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Norwegian Institute for Sustainability Research

BIOSWEET Conference 2020

Life Cycle Assessment of the products and services of an anaerobic digestion plant

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Biogas production and use in Norway

- Approximately 500 GWh biogas produced in 2018
- Approximately 40% is upgraded and used for transport
- Grid infrastructure is limited (CBG, some LBG)
- Feedstocks are mainly food waste and sewage sludge
- National objective (from 2009) of 30% livestock manure for biogas production within 2020, but currently at 1%.

The biogas plant: The Magic Factory

Food waste and livestock manure in the region to produce:

- Biofuel (biomethane) for transport
- Biofertilizer
- Bio CO_2 for greenhouse

Focuses on creating high value products

Developing circular value chains: From food waste to food

Learning centre for children: knowledge about source separation, recycling, climate change, energy and food production

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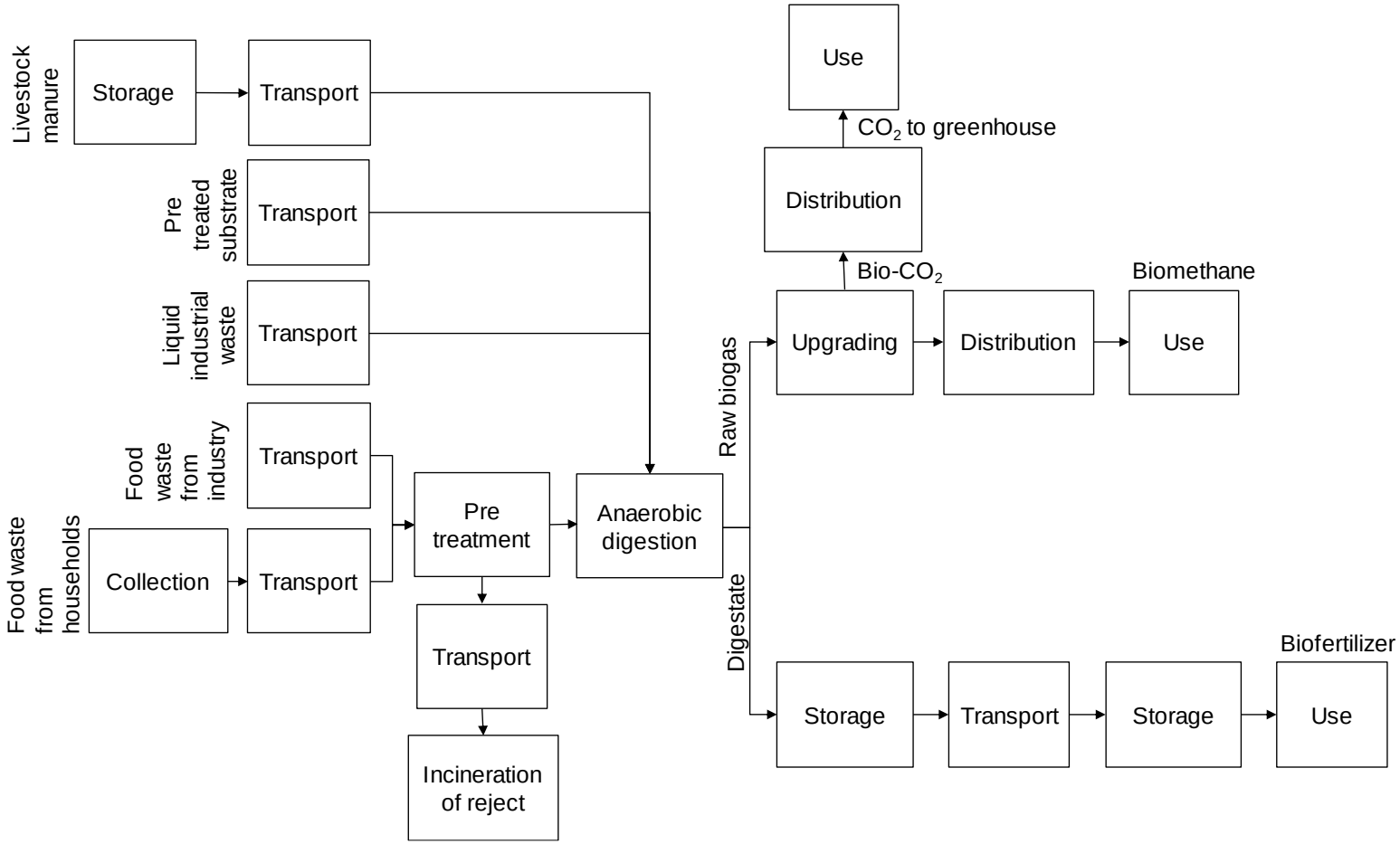
The Magic Factory



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Purpose of the study

1. **Document the potential impact on climate change** from the products and services of The Magic Factory:
    - The total effect of establishing the plant (per year)
    - Impact from treatment of food waste (per tonne)
    - Production and use of biomethane as fuel for transport (per km bus transport)

    Different system boundaries and functional units

2. **Contribute to an improved understanding** of how LCA-methodology should be adjusted to fit the purpose of the study

Life cycle assessment: multifunctional systems

Life Cycle Assessment is a methodology for assessing the environmental impact of products and services throughout the value chain.

When a production process generates several products/services, the system is ***multi functional***.

