

# Environmental comparison of alternative strategies for external carbon addition to manure biogas

*Lorie Hamelin & Henrik Wenzel*

A **greener** agriculture for a **bluer** Baltic Sea, November 2<sup>nd</sup>, 2011



# Outline

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- **Challenges for the future of manure-biogas**
- **Potential co-substrates**
- **Some LCA results**
- **Land use change: a rough glance at its potential importance**
- **Conclusion and perspectives**



# Producing more manure-biogas: Cha

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- **Animal slurries are too dilute, containing too little easily degradable C for economically attractive CH<sub>4</sub> yields**
- **Too low C/N ratio, leading to accumulation of NH<sub>3</sub> and potential inhibition**
- **Residual co-substrates are constrained**



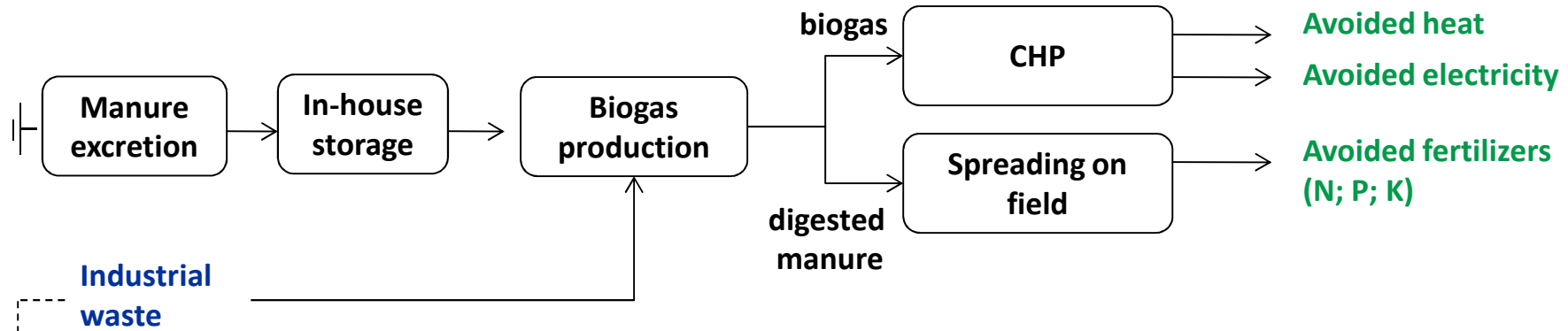
# Potential C co-substrates

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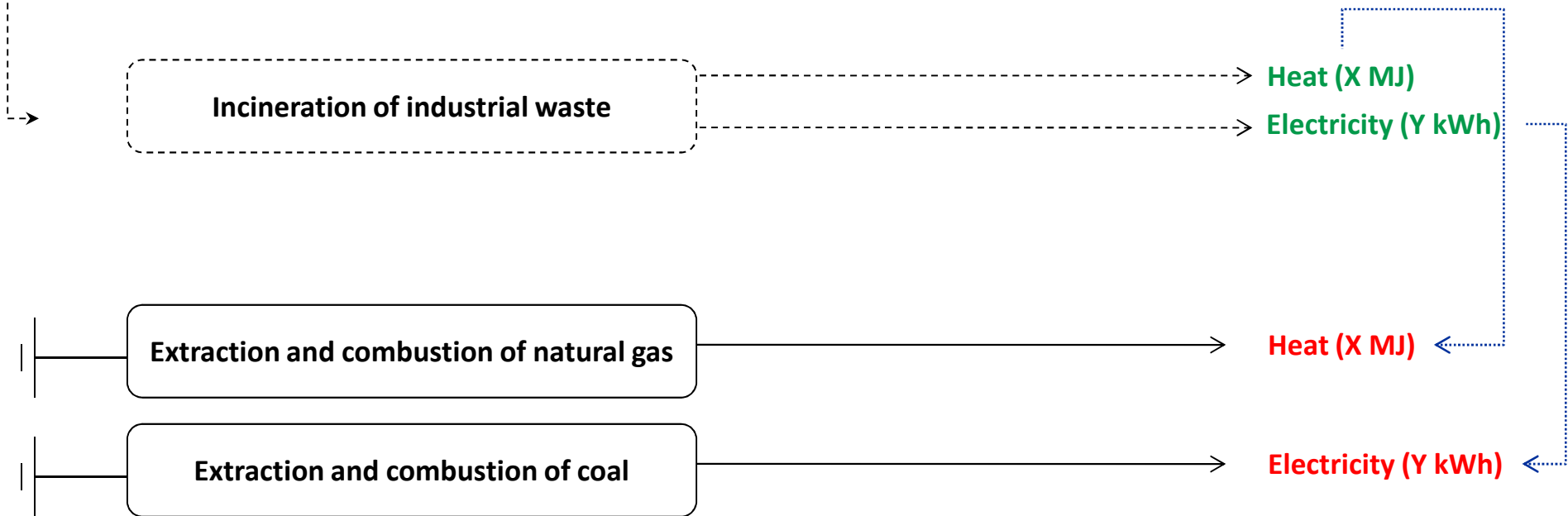
- 1. Industrial waste**
- 2. Energy crops**
- 3. Straw**
- 4. Household bio-waste**
- 5. Manure concentrate**



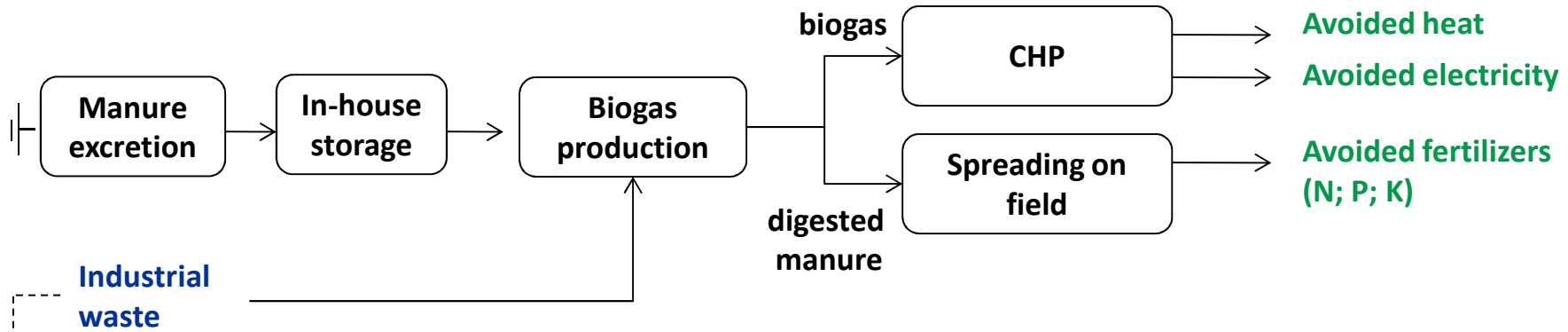
# 1. Industrial waste



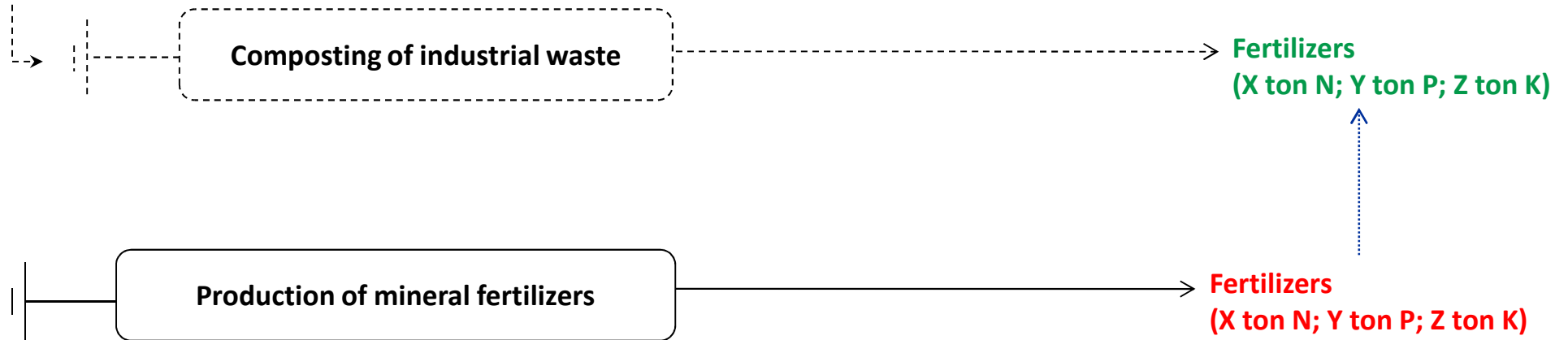
***What is the opportunity cost?  
a) Incineration?***



