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Baltic Sea Region
Baltic Slurry Acidification

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FLAGSHIP

Market potential analysis

Slurry acidification technologies in the Baltic Sea Region

Edited by Sebastian NEUMANN, Michael ZACHARIAS, Reinhold STAUSS, LLUR and Henning L. FOGED, Organe Institute Aps

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Preface

This report is prepared in the frames of the Baltic Slurry Acidification project, co-financed by INTERREG V B Baltic Sea Region and implemented by 17 partners from the Baltic Sea Region (BSR) in the period from March 2016 to February 2019. The report is part of the projects aim to develop policy recommendations and analyses of markets and legislation in relation to slurry acidification technologies (SATs) and its overall objective to promote a wider use of SATs in the BSR where this is found feasible.

The data for the report was collected and analysed in 2016 and 2017 by the persons, who co-authored the report.

We are especially glad that co-funding from the Swedish Institute made it possible to include collection, estimations and analysing of information from Russia and Belarus within the frames of the associated project "Bringing Russia and Belarus into Baltic Slurry Acidification".

August 2017

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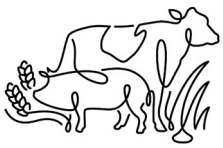

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Summary

Today, there is a theoretical, weighed potential for SAT installations with a capacity to process 244.5 million tons slurry and other liquid manures in raw and processed form in the Baltic Sea Region.

The potential corresponds to an estimated number of SAT installations as shown in the following table:

Table 1: Estimated, weighed potential for slurry acidification in tons capacity, converted to an example of the equivalent number of SAT installations in Baltic Sea Region countries.

	Estimated, weighed potential for slurry acidification	Example of equivalent number of SAT installations, given the same market share as for DK		
	Million tons	In-house	In-storage	In-field
Denmark	25.0	538	281	416
Estonia	1.1	24	12	18
Finland	3.9	83	44	65
Germany	159.5	3,435	1,794	2,655
Latvia	0.9	18	10	14
Lithuania	1.5	32	17	25
Poland	21.6	456	243	360
Sweden	13.4	289	151	225
Belarus	14.3	307	161	240
Russian BSR regions	3.3	70	37	54
Total	244.5	5,252	2,750	4,072

In practice, though, legal and financial incentives and impediments would be decisive for the dissemination of SATs.

An overview of the sub parameters used for assessing the country-wise market potentials is summarized in the following tables.

Table 2: Question 1 - The share of livestock manure being produced in the form of slurry or other liquid manure.

Country	Estimated share of liquid manure feasible for slurry acidification, %
Denmark	85
Estonia	68
Finland	36
Germany	90
Latvia	Not assessed
Lithuania	30
Poland	50
Sweden	82
Belarus	63
Russian BSR regions	62.8

Table 3: Question 2 - The number of facilities for intensive rearing of poultry and pigs according the Industrial Emissions and as well for cattle, and those who produce slurry.

Country	No. of farms with environmental approval
Denmark (2016)	23,940, whereof 4,000 cattle and 3,000 pig farms are requested to use BATs
Estonia (2017)	162, including 108 cattle, 45 pigs and 9 poultry farms
Finland (2015)	117, including 102 pigs and 15 poultry farms
Germany (2016)	2,800 (the figure includes only pig farms)
Latvia (2017)	29 (only pigs)

Country	No. of farms with environmental approval
Lithuania	39 pigs and 42 poultry farms
Poland (2010)	752: 146 pigs and 606 poultry farms
Sweden (2017)	285: 2 intensive aquacultures, 14 poultry or pigs, 160 poultry, 109 pigs, 14 sows
Belarus	106 pigs and 45 poultry farms
Russian BSR regions	There are 532 industrial enterprises in the considered area, including 200 falling under IPPC-farm size.

Table 4: Question 3 -The role (at present or envisaged) of ammonia emissions in the administrative practices concerning environmental permitting according the IED.

Country	
Denmark	Always considered if >75 AU[1]
Estonia	BATs about cattle, pig and poultry production, whole manure handling chain
Finland	Yes: criteria determined case by case
Germany	Yes: TA-Luft, BImSchG
Latvia	No
Lithuania	Is considered and permits can be conditioned the application of ammonia emission reduction measures.
Poland	Yes. Environmental permits might be conditioned the use of ammonia emission reduction BAT's.
Sweden	Ammonia emissions are considered in Sweden when allocating environmental permits to

[1] 1 Animal Unit (AU) is the equivalent of 100 kg N ex storage

	larger pig and poultry farms according to IED. It regards both slurry storage and spreading.
Belarus	Ammonia emissions from Belarus livestock farms is considered, and the farms imposed an excise tax on basis of their emissions, except in cases where they use a single tax payment system.
Russian BSR regions	Current environmental legislation regulates pollution emissions, including ammonia. It is expected that BAT introduction will cause tightening of regulations.

Table 5: Question 4 - The designation of areas that are specially sensitivity to pollution according the Nitrates Directive and the Habitats Directive.

Country	Nitrate Vulnerable Zones %	Nartura2000
Denmark	100	8,3 / 17,7% (on / off shore)
Estonia	7.2	17
Finland	100	5 Mio. ha: 25 / 75% (on / off shore); 12,4% of total area of Finland
Germany	100	156.000 / 756.000 ha (on / off shore)
Latvia	13	12% of the territory or 787,729 ha
Lithuania	100	13% of the territory.
Poland	4	4.5% of the area designated as NVZ. 983 Natura2000 areas: 145 birds, 845 habitats
Sweden	70	11.6% of territory (4532 ha or 1,7% of the agricultural land
Belarus	N/A	7.6% of the total territory.

Country	Nitrate Vulnerable Zones %	Nartura2000
Russian BSR regions	N/A, but Water code of the Russian Federation	n/a, but HELCOM Marine Protected Areas

Table 6: Question 5 - The role of nitrogen in water action plans in relation to the Water Framework Directive.

Country	
Denmark	Further reductions of 6,000 tons nitrogen planned, but ammonia emission reductions do not count in that respect.
Estonia	No, but Estonian Water Act 2016.
Finland	No, but Nitrate Directive and the agro-environmental protection scheme, where 90% of farms are committed to support WFD
Germany	No, but instruments are agricultural advice service, special agricultural provision programs and the fertilisation decree.
Latvia	No concrete goals determined.
Lithuania	Governmental Action Plans includes plans to develop various measures. Concretely Lithuania has under HELCOM committed themselves to reduce nitrogen loads to the Baltic Sea with 15,66 Kt per year.
Poland	Yes: Water Law 2001 transposes the Water Framework Directive 2000/60/EC, flaws occurred in implementing process, new Program of Action improves
Sweden	No concrete goals determined.
Belarus	No concrete goals determined.
Russian BSR regions	n/a, but Russian Schemes of integrated use and protection of water bodies (SKIOVO), are for some rate similar to Action Plans under Water Framework Directive.

As appear from Table 6, most Baltic Sea Region countries answers that they have not defined concrete goals for reduction on N losses connected to their water action plans in relation to the Water Framework Directive. We therefore assume that these countries alone have the goals for reduction of airborne and waterborne nitrogen as defined within the HELCOM cooperation.

Aiming to have a Baltic Sea unaffected by eutrophication, HELCOM Contracting Parties – Denmark, Estonia, the European Union, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden, agreed in 2007 within the Baltic Sea Action Plan on applying a Nutrient Reduction Scheme. HELCOM Nutrient Reduction Scheme is a regional approach to sharing the burden of nutrient reductions to achieve good environmental status of the Baltic Sea. It was estimated in 2007 that for achieving this goal, the maximum allowable annual nutrient pollution inputs (MAI) into the Baltic Sea would be 21,000 tonnes of phosphorus and about 600,000 tonnes of nitrogen. Annual reductions of some 15,000 tonnes of phosphorus and 135,000 tonnes of nitrogen would be required to achieve the plan's crucial "clear water" objective. In 2013, the HELCOM Copenhagen Ministerial Meeting adopted the revised HELCOM nutrient reduction scheme.

One of the main components of the nutrient reduction scheme is the Country-Allocated Reduction Targets (CART), indicating the target for HELCOM countries' reduction of atmospheric and waterborne nutrient inputs of total nitrogen and phosphorous, compared to a reference period from 1997 to 2003. The 2013 HELCOM Ministerial Meeting also stressed that the achievement of good environmental status for the Baltic Sea also relies on additional reduction efforts by non-Contracting Parties.

Table 7: 2007 and 2013 CARTs on nitrogen for HELCOM and non-HELCOM countries, as well as progress towards CARTs for 2012.

Country	2007	2013	2012	
	Country-Allocated Reduction Targets, Kt/a		Extra reduction (total input) compared to targets for Baltic Sea basins since 1997-2003, Kt/a	Missing reduction (total input) to fulfil targets for Baltic Sea basins since 1997-2003, Kt/a
DA	17.21	2.89	16.86	0
DE	5.6	7.17 +0.5*	6.18	2.66
EE	0.9	1.8	0.2	2.42
FI	1.2	2.43 +0.6*	0.29	7.66
LV	2.56	1.67	0.001	9.83

Country	2007	2013	2012	
	Country-Allocated Reduction Targets, Kt/a		Extra reduction (total input) compared to targets for Baltic Sea basins since 1997-2003, Kt/a	Missing reduction (total input) to fulfil targets for Baltic Sea basins since 1997-2003, Kt/a
LT	11.7	8.97	0.02	15.66
PL	62.4	43.61**	1.24	23.78
SE	20.78	9.24	9.64	2.77
RU	6.97	10.380*	0	14.86
Transboundary Common pool* (including BY)	3.78	3.32 1.98	0 0	2.65 1.85

** Reduction requirements stemming from*
- German contribution to the river Odra inputs, based on ongoing modelling approaches with MONERIS;
- Finnish contribution to inputs from river Neva catchment (via Vuoksi river);
- these figures include Russian contribution to inputs through Daugava, Nemunas and Pregol

*** At this point in time Poland accepts the Polish Country Allocated Reduction Targets as indicative due to the ongoing national consultations, and confirms their efforts to finalize these consultations as soon as possible*

The updated CART (2013) are calculated for waterborne and airborne inputs of nitrogen and for countries and specific sub-basins. That is why it might be extra reduction for one basin which cannot be directly accounted within progress for the whole country due to missing reduction to another basin. Moreover, there are no strict amount which should be reduced via air or via water, and the country can decide how to reduce the total load.

Per the latest results of HELCOM assessments the following conclusions can be made:

- Denmark fulfilled nitrogen ceilings to all HELCOM sub-basins
- Germany and Sweden met their nitrogen CART's to all HELCOM basins except to the Baltic Proper
- Russia and Belarus exceeded their maximum allowable inputs to all sub-basins
- Finland increased its nitrogen inputs to Bothnian Bay.

Table 8: Question 6 - The existence of machine pools to service farms with field spreading of manure.

Country	
Denmark	Yes
Estonia	Yes – a few
Finland	Yes
Germany	Yes
Latvia	Yes – a few
Lithuania	This service sector is not developed.
Poland	Machine pools does not exist, except very few cases.
Sweden	Around 25
Belarus	None, big farms have their own machine pools.
Russian BSR regions	No, not in the same way, but all big farms have their own machine pools.

Table 9: Question 7 - The possible existence of ammonia emission reduction measures to implement the National Emissions Ceilings Directive.

Country	
Denmark	Yes/No, measures are integrated in other legislation, especially IED
Estonia	No - some measures via ND regulations (Estonian Water Act, 2016)
Finland	Yes/No, through feeding and manure handling – legislation integrated in other legislation, f. ex IED
Germany	Yes/No - New measures related to slurry spreading will be implemented under the new fertilisation ordinance (Düngeverordnung, DüV)

Country	
Latvia	Yes/No – Cabinet Regulations No. 829 and 834, considerations ongoing
Lithuania	There are no concrete measures to reduce ammonia emissions from farming, but several measures are integrated in the entire regulation of farming.
Poland	No, and Polish Government is actively working against the reach of the decided target.
Sweden	No: Based on Gothenburg Protocol, 15% reduction of NH3 (from 2005 to 2020) and an objective of no eutrophication.
Belarus	None, but ammonia emissions are considered as part of the entire set of regulations for farming.
Russian BSR regions	n/a, but Russian Schemes of integrated use and protection of water bodies (SKIOVO), are for some rate similar to Action Plans under Water Framework Directive.

Table 10: Question 8 - The number of agricultural biogas plants.

Country	No of biogas plants	Amount of digestate
Denmark	76	6.8 million ton
Estonia	5	
Finland	14	
Germany	9,000	32.5 million ton
Latvia	51	
Lithuania	8	No data
Poland	85	1.2 million ton
Sweden	40	0.3 million ton

Country	No of biogas plants	Amount of digestate
Belarus	9	1.2 million ton
Russian BSR regions	0	0

Table 11: Question 9 - Number of cattle farms > 150 dairy cows, and the average size of them in terms of number of dairy cows.

Country	Number	Average herd size
Denmark	974	180
Estonia	130	504
Finland	340 with > 100 cows	144[2]
Germany	15,969 farms with buildings for more than 200 animals in 2016	55[3]
Latvia	127	331
Lithuania	150	403
Poland	577	188
Sweden	271 holdings with more than 200 dairy cows	320
Belarus	4,160	App. 500
Russian BSR regions	320	ca. 500

[2] This is the average size of >100 cows' dairy farms. The average size of all dairy farms in Finland is 35 cows.
[3] https://www.ciwf.org.uk/media/5235182/Statistics-Dairy-cows.pdf

1: Background

Livestock manure is the main source of ammonia-nitrogen emissions in the Baltic Sea Region (BSR), which through atmospheric deposition accounts for a major portion of the nitrogen entering the Baltic Sea. Acidification is a well-known technique to reduce ammonia loss from livestock manure. Slurry acidification technologies (SATs) have been developed in Denmark and are approved by the Danish Environmental Protection Agency as Best Available Techniques (BAT) that Danish farms can utilise to reduce ammonia loss by up to 70%. The objective of Baltic Slurry Acidification is to promote the use of SATs throughout the BSR due to its proven advantages.

Table 12: Advantages of slurry acidification technologies.

Perspective	Advantages of slurry acidification technologies
Society, politicians, policy makers	Agriculture is the source of 93% of all ammonia emissions in the EU and BSR countries are committed to improving air quality with strict targets for reducing ammonia emissions. SATs can reduce ammonia emissions between 40 - 70% from livestock houses, slurry storage tanks and from field application of slurry depending on which SAT is used. Furthermore, SATs can decrease greenhouse gas emissions from livestock production by reducing nitrous oxide emissions that are indirectly related to ammonia emissions and, since sulfuric acid inhibits methanogenesis, by reducing methane emissions from slurry storages. Due to documented benefits, SATs appear in chapter 5 of the draft Reference Document for the Intensive Rearing of Poultry or Pigs (BREF) and is with the so-called BAT-conclusion of February 2017 (2017/302/EU) made compulsory Best Available Technologies (BATs) in all EU Member States.
Farmers	Farmers benefit directly from reducing ammonia emissions by saving nitrogen in their slurry which reduces the need to purchase mineral nitrogen fertiliser or through increased crop yields when extra nitrogen is not applied. Further benefits arise from using sulfuric acid which acts as a S fertiliser and thus saves the cost of mineral S fertilisers. Via legislation, Danish farmers have been given an additional advantage that they do not need to inject slurry on grass fields when using acidified slurry.

	Also, they save investment costs for storage tank covers in case they use in-house acidification.
Biogas plants	10 – 20% acidified slurry can stimulate the methane yield during anaerobic digestion by almost 20%, however larger amounts can negatively affect the methane yield. In addition, gas yield increases of approximately 50% compared to a biogas plants utilising only slurry is seen when adding 30% separation solids.

As mentioned, slurry acidification is now recognised by the European Commission as a Best Available Technique (BAT). It is described in the current draft of the Best Available Techniques (BAT) Reference Document for the Intensive Rearing of Poultry or Pigs (BREF) and made a compulsory BAT in all EU Member States by the Commission Implementing Decision (EU) 2017/302 of 15 February 2017.

This means that SATs are technologies that are relevant for all EU Member States to request intensive livestock farms to use as a condition for the issue of environmental permits in relation to the Industrial Emissions Directive (IED). The environmental permission in relation to IED is needed for farms with more than 40,000 birds, 2,000 pigs (over 30 kg) and 750 sows and BAT-technologies are applied to decrease the ammonia emissions. Member States have in some cases expanded the need for environmental approvals and use of BATs to other sizes and types of livestock farms. This is for instance the case in Denmark, where environmental permits also are required for cattle farms.

2: Method and organisation

The overall goal of this market analysis is to provide an estimate of the potential for slurry acidification and an example of the corresponding number of SAT installations in each of the eight EU member states of the Baltic Sea Region as well as Russia and Belarus.

2.1: Work process

The structure of report was discussed during a WP6 Workshop in Lithuania in April 2016. The report should give a relatively uniform, informative presentation on the assessment of the potential for the SATs in all States of the Baltic Sea catchment area. It was agreed on the creation of different questions, representing the respective differences in the individual countries on which basis a country specific assessment for the potential of slurry acidification should be done.

The collected information is now structured and analysed, and results presented in a way that allow easy comparison between countries, and the market feasibility for SAT is given a short, overall characteristic for each country.

The market analysis focuses on the global, possible market as it is today if SATs were introduced in its full potential without any technical, legal, economic or other hindrances. Efforts are made to avoid issues related with current transposition and enforcement of EU-based legislation of policy nature. The market analysis gives priority to present findings in an objective way, using facts and figures to present the estimates we have found where no statistics exists. In some cases, the quantified estimates are supplemented with narrative descriptions.

2.2: Rationale behind the nine parameters for estimation of market potentials

It was decided to base the estimates of market potentials on nine specific parameters:

1. The share of livestock manure being produced in the form of slurry or other liquid manure.
2. The number of facilities for intensive rearing of poultry and pigs according the Industrial Emissions Directive (2010/75/EU) and as well for cattle, and those who produce slurry.
3. The role (at present or envisaged) of ammonia emissions in the administrative practices concerning environmental permitting according the IED or national and regional regulations, which may be stricter than IED.

4. Regulations concerning areas that are especially sensitive to pollution according the Nitrates Directive (ND - Council Directive 91/676/EEC of 12 December) and the Habitats Directive (Council Directive 92/43/EEC of 21 May 1992).
5. The role of nitrogen in water action plans in relation to the Water Framework Directive (WFD - Directive 2000/60/EC).
6. The situation concerning the existence of machine pools to service farms with field spreading of manure.
7. Possible ammonia emission reduction measures to implement the National Emissions Ceilings Directive (2003/35/EU).
8. The number of agricultural biogas plants and the amount of fermentation residues or digestates from biogas plants in your country.
9. The number of cattle farms > 150 dairy cows, and the average size of them in terms of number of dairy cows.

It is seen that several parameters, including no. 3, 4, 5 and 7 are related with EU's regulatory framework for farming and environment, whereas other parameters are based on other factors, including those that according Danish experiences are important for the market feasibility for slurry acidification.

It is worth noticing that the current market potential analysis shall be seen in relation to the entire activities within the frames of the 'Baltic Slurry Acidification' project, that e.g. includes later activities to assess legal frameworks, field trials and other trials to verify the economic, technical and environmental performance of slurry acidification technologies in national contexts.

The parameters this market potential analysis deals with is on this basis carefully selected, so that they do not overlap with activities and production of information in other parts of the project.

2.2: Overall estimates and conclusions

Rather than to deliver narrative estimates that could be subject for individual interpretation, this report aims at providing as well concrete and quantified estimates for the potential use of slurry acidification and the number of SAT installations in each of the eight EU member states of the Baltic Sea Region as well as Russia and Belarus.

The standardised method we have used for that includes the following steps:

1. The market potential for each of the nine parameters were given a subjective score between 0 and 100, i.e. the maximal score for the market potential would be 900.

2. The available amounts of slurry and other liquid manures in raw or processed form is multiplied with the relative score. For instance, if 40 million tons is available for slurry acidification and the score is 450, then the relative score is 50%, and the estimated, weighed potential for slurry acidification is 40 million tons x 50% = 20 million tons.
3. The estimated potential for slurry acidification is computed into number of required SAT installations. For this, the market share for the three types of slurry acidification in Denmark is used as a baseline. Based on information from Peters (2016), the following market shares and capacities for one installation can be calculated:
    - In-stable: 20% market share. Capacity of 9,286 tons per installation.
    - In-storage: 24% market share. Capacity of 21,333 tons per installation.
    - In-field: 56% market share. Capacity of 33,636 tons per installation.

The used method thus provides an estimate of the weighed potential for slurry acidification in the Baltic Sea Region countries, as well as an example of the number of required SAT installations for fulfilling this potential, assuming the market share of the SATs would be like the one presently found in Denmark. The result of using this pragmatic methodology assumes all factors that are not researched in connection to the production of this report must be considered for judging of the realistic potential. These other factors include for instance weather conditions, crop responses, other legislation than investigated here, and local price conditions. The way that these other factors might limit the fulfilling of the slurry acidification potential according this report, will be clarified in other reports of the 'Baltic Slurry Acidification' project.

3: SATs market potential in EU member states in the Baltic Sea Region

In the following is found some main conclusions of the analyses of the collected market information for the eight EU member states in the Baltic Sea Region. Details are found in annexes A – K.

3.1: Denmark

A combined evaluation of the market potentials for slurry acidification in Denmark is that

1. The total livestock manure production in Denmark is estimated to be 38 million ton per year, whereof 85%, or 32 million ton per year is feasible for slurry acidification.
2. An estimate of 23,940 holdings with livestock in Denmark needs an environmental approval, assuming that all Danish livestock holdings have more than 3 AU, and that herds with less than 3 AU are kept at non-agricultural holdings, which according the Danish Law on Agricultural Holdings have less than 2 ha. The environmental approval is alone considering Best Available Techniques for livestock farms with more than 75 AU, which on basis of information from Statistics Denmark is estimated to be roughly one third of the cattle herds, or 4,000 cattle herds, and three quarter of the pig herds, or about 3,000 pig herds. These ~7,000 pig and cattle herds with more than 75 AU would, according our estimates and with only a few exceptions, all produce slurry as the main type of livestock manure.
3. In Denmark, ammonia emissions are always considered in connection with the appraisal of environmental permit applications for livestock holdings with more than 75 Animal Units, equal to an annual production of 7,500 kg nitrogen in the livestock manure, and for land fertilised with livestock manure from facilities with environmental permits. Permits to facilities with more than 75 Animal Units (article 11 and 12 permits) are always conditioned use of BAT's with an ammonia emission reduction effect defined by the law, e.g. currently 30% for sows, compared to best facilities without use of BATs.
4. The entire Danish territory is designated as Nitrate Vulnerable Zone according the Nitrates Directive (91/676/EC). Denmark has according the Habitats Directive (92/43/EC) and the Birds Directive (2009/147/EC) designated 252 Natura2000 areas that covers 8,3% of the area of Denmark and 17,7% of Danish sea area.

5. The current "Agricultural Package" is focused on streamlining and cleaning up the complex legal framework for farming, and includes an app. 6,000 tonnes target for reduction of N-loss from farming in the years 2016 to 2021. The means to achieve the reduction includes introduction of emission-based regulation of farming with diversified fertiliser norms, as well as collective measures, such as afforestation.
6. In Denmark, there exists a large network of machine pools and contractors, who provide field operation services to farms, such as spreading of slurry. The machine pools have a joint association, DM&E, with the webpage http://www.dmoge.dk, whose secretariat informs that they have 167 machine pool members that are specialized in farm operation services, and in addition 213 members, who in addition to farm operation services also offers services to other sectors, such as road and building construction sectors. Slurry spreading is among the most common services provided by Danish machine pools, whom according DM&E analyses are spreading app. 22 million ton of slurry each year, which according the above (question 1) corresponds to a bit more than three quarter of the total slurry production in Denmark.
7. Denmark shall according the Gothenburg Protocol reduce ammonia emissions with 24% in the period 2005-2020, and remain on that level until 2030.
8. The estimated minimum of 5 million tonnes of livestock manure that currently is anaerobically digested in Denmark corresponds to at least 14% of the entire Danish livestock manure production, or 17% of the liquid manure and slurry that is available for slurry acidification. The current use of anaerobic digestion in Denmark is neither inhibiting or giving synergy to slurry acidification.
9. There were according Denmark's Statistics 974 herds with more than 150 dairy cows in Denmark in 2015. The average dairy cow herd size is in 2017 about 180.

Shown on a spider web the evaluation of the key indicators for the market potential for slurry acidification in Denmark looks like shown here:

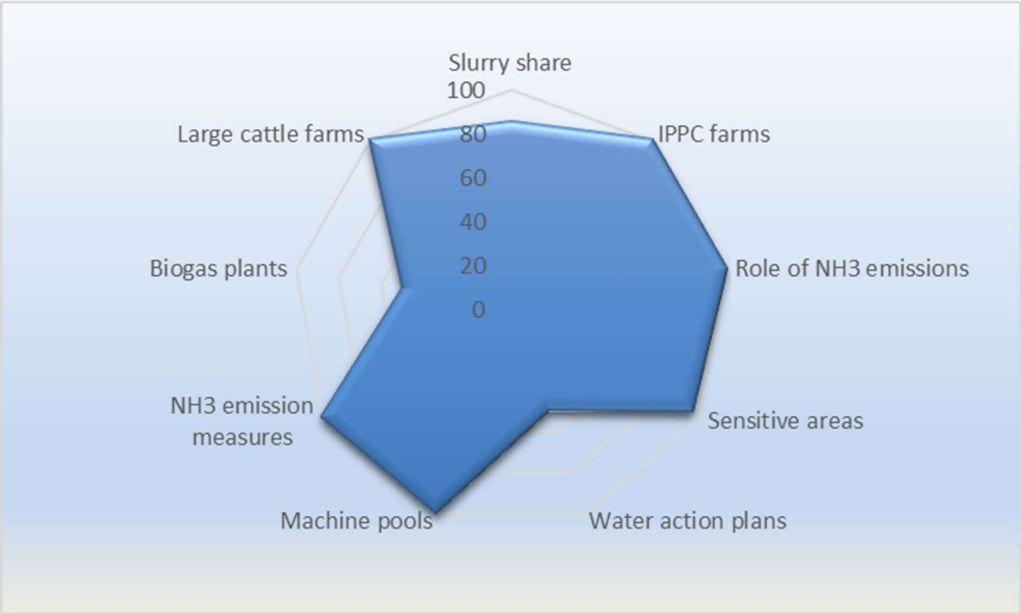

Figure 1: Spider web for Danish SAT market potential.

Denmark is scoring high on many parameters, for instance due to its high focus on NH^3 emissions in regulation of livestock farming. The total of the subjective scoring is 780 and the weighed potential for slurry acidification thus estimated to be 25 million tons. The production of this amount of acidified slurry would require 538, 281 and 416 installations, respectively for in-house, in-storage and in-field slurry acidification.

Whether the mentioned estimates for market potentials would be realised, depends much on political initiatives, such as support systems, the will to set ambitious policy targets for ammonia emission reductions, and the political will to realise the targets.

3.3: Estonia

1. The amount of manure is 2,195,000 tons, of which the liquid manure share is 68%.
2. 9 poultry, 45 pig and 108 cattle farm has a size that require an environmental permit.
3. The environmental permit requires use of BAT's.
4. 7.2% of the Estonian area is Nitrate Vulnerable Zone and 17% Natura2000 area.
5. Estonia has an obligation to reduce the amount of N reaching the sea by 1,800 t yearly.
6. At least 6 machine pools services with spreading slurry.

7. No specific ammonia emission reduction measures are directly linked to the NEC, and emission reductions are reached through other legislation, such as Nitrates Directive based legislation.
8. There are 5 agricultural biogas plants.
9. 130 farms has more than 150 dairy cows.

Shown on a spider web the evaluation of the key indicators for the market potential for slurry acidification in Estonia looks like shown here:

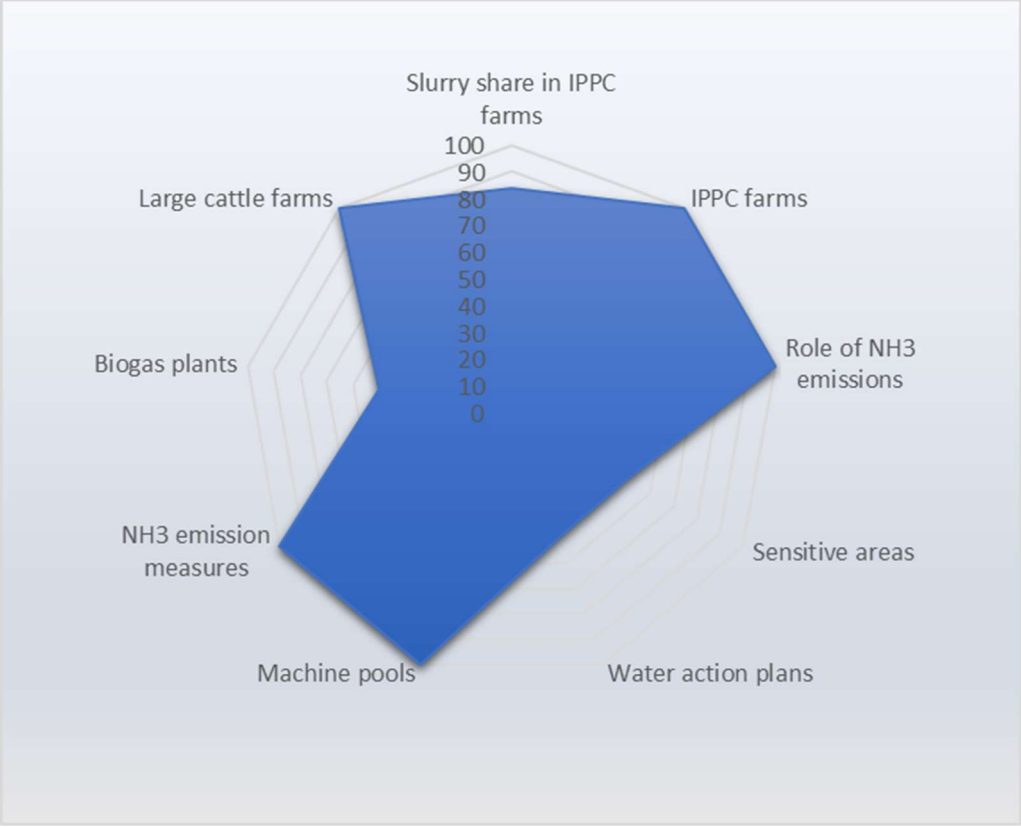

Figure 2: Spider web for Estonian SAT market potential.

Estonia is scoring high on parameters for IPPC farm, role of NH3 emissions in the regulation and existence of machine pools. The total of the subjective scoring is 734 and the weighed potential for slurry acidification thus estimated to be 1.1 million tons. The production of this amount of acidified slurry would require 24, 12 and 18 installations, respectively for in-house, in-storage and in-field slurry acidification.

3.4: Finland

1. The total livestock manure production in Finland is estimated to be 17 million ton per year, whereof approx. 36% i.e. 6 million

ton per year is in form of slurry and therefore – theoretically - feasible for acidification.

