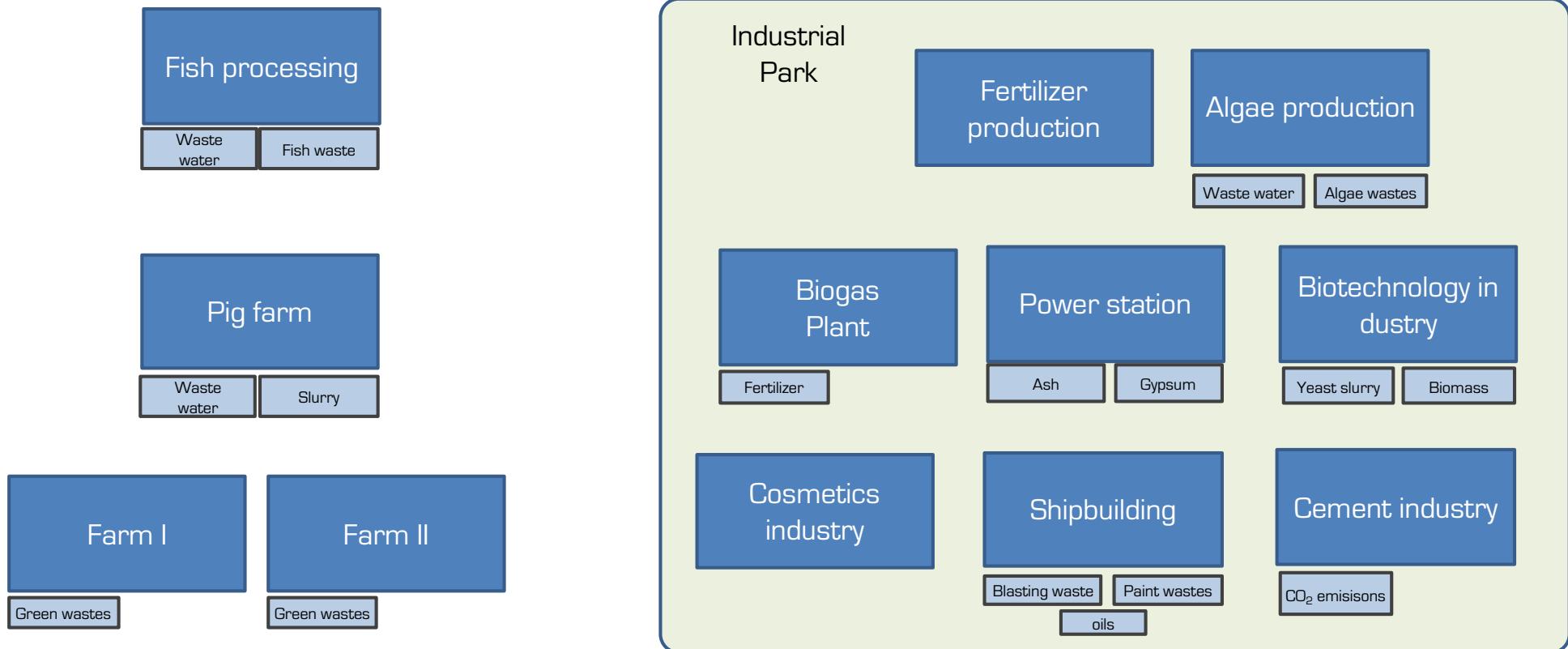


Protein shakes

# Exercise

groups of 3

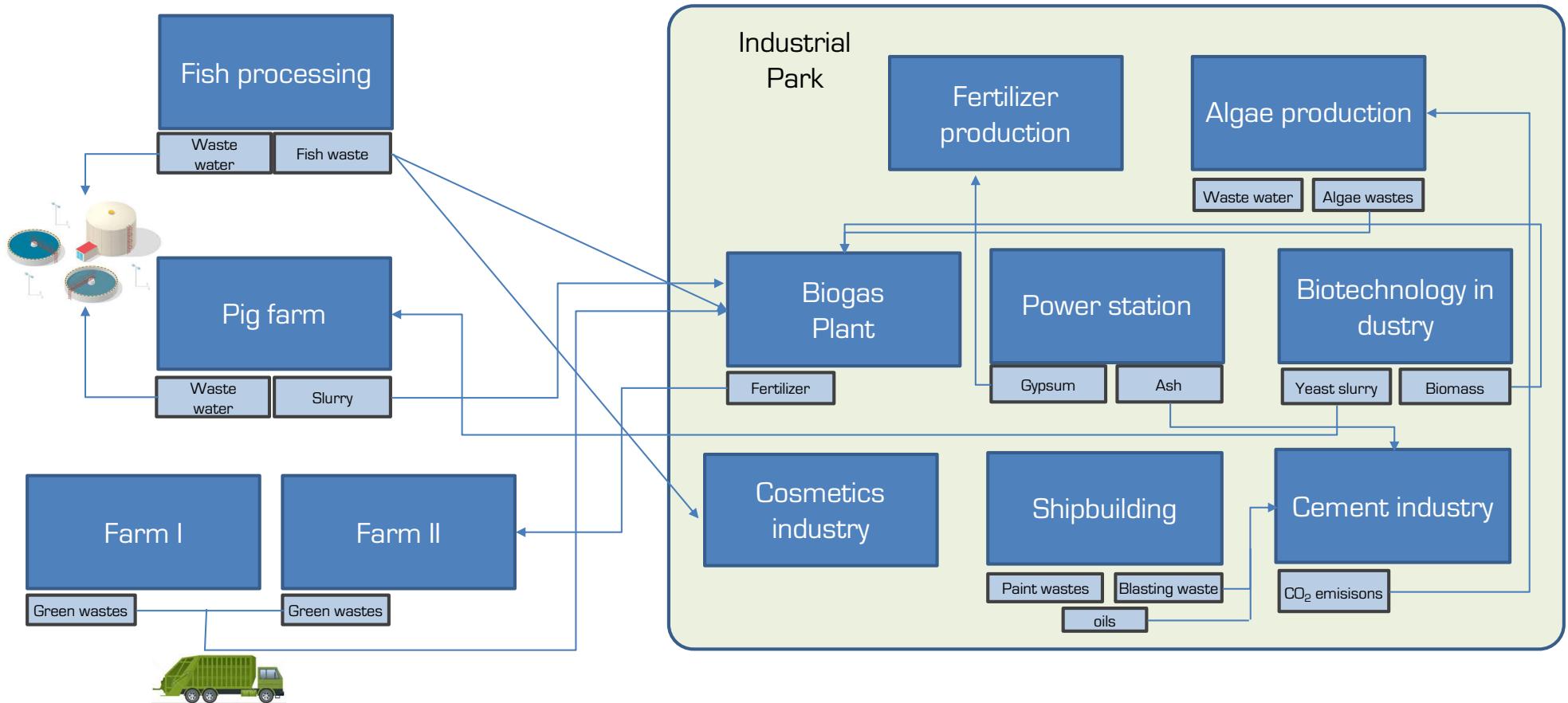
suggest industrial symbiosis partnerships that could be implemented in the following system:



# Exercise

groups of 3

suggest industrial symbiosis partnerships that could be implemented in the following system:

