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Biomass for Swiss Energy Future
Swiss Competence Center for Energy Research

Energy and greenhouse gas emissions benefits of converting manure to biogas through anaerobic digestion

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Burg, V., Bowman, G., Haubensack, M., Baier, U., & Thees, O. (2018). Valorization of an untapped resource: energy and greenhouse gas emissions benefits of converting manure to biogas through anaerobic digestion. Resources, Conservation and Recycling, 136 (53-62).

Objectives

Today only 6 % of animal manure is used for energy: high untapped potential for energetic use!

- Taking into consideration :
  - the spatial distribution of manure throughout the country,
  - specific manure composition and methane yield,
- … we want to assess within the same study :
  - the resource biogas potentials,
  - the GHG emissions benefits of converting manure to biogas in Switzerland.

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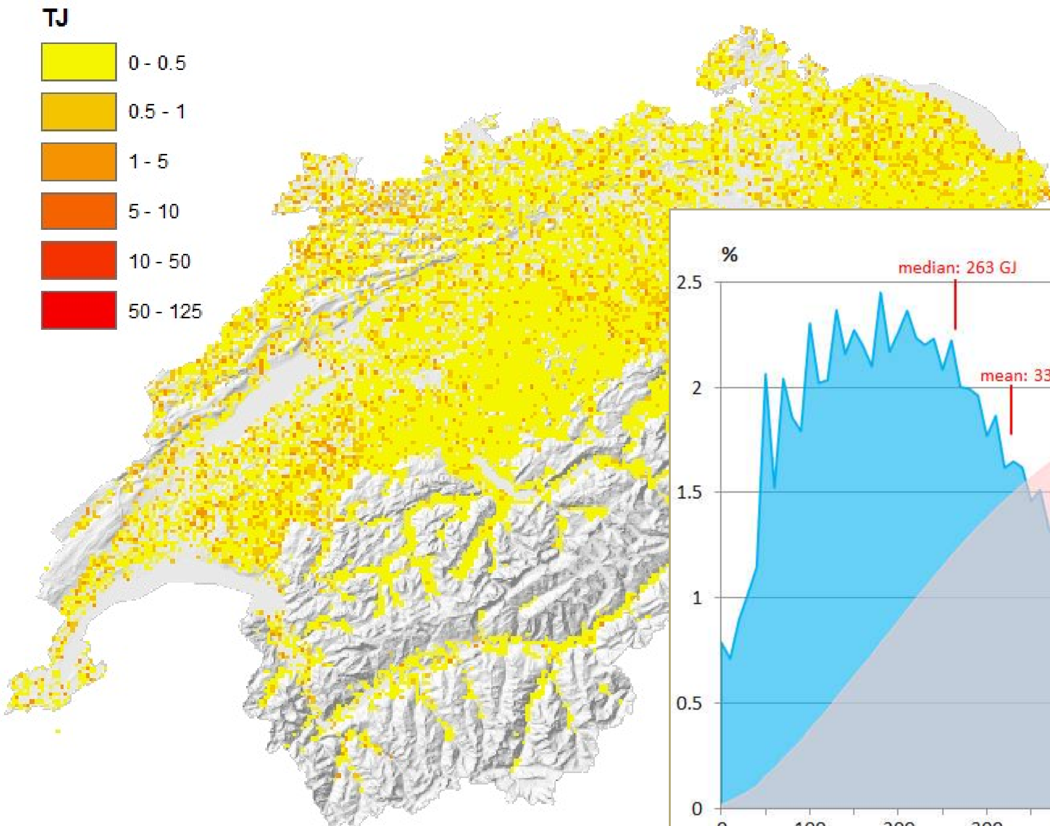
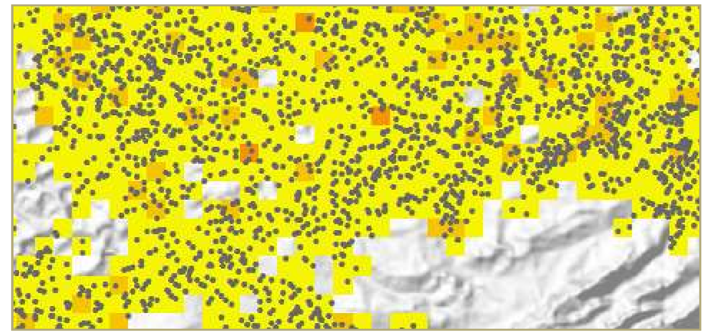
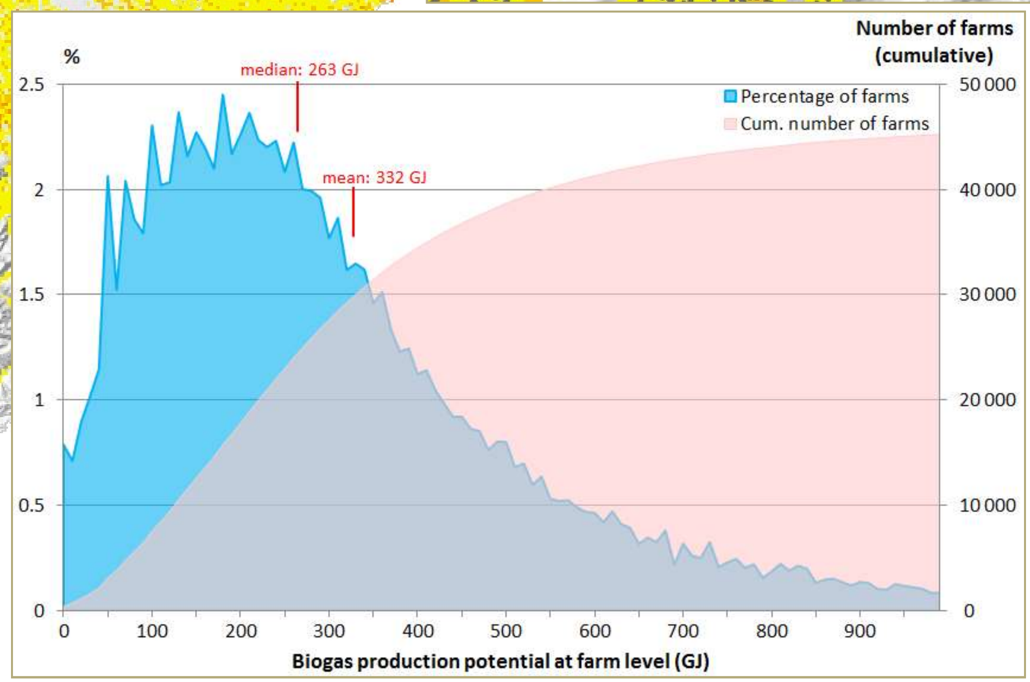
Spatial distribution