2. The environmental permission in relation to IED is needed for farms with more than 40,000 birds, 2,000 pigs (over 30 kg) and 750 sows in Finland. An estimate of 102 pig farms and 15 poultry farms in Finland need an IED environmental approval based on these criteria.
3. In Finland, environmental permission is required nearly from all cattle farms, the minimum size is 30 cows, 210 pigs and 10,000 birds. Therefore, practically all pig and poultry farms (680 and 400 farms, respectively) require environmental permission and from dairy farms 30% (3,400 farms) is under the environmental permission. Nitrate directive and BAT-technologies are applied to decrease the ammonia emissions but there may also be stricter requirements depending on the case.
4. The entire Finnish territory is designated as Nitrate Vulnerable Zone according the Nitrates Directive (91/676/EC). In Finland, there are approx. 5 million hectares of Natura 2000 areas which cover 12.4% from the total area of Finland. From these, 25% is water areas and 75% land areas.
5. Water Framework Directive settled an objective to reach the good status in water areas until the year 2015 and thereafter 2021 or 2027 in Finland. The targeted reduction of N concerning Baltic sea is 6,600 tonnes meaning 13% reduction in N load. Nitrates directive is a key instrument to be followed to decrease nutrient leakages to water areas. Also, agri-environmental protection scheme, where 90% of farms are committed, supports the goals for water framework directive.
6. In Finland, the number of contractors spreading manure is approximately 9,000 and it has increased during the last years. One contractor spreads approximately 19,000 m^3 slurry per year. Spreading by injection covers 26,000 m^3 of slurry per year. It is estimated that half of the slurry is spread by contractors.
7. In 2012 all ammonia emissions in Finland were approx. 37 kt. In 2012 the new Gothenbourg's document settled the new commitment for decreasing ammonia emissions 20% from the emissions from the year 2005, which means 31 kt for the year 2020. Also, the new EU's emissions ceilings directive has settled the commitment of 20% decrease in ammonia emissions for 2020 in Finland.
8. The number of agricultural biogas plants in Finland is estimated to be 14 but nearly the same amount is under planning.

Information how much livestock manure they are using is however at the moment not available. The current use of anaerobic digestion in Finland is neither inhibiting nor giving synergy to slurry acidification.

9. There were 340 herds with more than 100 dairy cows in Finland in 2015. The average dairy cow herd size in >100 cows' farm was 144.

Shown on a spider web the evaluation of the key indicators for the market potential for slurry acidification in Finland looks like shown here:

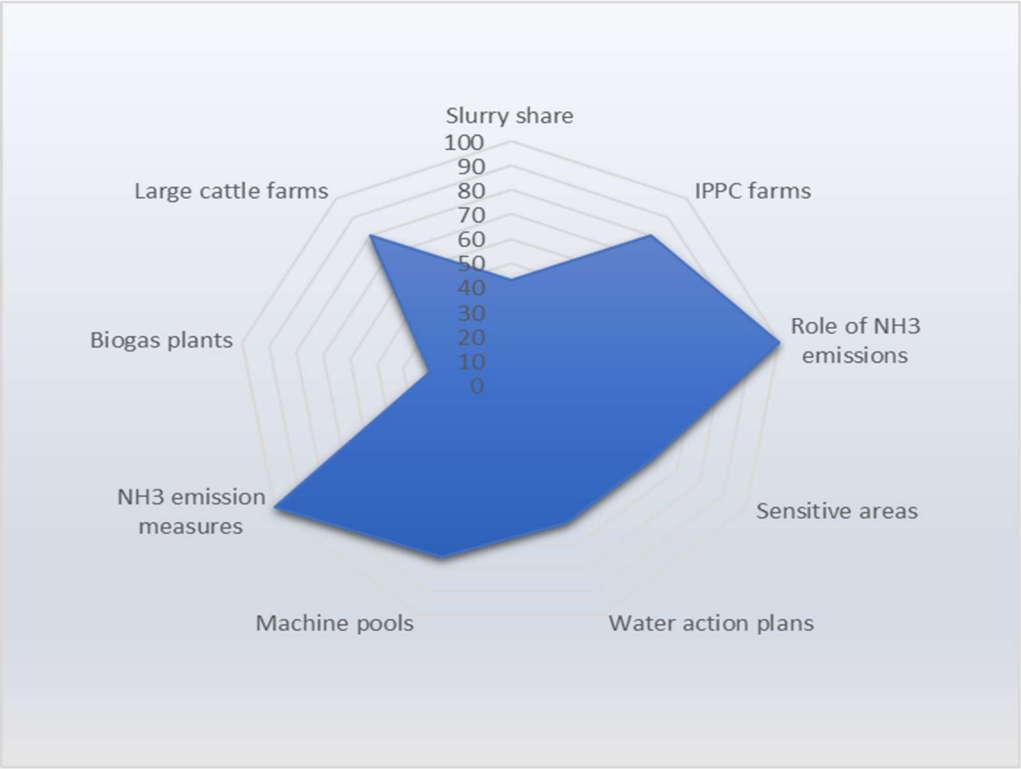

Figure 3: Spider web for Finnish SAT market potential.

Finland is scoring high on parameters for the role of NH3 emissions in the regulation and existence of machine pools. The total of the subjective scoring is 646 and the weighed potential for slurry acidification thus estimated to be 3.9 million tons. The production of this amount of acidified slurry would require 83, 44 and 65 installations, respectively for in-house, in-storage and in-field slurry acidification.

In Finland, the potential for implementation of SAT is relevant because approx. half of the manure is handled as slurry, especially in larger farms, and it is getting more common. However, the technology for using SAT is not developed in addition to that handling of acid in farms

has big safety risks. Also, clear benefits for using acid needs still to be clarified as well as the costs.

3.5: Germany

A combined evaluation of the market potentials for slurry acidification in Germany is that

1. Overall 191 million cubic metres *(Federal Statistical Office, 2010*) of liquid livestock manure and digestate of biogas plants were applicate on 7.5 million hectares of agricultural area in 2010. With a proportion of about 60% cattle slurry was the most applied organic fertiliser. But also, pig slurry (19%) and digestate from biogas plants (17%) were often used.
2. The Industrial Emissions Directive (2010/75/EU) concerns farms with more than 40,000 poultries, 2,000 pigs (over 30 kg) and 750 sows. 2,800 pig farms over 2,000 pigs and 500 buildings for more than 5,000 pigs are affected of the Industrial Emissions Directive in Germany.
3. Regulatory limits for ammonia emissions are not declared. The first general administrative regulation to the Federal Emission Control Law (Technical Instructions on Air Quality Control – TA Luft) principally constitutes requirements for the construction and firm of holdings which need or not need after BImSchG a requiring approval for keeping and rearing of livestock. In the TA-Luft no regulatory limits for ammonia emissions are declared. Hence it must be proved after Nr. 4.4.2. i. V. m Nr. 4.8 TA Luft, if the protection against significant disadvantages for sensitive plants and ecosystems due to the exposure of ammonia emissions is ensured.
   Requirements of emission control for facilities of livestock and storage of slurry after BImSchG were legal regulated with the filter-decree in Schleswig-Holstein since 2014.
4. Germany has according the Birds Directive and the Habitats Directive build up the Natura2000 areas. Schleswig-Holstein has reported like other federal states chosen FFH and bird's protection areas to Brussel since 1996. Natura 2000 areas consists of 311 areas (271 FFH- and 46 bird's protection areas) with an off-shore area about 156,000 ha and an on-shore area of about 765,000 ha.
5. In Germany, the burden of waterbodies with nutrients, especially with nitrate, is the main reason for the default of the Water Framework Directive. Instruments which can improve the chemical status and the nutrient problem can be the agricultural advice service, special agricultural provision programs and a new fertilization decree with stricter rules

regarding nutrient management and balancing. A central point will be a better nitrogen use efficiency of livestock manure, due to more efficient application technique. SATs may be an important tool in the implementation of the WFD.

6. In Germany, the BLU, Bundesverband Lohnunternehmen (National Employers' Association of Agricultural and Rural Contractors) has currently approx. 3,200 members, i.e. professional contractors from the agricultural, rural and forestry sector. However, over 40% of these enterprises are run by farms as a side-line activity. In 2014, the sector generated a total turnover of approximately €3.3 billion. As before, agriculture is the most important customer group, with a share of over 70%. Agricultural, rural and forestry contractors offer all kinds of services "from sowing to harvesting" on arable land and grassland. They also harvest silage and/or grain maize and apply commercial fertilisers (slurry, manure) for livestock farms, which represent the largest market shares. The agricultural, rural and forestry contractor sector currently employs about 16,000 full-time and 20,000 part-time workers.
7. NEC-Directive provides an emission ceiling of 550 kt for Germany. Ammonia emissions resulting of fertiliser usage were calculated completely new by means of new revised methods in 2015. One result of the new calculation were higher new values than assumed in past. In consequence, national emission ceilings were exceeded severely with 740 kt in Germany 2014. To observe national emission ceilings in future further reduction measures like application of livestock manure with near-ground and low-emission application techniques, immediately incorporation of fertilisers and exhaust air purification are necessary.
8. After information of the trade association biogas and the German maize committee (DMK) the number of biogas plants has increased twentyfold between 1995 and 2011. In Germany there were about 9000 biogas plants in 2015. The average plant size increased since the year 2000 from 75 kW up to about 400 kW installed electrical power.
9. In Germany, there are 15,969 farms with buildings for more than 200 animals in 2016.

The above means in general that the market potential is big in Germany.

Regarding potential future costs of the technique, the legislative security regulations and other aspects, it is probable that the potential for SATs in German agriculture will be especial focused on bigger farms and agricultural contractors which achieve a transregional usage and a good average utilisation of SATs.

Shown on a spider web the evaluation of the key indicators for the market potential for slurry acidification in Germany looks like shown here:

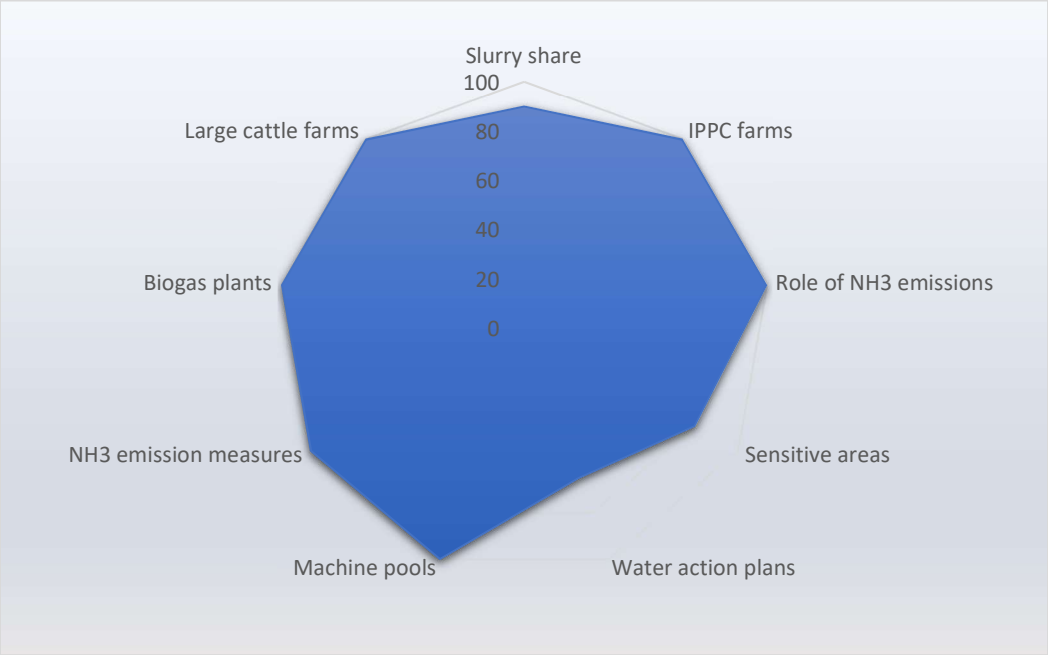

Figure 4: Spider web for German SAT market potential.

Germany is scoring high on many parameters, for instance due to its high focus on NH^3 emissions in regulation of livestock farming. The total of the subjective scoring is 835 and the weighed potential for slurry acidification thus estimated to be 159.5 million tons. The production of this amount of acidified slurry would require 3,435, 1,794 and 2,655 installations, respectively for in-house, in-storage and in-field slurry acidification.

Whether the mentioned estimates for market potentials would be realised, depends much on political initiatives, such as support systems, the will to set ambitious policy targets for ammonia emission reductions, and the political will to realise the targets.

3.6: Latvia

1. Slurry from cattle is produced by approx. half (43%) of the total number. If we estimate that one cattle unit produce approx. 20 t (according to the produced milk amount) and pig around 2 t, then total volume of slurry which is produced from cattle is 1,700,000 tons and from pigs – 400,000 tons, and totally – 2,100,000 tons per year.
2. Totally "A" categorises permits are issued for 29 pig breeders and 5 of them have biogas stations.

3. No role.
4. Territory of nitrates vulnerable zones in Latvia occupies 12,8% of state territory and are located within the boundaries of the administrative areas Dobele, Bauska, Jelgava and Riga districts except the administrative areas of Riga and Jurmala cities.
5. –
6. At least 2 machine pools are operating in Latvia.
7. No specific ammonia emission reduction measures are directly linked to the NEC, and emission reductions are reached through other legislation, such as Nitrates Directive based legislation.
8. There are 51 agricultural biogas plants.
9. 127 cattle farms have more than 150 dairy cows.

Shown on a spider web the evaluation of the key indicators for the market potential for slurry acidification in Latvia looks like shown here:

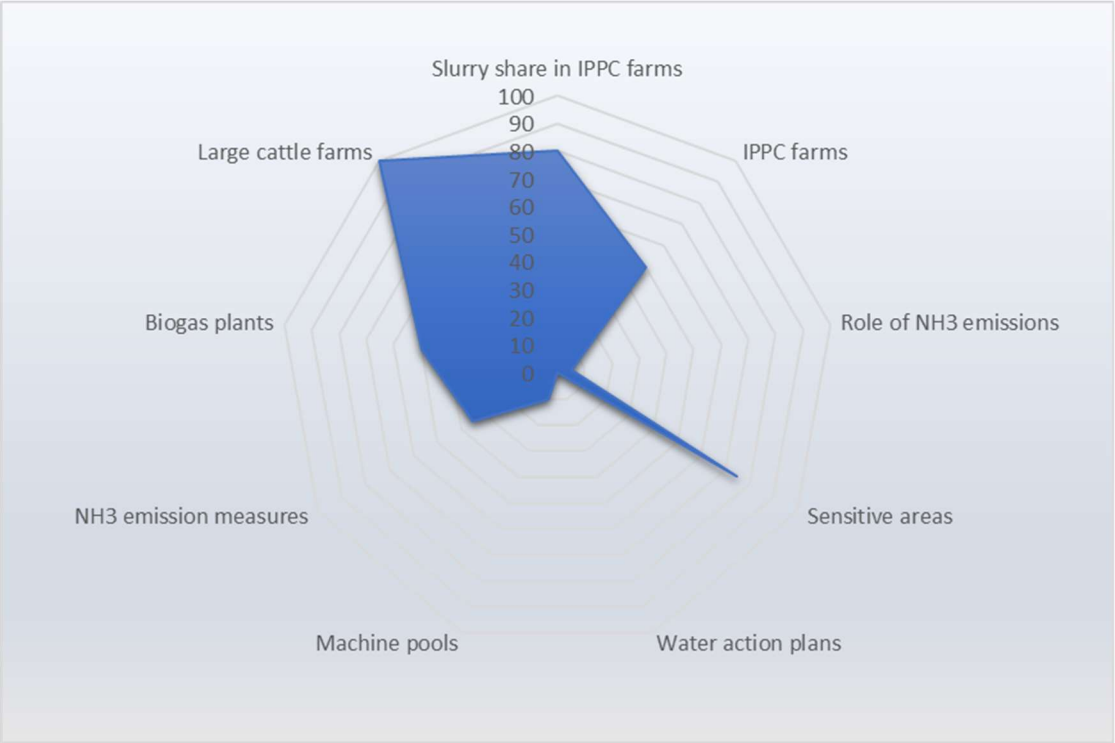

Figure 5: Spider web for Latvian SAT market potential.

The total of the subjective scoring is 405 and the weighed potential for slurry acidification thus estimated to be 0.9 million tons. The production of this amount of acidified slurry would require 18, 10 and 14 installations, respectively for in-house, in-storage and in-field slurry acidification.

3.7: Lithuania

The situation for Lithuania is as follows:

1. The total livestock liquid manure/slurry production in Lithuania is estimated to be 8 million ton per year, whereof 30%, or 2.4 million ton per year is feasible for slurry acidification.
2. Presently, there are 42 poultry and 39 pig farms having TIPK (Integrated Prevention and Pollution Control) permissions, which refers to the Industrial Emissions Directive.
3. Lithuania follows the minimum provisions of the IED for minimising of ammonia emissions.
4. The entire territory of Lithuania is designated as nitrogen vulnerable zone. In Lithuania, there are 181,690 ha (21%) of land and 542,689 ha of forests (65.6%) belonging to the Natura 2000 areas which is 13% of the territory of Lithuania.
5. According Country-Allocated Reduction Targets (CART) of HELCOM, Lithuania has the goal to reduce nitrogen emissions to the Baltic Sea with 15.66 Kt.
6. In Lithuania, agricultural services might be provided by the companies that sells agricultural machinery, but this activity is small-scaled and not specialised.
7. There are no concrete measures to reduce ammonia emissions from farming, but several measures are integrated in the entire regulation of farming
8. Currently, there are 8 biogas plants using manure and slurry as influents. Another 4 biogas plans are currently being planned.
9. There are 150 farms with more than 150 cows in Lithuania.

Shown on a spider web the evaluation of the key indicators for the market potential for slurry acidification in Lithuania looks like shown here:

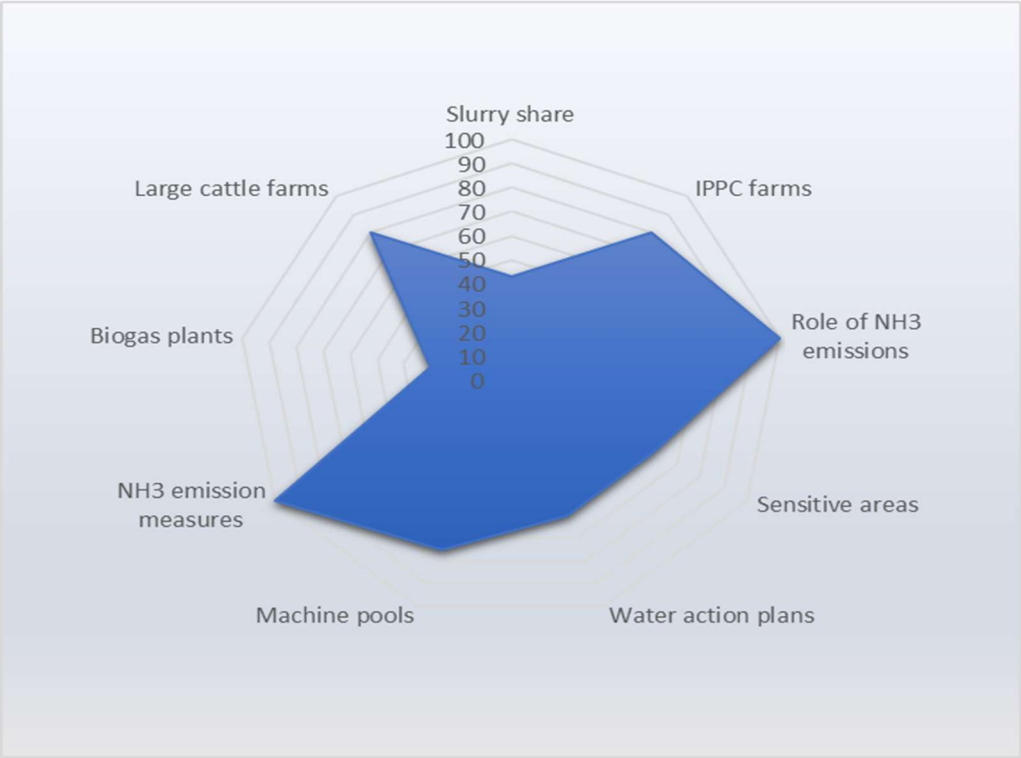

Figure 6: Spider web for Lithuania SAT market potential.

Lithuania scores high on parameters for the role of NH^3 emissions in the regulation of farming. The total of the subjective scoring is 626 and the weighed potential for slurry acidification thus estimated to be 1.5 million tons. The production of this amount of acidified slurry would require 32, 17 and 25 installations, respectively for in-house, in-storage and in-field slurry acidification.

The Action Plan of the Government Programme includes several measures for minimizing ammonia pollution from farming. It indicates a demand for an improvement in nitrogen use efficiency in Lithuanian agriculture. In this perspective SAT technologies seems relevant instrument for achieving the envisaged results.

Manure acidification technologies makes it possible to reduce nitrogen losses from farmyard manure thus paving the way for more efficient use of manure and saving of mineral fertilisers. Therefore, this system is relevant for pig and dairy farms with liquid manure.

Some pig complexes sell a part of their slurry to other farmers, i.e. the slurry is used as fertiliser on other farms. Therefore, an interest in slurry acidification technology may be higher among farms which use liquid manure on their land.

Also, not so many farmers are applying injection techniques in Lithuania, wherefore there is more possibilities for SAT technology. Application of SAT technology is used more during warm period with higher ammonia emissions. Therefore, grassland, maize, and black soil

for winter crops is potential areas for use of SAT technologies during summer (warm period). For other crops, there are restriction for applying manure ion the period between 15 July and 1 August.

3.8: Poland

A combined evaluation of the market potentials for slurry acidification in Poland is as follows:

1. The total Polish production of slurry is estimated at 35 million ton per year, whereof 50% is feasible for slurry acidification.
2. In Poland, each holding with number of livestock exceeding 210 AU have to apply for an environmental permit. The application must be annexed an environmental impact assessment. There are approx. 300 holdings with more than 200 cows and about 2,416 holdings with more than 500 pigs. 752 facilities for intensive rearing of poultry and pigs have an environmental permit and use BAT's in accordance with that.
3. The permissible concentration of ammonia is 20 ppm. Farms must use BAT's as prescribed by their environmental permit.
4. 4.46% of the area is designated as NVZ, i.e. 14,384.06 km^2. It is expected that this area will be increased after implementation of the new Water Law in Poland in 2017.
5. In accordance to the NEC Directive, Poland is obliged for reduce ammonia emissions with 1% per year from 2020 to 2029 and with 17% in each year from 2030. The reduction commitments have the year 2005 as base year. The Polish Government has opposed these reduction targets.
6. There are only a few machine pools servicing manure spreading so fertilizing with slurry is based on farmers own equipment.
7. Agriculture emits approx. 260 thousand ton of ammonia (approx. 98% of total emissions). The Code of Good Agricultural Practices, drawn up by the Ministry of Agriculture, is the only measure to reduce ammonia emission, apart from use of BAT's at intensive livestock farms according the IED.
8. There are 85 agricultural biogas plants in Poland. Their total productivity is 388 million m^3 of biogas. Poland's potential is much bigger considering its agricultural sector which can deliver substrates to produce 5-6 billion m^3 of biogas. Most popular substrate for biogas production is slurry (57%).
9. There are 577 farms with more than 150 cows with an average herd size of 188 cows.

Shown on a spider web the evaluation of the key indicators for the market potential for slurry acidification in Poland looks like shown here:

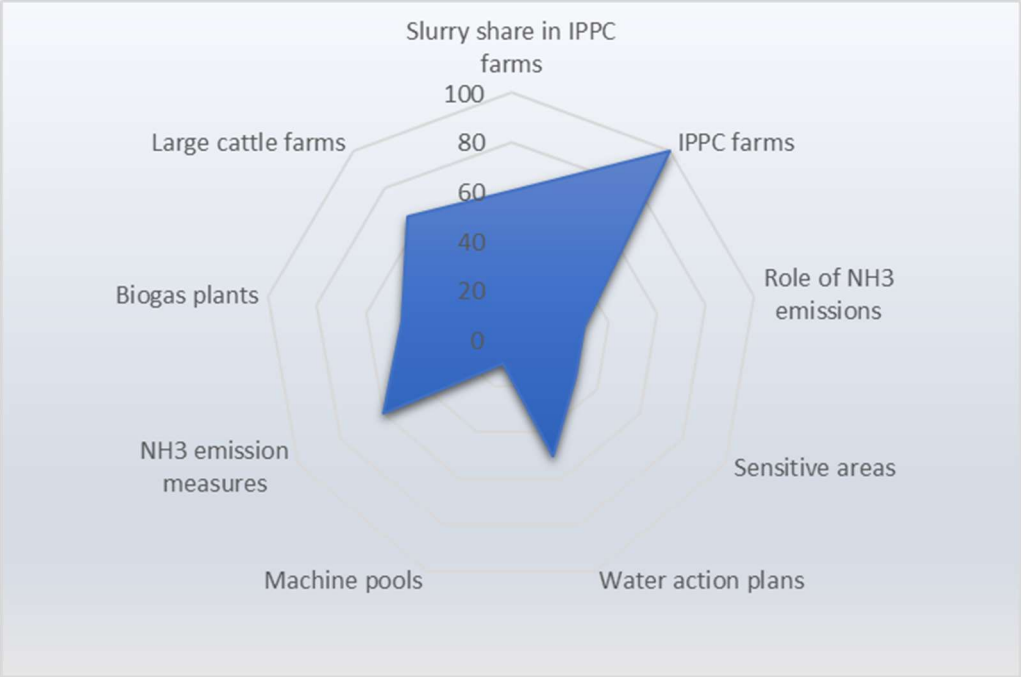

Figure 7: Spider web for Polish SAT market potential.

Poland scores high on IPPC farms. The total of the subjective scoring is 450 and the weighed potential for slurry acidification thus estimated to be 21.6 million tons. The production of this amount of acidified slurry would require 456, 243 and 360 installations, respectively for in-house, in-storage and in-field slurry acidification.

3.9: Sweden

1. In Sweden, annually app. 29 million tonnes of manures are produced, including app. 24 million tonnes liquid manure. Based on manure types, about 82% of produced manure is liquid and available for SAT.
2. There are 160 installations for the intensive rearing of poultry, with o more than 40,000 places for poultry, 109 installations with more than 2,000 places for production of pigs (over 30 kg) and 14 installations with 750 places for sows.
3. Ammonia emissions are considered in connection to the appraisal of environmental permit applications.
4. 2,2 M ha of agricultural land is designated as Nitrate Vulnerable Zones in Sweden (Personal Communication, 2017a), which is about 70% of the total agricultural land in Sweden (Statistics Sweden, 2013). 11.6% of the territory or 4,532,000 ha is Natura2000 area.
5. Sweden has not determined any concrete and quantified goals for reduction of N losses in connection with water action plans.
6. There are about 100 machine pools in Sweden with at least some agriculture related business. We estimate on basis of contact to 25 of them that about 3.5 million tons of slurry is spread by thirty machine pools in Sweden. It corresponds to about 15% of the annual slurry production.
7. There are no separate measures to reduce ammonia emissions, but emission reductions sought via other legislation, such as the environmental permitting.
8. 35 farm based biogas plants produced in 2015 314,895 tonnes (wet weight) of digestate, all used as organic fertiliser.
9. There are no exact statistics on holdings with more than 150 dairy cows, but from available statistics it is assumed that between one third and half of dairy cattle herds have more than 150 dairy cows.

Shown on a spider web the evaluation of the key indicators for the market potential for slurry acidification in Poland looks like shown here:

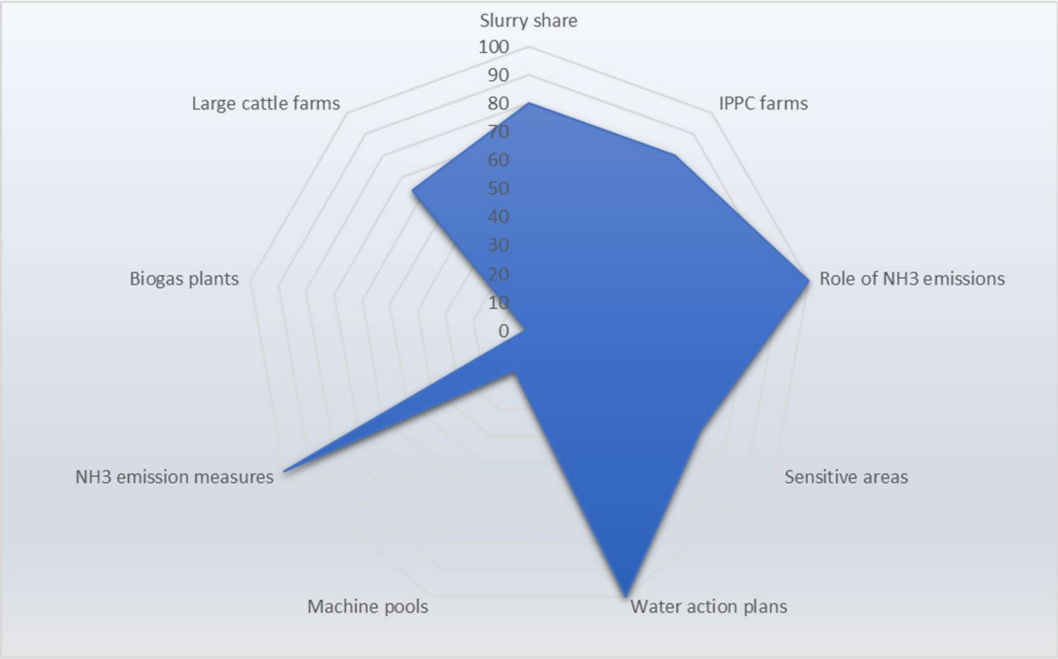

Figure 8: Spider web for Swedish SAT market potential.

Sweden scores high on water action plans and NH3 emission measures. The total of the subjective scoring is 610 and the weighed potential for slurry acidification thus estimated to be 13.4 million tons. The production of this amount of acidified slurry would require 289, 151 and 225 installations, respectively for in-house, in-storage and in-field slurry acidification.

3.10: Belarus

The conclusions concerning the nine parameters are as follows:

1. In total, the annual manure production in Belarus is 72.4 million tons, including 45.6 million tons slurry. The share of slurry is thus 63%.
2. 106 pig farms and 45 poultry farms are according the above information above the size threshold and would need environmental approvals if EU's Industrial Emissions Directive were applied in Belarus.
3. Ammonia emissions from Belarus livestock farms is considered, and the farms imposed an excise tax on basis of their emissions, except in cases where they use a single tax payment system.
4. No specific nitrogen sensitive areas are designated in Belarus. Specially protected natural areas of Belarus cover 1,570 thousand ha (7.6% of the country area).
5. The main goals and tasks for water protection are shown in the Water Strategy of the Republic of Belarus until 2020. Whereas

emission of nitrogen to the environment has been lowered during the last years, there are no official and concrete goal for further reductions. Belarus has the goal to further reduce nitrogen emissions with 1.85 Kt per year according the current Country-Allocated Reduction Targets (CART), established under HELCOM. However, this is not seen as having connection to ammonia emissions.