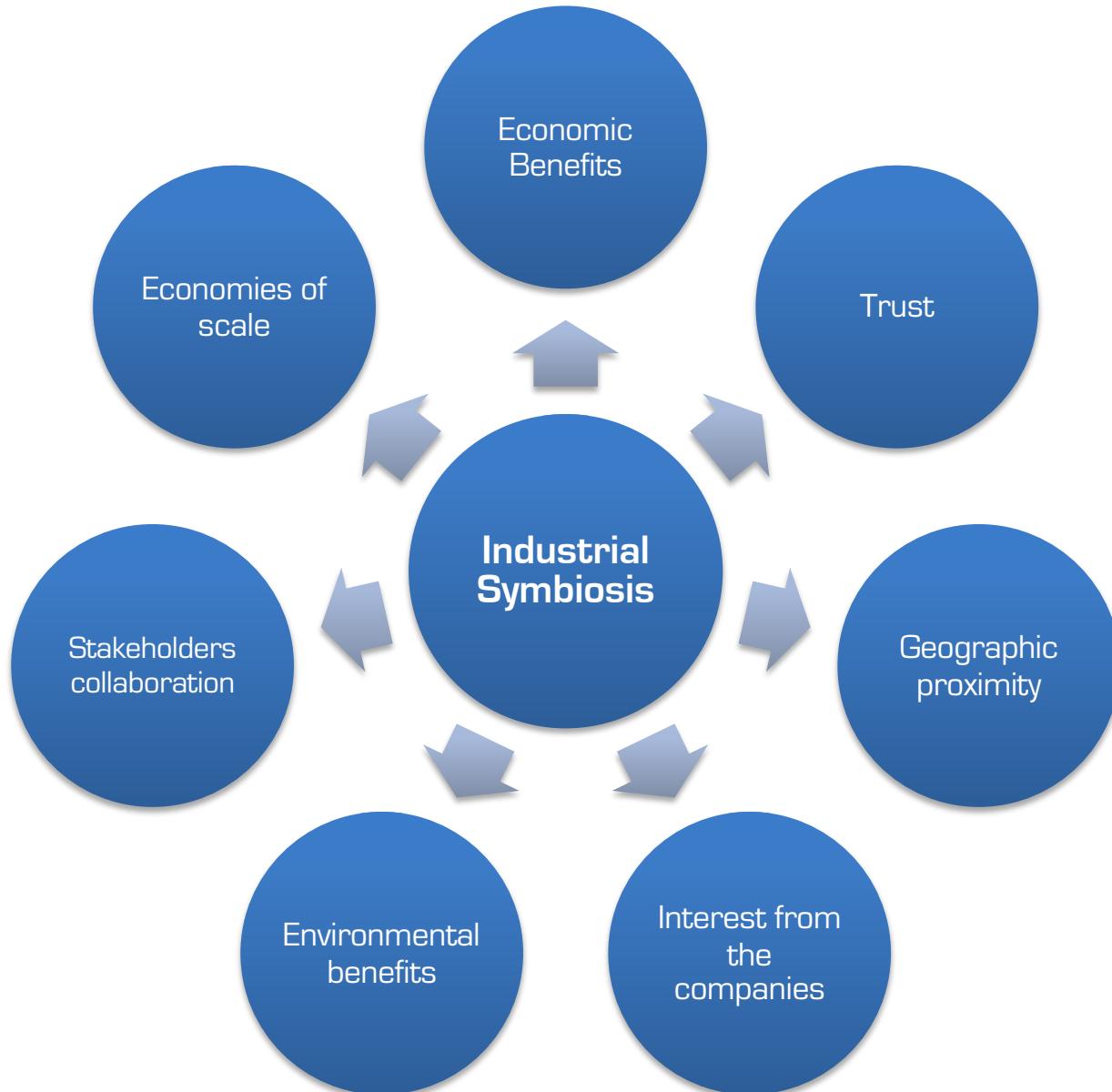


## **Discussion**

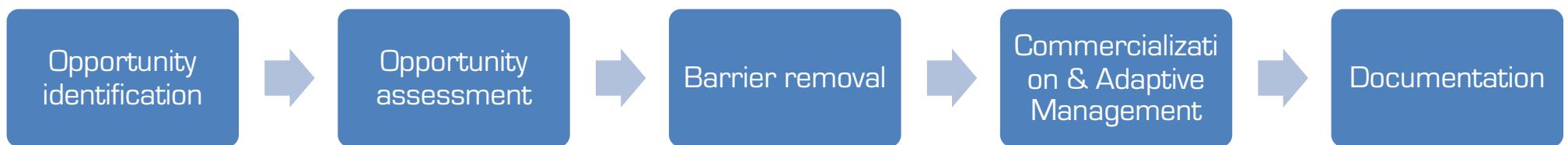
groups of 3

Discuss factors that may be important to make industrial symbiosis partnerships.  
