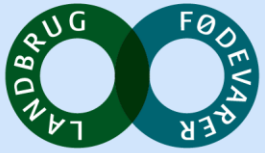
New insights in reducing the climate impact of pig production: Best practice examples and initiatives for the future

Dr. Christian Fink Hansen, director
Danish Agriculture & Food Council Pig Research Centre



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Pig Research Centre

Danish pig production 2021

2.576 pig producers
33.0 million pigs
2 million ton of pig meat

Pig feed
- **Wheat**
- **Barley**
- **Soja**

Live export:
14.5 million pigs

All slaughterhouses:
~18.5 million pigs

Danish Crown

Export:
DKK 33.0 billion
Domestic market:
DKK 3.0 billion

Markets:
Export 90%
Domestic 10%
Value: DKK 36 billion

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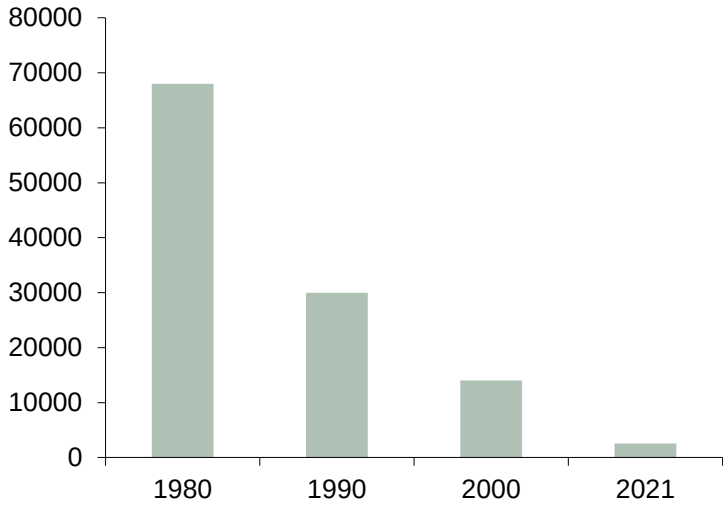
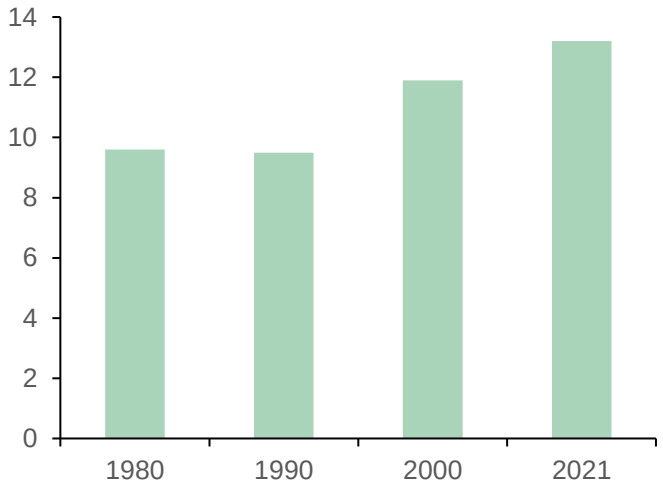
Primary Production
Pig producers & pig population and pig production in Denmark

No. of producers

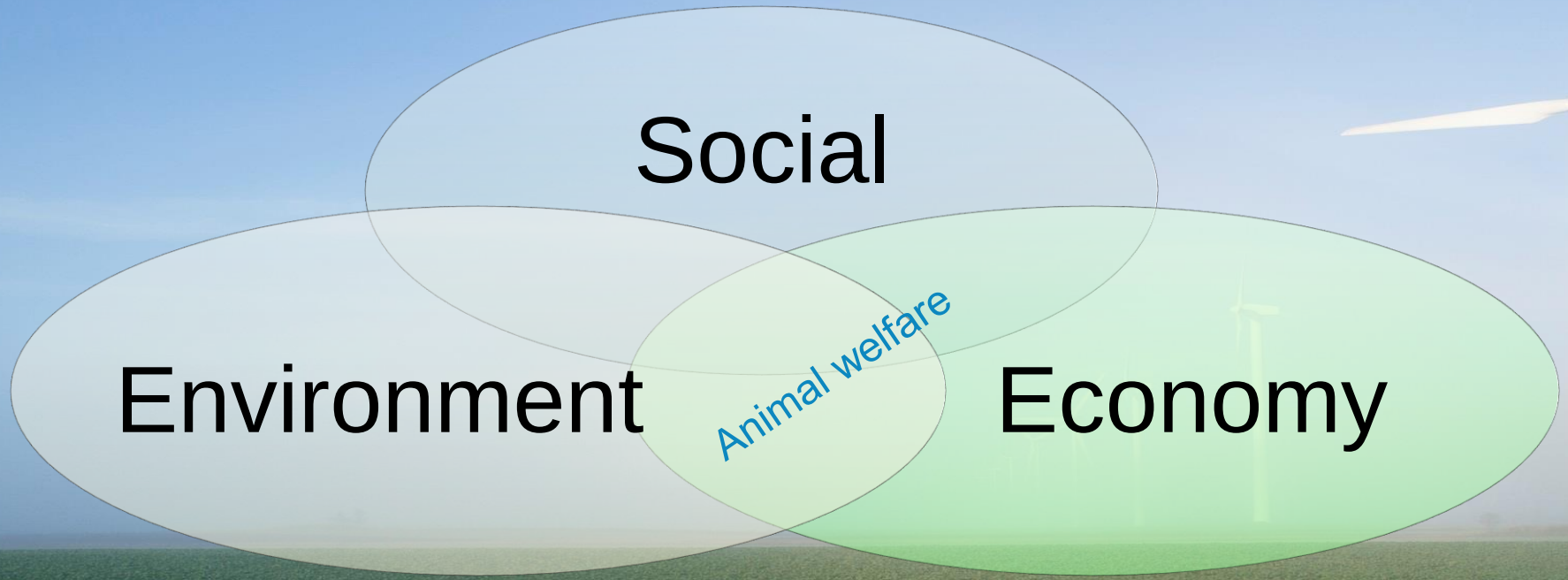


Pig population
Million pigs



Pig production
Million pigs

Our focus is environmental sustainability and climate change



Food companies:

- The market requires documentation of animal welfare, traceability, food safety and sustainability
- Sustainable production provides a better bottom line – produce more with less

Global Warming Potentials in a 100-year perspective (GWP-100)

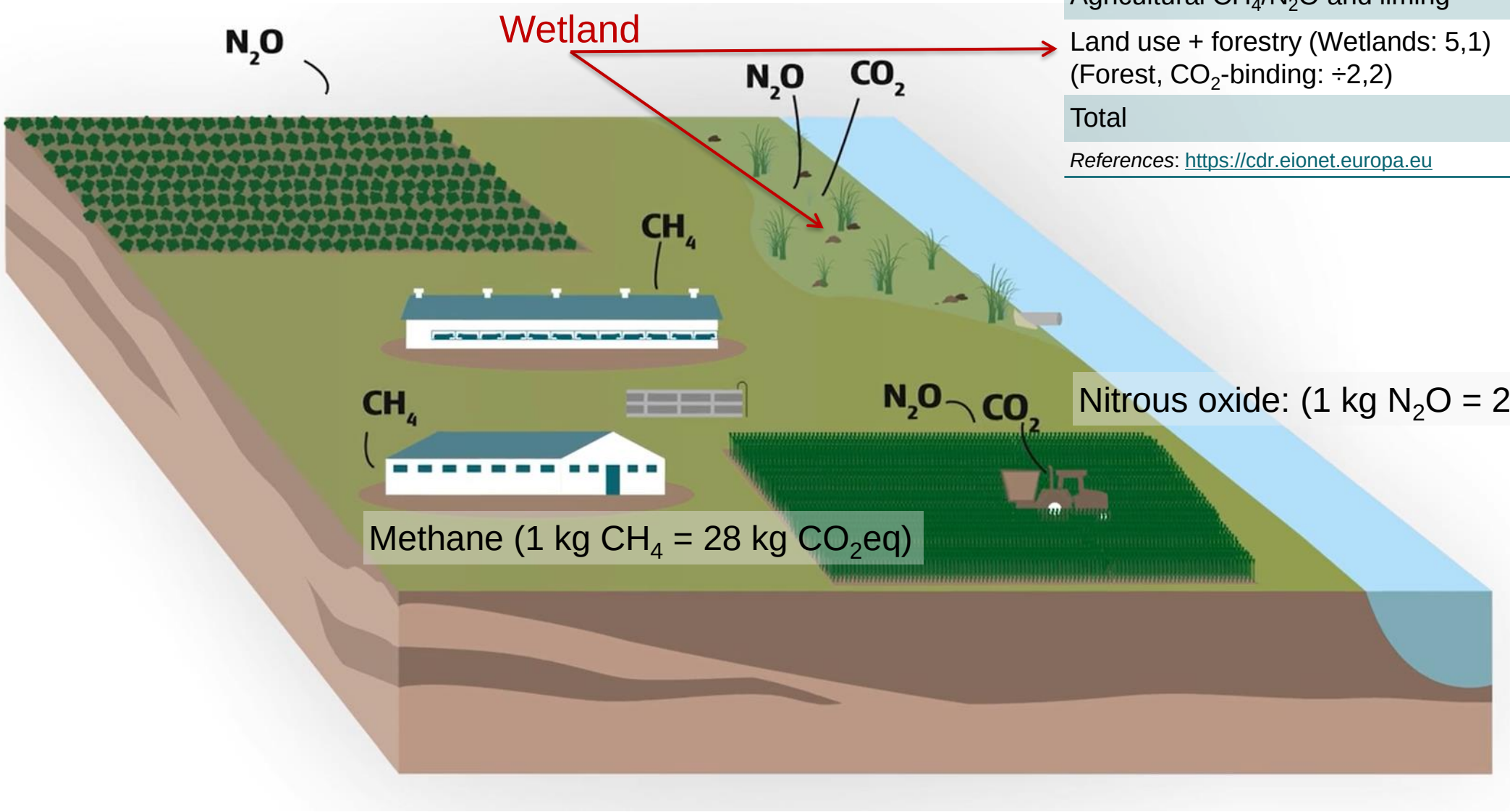
Conversion factor to CO_2eq (global warming potentials in a 100-year perspective)			
Greenhouse gas	**AR4 (IPCC2006)**	**AR5 (IPCC, 2014)**	**AR6 (IPCC, 2021)**
CO_2	1	1	1
CH_4	25	28	27
N_2O	298	265	273

