The Climate Emergency Brake Europe Needs:

How livestock pollution hotspots put the EU's climate and clean-air targets at risk







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1. Executive Summary

Europe is now the world's fastest-warming continent, warming more than twice as fast as the global average.[1] Atmospheric methane concentrations have hit record levels in recent years, and along with ammonia its pollution continues to threaten public health and ecosystems across the region.[2,3] New research from the University of Oxford maps where Europe's livestock methane and ammonia emissions are concentrated. This pollution is edging us closer to devastating climate tipping points, damaging crops and harming the health of people living in Europe. Over 20 years, methane is around 80-times more powerful than Carbon Dioxide (CO_2) - in the short-term, cutting methane emissions is the best emergency brake we have to slow global heating.

According to the IPCC,[4] methane has already caused about a third of the warming from greenhouse gases to date and about 0.5°C of warming since pre-industrial times. This evidence comes at a pivotal moment for the future of EU livestock policy, as the key findings, read alongside EU rules, point towards the need for closing of regulatory gaps. The EU was one of the initiators of the Global Methane Pledge (GMP), which commits 159 countries

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and the European Commission to collectively cut methane emissions by 30% from 2020 levels by 2030. Yet current action is projected to deliver only around an 8% reduction, leaving a substantial gap to the target.[5]

Research by the University of Oxford mapped livestock-related methane emissions at resolutions as fine as 1 km across 32 European countries, using national emissions totals reported to the UNFCCC. Inventories indicate that 9.36 million tonnes of methane was emitted in 2020 from enteric fermentation and manure management. This is virtually the same amount as US livestock methane in the same year,[6] and the equivalent, over 100 years, of 284 million annual transatlantic passenger journeys.[A]

A related story is told through the region's ammonia (NH_3) emissions. Inventories indicate that across the 32 countries, the main crop and livestock sources (manure, grazing, and inorganic fertilizer) emitted 3.5 million tonnes of NH_3 in 2020. For manure managed in storage and housing, this amounted to almost 1.5 million NH_3. Ammonia is a powerful air pollutant and precursor to PM2.5 causing respiratory and cardiovascular disease and contributing to local and regional air pollution. Nonetheless, 94% of the EU's urban population is exposed to levels above WHO guidelines,[7] and exposure to small particulate matter (PM2.5) caused an estimated 182,000 premature deaths in the EU in 2023.[8] The economic losses from air pollution are significant, with some estimates putting it at €600 billion annually, or the equivalent of 4% of GDP. Italy is one of the worst affected, predicted to cost the country 6% of GDP until 2030.[9] Despite this, of the main air pollutants in Europe, ammonia emissions have fallen the least and in some places have even increased.[10]

Livestock pollution is concentrated in a small number of places.

Almost 60% (57.3%) of the livestock methane mapped across Europe comes from just five countries: France, Germany, the United Kingdom, Spain and Italy. This figure captures direct livestock methane emissions. The livestock sector also contributes GHG emissions beyond methane, including through the production of animal feed, which are not addressed here. Almost all cattle manure methane comes from manure managed in housing and storage systems: dairy cattle spend about a fifth of their time grazing (20.4%), yet manure dropped at pasture produces only 1.6% of their manure methane; for non-dairy cattle the figures are 40.2% and 5.4%. The top 10% of EU regions (24 of 240) emit around two-fifths of the bloc's livestock methane emissions.

The European livestock industry and the EU Commission itself promote the sector as one of the most "efficient" globally,[1112] meaning its emissions per litre of milk are lower than in other places, for example. However, the absolute total emissions from the sector remain stubbornly high. The European Scientific Advisory Board on Climate Change (ESABCC) highlights that a systemic transition in the food system is needed to stay on track with climate neutrality by 2050. This includes shifts in production and consumption that could lead to 50% reductions in non-CO_2 GHG emissions from agriculture by 2050, compared to 2005 levels.[13]

A This includes the non-CO2 radiative forcing.

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Table 1: Europe's Methane and Ammonia agricultural pollution - the top ten[B]

Shares of the 32-country totals (EU27, UK, Iceland, Liechtenstein, Norway and Switzerland) for 2020.

	Country	Percentage (%) of Europe's crop and livestock ammonia emissions		Country	Percentage (%) of Europe's livestock methane emissions
	France	16.6		France	17.6
	Spain	13.0		Germany	12.7
	Germany	12.6[C]		United Kingdom	10.5
	Italy	9.4		Spain	9.6
	Poland	9.0		Italy	6.9
	United Kingdom	5.8		Poland	6.1
	Romania	4.3		Ireland	5.8
	Ireland	3.5		Netherlands	5.0
	Netherlands	3.0		Romania	3.4
	Hungary	2.4		Denmark	2.9
	Total	**79.5%**		**Total**	**80.5%**

France, Germany, Spain and Italy also appear in the top five culprits for ammonia emissions and together with Poland are responsible for more than 60% of ammonia emissions across the region.

B Methane: livestock enteric fermentation and manure management. Ammonia: crop- and livestock-related sources (manure management, manure applied to soils, grazing, and inorganic fertiliser). Each of the remaining 22 countries accounts for 2.2% or less. Figures may not sum because of rounding. Source: National emission inventories reported to the UNFCCC (CH_4) and EMEP/CEIP (NH_3).

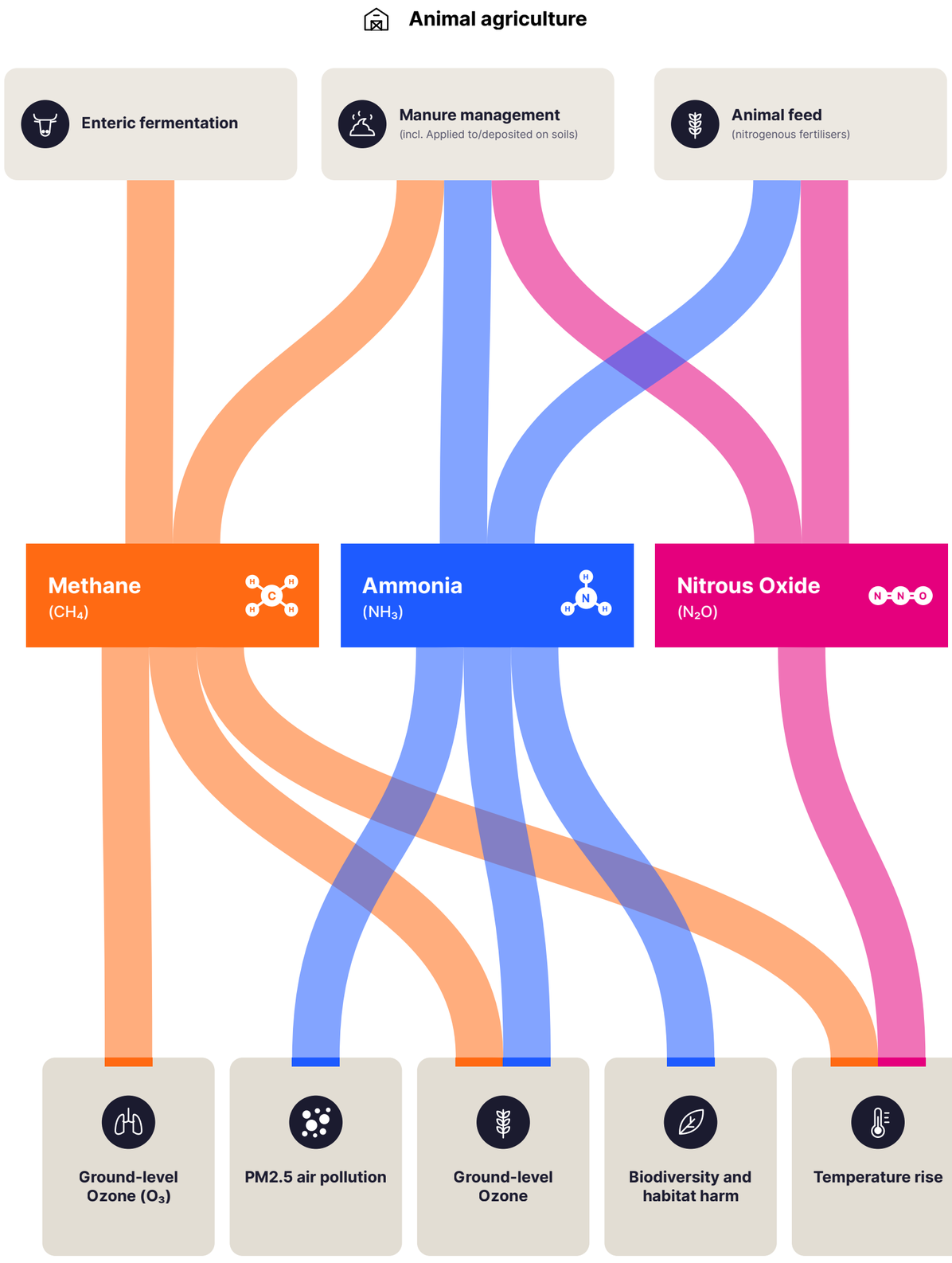
C The table covers the four agricultural sources mapped by the University of Oxford (manure management, manure applied to soils, grazing, and inorganic fertiliser). Counting all agricultural sources, or all sectors, Germany is the EU's second-largest emitter of ammonia, after France (Eurostat, env_air_emis, 2020): https://ec.europa.eu/eurostat/databrowser/view/env_air_emis/default/tableEVIDENCE

The same places produce both gases, tackling them one at a time is a missed opportunity

Pollutants from agriculture are intrinsically linked together, and of the top ten methane offenders across Europe, nine appear in the top ten ammonia polluters. Both gases must be tackled together to limit emissions and reduce the human and economic impact of pollution. The data reveals a highly unevenly distributed problem and is increasingly difficult to ignore.

