Mitigation of ammonia emission from agriculture

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Outline

- Nitrogen policies
- Sources of ammonia in agriculture
- Mitigation of ammonia emission
- Emission factors of applied manure and fertilizer

- Mini break

- National Ammonia Model Agriculture
- Trends since 1990 and outlook for 2030
- Challenges

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100years
1918 — 2018

Nitrogen policies

- Ammonia (NH_3) and nitrogen oxides (NOx: NO and NO_2)
  - Emission ceilings:
    - NEC Directive and UNECE Gothenborg protocol
  - Biodiversity (nature polic)
    - EU birds and habitats directive (Natura 2000)

- Nitrate (NO_3^-):
  - EU Nitrates Directive
  - EU Water Framework Directive

- Nitrous oxide (N_2O)
  - UNFCCC Kyoto/Paris Convention

Sources of ammonia in agricultural systems

Housing and manure storage

- Housing systems
- Manure storage

Soils

- Applied manure
- Grazing
- Applied fertilizer (mineral and organic)
- Crop residues

Mitigation of ammonia emission

Main mechanisms of measures to decrease NH_3 emission

- Decrease ammonium content in manure and/or soil
- Decrease pH
- Decrease contact of ammonium with air
- Trap volatilized ammonia

Mitigation of ammonia

Decrease ammonium content in manure and/or soil

- Less manure production/application
- Less fertilizer application
- Low protein feed
- Urease inhibitors
- Adsorption in soil (CEC)
- Immobilization (straw, additives, bedding materials in housings)
- Manure separation in liquid and solid fraction

Mitigation of ammonia

Decrease pH

- Acidification
- Soil processes: nitrification and NH_4 uptake plants
- Ammonia emission itself

Mitigation of ammonia

Decrease contact of ammonium with air

- Cover stored slurry
- Rapid manure removal from floor housing
- Injection or incorporation of manure in soils
- Manure application during/before rain/add water

