Biogas digestate processing
A cost efficient and climate friendly strategy for nutrient export from excess regions?

Ursula Roth, Sebastian Wulf, Maximilian Fechter,
Carsten Herbes, Johannes Dahlin

KTBL

Hochschule für Wirtschaft und Umwelt Nürtingen-Geislingen

TU berlin

Background

- regional nutrient surpluses for both N and P
- different focuses of digestate processing techniques
  - volume reduction
  - separation of nutrient flows

Which technology suits which regional / individual situation?

➔ greenhouse gas emissions and costs of processing compared to the utilization of untreated digestate for an export demand

- of 50% P ("P50")
- of 50% N ("N50")
- of all nutrients ("100%")

in the digestate

2 MW biogas plant

transport distance **300 km**

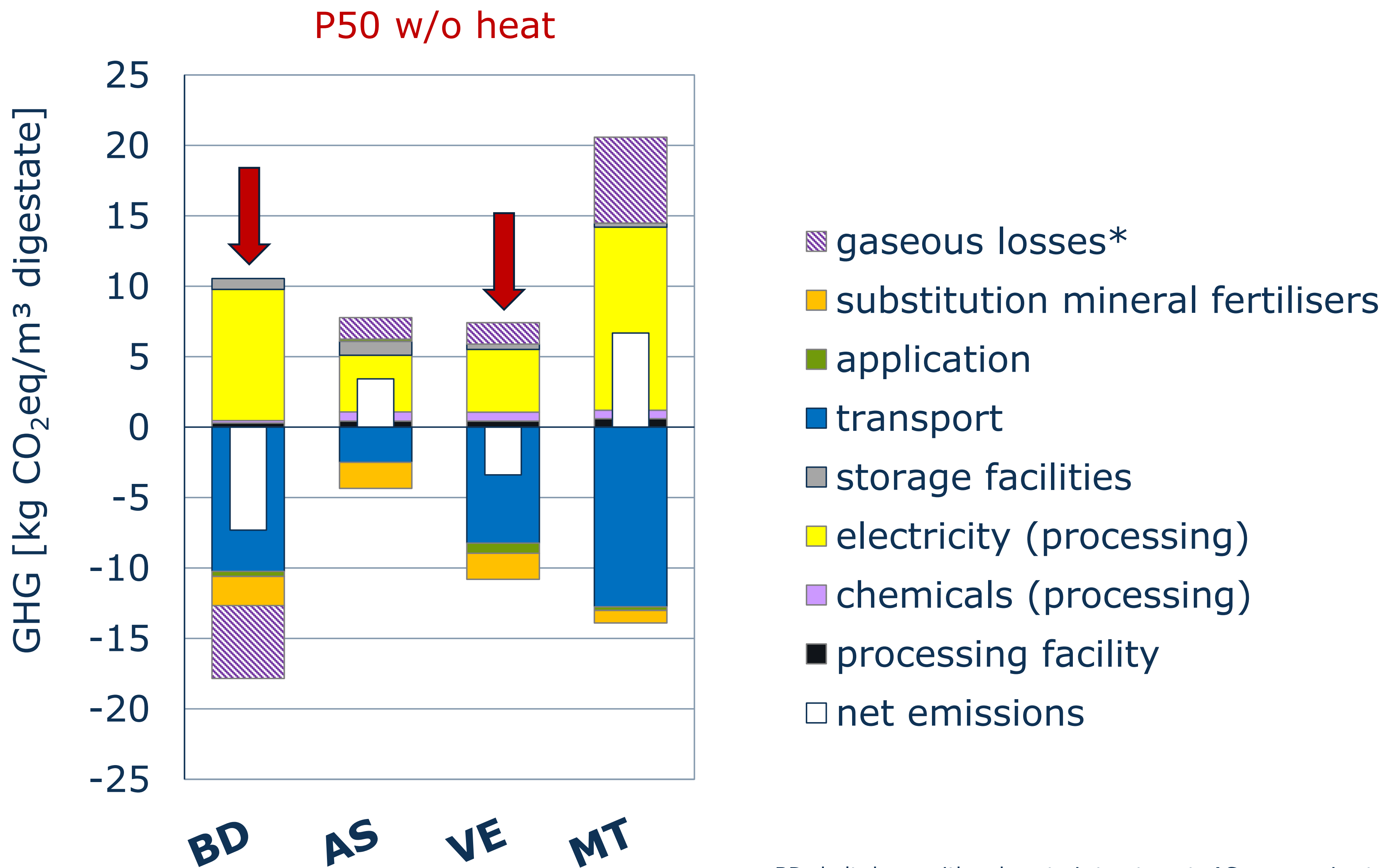
storage of exported share in the demand region

revenue for the exported nutrients

Greenhouse gases

(GHG)