Reference: The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change

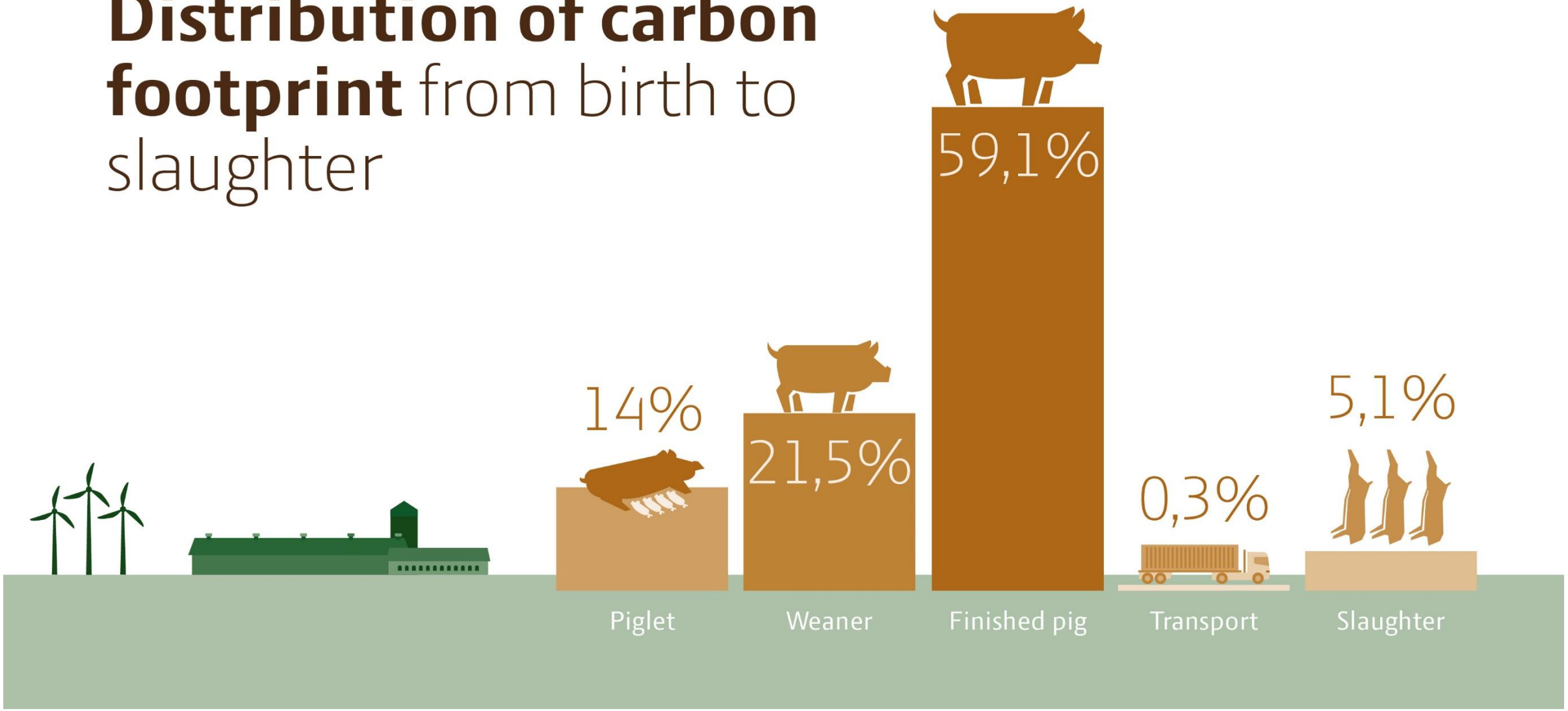
Greenhouse gas emission from agriculture

Mio. ton CO_2eq (2020)	Agriculture
Agricultural CH_4/N_2O and liming	11,4
Land use + forestry (Wetlands: 5,1) (Forest, CO_2-binding: ÷2,2)	2,9
Total	14,3

References: https://cdr.eionet.europa.eu



Distribution of carbon footprint from birth to slaughter



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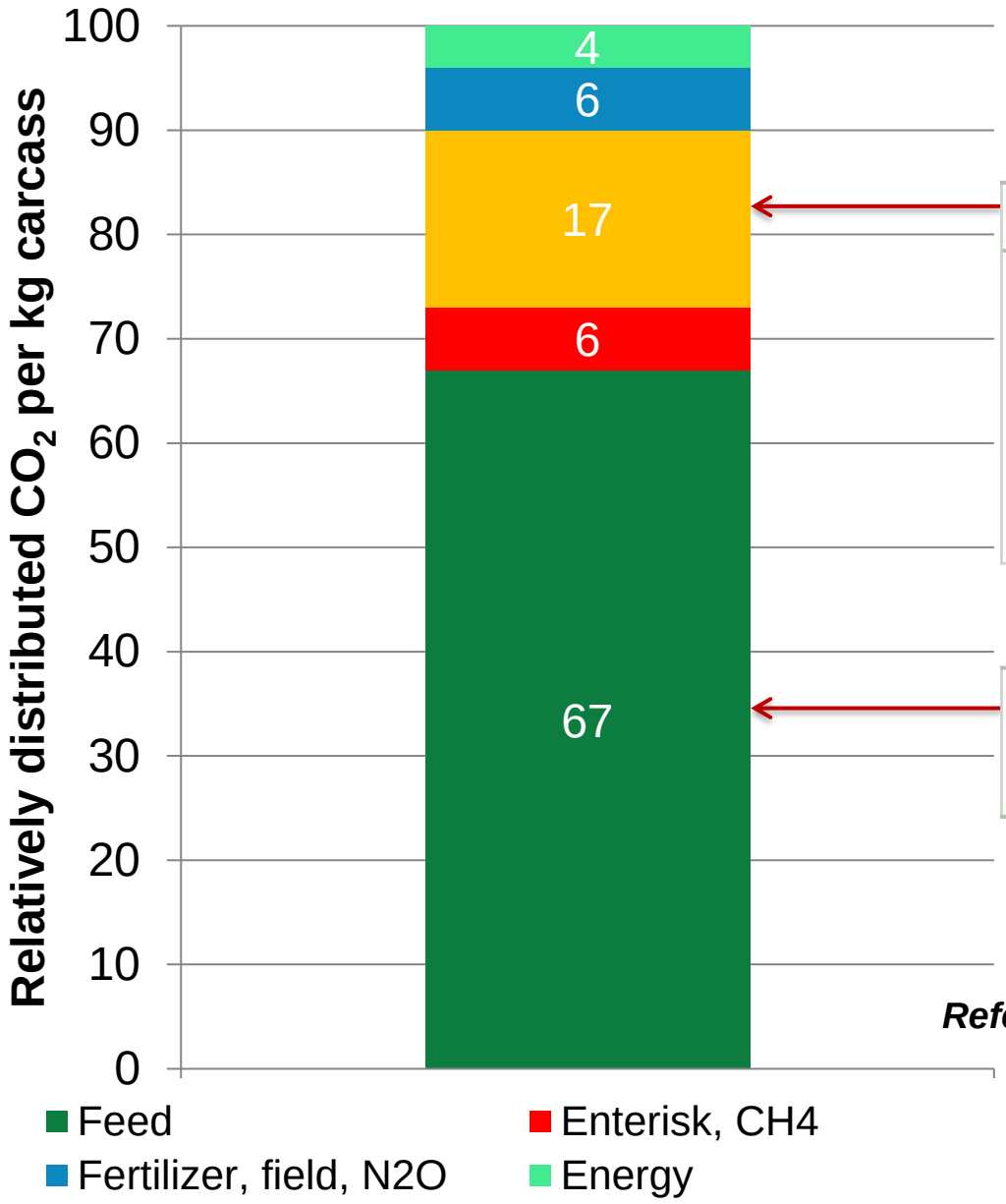
Pig from birth to slaughter (115,3 kg)
(distribution of climate footprint of a pig from birth to delivery from the stable)



Manure handling → Effect on methane

Measures that reduce methane loss:

- Frequent vacuum flushing of manure + Biogasification
- Acidification of manure in the barn
- Frequent vacuum flushing of manure → acidification in manure stores

Efficiency improvement (fattening pigs)