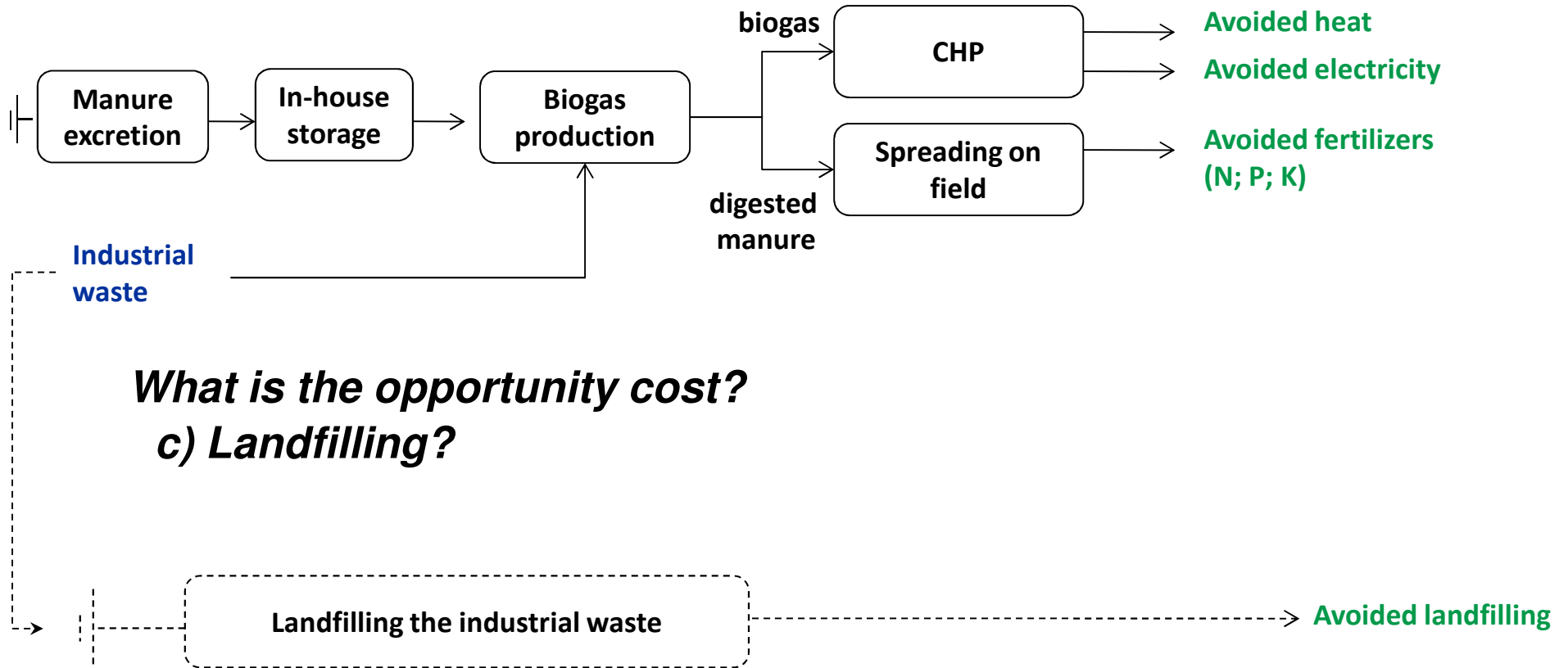
# 1. Industrial waste



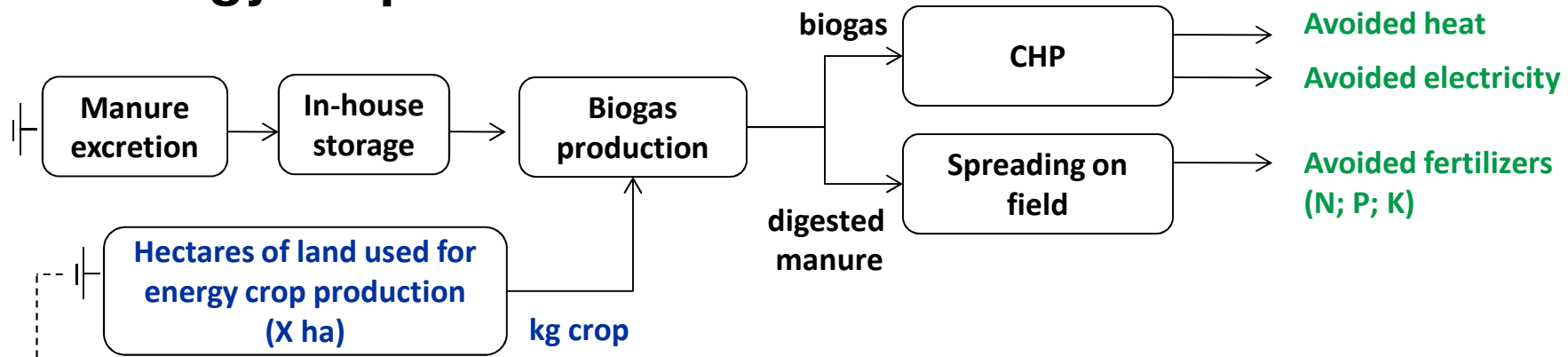
*What is the opportunity cost?  
b) Composting?*