6. No machine pools exists and all field operations are undertaken by each individual agricultural enterprise.
7. Belarus has regulations comparable to EU National Emissions Ceilings Directive. There are no specific measures taken to reduce ammonia emissions, but ammonia emissions are considered as part of the entire set of regulations for farming.
8. In the agricultural sector of the Republic of Belarus, 9 biogas plants with a total established output effect of 10,700 kWh is in operation. The annual output of digestate is about 1.2 million tons.
9. There are about 4,160 dairy farms with more than 200 cows.

Shown on a spider web the estimation of the key indicators for the market potential for slurry acidification in Belarus looks like shown here:

Country	Number	Average herd size
Denmark	974	180
Estonia	130	504
Finland	340 with > 100 cows	144[4]
Germany	15,969 farms with buildings for more than 200 animals in 2016	55[5]
Latvia	127	331
Lithuania	150	403
Poland	577	188

[4] This is the average size of >100 cows' dairy farms. The average size of all dairy farms in Finland is 35 cows.
[5] https://www.ciwf.org.uk/media/5235182/Statistics-Dairy-cows.pdf

Country	Number	Average herd size
Sweden	271 holdings with more than 200 dairy cows	286[6]
Belarus	4,160	App. 500
Russian BSR regions	320	ca. 500

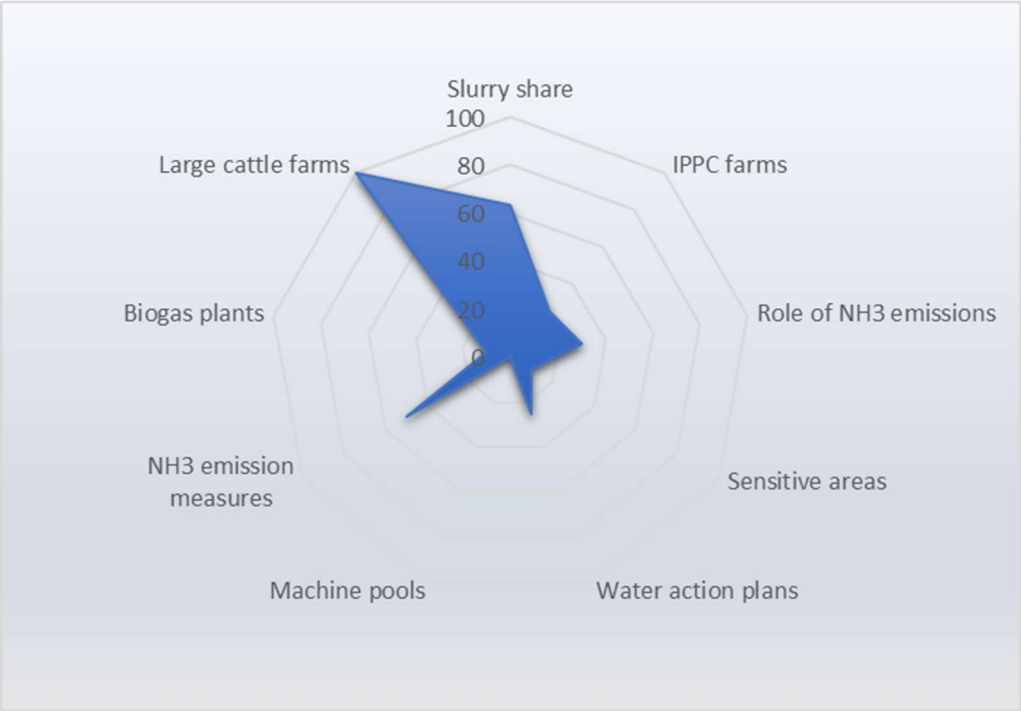

Figure 9: Spider web for Belarus SAT market potential.

The most favourable conditions for SATs in Belarus are the relatively high share of slurry and the high number of large cattle farms. The combined, subjective scoring of the market potential for Belarus is 310. Based on the availability of 45.6 million to slurry, the weighed market potential is estimated to be 14.3 million tons acidified slurry, produced with 307, 161 and 240 installations for in-stable, in-storage and in-field acidification, respectively.

However, implementation of the use of SATs in Belarus SAT would require huge efforts to educate heads of agricultural enterprises about the efficiency of SATs in saving nitrogen in liquid manure and about liming. Apart from this, training is needed concerning labour safety while working with H_2SO_4.

[6] Dairy cows plus other cattle

3.11: Russia (5 Russian regions, fully of mostly located within the Baltic Sea drainage area)

An evaluation of the market potentials for slurry acidification in Russia is that:

- Major negative impact from the Russian part of the Baltic Sea catchments area can be related with 5 Russian regions: Kaliningrad region, Leningrad region, Novgorod region, Pskov region and Republic of Karelia. In total, their area represents 90% of the Russian part of the Baltic Sea catchment.
- Total cattle capacity in the considered area coincides 345.4 thousand heads, including 154.7 thousand cows; 15 thousand goats and sheep; poultry population is 39,107.1 thousand heads; 1,356.8 thousand heads of pigs. Total manure production is 11.8 million tonnes annually. Slurry amount, potentially available for acidification, is 7.4 million tonnes (62.8% of total manure).
- There are 532 industrial enterprises in the considered area, including 200 falling under IPPC.
- Current environmental legislation regulates pollution emissions, including ammonia. It is expected that BAT introduction will cause tightening of regulations.
- Large-scale agricultural farms-enterprises own necessary machinery and equipment (machine pools), however for SATs introduction modernization is needed.
- There are no biogas plants in the considered area. Due to this all produced slurry can be considered as potential for SATs application.
- The number of cattle farms with > 150 dairy cows is 320 in the selected 5 regions of Russia. Average size of these farms is 500 dairy cows.
- Due to lack of experience in applying SATs in Russian conditions there is need for complex eco-environmental feasibility investigation, considering specific features of Russian legislation and different technical options of SATs introduction.

Spider web evaluation of the key indicators for the market potential for slurry acidification in Russia:

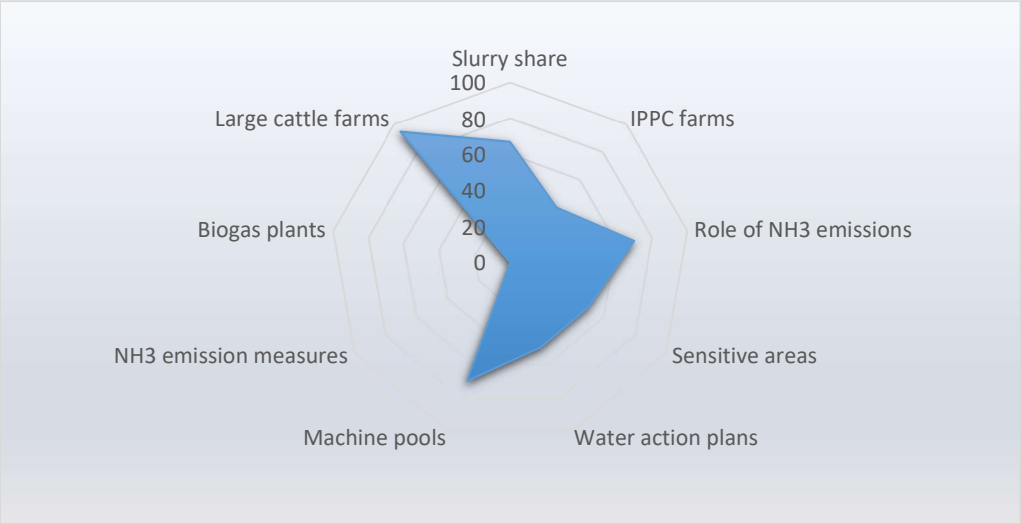

Figure 10: Spider web for 5 selected Russian regions' SAT market potential.

The most favourable conditions for SATs in the 5 regions are the machine pools, actually owned by the large agricultural enterprises themselves, and the high number of large cattle farms. The combined, subjective scoring of the market potential is 440. Based on the availability of 7,4 million to slurry, the weighed market potential is estimates to be 3.3 million tons acidified slurry, produced with 70, 37 and 54 installations for in-stable, in-storage and in-field acidification, respectively.

The analysis of the market potential[7] and conversion of the available slurry amounts into a potential number of SAT installations is done with the following assumptions:

- financing is available;
- legislation barriers are removed;
- technological problems are solved;
- no competing technologies, meaning SATs are more cost-effective than alternatives.

[7] According NWRIAEO experts

4: General references

- Commission Implementing Decision (EU) 2017/302 of 15 February 2017 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the intensive rearing of poultry or pigs (notified under document C(2017) 688) (Text with EEA relevance.) http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2017.043.01.0231.01.ENG
- Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control). http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0075
- European Commission, Joint Research Centre. 2015. Best Available Techniques (BAT) Reference Document for the Intensive Rearing of Poultry or Pigs (BREF). Final Draft. http://eippcb.jrc.ec.europa.eu/reference/BREF/IRPP_Final_Draft_082015_bw.pdf
- Foged, Henning Lyngsø and Natalia Oblomkova. 2017. Status for air quality in the Baltic Sea Region with respect to ammonia. http://www.enagro.eu/docs/article-Status_for_air_quality_in_the_Baltic_Sea_Region_with_respect_to_ammonia.pdf
- National Emission Ceilings Directive (NEC Directive – 2001/81/EC). http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32001L0081
- Peters, Karin. 2016. Introduction to slurry acidification. Presentation at International Slæurry Acidification Conference, organised by Danish Environmental Protection Agency, September 2016. http://eng.mst.dk/topics/agriculture/acidification/.

Annex A – Market information for Denmark

A.1: The share of livestock manure being produced in the form of slurry or other liquid manure

Denmark has according Eurostat 38,830 farm holdings, whereof 23,940 with livestock. The number of livestock of different type is seen from the following table:

Table 13: Number of livestock of different type in Denmark.

Livestock type	Number
Equidae	57,250
Cattle, total	1,614,640
Dairy cows	582,340
Sheep	151,300
Goats	12,090
Pigs	12,075,750
Broilers x 1000	13,220
Hens x 1000	5,670
Poultry, other x 1000	540
Rabbits, females	880

Following a method that is like the one used by Foged et al. (2011), the total manure production is in the level of 33 million tonnes in Denmark, and it is estimated that about 27 million tonnes is in liquid form, such as slurry and liquid manure, and therefore feasible for slurry acidification. The assumptions for these estimates include a suggestion of 86% of all cattle manure in Denmark being produced in the form of slurry, and 84% for pigs. Almost 95% of all livestock manure in Denmark are produced by either cattle or pigs.

However, the figures are not adjusted for water evaporation and dilution, which are due to the feed type, water spillage, water sprinkling, cleaning of stables and milking parlours, and water evaporation from surfaces. Birkmose & Tybirk (2013) has indicated

that this for fattening pigs may be up to as much as 240 litres of water, equal to an increase of about 50% of the slurry production from a fattening pig. However, an average water dilution is smaller according to SEGES (2009), which on the other side informs, that the normal level of washing water for a sow is 340 litres per year, and 3,000 litres for a dairy cow.

In addition, almost 20% of the livestock manure is currently being anaerobically treated in biogas plants in Denmark. In that connection, there are typically used 25% non-livestock manure influent, such as food wastes, silage and haylage, while a part of the treated livestock manure is deep litter. The output of liquid manure (digestate) from agricultural biogas plants are thus, all in all larger than the manure input volumes. It is in this connection important to notice that it technically and according Danish legislation is decided that all influents becomes livestock manure (in processed form) after being co-digested with livestock manure.

Despite a limited loss of organic matter from livestock manure during the supply chain from production to field spreading, there are all in all a higher amount of liquid manure available for slurry acidification than the indicated 27 million tonnes per year. Due to the net amount of water evaporation and dilution, as well as the part that are liquefied and added in biogas plants, the total livestock manure production may be in the level of 38 million ton per year, and the amount that is available for slurry acidification may be about 32 million tonnes. However, it could in some cases be questioned, whether digestate is feasible for slurry acidification.

It is estimated that 80% of the slurry, equal to 26 million tonnes slurry, is spread on fields by use of trailing hoses, while the rest app. 6 million tonnes are spread by use of injection.

The total livestock manure production in Denmark is estimated to be 38 million ton per year, whereof 85%, or 32 million ton per year is feasible for slurry acidification.

A.2: The number of facilities for intensive rearing of poultry and pigs according the Industrial Emissions and as well for cattle, and those who produce slurry

Denmark has according to Table 1.2 of the Final Draft of the Best Available Techniques (BAT) Reference Document for the Intensive Rearing of Poultry or Pigs (BREF) (European Commission, 2015) 1,433 farms that require an environmental approval according the Industrial Emissions Directive (IED), whereof 1,233 pig farms (both fattener and sow farms).

However, the Danish Law on Environmental Approval of Livestock Holdings is stricter than required by the IED. The law applies for all livestock holdings that keep more than 3 Animal Units (AU), who have to seek an approval in case of expansion or change of their production to a more polluting production.

Animal Units

One Animal Unit is defined as the number of animals that produce 100 kg N ex storage per year. Manure that exits the storage (and enters the field) has typically lost 15-25% of its nitrogen content via ammonia emissions etc. in comparison to the quality of it at excretion.

However, the Animal Unit is being phased out along with phasing in of new environmental regulation, which also will take phosphorus into consideration.

Animal Units is a pure Danish unit. It should not be mixed with the Livestock Unit, defined by EU, which is a grazing equivalent without direct correlation to the environmental burden of the livestock, but often misunderstood as such.

Generally speaking, there are five livestock holding size categories in connection with environmental permitting of livestock holdings in Denmark:

- <3 AU: No specific approval or notification needed.
- 3-15 AU: The livestock holding must notify the competent authorities of changes in the production.
- 15-75 AU: A so-called article 10 approval is needed. Requirements for the approval are relatively simple and do for instance not comprise requirements for use of Best Available Techniques, but includes a public hearing.
- 75-250 AU: The conditions for environmental approval after article 11 could comprise the use of Best Available Techniques to reduce the environmental impacts of the production.
- >250 AU (250 AU is approximately equal to the thresholds for herd sizes given by article 6.6 of the IED Annex I): The appraisal is more complicated and would include an environmental impact assessment and a public hearing before an article 12 approval is given.

A Cabinet Regulation on Livestock Manure (BEK nr. 1318 af 26/11/2015) defines the issues that are regulated at livestock farms and have to be complied with as general requirements for issuing of environmental permits. These issues comprise e.g. the storage and use of the livestock manure, as well as cross compliance conditions and distance requirements for facilities.

Ammonia emission from the land for field spreading of livestock manure that is produced at a livestock holding with an environmental

permit is regulated via article 16 and in relation to designated nature protection areas, water action plans, habitats and several other types of areas that are designated as sensitive to ammonia emissions or other pollution from the use of livestock manure.

Currently, an environmental permit comprises both the facilities and the land. However, there are plans to separate environmental permitting for the production facilities and the land, and to regulate the land under general provisions.

An estimate of 23,940 holdings with livestock in Denmark needs an environmental approval, assuming that all Danish livestock holdings have more than 3 AU, and that herds with less than 3 AU are kept at non-agricultural holdings, which according the Danish Law on Agricultural Holdings have less than 2 ha. The environmental approval is alone considering Best Available Techniques for livestock farms with more than 75 AU, which on basis of information from Statistics Denmark is estimated to be roughly one third of the cattle herds, or 4,000 cattle herds, and three quarter of the pig herds, or about 3,000 pig herds. These ~7,000 pig and cattle herds with more than 75 AU would, according our estimates and with only a few exceptions, all produce slurry as the main type of livestock manure.

A.3: The role (at present or envisaged) of ammonia emissions in the administrative practices concerning environmental permitting according the IED

The role of ammonia emissions in the administrative practices concerning environmental permitting of livestock holdings has been investigated by reviewing concrete examples of article 11, 12 and 16 environmental permits. These permits are freely accessible and published on the homepages of the competent authorities, the municipalities. The reviewed examples comprise:

- An article 11 environmental permit (http://www.naestved.dk/~/media/Naestved_Kommune/Erhverv_media_ny_struktur/MiljoetilsynLandbrugVirksomhed/Landbrug/Miljoegodkendelser/Blegebjergvej%20_1_Miljogodkendelse.ashx?la=da), issued to a beef cattle farm with 147 suckler cows + young stock and bulls, kept at two sites. The environmental permit includes a presentation of extensive analyses of the impacts of ammonia emissions from the herd, taking into consideration various nature types, such as Natura2000 areas, habitats and other sensitive nature. Also, other farms in the area that on beforehand contribute to ammonia emissions are taken into account in relation to the sensitivity of the nature. The permit is in this connection given without requirements for use of BAT

because the ammonia evaporation is kept under defined threshold values.

- An article 12 environmental permit (https://www.aabenraa.dk/media/861009/miljoegodkendelse-oerslevvej-28-6230-roedekro.pdf) for a farm that expands to 1.300 mother sows, 1.700 fatteners and 400 sheep. The permit includes a detailed analysis of ammonia emissions form the production facilities, stables and manure storages, taking into consideration various nature types, such as Natura2000 areas, habitats and other sensitive nature. A general ammonia emission reduction of 25%, compared to best reference facilities must be achieved according the law for environmental permitting of livestock holdings. In this case, the decision is to use slurry cooling as one of the preferred BATs, with an expected ammonia emission reduction effect of 19%, and a number of other BATs, including, among other, phase feeding, tent cover on slurry tanks, and injection of slurry close to sensitive areas.
- An article 16 environmental permit (http://www.wss.struer.dk/documents/Dokumenter/Ny%20hjemmeside/Plan%20og%20Milj%C3%B8/Afg%C3%B8relser/Husdyrbrugsloven/Arkiv/2014/%C2%A7%2016%20Godkendelse%20-%20Lindeborgvej%2019.pdf) of a 90,95 ha crop-farm that received livestock manure (deep litter) from a livestock farm, and digestate form a biogas plant – both suppliers have environmental permits. The nitrogen content of the received deep litter and digestate has been equal to 139 kg per ha (1,39 AU per ha). The permit is given for spreading of deep litter and digestate equal to maximally 119 kg N per ha, due to the location of the fields in relation to e.g. Natura2000 areas. There is no ammonia sensitive nature close to the fields, wherefore the permit is given without requirements to BAT's for ammonia emission reduction.

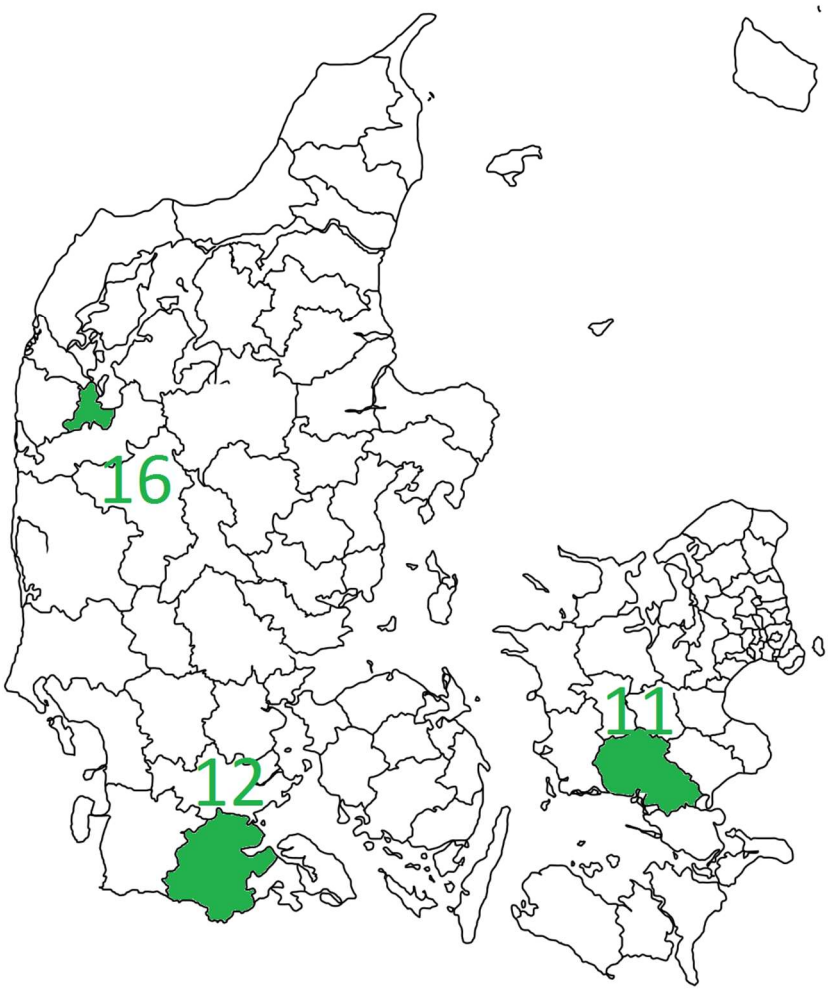

Figure 11: Location of the municipalities, Næstved – 11, Åbenrå – 12 and Struer - 16, for the given examples of environmental permits.

In Denmark, ammonia emissions are always considered as part of the appraisal of environmental permit applications for livestock holdings with more than 75 Animal Units, equal to an annual production of 7.500 kg nitrogen in the livestock manure, and for land fertilised with livestock manure from facilities with environmental permits. Permits to facilities with more than 75 Animal Units (article 11 and 12 permits) are always conditioned use of BAT's with an effect defined by the law, e.g. currently 30% for sows, compared to best facilities without use of BATs.

A.4: The designation of areas that are specially sensitivity to pollution according the Nitrates Directive and the Habitats Directive

The entire Danish territory is designated as Nitrate Vulnerable Zone according the Nitrates Directive (91/676/EC).

Denmark has according the Habitats Directive (92/43/EC) and the Birds Directive (2009/147/EC) designated 252 Natura2000 areas that covers 8,3% of the area of Denmark and 17,7% of Danish sea area.

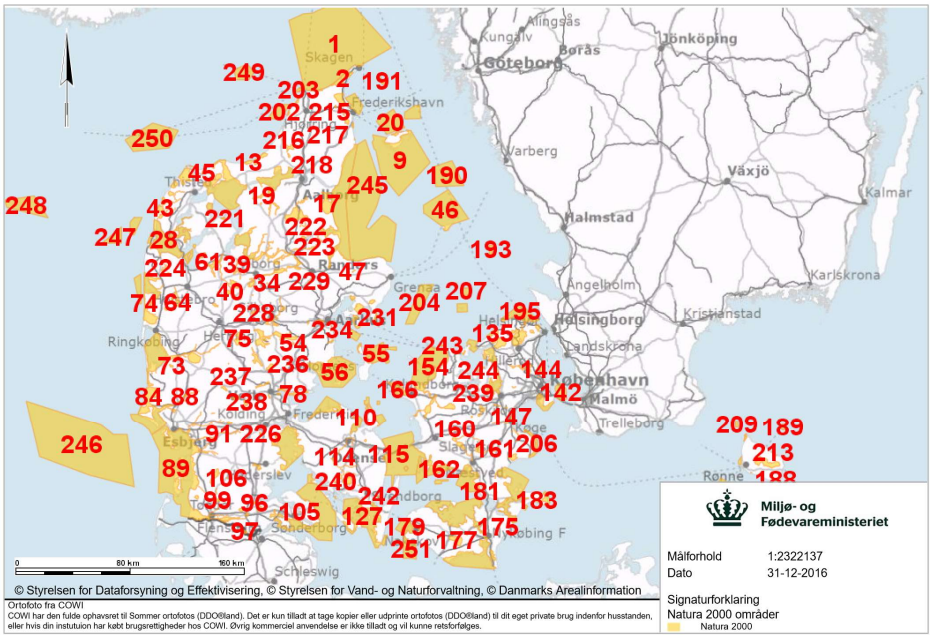

Figure 12: Danish Natura2000 areas.

A.5: The role of nitrogen in water action plans in relation to the Water Framework Directive

The history of water action planning in Denmark started in 1985 with a so-called NPO plan, was followed by Water Action Plans I, II and III, continued with a Green Growth Agreement, and currently the so-called Agricultural Package launched in 2016.

An overview of the main Action Plans until 2015, including their main components, are seen at - http://mst.dk/media/mst/69160/Overview%20of%20APAEs%20and%20the%20Green%20Growth%20Agreement.pdf.

As a result of the water action plans, there has been registered a substantial reduction of the nitrogen load on the environment from farming, as seen from the following figure.

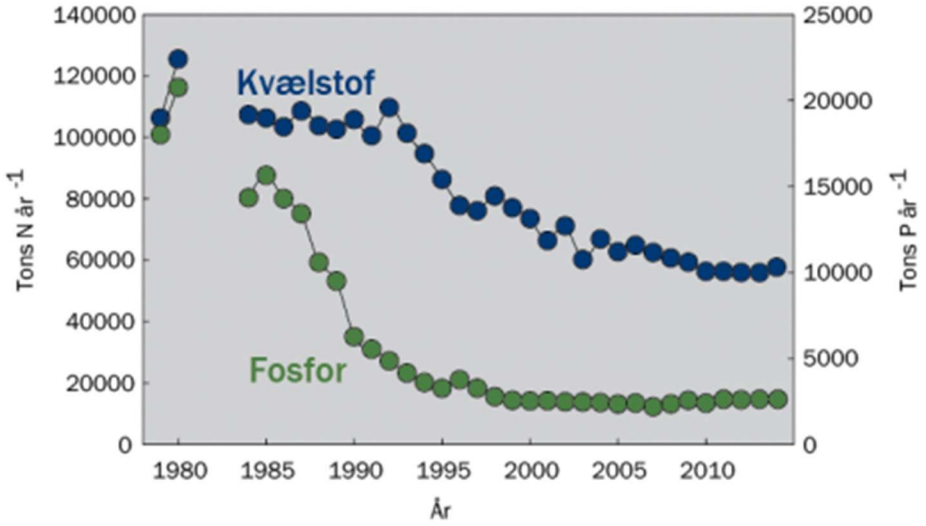

Figure 13: Development in nitrogen loss (blue) and phosphorus loss (green) in Denmark (Source: http://videnskab.dk/miljo-naturvidenskab/naturen-saetter-en-graense-havet-er-et-rammevilkar-danske-landbrug)

Compared to earlier water action plans, the current "Agricultural Package" is not expected to have major influence on the nitrogen loss from farming, but is focused on streamlining and cleaning up the complex legal framework for farming. The current target is a app. 6,000 tonnes reduction of N-loss from farming in the years 2016 to 2021. The means to achieve the reduction includes introduction of emission-based regulation of farming with diversified fertiliser norms, as well as collective measures, such as afforestation.

A.6: The existence of machine pools to service farms with field spreading of manure

In Denmark, there exists a large network of machine pools and contractors, who provide field operation services to farms, such as spreading of slurry. The machine pools have a joint association, DM&E, with the webpage *http://www.dmoge.dk*, whose secretariat informs that they have 167 machine pool members that are specialized in farm operation services, and in addition 213 members, who in addition to farm operation services also offers services to other sectors, such as road and building construction sectors.

It is further informed that Danish farms' total use of machine pools had a value of M€ 400 in 2016.

Slurry spreading is among the most common services provided by Danish machine pools, whom according DM&E analyses are spreading app. 22 million ton of slurry each year, which according the above (question 1) corresponds to a bit more than three quarter of the total slurry production in Denmark.

When it comes to slurry acidification, the share that is undertaken by machine pools may be smaller due to the fact that a subsidy for the investment in slurry acidification has included conditions about the beneficiaries' ownership of farmland. Therefore, a relatively larger share of in-field slurry acidification is performed by private farms on their own land.

A.7: The possible existence of ammonia emission reduction measures to implement the National Emissions Ceilings Directive

A typical feature of Danish legislation is that it implements EU legislation and policy targets across a number of regulatory measures, which is also the case for ammonia emission reductions.

The Danish Government had in 2001, in the same year as the NEC Directive came, approved an Ammonia Action Plan, which included measures to reduce the emissions to 69,000 ton in 2003. The measures included for instance a ban of ammonia treatment of straw, ban of broad-spreading of slurry and tighter rules on storage of manure. The Ammonia Action Plan was a major reason for the reduction of ammonia emissions from 124 to 73,000 ton in the period 1990 to 2012.

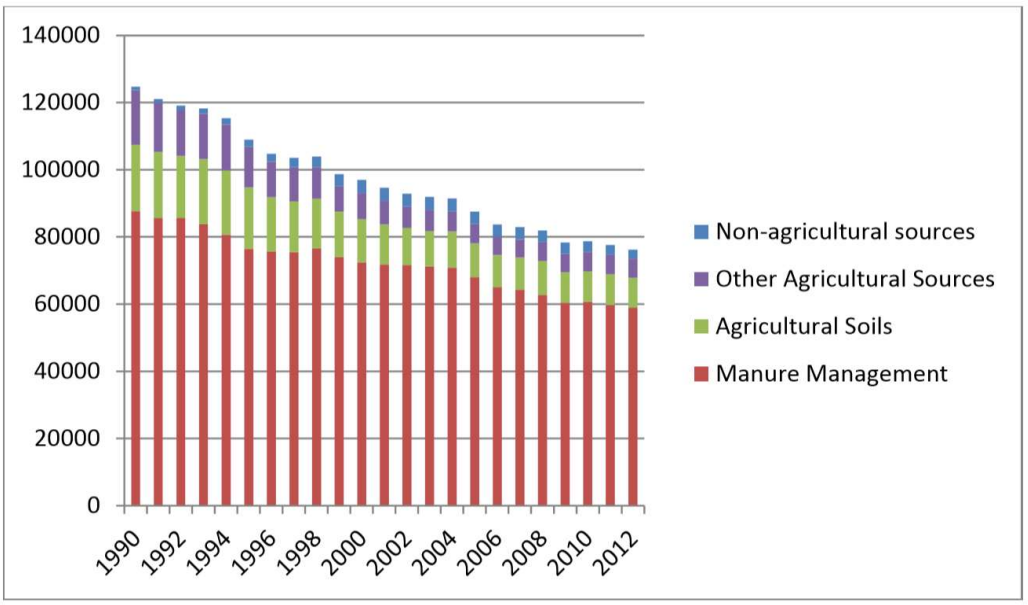

Figure 14: The development in emissions of ammonia in ton NH3. The category "Non-agricultural Sources" include all emissions from the following sectors: Energy (including Mobile sources), Industry and Waste. The category "Other Agricultural Sources" is comprised of: Crops, Field Burning, Sewage Sludge, Ammonia Treated Straw. (DCE 2014b).

Denmark shall according the Gothenburg Protocol reduce ammonia emissions with 24% in the period 2005-2020, and remain on that level until 2030.

As mentioned, the attainment of the NEC Directive-based targets for ammonia emission reduction is in Denmark not implemented via measure that are specifically linked to the NEC Directive. The ammonia emission reduction targets are achieved via a number of relevant regulations, such as the environmental approval of farms, the Nitrate Directive-based Action Programme, the regulations introduced via the various water action plans, and more.

A.8: The number of agricultural biogas plants

There are according the Danish Energy Authority (https://ens.dk/sites/ens.dk/files/Bioenergi/liste_over_biogasanlaeg_september2016.pdf) 166 biogas plants in Denmark in 2016, including 53 installed at wastewater treatment plants, 28 at landfills, 49 at individual farms, while 27 are established as regional agricultural biogas plants. See the map below.

