



Webinar | Fueling the future

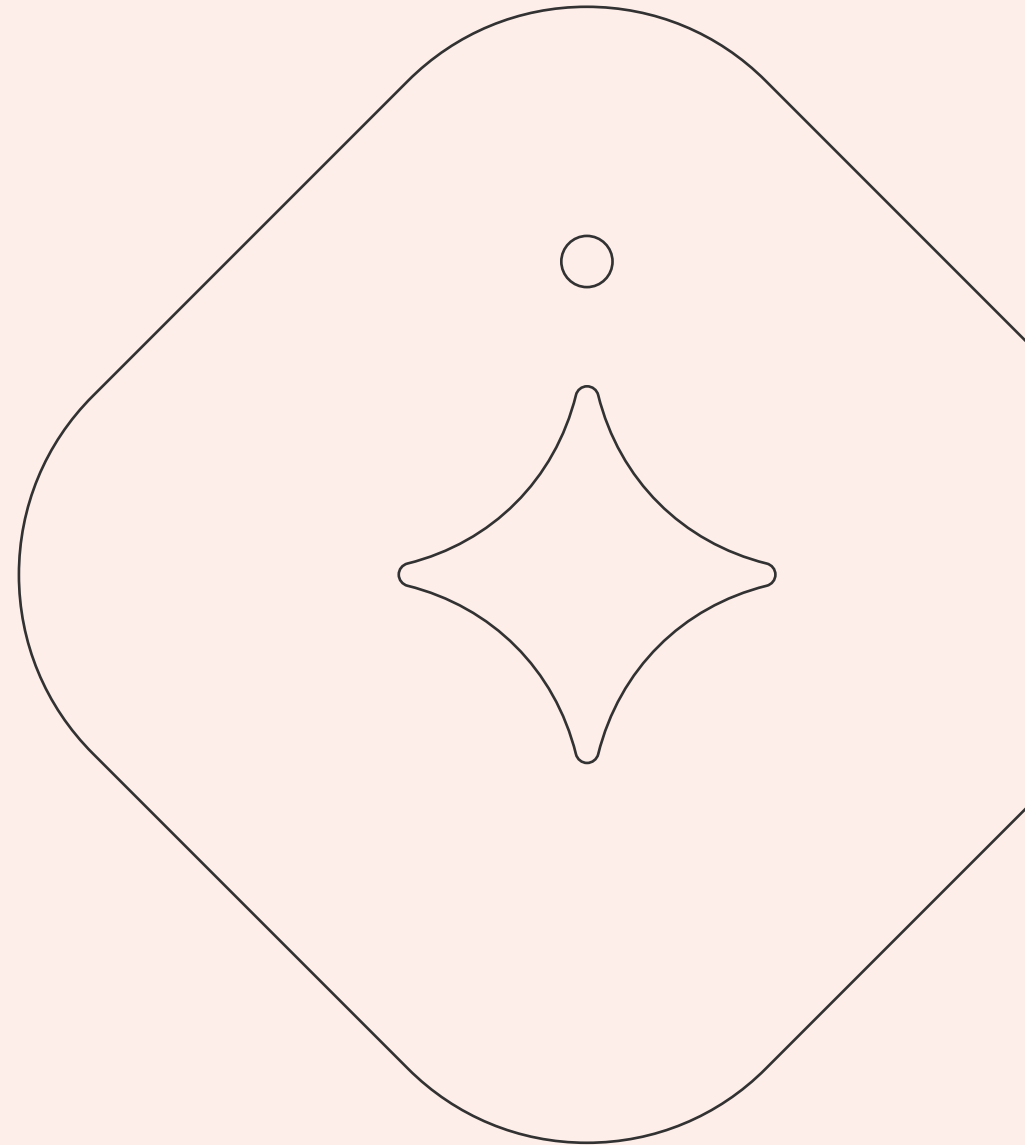
Methane Emissions from the Value Chain of Biogas-Based Biofuels



Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping

On today's agenda:

- | | | |
|----|--|----------|
| 01 | Biogas-based biofuels for shipping.
Methane emissions | To 15:25 |
| 02 | Presentation of the panel and
discussion | To 16:10 |
| 03 | Questions from the audience | To 16:25 |
| 04 | Conclusions and closure | To 16:30 |



On today's panel



Mieke Decorte

Technical and Project Manager
European Biogas Association



Charlotte Scheutz

Professor, Head of Section
Climate and Monitoring

DTU Department of
Environmental and Resource
Engineering



Georges Tijbosch

CEO
MIQ – methane intelligence



Bjørn Ove Jansen

Project Manager Sustainability and
Climate
Equinor



Jyrki Ristimäki

Senior Superintendent
Machinery and Technical
Royal Caribbean Cruises



Roberta Cenni

Head of Biofuels



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Biogas-based biofuels for shipping

Liquified biomethane and biomethanol



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Project Partners:



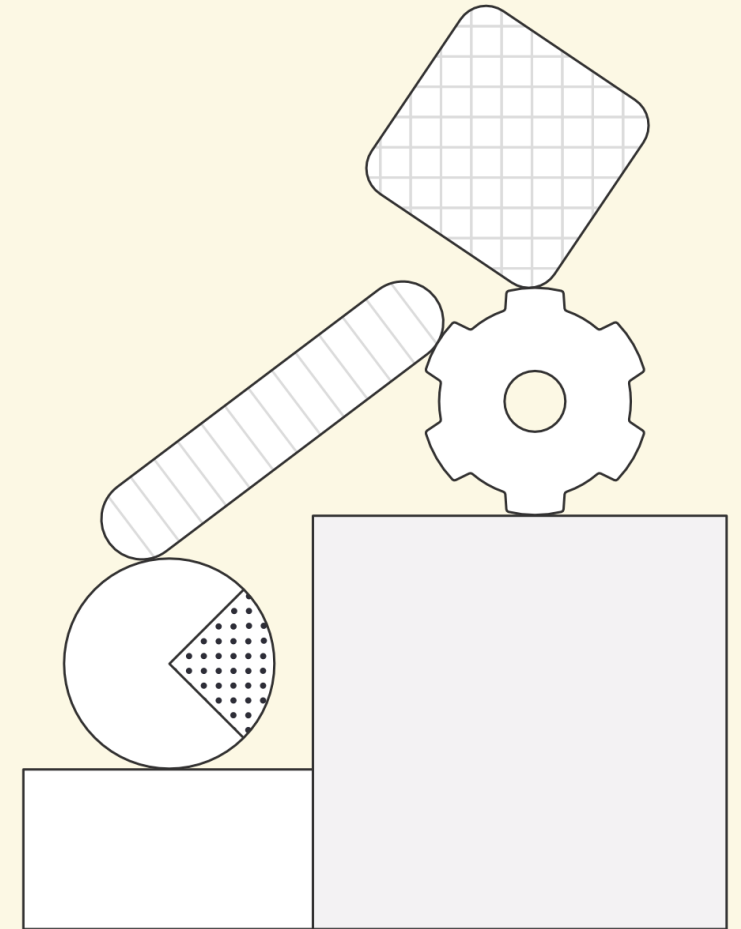
Biogas-based biofuels for shipping

Liquified biomethane and biomethanol

Project purpose

To understand whether biogas is an interesting energy carrier for shipping.