Tackling powerful super-heating gases like methane and air pollutants like ammonia separately leaves significant gaps in the EU's policymaking. Recent analysis from the Climate and Clean Air Coalition (CCAC) showed that addressing air and climate together reaps significant economic rewards, $15 for every $1 invested. Moreover, for Europe and the UK, dietary shifts would bring the greatest economic reward whilst reducing emissions and air pollution.[14]

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The biggest source sits outside the rules

Agriculture is responsible for a staggering 56% of the EU's methane emissions, primarily from enteric fermentation, and 93% of the region's ammonia emissions,[15,16] with much of it produced from animal manure released during housing, storage and spreading. Global methane emissions, from both natural and human sources, are estimated to be responsible for 37% of background ozone levels in Europe, a harmful air pollutant, linked to global methane.[17] Despite these clear statistics, an agricultural methane blind spot remains in EU policymaking, and existing ammonia regulations are failing to bring pollution down fast enough.

Regulation - what's missing?

An absolute emission reduction target for agricultural non-CO_2 emissions, including methane, remains absent from EU regulation. Although methane is included in the Effort Sharing Regulation (ESR), this only counts towards each Member State's overall target under the ESR and does not specify any action for agriculture. Moreover, dietary shift alongside herd size reduction is recognised as the most effective lever to reduce emissions from this sector,[18][19] but is not included in any EU commitments or strategies. As the EU's largest source of methane emissions, this leaves the bloc out of step with the Global Methane Pledge. Ammonia is already subject to binding EU controls under the National Emission reduction Commitments Directive (NECD),[20] but even when regulated, pollution from the agriculture sector remains exceptional and progress remains too slow. According to the EU Clean Air Outlook, under baseline assumptions, 21 of 27 Member States are projected to miss their ammonia (NH_3) targets in both 2030 and 2050,[21] with the current Industrial

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and Livestock Rearing Emissions Directive (IED) and existing policies insufficient to deliver the required reductions. The need for structural changes in agricultural systems and behavioural changes, such as dietary shift is clear.[22]

The European Environment Agency (EEA) identifies ammonia as the NECD's most persistent challenge, with Member States needing further cuts to meet tougher 2030 targets.[23] Intensive livestock farming and manure and slurry management are not only climate issues, but central to whether Member States deliver on existing clean air obligations. More than half of Member States still need to cut ammonia and PM2.5 emissions to meet their 2030 reduction commitments.[24]

For methane, most emissions come from animal agriculture, primarily ruminants through enteric fermentation, but regulation in the region to minimise these emission sources is lacking. Agricultural non-CO_2 GHG emissions have fallen by a mere 7% in the EU since 2005, and even where all existing policies are implemented, this is only projected to reach 15-22% reductions by 2050, far from the 50% recommendation from the European Scientific Advisory Board on Climate Change (ESABCC).[25] The EU's Methane Action Plan notes how agricultural methane emissions have 'remained essentially stable' between 2010 and 2020, despite reductions in the emissions intensity of livestock production.[26] The NECD and the IED remain clear opportunities to invest in emission reductions from the sector, yet methane remains excluded from the NECD and cattle remain exempt from the IED.

Big Meat and Dairy Lobbying Derailed Regulation

Originally proposed to tackle pollution from industrial livestock production, including cattle, the Commission's proposal for IED revision was set to apply to cattle, pigs, and poultry farms with 150 livestock units and above. Significant industry lobbying led to the weakening of the IED for agriculture, increasing the number of animals a farm had to have to be regulated, and excluding cattle completely from the Directive. Lobby groups such as Copa-Cogeca focused on the risks to 'family farms' (despite the Directive focusing only on the largest and most industrial farms) and some MEPs engaged in the decision-making had conflicts of interest, earning income from livestock farming themselves.[27] The IED currently covers intensive pig and poultry farms but excludes cattle, despite cattle accounting for around 50% of EU methane emissions and 25% of ammonia emissions.[28] With the Commission due to assess further action on cattle by the end of 2026, there is a clear opportunity to bring these emissions under stronger, joined-up controls. Industry groups continue to be vocal in their support for weakening the IED further,[29] despite the evidence that livestock directly accounts for half of EU's agricultural greenhouse gas emissions, most of it methane from enteric fermentation in ruminants.[30]

The NECD showcases a similar story of agricultural exceptionalism in EU policymaking. Methane was originally proposed as part of the NECD, which came into law in 2016 and now covers five major air pollutants - nitrogen oxides, non-methane volatile organic compounds, fine particulate matter, sulphur dioxide and ammonia. Methane should have been the sixth pollutant included in the NECD as a precursor to ground-level ozone, a damaging air pollutant impacting human health and crop yields. Lobby groups successfully pushed for methane's exclusion from the NECD using fearmongering arguments about 'emissions leakage', suggesting that by regulating methane in the EU, those emissions would be imported from elsewhere instead. The threat of 'double regulation' was also a tactic used by lobby groups in response to agricultural methane's proposed inclusion in the NECD, the IED and the Effort Sharing Regulation. The tactic successfully ensured agricultural methane remained absent from all three policies.[31] MEPs tabling amendments that favoured the agricultural industry in the Directive also showed conflicts of inter-

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est, declaring income from livestock production activities.[32] The European Dairy Association, a powerful industry lobby group, celebrated the exclusion of methane from the NECD and committed to ensure it does not get included in the future.[33]

"'Methane targets thankfully were ejected out of the deal', adding that 'we may need to make sure they do not come in again'." [34]

European Dairy Association (2019)

Methane's role as a contributor to air pollution has also been acknowledged in the recent review of the NECD,[35] but methane has yet to be included in the Directive despite its important impact on air quality, human health and crop yields.

"Therefore, there is still an urgent need to address methane, given its role both as a potent GHG and as an ozone precursor." [36]

European Commission (2025)

The EU Strategy on Livestock

Published in July 2026, the EU Strategy on Livestock recognises livestock emissions, but fails to adequately outline how these will be reduced. The Strategy does not set a specific emissions reduction target and focuses primarily on technical measures favourable to more industrial systems of livestock production. Although dietary shift and moving away from unsustainable livestock models have been identified as central pillars to emission reductions as well as co-benefits for human health for EU populations, the Strategy fails to acknowledge this. Conversely, the Commission's focus has been to highlight how reductions in livestock in the most polluting countries is something of concern, rather than necessary to achieve climate targets. In countries which appear in the top five polluters across the region for methane and ammonia, like France and Germany, these pollution hotspots must be supported to reduce emissions, not to maintain or increase them. This comes with a concerning focus on the 'biogenic nature' of methane and its role in a 'short-term carbon cycle',[37] a common industry narrative used to cast doubt on methane's impact on global heating. Once emitted, a tonne of methane from livestock traps as much heat as a tonne of fossil methane; the only difference is that fossil methane leaves an extra CO_2 behind when it breaks down, and the difference in warming factors is 27 vs 29.8.[38] The atmosphere is not interested in where the methane came from, its impact on heating is the same. 42 global climate scientists, including 11 IPCC authors have expressed significant concern about the possible misuse of methane accounting methodologies that minimise the impact of agricultural methane on global heating.[39] More broadly, the livestock strategy fails to address the wider food system in the EU, relying heavily on technical measures alone.