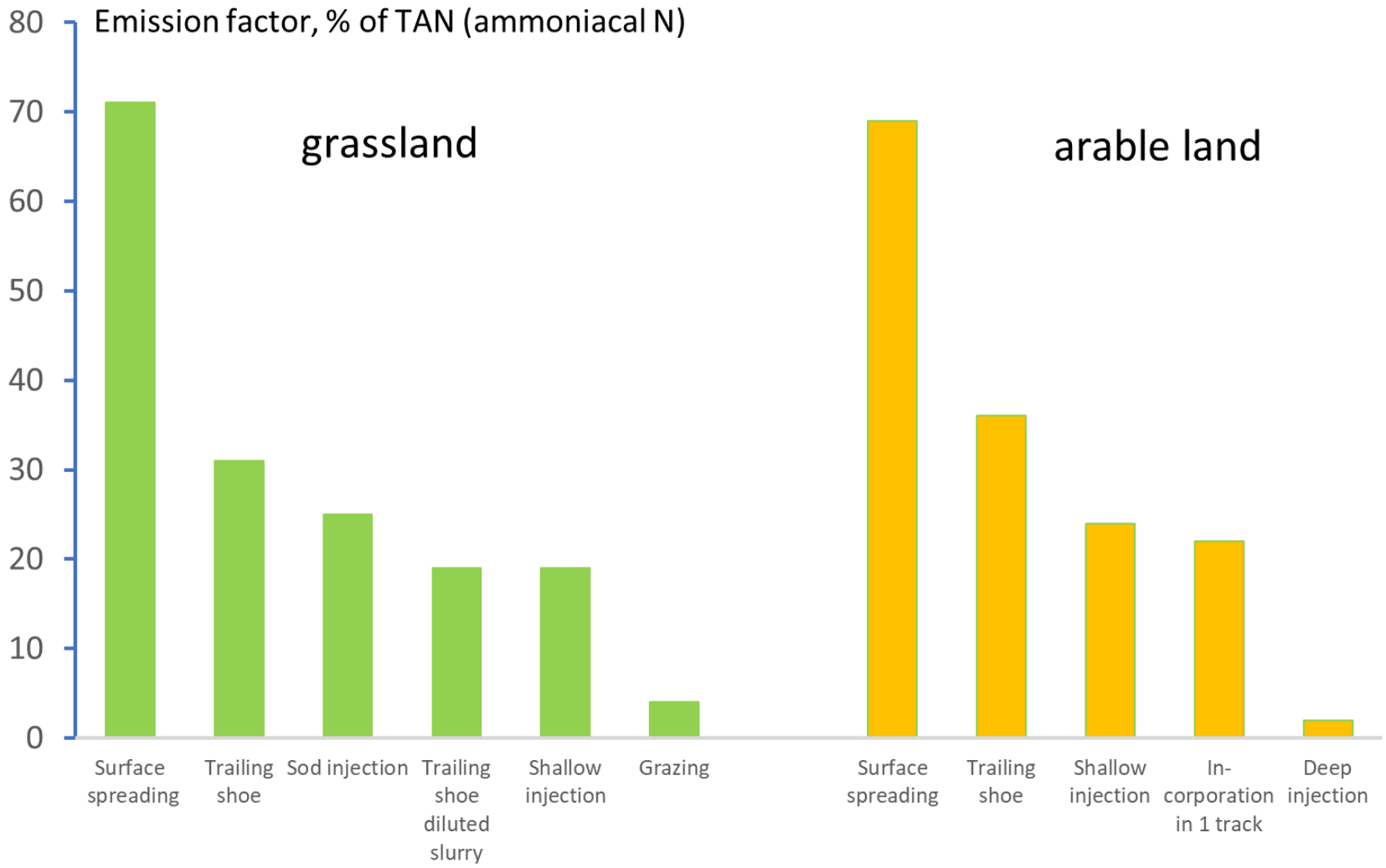
Mitigation of ammonia

Trap volatilized ammonia

- Air purification in livestock housing
  - Acid traps
  - Biological traps (nitrification)

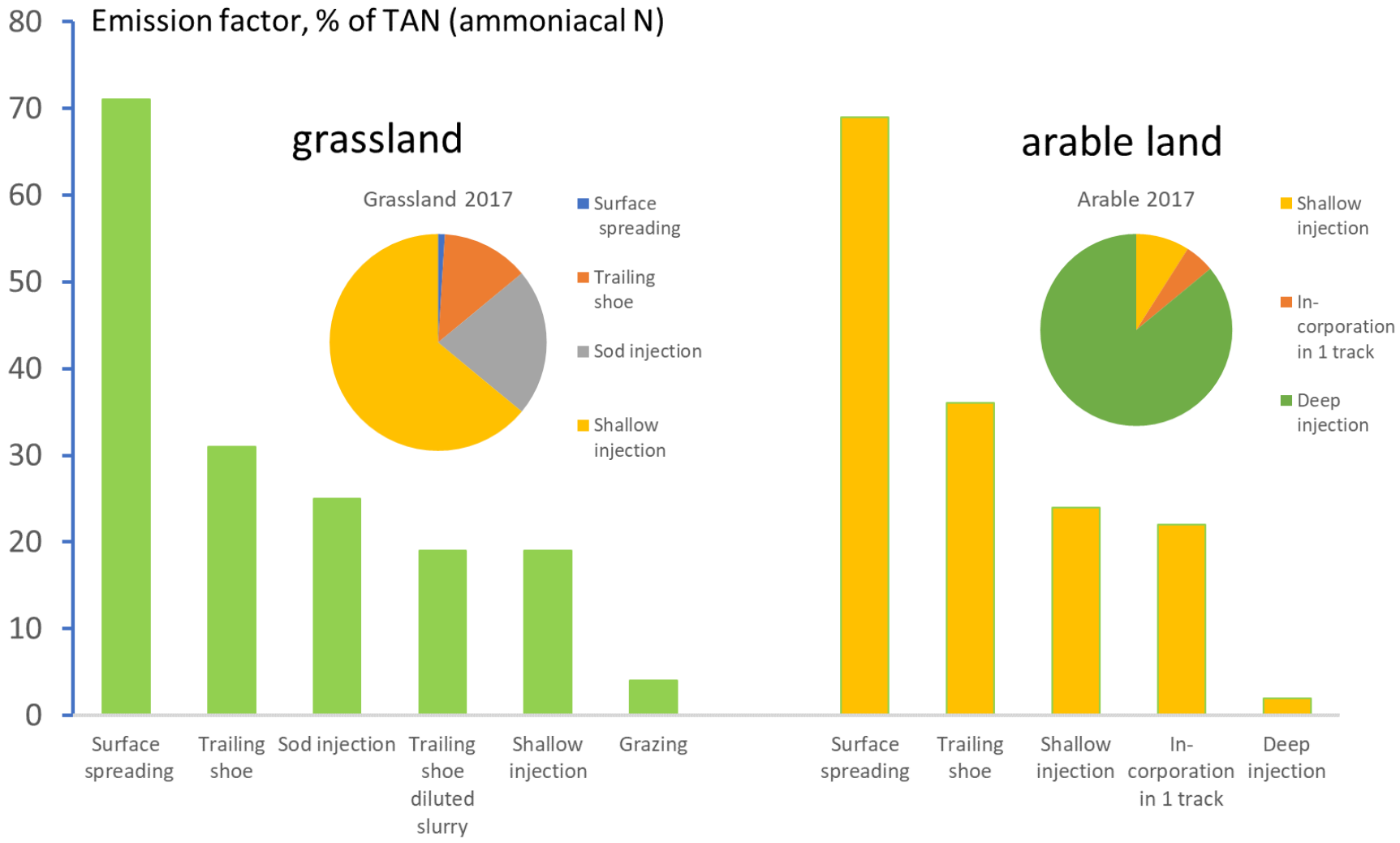
$$2\ NH_3 + H_2SO_4 \longrightarrow (NH_4)_2SO_4$$