Potential biogas production of stored manure
(aggregated over 1 km x 1 km)



Average distance to the nearest neighbor: 280m





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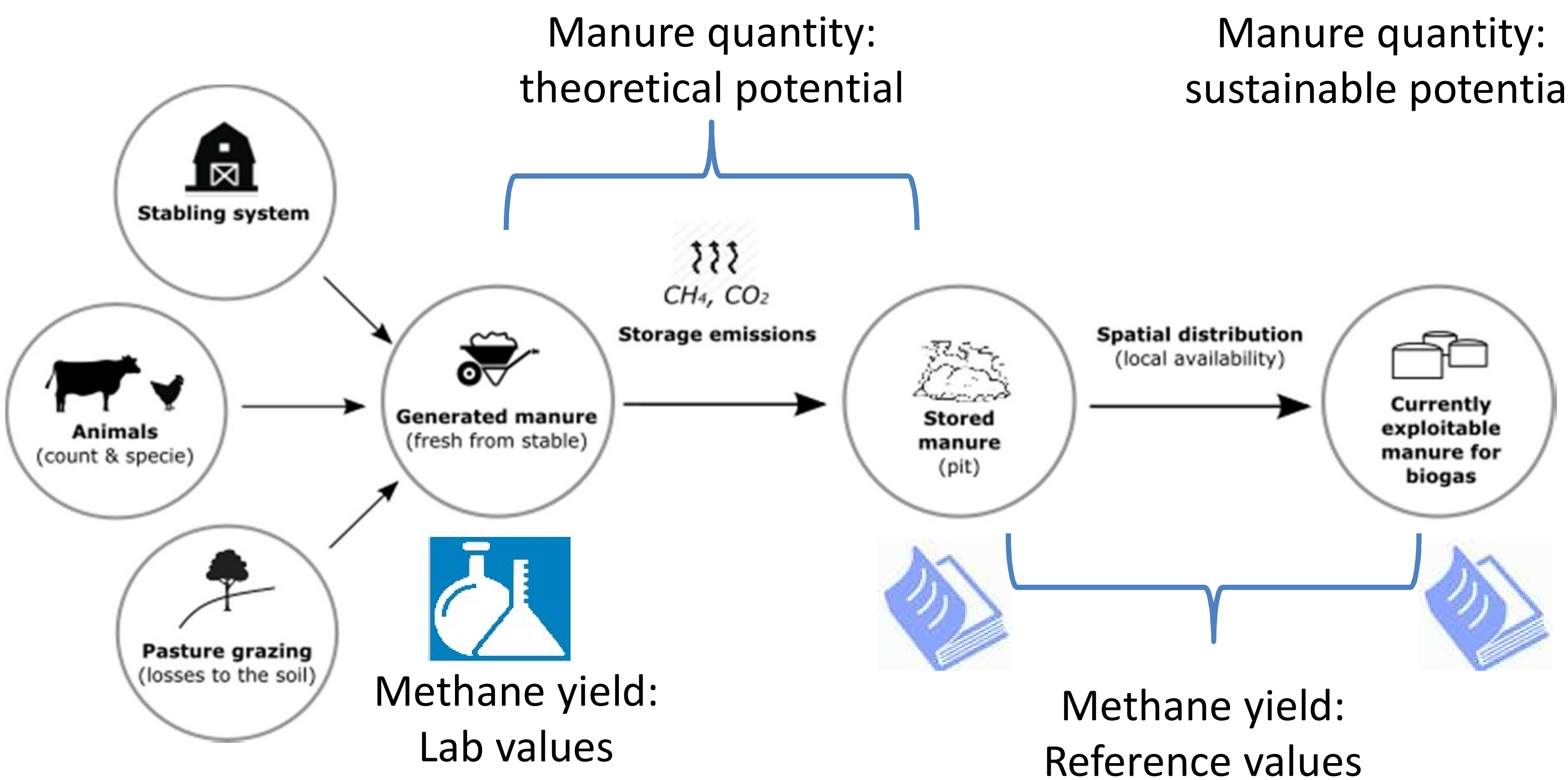
Lab-scale measurements, specific manure composition and methane yield