The regional biogas plants and those placed at individual farms are agricultural biogas plants, meaning they mainly produce biogas on basis of livestock manure, while up to 25% of the influent is non-manure material. The Danish Government has decided that subsidies for biogas production is conditioned that maximally 25% energy crops are used as input material, and that maximum is reduced to 12% from 2018. An exception is clover grass and grass from organic farms, and grass from areas that has not been ploughed for at least 5 years. These rules favour the use of livestock manure in Danish agricultural biogas plants, and have the effect that the digestate amounts are up to 33% higher than the input amounts of livestock manure. There are no official or updated statistics for the amount of digestate from agricultural biogas plants in Denmark. Foged et al. (2009) estimated that Danish agricultural biogas plants had a capacity to treat 3,4 million tonnes per year, whereof 2,5 million tonnes of livestock manure.

The Danish Biogas Association has estimated a 100% increase in the biogas production in the period from 2011 to 2016, meaning that currently there would be an estimate of at least 2 x 2,5 = 5 million tonnes of livestock manure treated at Danish agricultural biogas plants, and that the amount of digestate is about 6,8 million ton per year.

The increase in the production is supported by a policy goal of reaching 50% of all livestock manures being anaerobically treated by 2020. Favourable conditions have made existing biogas plants expand their production and new plants established. The largest increase in the production capacity happens at the regional biogas plants. However,

despite current 2-digit annual growth rates in the Danish agricultural biogas production, it would be unlikely that the goal of 50% by 2020 is reached as this would require annual growth rates of 31% in the years 2017-2020.

The estimated minimum of 5 million tonnes of livestock manure that currently is anaerobically digested in Denmark corresponds to at least 14% of the entire Danish livestock manure production, or 17% of the liquid manure and slurry that is available for slurry acidification.

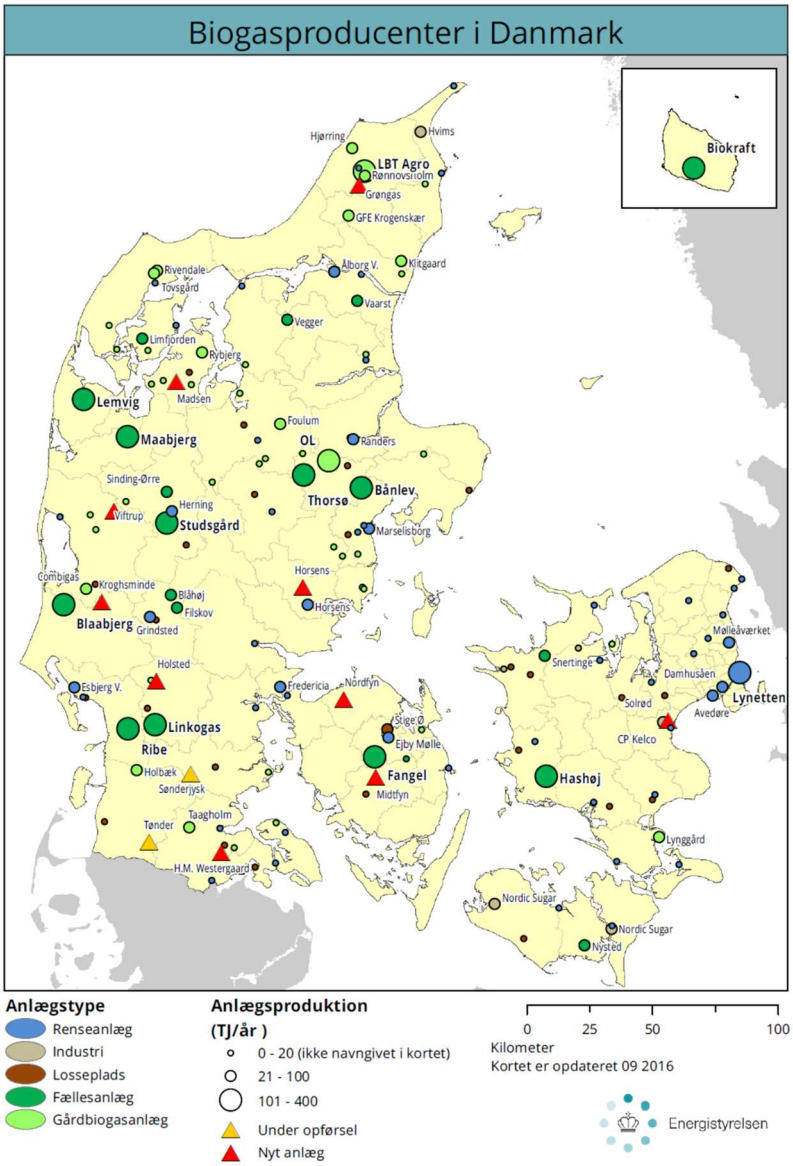

Figure 15: Map of Danish biogas plants 2016.

A.9: Number of cattle farms > 150 dairy cows, and the average size of them in terms of number of dairy cows

There were according Denmark's Statistics 974 herds with more than 150 dairy cows in Denmark in 2015.

A.10: References

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A.11: List of people met

- Mogens Kjeldahl, DM&E Agro, kjeldal@dmoge.dk, tel. +45 7641 3675 (via telephone)

Annex B – Market information for Estonia

B.1: The share of livestock manure being produced in the form of slurry or other liquid manure

Table 14: Table Number of animals in Estonia 2009-2015. Estonian Statistics (http://www.stat.ee/34218). Thousands of animals.

	2008	2009	2010	2011	2012	2013	2014	2015
Cattle	237,9	234,7	236,3	238,3	246,0	261,4	264,7	256,2
..dairy cows	100,4	96,7	96,5	96,2	96,8	97,9	95,6	90,6
Pigs	364,9	365,1	371,7	365,7	375,1	358,7	357,9	304,5

In 2009 the amount of solid manure was 695,000 t per year, from which cattle manure was 656,000 t per year and in pig manure 39,000 t.

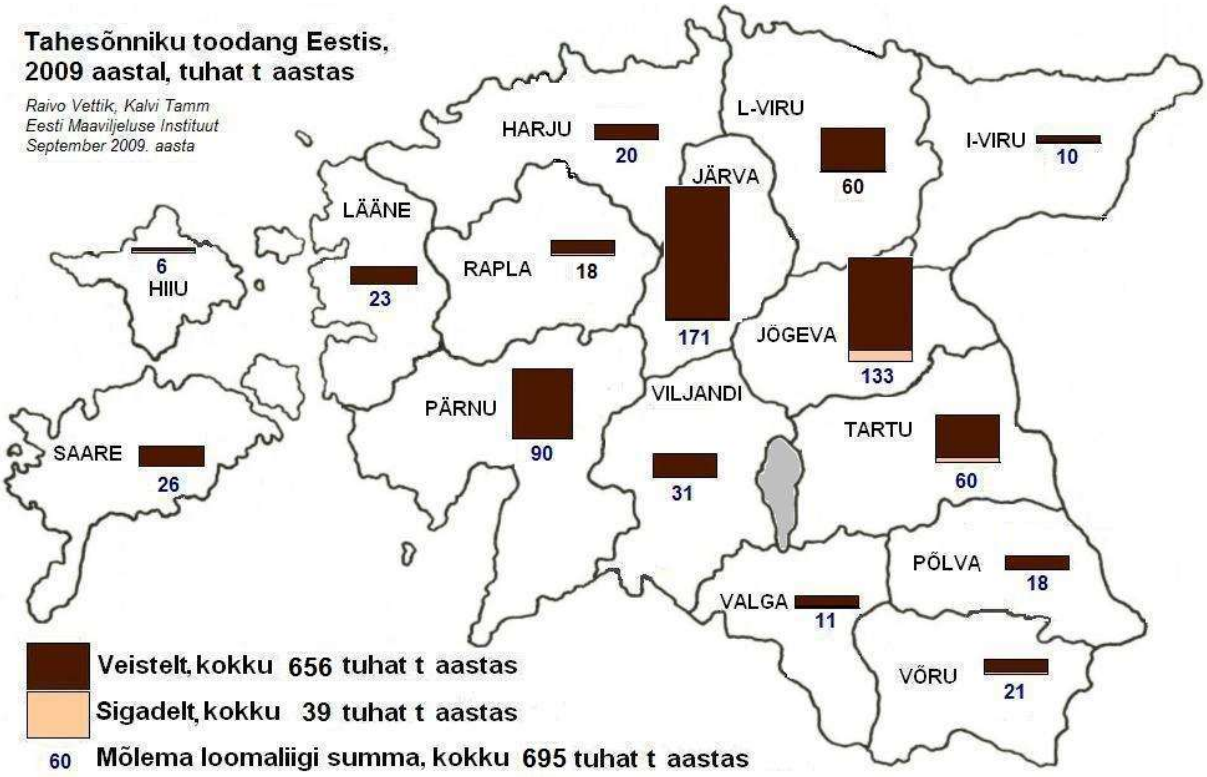

Figure 16: Amount of solid manure in Estonian pig and cattle farms which belong in group- intensive rearing of cattle and pigs according the Industrial Emissions Directive. Dark brown –cattle manure and light brown –pigs manure.

The amount of liquid manure was 1,500,000 t per year, from which cattle manure was 1,036,000 t per year and in pig manure 464,000 t.

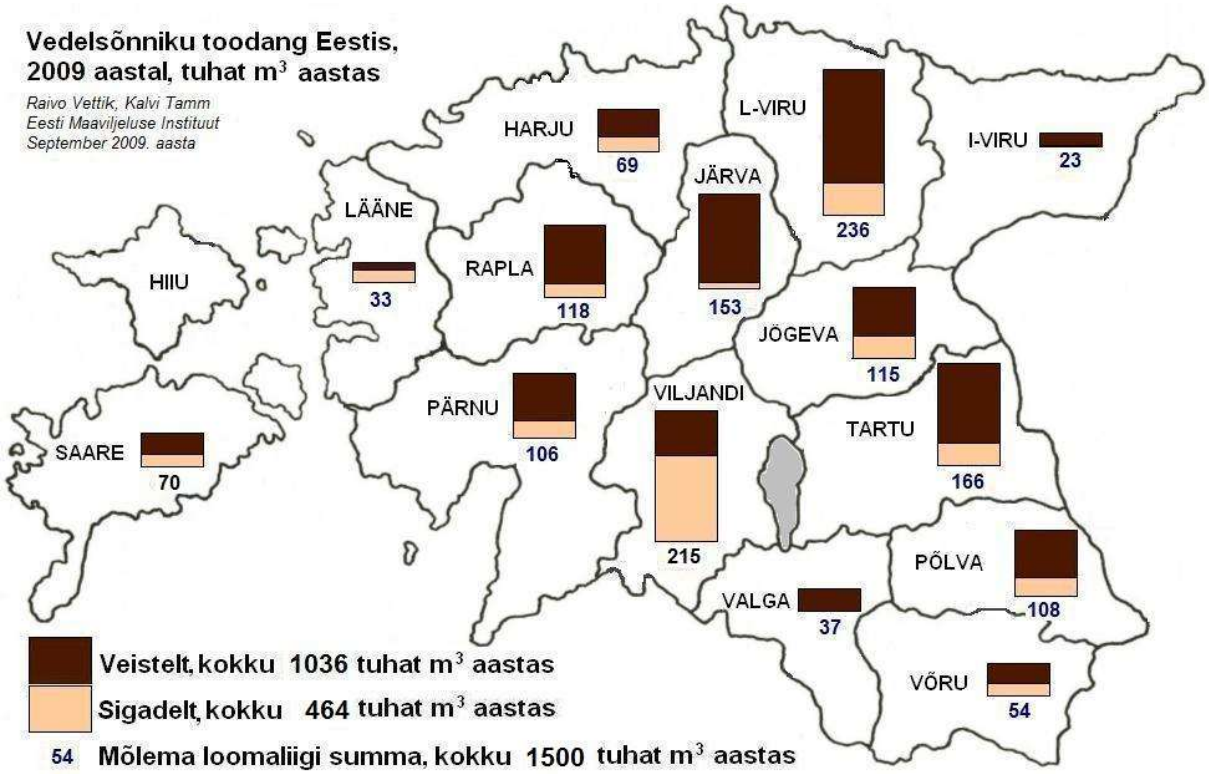

Figure 17: Amount of liquid manure in Estonian pig and cattle farms which belong in group- intensive rearing of cattle and pigs according the Industrial Emissions Directive. Dark brown –cattle manure and light brown –pigs manure. Source: Tamm & Vettik, 2011.

The share of liquid manure from total amount is 68%.

B.2: The number of facilities for intensive rearing of poultry and pigs according the Industrial Emissions and as well for cattle, and those who produce slurry

62 pig facilities and 190 cattle facilities in 2009.

Source: Tamm, K., Vettik, R. 2011. Sõnniku liigiline jaotus Eestis ja selle toitainete rahaline väärtus. Agronoomia 2010/2011, lk 231-236 (Tamm, K., Vettik, R. 2011. Allocation of different types of manure in Estonia and monetary value of manure nutrients – Agronomy 2010/2011, 231–236)

9 poultry, 45 pig and 108 cattle facilities in March 2017.

Source: Keskkonnaamet. Keskkonnaload. Keskkonnakompleksluba.

https://eteenus.keskkonnaamet.ee/?page=eklis_list&desktop=1017&act=avalik_info&tid=2234

B.3: The role (at present or envisaged) of ammonia emissions in the administrative practices concerning environmental permitting according the IED

In the environmental permitting process is required to use Best Available Techniques to reduce ammonia emissions. These BATs are composed for cattle, pig and poultry production, whole manure handling chain.

Sources:

http://www.ippc.envir.ee/docs/PVT/PVT_Veised-t2iendatud111007.pdf

http://www.ippc.envir.ee/docs/PVT/sead-linnud-pvt%20eesti%20k.pdf

B.4: The designation of areas that are specially sensitivity to pollution according the Nitrates Directive and the Habitats Directive

In Estonia is the portion of Nitrate Vulnerable Zones 7.2%

Source:
http://www.envir.ee/sites/default/files/nitrate_report_2016_estonia.pdf

In Estonia, the share of Nartura2000 area is 17%.

Source: http://www.envir.ee/et/natura-2000

By the regulations in Estonian Water Act (Veeseadus).

The max amount of N with mineral fertilisers is 100 kg per year.

Up to 1,5 animal unit per hectare.

50 m buffer zone to well.

30% of arable lands should be covered with plants in the period 30 November – 31 March. 1/3 from this are may be replaced with stubble incorporation.

B.5: The role of nitrogen in water action plans in relation to the Water Framework Directive

By the information of Estonian Ministry of Environmental Issues, there is no fixed number about reduction of N losses set in Estonian water action plans. However, these plans are connected to the HELCOM goals and Baltic Sea action plans. In the Convention on the Protection of the Marine Environment of the Baltic Sea Area, the Ministerial Declaration 2013 defines that Estonia has an obligation to reduce the amount of N reaching the sea by 1,800 t yearly (HELCOM 2013).

According to Estonian Water Act (Water Act, 2016) every arable hectare may be fertilised yearly with up to 170 kg nitrogen, including manure left by pastured animals.

Time for manure spreading:

Liquid manure cannot be spread from 1 December until 20 March or any other time, when the soil is frozen, covered with snow, periodically flooded or saturated with water	Today in act
Liquid manure cannot be spread from 15 November until 20 March or any other time, when the soil is frozen, covered with snow, periodically flooded or saturated with water. Environmental Board can vary spreading brake time start date according to weather and growing conditions from 1 November.	From 1.1.2018 onwards
Liquid manure cannot be spread from 1. of November until 20 March or any other time, when the soil is frozen, covered with snow, periodically flooded or saturated with water. Environmental Board can vary spreading brake time start date according to weather and growing conditions from 15 October.	From 1.12.2018 onwards
Liquid manure broadcast spreading is forbidden from 20 September until 20 March or any other time, when the soil is frozen, covered with snow, periodically flooded or saturated with water.	Today in act
Solid and deep litter manure or any other organic fertilisers cannot spread from 1st of December until 20 March or any other time, when soil is frozen, covered with snow, periodically flooded or saturated with water.	Today in act

Farm keeping over 300 animal units and with slurry production, or enterprises spreading slurry by contract in amount corresponding to more than 300 animal units, have to prepare a slurry spreading plan before slurry spreading. The plan should contain information on the amount of spread slurry, area for distribution, the spreading method, and the protection level of groundwater, the open surface water bodies and water catchments.

The slurry application plan should be approved before application by Environmental Board. The plan is approved for three years. If the slurry amount increases, then the animal owner asks for improvement of existing plan or declares the new application plan. The animal owner

has to preserve the slurry application plan for one year after slurry application.

B.6: The existence of machine pools to service farms with field spreading of manure

Data from machine pools offering slurry spreading service in Estonia, 2015.

Table 15. Amount of slurry spread by machine pools in Estonia with different technology, all figures in 1,000 tons. ND = no data available. All figures in 1,000 tons. Source: Representatives in corresponding firms.

		Disc incorporator	Disc injector	Trailing hose	Total	No of spreaders
1	Baltic Agro AS	365	35		400	5
2	Tuulemaa OÜ	250	20		270	4
3	OÜ Hercule	ND	ND	ND	ND	ND
4	Impeerium OÜ	ND	ND	ND	ND	ND
5	Masareelia OÜ	ND	ND	ND	ND	ND
6	AS Rakvere Farmid			98	98	3
	Total	615	55	98	768	

Disc incorporator. The slurry is mixed with the soil in tillage depth. The device is used on arable lands.
Source:
http://www.joskin.com/?page=outils_epandage&model=terradisc&user_lang=en

Disc injector. The slurry is injected to the slots cut by discs. The device is generally used on grasslands.
Source:
http://www.joskin.com/?page=outils_epandage&model=solodisc&user_lang=en

B.7: The possible existence of ammonia emission reduction measures to implement the National Emissions Ceilings Directive

There are no specific ammonia emissions reduction measures implemented in Estonian legislation. However, in the following table are listed some provisions of Estonian Water Act (Water Act, 2016), which primarily are targeted reduction of nitrogen loss to the aquatic environment via leaching and runoff, but which to some extent also influence on ammonia evaporation.

Table 16. Provisions of Estonian Water Act (Water Act, 2016).

Issue	Decision	Enforcement date
Liquid manure broadcasting	Liquid manure broadcast spreading is forbidden from 20 September until 20 March or at any other time, when the soil is frozen, covered with snow, periodically flooded or saturated with water.	Today in act
Manure incorporation on bare soil	The manure spread on bare soil must be incorporated to soil as soon as possible, but not later than in 48 hours.	Today in act
	The manure spread on bare soil must be incorporated to soil as soon as possible, but not later than in 24 hours after the finishing of manure spreading.	From 1.1.2021 onwards
Manure spreading on fields with plant coverage	Fields with plant coverage can receive manure during November only, if the manure is incorporated to the soil within 48 h.	Today in act
	Solid and deep litter manure can be spread to the fields with overwintering plant coverage until 15 October. Liquid manures must be spread with injector or incorporation into the soil after 20 September.	From 1.1.2021 onwards

B.8: The number of agricultural biogas plants

5 biogas plants: Jööri, Oisu, Ilmatsalu, Aravete ja Vinni.

Source: Peep Pitk., +37255604106

Table 17: Performances of Estonian biogas plants (Puks. 2017)

Biogas plant	Electric power, kW	Heat power, kW
Jööri	350	420
Aravete	2000	2000
Oisu	1200	1200
Ilmatsalu	1450	1500
Vinni	1363	1409

B.9: Number of cattle farms > 150 dairy cows, and the average size of them in terms of number of dairy cows

In Estonia are 130 farms, which have over 150 dairy cows, they have 65,454 dairy cows in total, and thus the average is 503.5 cows per farm. These data are representing the situation on 03.04.2017.

Source: Estonian Agricultural Registers and Information Board.

B.10: References

- Tamm, K., Vettik, R. 2011. Sõnniku liigiline jaotus Eestis ja selle toitainete rahaline väärtus. Agronoomia 2010/2011, lk 231-236 (Tamm, K., Vettik, R. 2011. Allocation of different types of manure in Estonia and monetary value of manure nutrients – Agronomy 2010/2011, 231–236)
- Estonian Statistics. Number of animals in Estonia 2009-2015. (http://www.stat.ee/34218)
- Source: Puks, Peter (2017) Taastuvenergia tootmise perspektiivid biogaasijaama juhtide hinnangul. [lõputöö] [en] Renewable Energy Production Perspectives According to the Opinions of Biogas Plant Directors. http://eprints.tktk.ee/2815/1/PETER%20PUKS_LOPUTOO_loplik%20versioon_16.05.17.pdf
- HELCOM 2013. HELCOM Copenhagen Ministerial Declaration http://www.helcom.fi/Documents/Ministerial2013/Ministerial%20declaration/2013%20Copenhagen%20Ministerial%20Declaration%20w%20cover.pdf

Annex C – Market information for Finland

C.1: The share of livestock manure being produced in the form of slurry or other liquid manure

Table 18: Number of livestock and their manure production in Finland.

Cattle	1,000 animals	Type of manure	Manure produced per animal m^3/year	Total amount of manure, million m^3/year	Amount of slurry, million m^3/year
Cows	909	dry manure 70%	20	12.54	3.76
from which dairy cows	282	dry manure 55% / slurry 45%	27	7.61	3.42
Pigs	1,230	slurry 85%	2.5	2.82	2.40
from which sows	102	slurry 85%	10	1.02	0.87
Birds	12,400	dry manure 100%	0.015/0.04	0.3	-
Lambs	155	dry manure 100%	1.3	0.2	-
Horses	75	dry manure 100%	17	1.28	-
Total				17.1	6.16

Share of slurry/liquid manure from total amount of manure is: 36%.

Slurry spreading techniques used in Finland (data from 2010):

- injection - 31%
- surface-spread - 20%
- surface-spread with tillage within 24 hrs - 48%

The field area spread with slurry is approx. 16% of total field area = approx. 360,000 ha.

The field area spread with other liquid manure is 3% of total field area = approx. 68,000 ha.

C.2: The number of facilities for intensive rearing of poultry and pigs according the Industrial Emissions and as well for cattle, and those who produce slurry

In Finland, there are farms with

- more than 1500 pigs = 77
- more than 750 sows = 25
- more than 40,000 birds (poultry) = 15

(data from 2015)

C.3: The role (at present or envisaged) of ammonia emissions in the administrative practices concerning environmental permitting according the IED

Environmental permission is required nearly from all cattle farms, the minimum size is 30 cows, 210 pigs and 10,000 birds. Practically all pig and poultry farms require environmental permission and from dairy farms 30% is under the environmental permission but the structural changes in farm sizes changes this situation rapidly.

Number of farms that require environmental permission based on the previous-mentioned criteria

- Pig farms = 680
- Poultry farms = 400
- Dairy farms with more than 30 cows= 3,392 (total 7,285)

Nitrates directive (explained closely in question 4) are followed in environmental permissions but the regulations may be stricter, especially concerning the placement of the buildings in relation to water areas and concerning the structural requirements. In the environmental permission, the requirements to decrease ammonia emissions follow closely measures to decrease smell discomfort. There are no settled criteria for the placement of the cattle farm in terms of ammonia emissions but it is determined case by case.

The most common requirement in environmental permissions to decrease ammonia emissions is that the slurry storage tank has to be covered. More recently, BAT requirements have been published for pig and poultry farms (but not for dairy farms). That means that in the

future there will be more practical requirements how the ammonia emissions have to be decreased in environmental permissions.

C.4: The designation of areas that are specially sensitivity to pollution according the Nitrates Directive and the Habitats Directive

All area in Finland is classified as nitrate sensitive area, which means that Nitrates directive should be followed in whole Finland.

In Finland, there are 5 million hectares of Natura 2000 areas. From these 25% is water areas and 75% land areas. Total number of areas is 1,865, from which 87 is located in Åland. There are 1,721 SAC areas (specific protection areas) according to Nature directive, which cover 4.8 million hectares (12.4% from the total area of Finland)

In Nitrates Directive, there are regulations for manure storage buildings and their capacities, spreading manure onto the fields, maximum amount of nitrogen used in different crops and soil types (max total N 170 kg/ha), and requirements for analysis of manure and keeping plot-based notes from the use of manure and other fertilisers.

Concerning ammonia emissions, manure storage tanks should be covered in new buildings and manure spread onto the fields should be ploughed or tilled within 24 hrs.

C.5: The role of nitrogen in water action plans in relation to the Water Framework Directive

Water Framework Directive settled an objective to reach the good status in water areas until the year 2015. Now the new goal is 2021 or 2027. The targeted reduction of N concerning the Baltic Sea is 6,600 tonnes meaning 13% reduction in N load. Finland is divided into seven water protection areas for each of which it has been made action plans for water protection and plans to reach the status "good". Local authorities make follow-up of the action plans and regular surveys concerning the status of water areas.

Nitrates directive is a key instrument to be followed to decrease nutrient leakages to water areas. Also, agri-environmental protection scheme, where 90% of farms are committed, supports the goals for water framework directive.

Measures related to N in Nitrate directive

- max 170 kg N_{tot} per ha from manure
- crop-based maximum $N_{soluble}$ per ha
- amount of N spread exceeding 150 kg/ha should be divided in two portions

- in the autumn, the maximum N spread from manure is 35 kg/ha
- nutrient (N_{sol}, N_{tot}, P_{tot}) analysis of manure should be done every 5^{th} year
- fertilization should be based on manure analysis or standard values, achievable yield levels, crop rotations and soil properties
- fertilization should be done with no or minor possible leakage to water frames and compaction to the soil
- fertilization is not allowed during the period from 1 November until 31 March.
- fertilization is not allowed to frozen soils or soils with snow cover
- manure spread on the soil should be tilled within 24 hrs (excluding spreading to the crop)
- from 15 September onwards, only injection of manure is allowed to the crop
- fertilization is not allowed closer to 5 m from the water frames, and from 5 m onwards, surface-fertilization is not allowed unless tilled within 24 hrs
- in field plots with slope of more than 15% slurry is allowed to be spread only by injection
- there should be 30-100 m buffer zone for wells when spreading manure
- plot-based notes from fertilization used, fertilization dates and yields should be kept

Measures related to N in agri-environmental protection scheme

- maximum levels of N used for crops according to soil type
- fertilization should be marked in plot-based notes
- field margins / protection zones (3 m – 10 m) should be left along the water frames

Optional: injection of slurry is used.

C.6: The existence of machine pools to service farms with field spreading of manure

The number of contractors spreading manure is approximately 9,000. The number of contractors spreading manure has increased over the years. One contractor spreads slurry approximately 19,000 m^3 per year and spreading by injection covers 26,000 m^3 of slurry per year.

It is estimated that half of the slurry is spread by contractors (estimate form 2011).

C.7: The possible existence of ammonia emission reduction measures to implement the National Emissions Ceilings Directive

In 2012 all ammonia emissions in Finland were approx. 37 kt. From that 90% is derived from agriculture. Agricultural ammonia emissions are mainly from cattle manure and inorganic N-fertilisers. In EU's emission ceilings directive (2001) the maximum ammonia emissions for Finland were settled as 31 Kt for the year 2010. In 2012 the new Gothenburg document settled the new commitment for decreasing ammonia emissions to 20% from the emissions from the year 2005, which means the same 31 Kt for the year 2020. Also, the new EU's emissions ceilings directive has settled the commitment of 20% decrease in ammonia emissions for 2020 in Finland.

In Finland, the results show that the protein feed should be decreased or stopped especially in young cows' but also in milking cows' feeding. This means that feeding strategies in the farm level are estimated more carefully by consultation services. Concerning the manure handling, the most cost-efficient ways are implementation of management practices in manure spreading that decrease emissions. Slurry and urine are mainly spread by injection. Surface spreading should be avoided. Manure spread on top of the field surface should be ploughed or tilled as soon as possible, at least within 12 hrs after spreading. All manure containers or tanks should be covered at least with floating cover material. It is recommended that all new slurry containers are covered with fixed and tight lid. All urine containers should be tightly covered in every case. The filling of slurry containers should be done underneath.

Legislation is integrated in other national legislation, for instance IED.

(Source: Grönroos 2014)

C.8: The number of agricultural biogas plants

Number of agricultural biogas plant = 14 (under planning 10)

As one example, the amount of digestate produced in a biogas plant is approximately 19 ton/year. (no average data available)

Total number of biogas plants = 49 (under planning 30) (Data from 2013).

C.9: Number of cattle farms > 150 dairy cows, and the average size of them in terms of number of dairy cows

Number of cattle farms >100 dairy cows = 340 farms

Average number of cows in >100 dairy cows' farms = 144 cows/farm

(no data from >150 dairy cows' farms exist)

Data from 2015

C.10: References

- Aaltonen, R. & Heikkilä, H. 2011 Tuota ja hanki urakointipalveluita. Tieto Tuottamaan 135.
- Grönnroos, J. 2014 Maatalouden ammoniakkipäästöjen vähentämismahdollisuudet ja -kustannukset. (in Finnish) Ympäristöministeriön raportteja 26/2014 https://helda.helsinki.fi/handle/10138/152766
- Hari, L. & Riiko, K. 2016. Ravinnekierrätyksen eurokiemuroita (in Finnish). Baltic Sea Action Group.
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Annex D – Market information for Germany

D.1: The share of livestock manure being produced in the form of slurry or other liquid manure

More than half of the farmers fertilises with liquid manure in Germany.

About 166,000 agricultural holdings (total 280,800 (*Source: Federal Statistical Office, 2015*)) have in 2010 fertilised on her agricultural used area with liquid manure and liquid digestate from the biogas plants. This was 55% of all agricultural holdings in Germany, which farmed agricultural lands in the year 2010 *(Federal Statistical Office, 2016)*.

Overall 191 Million cubic metres *(Federal Statistical Office, 2010*) of liquid livestock manure and digestate of biogas plants were applicate on 7.5 Million hectares of agricultural area in 2010. This complied about 45%. About two-thirds of fluent livestock manure and digestate were applied on arable land and one third on permanent grassland.

With a proportion of about 60% cattle slurry was the most applied organic fertiliser. But also, pig slurry (19%) and digestate from biogas plants (17%) were often used. The remaining amount accounted for sewage and other slurry.

Table 19: Number of livestock for Cattle in Germany. All figures in 1,000 animals. (Source: Federal Statistical Office, November 2016).

Country	Cattle (total)	Dairy cows	Other cows	Calves ≤ 1 year	Cattle 1 – 2 years (without calved)	Cattle 2 years and older (without calved)
Germany (total)	12,467	4,218	670	3,795	2,960	825
Schleswig-Holstein	1,104	394	39	312	267	92
Mecklenburg-Vorpommern	548	172	68	162	119	28

Table 20: Number of livestock for Pigs in Germany, Mecklenburg-Vorpommern and Schleswig-Holstein. All figures in 1,000 animals. (Source: Federal Statistical Office, November 2016).