Manure application and grazing



Sources: NEMA; Huijsmans et al.; Bussink et al.

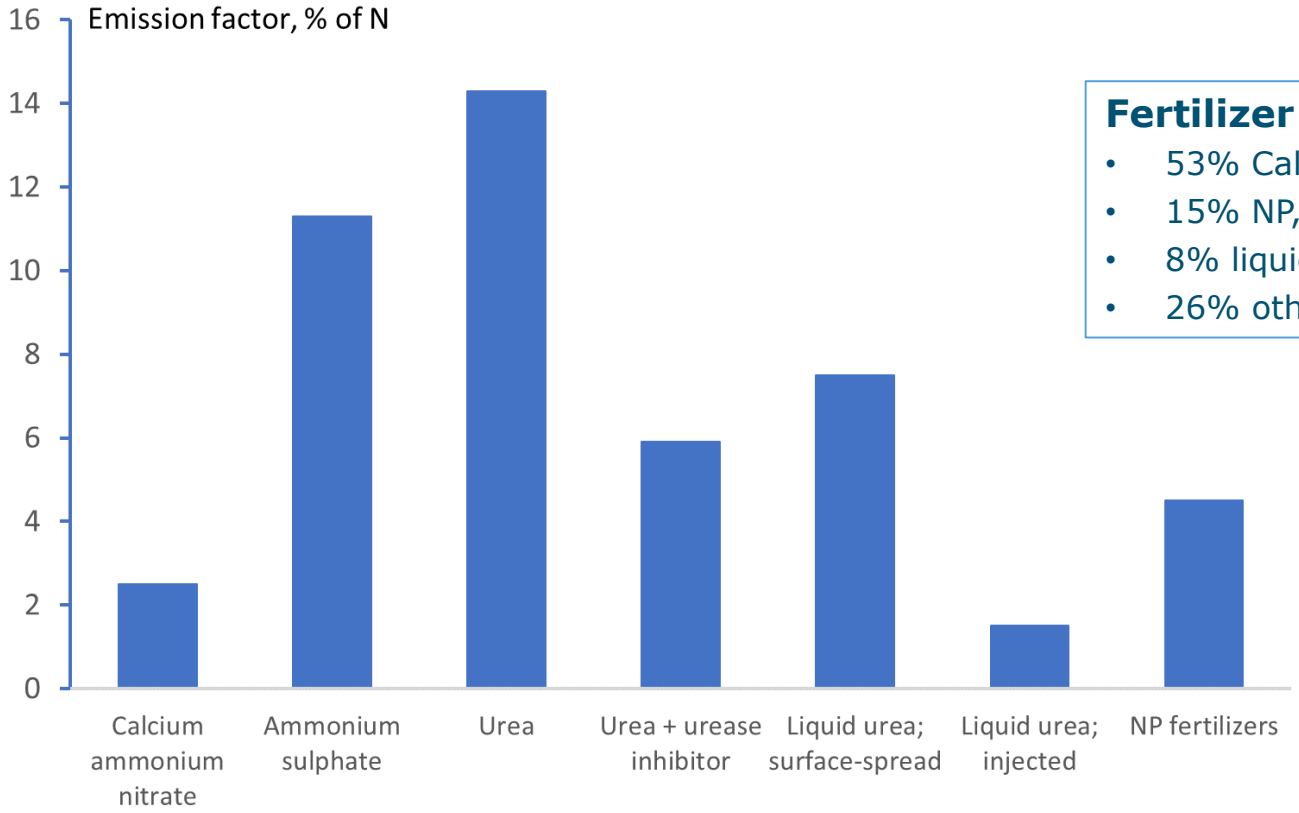
Manure application and grazing



Sources: NEMA; Huijsmans et al.; Bussink et al.

Mineral fertilizers

- Emission factors derived from Bouwman et al. (2002):