# 1. Industrial waste

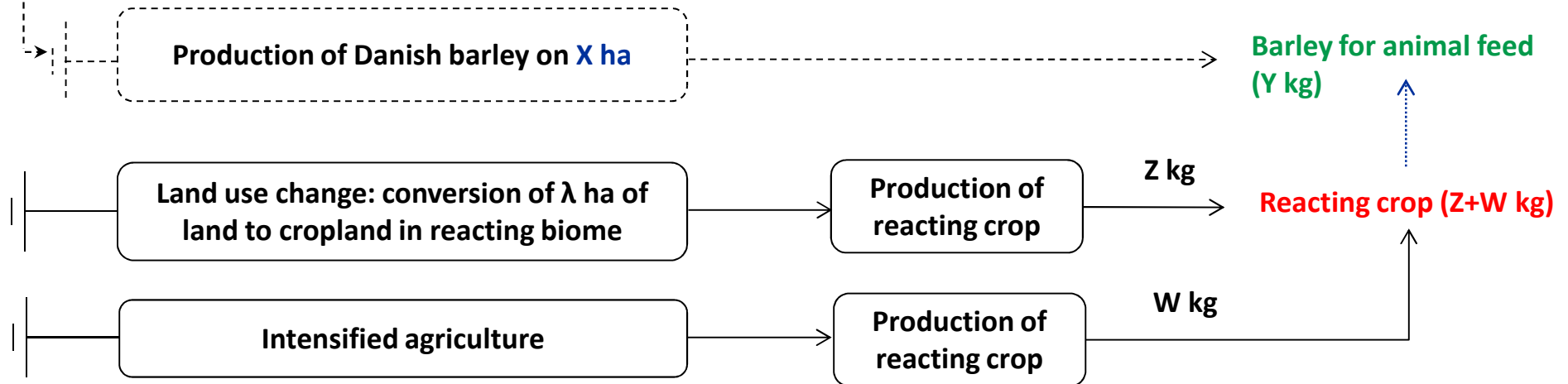


## 2. Energy crops

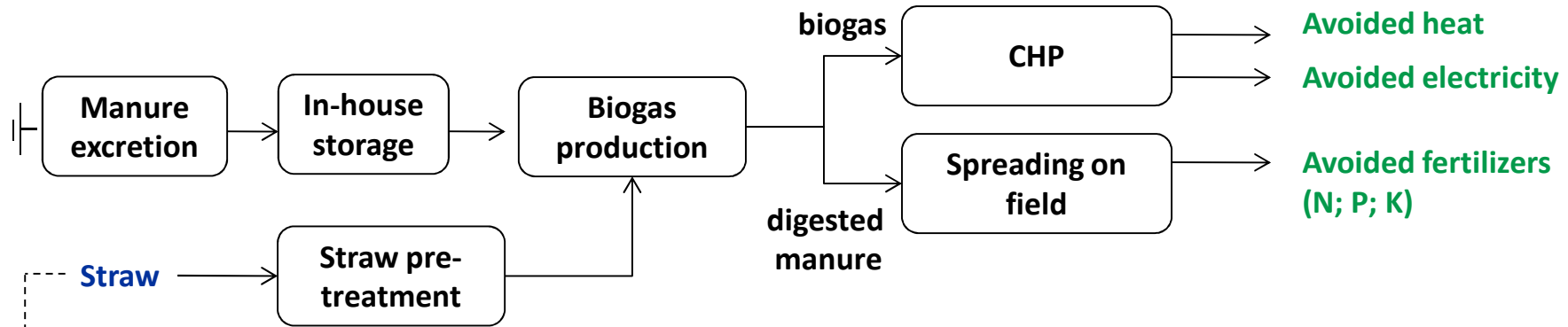


### *What is the opportunity cost?*

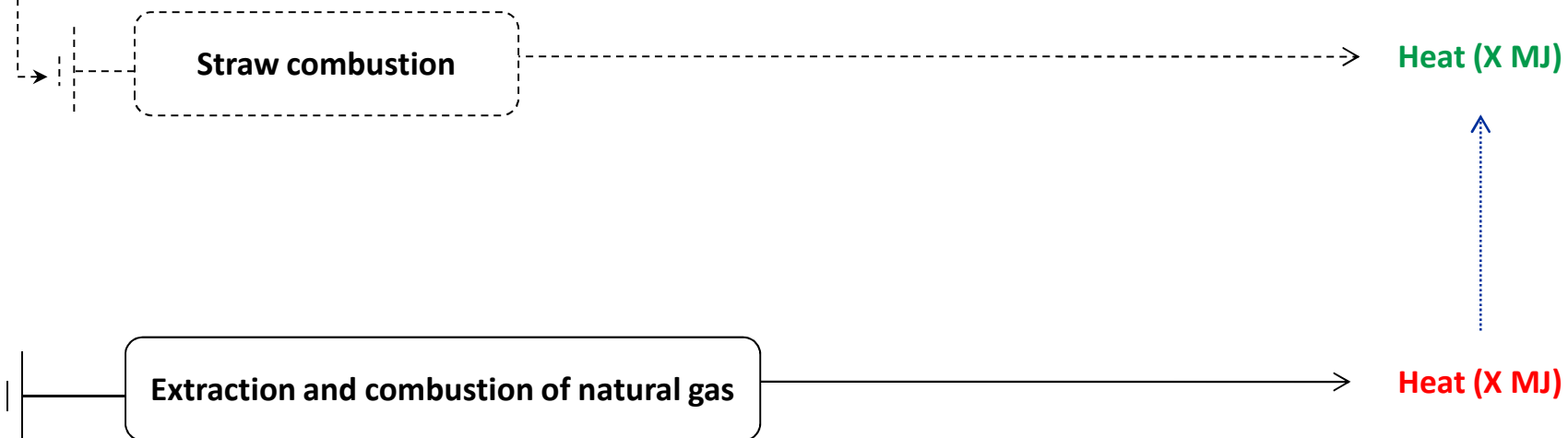
*Some land nowadays used for crop production is used for energy crops. The displaced crop production is not available on the market anymore*



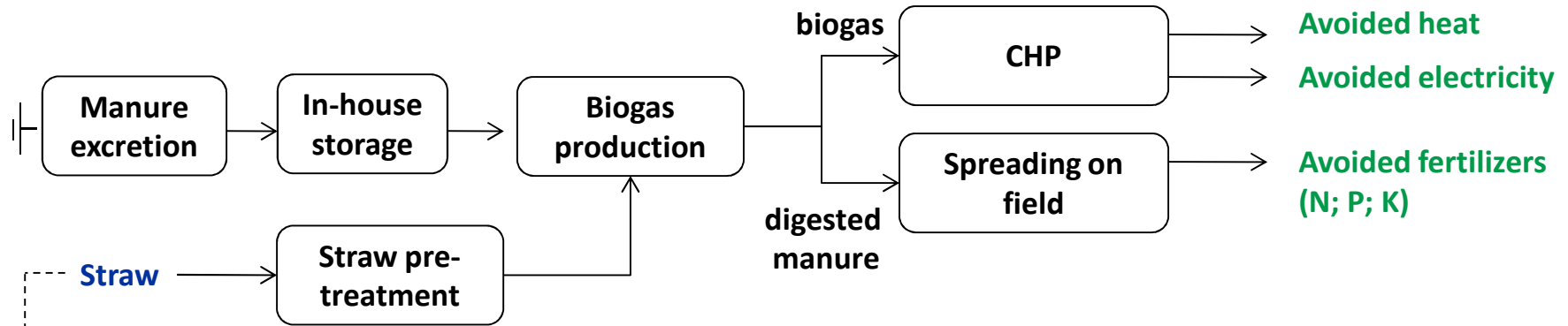
### 3. Straw



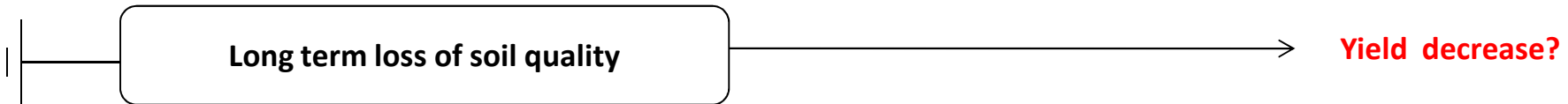
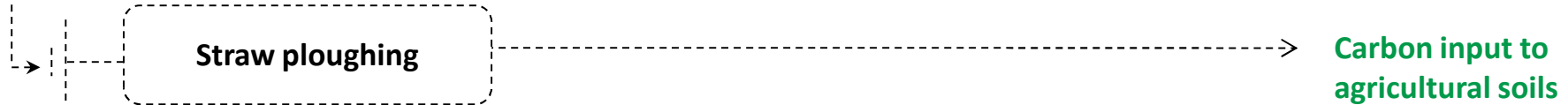
*What is the opportunity cost?  
a) Combustion?*