Country	Pigs (total)	Rearing pigs	Breeding sow	Piglets under 50 kg live weight
Germany (total)	28,339	12,408	2,074	13,857
Schleswig-Holstein	1,469	688	91	690
Mecklenburg-Vorpommern	828	275	92	461

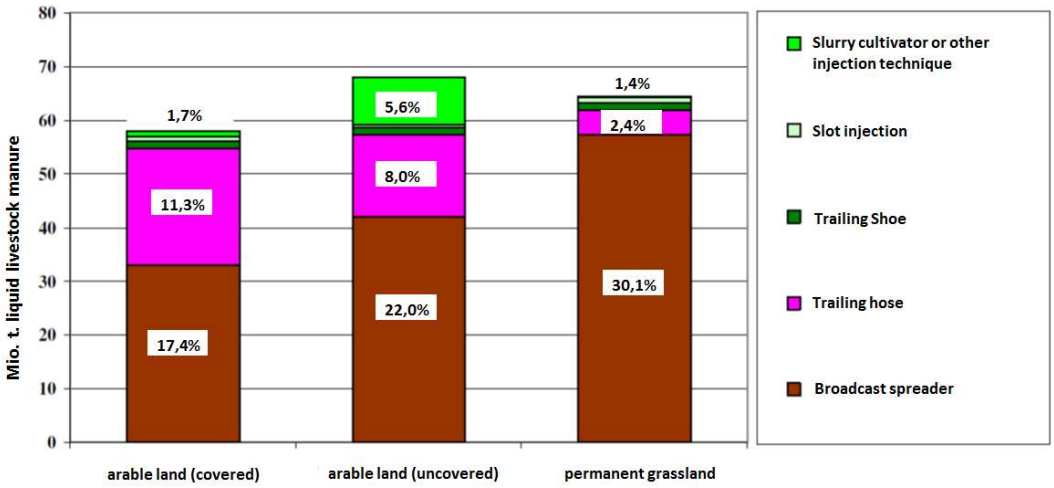

Figure 18: Application technique of liquid livestock manure in Germany 2010, differentiated after arable land and grassland (Proportion of the whole spreading amount of 190, 7 Mio. t of liquid manure (Source: Federal Office of Statistics, 2011; Thünen-Institut).

In Germany, the common application technique for livestock manure was still broad spread application in 2010, were slurry is wide spread on soil and crop surface. About 132 Million cubic metre of liquid livestock manure were applied with this technique on arable land and grassland in Germany. About 58 Million cubic metre were applied with trailing hose, trailing shoe, slit injection technique or slurry cultivator. These application techniques of livestock manure are accepted as effective and environmental friendly application methods, because of their low nutrient losses and emissions due to the near-ground application or rather due to the directly following incorporation into soil.

D.2: The number of facilities for intensive rearing of poultry and pigs according the Industrial Emissions and as well for cattle, and those who produce slurry

The Industrial Emissions Directive(2010/75/EU) concerns farms with more than 40,000 poultries, 2,000 pigs (over 30 kg) and 750 sows. The table below shows that 2,800 pig farms are affected of the Industrial Emissions Directive in Germany.

Table 21: Number of farms and their stock density in Germany, Mecklenburg-Vorpommern and Schleswig-Holstein (Source: Federal Statistical Office, November 2016 and 2013).

	Number of farms with buildings for cattle. Slurry system				
Country	Total	50 - 99	100-199	200-499	500 and more
Germany (total, information from 2016)	147,094	25,351	22,404	13351	2618
	Total	<50 LSU	50-100 LSU	100-200 LSU	200 LSU and more
Schleswig-Holstein (information from 2013)	4,700	500	900	2000	1200
Mecklenburg-Vorpommern (information from 2013)	700	100	100	200	400

Table 22: Number of farms and their stock density in Germany, Mecklenburg-Vorpommern and Schleswig-Holstein (Source: Federal Statistical Office, November 2016 and 2013).

Country	Number of farms with buildings for pigs. Slurry system				
	Total	500-999	1000-1999	2000-4999	5000 and more
Germany (total, 2016)	24,400	5,900	6,400	2,300	500
	Total	<50 LSU	50-100 LSU	100-200 LSU	200 LSU and more
Schleswig-Holstein (2013)	1,300	300	300	400	300
Mecklenburg-Vorpommern (2013)	400	200	0	0	200

Table 23: Number of poultry farms and number of poultry in Germany, Schleswig-Holstein and Mecklenburg-Vorpommern (Source: Federal Statistical Office, 2013).

Country	Number of chicken-farms	Number of chicken, million (for fattening and layers)	Number of other poultry farms (ducks, geese, turkeys)	Number of other poultry, million (ducks, geese, turkeys)
Germany (total)	56,600	161	9,000	16.6
Schleswig-Holstein	1,600	3.2	500	No data
Mecklenburg-Vorpommern	600	7.9	200	0.6

D.3: The role (at present or envisaged) of ammonia emissions in the administrative practices concerning environmental permitting according the IED

The first general administrative regulation to the federal Immission Control law (Technical Instructions on Air Quality Control – TA Luft) principally constitutes requirements for the construction and firm of holdings which need or not need after BImSchG a requiring approval for keeping and rearing of livestock.

After Nr. 5.4.7.1 TA-Luft requirements in relation to the minimum distance towards nitrogen sensitive plants and structural and corporate measures are delivered (e.g. feeding which is adapted for nutrient requirement of animals, optimal barn climate, storage of livestock manure).

In the TA-Luft no regulatory limits for ammonia emissions are declared. Hence it must be proved after Nr. 4.4.2. i. V. m Nr. 4.8 TA Luft, if the protection against significant disadvantages for sensitive plants and ecosystems due to the exposure of ammonia emissions is ensured. The sensitivity of areas is defined due to the International list of nitrogen sensitive ecosystems and the List of nitrogen sensitive plants on national level. After Nr. 4.8 par. 5 TA-Luft the minimum distance after annex 1 Figure 4 of TA Luft to facilities to sensitive plants (e.g. tree nurseries) and ecosystems states a first indication for the presence of significant injury of these protective goods due to the exposure of ammonia.

After Nr. 4.8 par. 6 TA-Luft further clues for disadvantages could exist if the protection against significant disadvantages for sensitive plants (e.g. tree nurseries) and ecosystems (e.g. heather, bog, forest) due to the exposure of nitrogen emissions is not ensured. The assessment of nitrogen deposition takes place after chapter 7 of the guideline for the investigation and assessment of nitrogen input of the federal and federal states-consortium for imission protection (LAI-guideline).

An indication for significant disadvantages exists e.g. if the additional load of the whole facility in a sensitive terrestrial ecosystem exceeds 5 kg N/(ha*a). Due to lower burden values of some aquatic ecosystems a further indication for significant disadvantages exists, if the additional load of the whole facility exceeds 3 kg N/ (ha*a).

Federal state level:

Requirements of immission control for facilities of livestock and storage of slurry after BImSchG were legal regulated with the filter-decree in Schleswig-Holstein since 2014. For a reduction of ammonia emissions among others the application of exhaust air treatment systems for big

pig farms and also coverage of livestock manure storages is demanded.

However regulatory limits for ammonia emissions are not declared.

D.4: The designation of areas that are specially sensitivity to pollution according the Nitrates Directive and the Habitats Directive

According to article 10 of the Nitrates Directive (ND - Council Directive 91/676/EEC of 12 December) there is a liability to submit a report to European Commission about the implementation every fourth year. The report describes the status and development of the water pollution for groundwater, coastal water and surface waters. Germany has used article 3, paragraph 5 and has applied the action programs on the entire territory. In Germany, the fertilization decree (DüV) is a central component of the national action program for implementation of the Nitrates Directive.

Germany has according the Birds Directive and the Habitats Directive build up the Natura 2000 areas. Schleswig-Holstein has reported like other federal states chosen FFH and bird's protection areas to Brussel since 1996. Natura 2000 areas consists of 311 areas (271 FFH- and 46 bird's protection areas) with an off-shore area about 156,000 ha and an on-shore area of about 765,000 ha.

D.5: The role of nitrogen in water action plans in relation to the Water Framework Directive

SATs may be an important tool in the implementation of the WFD. The N surplus in Schleswig-Holstein is still far too high, which is partly due to the poor N-utilisation of manure and biogas digestate. Data from the Water Protection Consulting reveal an average farm gate N balance of 135 kg/ha for dairy forage farms, which is much too high. Averaged over all farm types (cash crop, fodder crops and grassland, mixed and finishers; n = 125; reference year 2015), the N balance is 114 kg / ha (Source: LLUR, Zacharias 2016). Even this value is too high, especially when considering that these figures include a 30% N loss due to assumed discharged organic fertiliser yet. The largest share of this loss is due to ammonia emission during application. The SATs may be an important component to improve manure utilization and would contribute to reduce the N balances on the operational level, which is a crucial parameter in the implementation of the WFD.

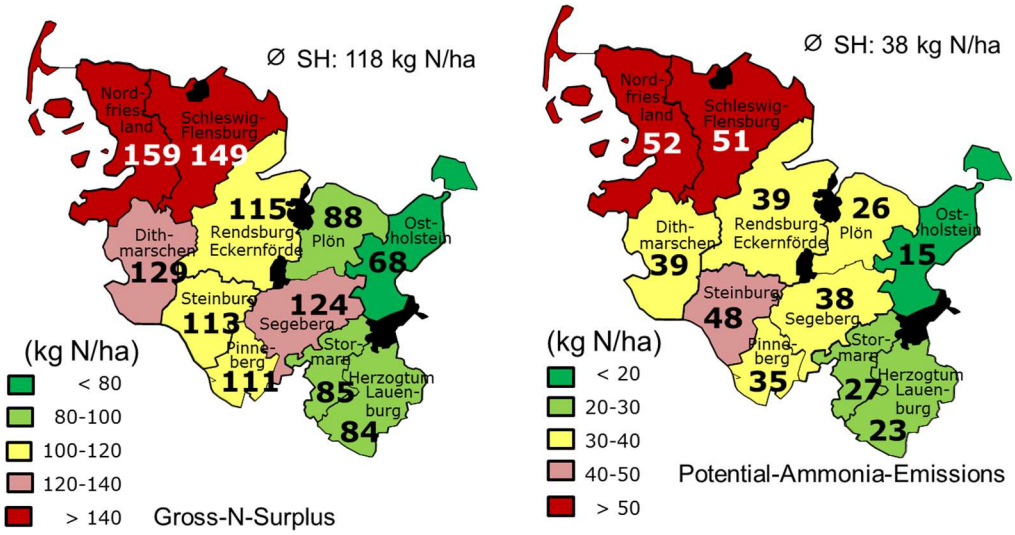

Figure 19: potential ammonia emissions (right) and N-balance-surplus (left) of the counties in the state of Schleswig-Holstein (Source: Nutrient report from Schleswig-Holstein (2015), Henning et al. (2004) and Taube et al. (2013)).

In Germany, the burden of waterbodies with nutrients, especially with nitrate, is the main reason for the default of the Water Framework Directive. The figures below illustrate the groundwater quality in Germany and in addition in the federal state Schleswig-Holstein, especially the light sandy soils in the geest landscape are affected in Schleswig-Holstein, many measurement points show values over 50 mg nitrate/l groundwater. The geest is a landscape of sandy and gravelly soils formed as a glacial outwash plain and now usually mantled by a heathland vegetation on the glacial deposits, occurs on the plains of Northern Germany, the Northern Netherlands and Denmark.

Instruments which can improve the chemical status and the nutrient problem can be the agricultural advice service, special agricultural provision programs and a new fertilization decree with stricter rules regarding nutrient management and balancing. A central point will be a better nitrogen use efficiency of livestock manure, due to more efficient application technique.

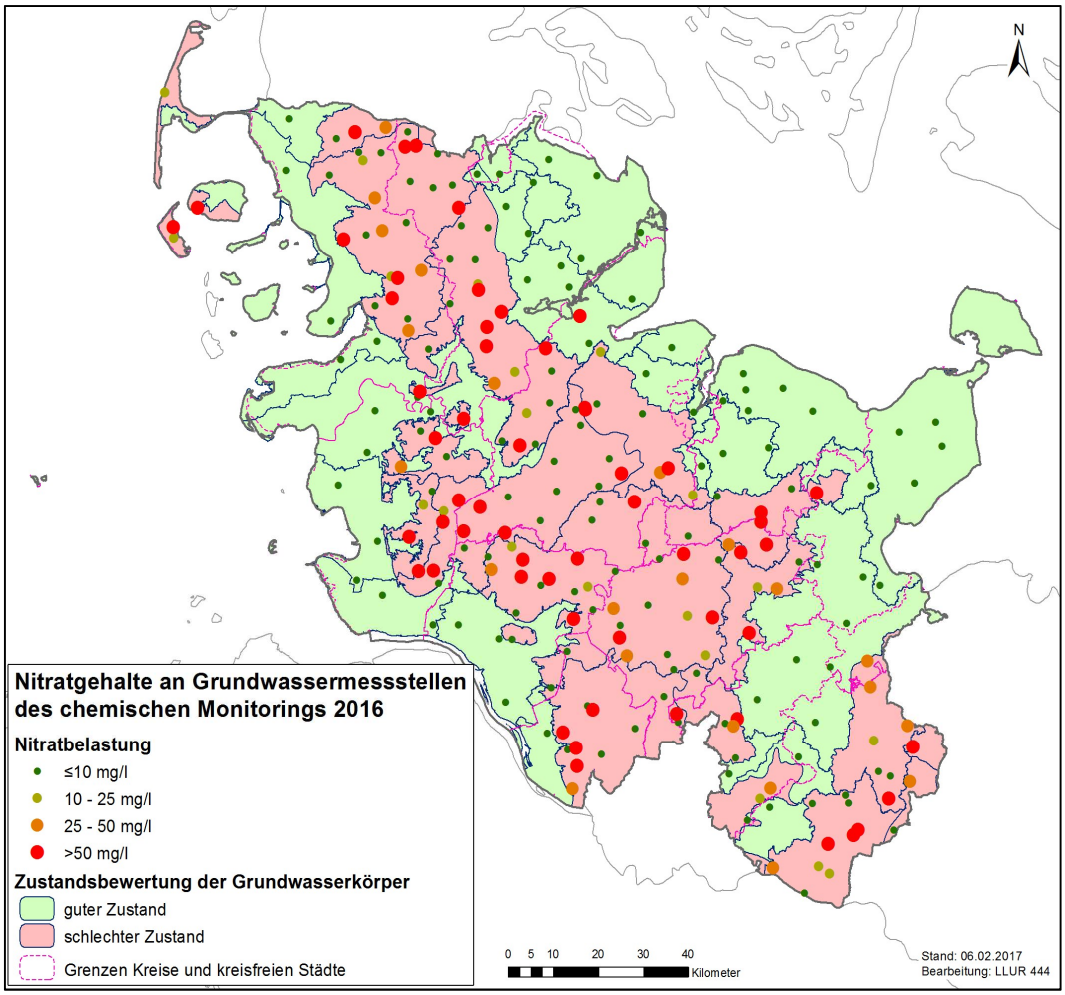

Figure 20: Groundwater quality concerning nitrate in Schleswig-Holstein (Source: State Agency for Agriculture, Environment and Rural Areas of the German Federal State Schleswig-Holstein (LLUR), 2017).

D.6: The existence of machine pools to service farms with field spreading of manure

In Germany, the BLU, Bundesverband Lohnunternehmen (National Employers' Association of Agricultural and Rural Contractors) has currently approx. 3,200 members, i.e. professional contractors from the agricultural, rural and forestry sector. However, over 40% of these enterprises are run by farms as a side activity.

In 2014, the sector generated a total turnover of approximately €3.3 billion. As before, agriculture is the most important customer group, with a share of over 70%. Agricultural, rural and forestry contractors offer all kinds of services "from sowing to harvesting" on arable land and grassland. They also harvest silage and/or grain maize and apply commercial fertilisers (slurry, manure) for livestock farms, which

represent the largest market shares. Over the last 10 years, providing supplies and waste management for biogas systems used to generate renewable energy has now developed into a major source of income, which amounts to €600 million per year.

With an average annual turnover of over one million Euros, German agricultural, rural and forestry contractors have a highly-varied profile and can employ up to 200 people (as Blunk GmbH with 200 employees).

It is estimated that they invest approx. 800 million Euros per year, so that their customers can benefit from technological progress in the agricultural sector and acquire new market shares.

The agricultural, rural and forestry contractor sector currently employs about 16,000 full-time and 20,000 part-time workers. This means that approximately 20,000 full-time employees (full-time equivalent) work for German agricultural, rural and forestry contractors.

Schleswig-Holstein

In Schleswig-Holstein, there are 254 contractors, here count also the part-time farms with enclosed offer rewarding entrepreneurial activities and reported in accordance with the association (Source: National Employers' Association of Agricultural and Rural Contractors Schleswig-Holstein).

Additional Information

(see http://www.wilke-maack.de/download/2013/05/EF1179EN.pdf, pp. 28-29)

Geography and tradition have led to a situation where German agriculture is characterized by a strong north–south divide, with large agricultural holdings in the northern plains and smaller-sized ones in the south. In eastern Germany agriculture is characterized by comparably large farms and immense utilized areas, mainly the result of state agricultural policy during the Communist era, with its focus on land redistribution and large agricultural units. Accordingly, most agricultural and rural contractors (ARC) are located in the northern and north-western part of Germany, with its strong tradition of cultivation and stock breeding.

According to BLU, nearly 60% of its members are located in the three northern German states of Lower Saxony, North Rhine-Westphalia and Schleswig-Holstein. ARCs are particularly active in the regions where farms concentrate on value-adding livestock operations, with a major factor influencing demand for contractors being the unavailability or lack of working capacity on farms. Time is limited on these value-adding farms and contractors are responsible for noncore activities. In eastern Germany, the number of ARCs is not as high as in the north-west, although the size of ARCs is usually larger, corresponding to the larger size of agricultural holdings in this region. There are a large

number of ARCs in southern Germany, but they are generally smaller in size than their counterparts in northern Germany for structural reasons – agricultural holdings are smaller and more fragmented in southern Germany, such that requirements for ARCs in terms of size and capacity are different. In Bavaria and Baden-Wurttemberg, ARCs often cooperate with farmers in process chains, with contractors responsible for cutting and farmers transporting.

D.7: The possible existence of ammonia emission reduction measures to implement the National Emissions Ceilings Directive

Ammonia emissions in Germany originates mainly from agriculture (proportion of 95% of whole emissions). Emissions decreased in whole stock about 53 thousand tonnes (6,7%) between 1990 and 2014. The reductions in the last decades are mainly a result of the reduction of animal stocks in the new eastern states of Germany immediately after German reunification.

Ammonia mainly originates from animal farming (especially from cattle and pig farming systems) and to a lesser extent by fertiliser utilization and also storage and application of digestate by biogas production in agriculture. Industrial processes (production of ammonia and nitrogenous fertilisers, etc.), catalysts etc. are of lower importance.

NEC-Directive provides an emission ceiling of 550 kt for Germany. Ammonia emissions resulting of fertiliser usage were calculated completely new by means of new revised methods in 2015. One result of the new calculation were higher new values than assumed in past. In consequence, national emission ceilings were exceeded severely with 740 kt in Germany 2014. To observe national emission ceilings in future further reduction measures like application of livestock manure with near-ground and low-emission application techniques, immediately incorporation of fertilisers and exhaust air purification are necessary.

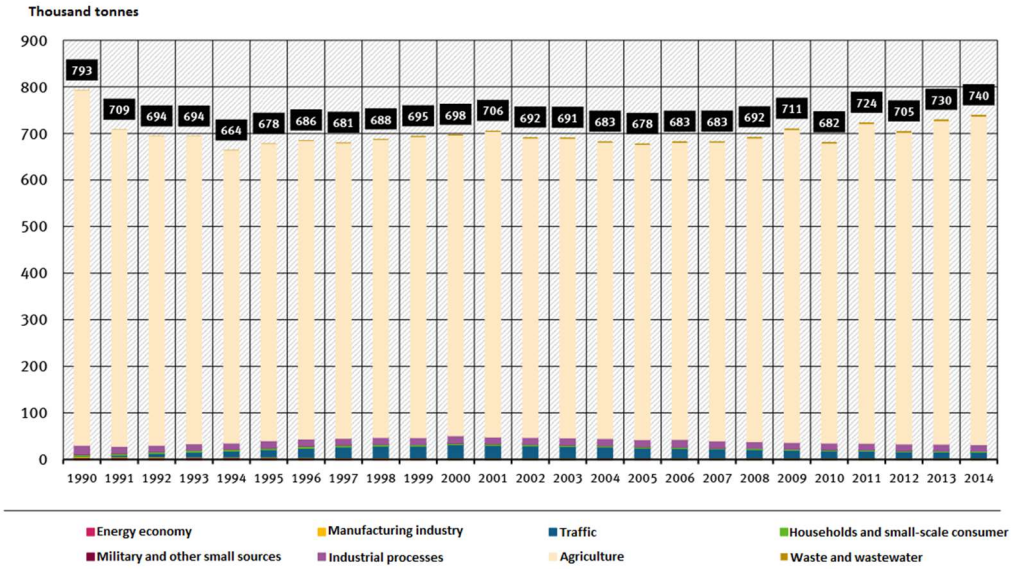

Figure 21: Ammonia emissions after source-categories (Source: Federal Environment Agency (UBA, 2016)).

The European Commission had proposed a progression of NEC-Directive in the end of 2013. (NERC-Directive, "national emission reduction commitments"). After a long proceeding process, European Commission, European Parliament and European Council has unified for reduction aims in the end of June 2016, as relative modifications towards the emissions of 2005. For emission starting from 2020 reduction aims are comparable with the reduction aims of the Gothenburg Protocol, for emissions starting in 2030 obviously higher reductions are provided (See table with reduction aims of national emissions in relation to emissions of year 2005)

Table 24: Overview about reduction aims of national emissions (Source: Federal Environment Agency (UBA, 2016)).

	Ammonia
Amended Gothenborg-Protocol, starting 2020	-5%
New NERC-Directive, starting 2020*	-5%
New NERC-´Directive, starting 2030*	-29%

* negotation outcome end of June 2016

Corresponding regulations to the reduction of ammonia emissions in Germany are anchored in the fertilization decree (Düngeverordnung-DüV) were periods of transition for low-emission application techniques are established. Slurry application on crop covered areas will be only allowed with trailing hoses and slit- or injection techniques, SATs could be a technic with these positive effects. Regulation will be applied on arable land in 2020, on grassland there will be a larger period of

transition till 2025. Broad spreading will be only allowed on bare soil in combination with incorporation of slurry and digestate within four hours after application.

D.8: The number of agricultural biogas plants

The figure below shows that the number of biogas plants has increased strongly since 2004 in Germany. After information of the trade association biogas and the German maize committee (DMK) the number of biogas plants has increased twentyfold between 1995 and 2011. The average plant size increased since the year 2000 from 75 kW up to about 400 kW installed electrical power. The strong growth of biogas production and plants are strongly linked to the increase between 2004 and 2006 and shows in consequence the positive effects of the renewable energy law in Germany (EEG) of the year 2004 on the biogas sector. A comparable increase could be observed since the year 2009, were effects of the amendment of the EEG (01.01.2009) become important (DMK).

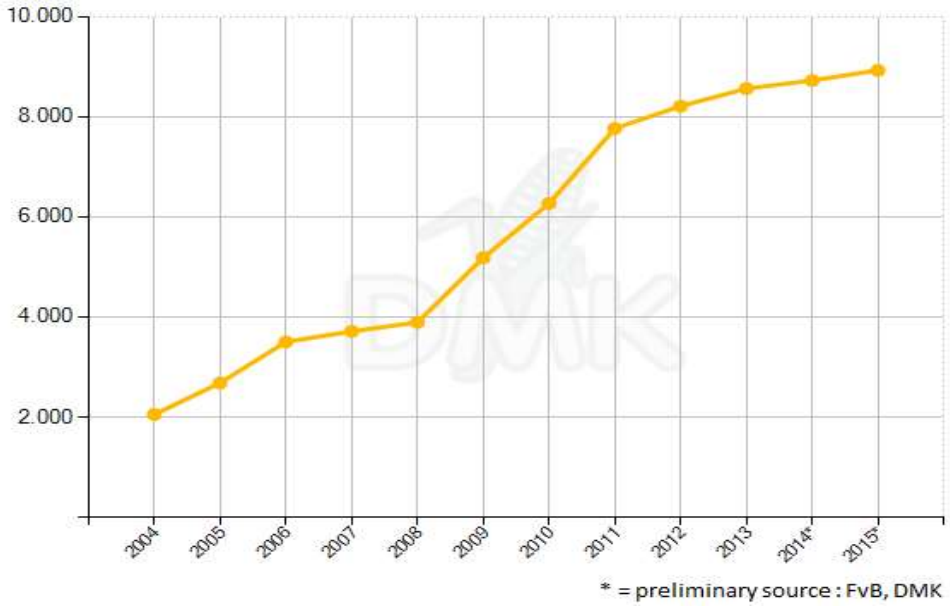

Figure 22: Number of biogas plants in Germany from 2004 to 2015 (Source: FvB, DMK, March 2016).

Most biogas plants (more than 1,000) can be found in Bavaria, Lower Saxony, North Rhine-Westphalia.

The following table shows the current statistics and characteristics of biogas plants in Schleswig-Holstein (status 17.01.2017).

Table 25: statistics and characteristics of biogas plants in Schleswig-Holstein (status 17.01.2017, LLUR internal information).

Plant Type		No	Capacity / Power / Energy		
biogas production plant	require approval	399	10.075 Mio Nm³/a raw gas		
	not subject to approval	123	80 Mio Nm³/a raw gas		
combined heat and power plants (CHP)		495		660 MW rated thermal input	266 MW el.
satellite CHPs	require approval	85		134 MW rated thermal input	52 MW el.
	not subject to approval	76		50 MW rated thermal input	20 MW el.

Maize is the dominating crop of all applied crops in biogas plants in Germany. This crop has the greatest yield potential of all crops on all locations. 90% of all biogas plants applied maize (see the figure below). But also, other crops are used for biogas production because of demands for sustainable agriculture, positive crop rotation effects or cross-compliance requirements. At border locations like altitudes or dry locations the maize can lost his excellence for biogas production and the production of cereal whole-plant silage can lead to economically advantages in comparison to maize. In permanent grassland regions grass silage can be a good alternative because of lower tenure costs this crop can have economically benefits.

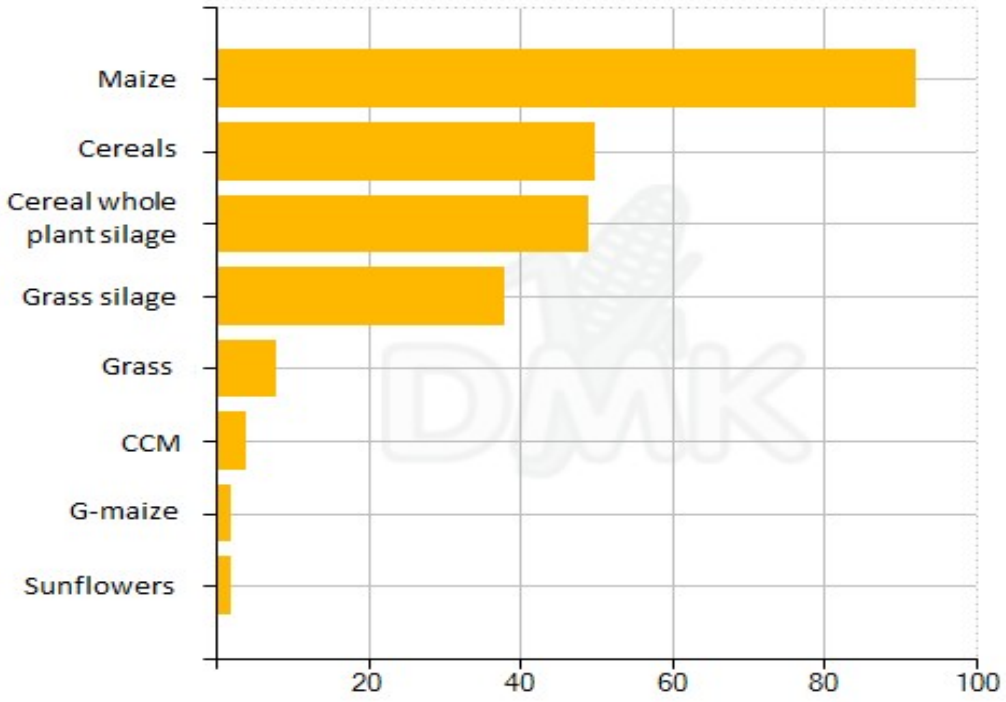

Figure 23: Usage of co-substrates at German biogas plants, % (Source: Trade association biogas/ German maize committee, 2006 (DMK)).

D.9: Number of cattle farms > 150 dairy cows, and the average size of them in terms of number of dairy cows

able 26: Number of farms and their stock density in Germany, Mecklenburg-Vorpommern and Schleswig-Holstein (Source: Federal Statistical Office, November 2016 and 2013).

Country	Number of farms with buildings for cattle, slurry system				
	Total	50 - 99	100-199	200-499	500 and more
Germany (total, 2016)	147,094	25,351	22,404	13,351	2,618
	Total	<50 LSU	50-100 LSU	100-200 LSU	200 LSU and more
Schleswig-Holstein (information from 2013)	4,700	500	900	2,000	1200
Mecklenburg-Vorpommern (information from 2013)	700	100	100	200	400

In Germany, there are 15,969 farms with buildings for more than 200 animals in 2016.

D.10: References

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- State Agency for Agriculture, Environment and Rural Areas of the German Federal State Schleswig-Holstein (LLUR), own data

Annex E – Market information for Latvia

E.1: The share of livestock manure being produced in the form of slurry or other liquid manure

Central Statistical Bureau data shows the number of farms by type of farming:

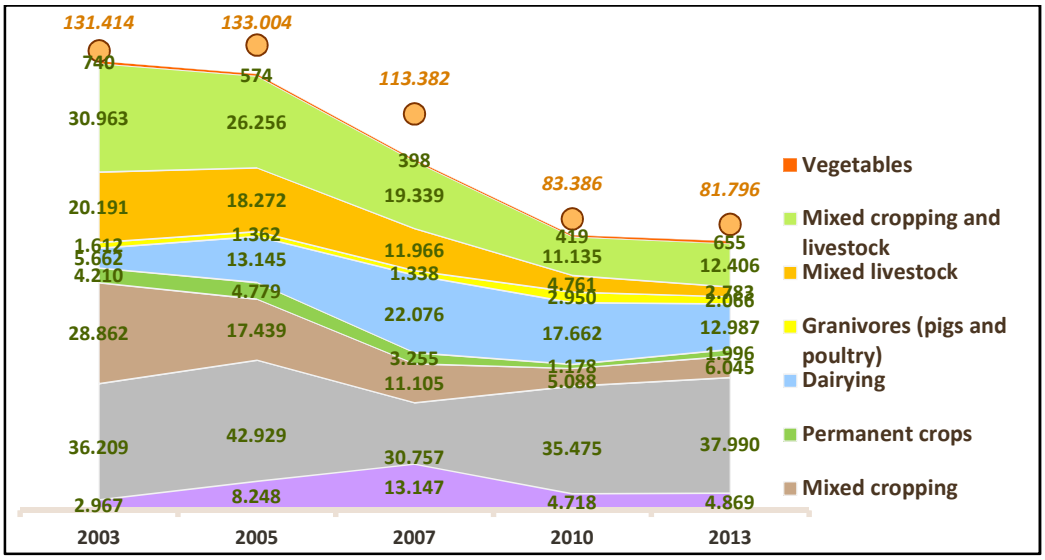

Figure 24: Development in types of Latvian farms.

According to Agricultural Data Centre Republic of Latvia information, the number of different livestock for last three years in Latvia, which produce slurry, is shown in the following tables:

Table 27: Cattle number in Latvia and their milk production.