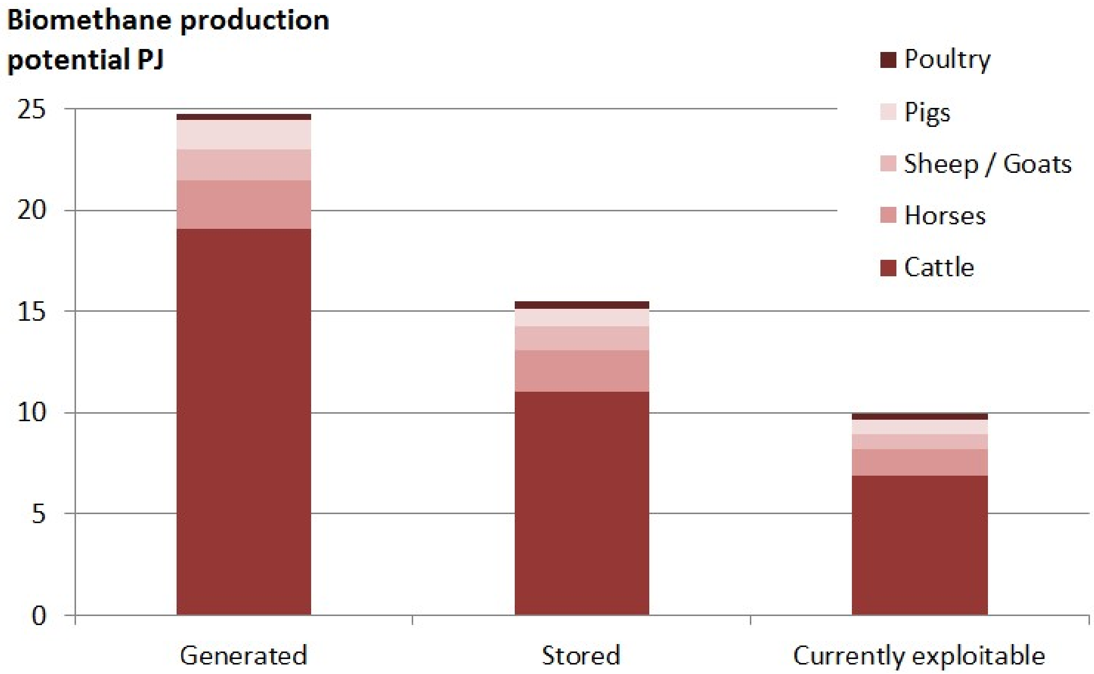
Categories	Lab measurements (fresh from stable)			Literature values		
	dw (%)	odw (%)	Methane yield (NL/kg oTS)	dw (%)	odw (%)	Methane yield (NL/kg oTS)
Dairy cows, liquid	8 (± 3)	70 (±17)	364 (±14)	9	78	150
Dairy cows, solid	20 (± 4)	80 (± 7)	359 (±14)	21	84	250
Fattening cattle, liquid	8 (± 3)	78 (±10)	326 (±2)	9	72	150
Fatening cattle, solid	17 (± 6)	80 (± 9)	355 (±3)	21	74	250
Pig, liquid	6 (± 1)	74 (± 2)	411 (±3)	5	72	250
Horse, solid	29 (± 4)	88 (± 3)	298 (±11)	35	86	255
Poultry, solid	53 (± 3)	78 (±10)	259 (±9)	50	71	290

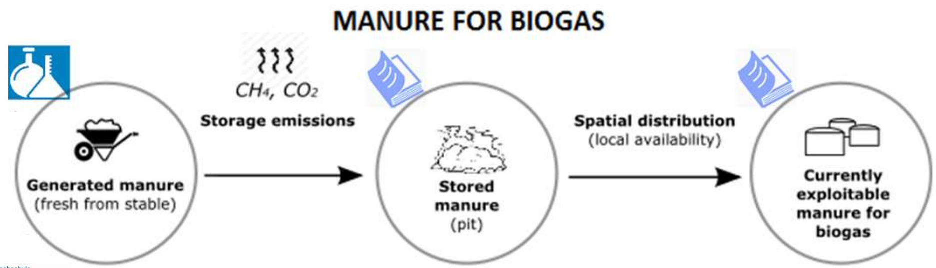
All lab measurements were performed by M. Haubensak under the supervision of U. Baier at ZHAW Wädenswill