METHANE & AMMONIA · EUROPE · TOP 5

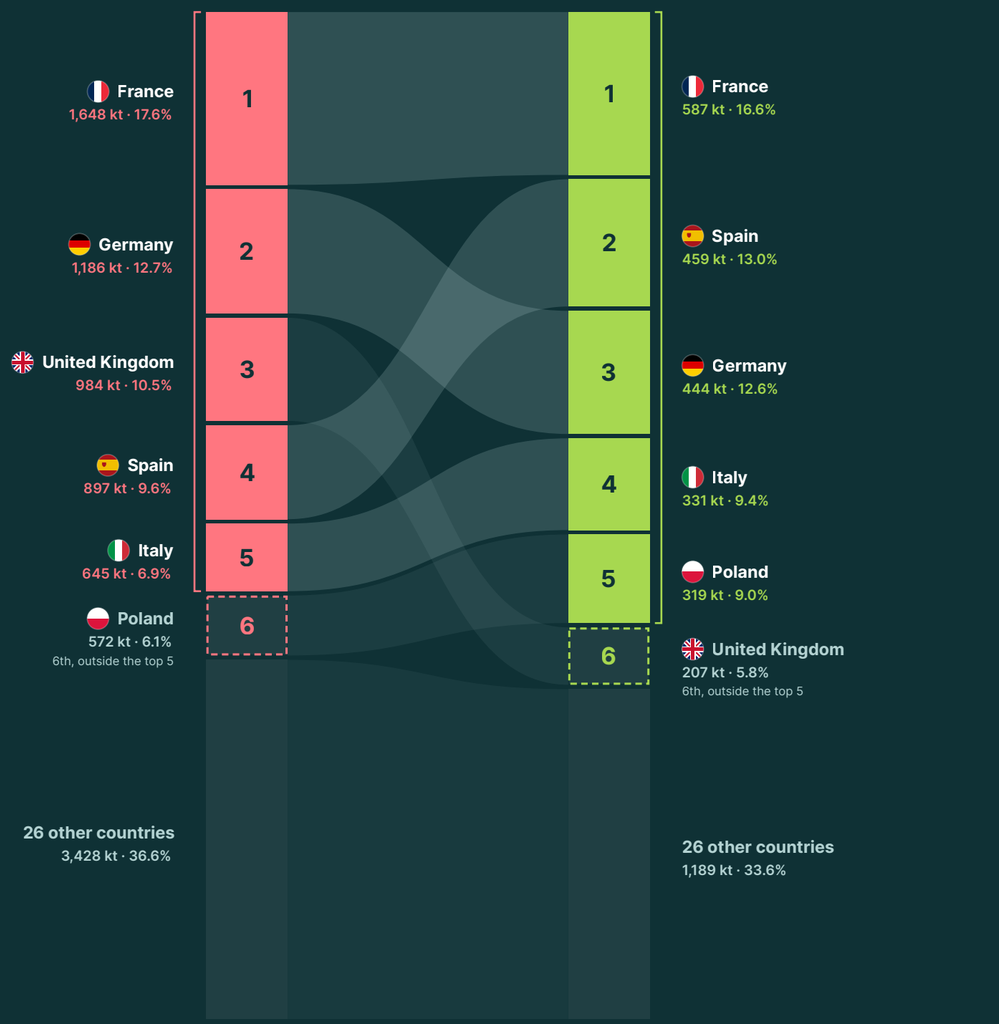
From crops and livestock

Five countries emit more than half of Europe's methane and ammonia from livestock and crops (2020)

France, Germany, Spain and Italy are in the top five for both gases. The United Kingdom ranks third for methane but sixth for ammonia; Poland swaps in, fifth for ammonia and sixth for methane.

57% of livestock methane comes from just 5 countries — METHANE (CH_4)

AMMONIA (NH_3) — **61%** of crop and livestock ammonia comes from just 5 countries



Share of total emissions across 32 countries: EU-27, Iceland, Liechtenstein, Norway, Switzerland and the UK. Totals: methane 9,360 kt, ammonia 3,536 kt.
Source: University of Oxford, AMPHORA project, preliminary data.

2. What the data tells us

New high-resolution mapping by the University of Oxford reveals the uneven distribution of emissions across 32 European countries and how different livestock types and manure management systems create different hotspot variations.

About the Data

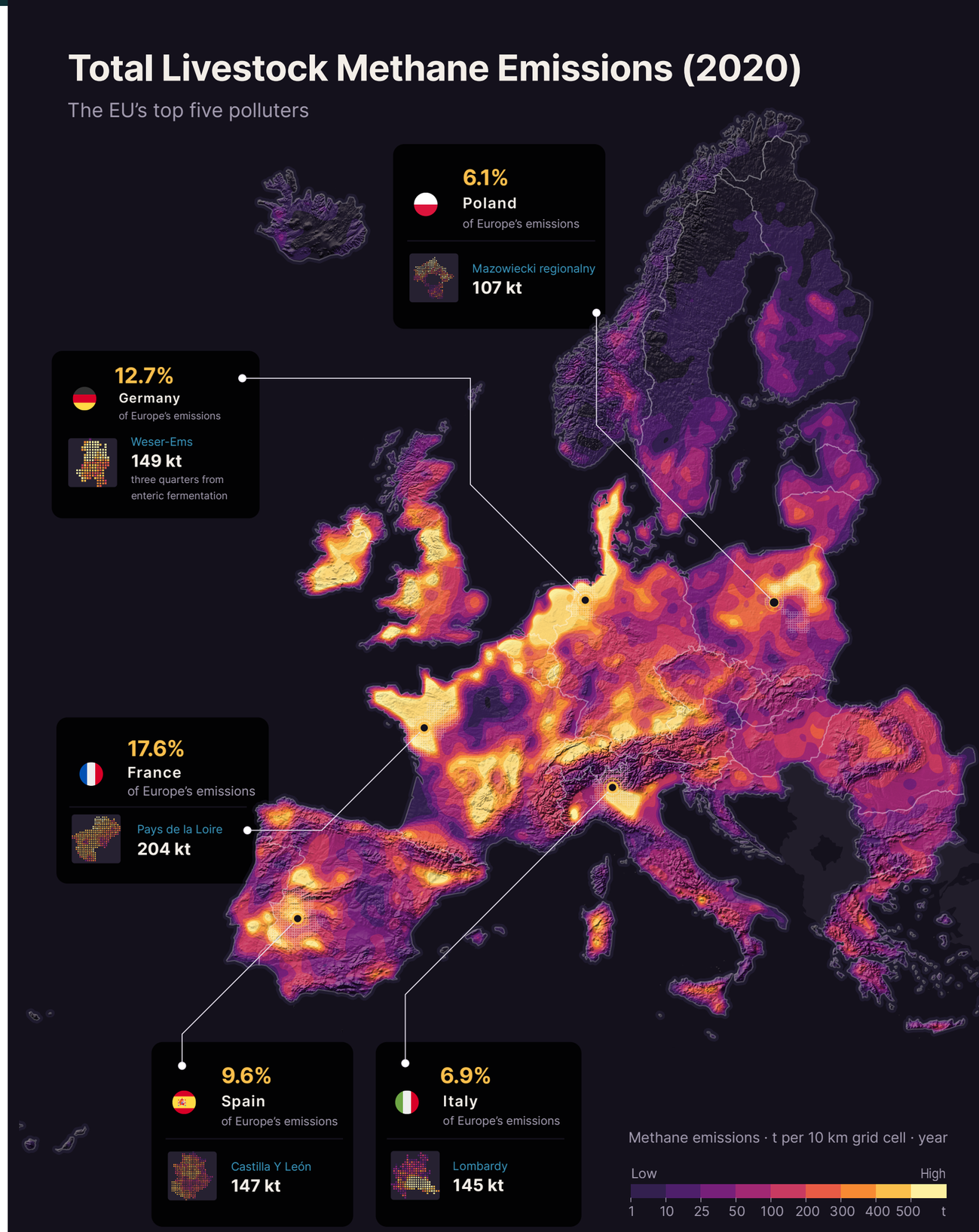
The national totals are countries' reported inventories (UNFCCC for methane, EMEP/CEIP for ammonia); what the University of Oxford adds is where those emissions occur, at 10 km and 1 km; the results are preliminary and not yet peer reviewed. AMPHORA is funded by The Wellcome Trust and run by the University of Oxford with the Changing Markets Foundation.

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Methodology

Methane (CH_4) emissions from enteric fermentation and manure management of dairy and non-dairy cattle, sheep, goats, swine (pigs) and from poultry manure management have been mapped to a resolution of at least 10km or a finer 1km resolution for cattle, sheep and goats in the EU27 and UK. The most recent, comprehensive datasets available have been used for livestock maps from 2020 (cattle, sheep, and goats in the EU27 and UK) or 2015 (swine (pigs) and poultry everywhere, and all livestock in Iceland, Liechtenstein, Norway and Switzerland), calibrated to national livestock numbers and CH_4 emissions for 2020.

A spatially explicit dataset of agricultural ammonia (NH_3) emissions was developed for 32 European countries for 2020. The dataset covers NH_3 emissions associated with both livestock and crop production, corresponding to the EMEP/EEA source categories 3B (manure management), 3Da1 (inorganic N fertilisers), 3Da2a (animal manure applied to soils), and 3Da3 (urine and dung deposited by grazing animals). The dataset has a spatial resolution of both 1 km and 10 km for source categories 3B, 3Da1, and 3Da3, while emissions from 3Da2a were developed at 10 km resolution only. The most recent comprehensive datasets, also for 2020, have been used.