Year	2014	2015	2016
Cattle, total	435,158	438,180	435,326
Dairy cows	169,270	167,207	160,828
Milk production (million kg)	804.39	807.66	814.00

Table 28: Pig number in Latvia.

Year	2014	2015	2016
Pigs, total	345,635	317,010	305,521

Sows	29,219	24,386	24,805

According to the given data, there are approx. 160,000 dairy cows and 300,000 pigs.

It is assumed that slurry is produced by approx. 85,000 cattle (dairy cows and young cattle) and 200,000 pigs (according to the breeding system or in the larger size of the farms).

Slurry from cattle is produced by approx. half (43%) of the total number. If we estimate that one cattle unit produce approx. 20 t (according to the produced milk amount) and pig around 2 t, then total volume of slurry which is produced from cattle is 1,700,000 tons and from pigs – 400,000 tons, and totally – 2,100,000 tons per year.

E.2: The number of facilities for intensive rearing of poultry and pigs according the Industrial Emissions and as well for cattle, and those who produce slurry

The law "On Pollution" and Annex No. 1 "Polluting activities (installations) that require A category permission", refers also to the pig farms:

- 6.6.b – farms for intensive rearing of pigs, with more than 2,000 places for production pigs with weight over 30 kg
- 6.6.c – farms for intensive rearing of pigs, with more than 750 places for sows.

According to the Environmental State Office information, the pig breeding farms that require A category permission are the following:

Table 29: Large pig farms in Latvia with an environmental approval.

No.	Name of the category A installations	Category according to the law "On Pollution"	Date of the Permit issued	Biogas plant
1	SIA "BALTIC BREEDERS", farm "AVOTI"	6.6.b.	08.03.2012	-
2	SIA "GAIŽĒNI", farm "TUNKUNI"	6.6.b.	12.12.2012	-
3	SIA "ANCERS", farm "BUNČI 1"	6.6.b.	23.08.2011	-

No.	Name of the category A installations	Category according to the law "On Pollution"	Date of the Permit issued	Biogas plant
4	SIA "BALTIC PORK", farm "RUKŠI"	6.6.b.	10.12.2012	-
5	SIA "DRUVAS UNGURI", farm "STRAUMĒNI"	6.6.b.	25.03.2014	+
6	SIA "NYGAARD INTERNATIONAL", farm "APRIĶI BACON"	6.6.b.	23.12.2014	-
7	SIA "NĪCAS RUKŠI"	6.6.b.	06.08.2010	-
8	SIA "GAIŽĒNI", farm "SMURĢI"	6.6.b.	20.02.2014	-
9	SIA "STARTERIS", farm "BRĪVKALNI"	6.6.b.	16.03.2012	-
10	SIA "NĪCA 1"	6.6.b.	21.11.2014	-
11	AS "LATGALES BEKONS", farm "LUKNA"	6.6.b., 6.6.c.	15.09.2009	-
12	SIA "ŠĶAUNES BEKONS"	6.6.b., 6.6.c.	22.01.2010	-
13	SIA "SĒĻI", farm "STIEBRIŅI"	6.6.b., 6.6.c.	05.05.2010	-
14	SIA "MIĶELĀNI BEKONS", farm "MIĶELANI"	6.6.b., 6.6.c.	16.09.2013	-
15	SIA "UZVARA-STRAUTI" and SIA "UZVARA-BIRZGAĻI", farm "STRAUTI"	6.6.b., 6.6.c.	01.06.2012	-
16	SIA "PF VECAUCE", farm "PŪPOLI"	6.6.b., 6.6.c.	21.10.2010	-
17	SIA "ULBROKA"	6.6.b., 6.6.c.	12.05.2010	+
18	SIA "BALTIC PORK"	6.6.b., 6.6.c.	02.12.2011	+

No.	Name of the category A installations	Category according to the law "On Pollution"	Date of the Permit issued	Biogas plant
19	SIA "NĪCA 1"	6.6.b., 6.6.c.	21.08.2009	-
20	SIA "VAIŅODES BEKONS"	6.6.b., 6.6.c.	14.03.2013	+
21	SIA "KORKALNS"	6.6.b., 6.6.c.	14.03.2013	-
22	SIA "EGLAT"	6.6.b., 6.6.c.	09.03.2010	-
23	SIA "CIRMAS BEKONS"	6.6.b., 6.6.c.	17.07.2014	-
24	SIA "SPRĪDĪTIS", farm "KALNA EĶĪTES"	6.6.b., 6.6.c.	28.12.2012	-
25	SIA "ANCERS", farm "RUKAS"	6.6.b., 6.6.c.	26.04.2010	-
26	SIA "LATVI DAN AGRO", farm "OŠLEJAS"	6.6.c., 5.11.	01.09.2011	+
27	SIA "GAIŽĒNI", farm "SKALDERI"	6.6.c.	09.05.2014	-
28	SIA "DRUVAS UNGURI", farm "UNGURI"	6.6.c.	27.03.2014	-
29	SIA "KUNTURI"	6.6.(b)	12.23.2015	-

Totally "A" categorises permits are issued for 29 pig breeders and 5 of them have biogas stations.

In Latvia poultry farms do not produce slurry manure.

E.3: The role (at present or envisaged) of ammonia emissions in the administrative practices concerning environmental permitting according the IED

In Latvia, ammonia emissions only plays a minor role in environmental permitting of livestock farms.

E.4: The designation of areas that are specially sensitivity to pollution according the Nitrates Directive and the Habitats Directive

Nitrate Directive requirements has been implemented in national legislation with Law „On Pollution" of July 2001 and accordingly with the Cabinet of Minister Regulations No.834 of 23 December 2014 "Regulations Regarding Protection of Water and Soil from Pollution with Nitrates Caused by Agricultural Activity", the Cabinet of Ministers Regulations No.829 of 23 December 2014 "Special requirements for the Performance of Polluting Activities in Animal Housing"

Cabinet of Minister Regulations No.834 of 23 December 2014 "Regulations Regarding Protection of Water and Soil from Pollution with Nitrates Caused by Agricultural Activity" prescribes:

- The requirements for the protection of water and soil from pollution with nitrates caused by agricultural activity
- Nitrates vulnerable zones to which increased requirements apply for the protection of water and soil from pollution with nitrates caused by agricultural activity, the borders and criteria for the designation
- The procedures for the management of vulnerable zones

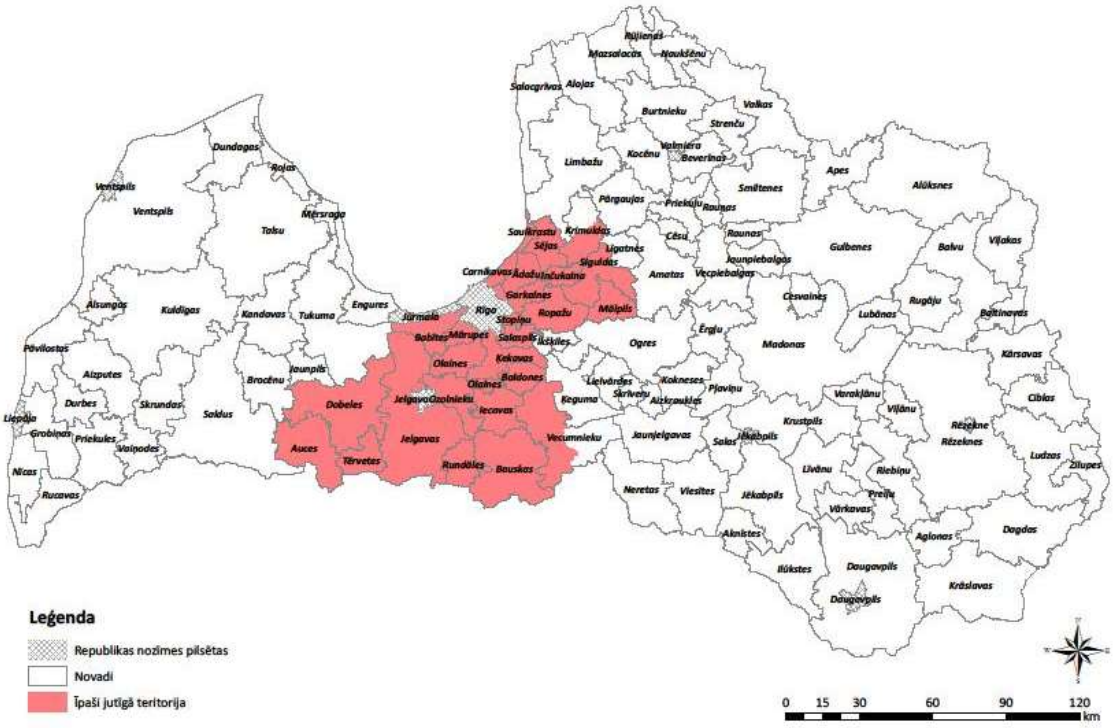

Figure 25: Nitrates vulnerable zones in Latvia.

Territory of nitrates vulnerable zones in Latvia occupies 12,8% of state territory and are located within the boundaries of the administrative areas Dobele, Bauska, Jelgava and Riga districts except the administrative areas of Riga and Jurmala cities.

The zones are recognised as vulnerable, if:

- The nitrate concentration in surface freshwaters, especially those used or intended to be used for the acquisition of drinking water, is 50 mg/l or more
- The nitrate concentration in groundwater is 50 mg/l or more
- Inland waters of natural origin and coastal waters have become eutrophic

Manure application regulations in Nitrate vulnerable areas:

- Shall not be spread to frozen, water-saturated and snow-covered ground;
- In lowlands and flood-endangered areas shall be spread only after the end of the potential flood season;
- Shall not be spread in locations where the spreading is prohibited according to the normative acts of protection zones;
- Shall not spread on sloping grounds
- Solid manure after spreading shall be worked into the soil within a period of 24 hours, liquid manure and urine within period of 12 hours;
- The amount of livestock manure applied on the land each year shall not exceed 170 kg N per ha
- Crop fertilization plan shall be prepared in all farms where fertilisers are applied over an area of 20 ha and more, in fruit and vegetable farms – over area of 3 ha and more
- Crop fertilization plan based on data of soil agro-chemical investigation for the spring and summer of the current year shall be developed not later than on 15 May

Cabinet of Ministers Regulations No.829 of 23 December 2014 "Special requirements for the Performance of Polluting Activities in Livestock Housing"

- Prescribes special requirements for the performance of polluting activities in livestock housing.
- Requirements for restriction and control pollution include:
- requirements for the collection, transport, management and storage of livestock manure;
- requirements for the manures storage facilities;

- requirements for the storage of silage in a trench and piles as well as use;
- requirements for the storage of slurry, semi liquid manure and urine.

Regulations cover also management of the digestate after biogas production.

To decrease the negative influence of farming on the environment and to prevent the impoverishment and irrational use of the main nature resources - soil, water, plants, animals, and landscape Latvia has developed Code of Good Agriculture Practice (GAP) (I part, II part). The Code of Good Agricultural Practice contains legislation obligations, recommendations and practical advice envisaged for farmers, horticulturists, individual growers, agriculture service employees and for everyone who is involved in agricultural production and preservation of rural environment. It is recommended to follow the rules accepted in Europe and in other developed countries.

First edition of „Codes of good agricultural practise" was prepared by Danish-Latvian joint project with participation of Swedish experts and was issued in 1999.

Second edition of „Codes of good agricultural practise" was issued in 2008 and includes:

- information about recent requirements in national legislation adopting EU Directives and Regulations
- information about HELCOM recommendations for Baltic Sea protection from eutrophication
- recommendations from scientists and practitioners which can be used in order to prevent or decrease agricultural load on environment
- additional section about genetically modified organisms (GMO)
- Livestock farming section enlarged with information about livestock identification and registration
- Information about requirements for the performance of polluting activities in livestock housing

Latvia has designated 13% of its territory as Nitrate Vulnerable Zone.

Information related to Habits Directive

There are 18,047 animals, 5,396 plants and 4,000 mushroom species in Latvia. The scientists consider 907 species (about 3,3% of total species) are rare and endangered.

In Latvia, requirements of protection of species and habitats are defined by the Law of Protection of Species and Habitats (ratified by the Parliament on 16.03.2000.). In compliance with this Law the lists

of specially protected species and habitats have been established, where endangered, vanishing or rare species and habitats or species which inhabit specific habitats have been included. The species traditionally protected in Latvia, as well as protected species and habitats defined by the EU Birds or Biotopes Directives have been included in the list. 723 plant and animal species and 93 biotopes have been included in the lists of specially protected species and habitats in Latvia. This protected species and habitats lists have been adopted by the Cabinet of Ministers.

The protection of species and habitats is ensured in Specially Protected Nature Territories, including in the network of Natura 2000 territories, and microreserves. The establishment procedure of microreserves and protection requirements are defined by regulations of the Cabinet of Ministers "Regulations of Establishment, Protection and Management of Microreserves" (Nr. 45/2001).

In addition to the mentioned, the protection of species and habitats is ensured by providing assessment to activities that can result in destroying of specially protected species or habitats.

Species or Habitats Management Plans are developed for particular species. In such management plans information about species' distribution, significant areas for protection of habitats, as well as population of species or tendencies, affecting factors, as well as measures to be taken for improving condition of species or habitats is aggregated.

Up to now, 8 Management Plans of Species have been developed and adopted in Latvia.

Latvian Environmental, Geological and Meteorological Agency maintains data base of protected plants species. This data base provides information on protected plant species (geographical location, quantitative and qualitative status), information covers historical information, as well as data on repeated inspection on the spot. Agency also maintains data base of microreserves. Data base provides information on object (species or biotope) for which microreserve has been established, location of microreserve (region, municipality, geographical coordinates and/or description of borders), as well as information on population of species or status of habitats.

In Latvia, 12% of the territory or 787,729 ha is Natura2000 area.

E.5: The role of nitrogen in water action plans in relation to the Water Framework Directive

Water protection is one of the main priorities in Latvian environmental protection policy.

The Law on Water Management came into force on October 26, 2002, and was the main regulation in water management and protection. The

aim of the Law is to establish surface water and groundwater protection and management system that promotes sustainable and rational use of water resources, improves protection of water environment, ensures water protection and facilitates achievement of goals set in international agreements.

The Law transposes requirements of the Directive 2000/60/EC of the European Parliament and of the Council. Several laws and regulations of the Cabinet of Ministers are resultant from the Law of Water Management, water protection is also regulated by the Law on Pollution and resultant laws and regulations.

The Law defines that hereafter water protection measures, their efficiency and usefulness must be controlled within river basins instead of administrative borders. The territory of Latvia is divided in Daugava, Gauja, Lielupe and Venta river basin districts.

Figure 26: River basins in Latvia.

Water resources management takes into account the various environmental, economic and social factors interact particular river basin district, each of them developing its river basin management plan.

Developed in every 6 years (2010.-2015., 2016.-2021.).

Include:

- rivers, lakes, ground and costal water status description

- Identify problems
- Recommendations for water quality improvements. Recommendations are not mandatory, but they are voluntary.

Each river basin district has its own advisory board, whose primary aim is to harmonize the national authorities, local governments, non-governmental organizations, businesses and other interest groups in the interests of water management issues in the area. Developed river basin management plans as regional planning documents, it is also carried out strategic environmental impact assessment and public consultation.

For explanation and more successful implementation of Water Framework Directive requirements there were developed Overall Strategy for Implementing and General implementation guidelines.

Currently good results have already been achieved.

University of Latvia researches shows:

1. The real-time measurements with nitrate sensor shows that concentration peaks are observed relating to high flow conditions and high content of the mineral nitrogen in soil. The risk of nitrate pollution is greatest when levels of available nitrate in the soil profile (especially in the soil surface) are high, and coincide with other circumstances which add to the vulnerability of underlying or adjacent waters to diffuse pollution.
2. Extreme weather conditions in summer and winter, due to the climate change in the future, might increase the nutrient concentration in agricultural run-off and role of diffuse pollution

Additionally, high risk of transboundary pollution flows is identified for Daugava and Lielupe river bassins.

Investment schemes are working successfully; wastewater treatment has been improved significantly. As a result of more efficient accounting and water saving, the total amount of wastewater has decreased two times, proportion of untreated wastewater has decreased by 5% from total amount, but pollution caused by urban wastewater has decreased more than two times. To encourage water management, investment projects are launched and implemented in several populated areas in Latvia.

River basin management plans in Latvia has recommendatory status since plans are approved by Minister of Environment and Regional Development.

E.6: The existence of machine pools to service farms with field spreading of manure

2 companies "ArAgro" Ltd and "Otaņķu dzirnavnieks" Ltd are offering the service to the farms with field spreading slurry manure.

"ArAgro" Ltd is located in Dobeles novads (Zemgale region, Central part Latvia) and SIA "Otaņķu dzirnavnieks" is located in Liepajas novads (Kurzeme region, West part Latvia). Total amount of slurry spread by both companies is 700,000 m^3 per year.

E.7: The possible existence of ammonia emission reduction measures to implement the National Emissions Ceilings Directive

There are no ammonia emission reduction measures defined by law in Latvia.

A right now in agriculture sector apply Cabinet Regulations Nr.829 about "Particular requirements for polluting activities in animal housing" and Nr. 834 about "PROVISIONS nominal value of water and soil protection agricultural pollution caused by nitrates".

However, Institute of Agricultural Resources and Economics and Latvia University of Agriculture are implementing research "Ammonia Emissions Limitation and Reduction Measures Substantiation in the Agriculture and the Assessment of the Effectiveness (Amonjaka emisiju ierobežošanas un samazināšanas pasākumu izvēles pamatojums lauksaimniecībā un to efektivitātes novērtējums)" and in 2017 will take place evaluation of measures and consultations with farmers' organizations as well as farmers surveys.

E.8: The number of agricultural biogas plants

In Latvia, there are 51 agricultural biogas plants. Data about amount of fermentation residues/digestates from biogas plants does not exist.

E.9: Number of cattle farms > 150 dairy cows, and the average size of them in terms of number of dairy cows

According to the Agriculture Data Centre Republic of Latvia given information by 01.12.2016.:

- A number of cattle farms > 150 dairy cows is 127
- Average size of them is 331 cows.

E.10: References

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- The study "Development of Agricultural Sector GHG Emissions Calculation Methodology and Data Analysis with Modelling Tool, by Integrating the Climate Changes" Agreement No. 2014/94.
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Annex F – Market information for Lithuania

F.1: The share of livestock manure being produced in the form of slurry or other liquid manure

There is no statistics about manure produced in Lithuania, neither about types of produced manure, wherefore this is estimated on basis of animal statistics and information from fertiliser planning.

Table 30: Information about Lithuanian cattle number and their manure production.

No of farms	7,852	263
Size of farms (cows)	6-100	<100
Animal number in farm	282,000	148,000
No of cows	141,000	74,000
Manure produced (t):		
Solid manure, ton	5,051,466	
Slurry, ton	3,028,680	
Liquid manure, ton		6211560

Some of the farms having 100 cows have liquid manure as well, but mostly in this category manure produced is either solid or solid and slurry.

Farms with more than 100 cows produces in general slurry, but some of farms have solid manure storage system.

Table 31: Information about Lithuanian pig number and their manure production.

No of farms	420	67
Size of farms (pigs)	11-500	>500
Animal number	13,700	535,000
Solid manure, ton	18,068	

Slurry, ton	8,056	1,759,080
Liquid	-	-

In farms with a few animals for example, 1-5 cows (42,000 holders) and up to 10 pigs (14,000 holders), 2,555,000 tonnes of solid manure and 1,520,000 tonnes of slurry might by produced. Small-scale animal holders are not obligated to build a manure storage for proper manure storage and use.

The total livestock liquid manure/slurry production in Lithuania is estimated to be 8 million ton per year, whereof 30%, or 2.4 million ton per year is feasible for slurry acidification.

F.2: The number of facilities for intensive rearing of poultry and pigs according the Industrial Emissions and as well for cattle, and those who produce slurry

Presently, there are 42 poultry and 39 pig farms having TIPK (Integrated Prevention and Pollution Control) permissions, which refers to the Industrial Emissions Directive.

F.3: The role (at present or envisaged) of ammonia emissions in the administrative practices concerning environmental permitting according the IED

Lithuania follows the minimum provisions of the IED for minimising of ammonia emissions. The main measures taken comprise building of new manure stores, covering of old manure stores, manure incorporation into the soil within 24 hours after application, manure/slurry processing in biogas plants, and installation of modern manure processing technology.

F.4: The designation of areas that are specially sensitivity to pollution according the Nitrates Directive and the Habitats Directive?

The entire territory of Lithuania is designated as nitrogen vulnerable zone.

In Lithuania, there are 181,690 ha (21%) of land and 542,689 ha of forests (65.6%) belonging to the Natura 2000 areas which is 13% of the territory of Lithuania.

Regulations related to Nitrates and Habitats directives are:

- „Special conditions for land and forest use". 1992 05 12 No. 343
- „Inventory of environmental requirements of manure and slurry handling" No D1-367/3D-342, last edition 2011 m. 09 26 Nr. D1-735/3D-700
- „Determination of rules for protection and buffer zones of surface waters, 2001 11 07 Nr. 540
- "Implementation rules of measurement „Payments related to Natura 2000 and Water Directive" of Lithuanian Rural Development Programme 2014-2020"
- Inventory of requirements for Good Agrarian Practices and Environmental Conditions 2014 12 05 Nr. 3D-932
- Law of Protected Areas in Respublic of Lithuania, 1993 m. 11 09 d. No. I-301, changes 2001 12 04 Nr. IX-628
- Confirmation of Inventory for Agricultural activity management requirements, requirements for fertilisers and plant protection products usage and appointment of manage institutions. 2008 01 16 No. 3D-23.

There are several obligatory requirements for farmers:

- Max. fertilization 170 kg/ha Nitrogen with the manure;
- Building up the manure storages if there are 100 animal unit in the farm.
- Liquid manure storages should be covered;
- Solid manure heaps without manure storages – 10-100 animal units;
- Manure storage volume – min. 6 month.
- Fertilising plans for farms, where 30 ha or more fertilized with the manure.
- Max 80 kg/ha of Nitrogen (N) and 15 kg/ha of Phosphorus (P) in water protection zones.
- No fertilisers/pesticides in the water buffer zones.
- No fertilization with mineral and organic fertiliser within 15 November – 1 April.
- No fertilization with manure within 07 15 -08 01, except: grassland, maize, black soil for winter crops.

Requirements for farming practices concerning the Habitats Directive (depends on specific area):

- Forbidden to plough pastures and meadows or reseed, or plant with the forest;
- Forbidden to use fertilisers or pesticides in Natura 2000;

- Forbidden to cut trees/bushes between a April and 1 August.
- Maximally 1 AU per ha
- Late moving.

The above-mentioned requirements in sensitive or polluted areas and the areas covered by Habitats Directive are obligatory for animal husbandry farmers and those who are farming in Natura 2000 territories. The requirements are coupled with direct EU payments.

F.5: The role of nitrogen in water action plans in relation to the Water Framework Directive

In the Execution Plan No. 167 of Governmental Programme, confirmed 13 March 2017 there is a measure No. 7 concerning: "Update and implementation of the Code of Good Agricultural Practices, to reduce the negative impact of agriculture on water bodies, ambient air and climate". Concerning fertiliser use, there is a measure No. 2 in the Programme: "Elaboration of functional soil fertilisation and monitoring system in environmental respect."

In 2014, the average nitrate concentration in ground waters in arable land wells was 12.6 mg/l, in urban areas - 18 mg/l, meadows and pastures - 0.86 mg/l, and in natural areas - 0.54 mg / l.

Only in local areas - generally in urban areas - the nitrate concentration is close to the maximum level which is 50 mg/l and the ammonium concentration of ~ 2.4 mg/l is several times higher than the maximum.

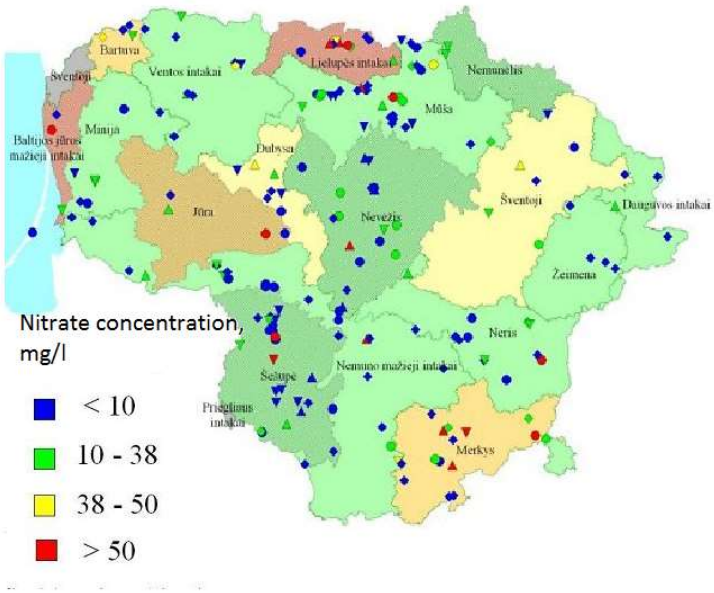


Figure 27: Nitrate concentration in ground water. Map of Lithuanian Geology Service, 2014.

The assessment of 2008 river monitoring sites shows that a high total nitrogen and nitrate concentrations in river water recorded mainly in agricultural areas - the central and northern Lithuania.

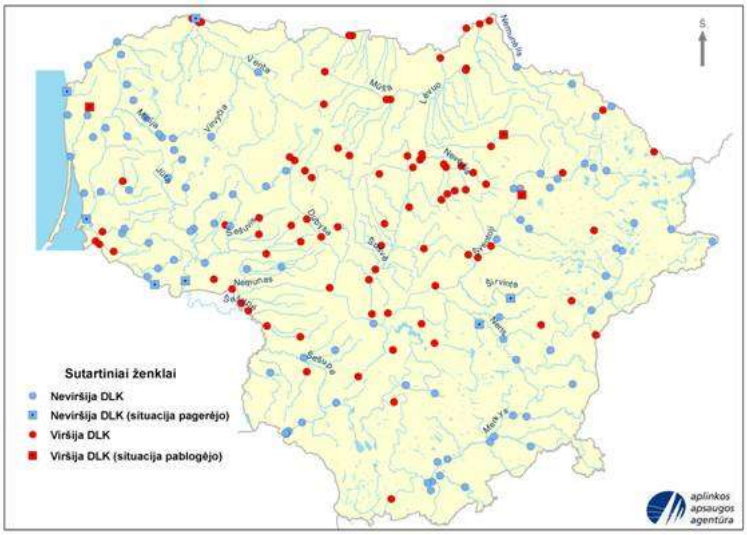


Figure 28: River water quality standards compliance according to total nitrogen, ammonium nitrogen and nitrate, phosphorus, phosphate concentrations in 2008 (Red coloured sites where maximum allowed concentrations overrun at least by one parameter). Source: Environment Protection Agency. 2008.

Measures of the Water Action Plan for 2017-2023 will comprise regulations of the use of mineral fertilisers to prevent nutrients loss from agriculture.

According Country-Allocated Reduction Targets (CART) of HELCOM, Lithuania has the goal to reduce nitrogen emissions to the Baltic Sea with 15.66 Kt.

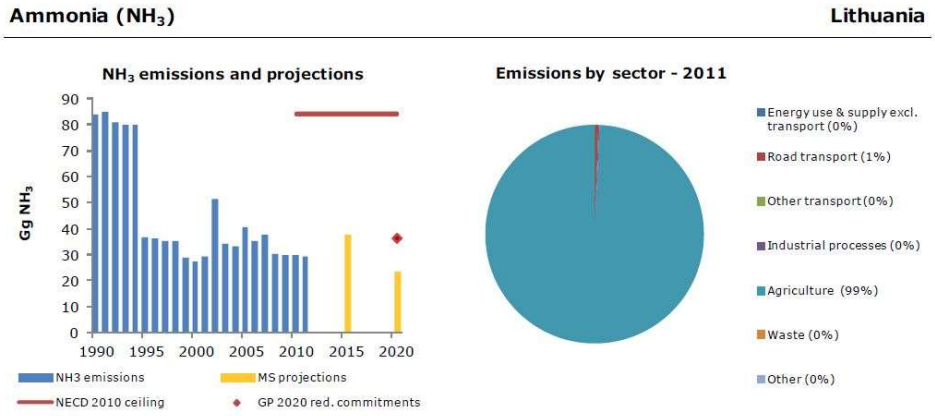
F.6: The existence of machine pools to service farms with field spreading of manure

In Lithuania, agricultural services might be provided by the companies that sells agricultural machinery, but this activity is small-scaled and not specialised.

F.7: The possible existence of ammonia emission reduction measures to implement the National Emissions Ceilings Directive

The vast majority of NH_3 emissions come from the agricultural sector, in connection with activities such as manure storage, slurry spreading,

and the use of synthetic nitrogenous fertilisers. It also contributes to the formation of secondary particles.



Progress towards ceilings	Current and projected progress towards ceilings	Value	Unit	
	2010 NECD emission ceiling for NH_3	84	(Gg)	
	2020 Gothenburg protocol (GP) reduction commitment for NH_3	37*	(Gg)	
	2015 WM projections	38	(Gg)	
	2020 WM projections	23	(Gg)	
		Absolute	**Unit**	**Relative (%)**
	Distance of latest year NH_3 emission data to emission ceiling in 2020	- 7	(Gg)	- 20
	Trend of total NH_3 emissions 1990-2011	- 55	(Gg)	- 65
	Trend of total NH_3 emissions 2001-2011 for comparison with air quality trends	0	(Gg)	- 1

* calculated based on the percentage emission reduction commitment for 2020 expressed relative to 2005 emissions

Figure 29: Information about NH3 emissions in Lithuania.

Efforts for reducing of the ammonia emissions follows the NEC Directive (2016/2284) on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC.

The Action Plan of the Government Programme, confirmed 13 March 2017 includes a measure "To Prepare Air Pollution Management Plan", which aims to implement air pollution measures within 2020-2030. The tasks to reduce air pollution were elaborated in the National Environment Protection Strategy No. XII-1626 (chapters 50-54) and adopted by Lithuanian Seimas on 16 April 2015.

In the Action Plan No 167 of the Governmental Programme confirmed 13 March 2017 there is a measure No 10: "To promote and support measures to reduce ambient air pollution with ammonia", using Rural Development Programme funds for the period 2014-2020.

F.8: The number of agricultural biogas plants

Currently, there are 8 biogas plants using manure and slurry as influents. Another 4 biogas plans are currently being planned.

F.9: Number of cattle farms > 150 dairy cows, and the average size of them in terms of number of dairy cows

There are 150 farms with more than 150 cows in Lithuania. According to the statistics there are 283,800 cows and 46,400 cow holders in Lithuania. The average herd consists of 6 cows. The number of cows according to the herd size is seen in the following figure.