GHG - compared to untreated digestate

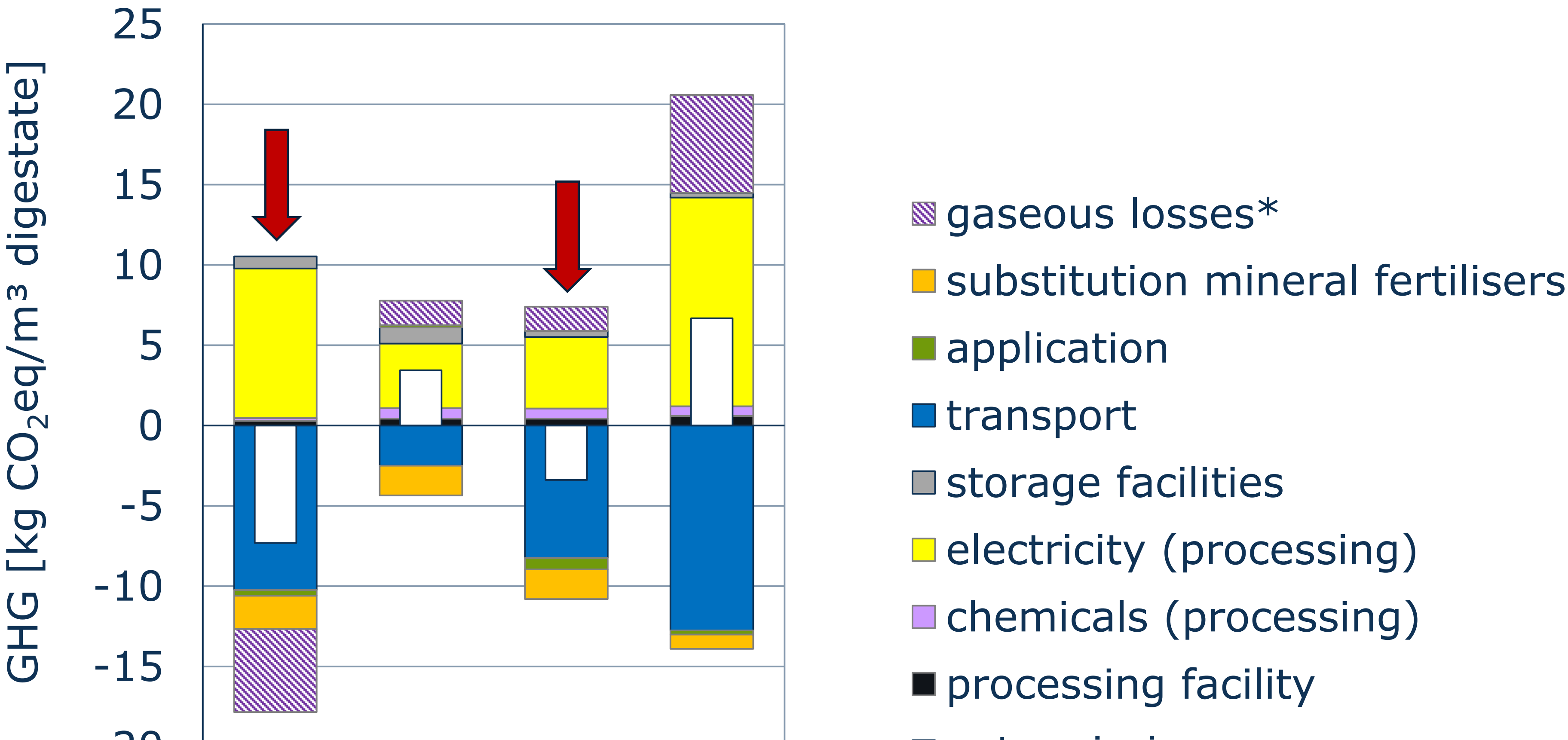


* processing, storage, application

BD: belt dryer with exhaust air treatment, AS: ammonia stripping, VE: vacuum evaporation and NH_3 stripping, MT: membrane technology

