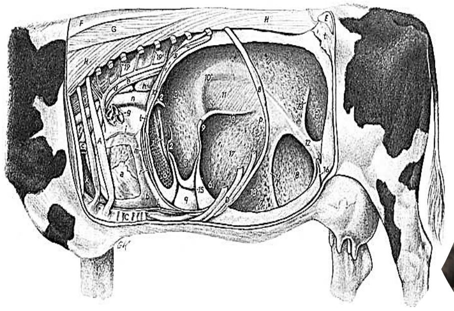
Holistic perspectives on climate care cattle farming

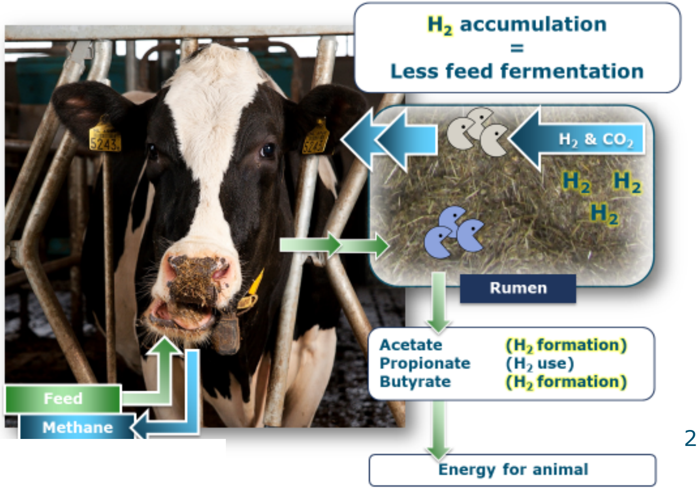
EAAP Lyon, 28 August 2023

Gert van Duinkerken

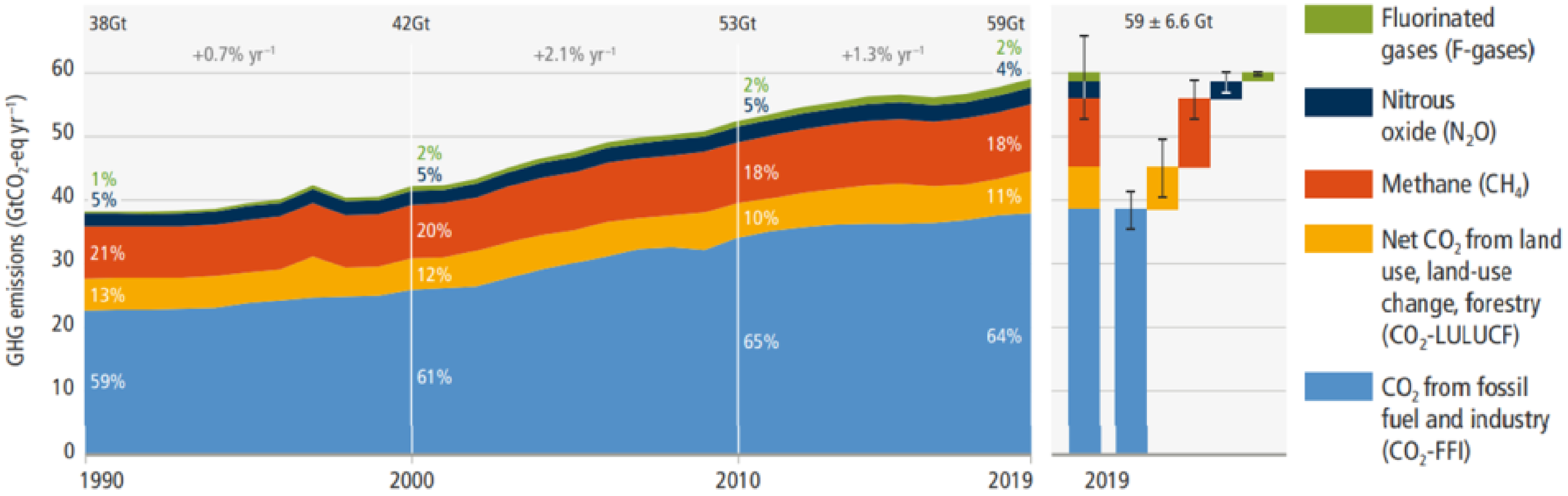



What will be discussed?

- Where are we with greenhouse gas (GHG) emissions?
- What are the mitigation pathways?
- Contribution of the *Climate Care Cattle Farming* project
- Need for integral solutions



Global net anthropogenic emissions (1990-2019) of greenhouse gases (IPCC, 2022)



Anthropogenic GHG emissions include:

CO2 from fossil fuel combustion and industrial processes (CO2-FFI);
net CO2 from land use, land-use change and forestry (CO2-LULUCF);
methane (CH4); nitrous oxide (N2O); fluorinated gases (HFCs, PFCs, SF6, NF3)