Anaerobic digestion at The Magic Factory is a multifunctional process because it is:

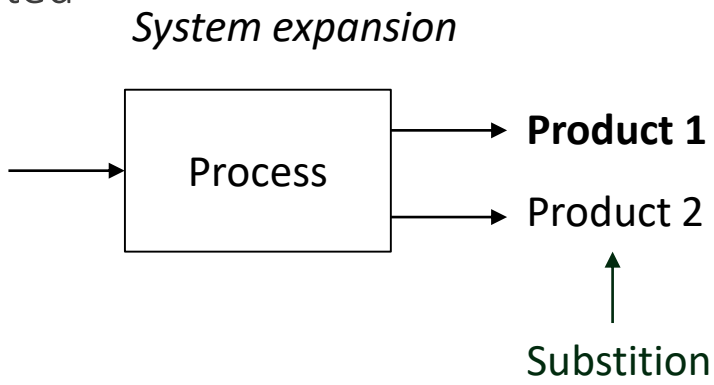
- A treatment method for food waste and manure
- A production process for biomethane
- A production process for biofertilizer
- A production process for bio-CO2

In life cycle assessment multifunctional process are normally handeled through ***system expansion*** or ***allocation***.

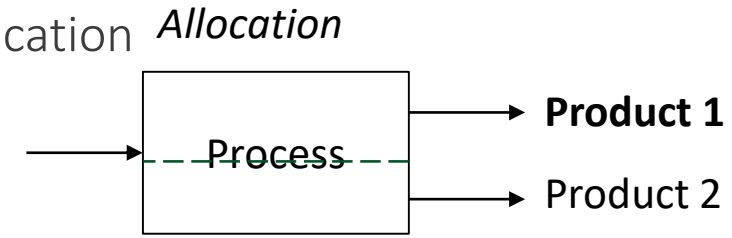
System expansion and allocation

System expansion: Including the avoided impacts from the substituted products of the additonal functions.

Example: biogas as a fuel substitutes diesel, digestate substitute biofertilizer or peat.



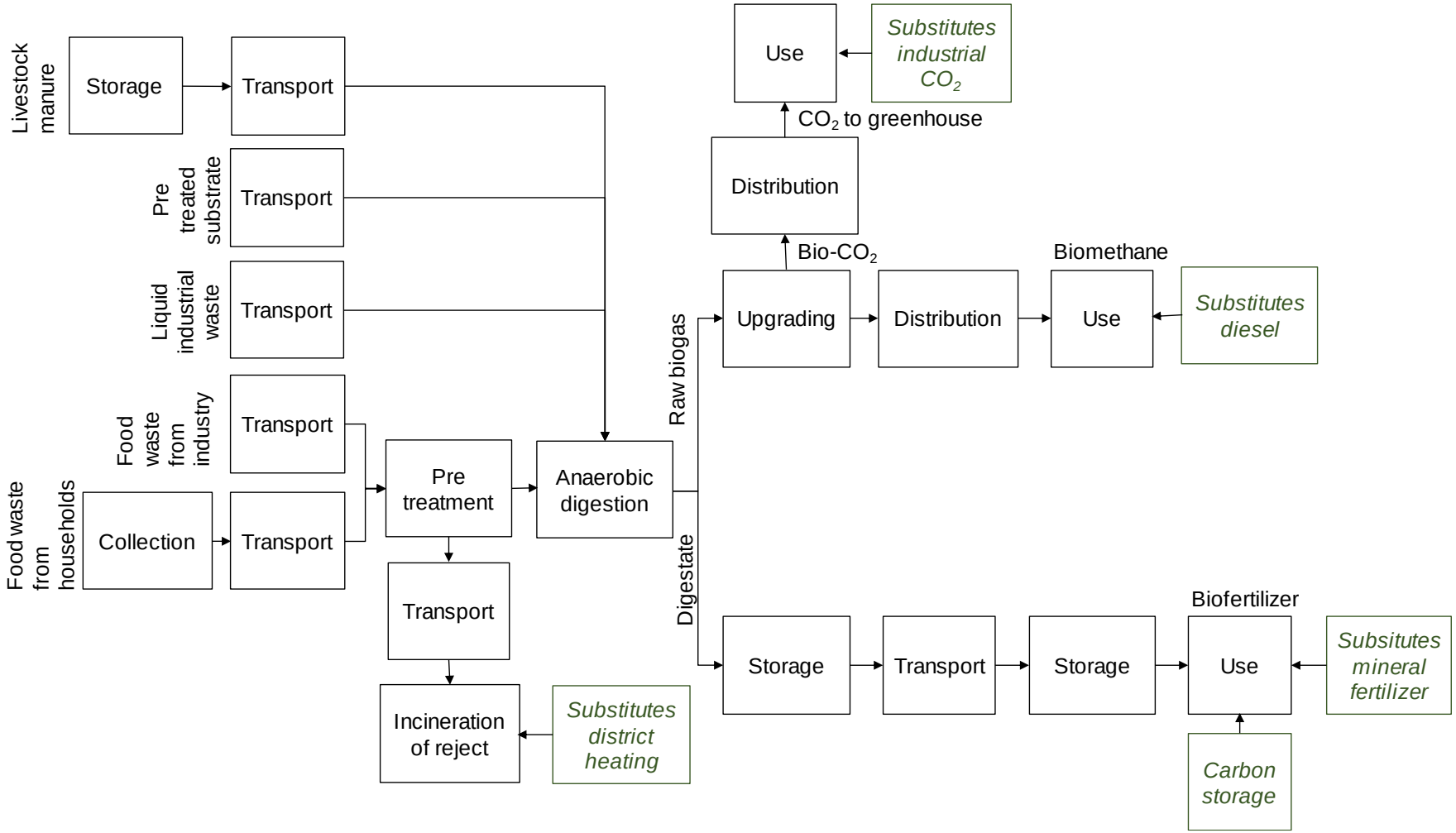
Allocation: impacts are allocated between the products, using allocation keys. Allocation keys may be calculated based on energy, mass, economic value.



Commonly used in Environmental Production Declarations (EPD) to obtain the principle of additionality and to avoid double counting of emissions and of emissions reductions.