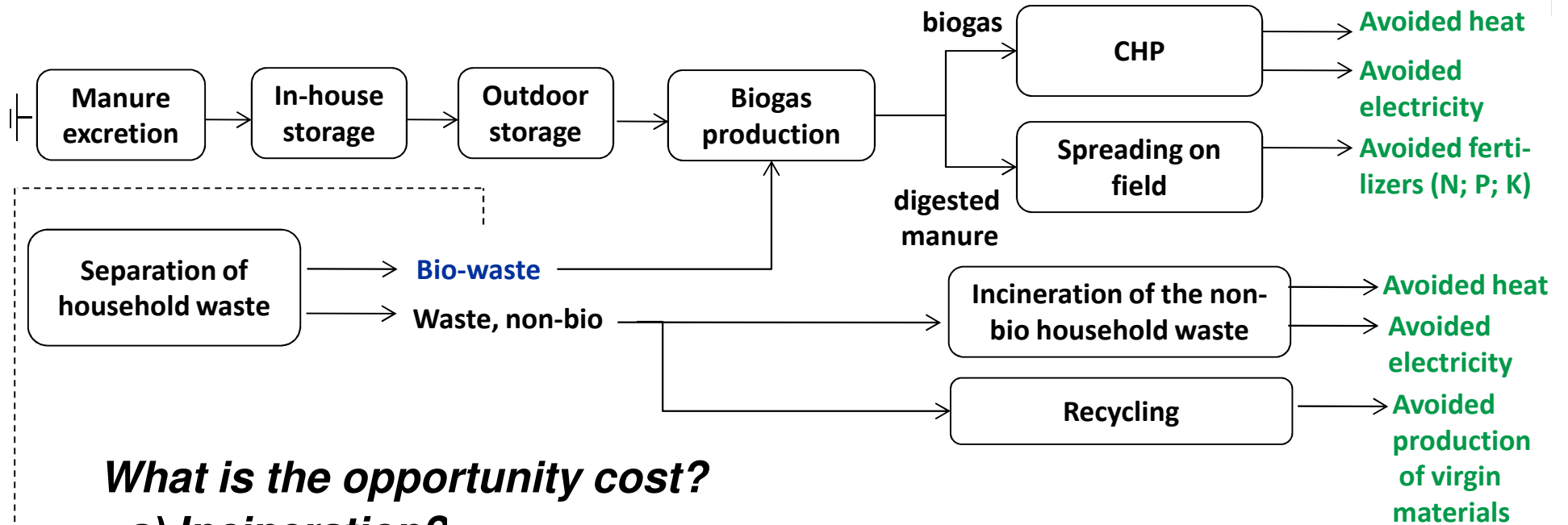
### 3. Straw



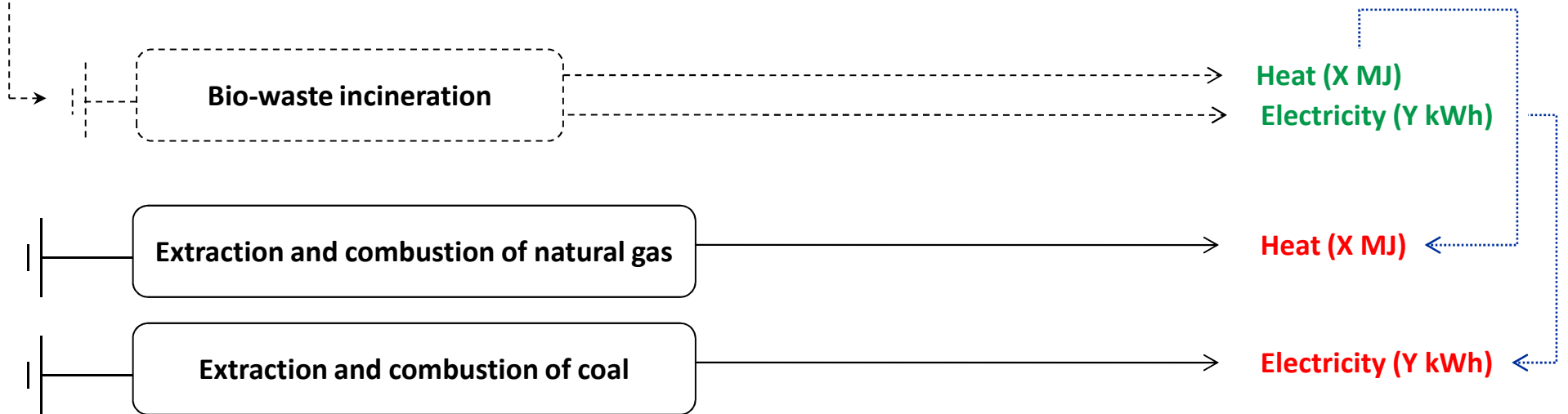
*What is the opportunity cost?  
b) Incorporation in soils?*



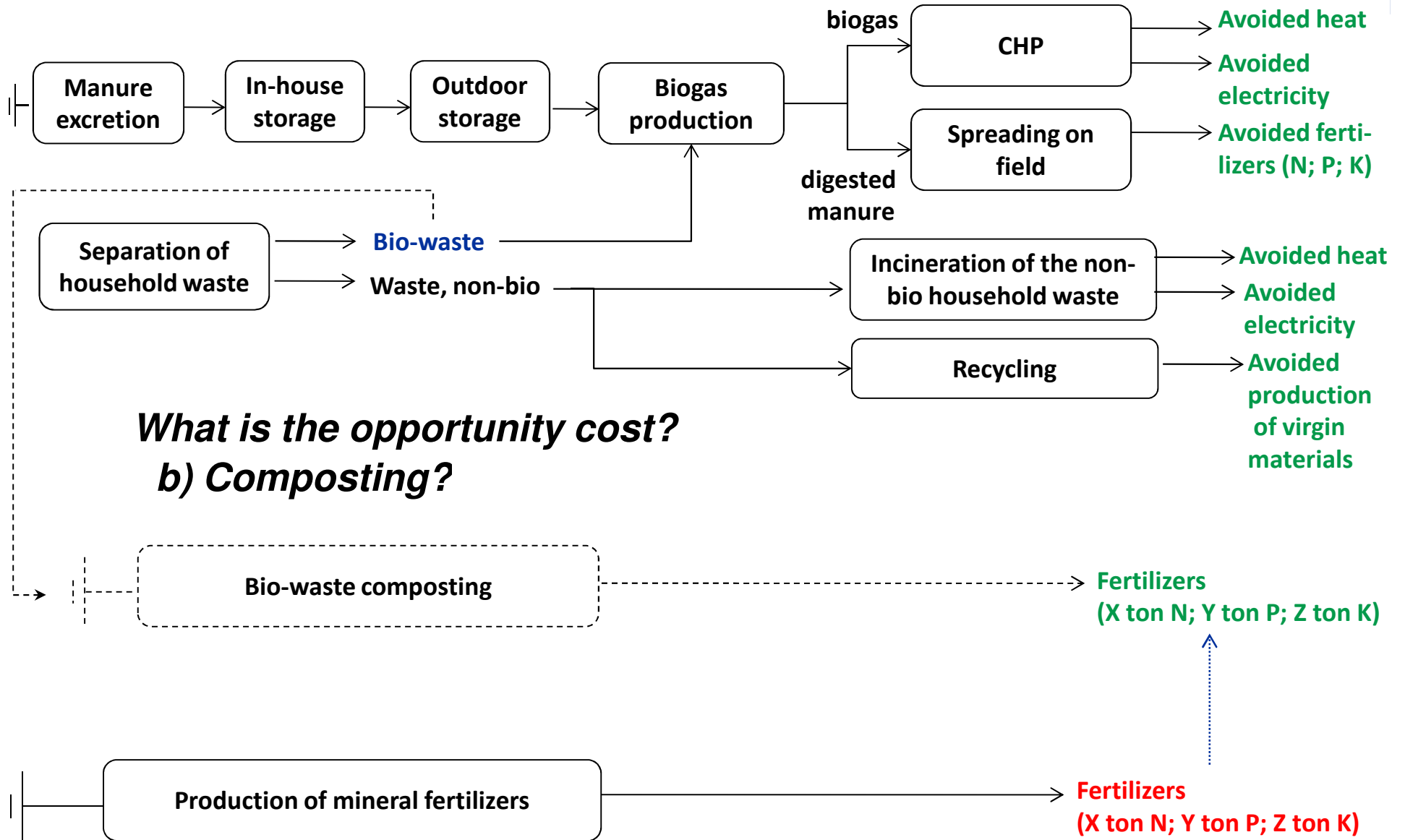
# 4. Household bio-waste



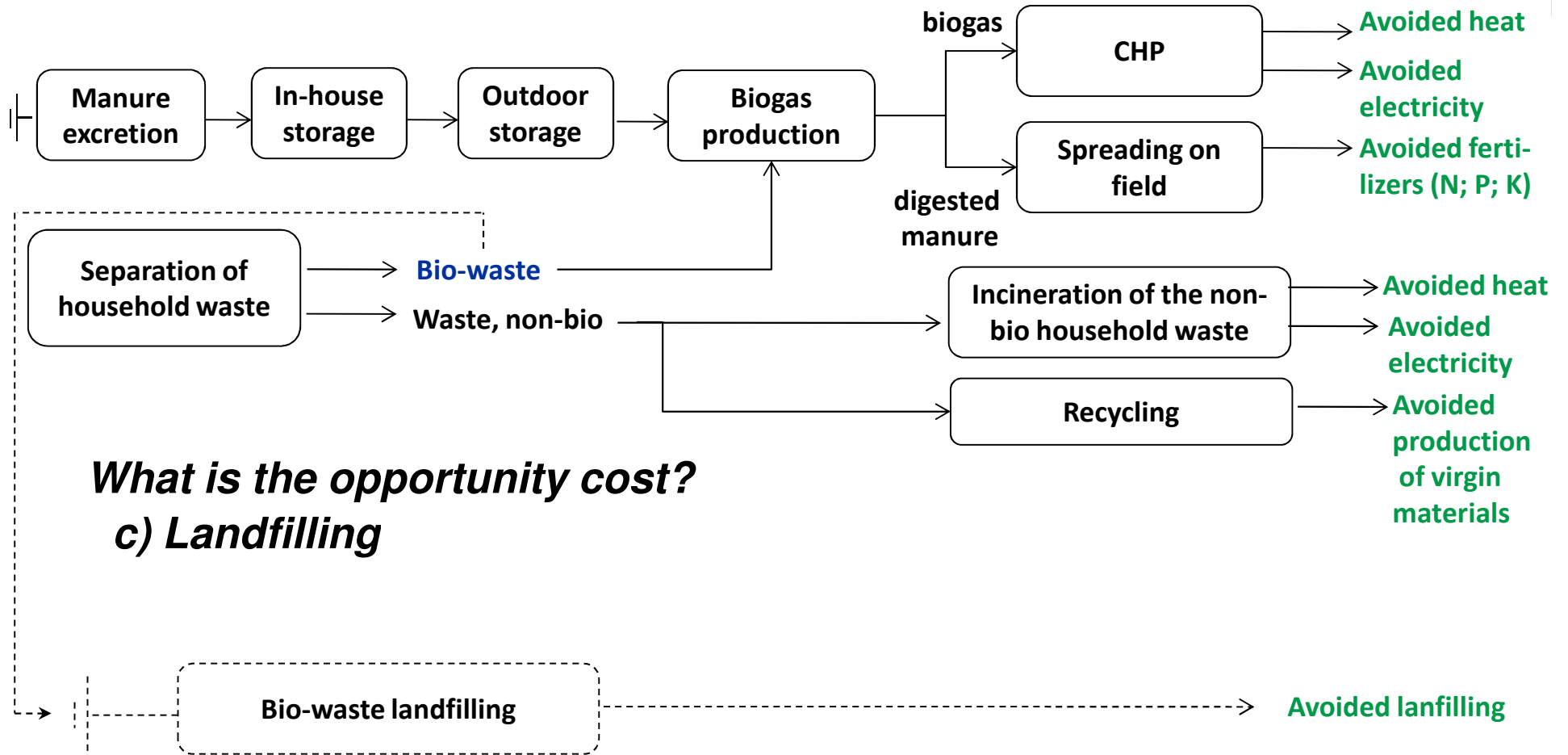
**What is the opportunity cost?**  
**a) Incineration?**