Use the previous linkages to give examples, if necessary.

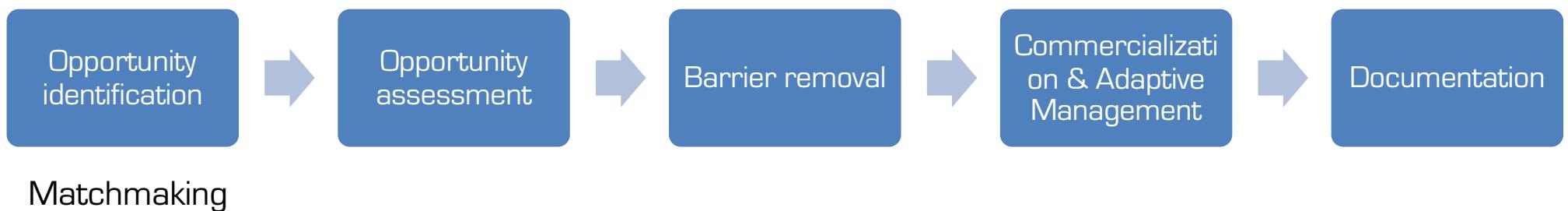
# Important factors for initiating Industrial Symbiosis



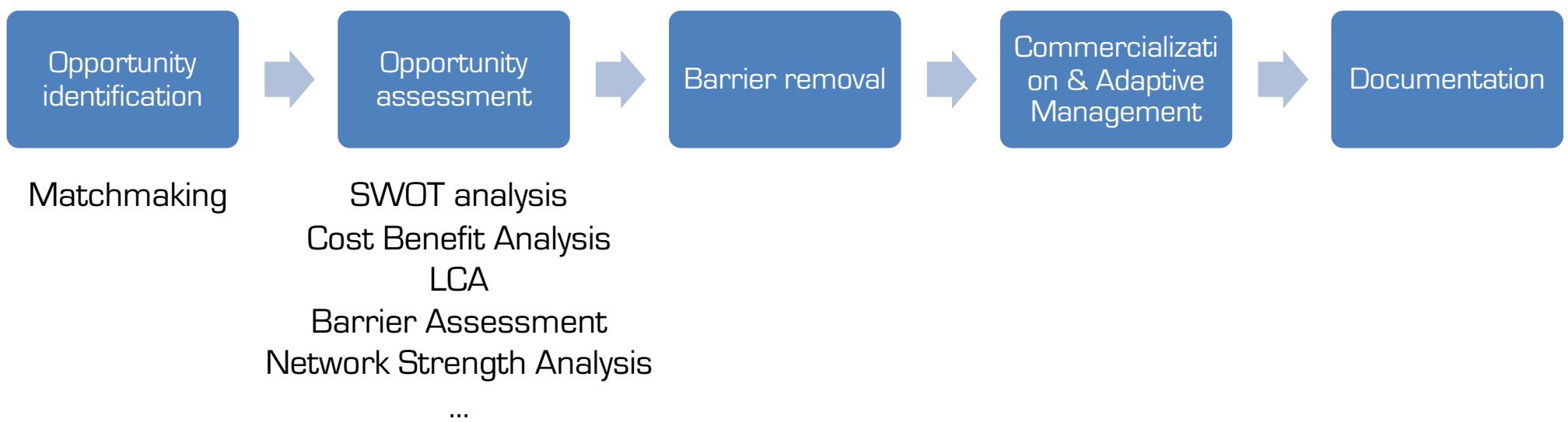
## Industrial Symbiosis implementation steps