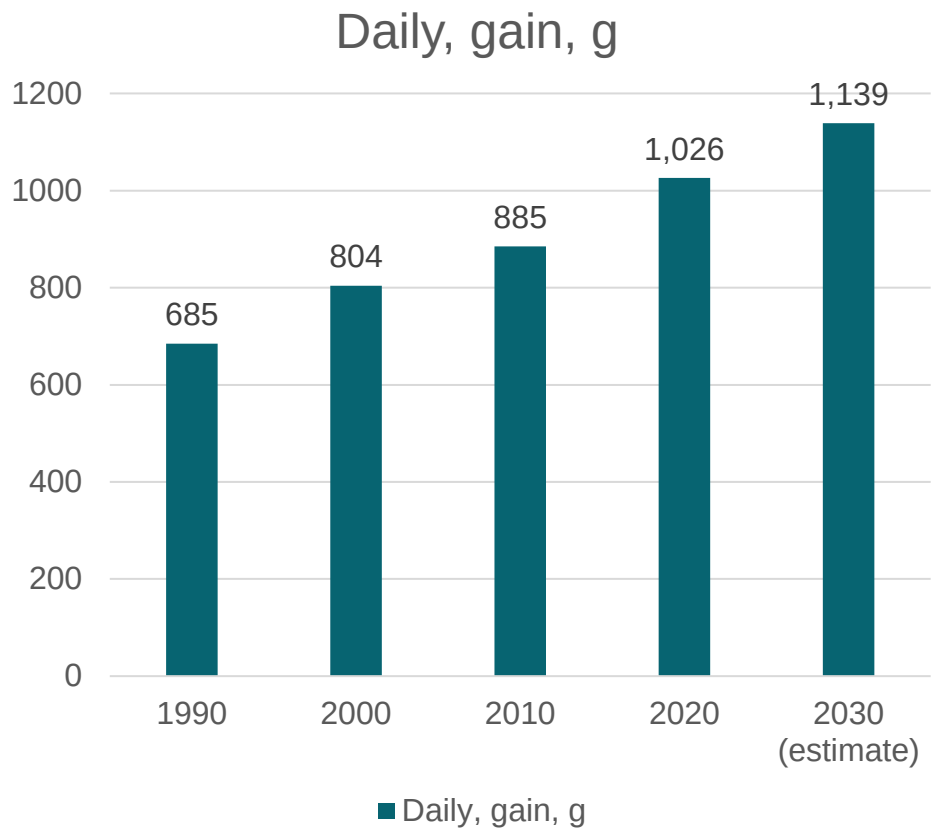
- ÷ 0,1 kg feed / kg growth = ÷ 6,8 kg CO_2e/pigs (↓ **2,5 %**)

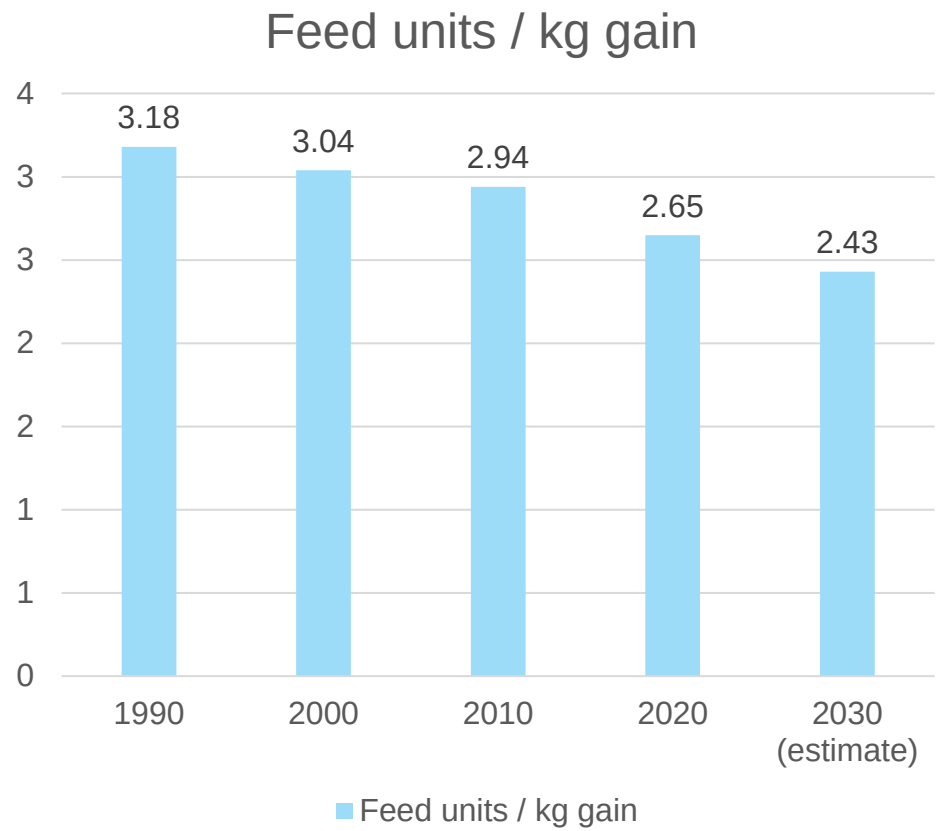
Reference: *Preliminary calculation in PORK project with PEF calculation method*

Most farmers in Denmark grow the barley and wheat they use in pig feed on their own agricultural land

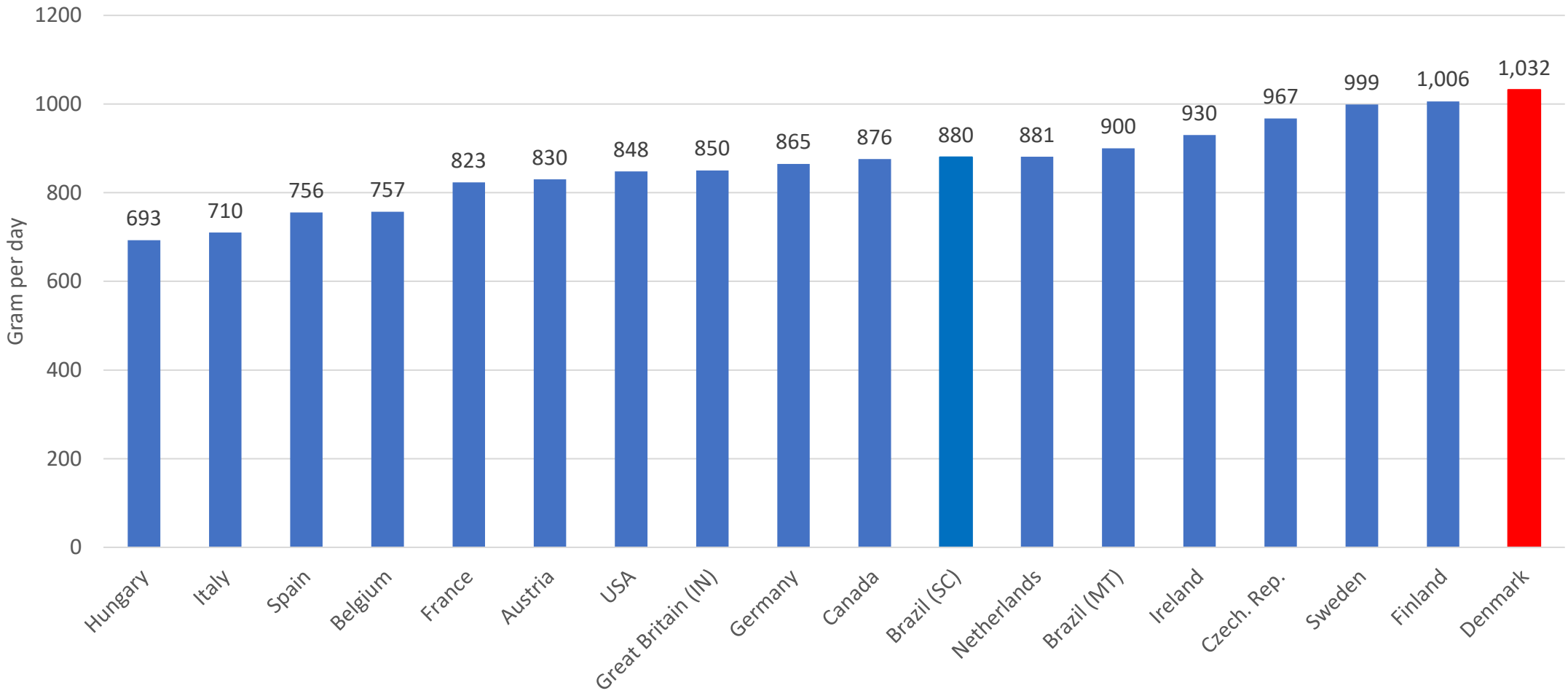
In 2025, all imported soy meal in Denmark will be produced sustainably and without deforestation