  - fertilizer type, soil pH, CEC soils, crop: average for NL



Fertilizer use 2017:

- 53% Calcium ammonium nitrate
- 15% NP, NK and NPK fertilizers
- 8% liquid urea
- 26% other

Source: NEMA

Mini break

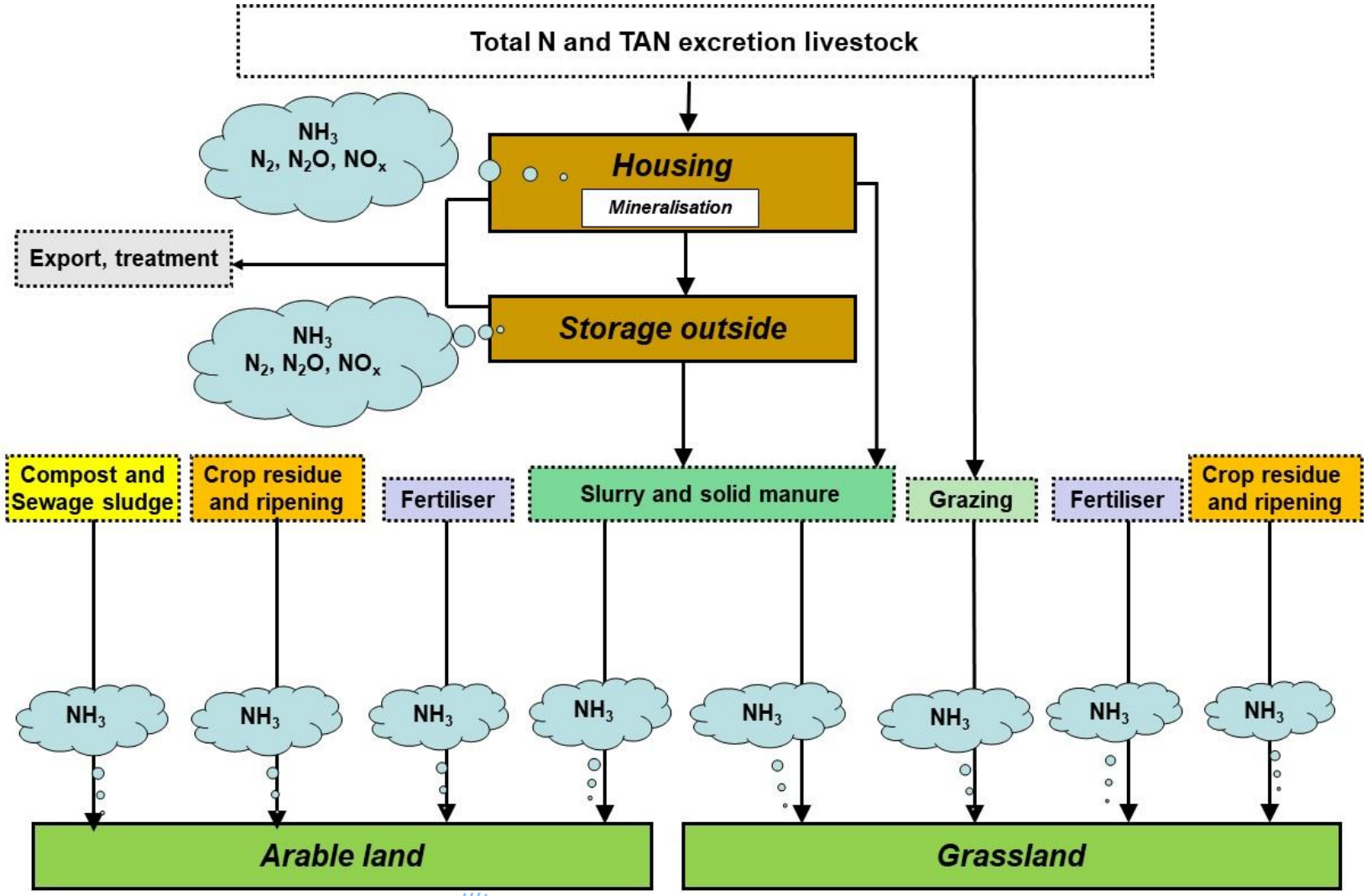
National Emission Model Agriculture NEMA