- Value chain
- Biomass availability and sustainability
- Energy conversion efficiency, carbon intensity and cost of production of biomethane and biomethanol
- **Methane emissions**
- Acceleration strategies



Project results:

Biogas can support the transition in the short term
but methane emissions must be addressed

Purpose of this webinar:

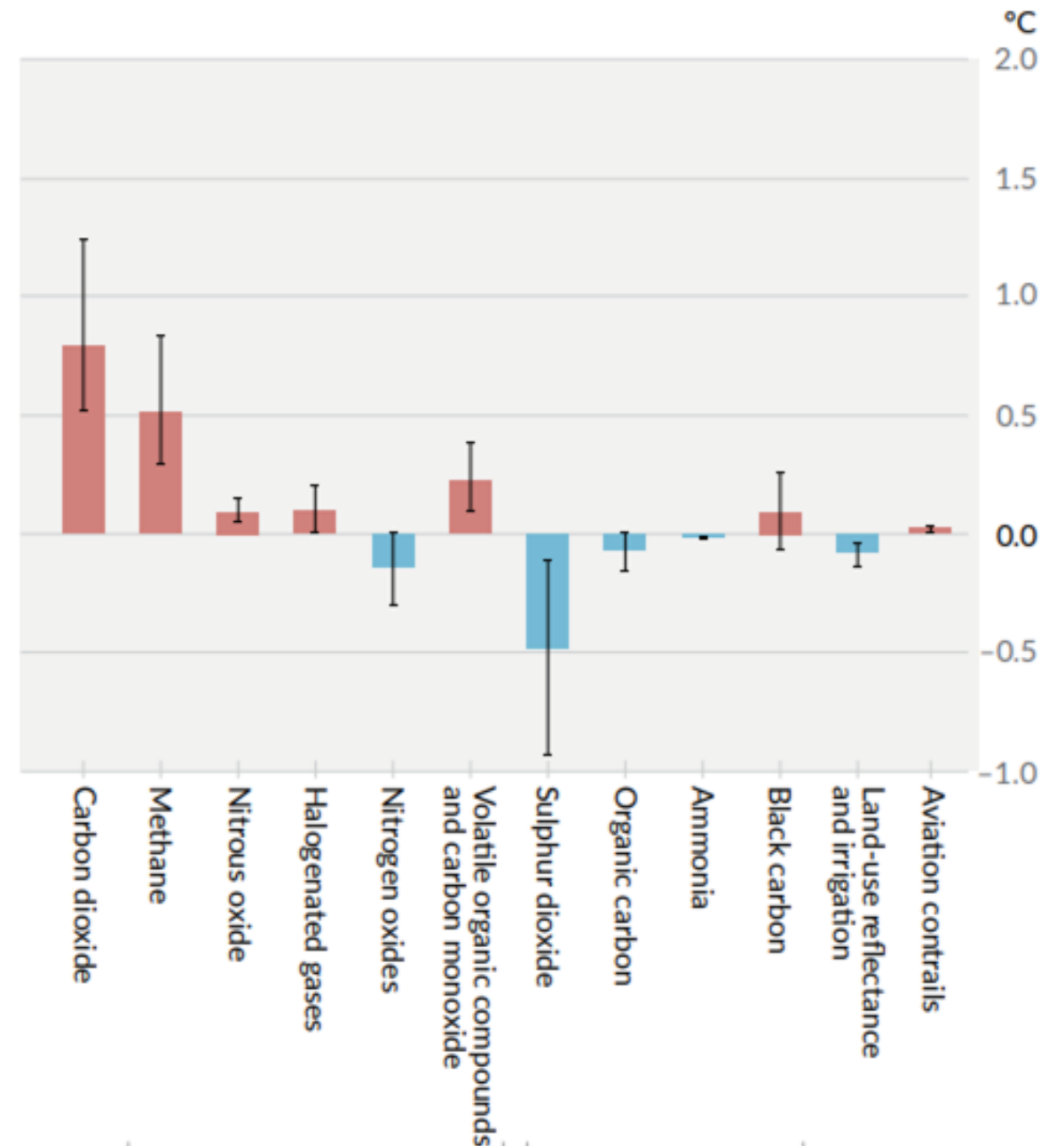
- To inform shipping of the methane emissions challenge.
- Debate what we can do as an industry to solve the challenge.



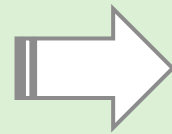
Why are we worried for methane emissions?

Anthropogenic methane emissions have contributed to ~30% of observed global warming to date

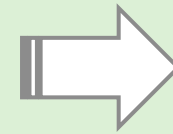
(The debate on how to account them is not settled: GWP100 vs. GWP20 vs. other metrics)



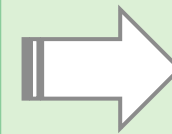
What is biogas?



Anaerobic digester



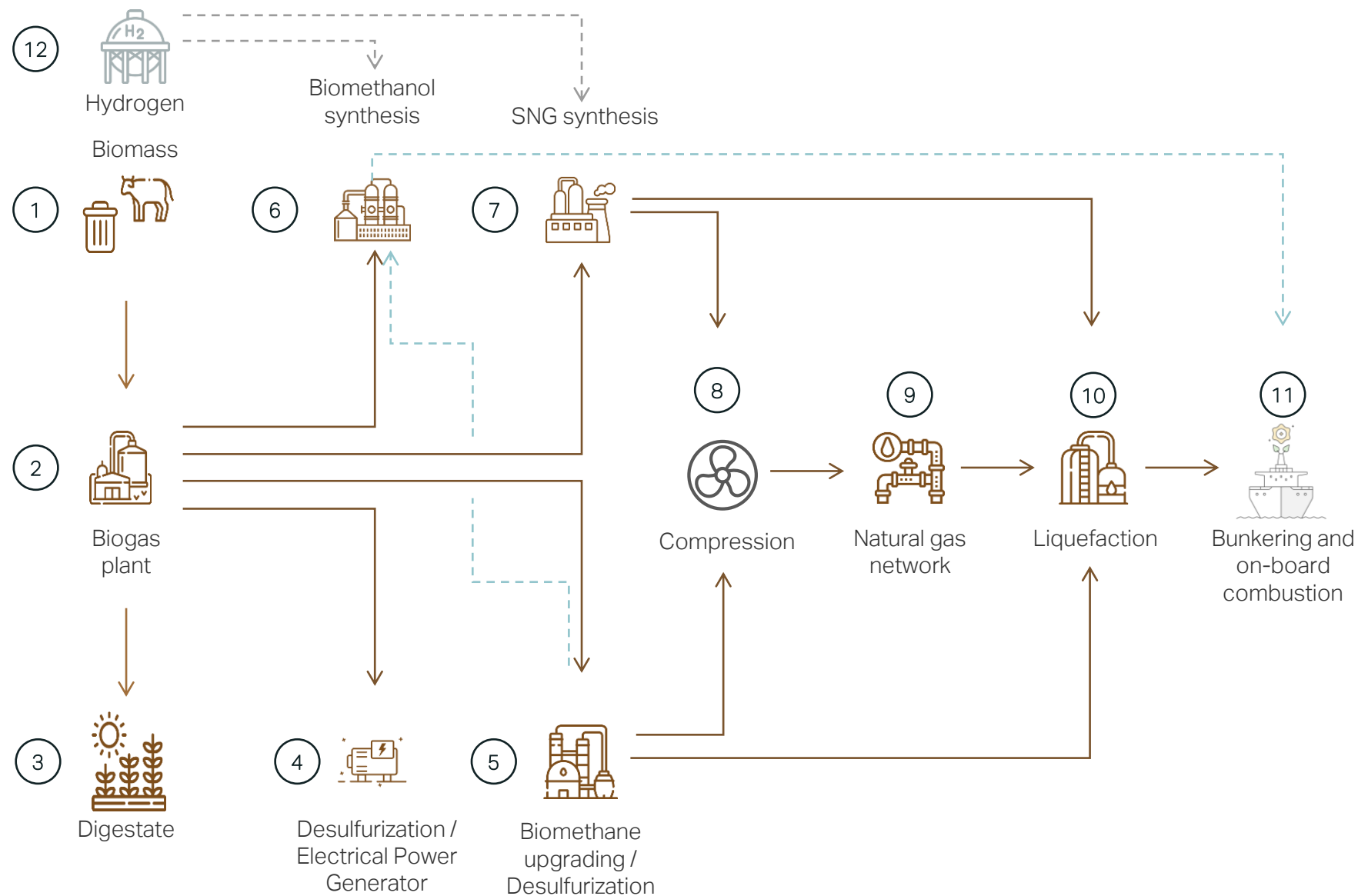
Biogas:
~ 50% methane
~50% carbon dioxide