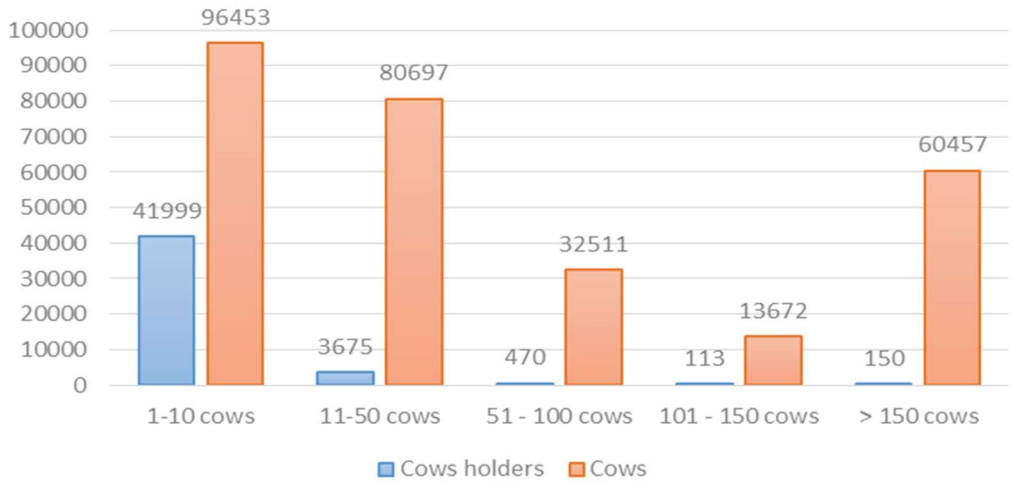


Figure 30: Number of cattle herds and cows in Lithuania.

F.10: References

- Agricultural Information and Rural Business Centre https://www.vic.lt/?mid=108
- Calculations of LAAS Fertilisation Planning Programme
- Information of Lithuanian Pig Breeders Association
- Information of De Laval representatives
- Information from Environmental Impact Assessment and Pollution Prevention Division, Ministry of Environment.

Annex G – Market information for Poland

G.1: The share of livestock manure being produced in the form of slurry or other liquid manure

In accordance with the Poland's Central Statistical Office (GUS) Poland has 1404,9 thousand farm holdings whereof 797,9 thousand with livestock. It constitutes about 59% of total number of farms. The table shows the numbers of most important types of animals.

Table 32: Numbers of most important types of livestock in Poland.

Type of animals	Number * 1,000
Cattle	5,660
Pigs	11,256
Poultry	133,086
Sheep	221.2
Horses	207.01

Table 33: Information about number and production of cattle in Poland in 2014-2015.

Year	Cattle			Milk production (million litres)	Average milk yield/cow (litres)
	Total number x 1,000	Cows	Other		
2014	5,660	2,403	3,257	12,607	5,164
2015	5,762	2,302	3,459	12,859	5,395

There are 356.8 thousand farms with cows in Poland, whereof only 22% has more than 10 cows. Currently 143 thousand farms (average herd of 10 cows) sell their milk as wholesalers. More than 54% of farms keep less than two cows therefore they usually use straw bedding. At the moment, Polish farmers have 7876 cow houses with grate floor.

Table 34: Number of pigs is Poland 2015.

	Number * 1,000
Sows	814.4
Total pigs	10,590.2

There are 441,115 farms with pigsties whereof 12,891 with grate floor and 36,645 with partly grate floor only.

Very popular system with deep bedding in buildings for livestock practised by Polish farmers determinate production of slurry to a considerable degree.

Table 35: Production of slurry and nitrogen by selected types of animals. Based on information from the National Research Institution Of Animal Production (Instytut Zootechniki. Państwowy Instytut Badawczy).

Type of animal	Production of slurry (m^3)	Production of Nitrogen (kg)
Heifer from 6 to 12 months with summer grazing	5.6	17.3
Heifer from 6 to 12 months in building for livestock	7.0	23.1
Cow with summer grtazing	18.5	73.6
Cow staying permanently in cow house	23.2	98.0
Young beef bulls	12.2	48.2
Boars	4.6	3.6
Sows	4.6	4.3
Piglets	1.4	3.0

Table 36: Holdings with manure storage facilities in Poland

Country	Holdings with manure storage facilities	Holdings with storage facilities for solid dung	Holdings with storage facilities for liquid manure	Holdings with storage facilities for slurry tank	Holdings with storage facilities for slurry lagoon
Poland	482,336	339,114	376,693	140,966	16,712

http://ec.europa.eu/eurostat/statistics-explained/index.php/Agri-environmental_indicator_-_manure_storage

Total annual production of manure amounts of approx. 80 million ton, liquid manure approx. 13 million m^3 (LIFE + MANEV PROJECT) and slurry approx. 35 million m^3 (is estimated that 30% can be used for biogas production (Zdzisław Ginalski). The most commonly used liquid manure is cattle slurry.

The amount available for slurry acidification is 13 + 35 = 48 million tons, equal to 60% of the total manure production.

G.2: The number of facilities for intensive rearing of poultry and pigs according the Industrial Emissions and as well for cattle, and those who produce slurry

Thera are 752 facilities for intensive rearing of poultry and pigs (Ministry of Agriculture 2010) in Poland whereof 146 farm run pig breeding (82 farms keep more than 2,000 butcher hogs with weight > 30 kg, 48 farms keep more than 750 sows and 16 farms have mixed pig breeding). The biggest numbers of such facilities are in region of Mazowsze, Zachodniopomorskie, Kujawsko-Pomorskie and Łodzkie. Only the number of IED facilities with slurry manure is relevant and for that matter we can omit poultry.

G.3: The role (at present or envisaged) of ammonia emissions in the administrative practices concerning environmental permitting according the IED

It is duty to every producer who is rearing more than 40000 poultry, 2000 butcher hogs or 750 sows to have integrated environmental permit. This document contains permits for:

- Putting gases and dusts into atmosphere; farmers must obtain an environmental permit and use prescribed BAT's and are obliged not to exceed maximally permitted ammonia emission levels. Conditions concerning the use of BAT's is described in the Environment Protection Law.
- Putting sewage into waters and earth.
- Producing wastes.
- Drawing waters.

Currently, in Poland, integrated permits are given for an unlimited period.

In case of keeping more than 210 AU (on condition that there is no need to have an integrated permit) is obligatory to have permit for putting gases and dusts to atmosphere. Furthermore, for undertakings with 40-210 animals (AU) which are localised on built-up areas is

necessary to have declaration with regard to putting substance to atmosphere.

The need of carry out an integrated permitting is stated by two directives i.e. 1.Dz.U.2002 nr 122 poz.1055 and 2. Dz.U.2010 nr 213 poz.1397

G.4: The designation of areas that are specially sensitivity to pollution according the Nitrates Directive and the Habitats Directive

Currently 4,46% of total Poland's area is recognised as NVZ, i.e. 14,384 km^2.

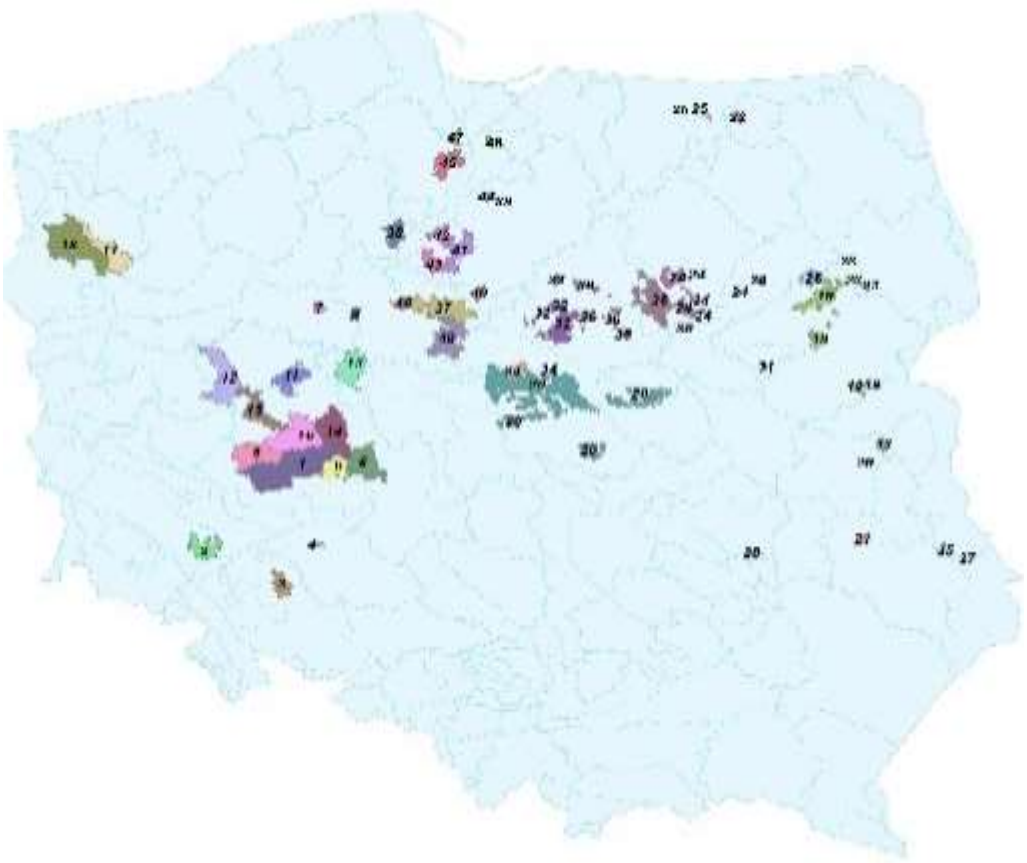


Figure 31: Nitrate Vulnerable Zones in Poland.

Regions with most frequent NVZ in Poland: Wielkopolskie, ŁódzkieKujawsko-Pomorskie, Mazowieckie

In 2014 Court of Justice of the European Union gave its negative opinion about Poland's efforts into establishing sensitive waters and Nitrate Vulnerable Zones. Poland changed its approach to implementing the Nitrates Directive and the special Program of

activities has been worked out. This Program will be implemented throughout the country in 2017. Among most important obligatory rules are activities concerning periods when using fertilisers containing nitrogen is banned, animal fertilisers storage or limited use of fertilisers.

Habitats Directive and Birds Directive:

NATURA 2000 in Poland

There are 983 areas of protection. 145 areas in respect of special protection of birds and 845 areas in respect of special areas for protection of habitats. Some areas coincide with each other.

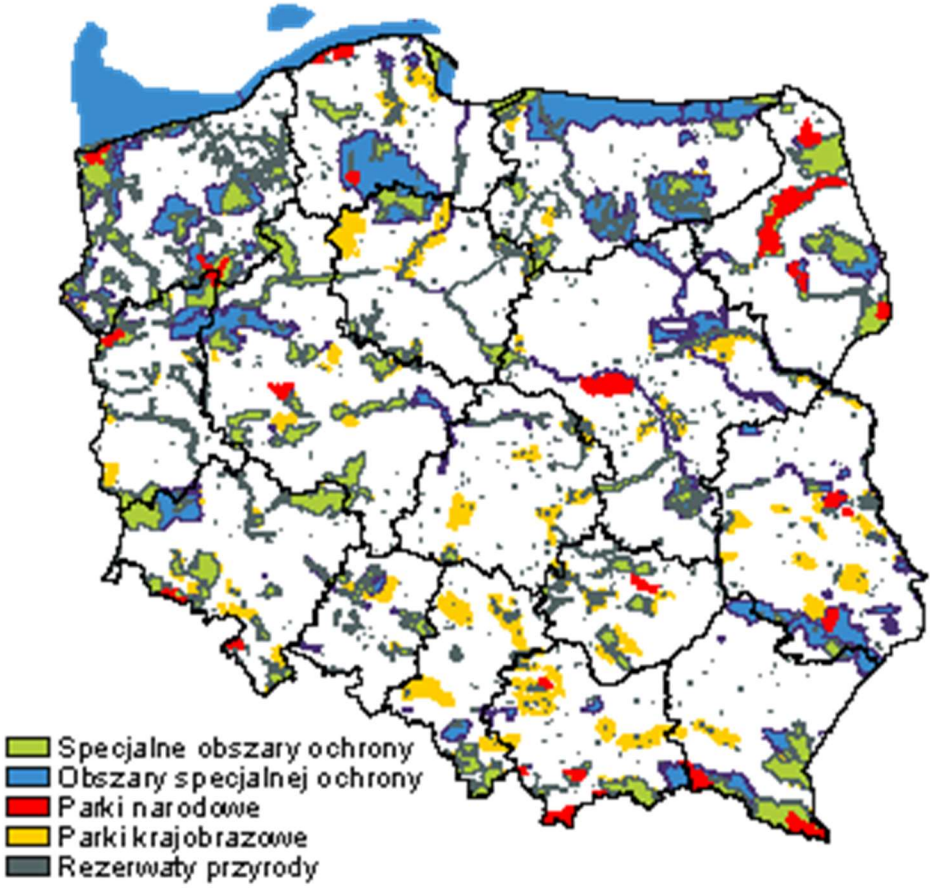


Figure 32: Natura2000 areas in Poland.

In Polish law system of nature protection Natura 2000 is treated as other forms of protection so there are established for them special plans in Poland. The plans determine possibilities and bans on undertaking activities in such zones meanwhile Habitats Directive ensures previous business activities in accordance with proper level of nature protection.

G.5: The role of nitrogen in water action plans in relation to the Water Framework Directive

In Poland, The Water Frame Directive has been transposing from 2001 as the Water Law. Unfortunately, lot of delays and flaws occurred in implementing process. It provoked conflict between the European Commission and Poland. The jury's decision was unfavourable for Poland. However new Program of Action contains:

- limitation of fertilisers applies
- conditions for using fertilisers on frozen or covered with snow soil, wet surfaces, slope areas and plants demand for nitrogen taking into consideration nitrogen being taking up from the soil
- determining proper periods for agricultural use of fertilisers, their doses and techniques of application
- determining periods in which some chosen fertilisers cannot be used
- specification of manure storage conditions
- planned use of nitrogen fertilisers for concrete plant
- list of intensive crops
- conversion rate for livestock unit (AU)
- determining minimal requirements for natural fertilisers storage Surface or capacity
- determining average yearly production of manure produced by individual animas
- calculation of mineral nitrogen fertilisers doses for individual plants
- calculation of manure dose used for 1 ha not exceeding 170 kg of nitrogen as a pure component.

Table 37: Poland's agricultural load of nitrogen to The Baltic Sea (Source: Marek Krysztoforski).

	1,000 tons N	Kg N per person[1)]	Kg N / km^2 [2)]
1995 – 1997	219	5.73	670
2005 - 2007	144	3.77	460

[1)] Number of citizens 38.2 million,
[2)] Total area 313 thousand km^2, 1 km^2 = 100 ha

Poland has according the determined Country-Allocated Reduction Targets (CART) within the HELCOM cooperation a goal to reduce the load to the Baltic Sea with 23.78 Kt per year.

G.6: The existence of machine pools to service farms with field spreading of manure

Machine pools does not exist in Poland.

G.7: The possible existence of ammonia emission reduction measures to implement the National Emissions Ceilings Directive

As a main source of ammonia emission in Poland is agriculture. This sector emits approx. 260 thousand ton of ammonia to atmosphere (approx. 98% of total emission). In accordance to the NEC Directive, Poland is obliged to reduce ammonia emission 1% per year from 2020 to 2029 and 17% in each year after 2030, using 2005 as base year.'

The Polish Government opposes the mentioned ammonia emission ceilings, which they find too ambitious and expensive to comply with. Talks with the European Commission on the issue is ongoing.

G.8: The number of agricultural biogas plants

There are 85 agricultural biogas plants in Poland. Their total productivity is 388 million m^3 of biogas. Poland's potential is much bigger considering its agricultural sector which can deliver substrates to produce 5-6 billion m^3 of biogas. (Zdzislaw Ginalski).

An amount of fermentation residues correspondences more or less with amount of used subtracts. Most popular substrate for biogas production is slurry (57%) and maize-silage (23%).

Table 38: Total amount of substrates for agricultural biogas stations in years 2011-2015 in Poland, 1,000 tons.

	2012	2013	2014	2015
Slurry	349	455	574	598
Secoction from distilleries	146	354	349	439
Maize silage	241	287	416	416
Fruit and vegetable residues	86	268	355	493
Sugar beet pulp	37	101	189	189
Solid manure	23	30	36	45
Digestate	no data	no data	619	1,224

G.9: Number of cattle farms > 150 dairy cows, and the average size of them in terms of number of dairy cows

Table 39: Number of farms with cows x 1,000.

Size of herd	1996	2004	2012
1 – 2	910	487	211
3 – 9	376	184	88.9
10 – 29	20.4	61.2	65.9
30 – 49	0.428	3.71	11
50 – 99	0.589	1.04	2.63
100 and more	0.746	0.572	0.825
100 – 199	0.579	0.325	0.568
200 and more	0.167	0.247	0.257
Total	1309	737	380

The table above shows that there is a relatively small number of cattle farms with more than 100 cows in Poland. During last several years we can observe tendency for increasing herds by farmers but on the other hand this process is rather slow.

According to the National Statistic Office for the year 2015 in Poland there were present total 5,762,400 pieces of cattle. The cows number were 40% of that sum, what means that were present 2,134,100 pieces of cows.

Concerning the herd size from 101 to 200 cows there were 1,377 farms like that. If we take into account the herd size from 301 to 400 cows, there were in Poland 117 farms like that. If we take into consideration the herd size above 400 cows there were 160 farms like that.

577 herds are with more than 150 cows, with an average of 188 cows.

G.10: References

- Agencja Restrukturyzacji i Modernizacji Rolnictwa. http://www.arimr.gov.pl/

- Agencja Rynku Rolnego. http://www.arr.gov.pl/ [Agricultural Market Agency], Reports
- Biogazownie szansa dla rolnictwa i środowiska. Prof.dr hab.Anna Grzybek, Dr Alina Kowalczyk-Juśko
- Bilansowanie składników nawozowych i gospodarowanie nawozami naturalnymi, a ochrona jakości wody. Jan Pietrzak.
- http://ec.europa.eu/eurostat/statistics-explained/index.php/Agri-environmental_indicator_-_manure_storage
- http://stat.gov.pl/obszary-tematyczne/rolnictwo-lesnictwo/rolnictwo/
- Stan hodowli i chowu bydła w Polsce oraz czynniki warunkujące rozwój tego sektora. Zygmunt Litwińczuk, Henryk Grodzki
- Substraty dla biogazowni rolniczych. Zdzisław Ginalski, CDR Radom

Annex H – Market information for Sweden

H.1: The share of livestock manure being produced in the form of slurry or other liquid manure

The number of farms with animals and the total number of animals, at the farms are presented in the following table.

Table 40: Number of farms and animals in Sweden 2013. (Statistics Sweden, 2014)

Animal	Number of farms	Number of animals
Cattle	18,962	1,496,528
Pigs	1,281	1,398,975
Sheep	8,869	576,769
Poultry	5,145	16,620,232

The information on total amount of used animal manure was collected from Statistics Sweden (2014). The figure used for the manure is manure spread during the growing season for the year 2012/13. 79% of all manure was spread as liquid manure. Manure from horses is not included in other animals.

The number of horses in Sweden is estimated to 355,500 animals kept on 76,800 holdings (Statistics Sweden, 2017). 76% of horses and 71% of holdings are situated in urban areas or close to urban areas. Horses annually produce 6-10 tonnes of solid manure, including bedding materials feed and water spillage. Horses produce in total between 2.1 million tonnes to 3.6 million tonnes of manure of which 1.05-1.9 tonnes is collected (unpublished material from Baltic Manure project). As an average, a horse produces 8 tonnes of solid manure per year and 4 tonnes is collected.

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Table 41: The use of animal manures by Swedish agriculture in the growing season 2012 and 2013 (1000 tons).

Animal	Solid	Semisolid	Deep litter	Urine	Liquid	Total
Cattle	2,680	510	790	1,010	19,200	24,190
Pigs	140				2,460	2,750
Other animals						470
Horses	1,422					1,422
Total	4,242	510	790	1,910	21,660	28,832

Thus, approximately 82% of the produced manure is on liquid form.

According to statistic Sweden (2014), 62% of the tanks are filled from below surface and 38% from above the surface. Liquid manure in Sweden is spread using broad cast spreaders - 33%, trailing hoses - 64%, injection - 2%, and 1% other spreading technology.

In total, 102,700 tonnes of total nitrogen (N), 25,900 tonnes of phosphorus (P) and 138,080 tonnes of potassium (K) were applied with manure (excluding horses) to Swedish agricultural soils (Table 42). Of the total amount of nitrogen applied with manure 45,480 tonnes was plant available. Remaining nitrogen was applied as organic nitrogen (Statistics Sweden, 2014).

Table 42: Use of nutrients nitrogen, phosphorus and potassium in mineral fertilisers and animal manure, all crops 2012/13 (Statistics Sweden, 2014)

Nutrient	Mineral fertiliser	Animal manure	Total
Nitrogen	155,330	102,700	258,030
Phosphorus	10,760	25,900	36,660
Potassium	25,140	138,080	163,220

H.2: The number of facilities for intensive rearing of poultry and pigs according the Industrial Emissions and as well for cattle, and those who produce slurry

According to Swedish Pollutant release and transfer register (SEPA), there are

- 160 installations for the intensive rearing of poultry with more than 40,000 places for poultry;
- 109 installations with more than 2,000 places for production pigs (over 30 kg); and
- 14 installations with 750 places for sows.

H.3: The role (at present or envisaged) of ammonia emissions in the administrative practices concerning environmental permitting according the IED

In Sweden, Regions are responsible to deliver the environmental permits according the IED. According to the permits published online (http://www.jordbruksverket.se/amnesomraden/tillsyn/instruktionertillkontrollanterochinspektorer/miljo/iedanlaggningar/tillstandochdomargallandeiedanlaggningar.4.35587698152bda825a15c8f0.html) ammonia emissions related to manure storage is taken into account. Slurry storages must be covered by a fixed or mobile roof. Concerning slurry spreading, the permits focus mainly on reducing leakage and spillage. However, in some cases farms must incorporate slurry within 12 hours after spreading on non-growing plots.

H.4: The designation of areas that are specially sensitivity to pollution according the Nitrates Directive and the Habitats Directive

The Nitrates Directive was implemented into Swedish legislation in 1995. The areas considered nitrate sensitive has since then been extended in 2002, 2003, 2011 and 2014 (Johansson & Bång, 2014). The Nitrate Vulnerable Zones, in grey delimited by a red line are from the 2014 revision. Agricultural land is divided into four areas. Further information is available at SBA website www.jordbruksverket.se.

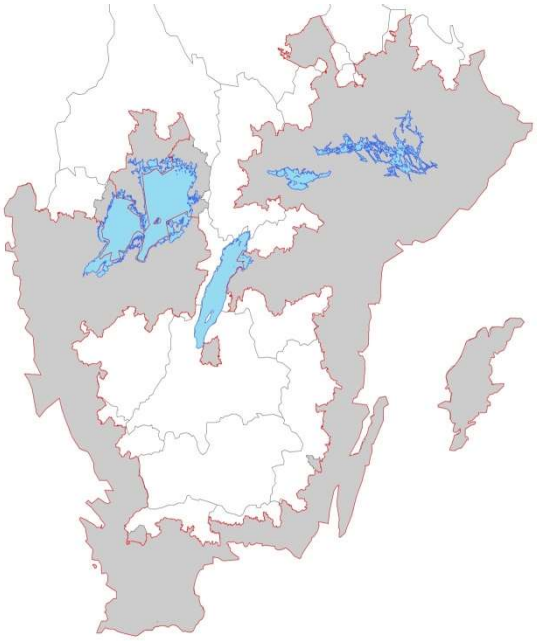

Figure 33: Nitrate Vulnerable Zones in Sweden (SBA, 2017)

1. Nitrate Vulnerable Zones in Skåne, Blekinge and Halland
    - Spreading of P is limited to 22 kg of P per ha spreading areal and year, calculated as an average for a 5-year period. Application of P is calculated as an average for the whole spreading area. Farms with less than 10 animal units (AU) are exempt from this rule if the manure is spread within the farm. If additional organic fertilisers is to be spread than the general rule for P is applied for the extra manure.
    - Nitrogen is not allowed to more than crops can utilise. Maximum total N application is 170 kg per ha and year. To oil seed sown in winter only 60 kg of readily available N is allowed and to other winter sown crops only 40 kg of readily available N is allowed per hectare and year.
    - 1 of August – 31 of October manure and other organic fertilisers are allowed to spread to growing crops or before sowing of winter oil seeds. This applies to soils with clay contents of 15% or less. If manure is spread on soils with clay contents over 15% then manure is allowed to be spread before sowing to other crops apart from winter oil seeds.
    - 1 of October – 31 of October there are restriction concerning solid manure spreading.

- 1 of November – 28 of February spreading of manure and other organic fertilisers are prohibited.
- When manure is spread on soil with no plants, it has to be incorporated into soil, minimum 5 cm depth, within 4 hours after spreading.
- For liquid manure spread to growing crops one of following technologies has to be used; 1) band spreading or similar technology that places the manure directly on soil in the crop canopy 2) shallow injection or similar that places manure directly into the soil 3) technology where the manure is diluted with minimum 50% of water before application and 4) technology where spreading is followed by irrigation with minimum 10 mm of water, starting at latest 4 hours after application and finished within 12 hours after application. Precipitation can be withdrawn from water applied by irrigation.
- Manure is not allowed to be spread on 1) Pasture land if it can harm natural and cultural values, 2) on waterlogged or flooded ground, 3) ground covered in snow or frozen, 4) not closer than 2 m from field edge that borders lakes or water and, 5) if the slope is more than 10% towards a water.

2. Nitrate Vulnerable Zones in rest of Sweden
    - 1 of August – 31 of October spreading of manure and other organic fertilisers are allowed to growing crops or before sowing. The crop to which manure is spread should be a winter crop and cannot be a catch crop.
    - 1 of October – 31 of October there are restriction concerning solid manure spreading.
    - 1 of November – 28 of February spreading of manure and other organic fertilisers are prohibited.
    - Same rules for allowed spreading of N and P as for Nitrate Vulnerable Zones in the counties of Skåne, Blekinge and Halland. Also, the same restriction concerning to what crops you could not spread manure.
    - Spreading of P is limited to 22 kg of P per ha spreading areal and year, calculated as an average for a 5-year period. Application of P is calculated as an average for the whole spreading area. Farms with less than 10 animal units (AU) are exempt from this rule if the manure is spread within the farm. If additional organic fertilisers are to be spread the general rule for P is applied for the extra manure.
3. Outside Nitrate Vulnerable Zones in Skåne, Blekinge and Halland

- 1 of December – 28 of February manure spread is to be incorporated into soil within 12 hours after spreading to a depth of 10 cm.
- Same constraints regarding to what manure isn't allowed to be spread to or on as for sensitive areas in Skåne, Blekinge and Halland.
- Spreading of P is limited to 22 kg of P per ha spreading areal and year, calculated as an average for a 5 year period. Application of P is calculated as an average for the whole spreading area. Farms with less than 10 animal units (AU) are exempt from this rule if the manure is spread within the farm. If additional organic fertilisers is to be spread than the general rule for P is applied for the extra manure.
- Manure spread on open soil is to be incorporated into soil, minimum 5 cm depth, within 4 hours after application.
- For liquid manure spread to growing crops one of following technologies has to be used; 1) band spreading or similar technology that places the manure directly on soil in the plant canopy 2) shallow injection or similar that places manure directly into the soil 3) technology where part of manure is diluted with minimum 50% water before application and 4) technology where spreading is followed by irrigation with minimum 10 mm of water. Starting at latest 4 hours after application and finished within 12 hours after application. Precipitation can be withdrawn from water applied by irrigation

4. Outside Nitrate Vulnerable Zones in rest of Sweden
    - 1 of December – 28 of February manure spread is to be incorporated into soil within 12 hours after spreading to a depth of 10 cm
    - Spreading of P is limited to 22 kg of P per ha spreading areal and year, calculated as an average for a 5-year period. Application of P is calculated as an average for the whole spreading area. Farms with less than 10 animal units (AU) are exempt from this rule if the manure is spread within the farm. If additional organic fertilisers are to be spread than the general rule for P is applied for the extra manure

Manure spread on open soil is to be incorporated into soil, minimum 5 cm depth, within 4 hours after application.

The purpose of the provisions of the Nature and Habitats Directive is to ensure biodiversity through the conservation of naturally occurring habitats as well as the wild flora and fauna in the EU member state

Sweden, the provisions of the directives have been implemented as provisions for area protection under Chapter 7 Environmental Code For water bodies belonging wholly or partly to Natura 2000 areas according to Chapter 7, Section 27 of the Environmental Code shall achieve favourable conservation status. Section 16 and 17 of the Environmental Protection Ordinance contain comprehensive descriptions of what this quality requirement implies. The more specific requirements for achieving favourable conservation status in a Natura 2000 area are evidenced by the conservation plan and or management plan to be established for such areas. Currently there are 4,000 Natura 2000 areas in Sweden covering 6 million hectares.

2,2 M ha of agricultural land is included in the Nitrate Vulnerable Zones in Sweden (Personal Communication, 2017a), which is about 70% of the total agricultural land in Sweden (Statistics Sweden, 2013).

Figure 2: Natura 2000 areas in Sweden, Naturvårdsverket.

The purpose of the provisions of the Nature and Habitats Directive is to ensure biodiversity through the conservation of naturally occurring habitats as well as the wild flora and fauna in EU member states Sweden, the provisions of the directives have been implemented as provisions for area protection under Chapter 7 Environmental Code For water bodies belonging wholly or partly to Natura 2000 areas according to Chapter 7, Section 27 of the Environmental Code shall achieve favourable conservation status. Section 16 and 17 of the Environmental Protection Ordinance contain comprehensive descriptions of what this quality requirement implies. The more specific

requirements for achieving favourable conservation status in a Natura 2000 area are evidenced by the conservation plan and or management plan to be established for such areas. Currently there are 4,000 Natura 2000 areas in Sweden covering 6 million hectares of which 54,185 ha are agricultural land (Personal communication, 2017b)

H.5: The role of nitrogen in water action plans in relation to the Water Framework Directive

The WFD aims to reach a good status in water areas by 2015 or at latest 2027. Sweden is divided into 5 districts under jurisdiction of 5 County Administrative boards within the water districts (vattenmyndigheterna). The Swedish environmental goals were used to implement the WFD, in case of nitrogen the goal of no eutrophication applies. The WFD is a part of the Nitrate directive from 1999. The nitrate directive includes WFD, ground water directive, air and surface directive and climate change

Swedish Board of Agriculture is according to action plan from the water authorities (Vattenmyndigheterna) for the time period 2009-2015 is to develop basis for regulations and other instruments towards areas where there are waters that are in risk for not reaching good ecological and chemical status.

No concrete goals in term reduction of nitrogen emission could be found.

H.6: The existence of machine pools to service farms with field spreading of manure

No statistics concerning the number of machine pools could be found in Sweden. Therefore, based on two online databases grouping the different machine pools, we performed an investigation via the internet but mostly with short telephone interviews.

There are about 100 machine pools in Sweden with at least some agriculture related business. We contacted 25 of them and focused on those who we thought had a slurry spreading service based on the online search. Unfortunately, only 12 machine pools agreed to answer our questions. In average, they are spreading just above 50 thousand tonnes per spreader and year, and they have in average 2.3 spreaders per machine pool. However, there are large differences between them in terms of spread slurry per spreader and year, from 6 to 75 thousand tons.

We estimate that about 3.5 million tons of slurry is spread by thirty machine pools in Sweden. It corresponds to about 15% of the slurry produced per year.