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Methane

The research maps livestock-related methane emissions across 32 countries, at 1 km and 10km resolution with 2020 - the most recent year with comprehensive data - as the baseline year.[D]

The maps show that livestock methane is concentrated in a limited number of hotspots.

80% of Europe's livestock methane emissions come from just 10 countries: France, Germany, UK, Spain, Italy, Poland, Ireland, Netherlands, Romania and Denmark. The remaining 22 countries are each responsible for less than 2% of livestock methane emissions each, except Belgium (2.2%).

Within these countries, some regions account for a large share of national methane emissions. Major methane hotspots were identified in regions such as Pays de la Loire in France, Weser-Ems in Germany, Castilla y León in Spain and the Po Valley in Italy

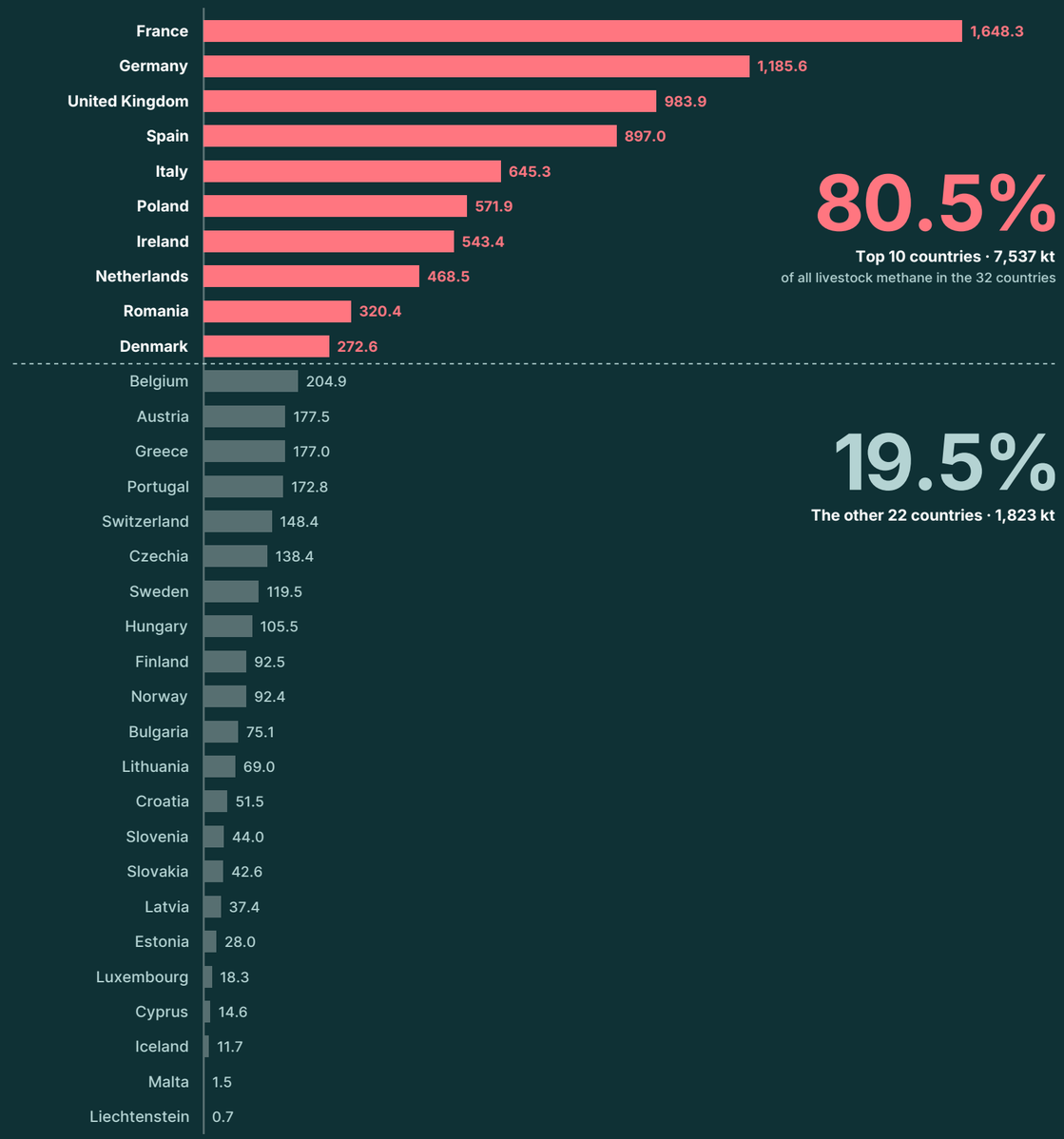
The methane data covers six livestock categories: dairy cattle, non-dairy cattle, sheep, goats, and swine (pigs), across both enteric fermentation and manure management and poultry for manure management only. Cattle, both dairy and non-dairy, account for almost 80% of Europe's livestock methane emissions, with swine accounting for 10.1%, mostly through manure management, and sheep for 8.6% mostly through enteric fermentation.

D 2020 was used because it is the most recent year for which 1-km cattle, goat and sheep datasets covering the UK and EU27 are available. More recent or high-resolution data are available for some countries, but not consistently across Europe.

LIVESTOCK METHANE · EUROPE

80% of Europe's Livestock methane comes from just 10 countries (2020)

Livestock CH_4 emissions by country, 2020 (kt)
EU-27 plus Iceland, Liechtenstein, Norway, Switzerland and the United Kingdom.



80.5%
Top 10 countries · 7,537 kt
of all livestock methane in the 32 countries

19.5%
The other 22 countries · 1,823 kt

Total for the 32 countries: 9,360.2 kt. Top 10: 7,536.9 kt (80.5%). Other 22: 1,823.3 kt (19.5%).
Source: National emission inventories reported to the UNFCCC (CH_4) and EMEP/CEIP (NH_3)

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Enteric methane (produced in ruminant digestion and expelled through burps) is spread relatively widely across cattle-producing regions, whereas methane from manure management (produced as manure decomposes in low-oxygen conditions, particularly when stored as liquid manure or slurry) is much more concentrated in particular areas and production systems.[40]

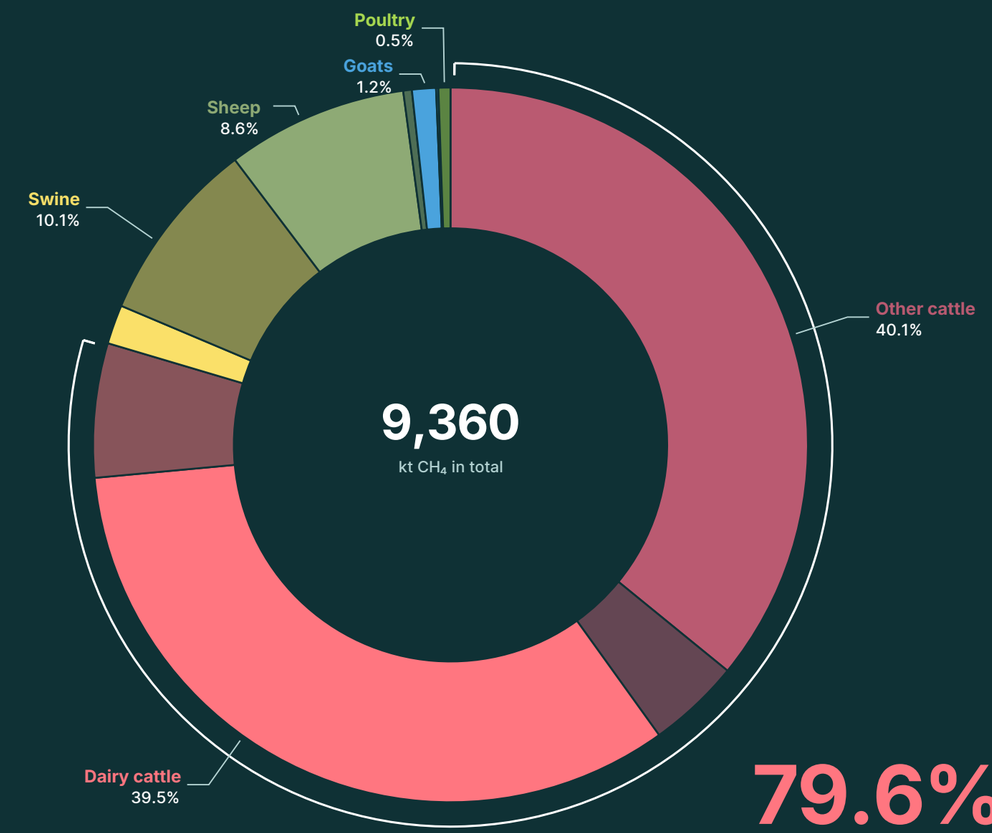
For example, dairy cattle spend about a fifth of their time grazing, yet manure dropped at pasture produces only 1.6% of their manure methane; for non-dairy cattle the figures are 40.2% and 5.4%. Almost all cattle manure methane comes from manure managed in housing and storage systems. The top 10% of EU regions (24 of 240) emit around two-fifths of the bloc's livestock methane emissions.