- Used for calculation emission at national scale

- Calculations based on: activity x emission factor
  - Activity data: number of animals, type of feed, housing types, fertilizer use, manure application types etc.
  - Different sources, e.g. agricultural census

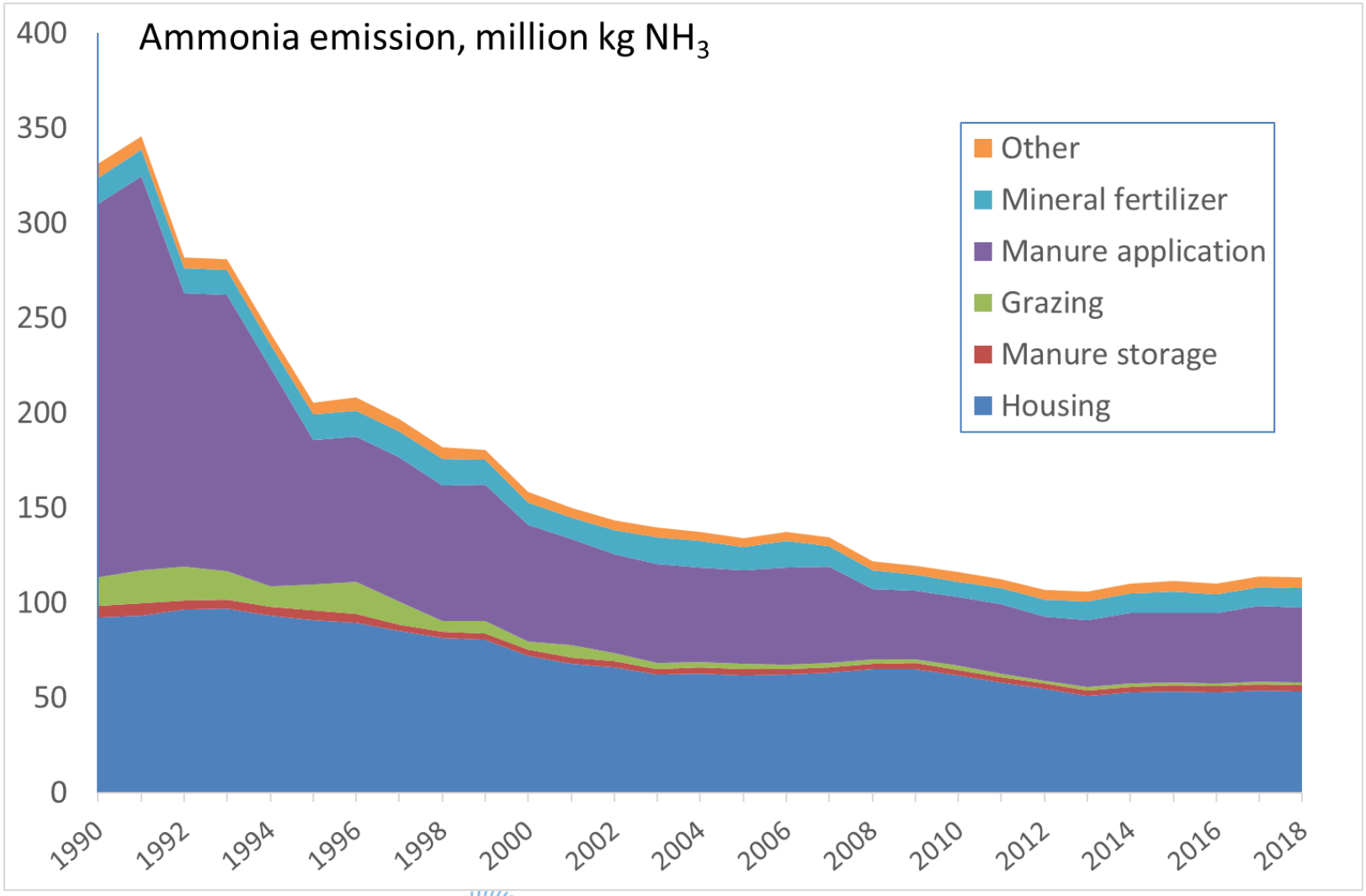
- Emission factors (% of N or ammoniacal N (TAN):
  - Housing, manure and fertilizer application, etc.
  - Measurements, literature