# 4. Household bio-waste

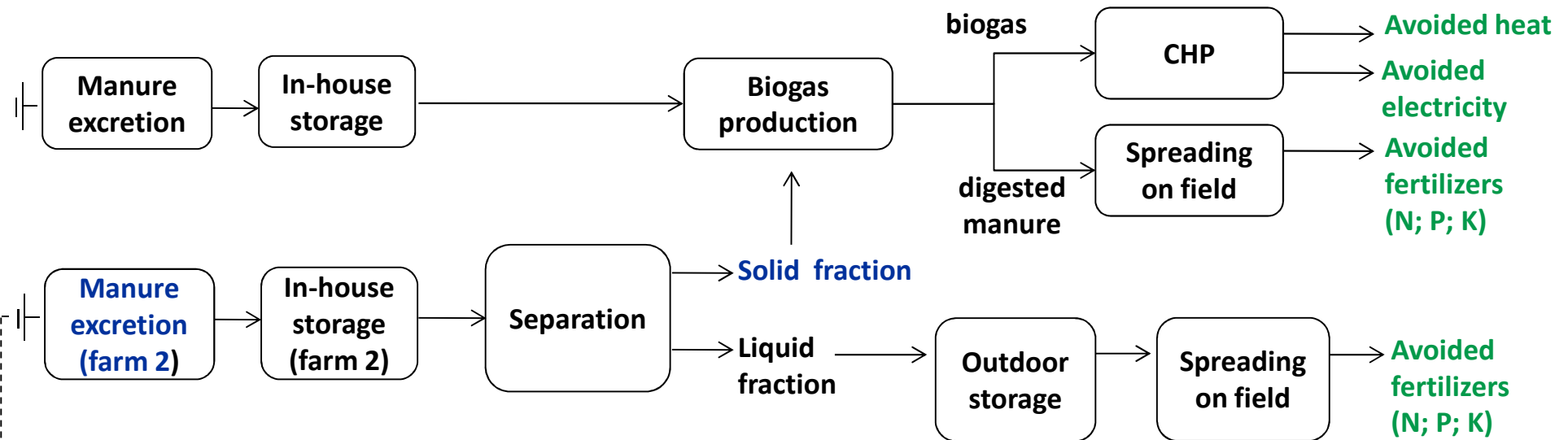


# 4. Household bio-waste



**What is the opportunity cost?**  
**c) Landfilling**

## 5. Manure concentrate

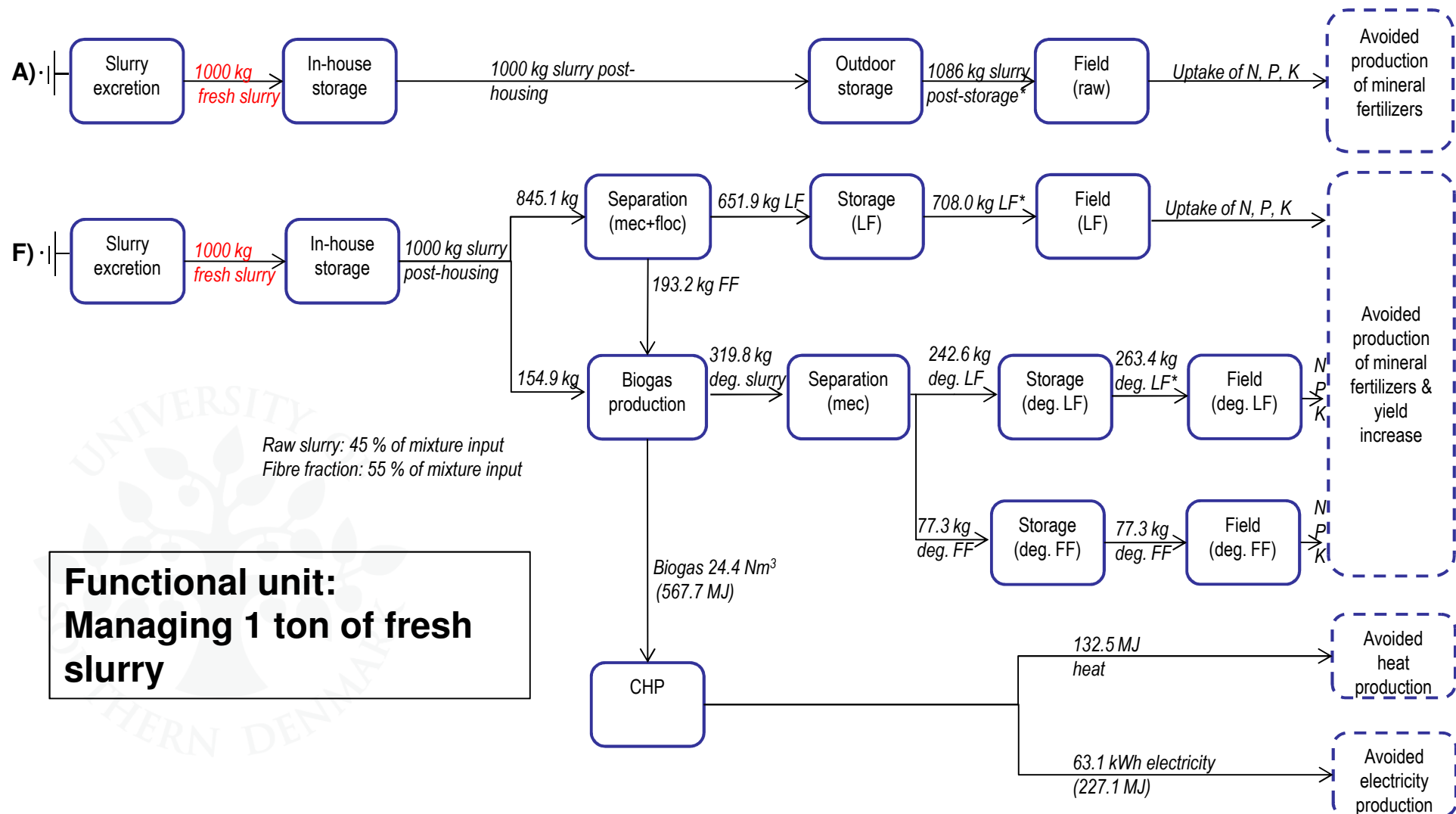


***What is the opportunity cost?***

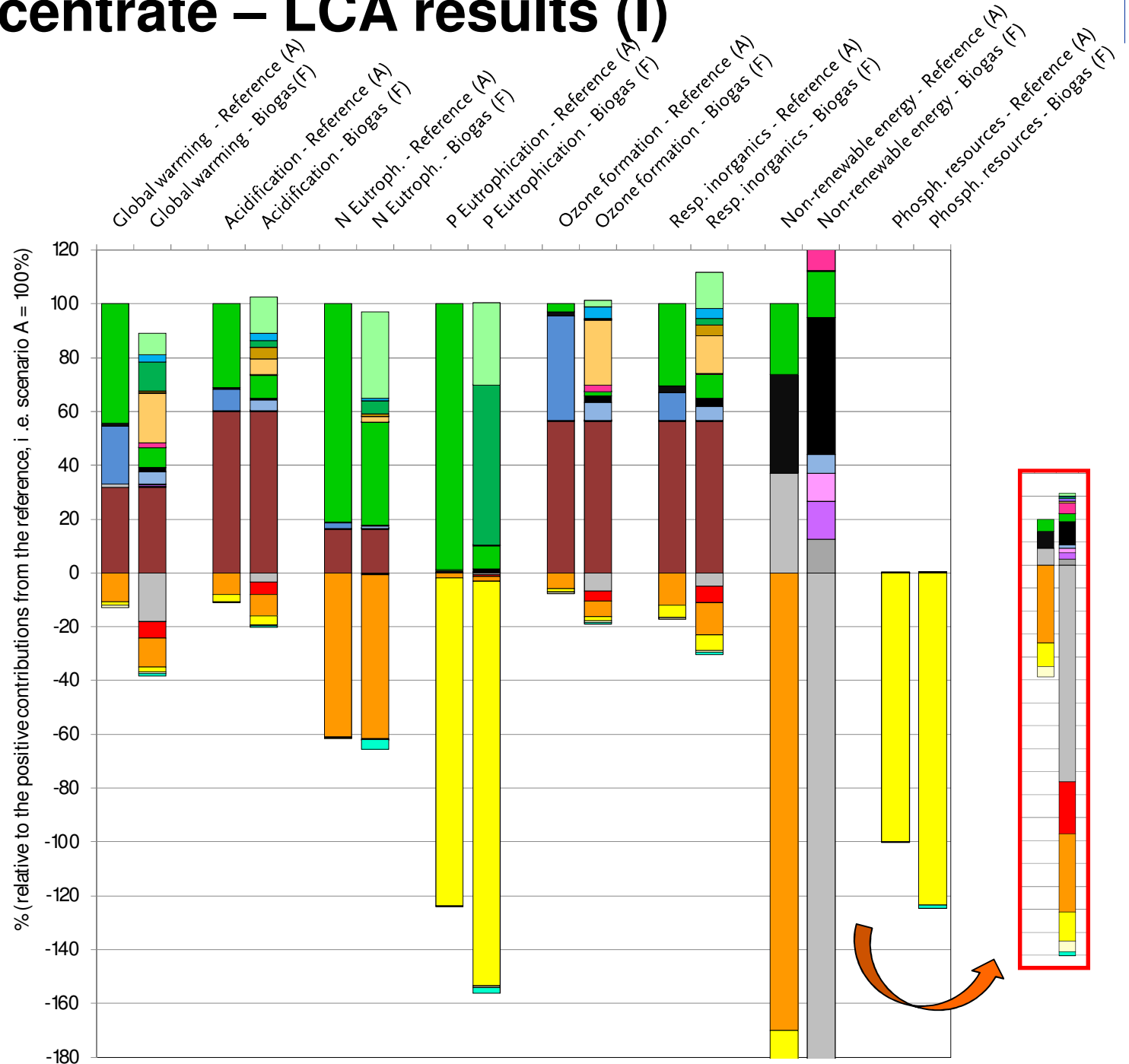
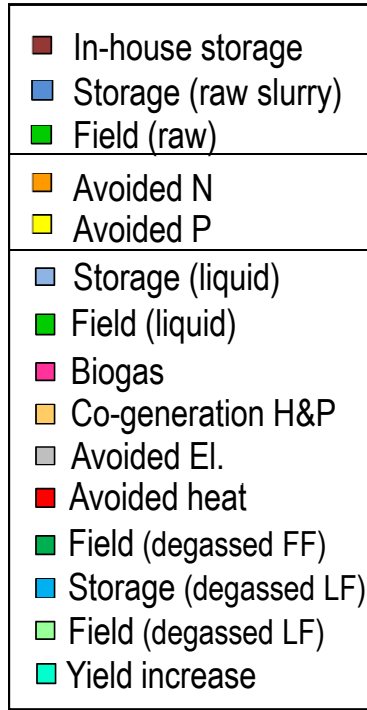
***a) Manure (from farm 2) would otherwise have been managed without treatment***