H.7: The possible existence of ammonia emission reduction measures to implement the National Emissions Ceilings Directive

In Sweden, the total ammonia emission in 2013 was 59,379 tonnes (not including international transportation). Ammonia emission from Swedish agriculture was 50,305 tonnes, of which manure management (ventilation, storage and spreading) emitted 32,465 tonnes of ammonia. Liquid manure handling emitted in 2013 about the half, 16,232 tonnes of ammonia (Statistics Sweden, 2017a). In short, Swedish agriculture emits 85% of all ammonia in Sweden and the liquid manure handling part is 27% of Sweden's total ammonia emissions. In the Gothenburg protocol from May 2012, emission reductions were agreed upon using the emission levels of 2005 as base and 2020 as target year. Emission reductions were for ammonia decided to be 15% (SEPA, 2014). Ammonia emissions are a part of Swedish environmental quality objective of no eutrophication. Although the total emissions of nutrients are decreasing, further measures are needed for decreasing the environmental load (miljömål.se).

H.8: The number of agricultural biogas plants

According to the Swedish Energy Agency (2016), there were 40 farm based biogas plants in Sweden in 2015, of which 37 were in use (Table 43), with a total digester volume of 32,367 m^3. The total digester volume in Sweden in 2015 were 676,083 m^3. The farm based biogas plants produced 50 GWh of a total biogas production of total Swedish production of 1,947 GWh. Compared to 2014 the biogas production from farm based digester increased with 14%. On 2015 farm based biogas plant digested (wet weight) 307,233 tonnes of manure, 4,565 tonnes of waste from food industries, 4,235 tonnes of slaughterhouse waste and 4,310 tonnes of other wastes.

Table 43: Number of farmed based biogas plants, amount of manure digested and energy produced.

	2010	2011	2012	2013	2014	2015
Number of plants	9	18	24	38	35	37
Tons manure	63,250	102,050	231,125	347,867	275,204	307,233
GWh produced	16	20	47	77	44	50

The biogas produced (GWh) at farm based biogas plants were utilised in 2015 as follows:

Heat including heat losses ant internal use at plant: 17 GWh

- Produced electricity: 8 GWh
- Upgraded biogas: 13 GWh
- Torched: 1 GWh
- No data available: 10 GWh

Farm based biogas plants produced 314,895 tonnes (wet weight) of digestate. All digestate were used as organic fertiliser spread on farmland.

H.9: Number of cattle farms > 150 dairy cows, and the average size of them in terms of number of dairy cows

Two different databases are presented in this paragraph. The first statistics for Swedish dairy farms and number of dairy cows were collected from Statistics Sweden (2016). The information provided is number of holdings with dairy cows by size of herd in June 2015 and the number of dairy cows by size of herd in June 2015. There were 744 holdings with 100-199 dairy cows and 270 holdings with > 200 dairy cows of totally 4,169 holdings. The total number of dairy cows were 338,169, and about 55% of dairy cows are kept in holdings with more than 100 dairy cows.

The second database dates from 2011. There were 1,749 holdings with more than 150 cattle (dairy cows and other cattle) (SBA, 2012).

Table 44: Number of Swedish holdings with milk production and cattle in June 2011 by size of herd.

Herd size (all cattle)	Number of holdings	Average, dairy cows per holding	Dairy cows	Other cattle	Total
150-199	634	73	46,348	62,585	108,933
200-499	978	130	126,218	160,893	287,111
500-999	118	287	33,887	42,888	76,775
>1000	19	661	12,577	14,234	26,811
Total	5380	64	346,484	447,015	793,499

The dairy cows from holdings with herd size bigger than 200 animals (both dairy and other cattle), represent about 50% of the total dairy herd in Sweden.

H.10: References

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H.11: List of people met

- Phone interviews were done with 25 machine pools in Sweden (Detailed list of persons contacted can be shared if needed, but we would rather prefer to keep it confidential).

Annex I – Market information for Belarus

H.I: The share of livestock manure being produced in the form of slurry or other liquid manure

According to the statistical collection "Agriculture of the Republic of Belarus", the total agricultural area is 85,819.9 thousand ha, including 5,869.1 thousand ha of cultivated land.

There are 1,469 agricultural organizations, and they are responsible for almost all animal production.

The number of livestock and poultry and the produced quantity of manure and litter is shown in the following table.

Table 45: Number of livestock and poultry in Belarus, and their manure production.

Livestock type	Number, thousands of heads	Total manure production, million tonnes per year	Slurry production, million tonnes per year
Cattle, total	4,233.3	64.5	33.0
Dairy cows	1,421.8	25.6	8.0
Pigs	2,751.1	4.8	4.3
Hens	43,144.6	3.1	0.3
Total		72.4	45.6

About 60% of meat cattle and 35% of dairy cows are kept without bedding. They produce annually about 33 million tons of slurry.

About 90% of total pig manure is collected as slurry.

In total, the annual manure production in Belarus is 72.4 million tons, including 45.6 tons slurry. The share of slurry is thus 63%.

I.2: The number of facilities for intensive rearing of poultry and pigs according the Industrial Emissions and as well for cattle, and those who produce slurry

In Belarus, there is no normative document restricting the number of livestock on livestock farms. However, in practice, the livestock

breeding complex is designed on basis of the availability of agricultural land for spreading of manure as fertiliser with up to 170-200 kg of nitrogen per hectare.

The following tables shows the structure of the livestock and poultry farms.

Table 46: Cattle-breeding complexes in Belarus.

Number of head	Number of objects
200	1496
400	1791
600-700	262
700-800	334
800-900	226
1000-1100	48
Total:	**4157**

Table 47: Poultry farms in Belarus.

Number of head	Number of objects
less than 50000	5
less than 100000	4
100000-200000	15
200000-300000	3
400000-500000	3
500000-600000	3
600000-700000	2
>800000	10
Total:	**45**

Table 48: Pig farms in Belarus.

Number of head	Number of objects
less than 5000	4

5000-10000	19
10000-15000	27
15000-20000	25
20000-25000	12
25000-30000	6
>30000	13
Total:	**106**

Table 49: Complexes for fattening of cattle in Belarus.

Number of head	Number of objects
< 2000	19
2000-3000	24
3000-4000	15
4000-5000	17
5000-6000	9
>6000	9
Total:	**93**

Thus, 106 pig farms and 45 poultry farms are according the above information above the size threshold and would need environmental approvals if EU's Industrial Emissions Directive were applied in Belarus.

I.3: The role (at present or envisaged) of ammonia emissions in the administrative practices concerning environmental permitting according the IED

In the Republic of Belarus the legal and institutional forms of protection of atmospheric air from emissions of pollutants are regulated by the Law №2-3 "On protection of atmospheric air" of 16 December 2008.

The decision of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus of 29 May 2009, No. 31 defines the list of polluting substances and categories of objects' impact on the

atmospheric air, which set standards for allowable emissions of pollutants into the air.

In accordance with the list there are not set standards for allowable emissions of pollutants into the air not required permits for their emissions from fur farms, objects for breeding and fattening of cattle with capacity of less than 400 heads, facilities for growing pigs with a capacity of less than 2,000 heads, and for growing birds with a capacity of less than 40,000 places.

The procedure for issue of permissions to emit polluting substances into the air for all businesses, including the livestock industry, is defined by the resolution №664 of Council of Ministers of the Republic of Belarus from 21 May 2009.

The mentioned regulations apply in relation to ammonia, that is included in the list of substances polluting atmospheric air

According to the technical codex of existing practice TKP 17.08.11-2008 (02120) of the Republic of Belarus, ammonia belongs to the fourth class of dangerous pollutants.

An environmental tax of € 60 per ton of ammonia emission is defined by the Tax Code of the Republic of Belarus. However, agricultural manufactures are exempted from ammonia emission taxation in case they use the single tax payment system.

Concludingly, ammonia emissions from Belarus livestock farms is considered, and the farms imposed an excise tax on basis of their emissions, except in cases where they use a single tax payment system.

I.4: The designation of areas that are specially sensitivity to pollution according the Nitrates Directive and the Habitats Directive

The "Republican Centre for Hydrometeorology, radioactive pollution control and environmental monitoring" monitors chemical pollutions of Belarusian lands once in three years using of 108 monitored items.

Data by average content of NO_3 in soils of different regions of Belarus are shown in the following table.

Table 50: Average content of NO_3 in soils in different regions of Belarus.

Region	The number of samples, PCs.	Average content of NO_3 in soil, mg/kg
Brest	15	10,4
Vitsebsk	15	8,5

Homel	4	7,2
Minsk	6	9,3
Mahileu	9	20,8
In Belarus	49	10,9

Received data reveals that concentration of NO_3 in soils in the net of background monitoring is 13.9 times below border permissible concentrations which is 130 mg/kg of soil [GN 2.1.7.12-1-2004 " List of maximum permissible concentrations (MPC) and approximate permissible concentrations (APC) of chemicals in soil"]

It reveals that ecological condition of surveyed soils is successfully for nitrates contents. *No specific nitrogen sensitive areas are designated in Belarus.*

In 1993 the Republic of Belarus ratified the Convention on biological diversity, adopted in 1992 in Rio de Janeiro.

The responsible institution for the implementation of the Convention is the Ministry of Natural Resources and Environmental Protection. The National Academy of Sciences is responsible for the scientific support of the Convention. From 1998 until 2014, there were made five national reports about the progress of the country about Convention provisions.

Natural vegetation in the structure of lands is 64.4% of the territory of Belarus. The most of it belongs to forests (39.5%) and meadows (15.8%). Agricultural lands occupy 28.3% of the territory. *Specially protected natural areas of Belarus covers 1,570 thousand ha (7.6% of the country area).*

43 categories of rare and typical biotypes are included in the list of the important lands for the safety of biological diversity (5 has the national importance and 38 international).

About 30% of kinds of wild animals and wild plants are included in the Red Book[8] of the Republic of Belarus.

About 1,000 passports and protection obligations on these kinds of plants and wild animals are prepared. 102,000 ha of rare and typical biotypes are marked and regimes of protection and using are developed for it.

Now on the national level of Belarus 293 kinds of plant and mushrooms, 17 kinds of wild animals, 71 kinds of birds, 2 types of reptiles, 2 kinds of amphibians and 10 kinds of fishes are protected.

[8] The Red Book of Belarus is the same as the red list of endangered species.

I.5: The role of nitrogen in water action plans in relation to the Water Framework Directive

Monitoring of superficial water on the territory of the Republic of Belarus happens at 300 monitoring places. Regular monitoring is made of 160 water objects, including 86 watercourses (179 monitored places) and 74 ponds (121 monitored places).

Water Codex №149-3 of the Republic of Belarus from 30 April 2014 by Ministry of Water Resources and Environmental Protection of the Republic of Belarus defines indicators for water quality of surface water objects and maximum permissible concentrations of chemicals and other elements in waters of surface water objects. 34 main indicators and ingredients are defined for classifying water quality.

The norms for water quality are:

- Indicators of water quality of surface water objects.
- Maximum permissible concentrations of chemicals and other elements in the water of surface water objects.

Indicators of water quality of surface water objects are defined depending on the category of these objects:

1. Surface water objects which are used for reproduction, gain, wintering, migration of fish kinds of squads salmon and sturgeon.
2. Other surface water objects.

For the first item, there is the Resolution No. 43/42 of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus and the Ministry of Health of the Republic of Belarus from 8 May 2007, "About some questions of regulation of water quality fishery water objects".

For the second item, the normative document is being developed. The draft document PDK nitrite ions NO_2 is 0.08 mg/dm^3.

In 2016, the channelling of sewage to superficial water objects of the Republic of Belarus was lowered to: ammonium nitrogen – 5.12 thousand tons, nitrite nitrogen – 0.14 thousand tones and nitrate nitrogen - 3.26 thousand tons.

The maximum permissible concentrations (MPC) of ammonium, nitrate and nitrite nitrogen in the waters of the rivers of Belarus are in accordance with this 0.39; 9.03 and 0.024 mg N/dm^3.

The main goals and tasks for water protection are shown in the Water Strategy of the Republic of Belarus until 2020. Whereas emission of nitrogen to the environment has been lowered during the last years, there are no official and concrete goal for further reductions. Belarus has the goal to further reduce nitrogen emissions with 1.85 Kt per year

according the current Country-Allocated Reduction Targets (CART), established under HELCOM. However, this is not seen as having connection to ammonia emissions.

I.6: The existence of machine pools to service farms with field spreading of manure

For spreading slurry and other liquid fertilisers in the fields of Belarus, local and imported technics with volume of 6, 11, 16 and 20 m^3 are used for surface spreading, injection and drip-hose spreading.

There are in total 3,500 slurry tankers in Belarus, including 250 with a volume of 16 m^3 or higher, whereas the need for a suitable spreading capacity would be about 7,000 slurry tankers.

There is a republican association, "Belagroservice" who serves agricultural enterprises with supply, repairing and spare parts for agricultural machinery.

No machine pools exist and all field operations are undertaken by each individual agricultural enterprise.

I.7: The possible existence of ammonia emission reduction measures to implement the National Emissions Ceilings Directive

The main measures for reducing of ammonia emissions from livestock production are shown in the technical codex of existing practice TKP 17.08.11-2008 (02120) "Environmental protection and natural resource management. Atmosphere. Emissions of pollutants and greenhouse gases into the atmosphere. Rules for the calculation of emissions from cattle-breeding complexes, fur farms and battery farms".

Methods of reducing of ammonia emissions are considering in house, in fields and in storage.

The maximally permissible air concentration of ammonia in the environment is considered to be 0.2 mg/m^3.

Belarus has regulations comparable to EU National Emissions Ceilings Directive. There are no specific measures taken to reduce ammonia emissions, but ammonia emissions are considered as part of the entire set of regulations for farming.

I.8: The number of agricultural biogas plants

In the agricultural sector of the Republic of Belarus, 9 biogas plants with a total established output effect of 10,700 kWh is in operation. The annual output of digestate is about 1.2 million tons.

I.9: Number of cattle farms > 150 dairy cows, and the average size of them in terms of number of dairy cows

In Belarus, there are 1,496 farms (36% of total count) with 200 heads of dairy cows and 1,791 farms (43% of total count) with 400 heads of dairy cows. The rest farms (21% of all existing) with livestock from 600 to 1,100 dairy cows.

Hence, there is about 4,155 dairy farms with more than 200 cows.

Annex J – Market information for Russia (North-West Federal District of Russia)

5 Russian regions (fully of mostly located within the Baltic Sea drainage area) were included the analysis, as shown here:

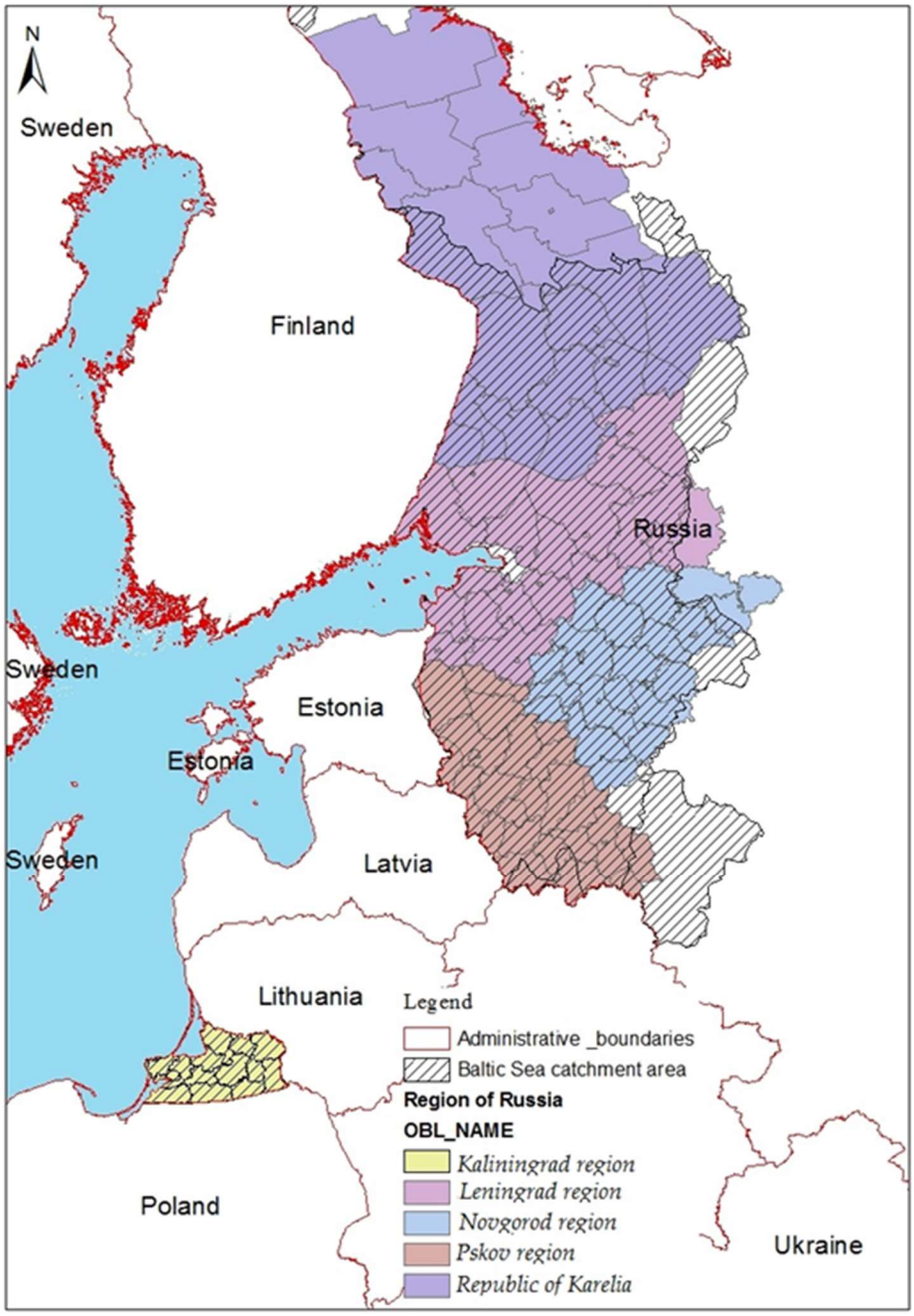


Figure 34: Russian regions located within Baltic Sea catchment area (selection criteria: more than 50% of region's territory belongs to the Baltic Sea catchment).

J.I: The share of livestock manure being produced in the form of slurry or other liquid manure

Table 51: Number of livestock in five Northwest Russian regions.

Region	Livestock population*, thousand heads				
	Cattle		Sheep and Goats	Poultry	Pigs
	Total cattle	Cows			
Republic of Karelia	20	9	0.4	0.1	7.7
Kaliningrad region	77.9	34.8	3.8	2,140.8	170.6
Leningrad region	163.1	71.5	6	29,174.8	178.1
Novgorod region	23.3	11.5	2.1	6,514.8	180.7
Pskov region	61.1	27.9	3.2	1,277	819.7
SUM	**345.4**	**154.7**	**15**	**39,107.1**	**1,356.8**

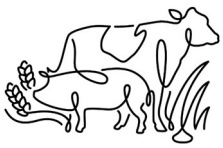
*figures for agricultural enterprises as of 1 December 2016.

About 50-60% of dairy farms in the leading milk producing regions of Northwest have switched to loose-house system without bedding and with milking in milking parlours. Other regions have more number of small and average scale farms with traditional technologies. In these regions slurry share could be 30-40%. So, we consider 55% of cattle manure as slurry.

Table 52: Amount of livestock manure production in North-West Federal District of Russia.[9]

Animal species	Livestock population, thousand heads	Manure, thousand tonnes	Slurry (potentially appropriate for SATs), thousand tonnes	Share of slurry in total manure, %
Cattle, including	345.4	5,928.9	3,255.0	54.9

[9] *Methods, elaborated and tested by IEEP, was used for quantitative assessment of manure production. This methodic is based on national methods for calculation excretions and includes also technical waters, milking parlor effluents and feed residuals.*



Animal species	Livestock population, thousand heads	Manure, thousand tonnes	Slurry (potentially appropriate for SATs), thousand tonnes	Share of slurry in total manure, %
cows	154.7			
Sheep and Goats	15	5.5	-	-
Poultry	39,107.1	1.712.9	-	-
Pigs	1,356.8	4,159.9	4,159.9	100
SUM		11,807.2	7,414.9	62.8

Manure production is defined with account of flock structure:

- Dairy cow manure production is 75.1 kg per day. However following coefficients are used to consider whole flock, including cows, calves, bred heifers, store cattle: tied housing – 97X for dairy cow, loose housing – 109X (X – dairy cows number);
- For sheep and goats– 2.75…3.2 kg per day depending on the housing season duration.
- Poultry: for egg production – 0.13Z+0.12z (Z – mature birds number, z – rearing flocks); broiler poultry – 0.11B for floor housing and 0.09B – cages housing (B – broilers number).
- Pigs: Farrow-to-Finish (full cycle) – 8.4Y, breeding farms – 7.3Y, fattening farms – 10.25Y (Y – total pig number).

The total livestock manure production in the selected 5 Russian regions is approximately 11.8 million tons per year. Slurry manure is estimated to about 7.4 million tons or 62.8% of total manure.

J.2: The number of facilities for intensive rearing of poultry and pigs according the Industrial Emissions and as well for cattle, and those who produce slurry

At the moment proactive efforts for application of the Best available techniques (BAT) requirements for intensive livestock farming in the Russian Federation are taken. BAT reference documents should be developed till the end of 2017 and will come into force from the beginning of 2019. These requirements will be relevant for fattening pig rearing enterprises with stock number more than 2000 pigs and for breeding farms with stock number more than 750 sows, and also for

poultry factories with stock number higher than 40 000 heads. Cattle farms are not covered by BAT system nowadays.

The regions with most intensive rearing of pigs are Pskov, Leningrad, Novgorod and Kaliningrad. There are several large pig producers (3-5) in each region. Each producer usually has a number of pig farms (1-8 or more) located in different areas closer or farther from each other. Each farm is usually more that 2000 pig places and could be considered as large facility for intensive rearing of pigs according the Industrial Emissions Directive. The leader in the development of pig production is a company from Pskov region with the plans to reach 1 million pigs in the coming 1-2 years. Therefore, the volume of slurry feasible for acidification will increase in the future.

The total number of the facilities for intensive rearing of poultry and pigs and as well for cattle in the selected 5 Russian regions is 532 out of which 200 IPPC farms.

J.3: The role (at present or envisaged) of ammonia emissions in the administrative practices concerning environmental permitting according the IED

Ammonia emission is regulated in a similar manner to other air pollutants. *Each agricultural enterprise is obligated to have a permission documentation for emissions of air pollutants (including ammonia), as well as other soil and water pollutants.* The maximum allowable emissions documentation is developed individually for each farm considering local conditions. Overall it is regulated by the environmental legislation of the Russian Federation. It is expected that BAT system application will lead to regulatory tightening.

J.4: The designation of areas that are specially sensitivity to pollution according the Nitrates Directive and the Habitats Directive

Mentioned regulations are not relevant for Russian Federation. However, according to parts 15 and 17 of Article 65 of the Water Code of the Russian Federation, with the aim to protect water resources, special conditions of economic or other activities are set within water protection zones (50 – 200 meters from shoreline depending on water object type and 500 meters for seas) and near-shore protective belts (30 – 200 meters в from shoreline depending on water object type, water usage purposes and slope) of the water objects. In particular, ploughing, grazing and fly camping are prohibited within the boundaries of near-shore protective belts.

Natura 2000 network areas are absent on the Russian part of the Baltic Sea catchment, nevertheless parts of the coastal areas (and also water areas) have been assigned as HELCOM Marine Protected Areas (HELCOM MPAs, see below).

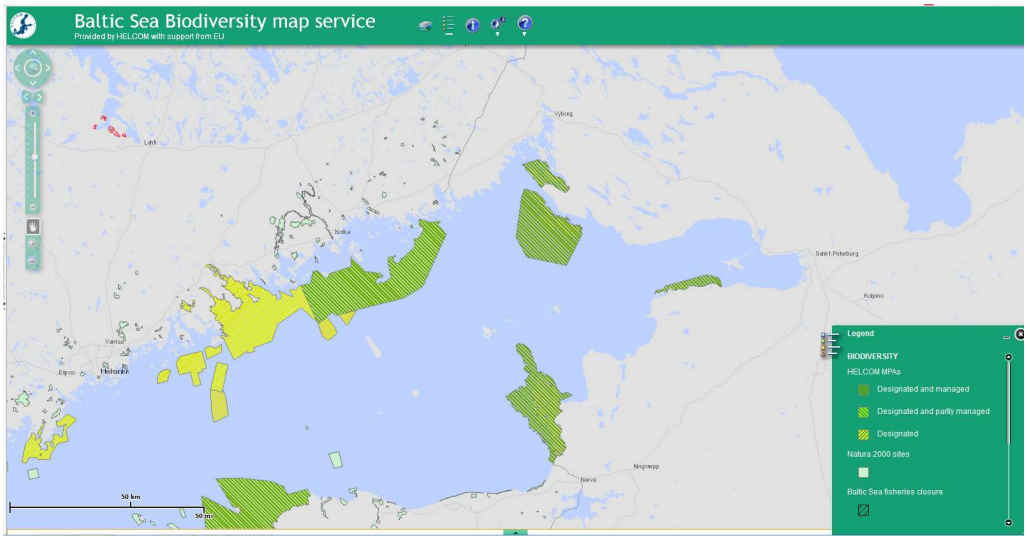


Figure 35: HELCOM Marine Protected Areas near Kaliningrad.

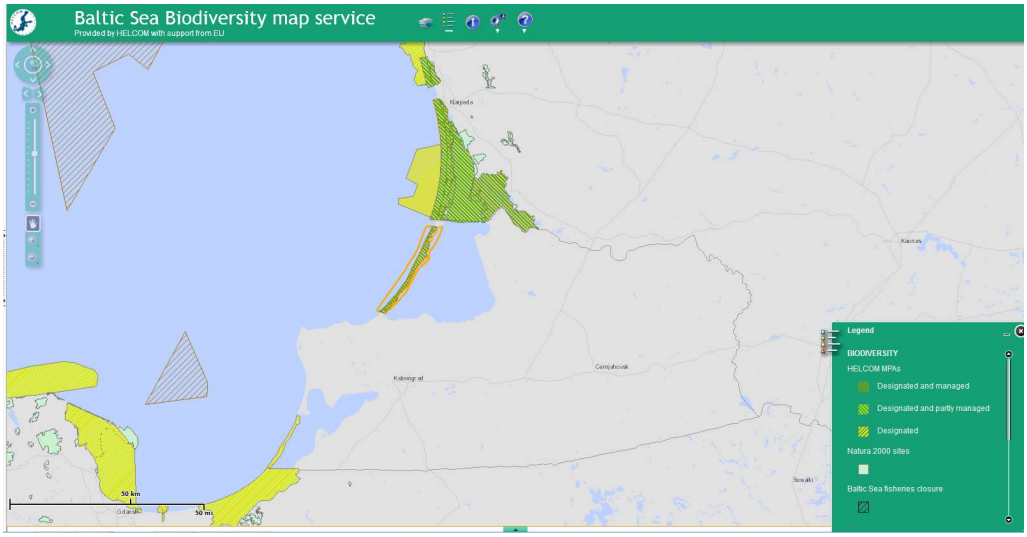


Figure 36: HELCOM Marine Protected Areas in Gulf of Finland.

J.5: The role of nitrogen in water action plans in relation to the Water Framework Directive

Russian Schemes of integrated use and protection of water bodies (SKIOVO), approved for each river basin of the Baltic Sea catchment, are to some extent similar to Action Plans under the Water Framework Directive. Water quality targets and Maximum Allowable Input of Chemical Substances (also for nitrogen compounds) are endorsed as a part of SKIOVO documentation. Maximum Allowable Input of Chemical Substances is used as basis for defining Allowable Discharge Rates for

managed and potentially managed sources (point sources and diffuse sources, whose quantitative and qualitative characteristics can be regulated through technical means nowadays).

Moreover, SKIOVO includes list of measures recommended for water object ecological state improvement.

According to the updated HELCOM country-allocated reduction targets, Russia is obligated to reduce annual nitrogen load up to 10,380 tons from reference level (1997-2003) t/a and by this reach a nutrient ceiling of 76,900 tons of total nitrogen in 2021. Nutrient ceilings can be fulfilled either by reducing waterborne loading or/and atmospheric emissions (including ammonia). *Recent HELCOM assessment shows that current Russian nitrogen water- and airborne input exceeds ceiling by 13,800 tonnes.*

In 2010 the draft Russian national action plan has been developed in accordance with HELCOM Baltic Sea Action Plan. This draft plan comprises measures for improvement urban waste water treatment and manure management handling system. Some of these measures have been included in the SKIOVO documents for Baltic Sea river catchments.

J.6: The existence of machine pools to service farms with field spreading of manure

Due to specific features of the agro-industrial complex development in the region, slurry manure is produced only by large-scale agricultural farm-enterprises which traditionally owns necessary machinery and equipment to transport their own manure, process it and spread it as organic fertiliser. Newly build or reconstructed cattle and pig farms that produce slurry are usually purchasing imported, modern highly productive machinery to transport and spread slurry. An average volume of manure produced by one enterprise is 25-30 thousand cubic meters per year.

J.7: The possible existence of ammonia emission reduction measures to implement the National Emissions Ceilings Directive

Russia has no obligations to reduce ammonia emissions to implement the National Emissions Ceilings Directive (2003/35/EU).

J.8: The number of agricultural biogas plants

Presently, there are no industrial biogas plants in the considered regions of Russia. Biogas production is not economically feasible in the conditions of relatively cheap energy, absence of the state financial support of the biogas technology and without green pricing for electric

energy supply in Russia. There are no examples in the North-West, but we can find a few pilot installations in South of Russia where climate conditions and support of regional authorities allowed to build biogas plants as an experiment.

J.9: Number of cattle farms > 150 dairy cows, and the average size of them in terms of number of dairy cows

The number of cattle farms which could be called large milk producers is more than 500 in the Northwest Federal District. Overwhelming majority of them are > 150 dairy cows.

Table 53: Number of cattle farms with >150 cows in North-West Federal District of Russia. Source: White Book, The Dairy News, 2015.

	Number of dairy farms (agri. enterprises)	Average size (number of cows)
Karelia Republic	16	1,188
Kaliningrad region	38	818
Leningrad region	106	665
Novgorod region	55	220
Pskov region	105	285
Total	320	500

J.10: References

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Interreg Baltic Sea Region

Baltic Slurry Acidification

EUROPEAN REGIONAL DEVELOPMENT FUND

EUROPEAN UNION

www.balticslurry.eu

Summary of the project

'Baltic Slurry Acidification' is an agro-environmental project, co-financed by Interreg Baltic Sea Region under the priority area 'Natural resources' and the specific objective 'Clear waters'. The aim of the project is to reduce nitrogen losses from livestock production by promoting the use of slurry acidification techniques in the Baltic Sea Region and thus to mitigate eutrophication of the waters, including airborne eutrophication.

Summary of the report

The market potential for slurry acidification technologies in Baltic Sea Region countries is analysed on basis of nine parameters. The collected and analysed information about the nine parameters is to a large extent providing imperial knowledge that is not found in official records, and have required subjective estimation by project partners and their network. The report concludes that there is an unlocked potential for slurry acidification technologies in most of the Baltic Sea Region countries.