National Emission Model Agriculture NEMA



Van Bruggen et al., 2019
Lagerwerf et al., 2019

Trend in emission



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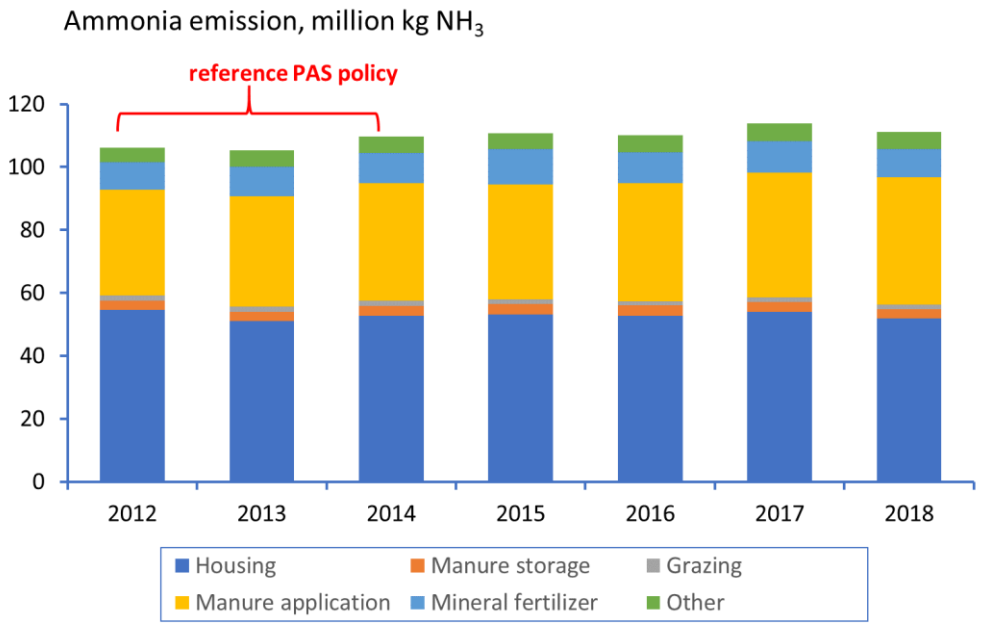
Source: NEMA; Van Bruggen et al., 2020

Recent trends in ammonia emission

Factors that increased emission:

- Increase of number of dairy cattle
- Higher milk production per cow
- Higher protein content of grass roughage
- Less silage maize/more grass in diet cows