Productivity, Finishing pigs 31-115 kg





Daily gain finishing pigs
InterPig 2021



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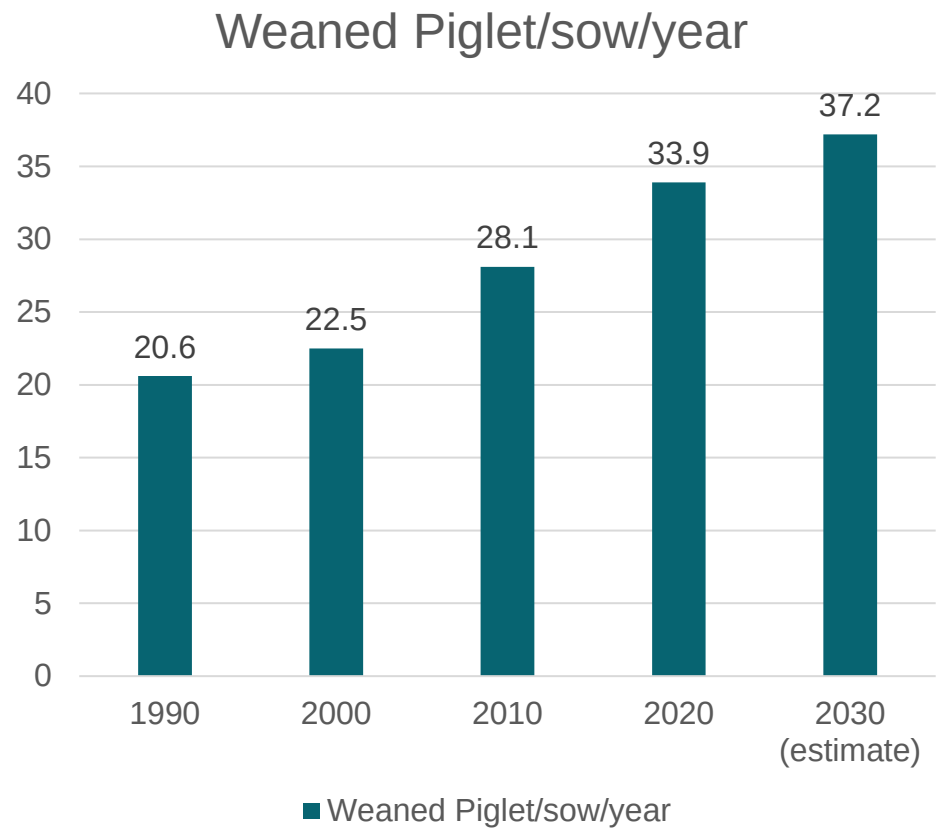
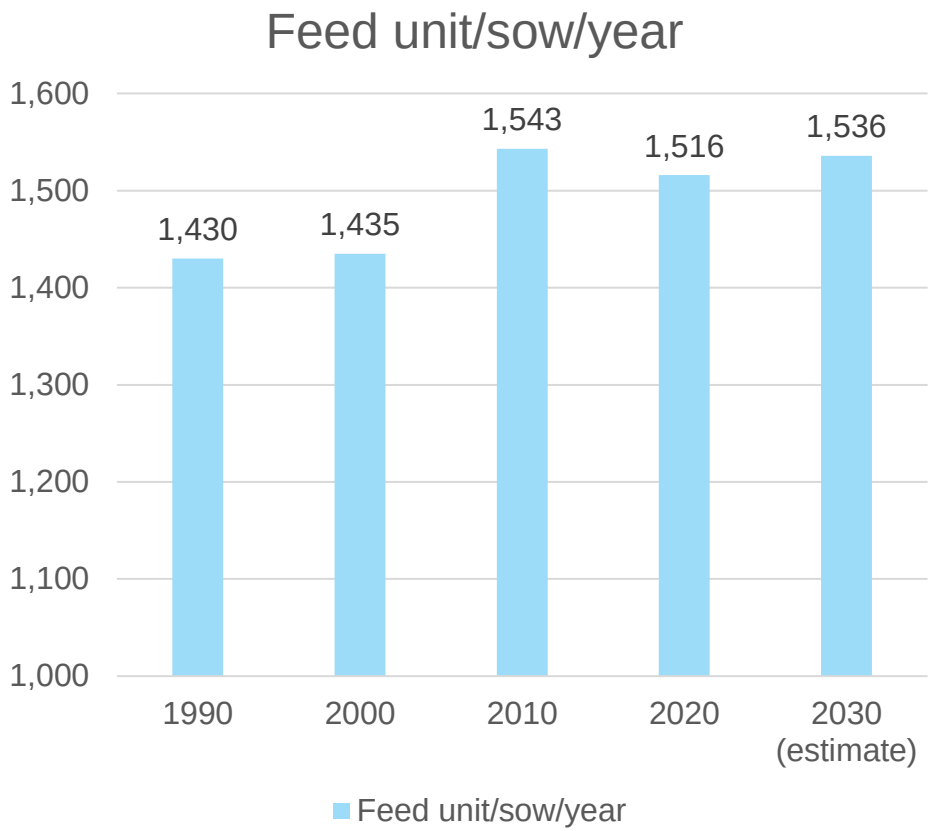
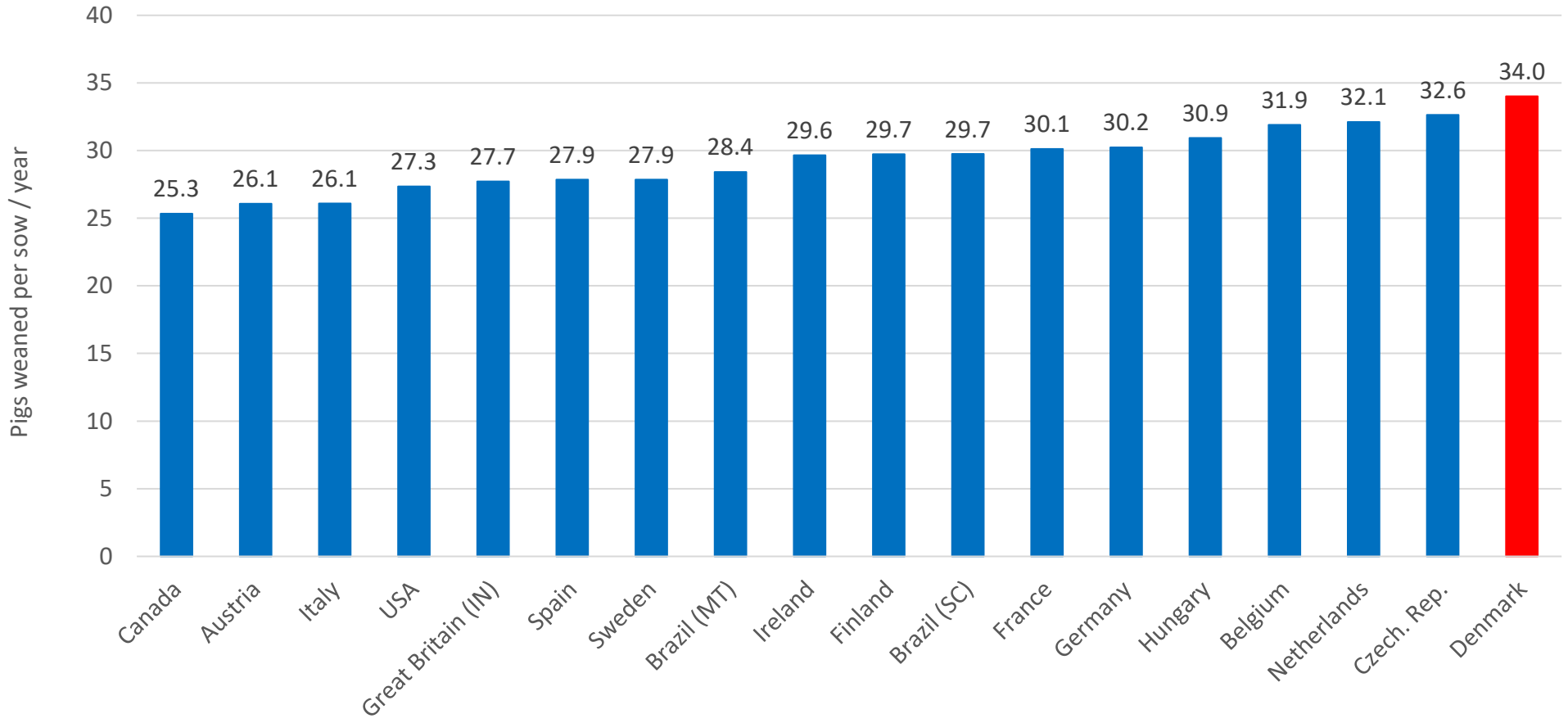
Productivity, sow