Total effect of establishing the plant

System expansion – physical end products



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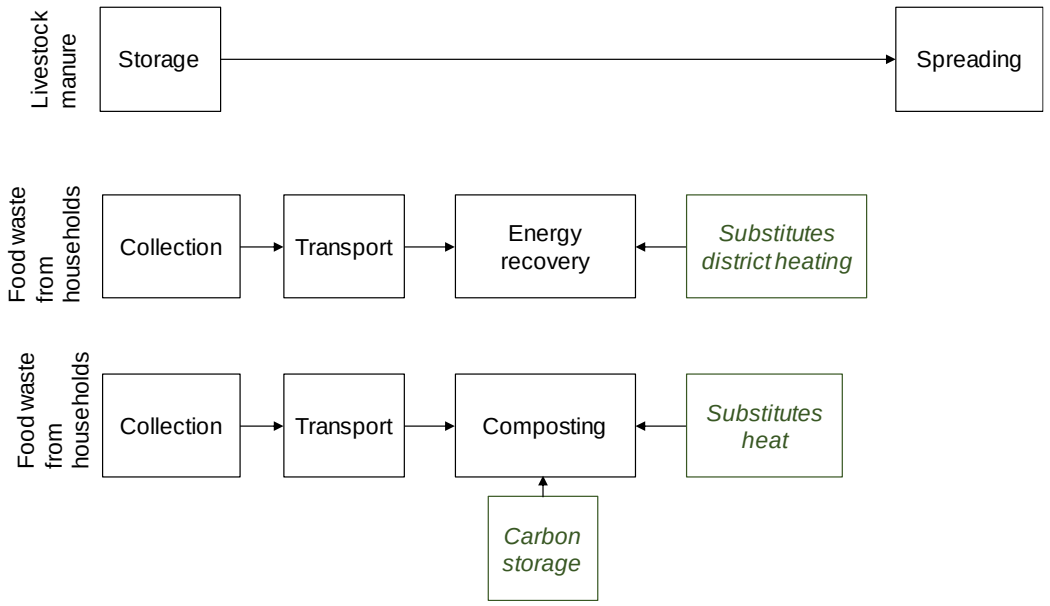
Total effect of establishing the plant

System expansion – reference scenarios



Impact of establishing an AD plant

\- Impact of reference scenario

= Total effect of establishing the plant

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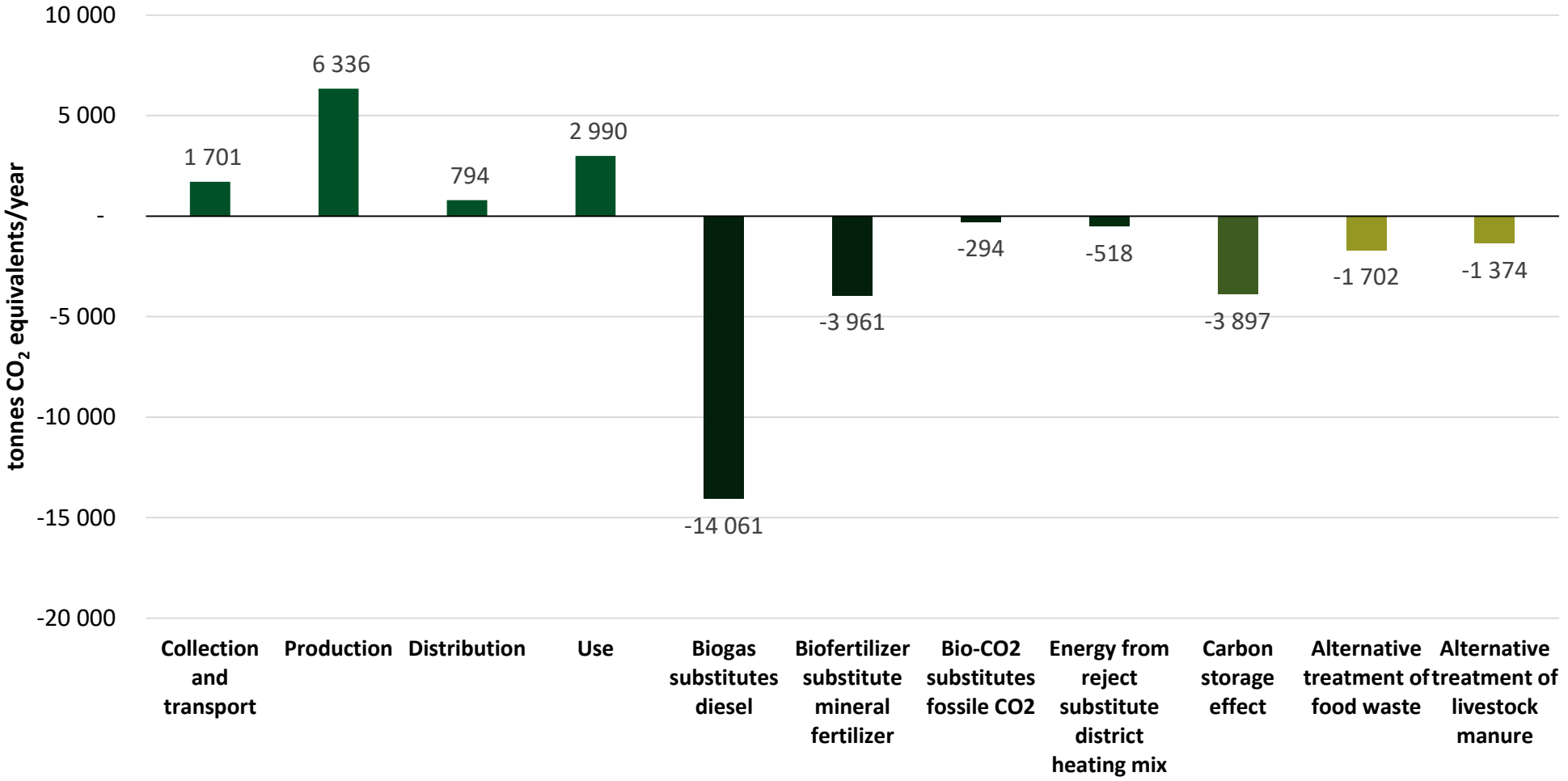
Results total effect of establishing the plant (per year)