GHG - compared to untreated digestate

P50 w/o heat



GHG emissions from utilization of untreated digestate in scenario P50

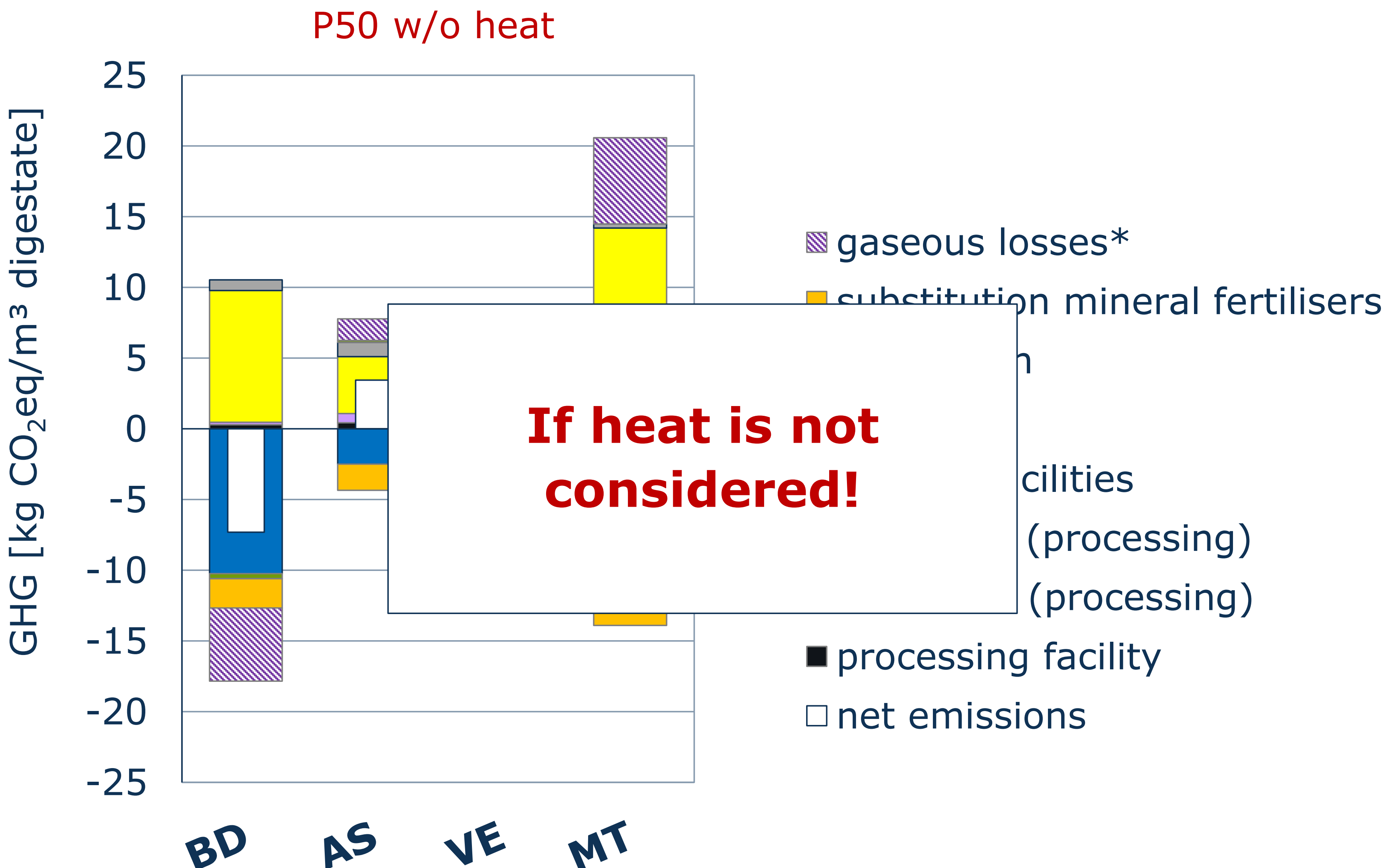
8,6 kg CO_2eq/m³

BD **AS** **VE** **MT**

* processing, storage, application

BD: belt dryer with exhaust air treatment, AS: ammonia stripping, VE: vacuum evaporation and NH_3 stripping, MT: membrane technology