Pigs weaned per sow / year
InterPig 2021



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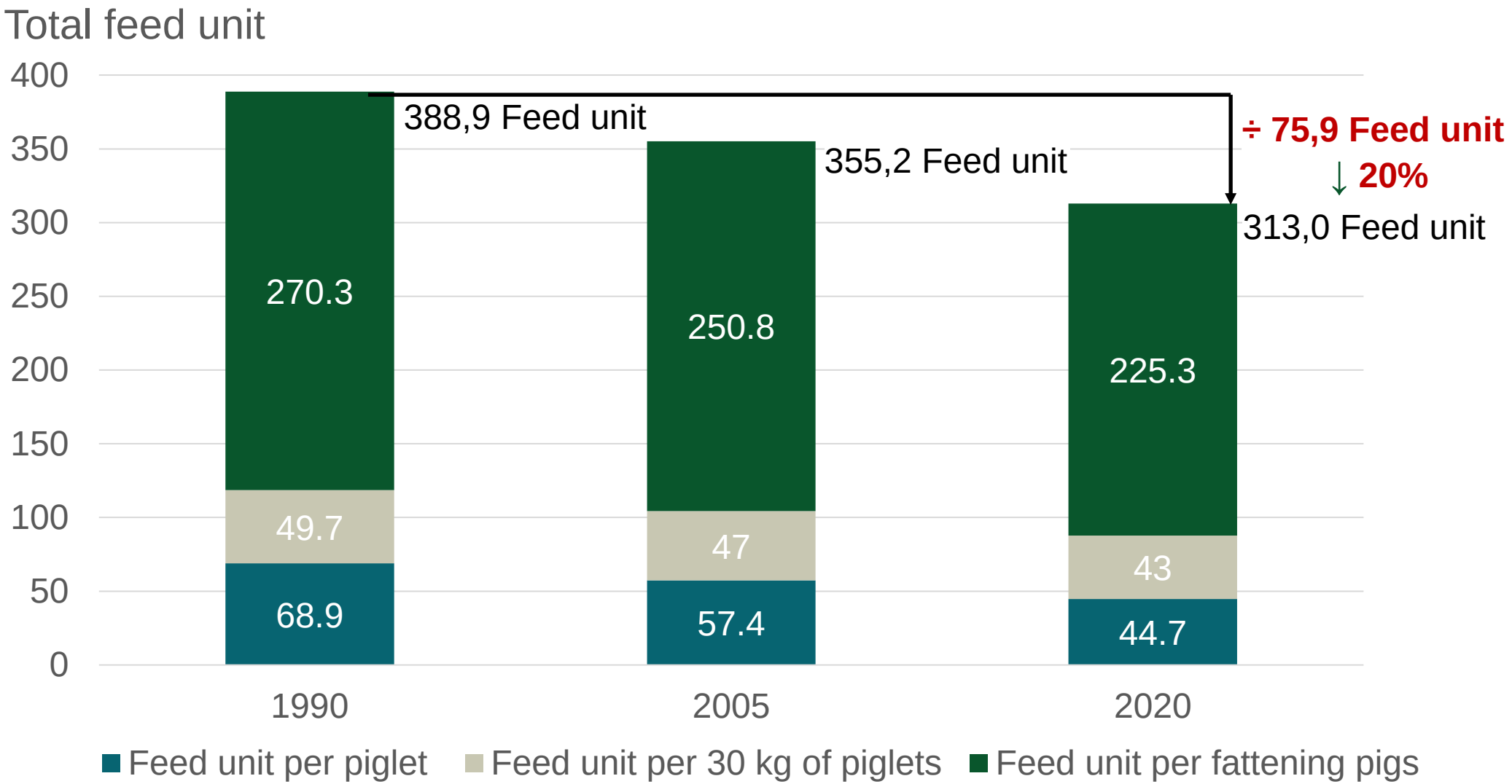
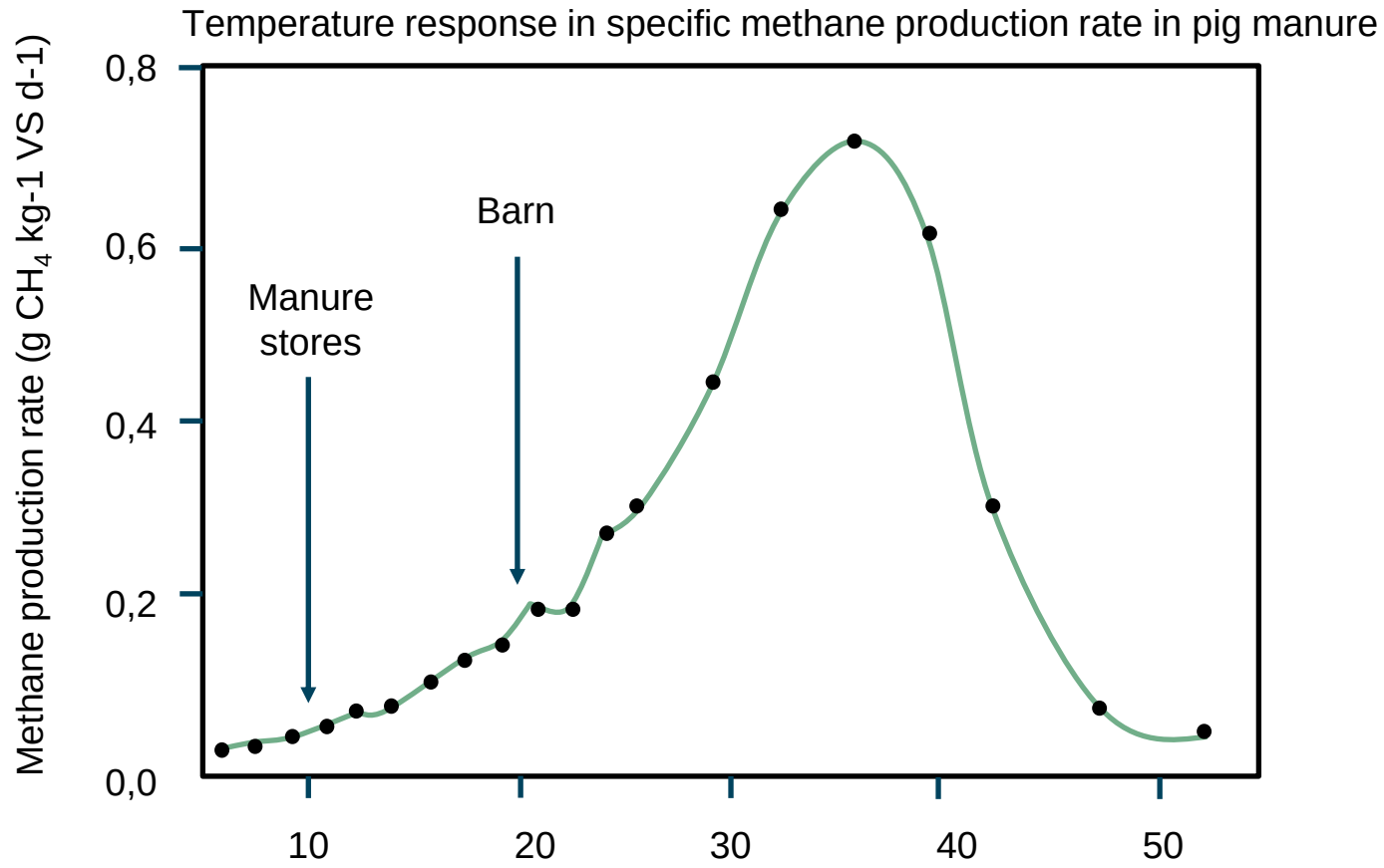
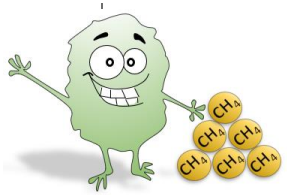
Development in feed consumption to produce a 115 kg pig

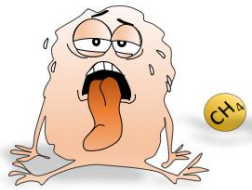


Reference: *Note no. 2129, SEGES Innovation*

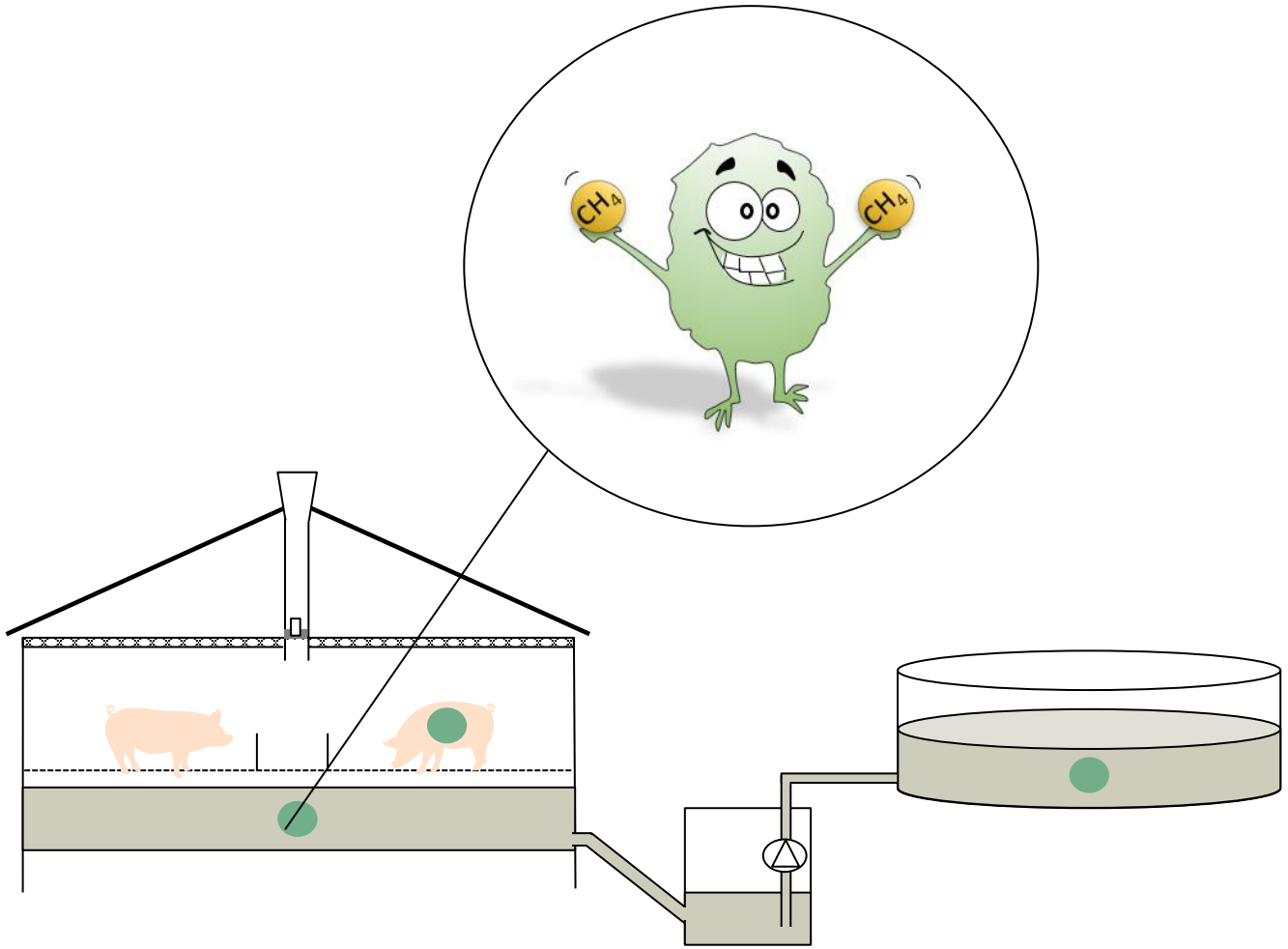
Bacteria in manure convert carbon into methane