System expansion: physical end products and reference scenario



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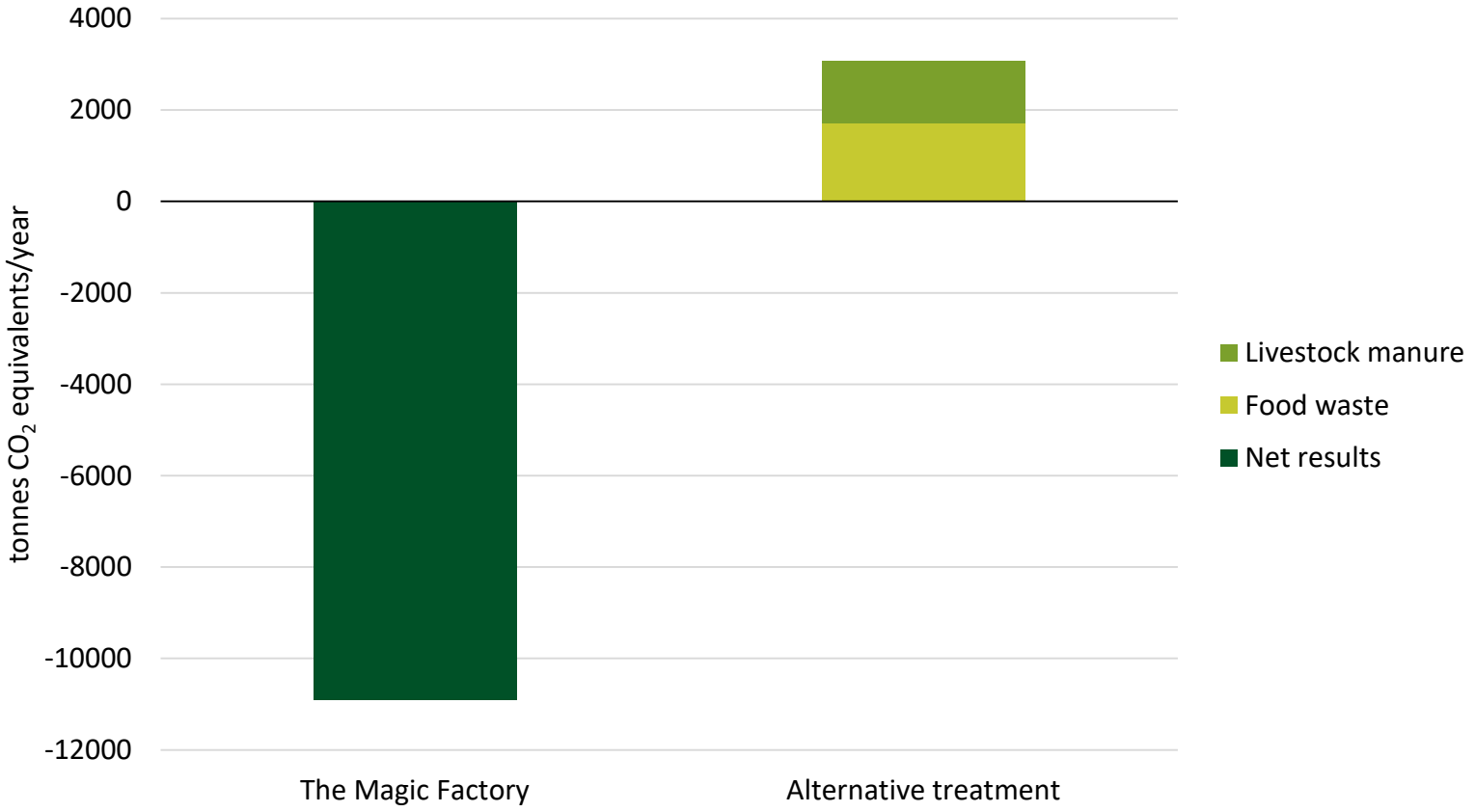
Results total effect of establishing the plant (per year)