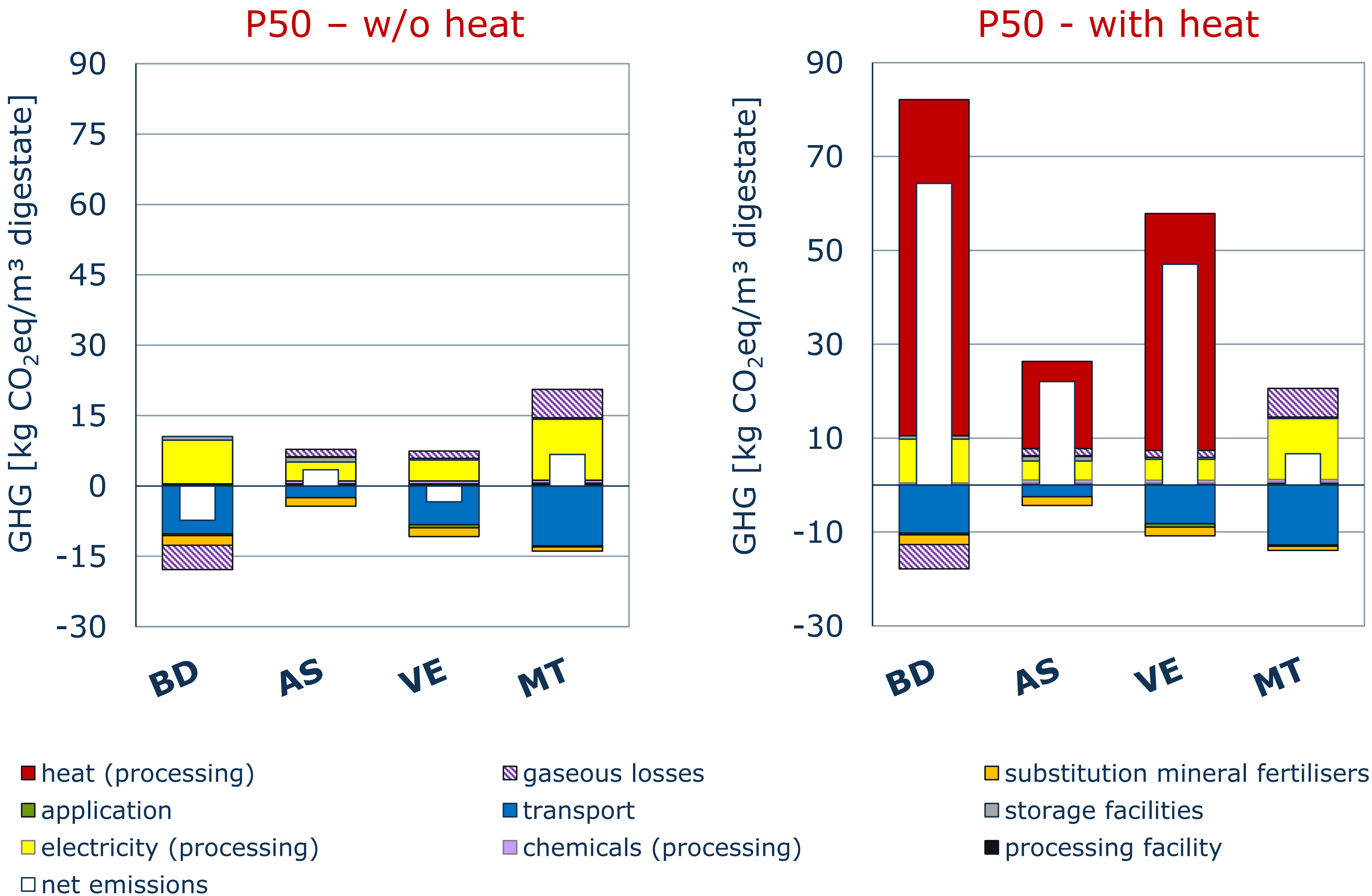
GHG - compared to untreated digestate



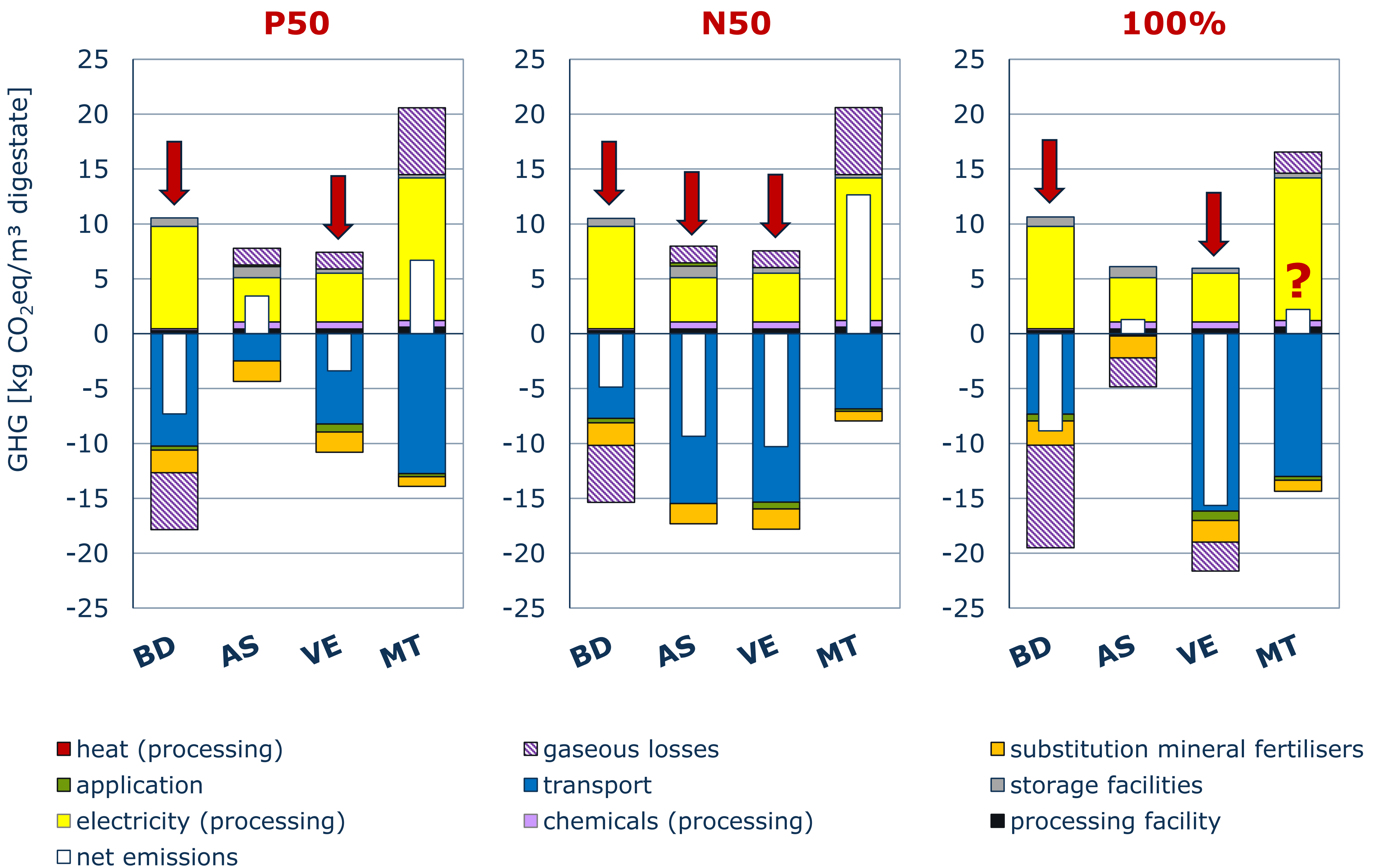
* processing, storage, application

BD: belt dryer with exhaust air treatment, AS: ammonia stripping, VE: vacuum evaporation and NH_3 stripping, MT: membrane technology