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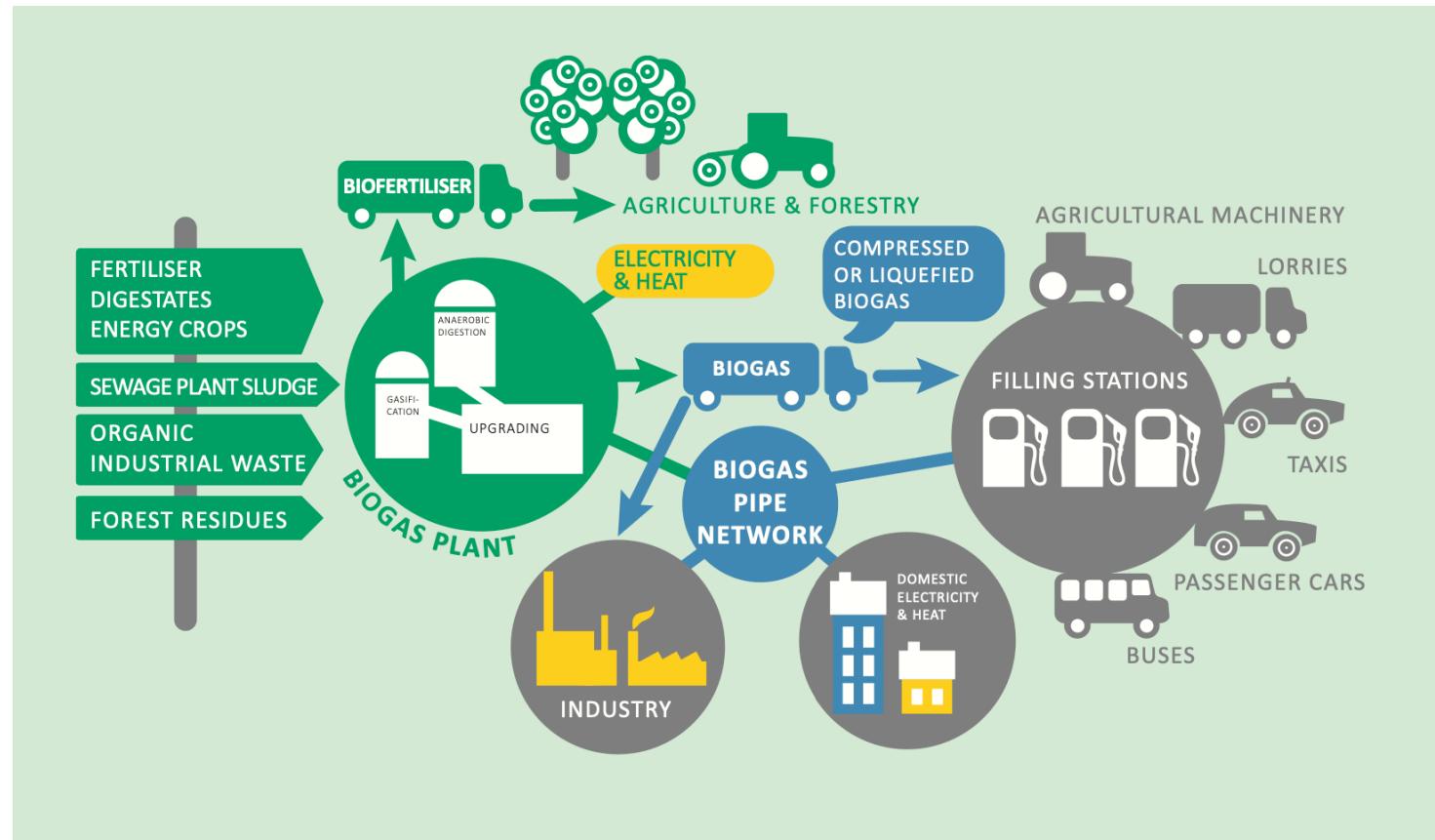