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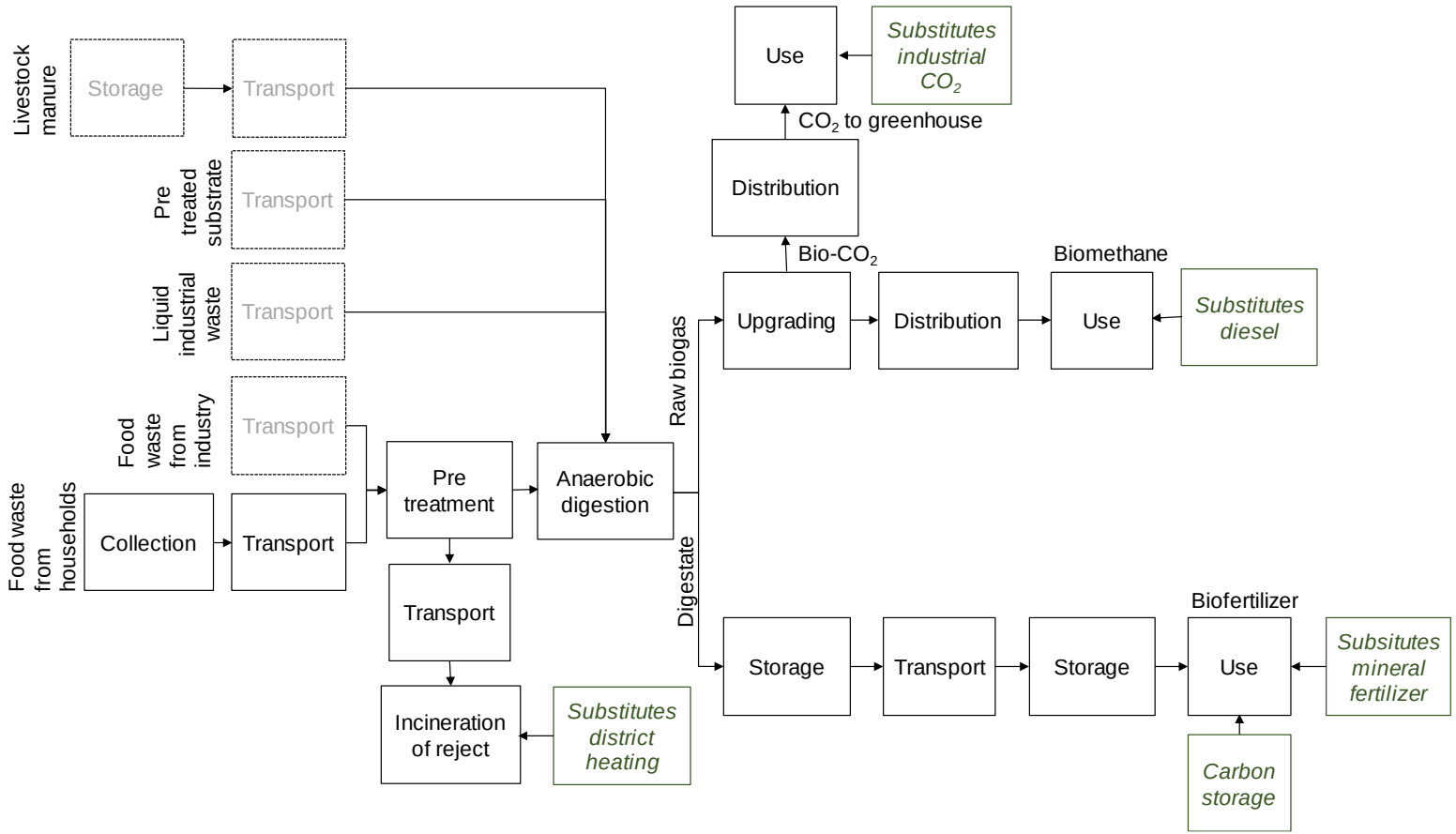
Assessment per tonne of food waste treated

System expansion: physical end products and reference scenario



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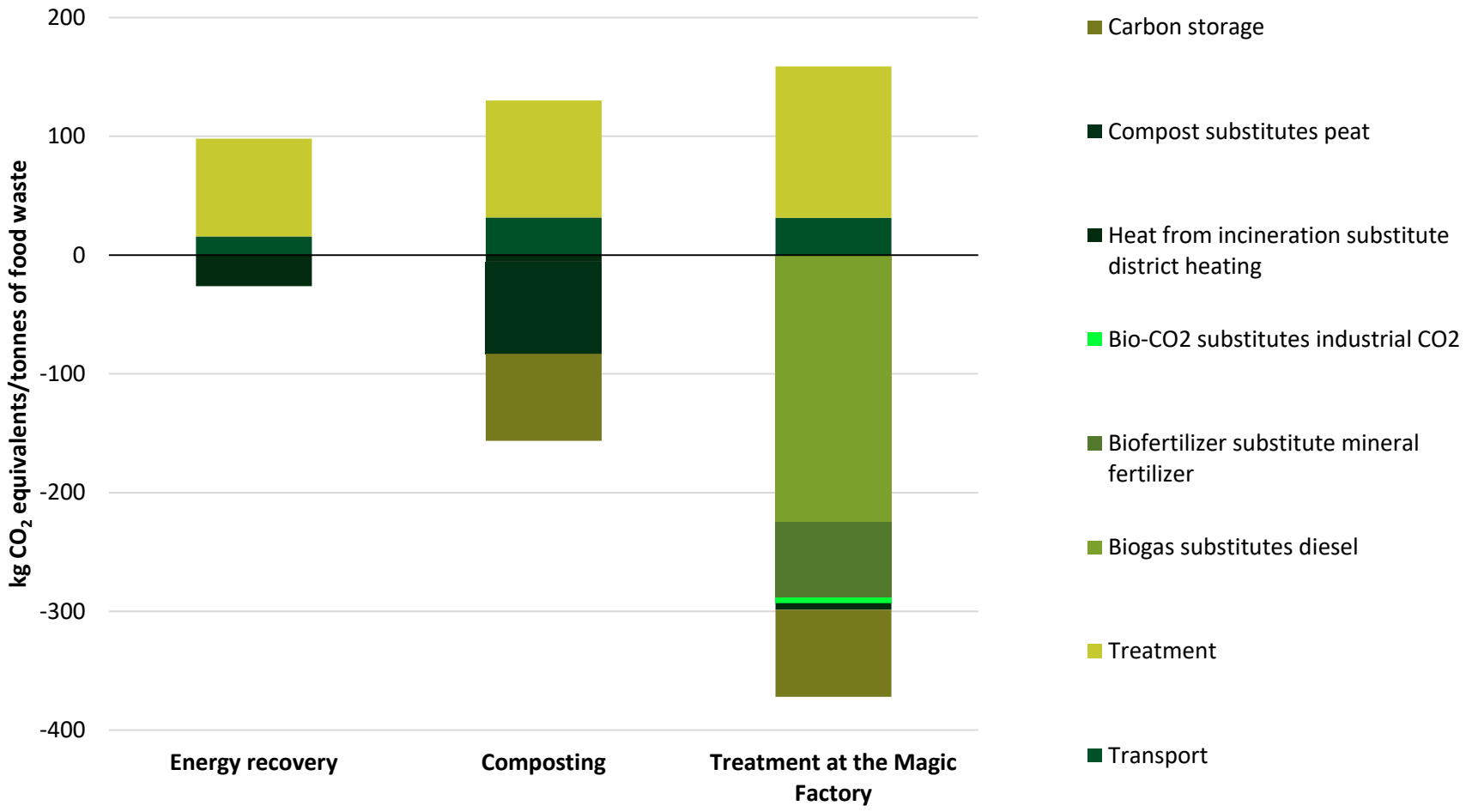
Results per tonne of food waste treated