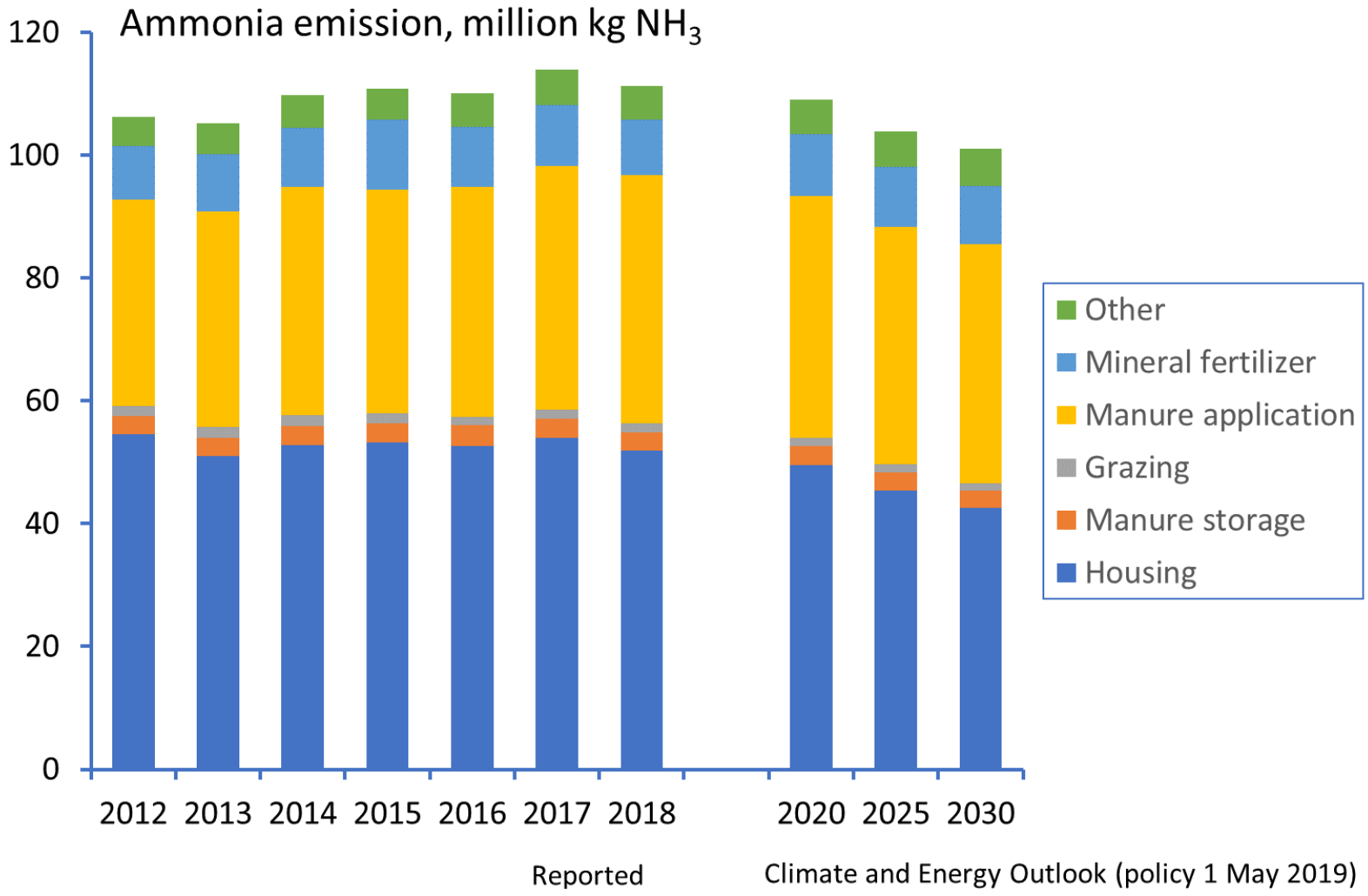


Factors that decreased emission:

- Higher implementation rate of low emission housing
- Higher implementation rate of low emission application
- Lower protein content concentrates