While countries such as Ireland often promote systems with low 'emissions intensity', these maps showcase why this should not be confused with total emissions produced. Low emissions per litre of milk do not mean low total emissions. According to 2022 data, Ireland has the highest per capita methane emissions (CO_2e) in the EU-27,[41] and according to Oxford's modelling has two of the largest regional hotspots of methane sources. Local hotspots can be significant in areas where systems are promoted as 'efficient'.

AGRICULTURAL METHANE · LIVESTOCK

Cattle are responsible for nearly 80% of Europe's Livestock methane

Share of total livestock emissions by type and source, CH_4 kiltonnes (kt)
EU-27 plus Iceland, Liechtenstein, Norway, Switzerland and the United Kingdom.



79.6%
Cattle · 7,450 kt
dairy and other cattle combined

Livestock	Enteric fermentation	Manure management	Total CH4 (kt)	Share
Other cattle	3,359.2	392.7	**3,751.8**	40.1%
Dairy cattle	3,130.6	567.7	**3,698.2**	39.5%
Swine	165.7	780.2	**945.8**	10.1%
Sheep	766.4	36.4	**802.8**	8.6%
Goats	101.3	9.6	**110.8**	1.2%
Poultry	–	50.7	**50.7**	0.5%

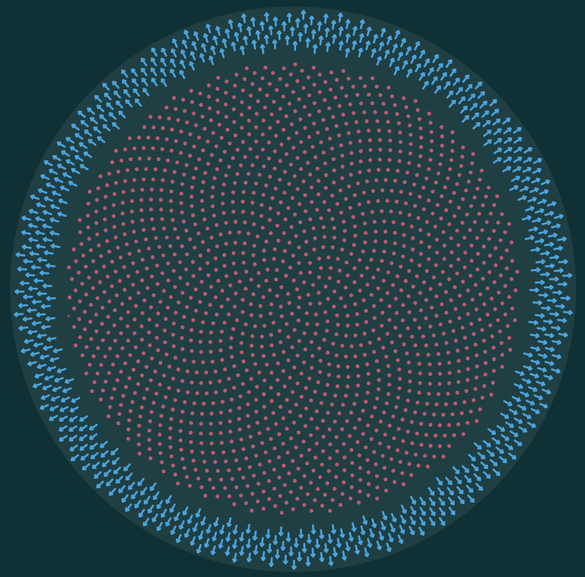
Solid = enteric fermentation Darker shade = manure management

Total: 9,360.2 kt. Enteric fermentation 7,523.0 kt (80.4%) · manure management 1,837.2 kt (19.6%). Poultry: manure management only.
Source: National emission inventories reported to the UNFCCC (CH_4) and EMEP/CEIP (NH_3).

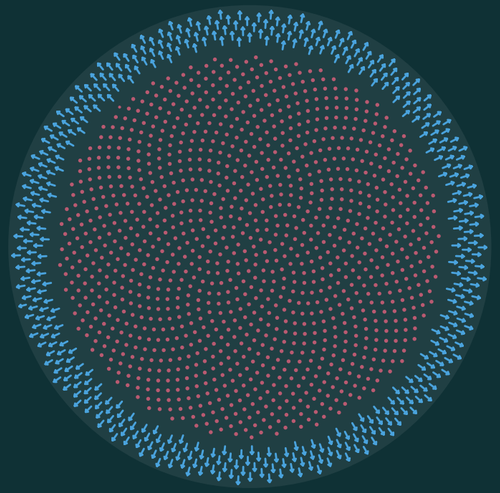
METHANE & AMMONIA · EUROPE

Emissions by country

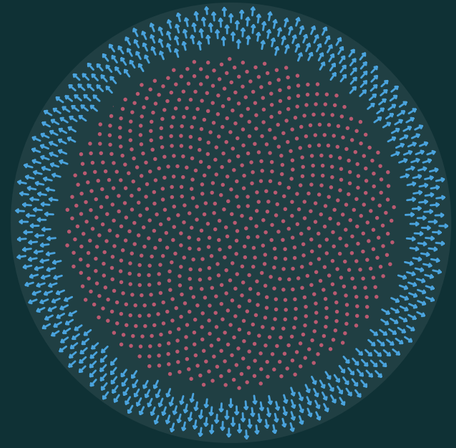
Europe's methane and ammonia: who emits what



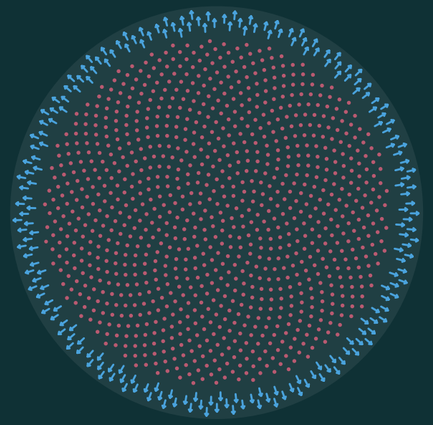
France
CH_4 17.6% NH_3 16.6%



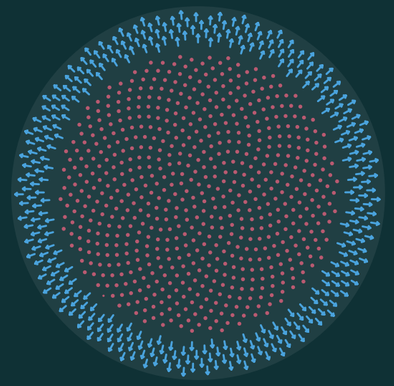
Germany
CH_4 12.7% NH_3 12.6%



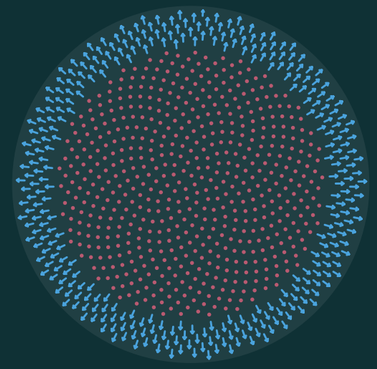
Spain
CH_4 9.6% NH_3 13.0%



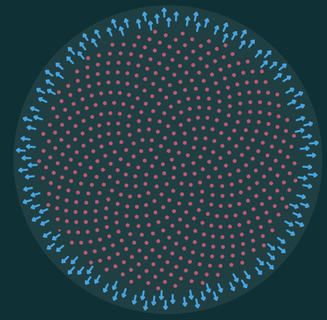
United Kingdom
CH_4 10.5% NH_3 5.8%



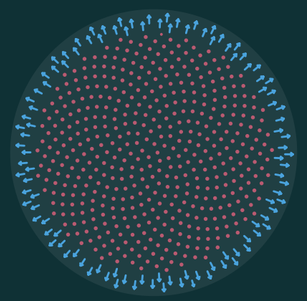
Italy
CH_4 6.9% NH_3 9.4%



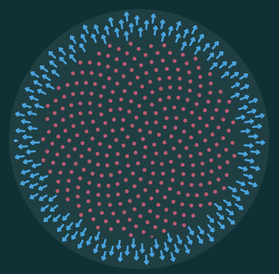
Poland
CH_4 6.1% NH_3 9.0%



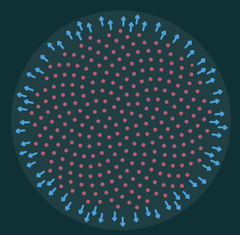
Ireland
CH_4 5.8% NH_3 3.5%



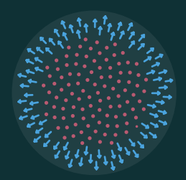
Netherlands
CH_4 5.0% NH_3 3.0%



Romania
CH_4 3.4% NH_3 4.3%



Denmark
CH_4 2.9% NH_3 1.8%



Hungary
CH_4 1.1% NH_3 2.4%

The 11 biggest emitters, ranked by total emissions, plus all other countries combined. Percentages are each country's share of Europe's methane and ammonia emissions.
Circle area follows the data: one glyph = 1 kt.