# Manure concentrate: LCA of biogas from separated slurry

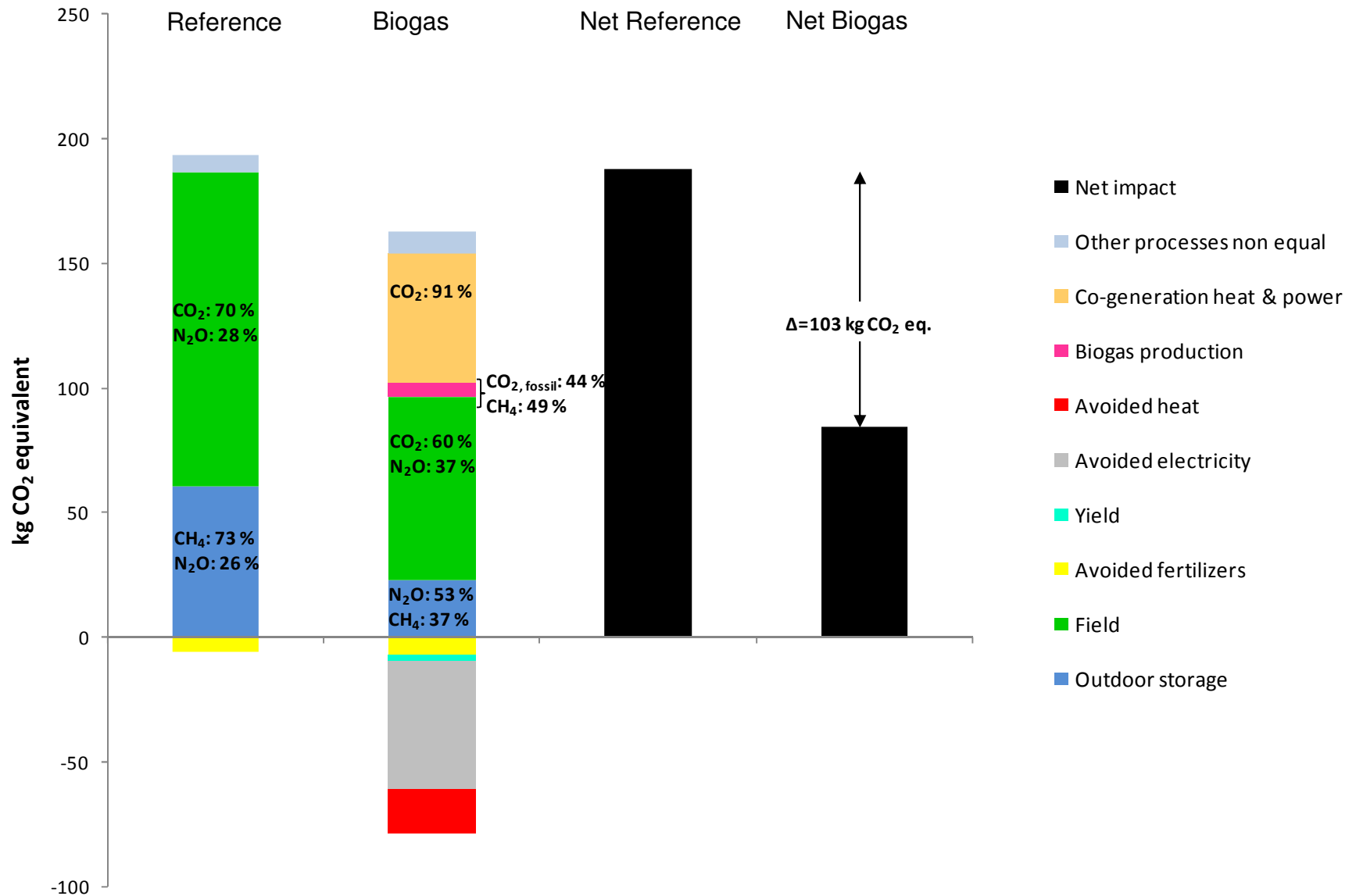


# Manure concentrate – LCA results (I)



# Manure concentrate – LCA results (II)

Global warming – Processes equal in both Scenarios not included



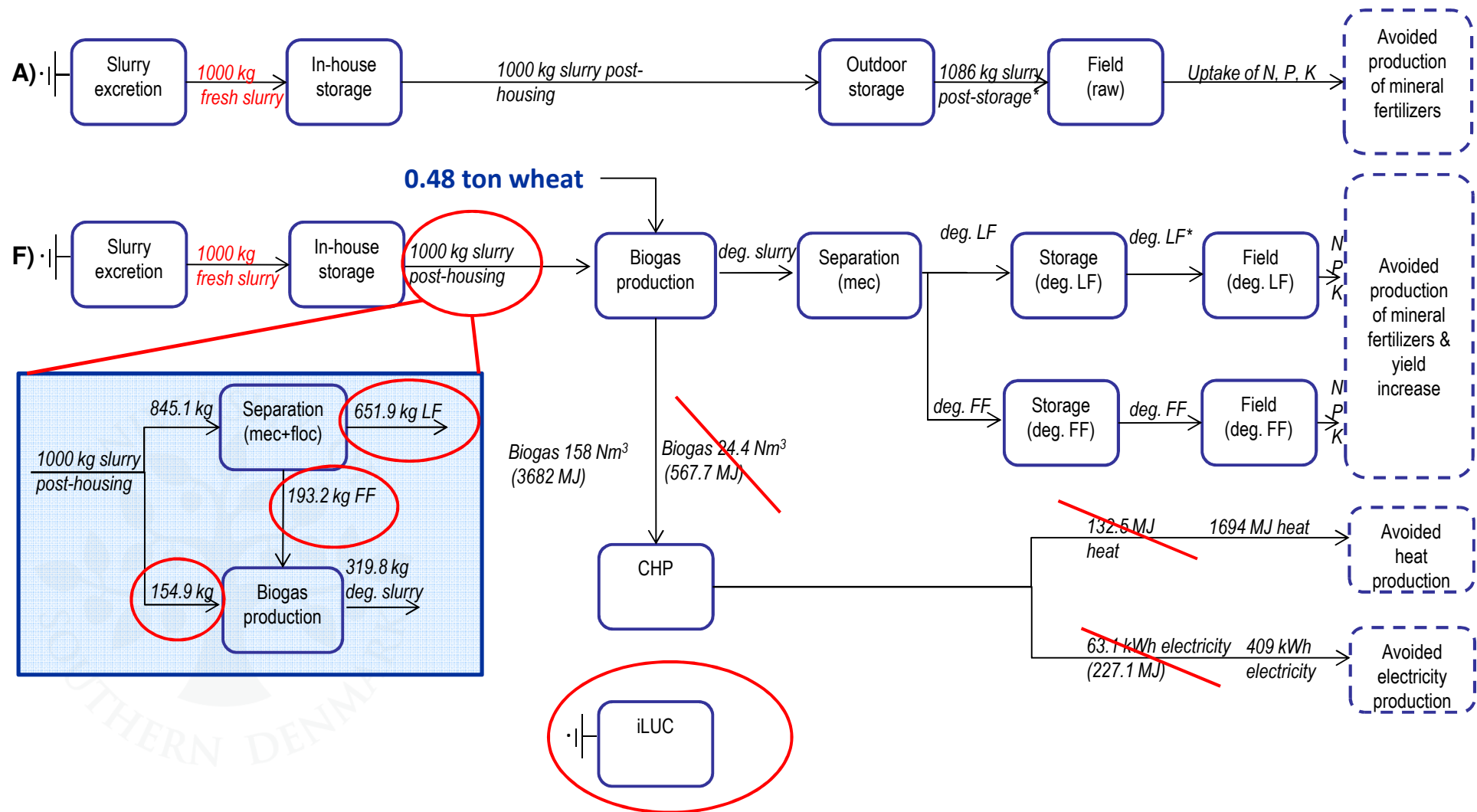


## Findings about “manure concentrate” s

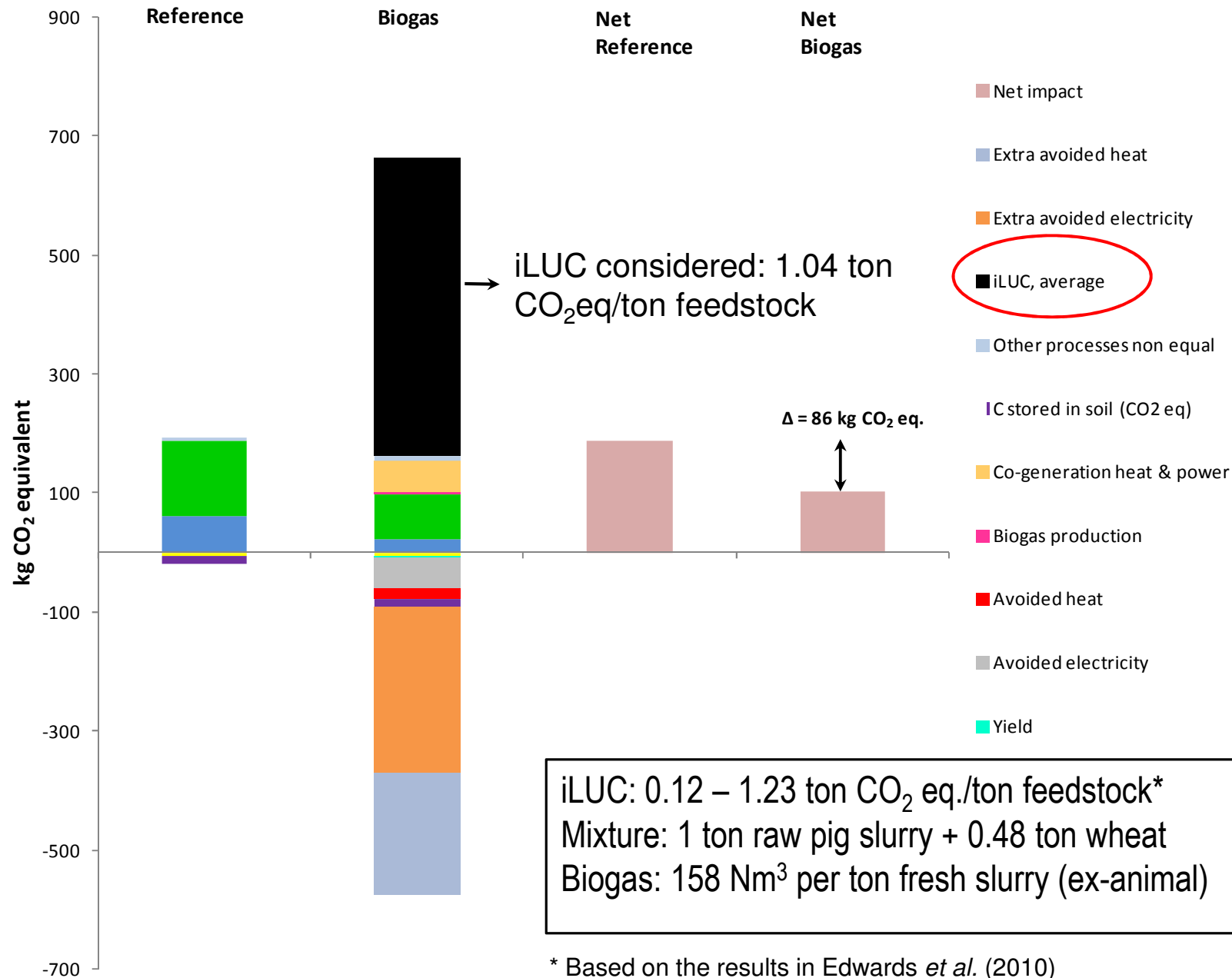
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- **This strategy does allow to reduce GHG as compared to reference manure management**
- **Environmental benefits very much dependant upon efficiency of separation technology**
- **May be limited if the ambition is to use biogas as part of renewable energy ambitions.**

# Importance of iLUC: a rough estimation based on the same LCA system



# Importance of iLUC: a rough estimation based on the same LCA system





# Baltic Manure

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- **In the framework of Baltic Manure, we will perform a few LCAs with a case-study BSR country to investigate what happens if:**
  - 40 % of the manure produced in DK is used for biogas (2020)
  - ca. 100 % of the manure produced in DK is used for biogas (2050)
- **This study should highlight what strategy should be prioritized, if we aim to use more manure for biogas**



# Conclusion and perspectives

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- **Research is needed in order to adopt a consistent strategy regarding manure-biogas in BSR**
- **Importance of the LCA perspective to avoid the so-called rebound effects**
- **There is other ways to boost CH<sub>4</sub> yields:**
  - Running the digesters in parallel
  - Pre-treatment
  - Injecting H<sub>2</sub>
  - Carbon capture and recycling