Methane production in manure

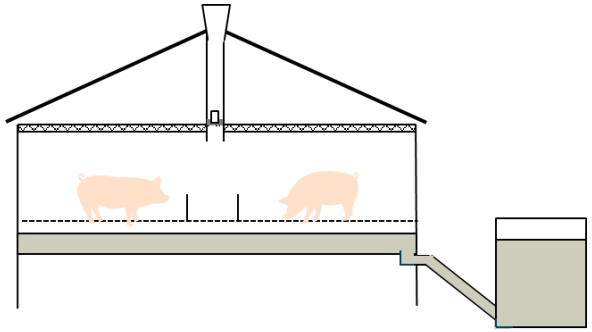


- Methane is formed by bacterial conversion of carbon under anaerobic conditions in manure and the pig's intestine.
- Approx. 80 % of the methane emission from the barn is formed in the manure pits.
- Currently, no technologies exist that can treat and remove methane from barns in the air phase.
- Fresh manure has very low methane formation as a result of few and less active bacteria
- Frequent vacuum flushing of manure can significantly reduce methane emissions

Best practices for manure management

20 % of pig manure is sent to biogas plants in 2020
60 % of pig manure is sent to biogas plants in 2030

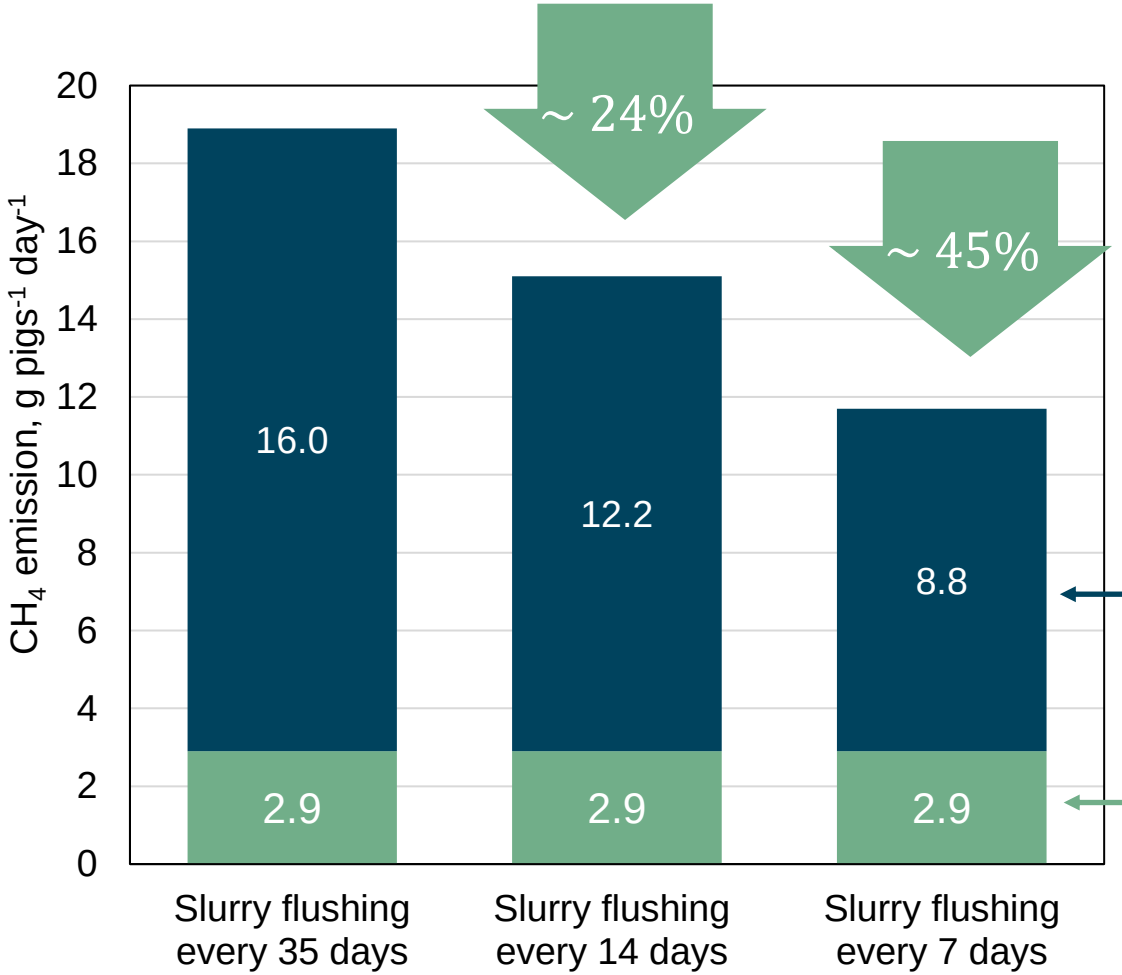
Short residence time of manure in pig house and storage