## Industrial Symbiosis implementation steps



# Identifying Industrial Symbiosis opportunities

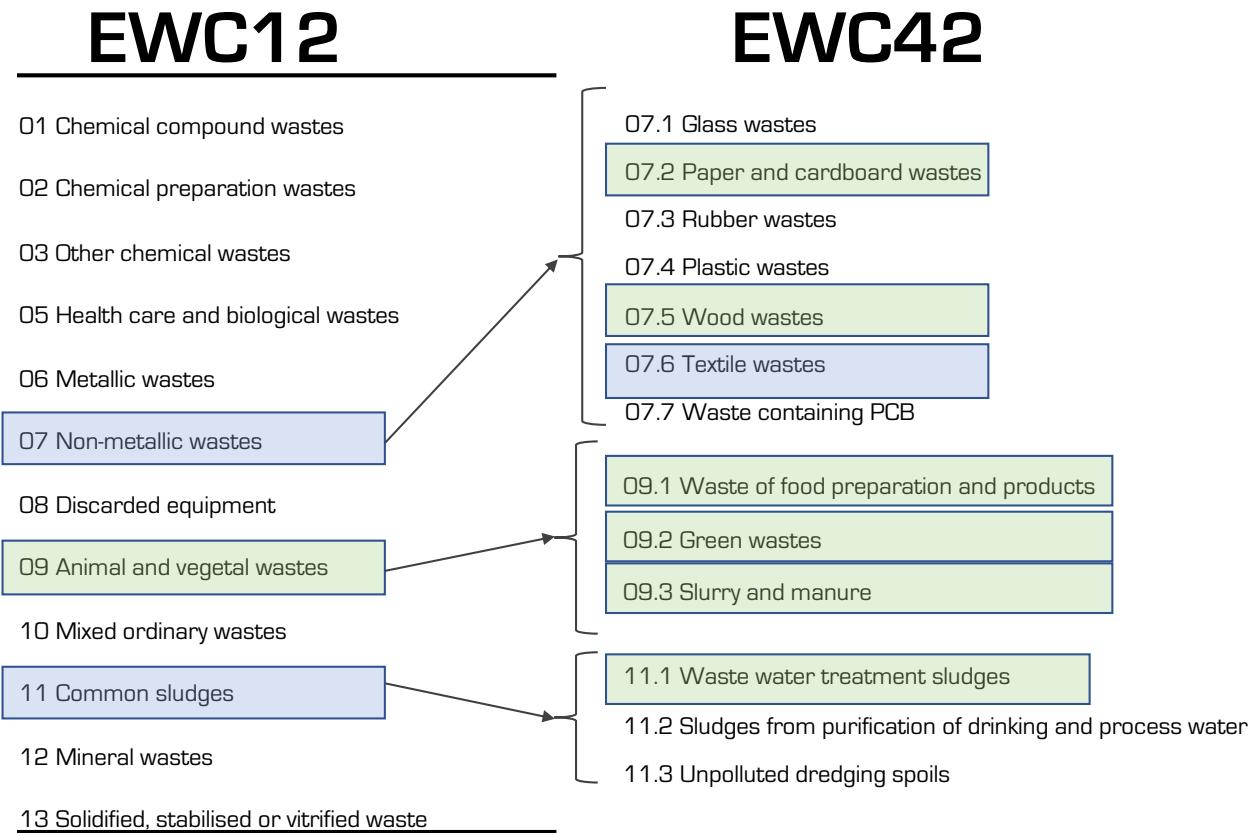
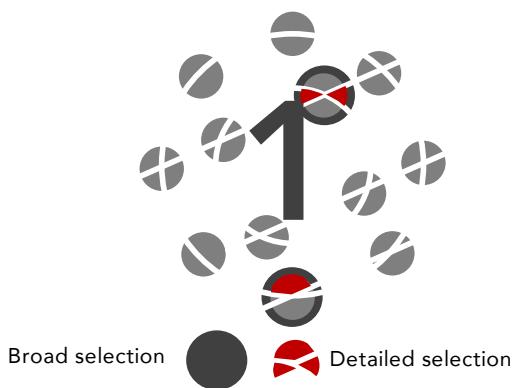
## Development objectives



Västra Götaland region set the target of raising biogas production to 2 TWh by 2020, from the current production of 0.329 TWh

# Identifying Industrial Symbiosis opportunities

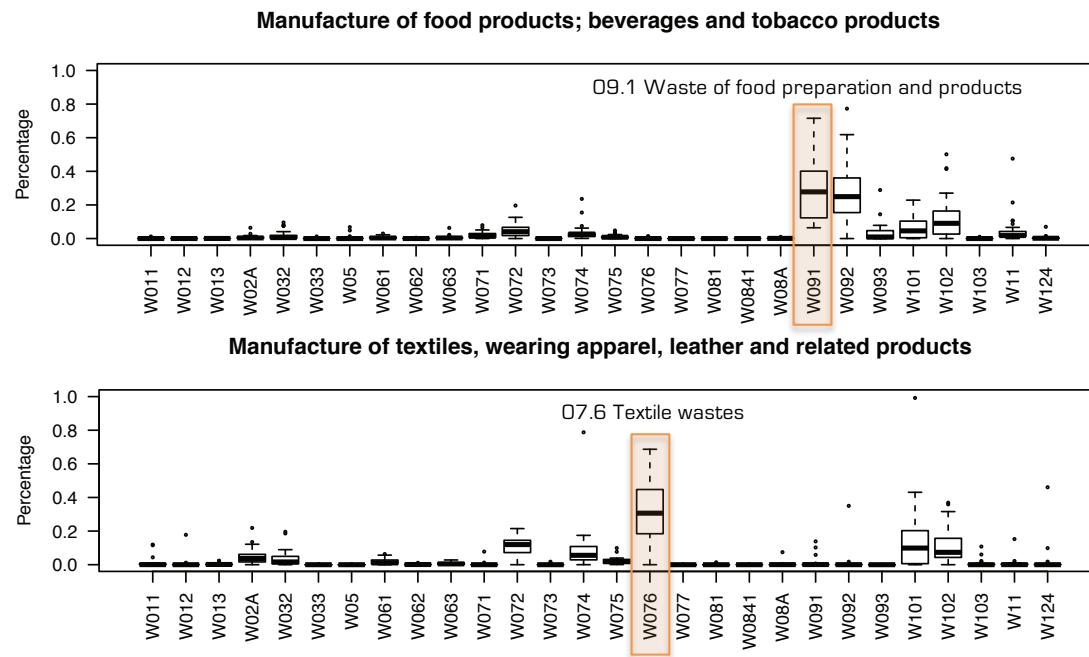
## Identification and selection of target wastes