Biogas potentials estimation

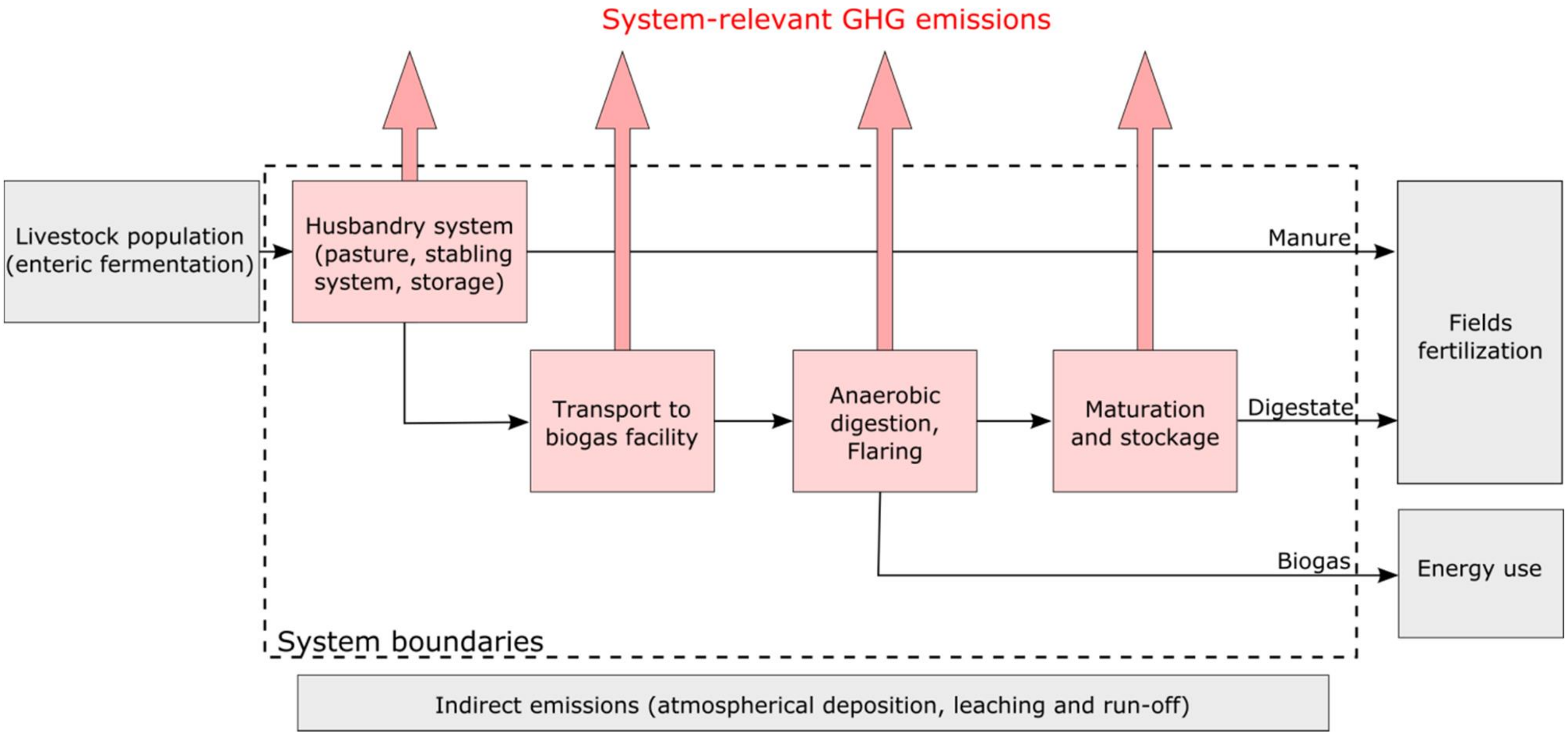


Biogas potentials estimation

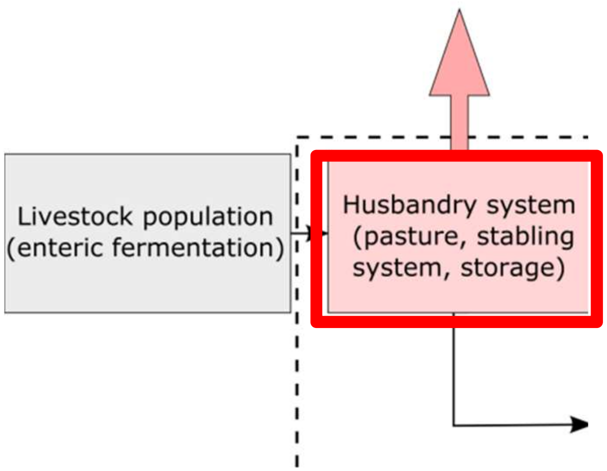




GHG emissions: system boundaries



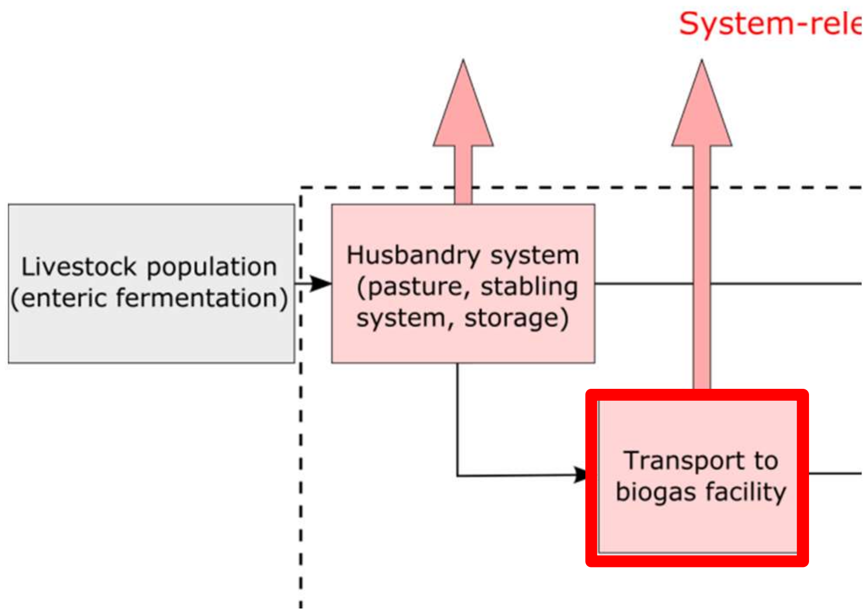
GHG emissions: Calculations