(per life cycle phase)



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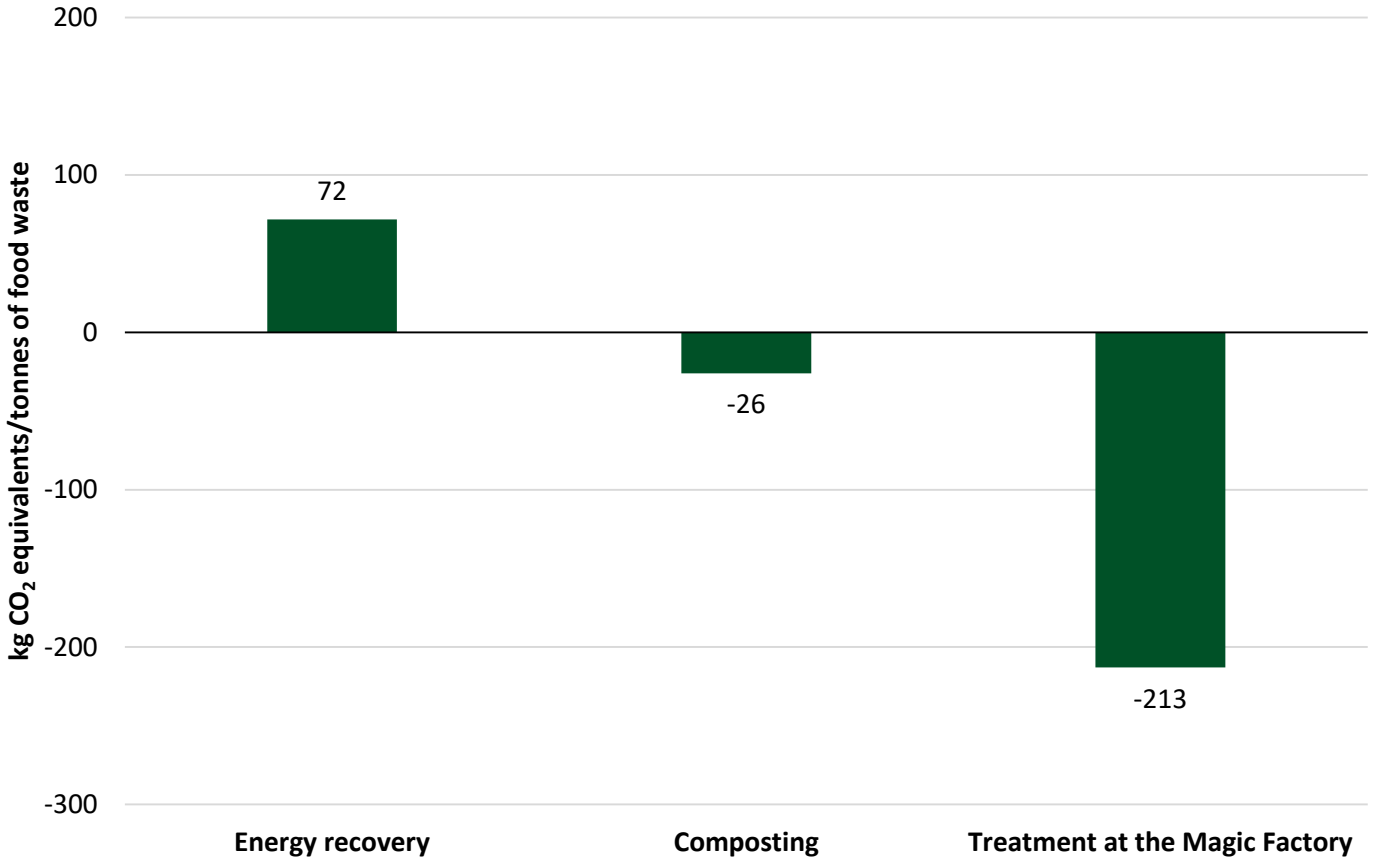
Results per tonne of food waste treated