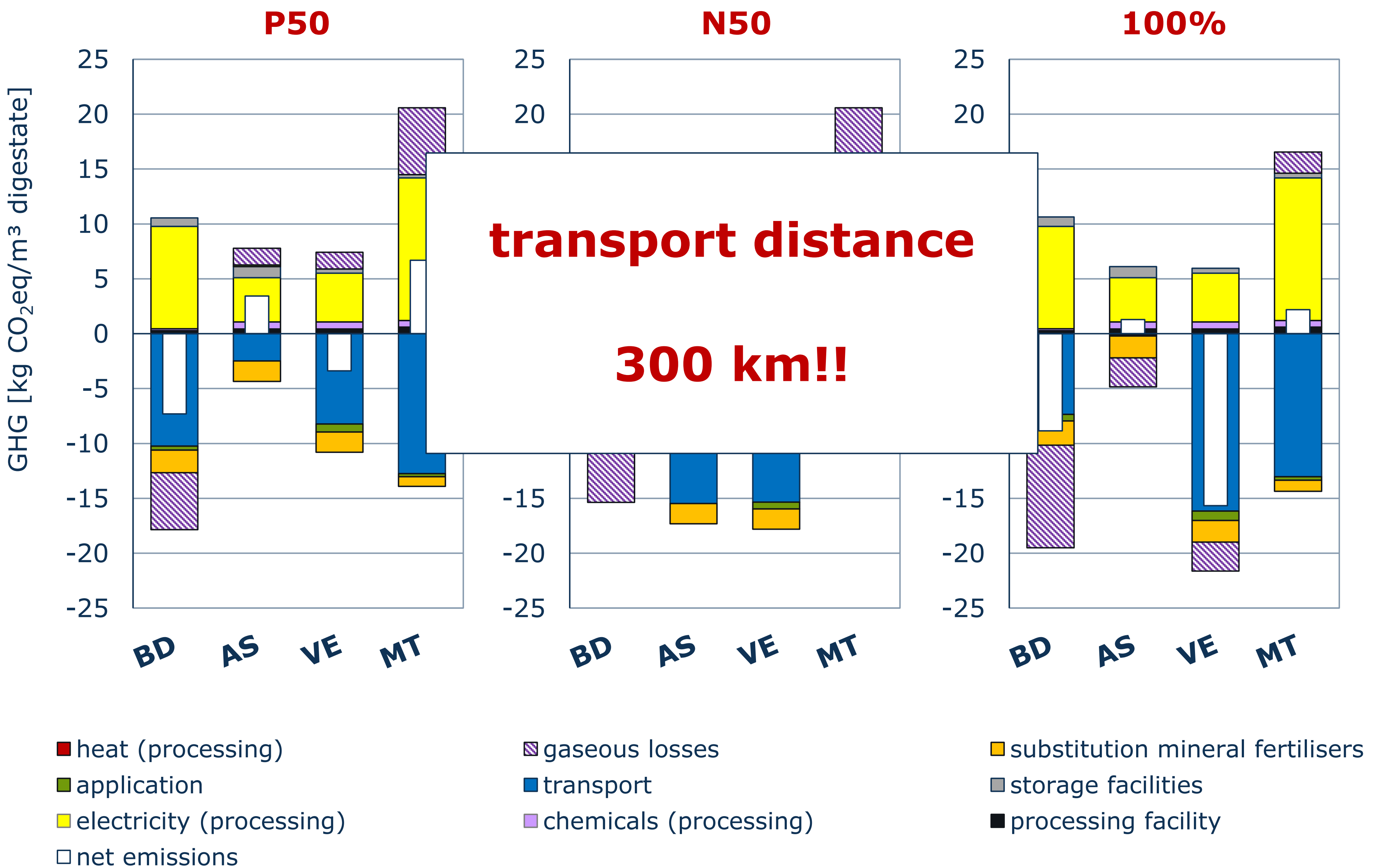
GHG – effect of heat



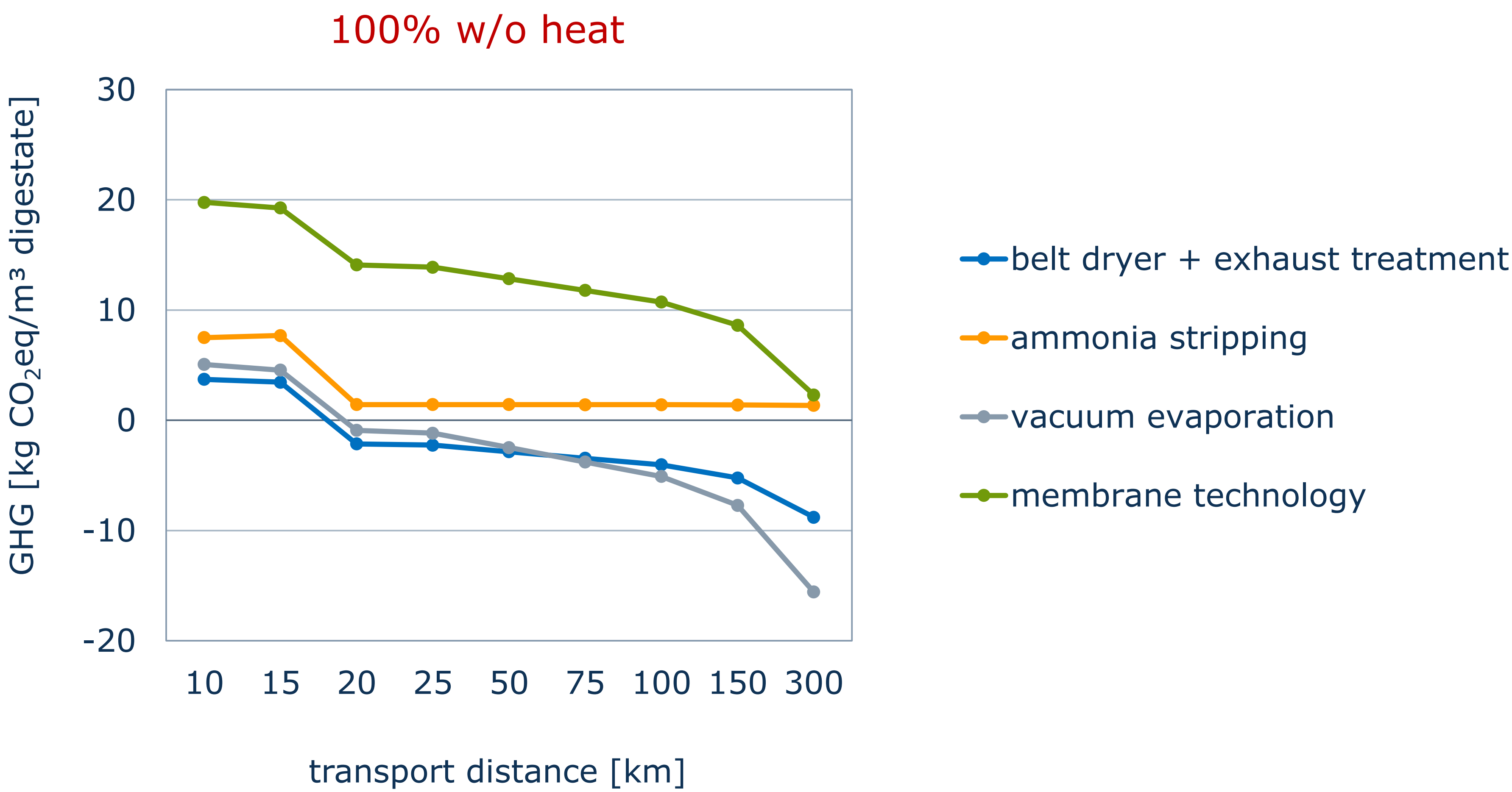
GHG – effect of export target



GHG – effect of export target



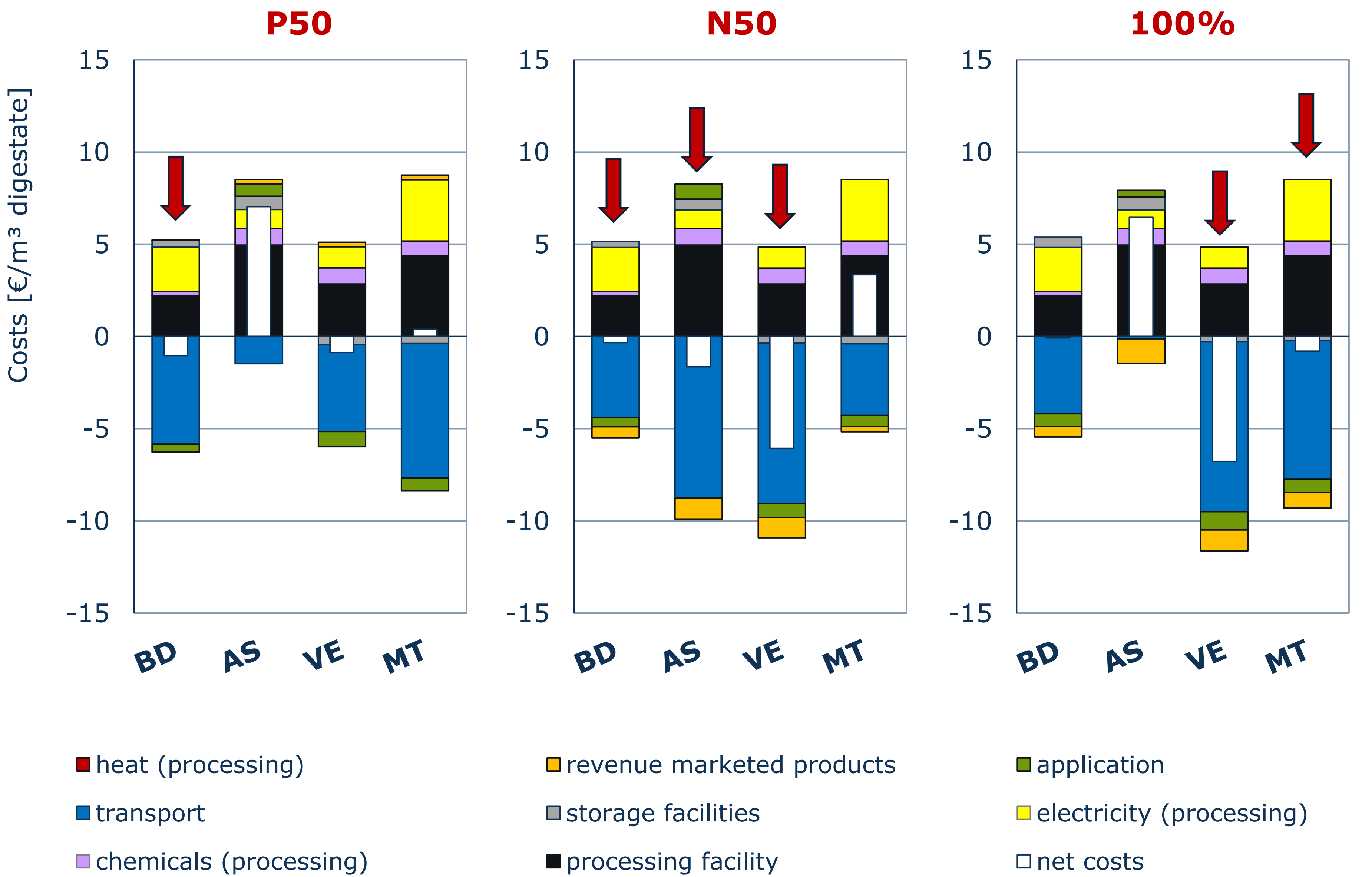
GHG – effect of transport distance



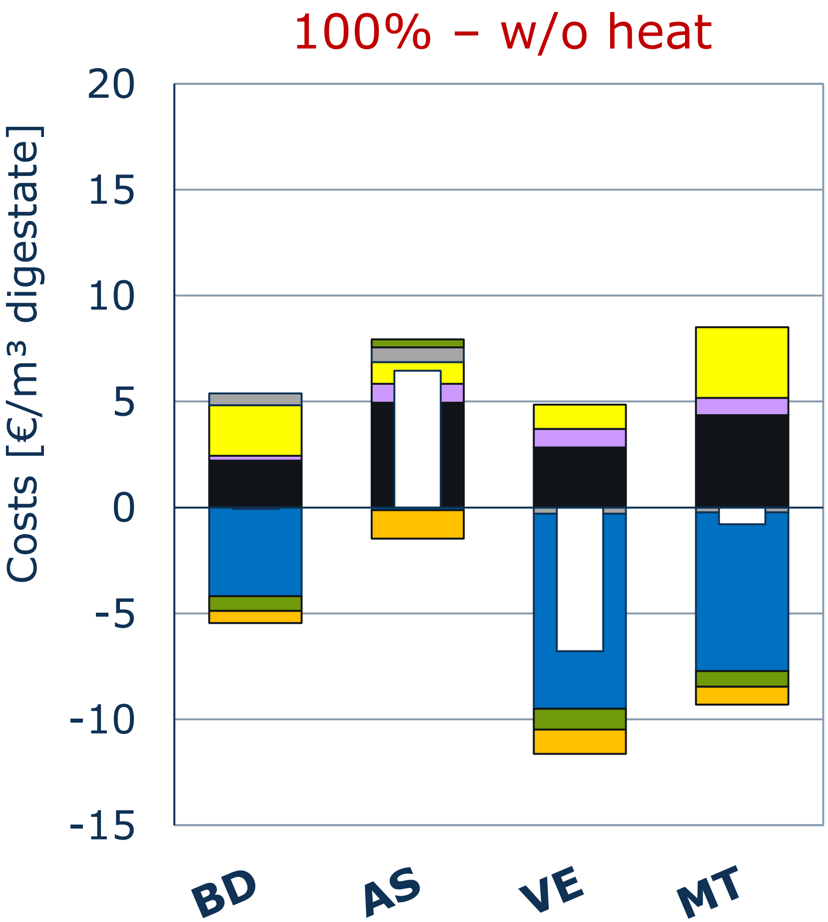
10 and 15 km: 1-phase application system (transport to field and application with the same device)
20 km and more: 2-phase application system (continuous transport to external storage with lorry during the year; application with a separate device in an 3 km radius from external storage)