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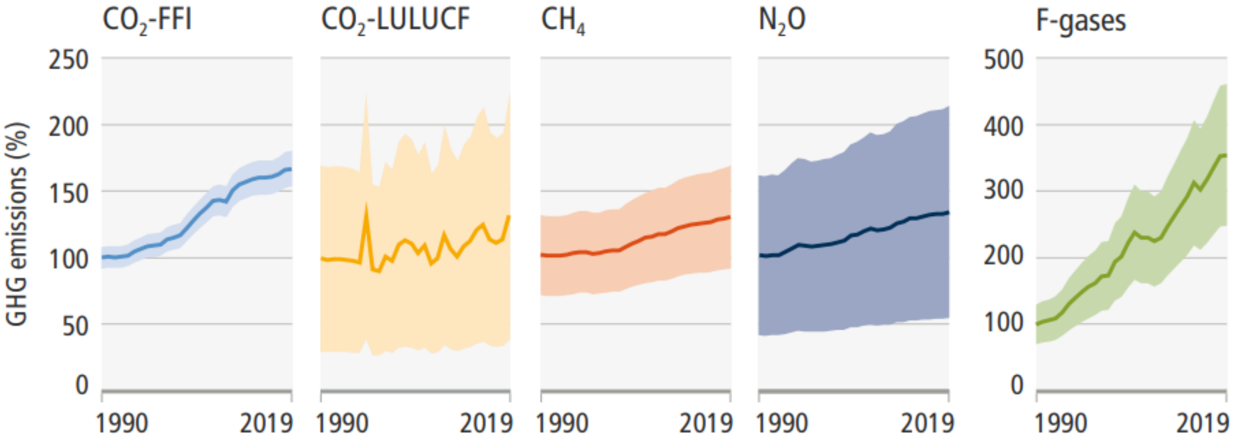
Global anthropogenic GHG emissions by gas relative to 1990 (IPCC, 2022)



The solid line indicates central estimate of emissions trends. The shaded area indicates the uncertainty range.

	2019 emissions ($GtCO_2$-eq)	1990–2019 increase ($GtCO_2$-eq)	Emissions in 2019, relative to 1990 (%)
CO_2-FFI	38 ± 3	15	167
CO_2-LULUCF	6.6 ± 4.6	1.6	133
CH_4	11 ± 3.2	2.4	129
N_2O	2.7 ± 1.6	0.65	133
F-gases	1.4 ± 0.41	0.97	354
Total	59 ± 6.6	21	154

Targets

- ‘Paris Agreement’ (2016):
    - hold increase in global temperature to well below 2°C above pre-industrial levels
    - pursue efforts to limit it to 1.5°C
    - in a way that does not threaten food production
- ‘Global Methane Pledge’ (2021):
    - 2030: global methane emissions reduced by at least 30% below 2020 levels
- EU ‘Green deal’ (2019):
    - total GHG emissions at net zero by 2050 → climate neutrality