Net results



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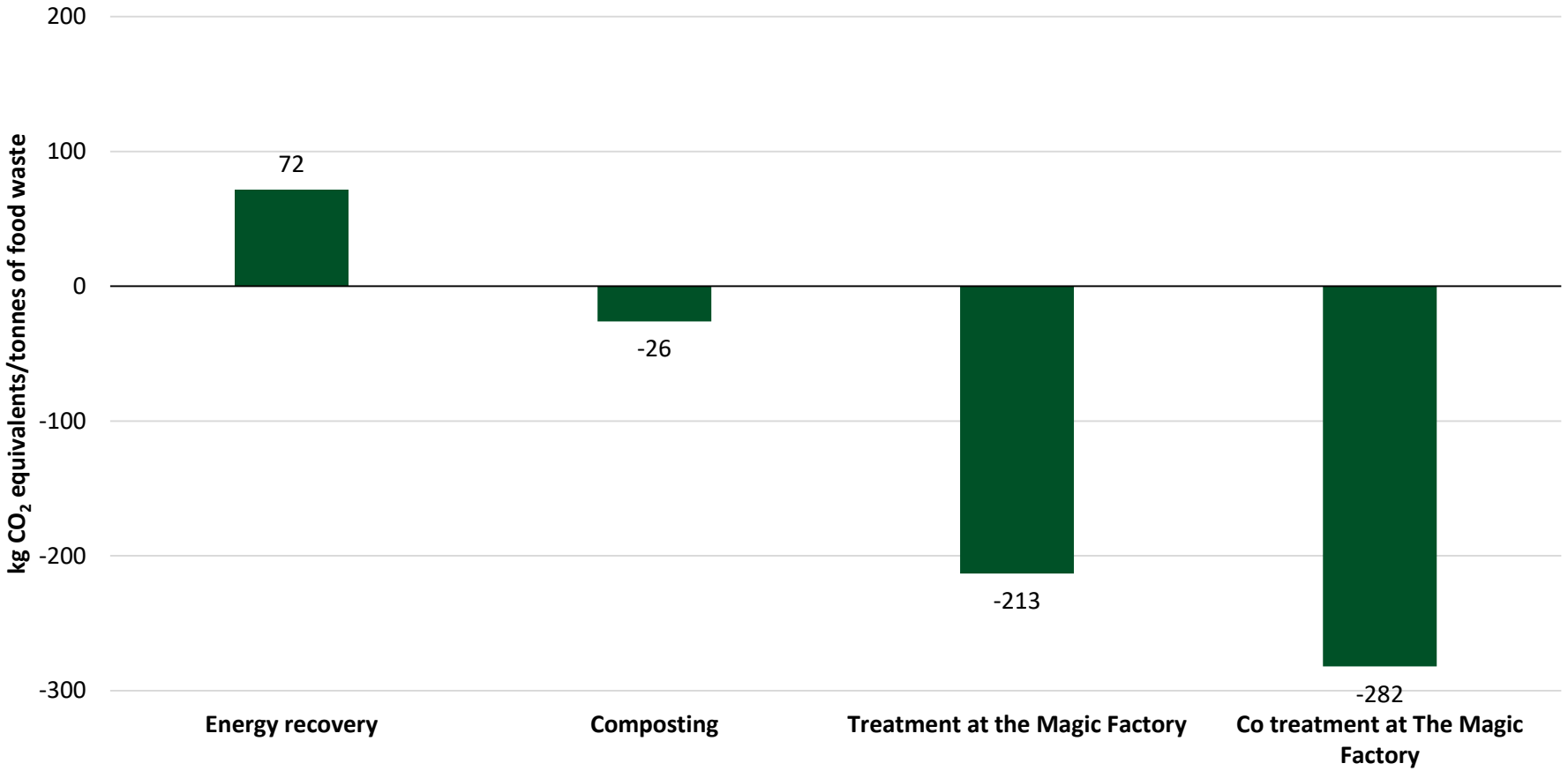
Results per tonne of food waste co-treated with manure



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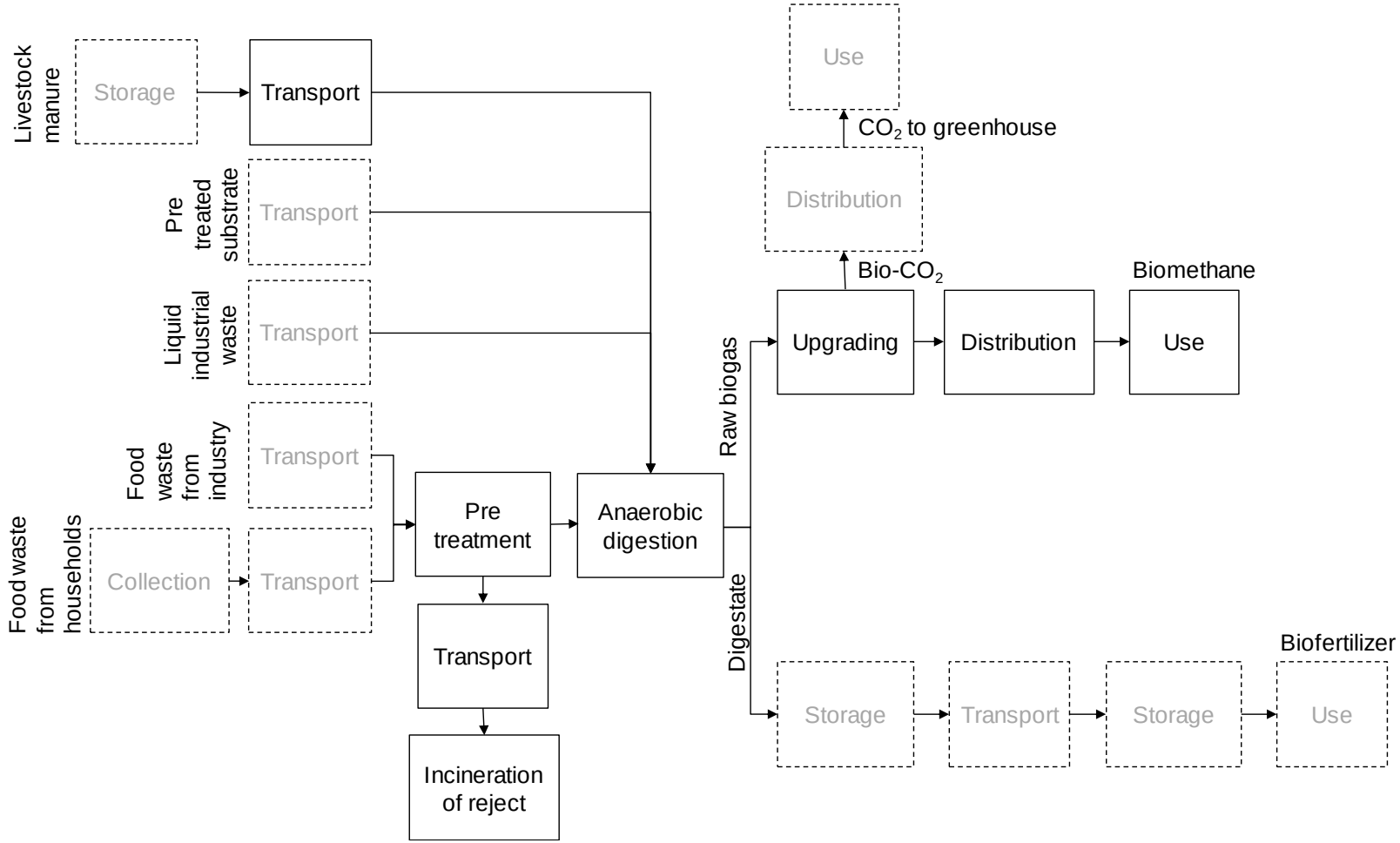
Biomethane as a fuel for transport