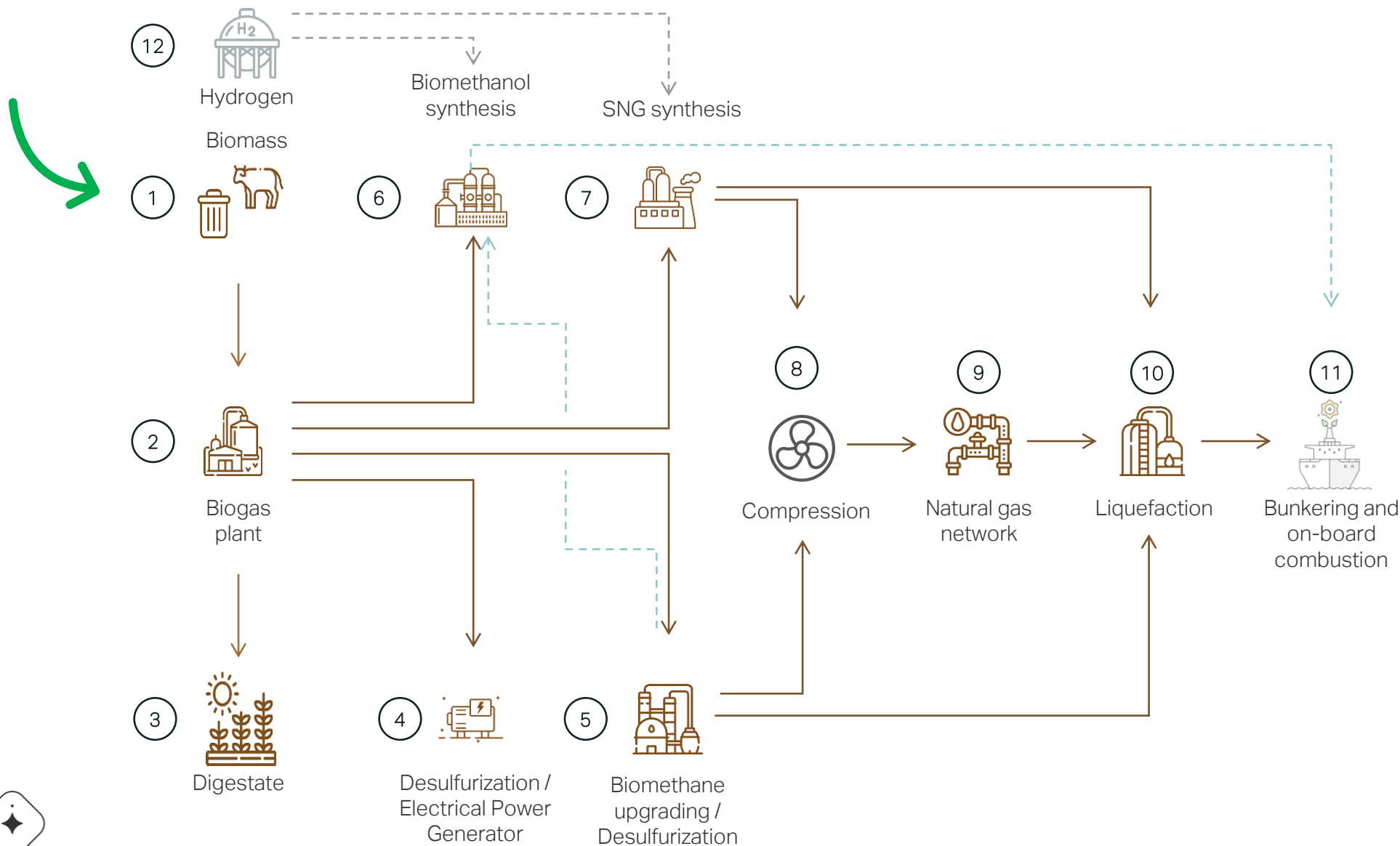
- ✓ Electrical power
- Biodiesel
- HVO
- ✓ Biomethane
- ✓ Biomethanol
- Bio-crudes
- Bio-oils
- ✓ FT-liquids
- Ethanol
- Lignin diesel oil
- ✓ ...



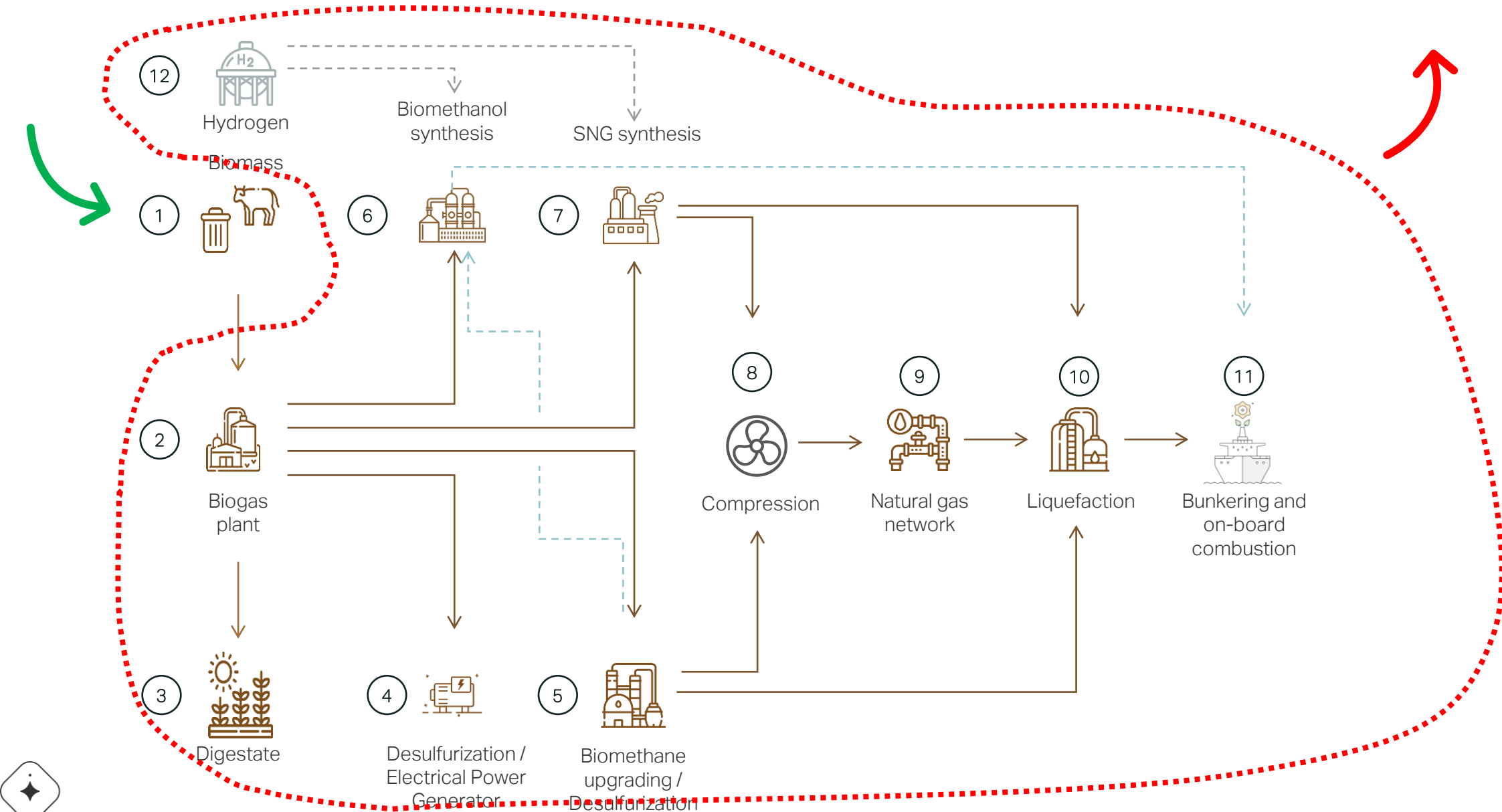
Steps of the value chain and methane emissions



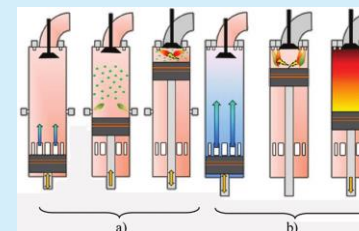
Steps of the value chain and methane emissions



Steps of the value chain and methane emissions



Where have emissions been found?