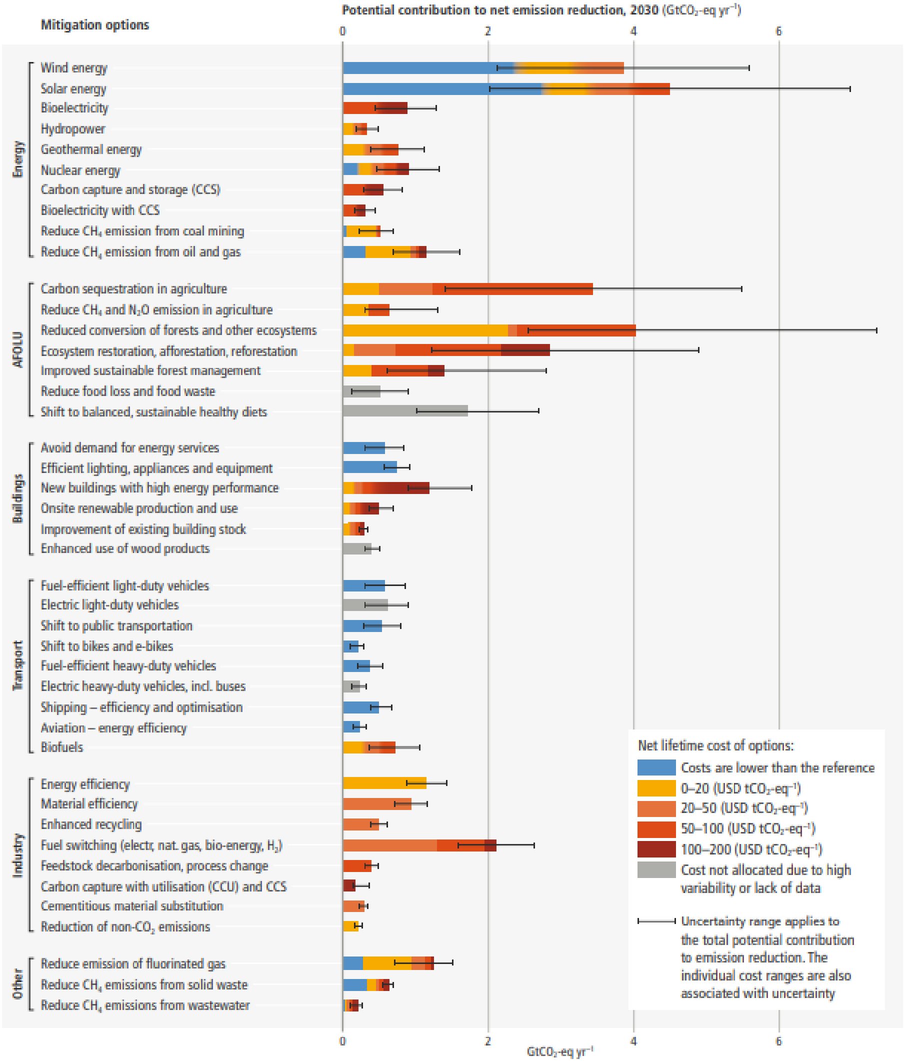
Forecasts EU agricultural GHG emissions

- With unchanged policies and efforts, and based on projections per member state, a reduction of only 2% is expected in the time span 2005 to 2030

European Environment Agency, 2022

IPCC (2022) Mitigation options, potential in 2030

In short: "many options"



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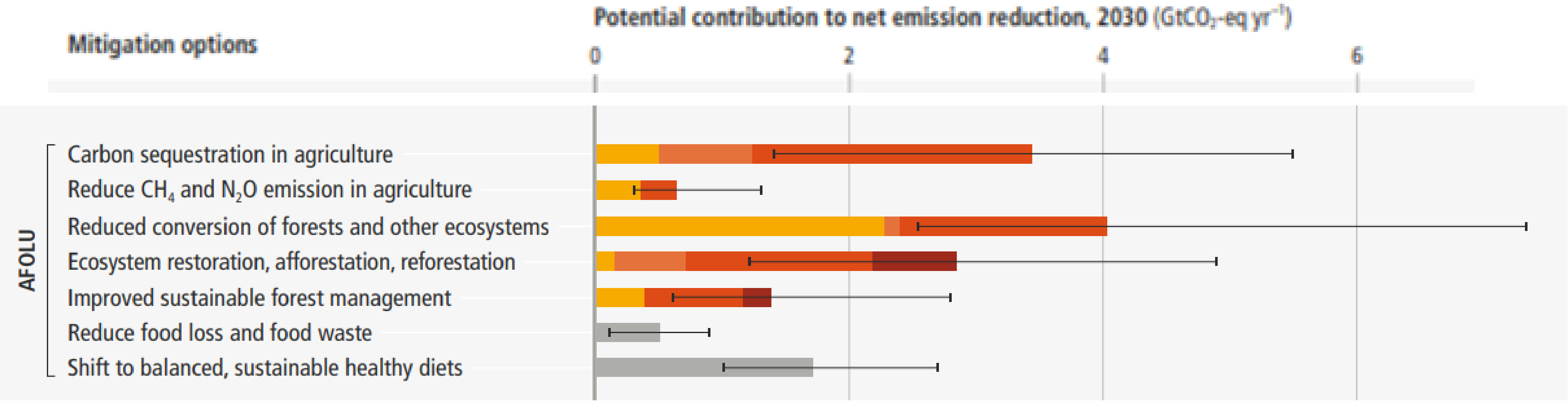
Agriculture, forest and other land use (IPCC, 2022)



Sources of anthropogenic methane emissions (%)

	Global*	EU**
Energy	37	19
Waste	19	26
Agriculture	44	53
Enteric fermentation	*29.5*	*43.3*
Manure management	*3.4*	*9.5*
Rice cultivation	*10.7*	*0.11*
Agric. waste burning	*0.5*	*0.02*