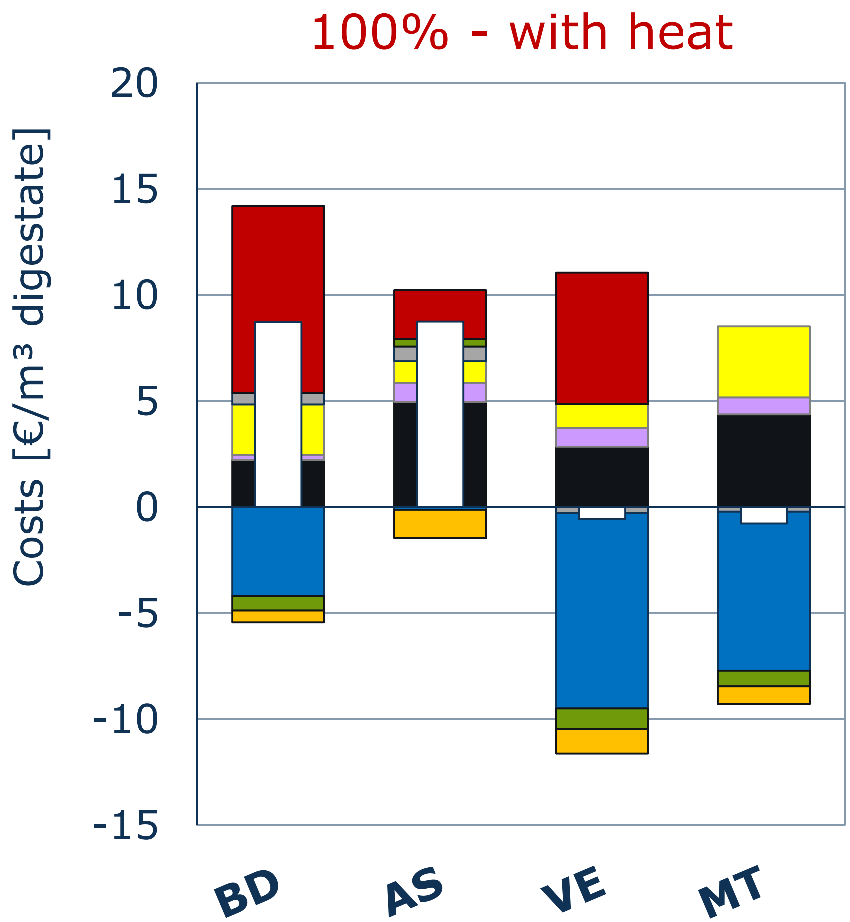
Costs

Costs – effect of export target



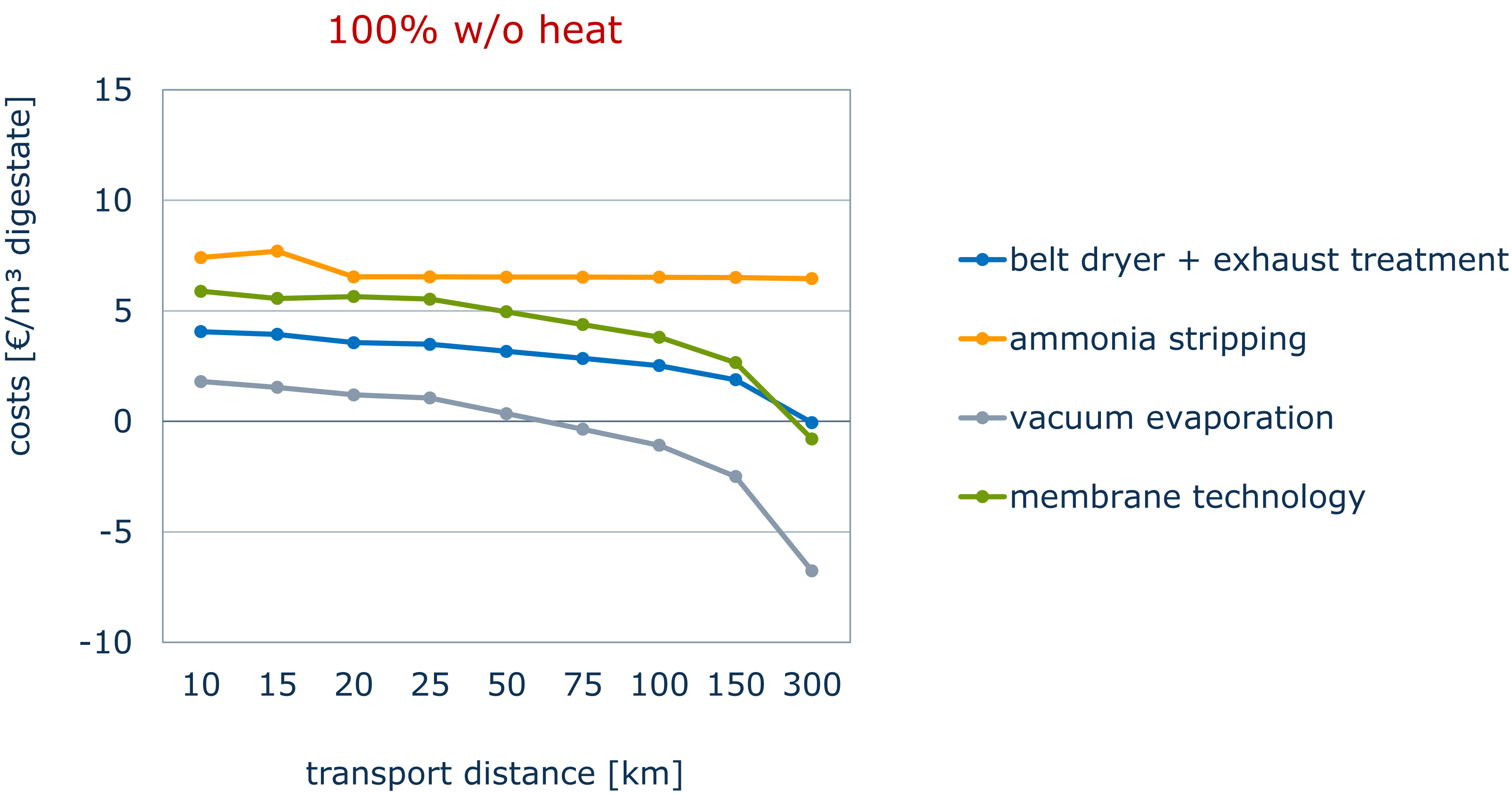
Costs – effect of heat





heat (processing)
substitution mineral fertilisers
application
transport
storage facilities
electricity (processing)
chemicals (processing)
processing facility
net costs

Costs – effect of transport distance



10 and 15 km: 1-phase application system (transport to field and application with the same device)
20 km and more: 2-phase application system (continuous transport to external storage with lorry during the year; application with a separate device in an 3 km radius from external storage)

Conclusions - GHG

If heat is not considered and long-distance transport is necessary:

- Belt dryer and vacuum evaporation save GHG compared to untreated digestate in all scenarios.
- Ammonia stripping can only save GHG, if N export is targeted at.
- Improved energy efficiency of membrane technology might result in GHG savings for this technology as well.