Legend: Biodegradable waste      Partially Biodegradable

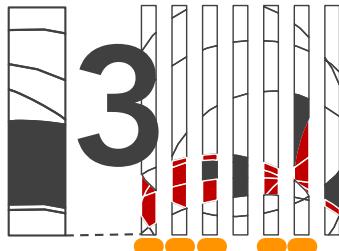
# Identifying Industrial Symbiosis opportunities

## Characterization and selection of economic sectors



# Identifying Industrial Symbiosis opportunities

## Detailed description of industries waste generation

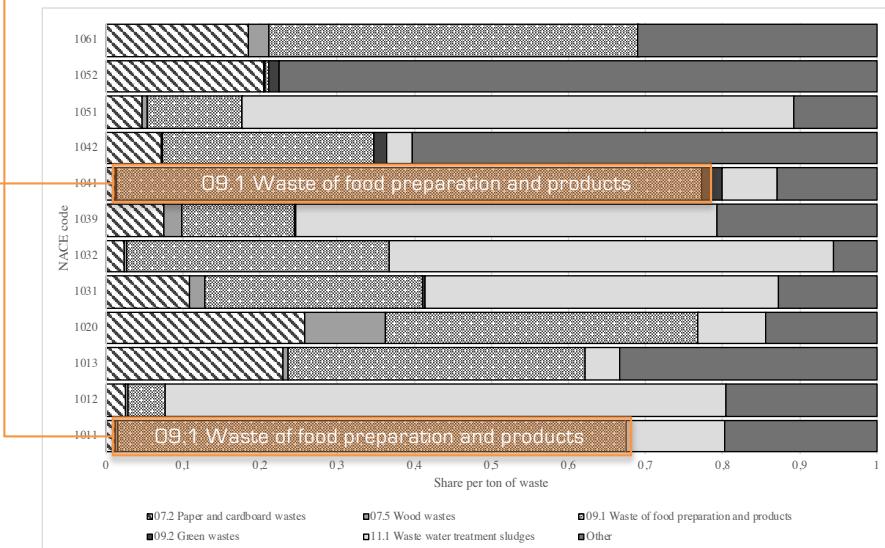


Selected detailed wastes

Selected industries

### Food processing sector

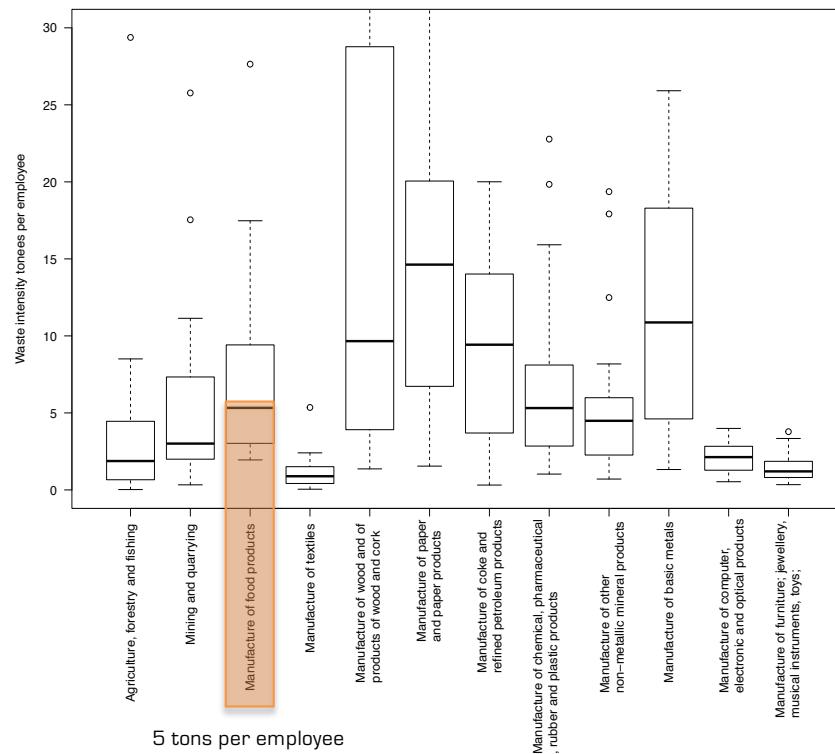
- 10111 Livestock slaughtering
- 10112 Processing and preserving of meat in cuts
- 10120 Processing and preserving of poultry meat
- 10130 Production of meat and poultry meat products
- 10200 Processing and preserving of fish, crustaceans and molluscs
- 10310 Processing and preserving of potatoes
- 10320 Manufacture of fruit and vegetable juice
- 10390 Other processing and preserving of fruit and vegetables
- 10410 Manufacture of oils and fats
- 10420 Manufacture of margarine and similar edible fats
- 10511 Cheese production
- 10519 Other dairy production
- 10520 Manufacture of ice cream
- 10611 Production of flour
- 10612 Manufacture of breakfast cereals, blended flour mixes and other prepared grain mill products
- 10620 Manufacture of starches and starch products
- 10710 Manufacture of bread; manufacture of fresh pastry goods and cakes
- 10721 Manufacture of crispbread
- 10722 Manufacture of rusks, biscuits and preserved pastry goods and cakes
- 10730 Manufacture of macaroni, noodles, couscous and similar farinaceous products
- 10810 Manufacture of sugar
- 10821 Manufacture of sugar confectionery
- 10822 Manufacture of cocoa and chocolate confectionery
- 10830 Processing of tea and coffee
- 10840 Manufacture of condiments and seasonings
- 10850 Manufacture of prepared meals and dishes
- 10860 Manufacture of homogenised food preparations and dietetic food
- 10890 Manufacture of other food products n.e.c.
- 10910 Manufacture of prepared feeds for farm animals