Emissions from the farm manure management:

- IPCC-Methods with our own database (number of animals, proportion of grazing and housing systems)

GHG emissions: Calculations

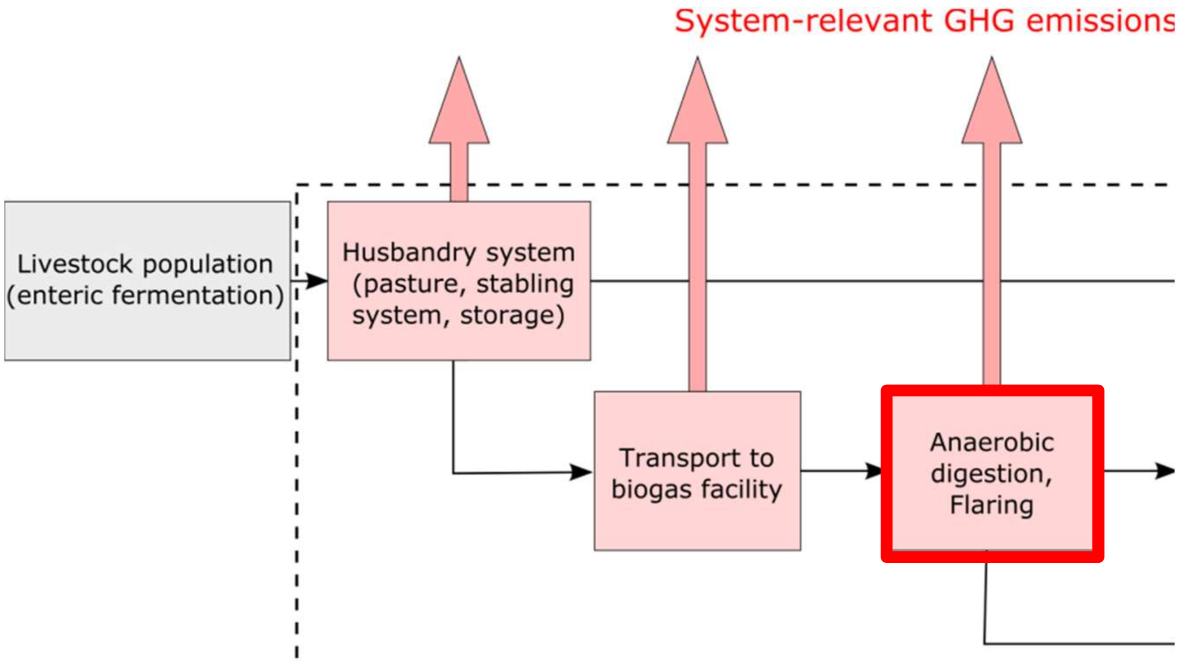


Emissions from transport:

- Estimation of the number of biogas plants, suppliers, transport distance and number of trips

→ Emissions factor per km driven

GHG emissions: Calculations



Emissions from the fermentation unit:

- Loss of 2% of the annual quantity of biogas produced

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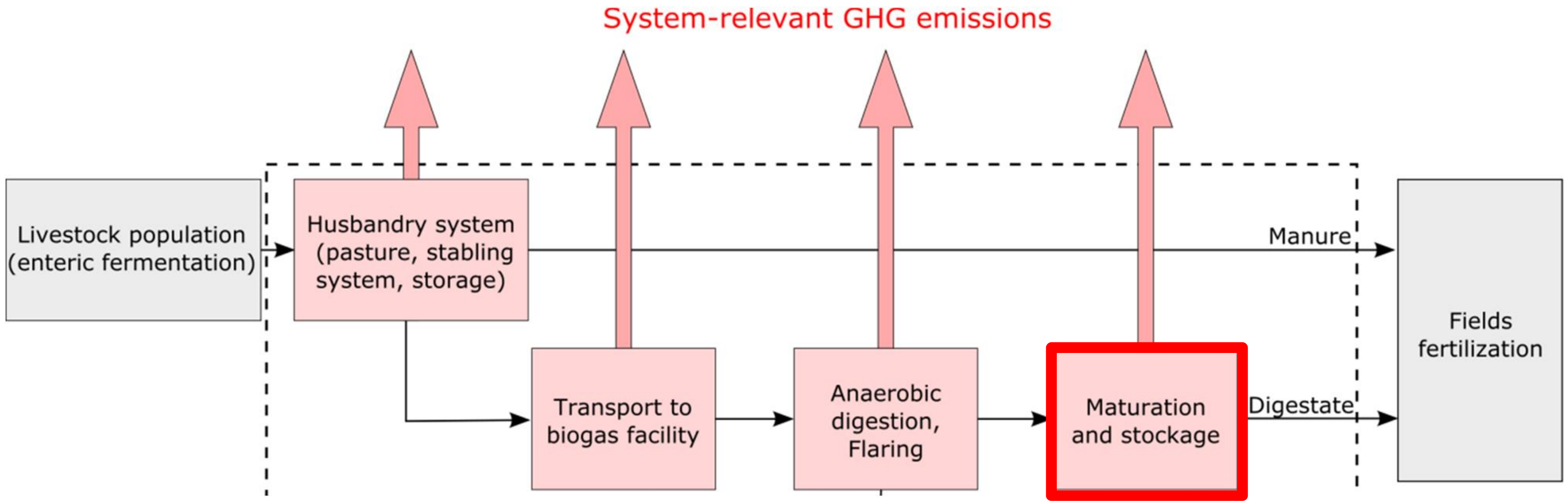
GHG emissions: Calculations



Emissions from maturation and storage of the digestate:

- Loss of 3% of the annual quantity of biogas produced

GHG emissions: scenarios

- **Scenario A:** business as usual (6%).
- **Scenario B:** maximal exploitation.

The treatment of livestock manure in anaerobic digesters is used for the total amount of stored manure (100%).

- **Scenario C:** feasible and sustainable scenario.

Only the currently exploitable manure quantity is being digested (65%), as determined in our previous study (Burg et al., 2018; Thees et al., 2017).

In all three scenarios, the local distribution of manure presented above was explicitly taken into account.