Quantifying emissions from closed conduits is not difficult but quantifying **fugitive** emissions **in the open** requires expert knowledge, highly specialized technology and cannot be done continuously

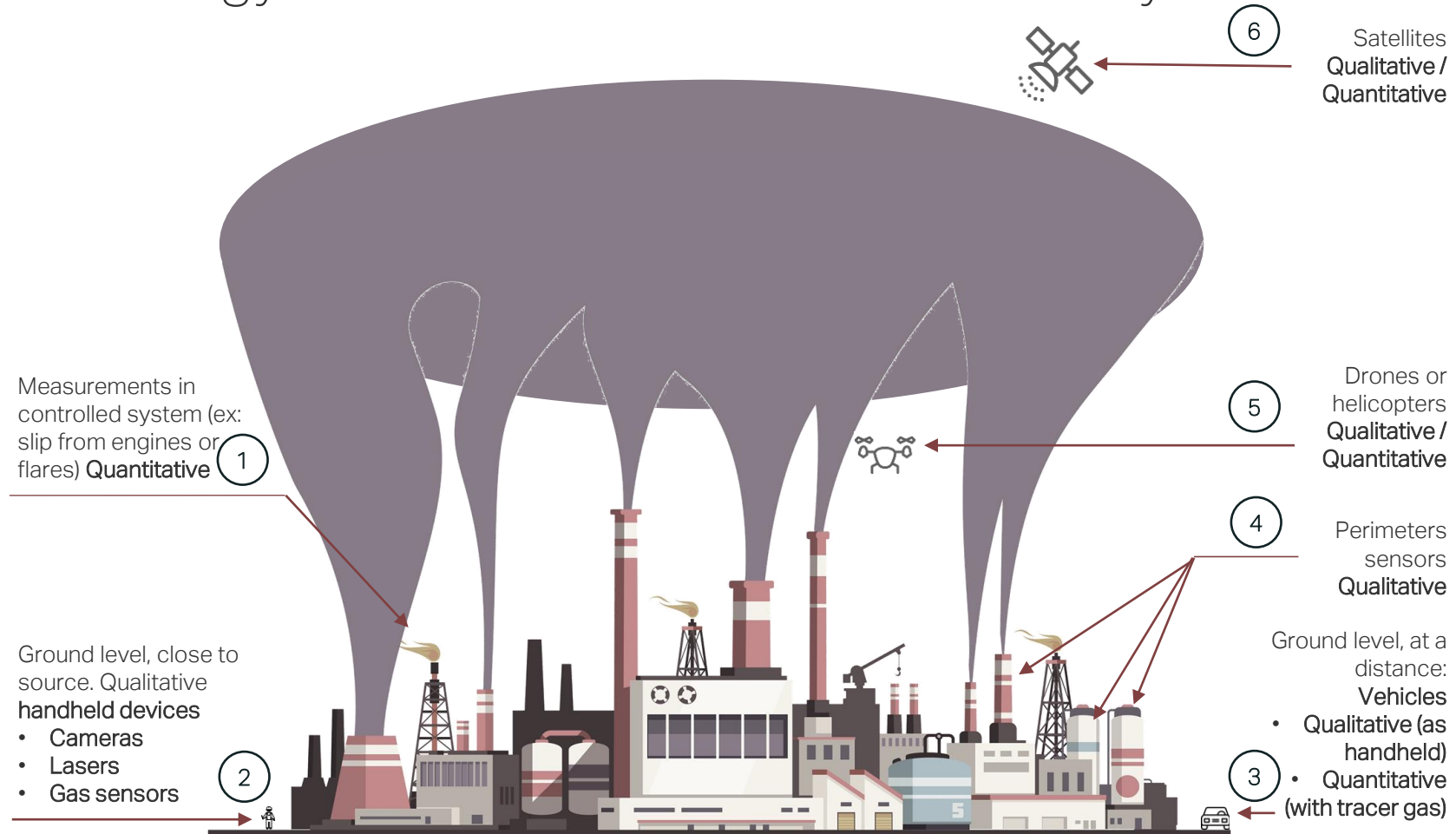
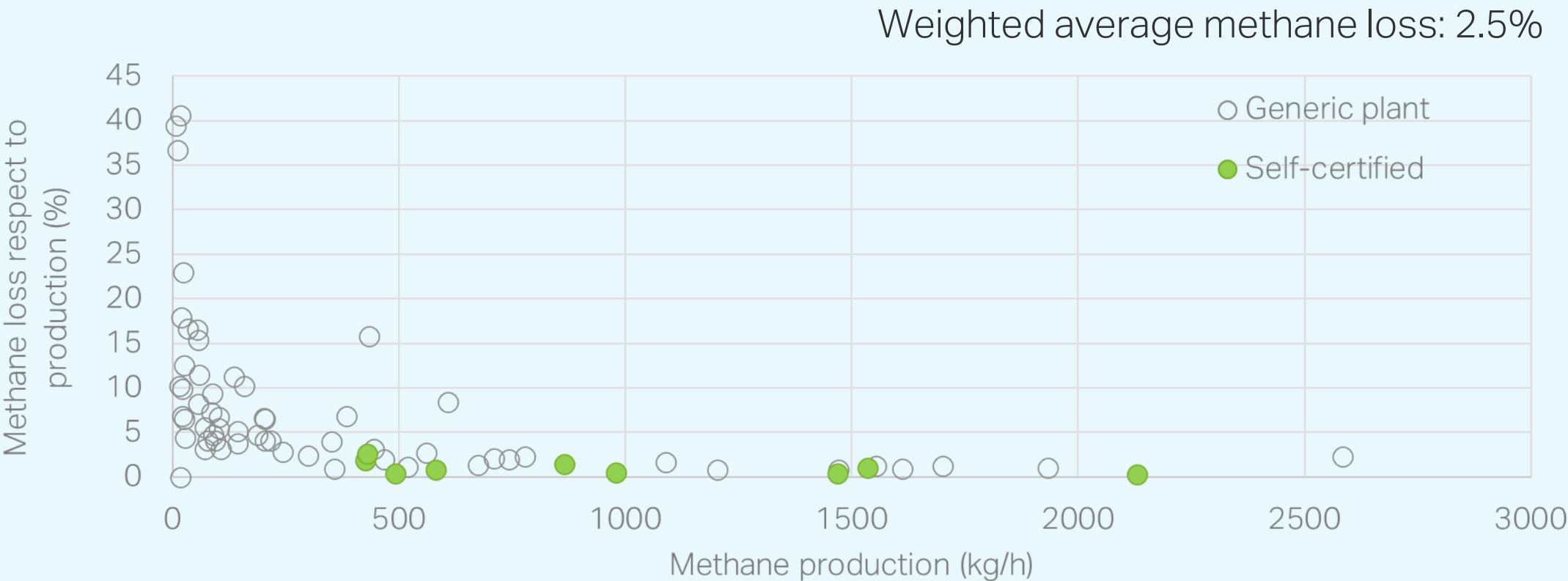


Image source: https://www.freepik.com/free-vector/industrial-flat-background-with-set-factories-toxic-harmful-emissions-from-plurality-tubes-illustration_6869910.htm#query=refinery%20plant&position=1&from_view=search Image by macrovector on Freepik