# Identifying Industrial Symbiosis opportunities

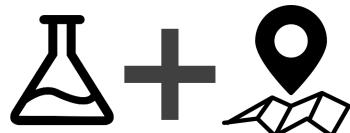
## Waste generation intensity

4



# Identifying Industrial Symbiosis opportunities

## Symbiosis identification



Waste characteristics +  
industry location



For each company:

**Raw Data:**

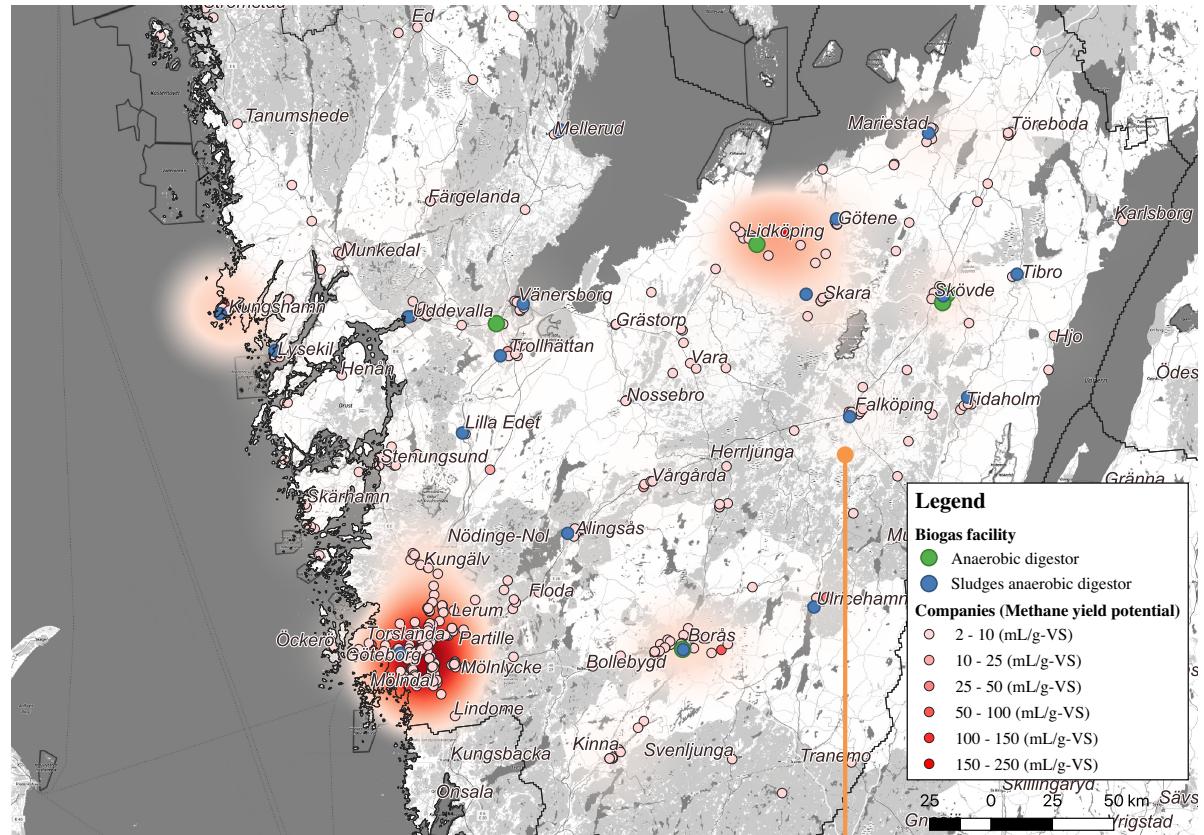
Company name  
Industrial Activity  
Company Size