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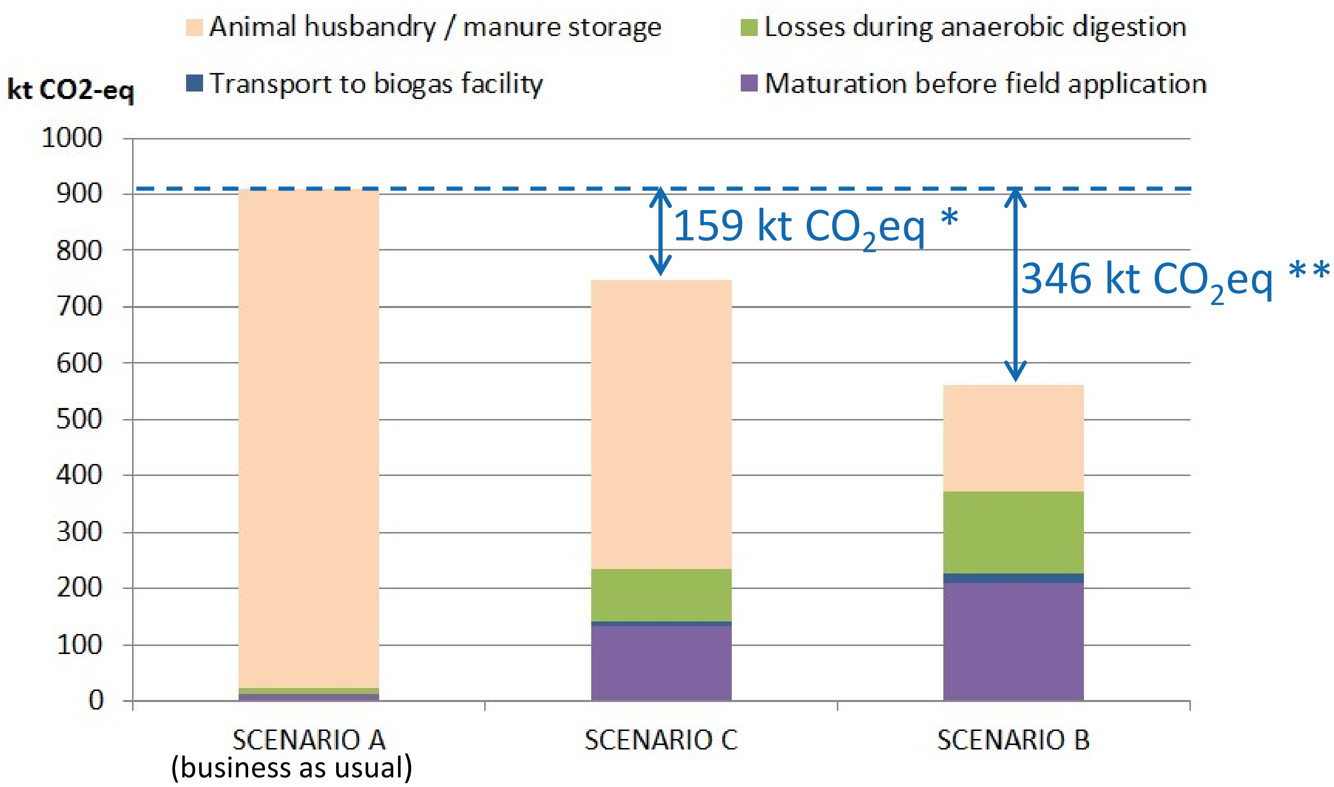
GHG emissions: results



* (3% of the remaining Kyoto target and 0.8% of the Paris agreement)

** (7% of the remaining Kyoto target and 1.6% of the Paris agreement)

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Summary

- Manure (fresh from the stable) characteristics:
  - H_2O similar to reference but CH_4 markedly higher than stored standards.
  - Local conditions and early storage matter.
- The Swiss CH_4 potentials:
  - 25 PJ from generated manure (fresh from the stable, 100% AD)
  - 15 PJ stored (100% AD)
  - 10 PJ currently exploitable (65% AD)
- Possible GHG emissions mitigation:
  - -159 kt CO_2 eq for 65% AD

Conclusion and perspectives

- Animal manure can be converted into significant quantities of energy and potentially reduce GHG emissions!
- How can we mobilize more of this resource in Switzerland, from 6% use up to 65%?
  - Investigation of farmers' decision-making process to build a biogas facility
  - Projection of future resource availability for decision-makers
  - Estimation of further advantages regarding energy autonomy and environment

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Acknowledgement

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Thank you for your attention!

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