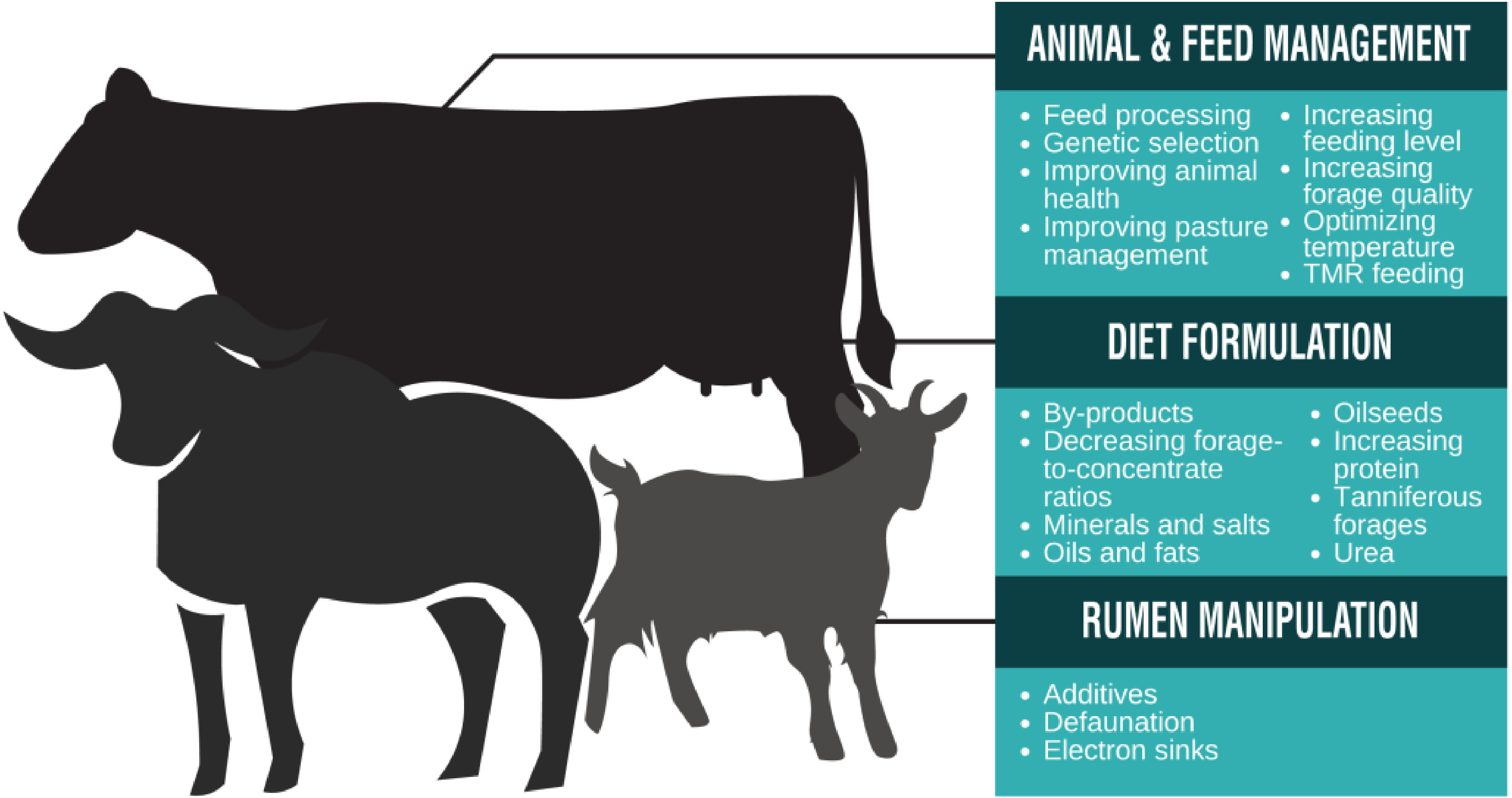
*Janssens-Maenhout et al. (2017) ; **EU Methane Strategy

Meta-analysis enteric CH_4 mitigation (Arndt et al, 2022)

- Identified strategies to decrease enteric CH_4 emissions
  - product-based (PB; CH_4 per unit meat or milk)
  - absolute (ABS)
  - maintaining or increasing animal productivity (AP; weight gain or milk yield)

- Database: 430 peer-reviewed studies, which reported 98 mitigation strategies
  - classified into three categories

Enteric methane mitigation strategies (Arndt et al., 2022)