TOTALS

9,360 kt
methane

3,536 kt
ammonia

EU-27, Iceland, Liechtenstein, Norway, Switzerland and the UK

LEGEND

Livestock Methane (CH_4)
1 dot = 1 kt

Crop and livestock Ammonia (NH_3)
1 arrow = 1 kt

Fractional glyph
1 · 0.5 · 0.2 · 0.05 kt

Ammonia comes from
Manure management · 3B
Inorganic N fertilisers · 3Da1
Manure applied to soils · 3Da2a
Urine & dung from grazing · 3Da3

Source: National emission inventories reported to the UNFCCC (CH_4) and EMEP/CEIP (NH_3)

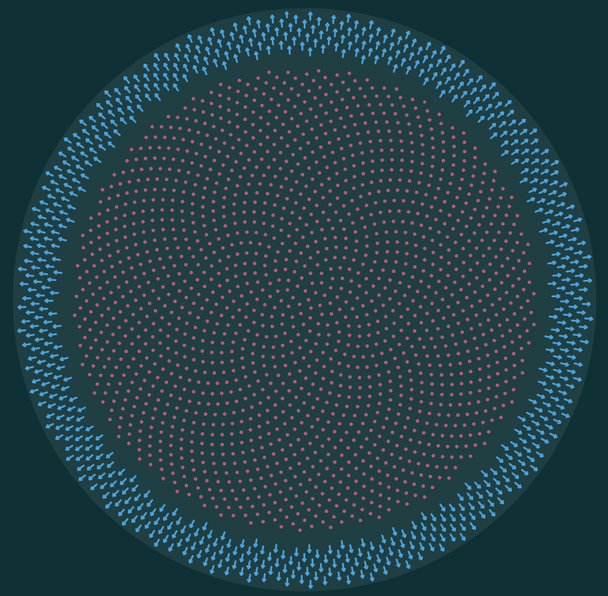
HOW A FLOWER IS BUILT



Core: methane, then ammonia arrows, spiralling outward, one glyph = 1 kt

CIRCLE AREA = TOTAL EMISSIONS





All other countries (21)
CH_4 18.4% NH_3 18.7%

Belgium
Greece
Austria
Portugal
Czechia
Switzerland
Sweden
Bulgaria
Norway
Finland
Lithuania
Croatia
Slovakia
Slovenia
Latvia
Estonia
Luxembourg
Cyprus
Iceland
Malta
Liechtenstein

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Ammonia

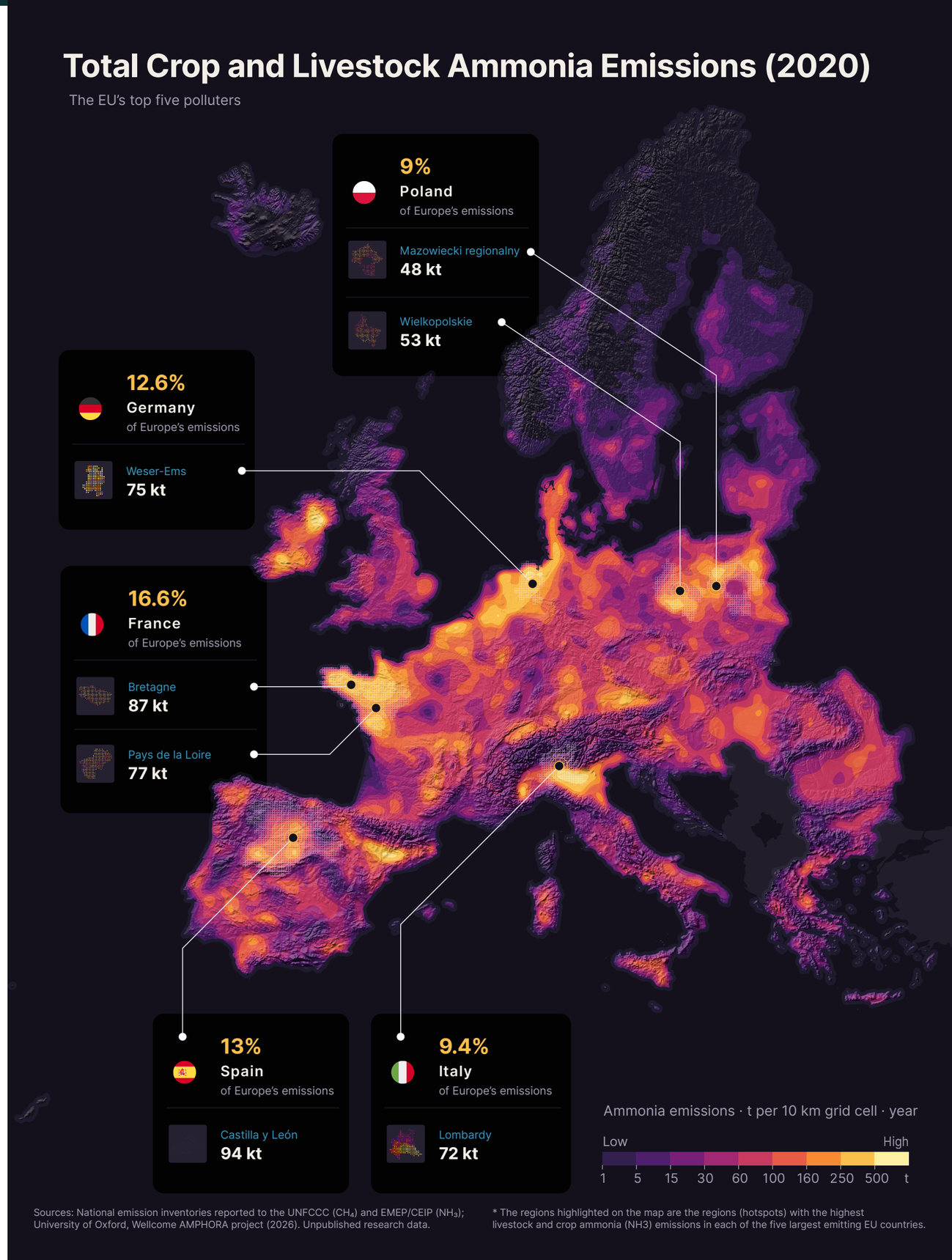
Concentrated livestock production creates multiple, interconnected pollution pressures - including ammonia, alongside methane. Ammonia from livestock manure and fertiliser contributes to the formation of harmful PM2.5, while methane from livestock mixes through the whole atmosphere and raises background ground-level ozone far from where it is emitted.

The data looks at manure management from livestock, animal manure applied to soils, and urine and dung deposited by grazing animals. It also maps ammonia from inorganic N-fertilisers applied to 18 crops, including wheat, barley, and maize.[E]

Agriculture is the dominant source of ammonia, with manure management and nitrogenous fertiliser use both making major contributions[42]. This differs from methane, where livestock emissions are dominated by enteric fermentation and manure management, with fertiliser use playing no comparable role. As with methane, manure management is a major source of ammonia emissions. Ammonia emissions from manure vary substantially depending on whether animals are grazing or housed, whether manure is stored or handled in solid or liquid systems, and how manure is applied to land. This analysis therefore helps identify not only where ammonia hotspots occur, but which stages of livestock production are driving them.

EU data shows how persistent the ammonia problem is. Emissions of other major air pollutants have fallen substantially, with sulphur dioxide falling

E The 15 other crops included are rice, rye, other cereals, fresh vegetables, dry pulses, potatoes, sugar beet, sunflower, soybeans, rapeseed, fibre crops, grapes, olives, fruits, nuts and two grasslands: permanent grass and temporary grass.



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by 84% and nitrogen oxides by 53% since 2005.[43] However, EU ammonia emissions declined by just 17% between 2005 and 2023, the smallest reduction of the five pollutants covered by the NECD. Under Member State's own projections, the majority remain off track to meet their targets.[44] Those which have reported they are 'on track' must ensure action to reduce ammonia is implemented and sustained to meet their 2030 targets.

Table 2: EU Member States that had met, or had not yet met, their 2030 ammonia emission reduction commitments in 2024

Not on track (further cuts needed)	On track
Austria	Belgium
Bulgaria	Croatia
Cyprus	Denmark
Czechia	Estonia
Germany	Finland
Hungary	France
Latvia	Greece
Luxembourg	Ireland
Malta	Italy
Poland	Lithuania
Portugal	Netherlands
Romania	Slovakia
Spain	Slovenia
Sweden	

Source: European Environment Agency (2026)[45]

As with methane, ten countries emit almost 80% (79.5%) of Europe's crop and livestock-related ammonia emissions - nine of which are also among the top ten largest methane emitters. France, Germany, Spain and Italy are in the top five for methane and ammonia emissions. Regions that are major methane hotspots are frequently also hotspots for ammonia. Regions including Pays de la Loire in France, Weser-Ems in Germany, the Po Valley in Lombardia, Italy, and also Castilla y León in Spain, where there are nearly 4,000 pig farms.[F, 46]

These findings demonstrate that Europe's livestock emissions are not evenly distributed but are heavily concentrated in a relatively small number of livestock-intensive countries and regions. These spatial concentrations are important because emissions per animal tell only part of the story. The total pollution burden in an area also depends on how many animals are concentrated there and, between countries, how they are managed.

This is further demonstrated by specific species contributing a greater proportion of Europe's livestock ammonia emissions, which is a different picture to that of methane, where cattle clearly dominate the emissions.

Ammonia emissions vary much more by species - dairy and non-dairy cattle combined represent 53.8% of Europe's ammonia emissions from manure management (housing and storage), with swine and poultry the next largest contributors, representing 24.9% and 17.3% respectively.