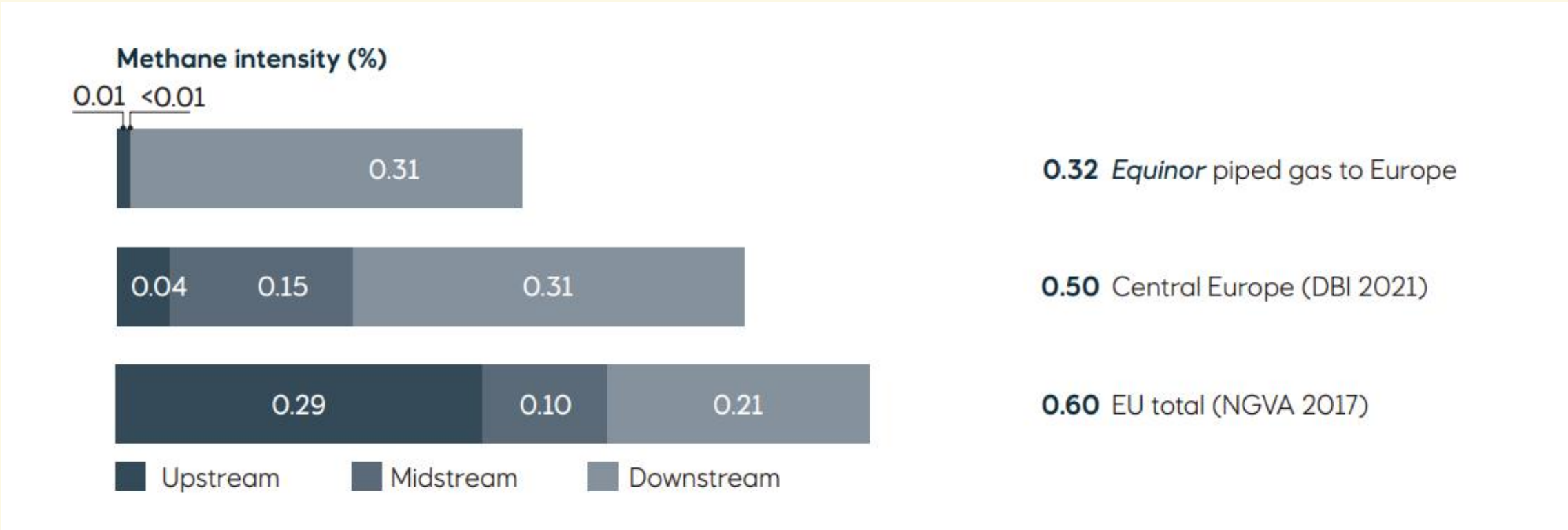
Measured emissions ranges from literature: biogas production



Adapted from: Gundmundsson et al.: Målrettet indsats for at mindske metantab fra danske biogasanlæg, 2021

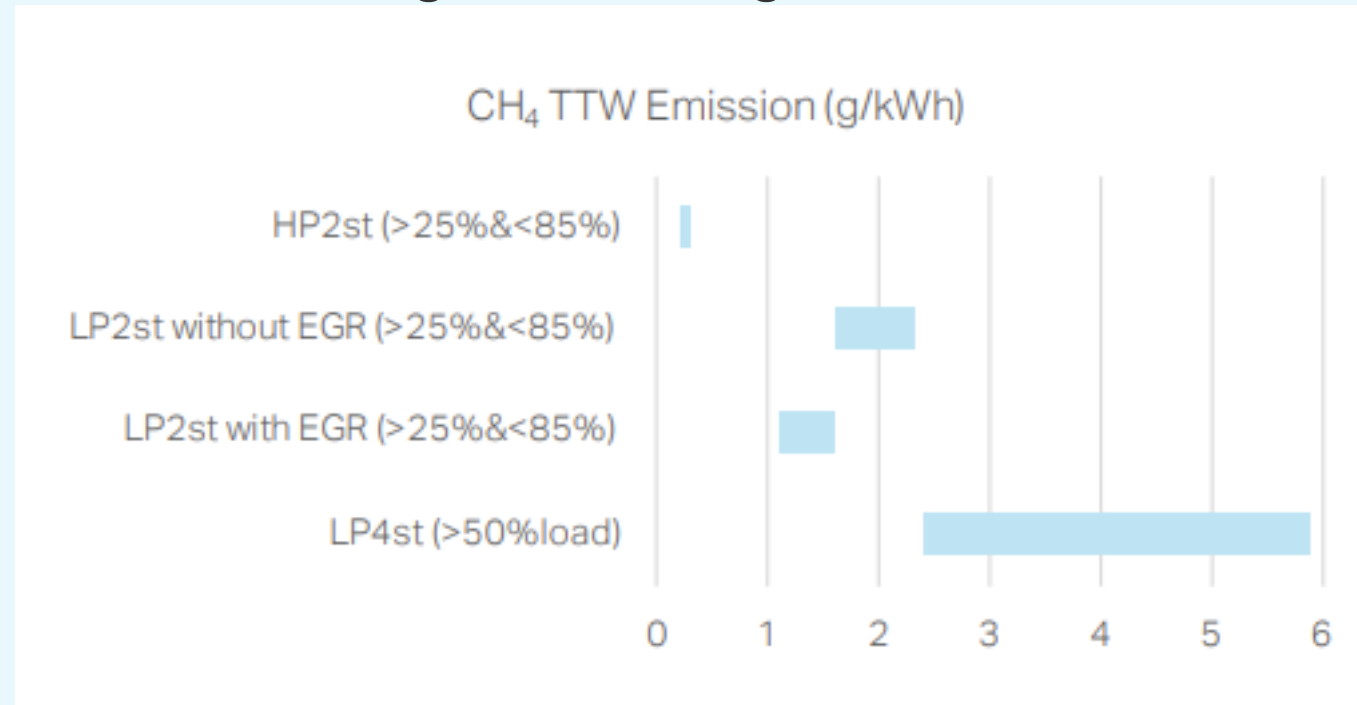
Measured emissions ranges from literature: methane distribution