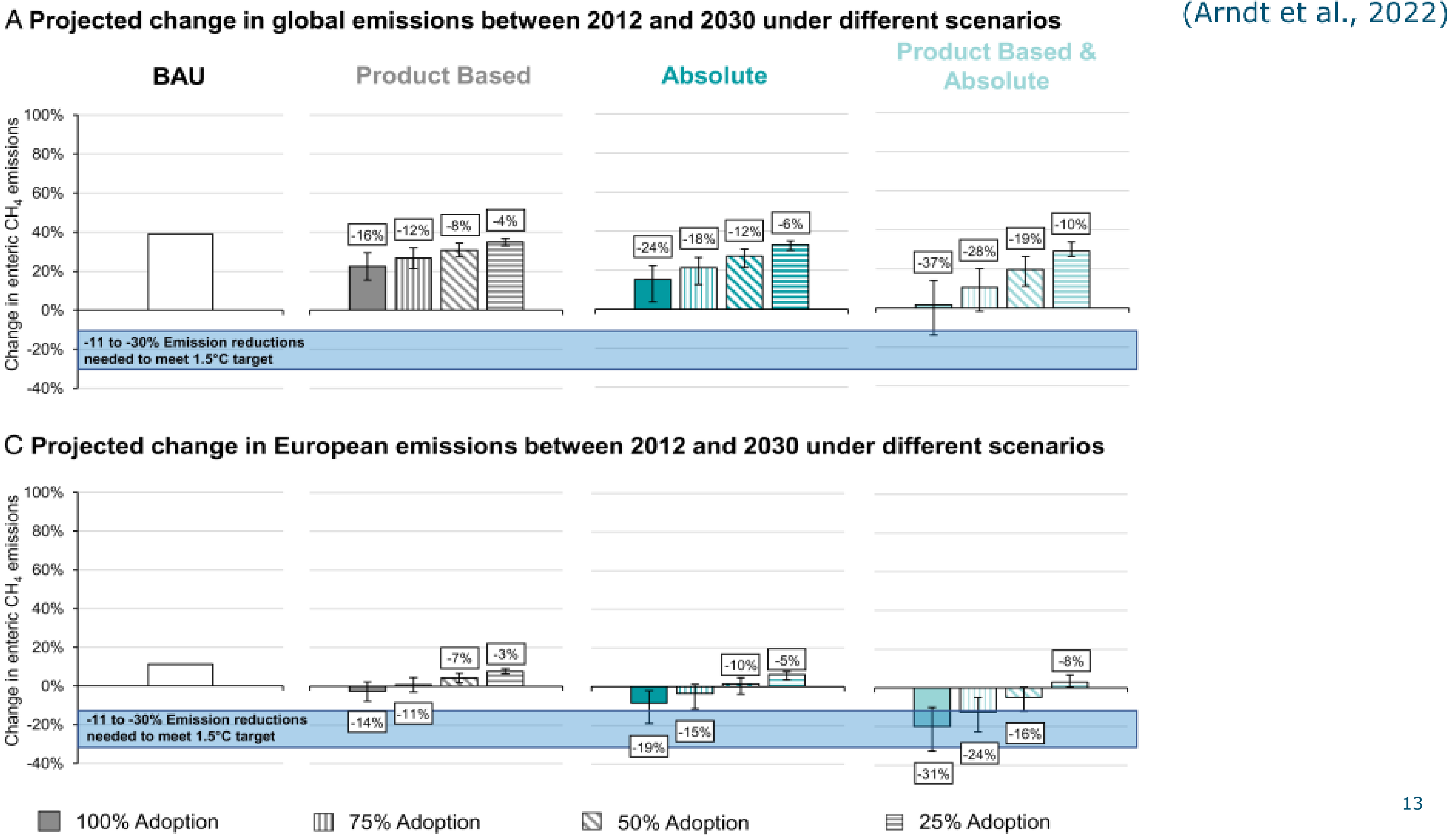


Meta-analysis enteric CH_4 mitigation (Arndt et al, 2022)

- Meta-analysis identified 3 effective PB and 5 effective ABS strategies

- PB strategies decreased product-based CH_4 emissions by on average 12% and increased animal production by a median of 17%

- ABS strategies reduced product-based CH_4 emissions by an average of 17% and daily CH_4 emissions by an average of 21%.

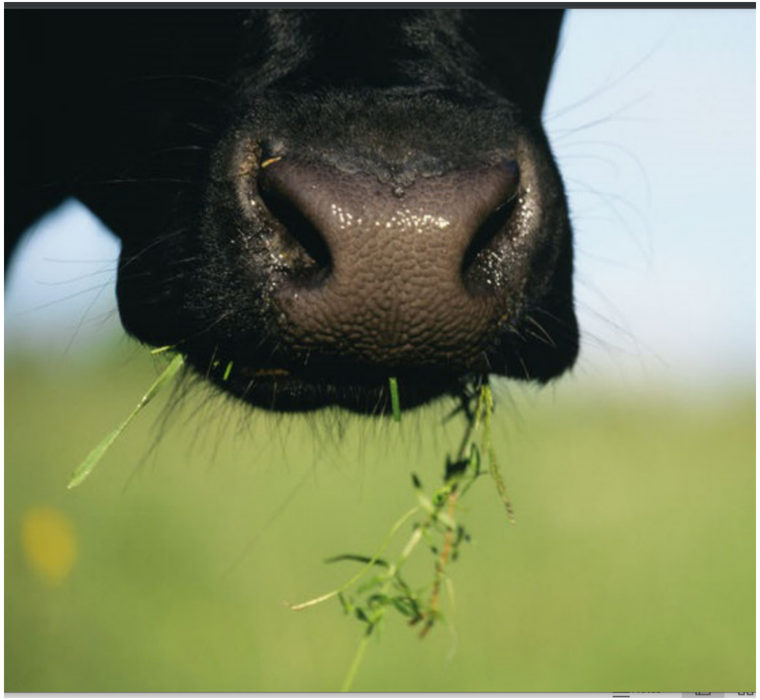

(Arndt et al., 2022)
A Projected change in global emissions between 2012 and 2030 under different scenarios
BAU
Product Based
Absolute
Product Based & Absolute
Change in enteric CH_4 emissions
100%
80%
60%
40%
20%
0%
-20%
-40%
-16%
-12%
-8%
-4%
-24%
-18%
-12%
-6%
-37%
-28%
-19%
-10%
-11 to -30% Emission reductions needed to meet 1.5°C target
C Projected change in European emissions between 2012 and 2030 under different scenarios
Change in enteric CH_4 emissions
-7%
-3%
-14%
-11%
-10%
-5%
-19%
-15%
-8%
-31%
-24%
-16%
-11 to -30% Emission reductions needed to meet 1.5°C target
100% Adoption
75% Adoption
50% Adoption
25% Adoption

Methane from dairy farms

- The Netherlands
  - ≈ 80% enteric methane
  - ≈ 20% from manure storage and handling

- Mitigation scenario’s studied for Dutch sector

  (Vellinga & Groenestein, 2023)



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Annual methane emissions by Dutch dairy sector could be reduced by 23 to 54% by 2050