# Questions & Discussions

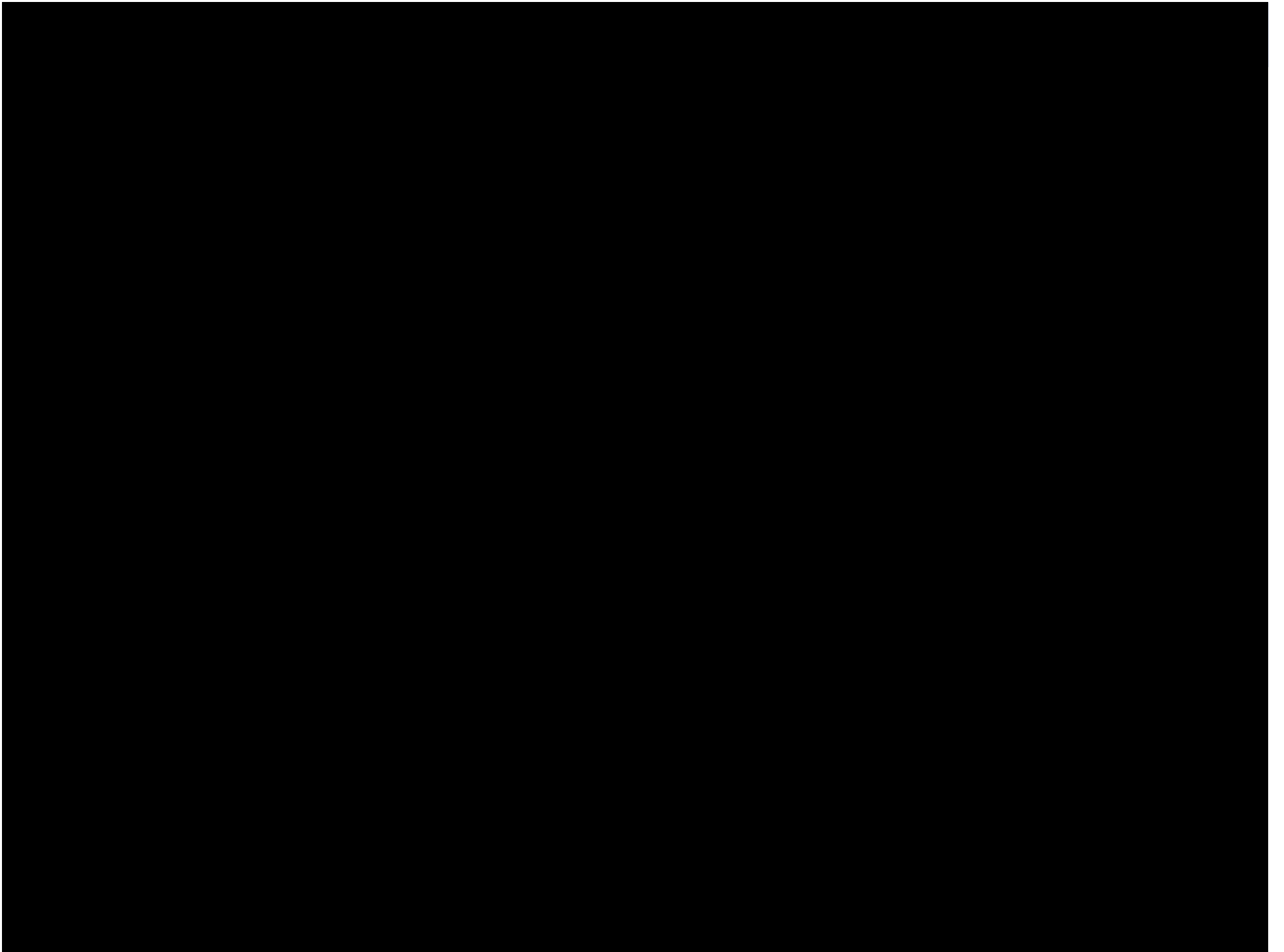
[loha@kbm.sdu.dk](mailto:loha@kbm.sdu.dk)

More details are available in our recent paper:

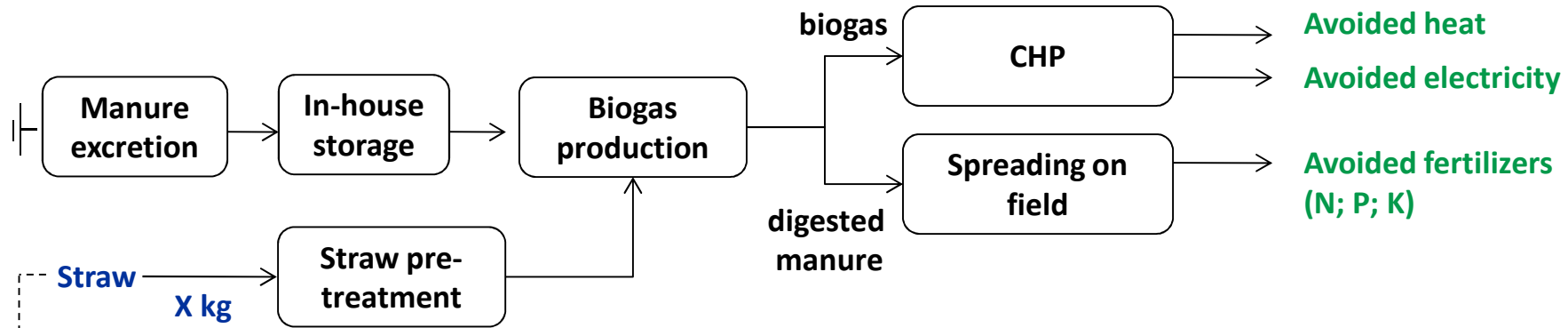
Hamelin et al. (2011). Environmental Consequences of Future Biogas Technologies.  
*Environmental Science & Technology*, 45 (13), 5869-5877.

The full report of our LCA study entitled “Life Cycle Assessment of Biogas from Separated Slurry” is available on the Danish EPA website: [www.mst.dk](http://www.mst.dk)

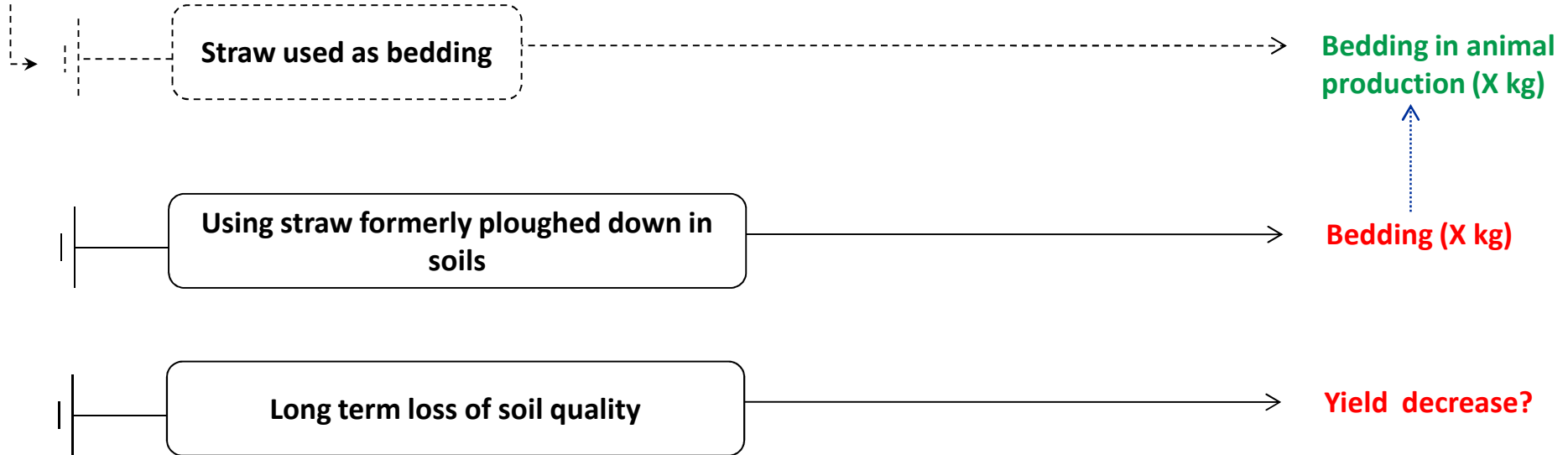




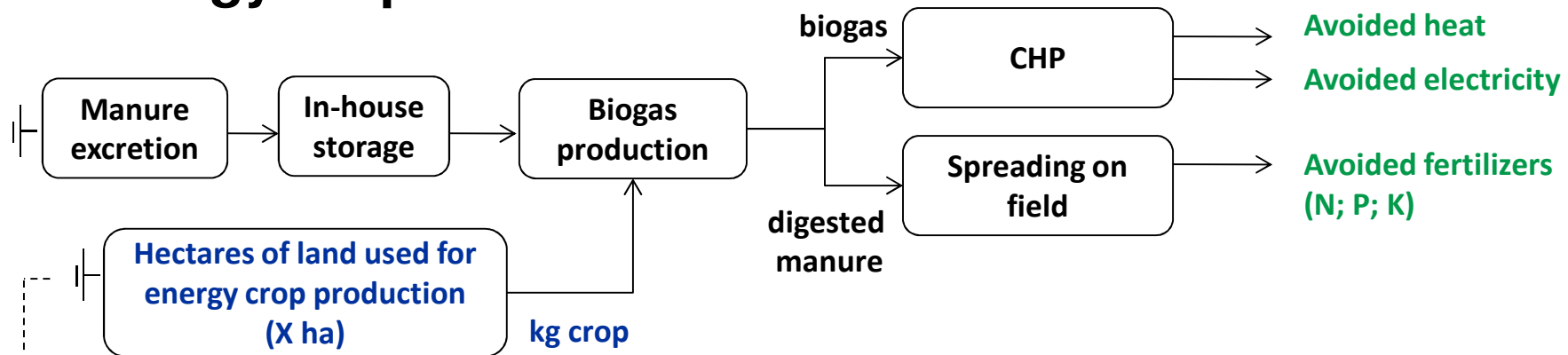
### 3. Straw



*What is the opportunity cost?  
c) Bedding?*



## 2. Energy crops



**What is the opportunity cost?**

**b) Using the crop for biofuels**