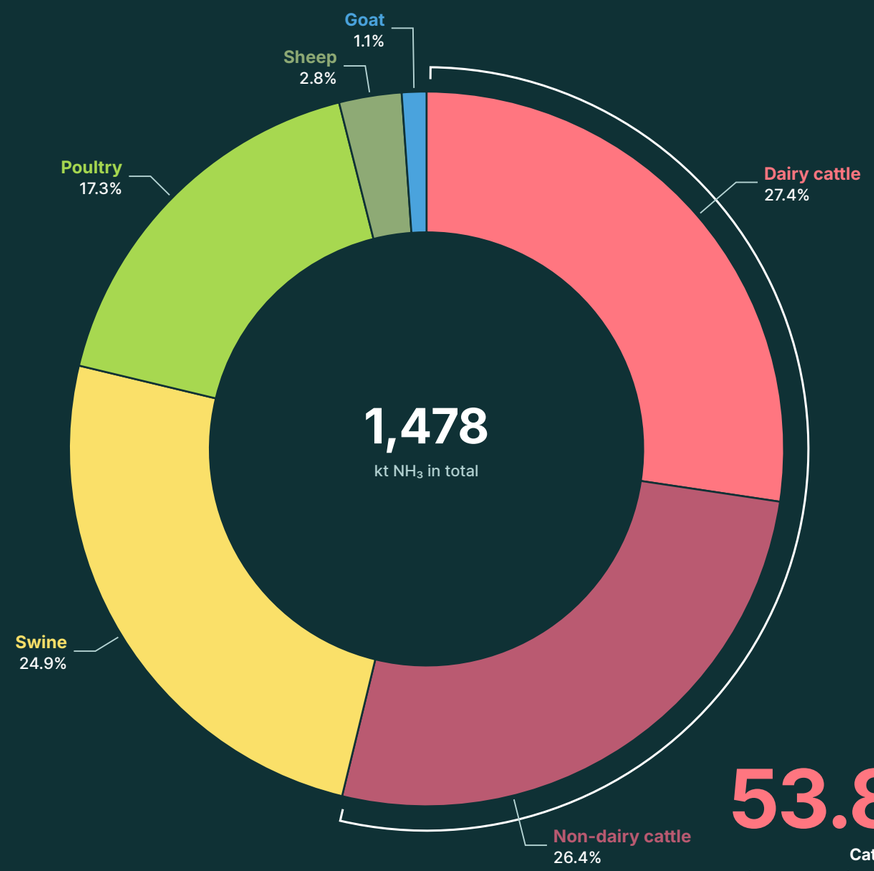
Geographic differences persist at the species level - the largest proportion of cattle-related ammonia emissions come from France and Italy, whereas for swine Germany is the largest source of ammonia accounting for 20.2% of swine-related

F 3,813 farms were registered as legal entities in the Instituto Nacional de Estadistica's latest Farm Structure Survey (2023)

AMMONIA·LIVESTOCK MANURE MANAGEMENT

Cattle contributes over half of Europe’s ammonia livestock manure management emissions

share of Europe's livestock ammonia (NH_3) emissions by species.



53.8%

Cattle · 795.0 kt

dairy and non-dairy cattle combined

Livestock	Total NH_3 (kt)	Share
Dairy cattle	404.3	27.4%
Non-dairy cattle	390.7	26.4%
Swine	368.7	24.9%
Poultry	255.9	17.3%
Sheep	41.7	2.8%
Goat	16.4	1.1%

Largest emitter = the country with the biggest share of Europe’s ammonia from that species.

Shares of total livestock NH_3 emissions. Cattle: dairy 27.4% + non-dairy 26.4% = 53.8%.
Source: National emission inventories reported to the UNFCCC (CH_4) and EMEP/CEIP (NH_3).

ammonia, followed by Spain at 18.4%. Meanwhile for poultry, Poland and Spain are the biggest contributors, accounting for 15.6% and 15.3% of poultry emissions respectively.

Taken together, the University of Oxford's mapping shows that Europe's livestock hotspots are not single-pollutant problems.

Large ruminant populations create substantial enteric methane emissions regardless of how manure is managed, while systems in which large volumes of manure are collected and stored, particularly as liquid slurry, can create an additional and highly concentrated methane - and ammonia - burden.

As is clear from the hotspots above, the same intensive production systems can generate both high methane and ammonia emissions, while also driving wider nitrogen pollution, linking livestock concentration to climate warming, ozone formation and harmful PM 2.5, with negative impacts on biodiversity, society and the economy.

EU action that tackles the scale and concentration of livestock production across all species, and all pollutants including methane and ammonia, is needed, rather than tackling individual pollutants or drivers, like swine and poultry, in isolation.

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Animal agriculture: from emissions to impacts

How livestock pollutants harm human health, crops, nature and the climate

Methane (CH_4) Ammonia (NH_3) Nitrous oxide (N_2O)

Flow colour = pollutant. Flow widths show connections, not emission volumes.

Animal agriculture

SOURCE

SOURCE

POLLUTANT

IMPACT

Enteric fermentation

Manure management
(including Applied to/deposited on soils)

Animal feed
(nitrogenous fertilisers)

Methane
CH_4

A greenhouse gas with a global warming potential is 86 times stronger per mass unit than carbon dioxide (CO_2) on a 20-year timescale, and 28 times more powerful over 100 years.

Ammonia
NH_3

Nitrogen from manure (and urine) and fertiliser, including those applied to grasslands[24], combines with hydrogen, producing ammonia (and in water, ammonium).

Nitrous oxide
N_2O

A powerful greenhouse gas, with a global warming potential 293 times more powerful than CO_2e.

HUMAN HEALTH

Ozone: Human health

Methane contributes to ground-level ozone, another major air pollutant that harms human health. Ozone is an irritant which can damage human airways, and also linked to exacerbating respiratory diseases.

Between 2005 and 2023, annual average ozone concentrations increased by around 2% at rural EU-27 monitoring stations and by around 13% at urban stations, even as peak ozone levels declined.

97%

In 2023, 97% of people living in EU urban areas were exposed to ozone concentrations above the WHO guidelines.

HUMAN HEALTH

PM2.5 air pollution

Ammonia contributes to the formation of PM2.5, fine particles linked to cardiovascular and respiratory disease.

In livestock-intensive regions, ammonia released from manure and fertiliser can react with other pollutants in the atmosphere to form secondary PM2.5, creating an important link between agricultural emissions and public health. This secondary PM2.5 can also be transported through the air over long distances, affecting the health of populations in other regions.

CROPS & ECOSYSTEMS

Ozone: Crops and ecosystems

Ground-level ozone forms in the atmosphere through reactions between precursor pollutants (like CH_4 and NOx) in the presence of sunlight and heat. If CH_4 is involved, it is more likely to increase ozone levels regionally and internationally.

Ground-level ozone harms crops and ecosystems.

17 Mt

In 2023, ozone pollution caused the loss of more than 17 million tonnes of wheat, worth around €3.75 billion.

NATURE

Biodiversity and habitat harm

Manure and ammonia deposited onto land can damage sensitive habitats, soils and biodiversity.

Agriculture is already the biggest pressure on surface and groundwaters across Europe.

CLIMATE

Temperature increase

Methane has a climate response time of only about 12 years,(ref) after which it degrades to CO_2 and water vapour. Methane's short-lived nature makes it an essential climate emergency brake to limit peak temperature and climate tipping points. Reducing N20 is also needed to limit temperature rise.

0.5°C

As of 2021, methane emissions had caused 0.5°C of warming.

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3. Pollution in practice

Despite significant pollution from methane and ammonia, risking Member States' failure to meet climate and clean air targets and impacting local communities, some of the highest polluters have advocated to weaken regulation in the EU on industrial livestock. Although France is the largest emitter for both gases, this briefing focuses on Germany, Italy and Spain. Germany and Italy, which are in the top five polluters for both gases, reportedly pushed to weaken the IED regulation,[47] and have strong national lobby groups attempting to further weaken environmental protections.[48,49] Italy is projected to be on track to meet existing regulations under the NECD for ammonia, but only if further action is taken to limit pollution and Germany is not yet on track.[50] Spain is off track and has faced significant pollution pressures impacting water quality and the health and wellbeing of local communities.[51]

Weser-Ems, Germany

The University of Oxford's research identifies Weser-Ems in north-west Germany as one of Europe's major livestock methane hotspots, showing how emissions are concentrated in some of the continent's most intensive livestock-producing regions. The region produces nearly 1.5 times as much methane as the next most polluting German region, Schleswig-Holstein. Cattle make a substantial contribution to this, and enteric fermentation contributes around three quarters of Weser-Ems total methane emissions, bringing into focus a major gap in current EU pollution rules.

Germany has the second-highest livestock methane emissions across Europe, at 1,185.6 kt CH_4, after France, and the third-highest crop and livestock-related ammonia emissions, at 443.8 kt NH_3, after France and Spain.