	Min	Max
Reduction methane from manure, barns with external manure storage		
Cooling	25%	75%
Oxidation	60%	90%
Fermentation	46%	96%
More grazing (manure in pasture)	11%	35%
Reduction enteric methane		
Breeding	0.22%/yr, total 5%	0.68%/yr, total 15%
Feed additives	20%	30%
Diet composition	0%	10%

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Vellinga & Groenestein, 2023

Focus in EU agriculture

- Integrated solutions to mitigate GHG emissions; simultaneously optimise nitrogen management (reduce ammonia emission and nitrate leaching)
- Strong need for applicable measures to reduce emissions along the cattle chain
- 2/3rd of cattle GHG-emissions have an on-farm origin

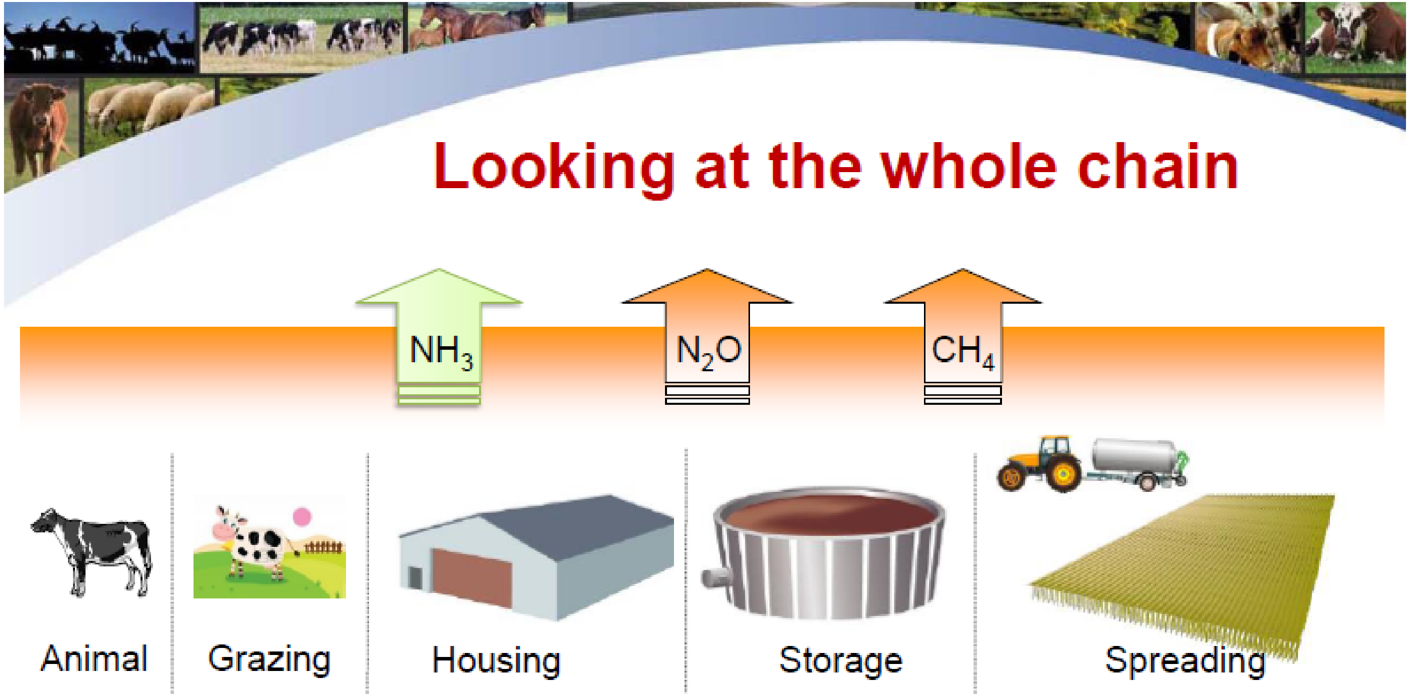
  (enteric methane, manure management, crop cultivation etc.)
- 1/3rd has an off-farm origin

  (production fertilizers/concentrates, processing, transport farm products)

Climate Care Cattle Farming


2018 JOINT CALL
FACCE ERA-GAS
ERA-NET SUSAN
ICT AGRI era-net
MID-TERM RESULT

How to reduce emissions?