**Estimated:**

Amounts of waste  
Types of waste

**Plugins:**

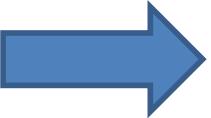
Methane Yield



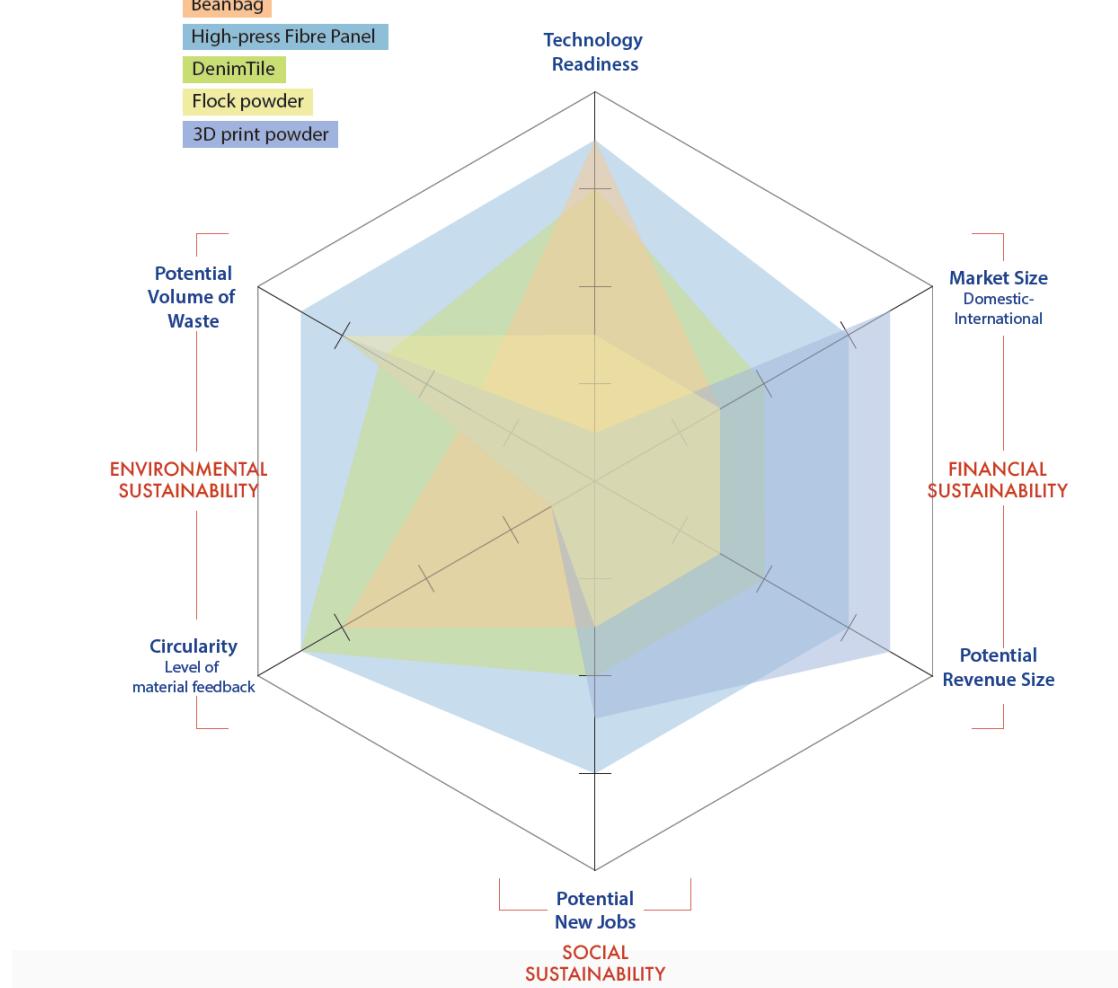
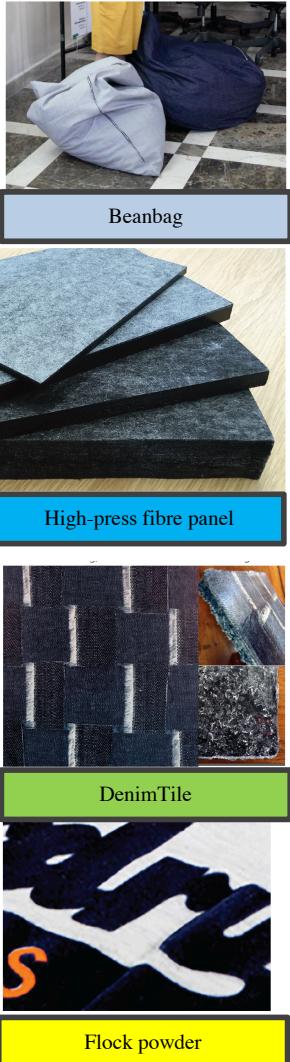
Methane yield potential: 2.2mL/g-VS

# Assessment of Industrial Symbiosis opportunities



294,000 tonnes of textile  44,100 tonnes of post-production textile waste

# Assessment of Industrial Symbiosis opportunities



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