Industrial dairy farm - Shutterstock (2025)

The concentration is particularly relevant to the IED. The European Commission recorded 1,128 intensive pig and poultry installations covered by the IED in Weser-Ems in 2024 - the third-highest number of any EU region.[52] Yet the region's substantial cattle and dairy sector remain outside the Directive. Oxford's mapping shows that cattle produce 84% of the region's livestock methane, so regulating intensive pig and poultry production alone leaves most of this hotspot's livestock

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methane outside the IED and its farm-level requirements. Germany's significant investment into biogas and biomethane production will not tackle the majority of its emissions from enteric fermentation.

The picture becomes more significant when methane is considered alongside Germany's ammonia challenge. Agriculture remains responsible for 91.7% of German ammonia emissions in 2024.[53] Most of this comes from managing livestock manure, particularly from cattle, followed by swine (pigs), and the spreading of this manure on soils. In 2020, Germany's ammonia emissions from grazing animals were only 15.3 kt compared to 184 kt from spreading manure on soils.

Under the NECD, Germany must reduce ammonia emissions by 29% from 2005 levels by 2030.[54] Deutsche Umwelthilfe (DUH) successfully challenged Germany's National Air Pollution Control Programme before the Berlin-Brandenburg Higher Administrative Court in 2024, including over its approach to ammonia. The court explicitly acknowledged significant uncertainties in the assumptions underlying Germany's projected compliance with its ammonia reduction commitments, particularly regarding declining livestock numbers, and ordered Germany to revise its programme. The judgment is not yet final, following a referral to the European Court of Justice in October 2026.

Germany's projected compliance relies heavily on assumptions that are not backed by policy. A key driver is an expected decline in livestock numbers: government projections assume substantial reductions in cattle and pig populations by 2030/34,[55,56] despite there being no binding policy mechanism to ensure these reductions happen. Moreover, the EU Strategy on Livestock cites the 22% fall in Germany's pig population over the last decade as a concern for the continuity of livestock farming and plans to bring livestock production back to regions at risk of abandonment, showcasing the significantly mixed and contradictory signals at the EU, regional and national policy level on livestock emissions.[57]

Castilla y León, Spain

Spain is a significant agricultural economy, with approximately 80% of agricultural land devoted to livestock farming .[58] Castilla y Leon is particularly well-known for its pork production, with a surveyed population of 4,271,319 pigs in 2023, the third-highest in Spain,[59] and is increasingly facing climate risks like increased fire, flood and drought.[60] It is also home to the largest number of cattle (dairy and non-dairy) in Spain, with a population of 1,417,270 in 2023 - representing over a fifth (22.4%) of Spain's total cattle population.[61]

In recent years the production style has shifted to larger, industrialised production systems and communities have been fighting back against ongoing pollution impacting their water supplies and fresh air.[62] Despite the communities' pleas for change, planning permission continues to be granted for industrial livestock units in the region.[63]

Industrial pig farm, Castilla - Spain, Shutterstock (2025)



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Intensive swine farm, Shutterstock (2019)

This region alone emitted around 20% of Spain's total ammonia emissions from agriculture in 2020. Non-dairy cattle and swine (pigs) production are the largest drivers of ammonia emissions from manure management in the region, contributing 8.99 kt and 8.5 kt respectively. The pollution from significant volumes of manure, predominantly from swine and cattle, has polluted the local water supply and in March 2024, the EU Court of Justice ruled that Spain had not taken all measures required against nitrate pollution from agricultural sources in several regions, including Castilla y Leon.[64] According to an investigation, pollution from pig farms may have also played a bigger role than publicly acknowledged in the collapse of the Mar Manor ecosystem, a saltwater lagoon in Murcia where dead fish and crustaceans have been found on the shores.[65]

Ammonia emissions are not the only issue facing the region, livestock production is also a major hotspot for methane, representing 19.5% of Spain's livestock methane emissions with 174.7 kt of CH_4 in 2020. About two thirds (67.5%) of the region's livestock methane comes from dairy and non-dairy cattle. The region's cattle alone emit 13% of Spain's total livestock methane.

Castilla y León is one of many hotspots across Europe, but on these estimates, the largest emitter of both methane and ammonia across Spain - representing around a fifth of both the country's methane and ammonia emissions. Large scale industrial agriculture such as swine production is a critical driver, but still cattle remain significant as the primary driver for methane and unregulated by the IED.

The Po Valley, Italy

In one of Europe's most livestock-intensive regions, the Po Valley, which stretched across Lombardy and neighbouring regions in Northern Italy, the result is a huge, combined pollution footprint - methane, ammonia, PM 2.5, and some of Europe's highest pressures from nitrogen deposition on ecosystems. In Lombardy, around 97% of ammonia emissions are estimated to originate from farming activities.[66] Lombardy alone accounts for 21.8% of Italy's crop and livestock related ammonia emissions.

Lombardy accounts for over 22% of Italy's livestock methane emissions. Other major emitting regions include Emilia-Romagna, Piemonte, Veneto and Sardegna. Again, enteric fermentation from cattle was the biggest culprit for Lombardy's high methane emissions.

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Cows grazing in the Po Valley, Shutterstock (2024)

The valley, which spans the Po River, is often described as Italy's 'breadbasket,'[67] and is home to around 80% of Italy's cows, swine (pigs) and poultry.[68] But this same region can be considered a canary in the coalmine for the climate crisis in Italy, and faces immediate climate risks.[69] In 2022, the region faced the worst drought in 70 years, with river levels around 2m (7ft) below average.[70] Despite itself being threatened by rising global temperatures, the region continues to be dominated by industrial scale animal agriculture and disproportionately high methane emissions.

Further to these emissions, the EEA states that in 2023 the Po Valley had among the highest exceedances of ecological critical loads for nitrogen deposition anywhere in Europe.[71] When these critical loads are exceeded, excess nitrogen can drive eutrophication and changes in species diversity.

Intensive livestock and agricultural production across the Po Valley generates large nutrient loads that enter the Po River and are transported downstream into the Northern Adriatic.[72] The Po supplies more than half of the external nutrient inputs reaching the Northern Adriatic, where excess nitrogen and phosphorus can fuel algal growth and eutrophication, contributing to oxygen depletion and damage to aquatic ecosystems.[73]

The Po Valley therefore illustrates two gaps at the heart of current EU policy. There is no comprehensive reduction target for agricultural super pollutants, like methane. In addition, the IED, which could drive technical measures to address some of these aspects of industrial agriculture's pollution, excludes cattle. This is one of the most concentrated livestock systems: the four regions that make up most of it (Lombardy, Emilia-Romagna, Piemonte and Veneto) emitted over 300kt of annual livestock methane in 2020. The pollution generated by intensive livestock production not only impacts the farms themselves, but contributes to pressures on the air, water and ecosystems experienced locally and across Europe.

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4. Policy Recommendations

As outlined by the European Scientific Advisory Board on Climate Change (ESAB-CC), wider action must be taken to meet climate and food security goals, including dietary shift and a move away from unsustainable livestock models.[74] The Commission had proposed concrete emission reduction targets for agriculture in draft documents to the 2040 target,[75] and it should immediately re-instate these.

Against this backdrop, identifying where emissions are concentrated and which livestock types and emission sources are driving them is particularly timely. Without stronger action on livestock, the EU will struggle to deliver the reductions needed under its wider climate and methane commitments, while Member States risk missing binding ammonia reduction targets and locking in some of Europe's most polluting livestock systems.

Relying on technical measures alone will not be enough to meet the EU's climate targets and farmers need long-term planning to shift practices. Solutions are on the table and can be implemented to deliver the emissions reductions required under the EU's wider climate and clean air quality commitments.

These should include:

1. Setting a Paris Agreement aligned non-CO2 GHG emission reduction target for agriculture of at least 30% by 2040 and at least 50% by 2050, compared to 2005.
2. Bringing cattle into the scope of the IED as the most significant contributor to the EU's methane and ammonia pollution, closing a major gap in EU rules.
3. Establishing policy coherence in the Common Agricultural Policy (CAP) and the IED with the Global Methane Pledge goal to reduce global methane emissions by 30% from 2020 levels by 2030, ensuring measures to reduce methane and ammonia go beyond technical fixes and address the scale and concentration of livestock production.
4. Defending and strengthening clean air protections, ensuring Member States deliver the ammonia reductions required under the NECD, include methane in its eventual revision, and resist further deregulation of EU climate and health policies.
5. Supporting healthy diets in line with national dietary recommendations and the EAT Lancet 2.0 report, prioritising plant-rich diets and reducing unhealthy overconsumption of meat and dairy across the region.
6. Supporting farmers to rebalance herd sizes to the levels climate and nature can support.

Europe cannot meet its climate and clean-air goals while leaving some of its biggest livestock pollution sources unregulated. The recommendations above would succeed in tackling methane and ammonia together and build a cleaner, more resilient European food system.[G]

G A detailed methodology is published alongside this briefing and can be found at https://changingmarkets.org/campaigns/growing-the-good/

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