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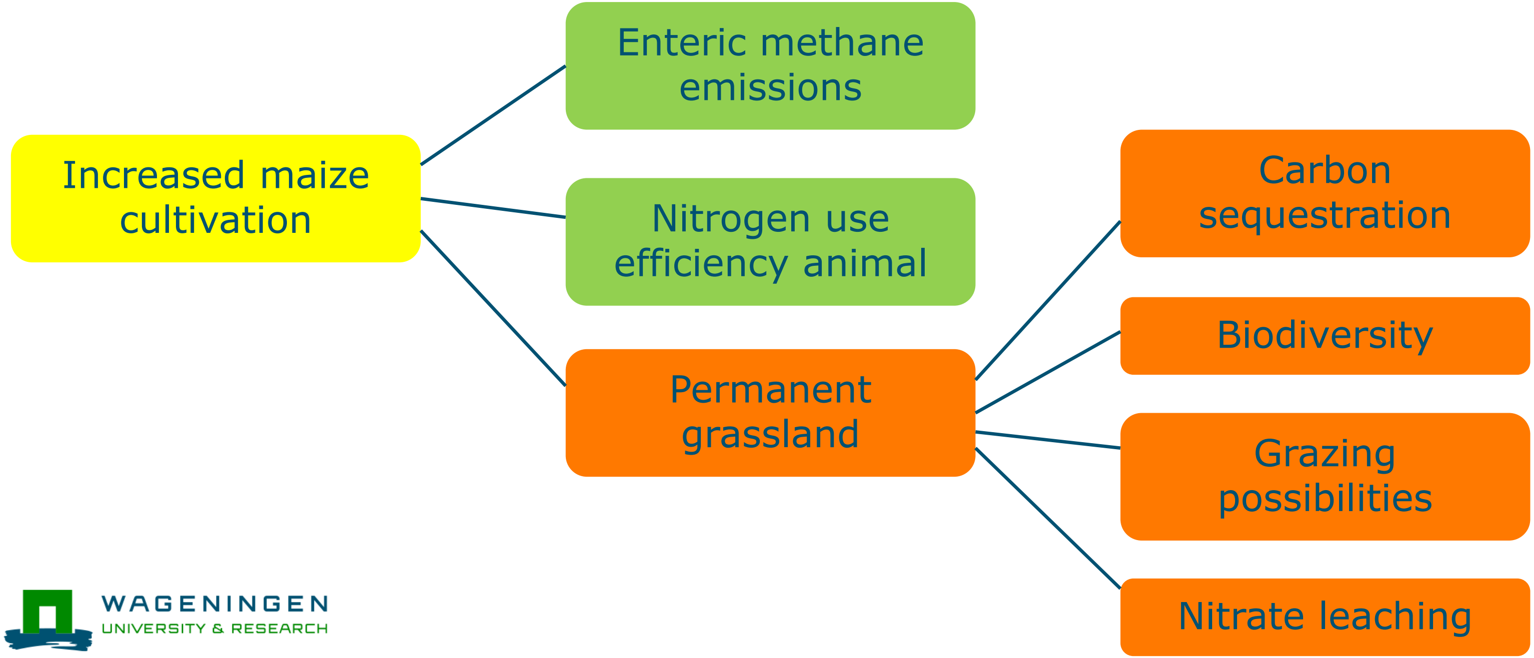
Need for integral solutions
Awareness of synergies & trade-offs

- Example: trade-offs on-farm



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Trade-off CH_4 and N emission at animal level

- Simulations with mechanistic 'rumen' model
  - Dutch Tier-3 model for enteric CH_4 in cows
- Calculations on a range of 40 diets, including effect of grassland management

Available online at www.sciencedirect.com

ScienceDirect

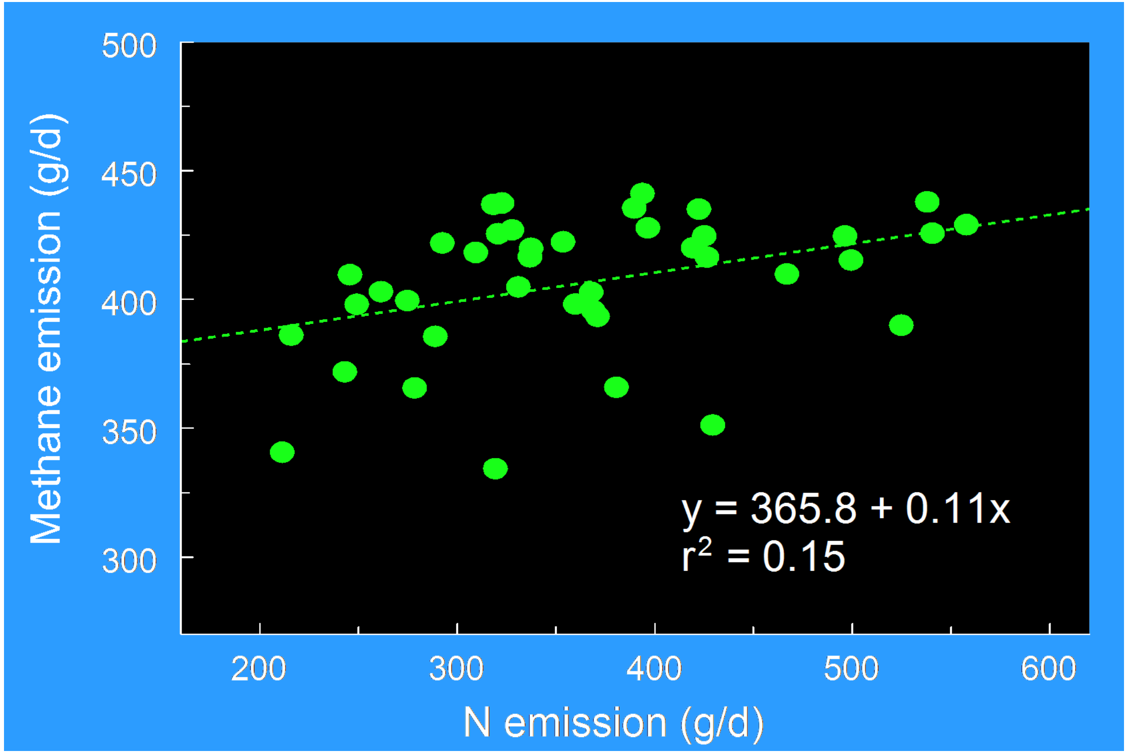
ELSEVIER

Current Opinion in Environmental Sustainability

Dietary strategies to reducing N excretion from cattle: implications for methane emissions