Downstream emissions 0.2-0.3%

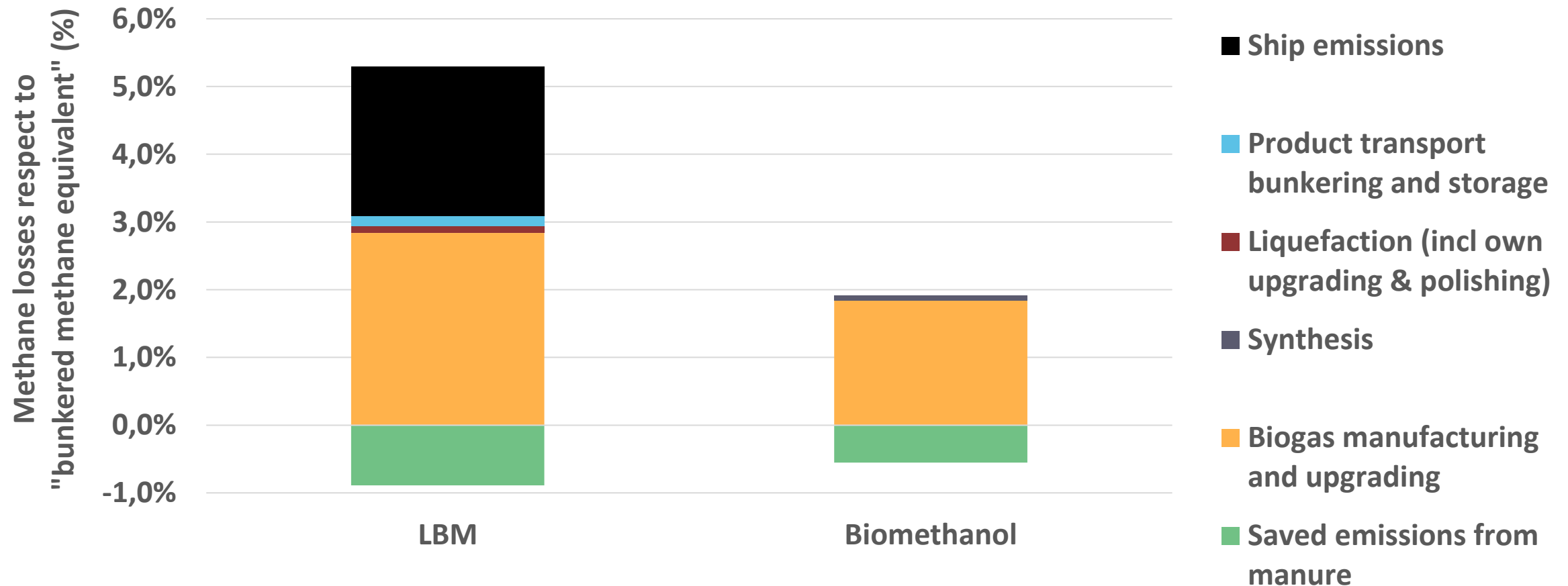


Measured emissions ranges from literature: on-board emissions

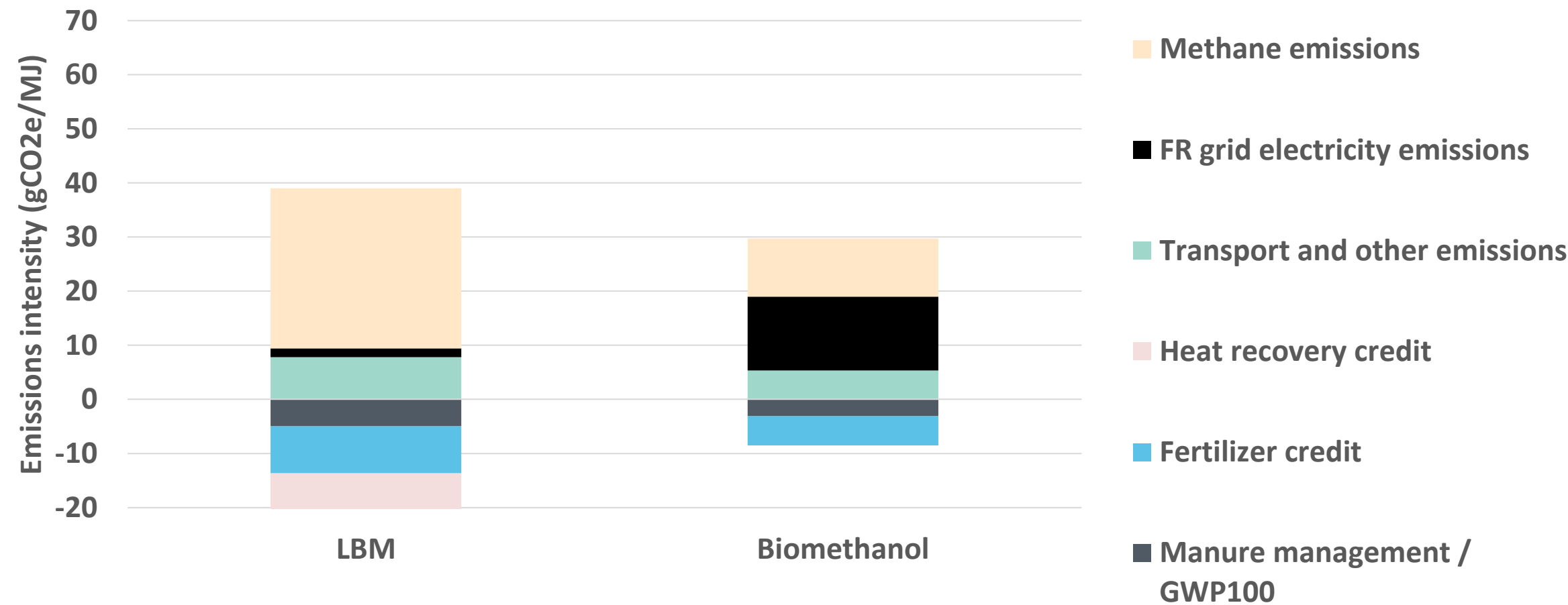
Weighted average methane loss: 2.2%



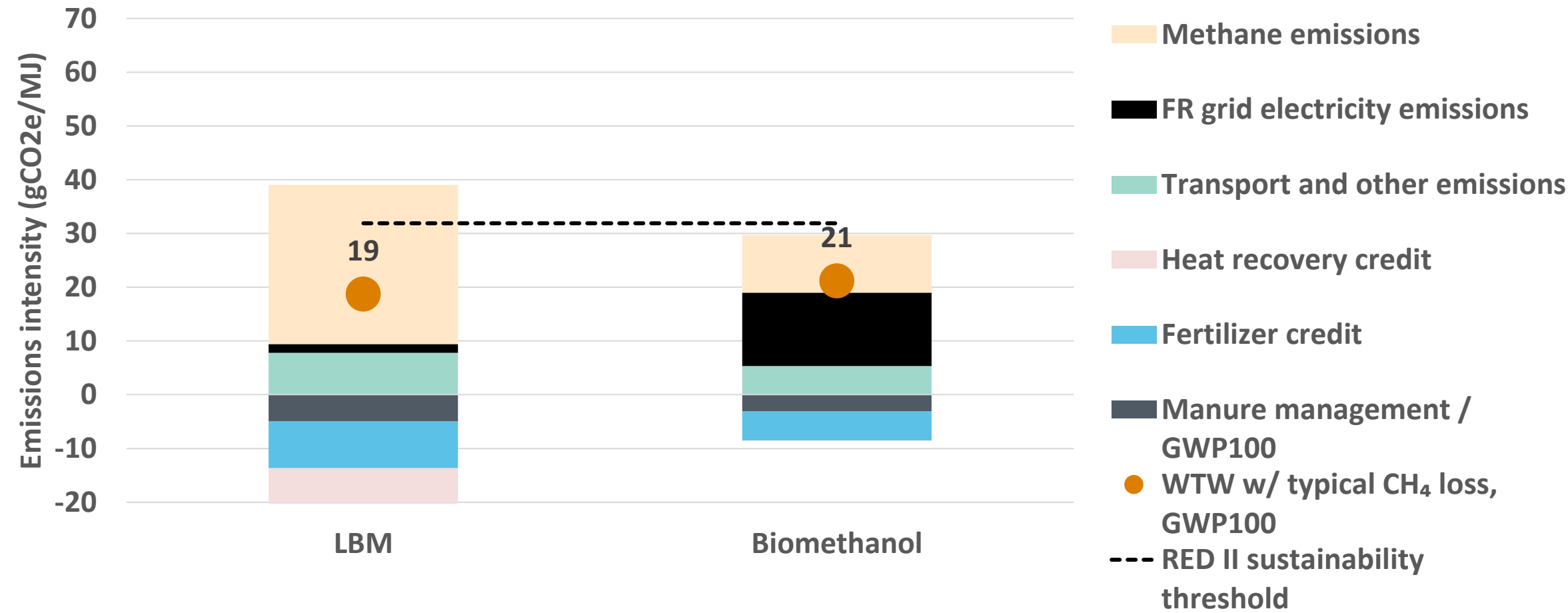
Methane emissions throughout the value chain for Liquified Biomethane and biomethanol