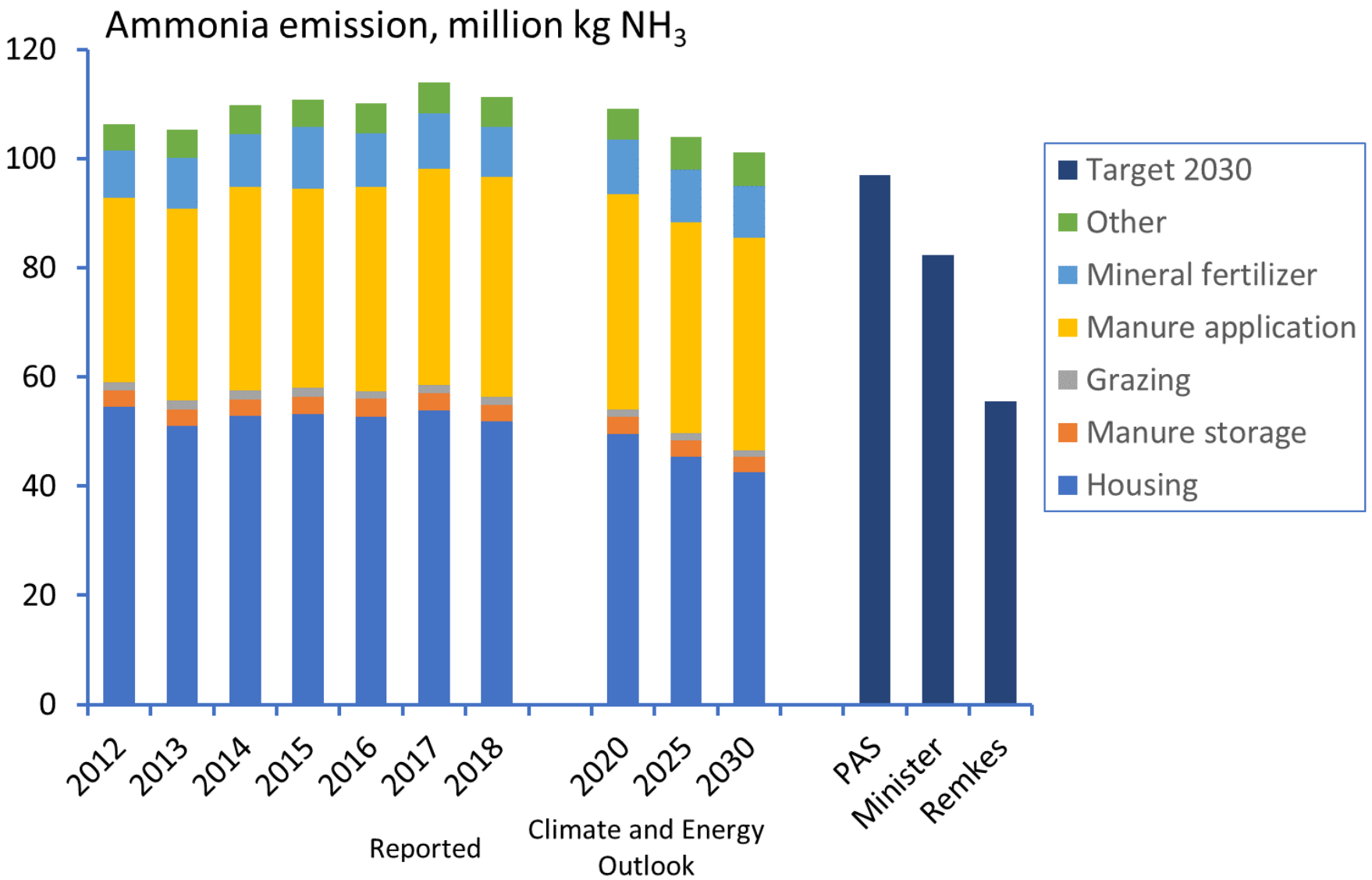
Source:
Van Bruggen et al. 2020
CDM, 2020

Recent trend and estimate 2020-2030



Van Bruggen et al., 2020; Velthof et al., 2019

Emission reduction targets 2030



Further reduction of ammonia emission?

Possible measures

	million kg NH3
More grazing	0.5
Water dilution slurry applied with shallow injection	1-2
Low emission housings	4-6
Decrease N content feed	5-11
Less livestock near Natura 2000	5

Source: PBL; Groenestein et al., 2019

- Effects uncertain: low emission housing and application, reduction protein content in roughage
- High costs
- Sufficient to reach target for 2030?

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Conclusions

- Large number of measures to reduce ammonia emission
- Strong decrease in ammonia emission since early nineties
  - Low-emission application techniques very effective
- Recent years: increase in ammonia emission
  - increase in number of cattle and milk production per cow, more N in roughage
- Large challenges to reduce emission towards 2030

Thank you!