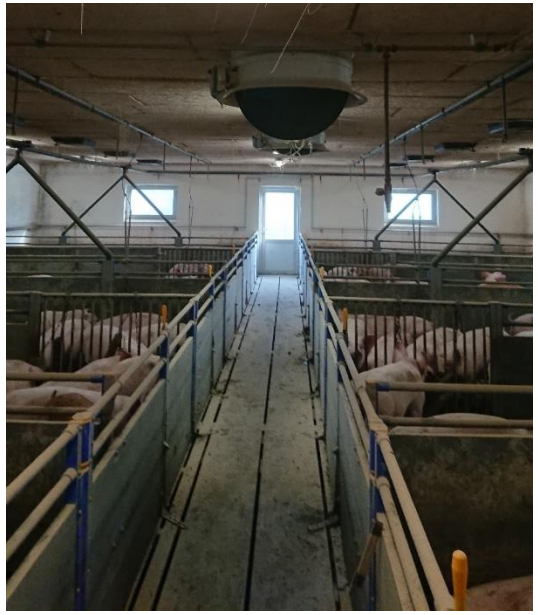


Biogas plant with methane production

Tent covered slurry tanks

Frequent vacuum flushing of manure



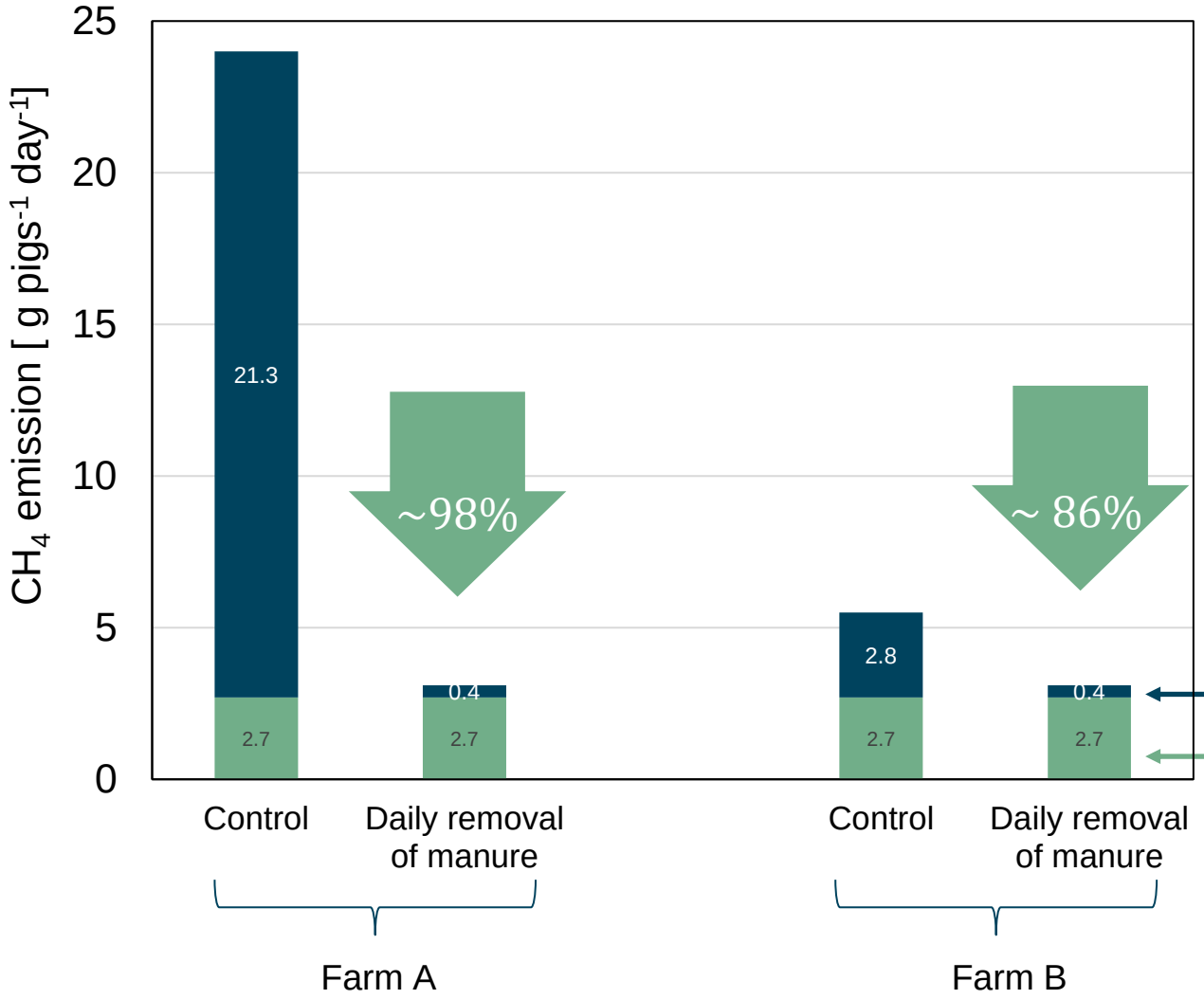


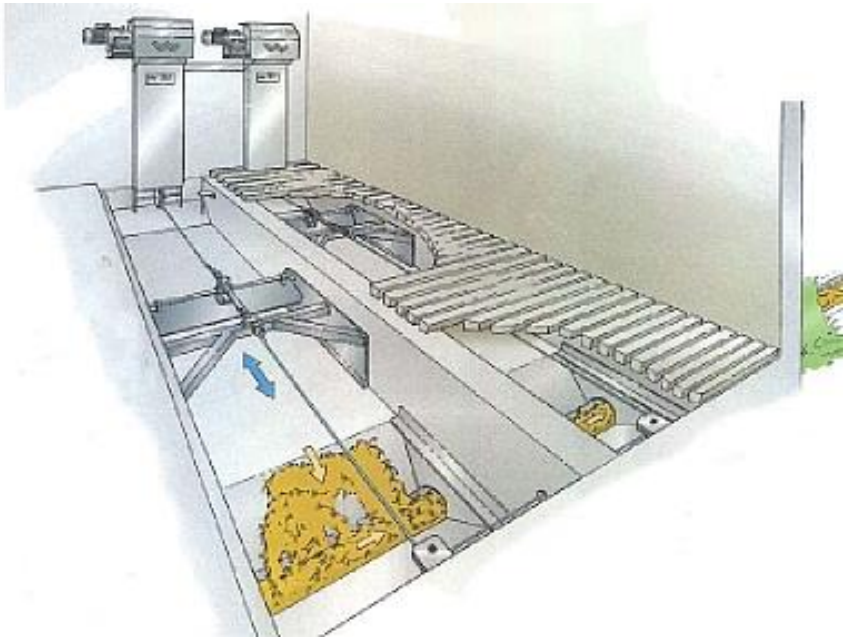
Methane emission from pig manure

Emission from enteric methane

Reference: *Notice no. 1253, SEGES Innovation*

Daily Removal of Manure by Scraper





Methane emission from pig manure

Emission from enteric methane

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Acidification of manure in the barn

Effect:

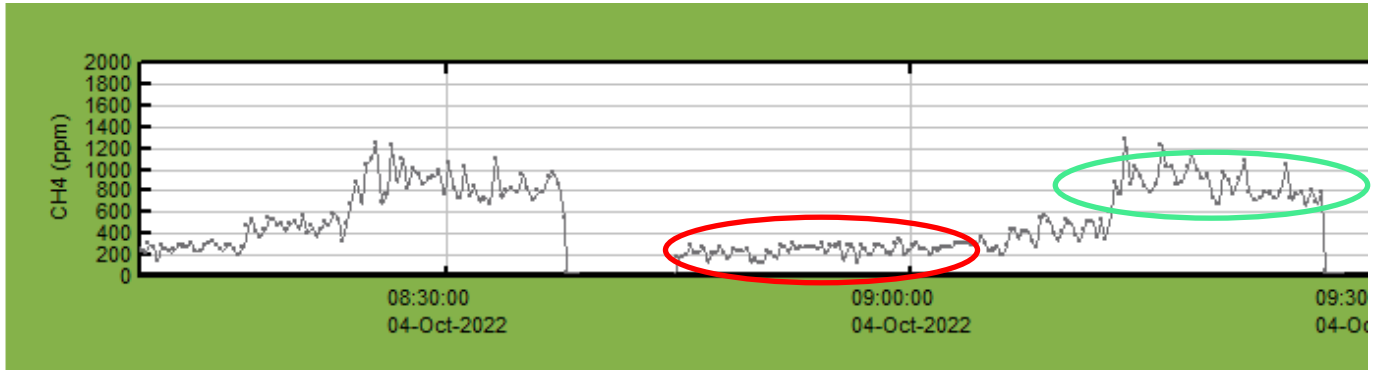
- Reduced methane emission (a share of the slurry's emission)
  - Houses for pigs ↓ 75% (documentation required)

- Reduced ammonia emission
  - Houses for pigs ↓ 64%
  - Effect in barn, manure stores and application of manure
  - Higher fertilizer value

Reduction of methane emissions during manure storage

Testing in process:

- Two identical tent covered slurry tanks of 2,500 m^3
- Added 8 tons of sulfuric acid to one tank in July 2022
- ~ 3.2 kg of sulfuric acid per m^3 tank capacity



Test measurement 4 october 2022:

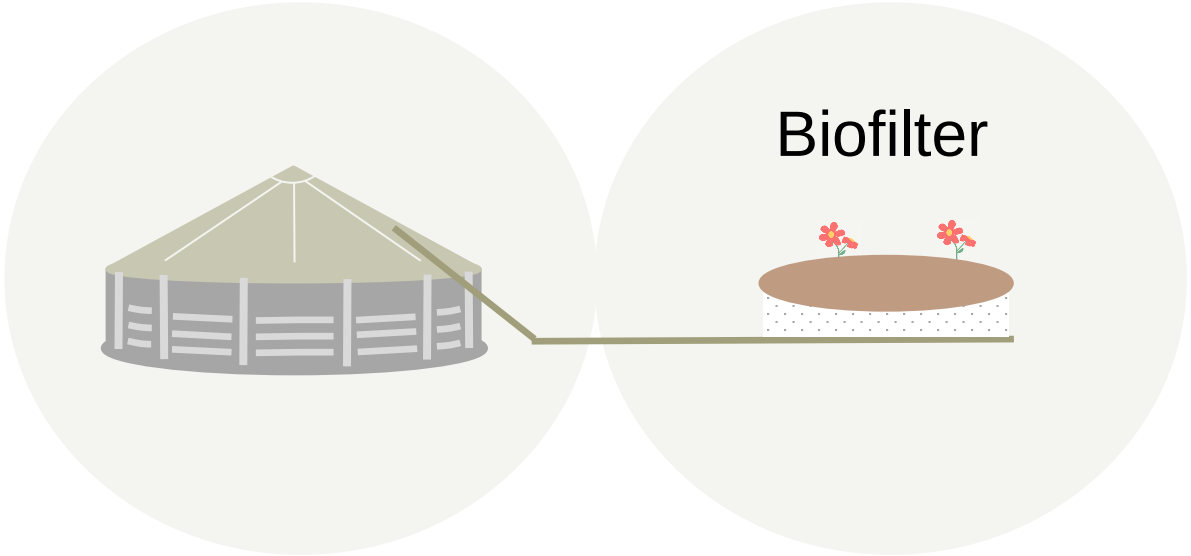
- 1.450 m^3 slurry in the tank, i.e. 5.5 kg of sulfuric acid per m^3 slurry
- Slurry temperature: 15.7 °C
- Current methane reduction ~ 65 %

Reduction of methane emissions during manure storage

Combustion requires high methane concentration:

- Tight tent covering of slurry tank
- Possible support gas during the winter period

Methane is burned to CO_2

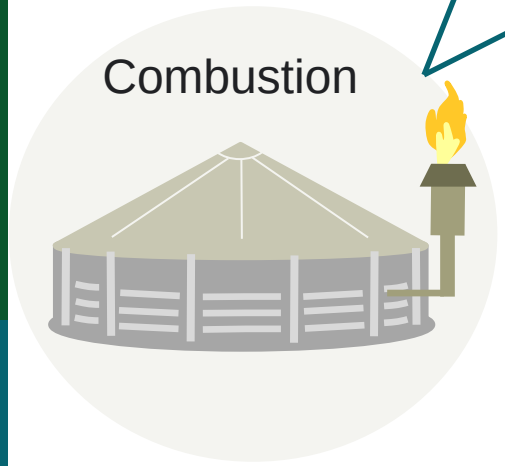


DTU testing biofilter by slurry tanks:

- 1 meter of compost as a biofilter
- Tight tent covering of slurry tank

- Methane-consuming bacteria in the compost oxidize methane to CO_2

Reduction of CH_4 in barn and manure storage

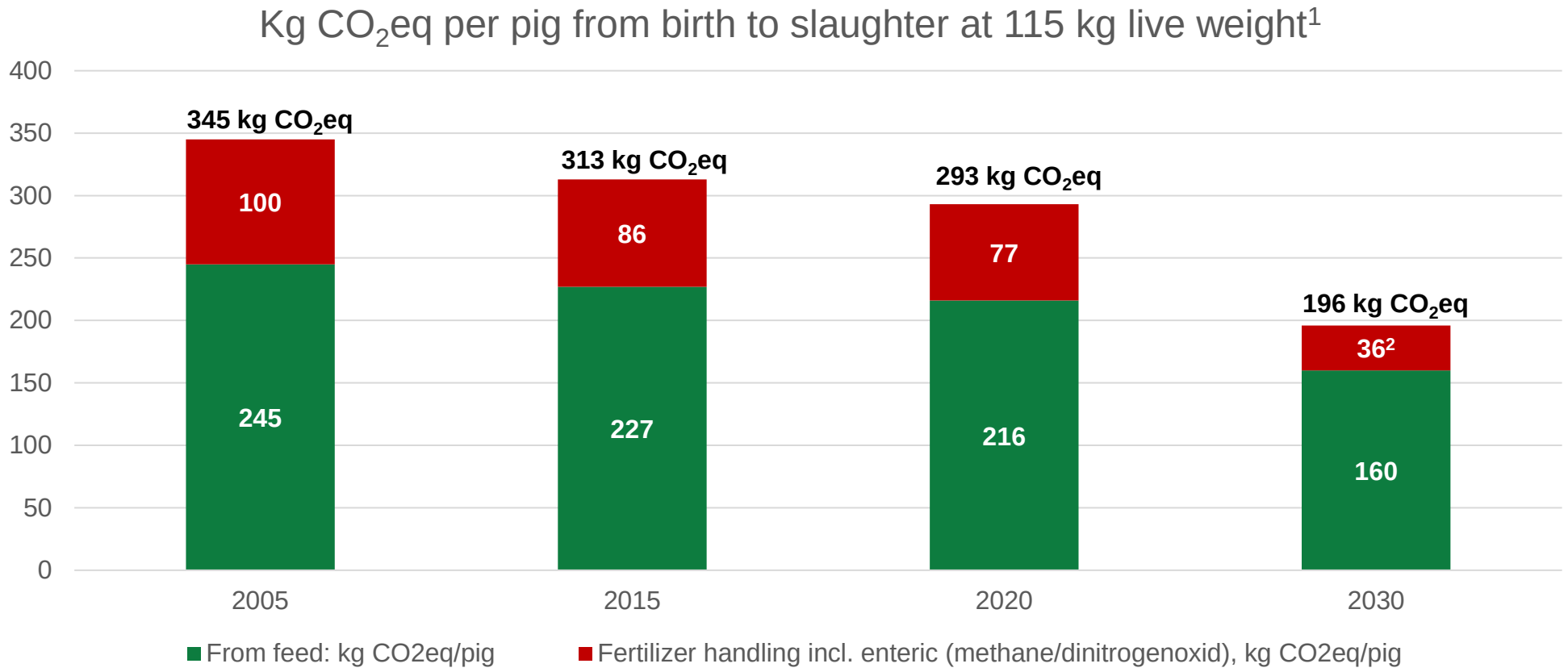


Manure handling in barns and manure stores[1]	Barn + manure stores reduction, %
Slurry flushing every 7 days	16
Slurry flushing every 7 days + Biogasification[2]	75
Slurry flushing every 7 days + Acidification in manure storage[2]	63
Slurry flushing every 7 days + Combustion[2]	59
Acidification af manure in barn and manure stores	70
Daily Removal of Manure by Scraper[3]	28
Daily Removal of Manure + Biogasification[3]	85
Daily Removal of Manure + Acidification in manure storage[3]	75
Daily Removal of Manure + Combustion[3]	71

[1] Reduction effect of climate technologies estimated by Aarhus University
[2] Theoretically calculated estimate
[3] SEGES Innovation calculation based on AU draft catalog, november 2022

References: Aarhus University, draft ”Virkemidler til reduktion af klimagasser i landbruget, 10.10.2022”

Climate footprint distributed in feed share and fertilizer management



[1] In this LCA calculation model, the effect of Land Use Change (LUC) is not taken into account

[2] Of a calculated emission of 36 kg CO_2eq/pig in 2030 from fertilizer, then the 15 kg CO_2eq from digesting the feed

Climate projection to 2030 – assumptions

Expected use of climate techniques in 2030 related to pig production:

- 60% of pig manure is delivered to biogasification in 2030 against 20% in 2020
- Frequent vacuum flushing of manure in all barns for slaughter pigs (legal requirement)
- Frequent vacuum flushing of manure in new barns for sows and piglet
- Daily Removal of Manure by Scraper + manure cooling in 50% of barns for pregnant sows
- Climate-friendly commercial fertilizer produced on green electricity
- Nitrification inhibitors are used in 100% of pig manure
- Climate-friendly energy consumption (climate footprint per kWh is reduced to ⅓ compared to 2020)

Strategic goals

Climate-neutral value chain in 2050:

- The climate footprint per kg of pork is at least reduced 50% in 2030 compared to 2005
- Feed consumption must continue to be reduced
- Develop and test new technology solutions that reduce the loss of methane in manure storage
- Daily Removal of Manure by Scraper / frequent removal of slurry as well as delivery of fresh slurry for biogasification considerably reduces the farm's loss of methane

Danish Quality System

Primary production

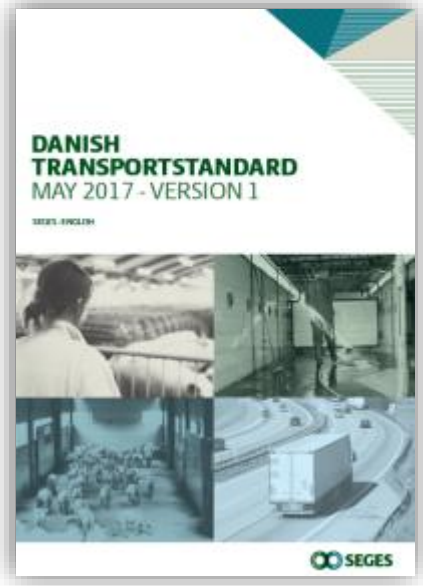
Transport

Slaughtering, cutting, deboning and sales

DANISH Product Standard

DANISH Transport Standard

Global Red Meat Standard



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DANISH Product Standard (DPS)

Scope

- Since 2007
- Approx. 2,800 audits per year

Aim

- Assurance and documentation that all Danish pig farms comply with Danish legislation and industry agreements
- Focus on animal welfare, food safety and traceability

Accreditation

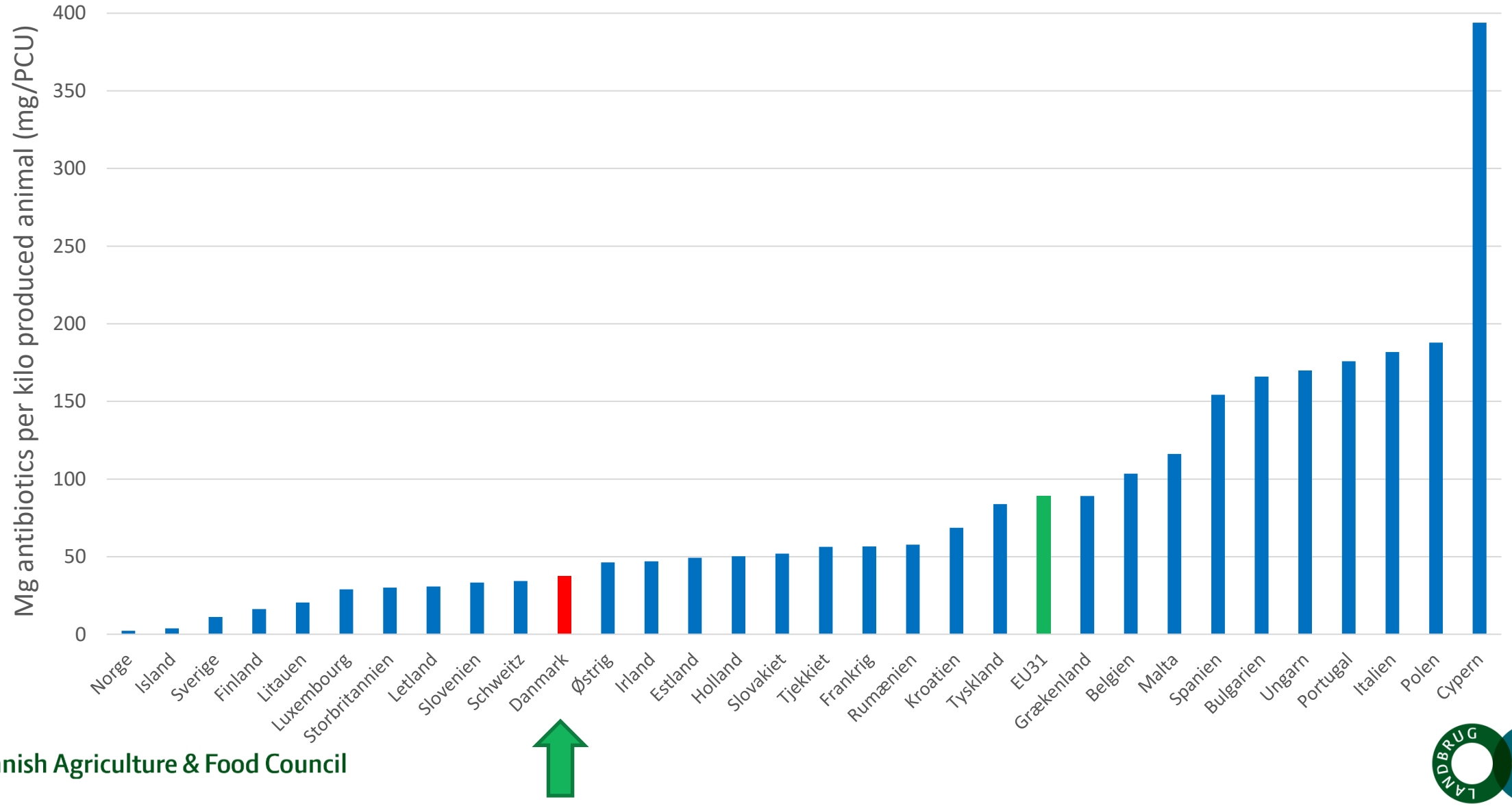
- The scheme is accredited to EN17065
- Audit – at least every three years (UK Contract/niche every year)
- Third party – partly ‘unannounced’
  (20% 'unannounced' with up to 48 hours warning)

Key Areas

Around 160 check points covering:

- Traceability
- Feed
- Health and use of medicine
- Animal welfare
- Housing and equipment
- Management
- Delivery of pigs

Sales of antibiotics for livestock in 31 European countries by 2020



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Danish livestock disease status

World Organisation for Animal Health
Founded as OIE

OIE Listed diseases

The following diseases do not occur in Denmark:

• **Foot and mouth disease**	1983
• Vesicular stomatitis	(never recorded)
• **Swine vesicular disease**	(never recorded)
• Rinderpest	1782
• Peste des petits ruminants	(never recorded)
• Contagious bovine pleuropneumonia	1886
• Lumpy skin disease	(never recorded)
• Rift Valley fever	(never recorded)
• Bluetongue	2008
• Sheep pox and goat pox	1879
• African horse sickness	(never recorded)
• **African swine fever**	(never recorded)
• **Classical swine fever (hog cholera)**	1933

Thank you for your attention !