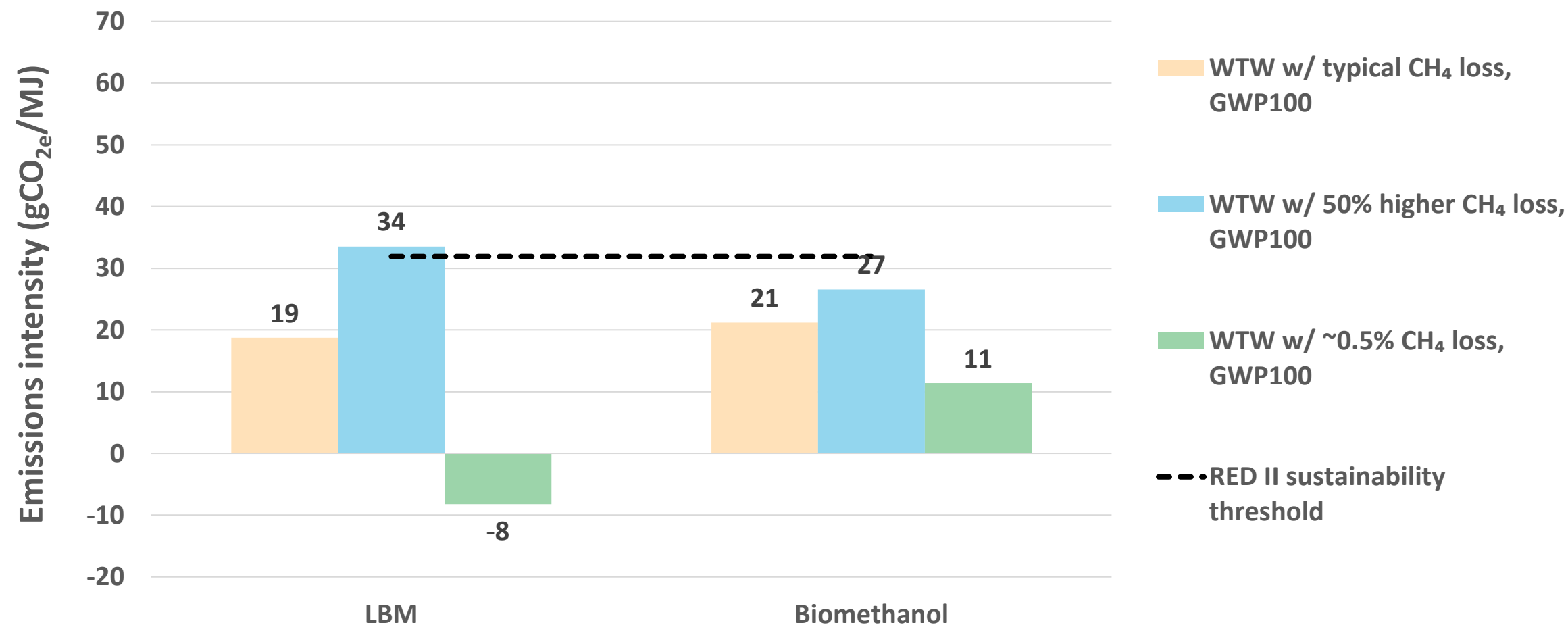
Well-to-wake GHG emissions intensity for liquified biomethane and biomethanol



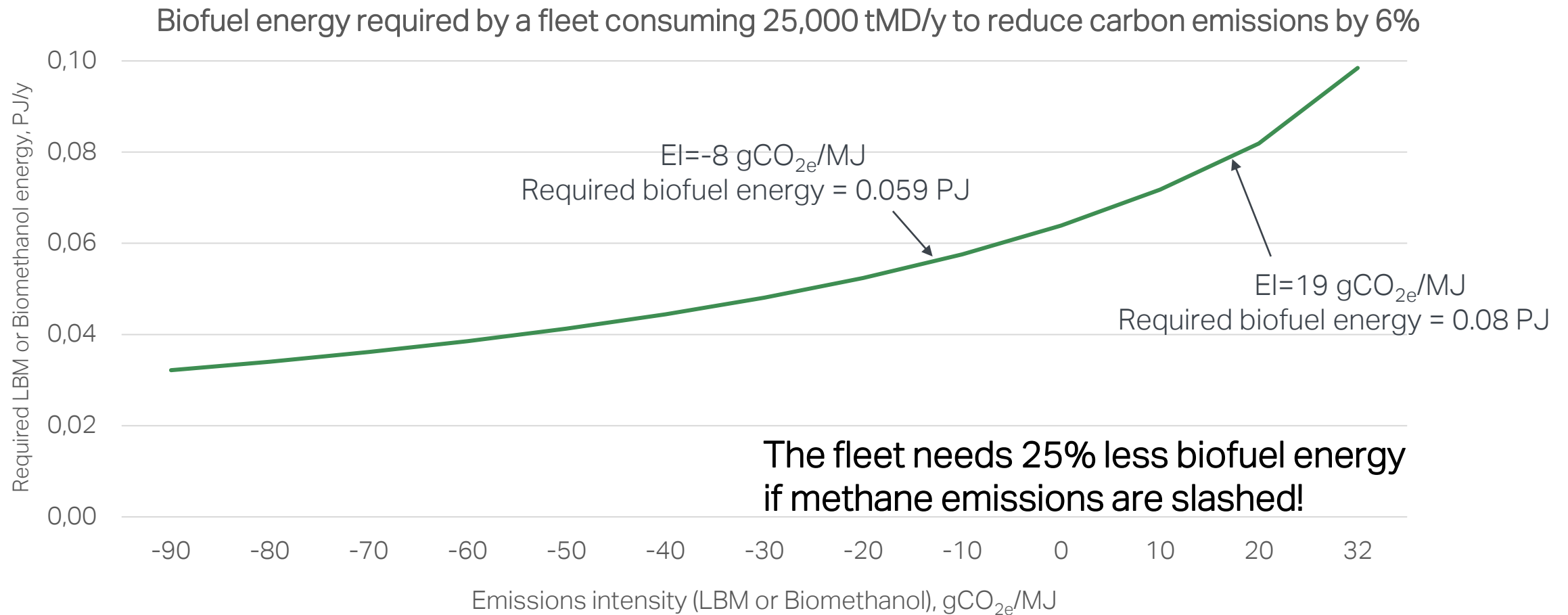
Well-to-wake GHG emissions intensity for liquified biomethane and biomethanol



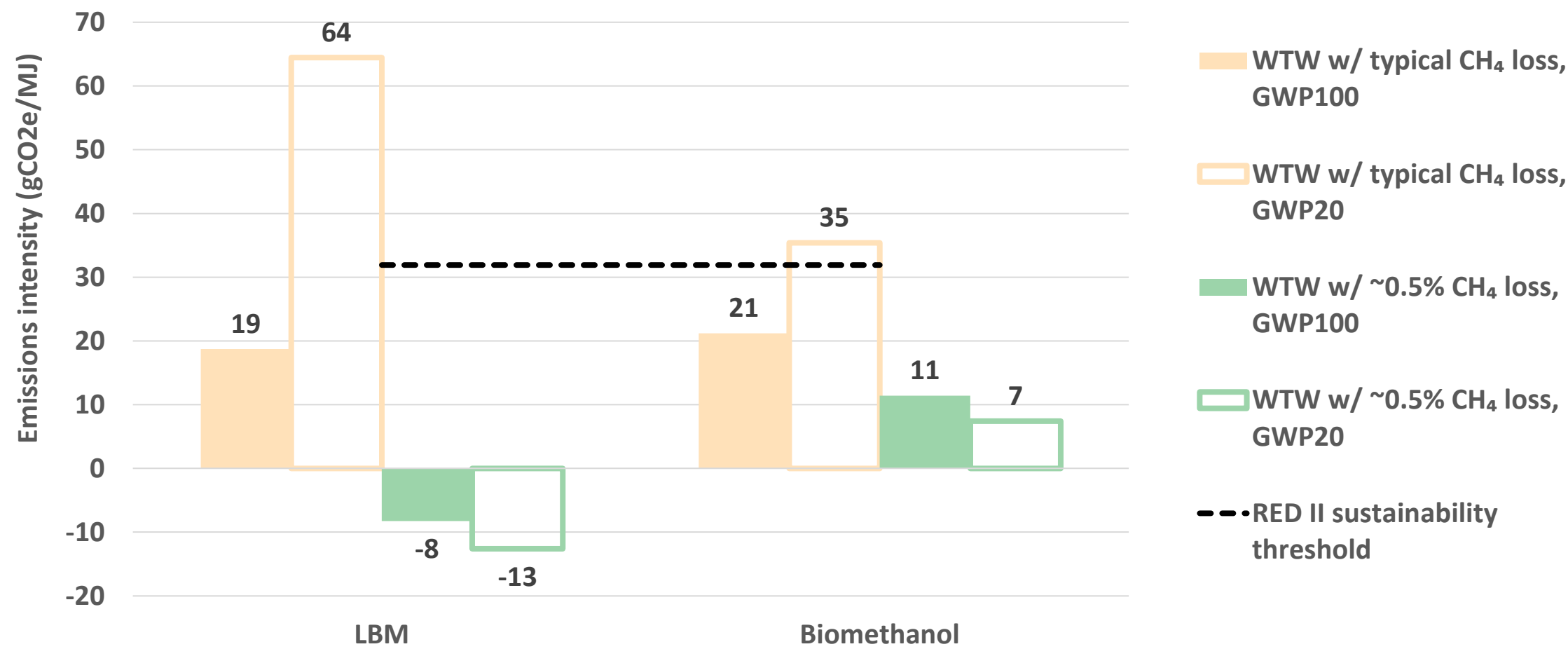
Well-to-wake GHG emissions intensity for liquified biomethane and biomethanol. Sensitivity to methane losses