J Dijkstra[1], O Oenema[2] and A Bannink[3], 2011

N versus CH_4 emission



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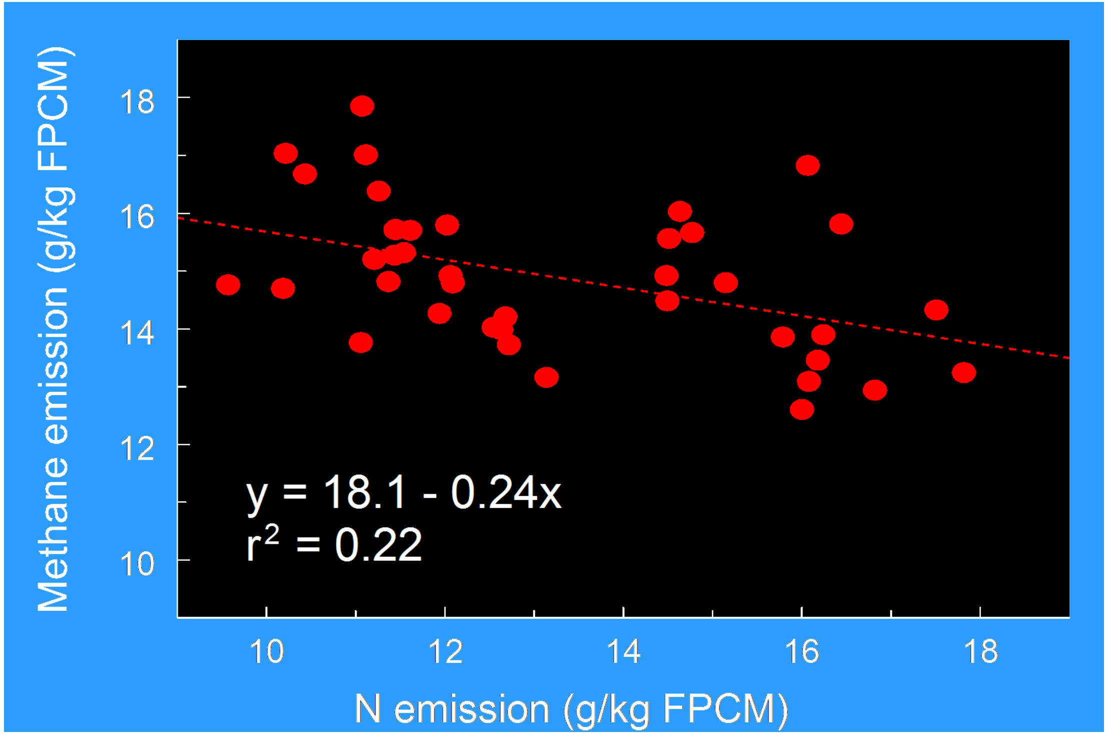
Dijkstra *et al* (2011)

N versus CH_4 per kg milk



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Dijkstra *et al* (2011)

Trade-off CH4 and N emission at animal level

- Trend of less CH4 with more N excreted per kg milk
- Simulated general trend indicates (Dijkstra *et al* 2011)

↓ 1 g N excreted/kg milk ↑ 0.24 g CH_4/kg milk

about 1% of nitrogen in soil gets lost as N_2O

thus, 1 g N ≈ 0.01 g N_2O versus 0.24 g CH_4

GWP N_2O : GWP CH_4 = 265 : 28 (GWP = Global Warming Potential)

thus, less N excretion generally compensated by more CH_4

However, a lot of variation!

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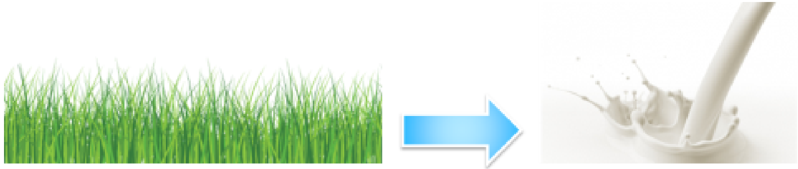
Take home messages

- Targets GHG mitigation will not be met with unchanged policies and efforts
- Broad range of mitigation options available, also in agriculture
- Level of adoption is important → identify potential barriers
- Integral sustainable solutions are required
  - Knowledge and awareness of trade-offs & synergies
  - At different scales
  - Highly complex, and highly variable
- **CCC Farming** is studying this at whole farm chain level



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gert.vanduinkerken@wur.nl

Thank you for your attention !

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