(Allocation, EPD calculation rules)



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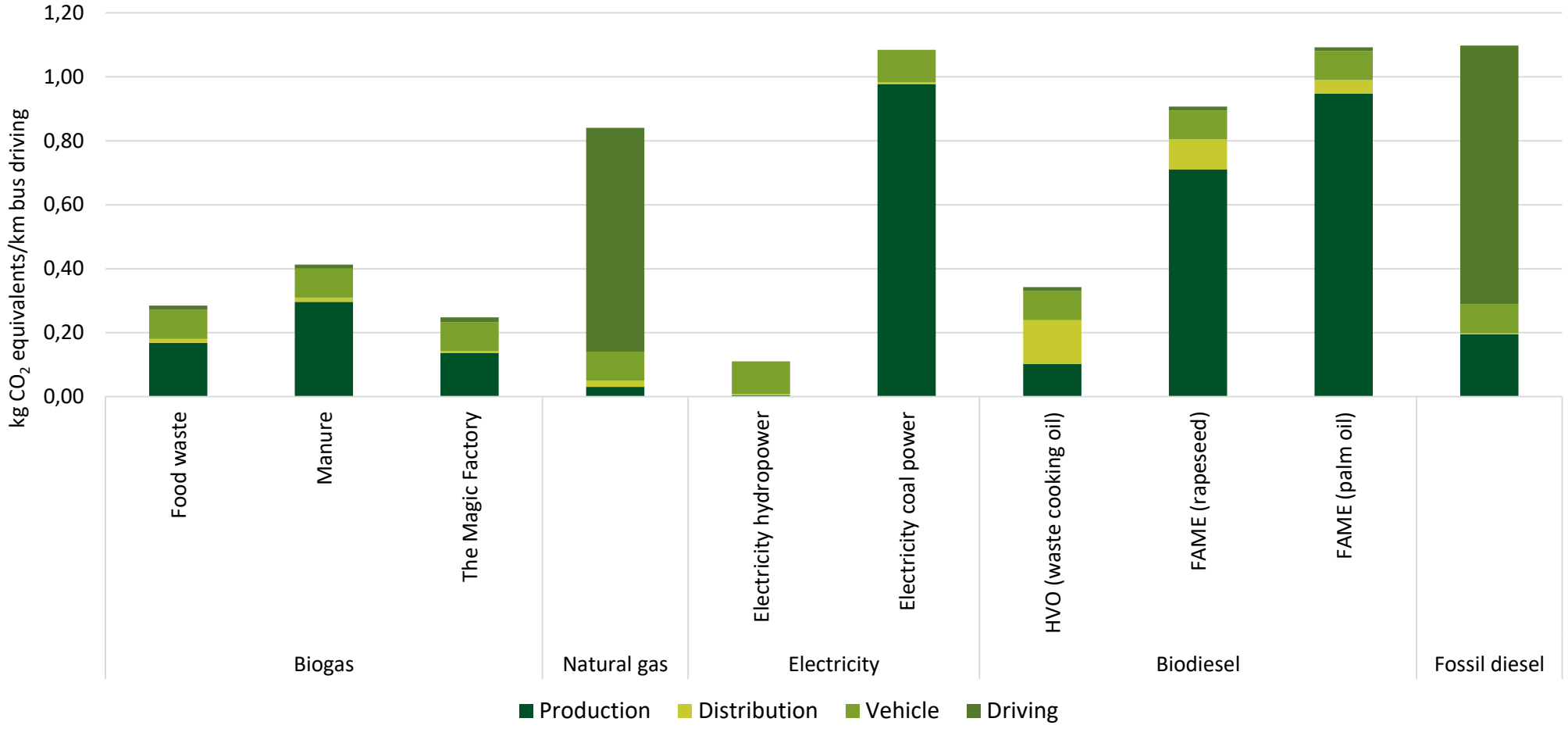
Results for biomethane as a fuel for transport
(allocation, EPD calculation rules)



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Main conclusions

- Establishing The Magic Factory has lead to a emissions reduction of approximately 14000 tonnes CO_2 equivalents per year
- Treatment of food waste at The Magic Factory represents a reduction in greenhouse gas emissions compared with the alternatives between 187 and 285 kg CO_2 equivalents/tonnes food waste. If co digestion with manure is taken into account, a reduction of additional 69 kg CO_2 equivalents is obtained.
- The greenhouse gas emissions from the production and use of biomethane from The Magic Factory are low compared with other fuels available on the market

Main conclusions cont.

- System boundaries, functional units and data quality should be adjusted to fit the purpose of the study.

- When using Environmental Product Declarations calculation rules (allocation), double counting is avoided. This is to ensure that several actors do not «claim» the same emissions reduction in their declarations. The downside is that some of the benefits relating to the multifunctionality are not visible.

- For political decisions and in waste treatment systems the overall picture is important (system expansion)

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This study was part of the research project Bærekraftig Biogass/Sustainable Biogas.

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