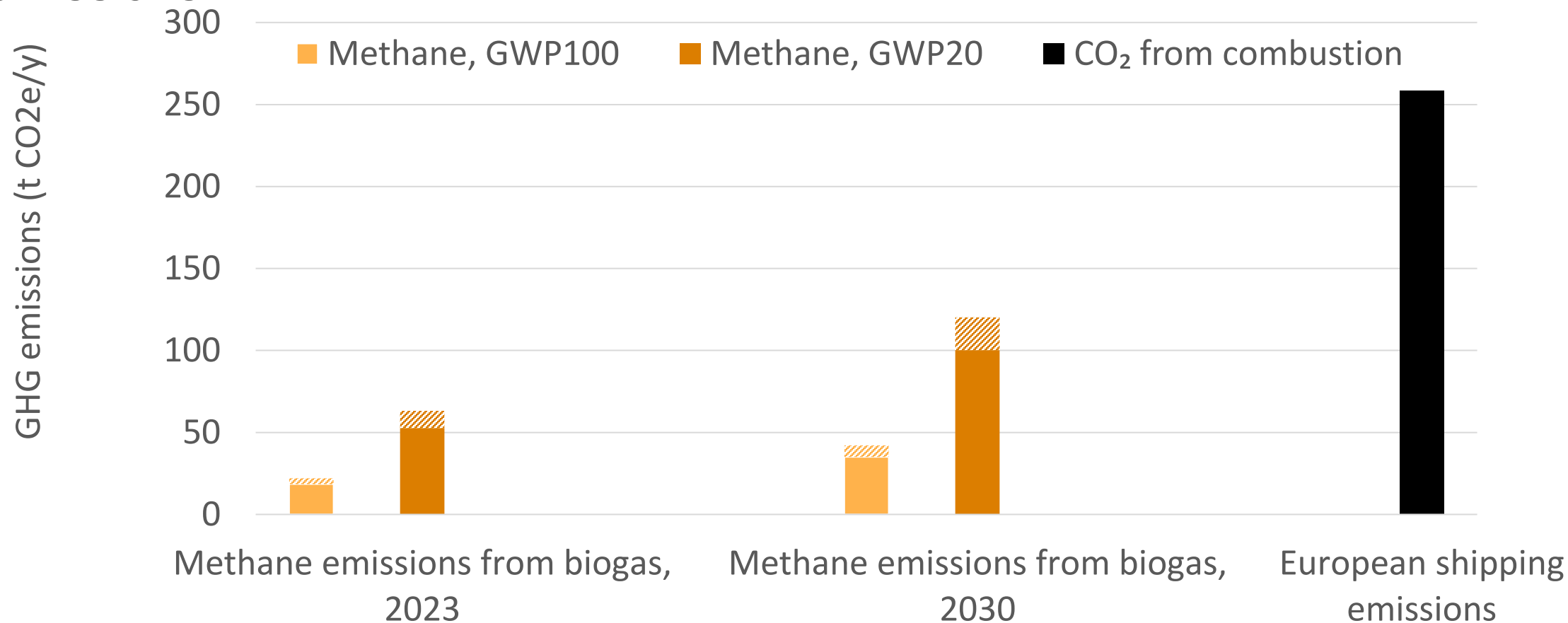
The amount of fuel required to achieve a decarbonization target depends upon the fuels' emissions intensity



Well-to-wake GHG emissions intensity for Liquified Biomethane and biomethanol. Sensitivity to GWP characterization factor



Digression: 5-6%¹ methane losses from European in biogas production is ~1.2-1.5 million tonnes methane in 2030: 15-45% of European shipping emissions



¹Bakkaloglou et al.: Methane emissions along biomethane and from biogas supply chains are underestimated, 2022

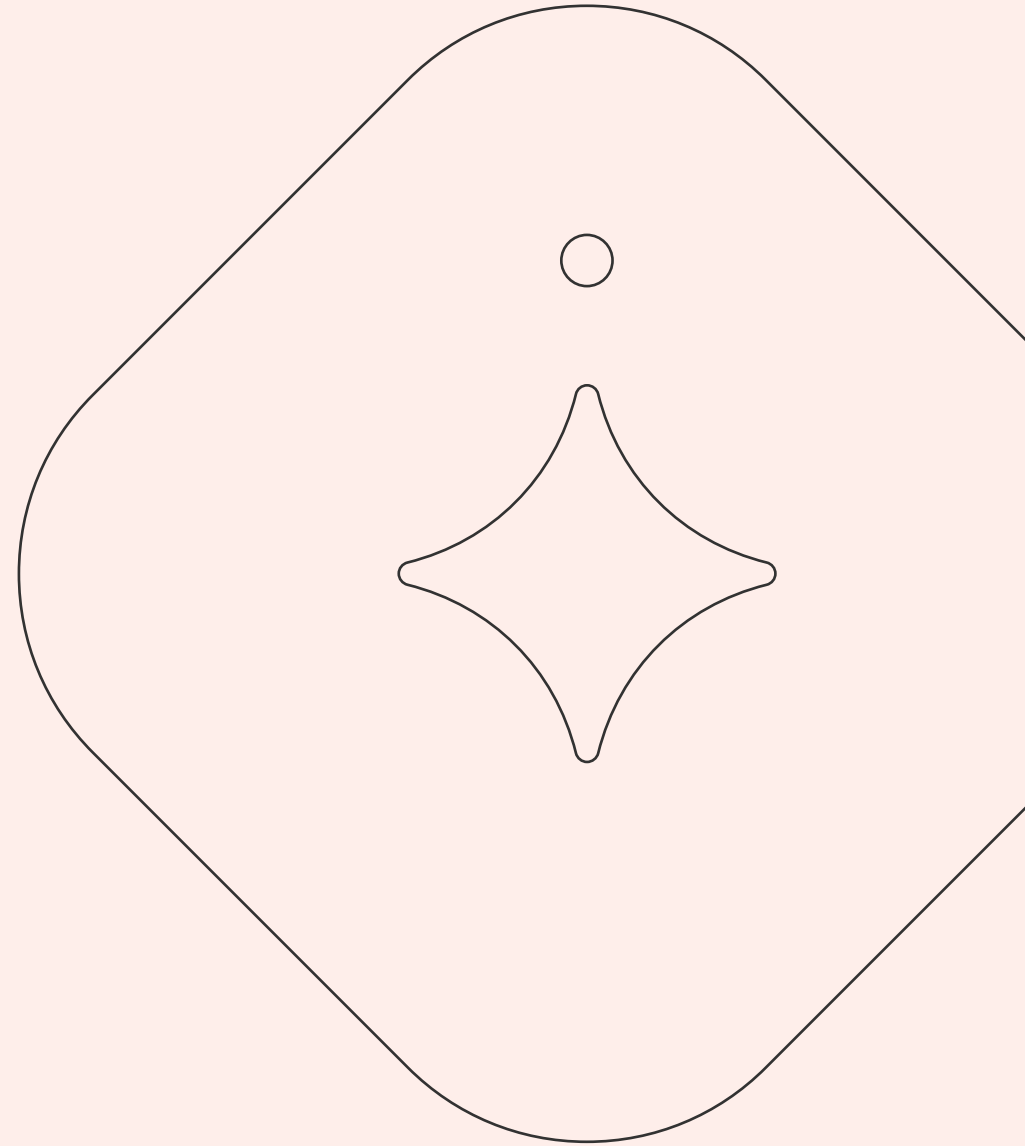
Conclusions:

Biogas-based biofuels can be very attractive **if** methane emissions can be controlled



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Panel Discussion



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