If reference emissions for process heat are taken into account, no GHG savings are possible – even for long-distance transport.

For short- or middle-distance transport no or only minor GHG savings are possible, especially if only partial export of nutrient is required.

Conclusions - costs

There is much less scope for cost savings due to high investment costs for digestate treatment technologies.

Therefore no cost-savings compared to untreated digestate are possible for short- or middle-distance transport.

If heat costs are considered, only MT can save costs compared to untreated digestate and only if all nutrients have to be exported.

Heat demanding technologies would clearly benefit from subsidies for the use of CHP heat.

Higher prices for the digestate products could turn digestate treatment advantageous already for short-distance transport.

Conclusions

For expanded excess regions digestate processing can be a promising option.

Best adapted solutions have to be developed taking into account the region / individual situation:

- excess nutrient
- extent of export required
- heat availability
- plant size
- marketing possibilities
- legal framework….

Thank you for your attention!

Any questions….??

This research was conducted within the framework of the research project GAERWERT (no. 22401913, 22402113, 22402213, 22402312). The project was supported by Fachagentur Nachwachsende Rohstoffe e.V. (FNR) on behalf of the German Federal Ministry of Food and Agriculture (BMEL).

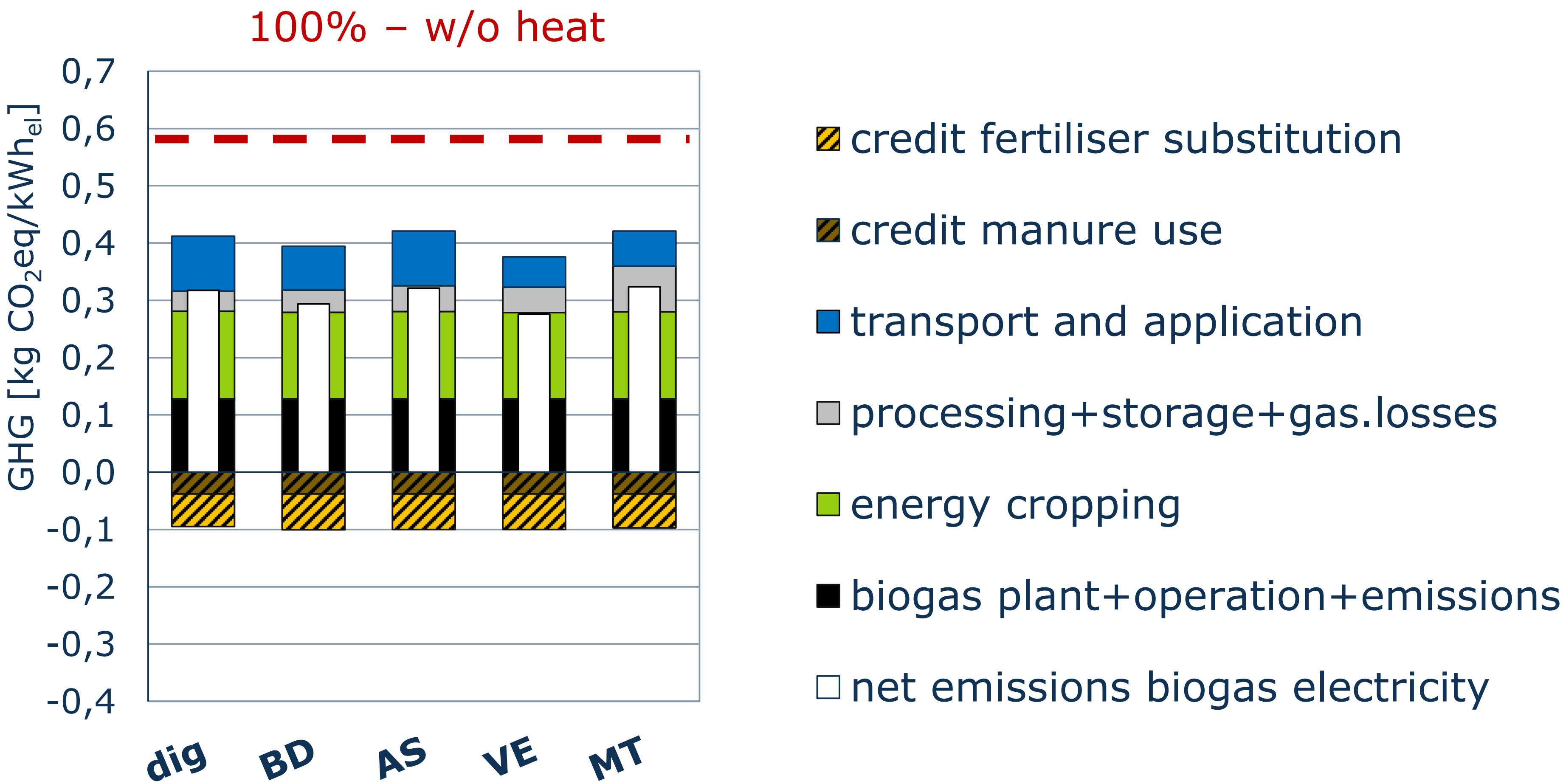
Gefördert durch:

Bundesministerium für Ernährung und Landwirtschaft

aufgrund eines Beschlusses des Deutschen Bundestages

Fachagentur Nachwachsende Rohstoffe e.V.

GHG balance biogas electricity



GHG emissions German power mix 2016:
0,584 kg CO_2eq/kWh$_{el}$ (Umweltbundesamt 2017)

GHG balance biogas electricity